SUGGESTED ROADMAP FOR TRANSFORMING INDIAN AGRICULTURE

A STRATEGIC PLAN FOR PROMOTING NATURAL FARMING IN INDIA

BY ISHA OUTREACH

Preface

The enormity of the diversity of experience and contribution of farmers in this country has overwhelmed us throughout these years of moving with them at the grassroot level, in many ways. We have seen farmers going through tremendous hardships just so that we can have food on our plate. It is indeed the greatest achievement of our country that our farmers, without proper infrastructure or technology, mostly with traditional knowledge have managed to feed 1.3 billion people.

We as a civilisation, have always revered the five elements that are the basis of our life. Our farmers have always been in tune with the five elements as it's an integral part of their survival. They have always respected nature and its ability to create abundance as well as despair. They have always looked for ways that mimic nature in order to produce food for us. However, with the advent of modern technology, we have managed to change our course for sometime now but at what cost? Is this way of agriculture sustainable?

These are very pertinent questions for our generation. And yet again the answer lies in the farming community of this nation who have silently yet actively shown us the way forward. This document is a collection of all the experience we have had over the past 2 decades which proves that being in tune with nature not only is the only solution, it is the most beneficial one to humanity at large.

This document surely cannot do justice to this vast traditional agricultural knowledge that we have inherited from our ancestors. But it can definitely throw light on the work of these fantastic faceless human beings who have selflessly committed their life towards the cause of sustaining natural resources for our future generations. We present this document with the hope that it will serve in some way, for developing policies and programs that will reflect the above in our agricultural operations.

We express our gratitude to the people who have been with us through thick and thin and given us the privilege of living their failures and successes. We feel that time has come to acknowledge these faceless and nameless farmers with utmost reverence and respect.

We thank MANAGE for giving us the opportunity to present our work.

Anand Ethirajalu
For Isha Outreach

Contents

Executive Summary

Strategic Plan for Promoting Natural Farming In India

The objective of this document is to discuss the strategic framework for promoting natural farming in India. The scope of this document centers around the historical evolution of agriculture in India, emphasizing the shift from traditional practices, characterized by generations of experiential knowledge transfer and innovation, to the more recent phenomenon of chemical-intensive agriculture referred to as the Green Revolution.

Over the past six to seven decades, the Green Revolution has indeed bolstered food production, benefiting both the global and Indian populations at a crucial time when the country was under a food crisis. However, its success has come at a cost, depleting natural resources such as soil, water and air and also human health to alarming levels. This has prompted various initiatives aimed at restoring the balance, including natural farming, organic farming, low external input agriculture, biodynamic farming, and other sustainable practices.

Presently, a movement is underway to transition from chemical-dependent agriculture to sustainable and ecologically conscious farming systems. This shift aligns with the perspectives of organizations such as the FAO and Niti Aayog. The Prime Minister in his speech on 16th Dec 2021 advocated for shifting to natural farming systems.

The objective is to make natural farming, which is currently at best a fringe phenomenon, into a mainstream phenomena. This transition necessitates a strategic plan that involves government participation and organized execution. Capacity building and program implementation are vital aspects, spanning different administrative tiers. These tiers include senior administration at the state and national levels, including bodies such as the Ministry of Agriculture and Farmer Welfare, Agricultural Commissioners, Directors, Joint Directors, and Krishi Sevaks at the district and local levels.

To shape this program, strategic planning must occur at the highest echelons and subsequently cascade down to the state and district levels. Implementation entails several key components, such as leveraging experiences from NGOs, engaging lead farmers and volunteers, fostering awareness among farmers and consumers, facilitating training and exposure visits, and ensuring a smooth transition with support networks like social media, WhatsApp groups and helplines.

Integral to this endeavor is the marketing and certification of produce, a driving force for farmer transition. Aligning economic incentives with environmental stewardship encourages widespread adoption. This shift in agriculture needs to be supported by government schemes and subsidies, with a comprehensive database to track progress.

At a more granular level, data collection is paramount. Parallelly, the existing national database on natural farmers should be updated. States can identify areas with minimal or no chemical usage, and with minimal intervention, declare them as default organic areas, farmers and produce. Certifying these farmers using certification systems and facilitating marketing of their produce will be a huge first step of harvesting low hanging fruits.

In sum, this document outlines a comprehensive approach to transition India's agriculture back to sustainable practices, with the core objectives being strategic planning, capacity building, transitioning farmers and market development. By adopting this multifaceted strategy, India can embark on a trajectory towards a more harmonious and environmentally conscious future in agriculture. This transformation is essential to meet the urgent need for feeding the growing population through sustainable and ecologically responsible farming practices.

India's Agriculture Heritage: Challenges and Opportunities

History Of Indian Agriculture

The history of Indian agriculture dates back to around 9000 BC when early inhabitants domesticated plants and animals and developed cultivation methods. This marked the transition to settled life and the development of tools and techniques for farming. The unique double monsoon system enabled multiple harvests in a year, and over time, advanced land and water management practices emerged. The reverence for nature, considering elements as divine manifestations, led to experiential knowledge transfer across generations.

Water management in India relied on rainfed and glacial rivers, with man-made channels diverting river water to farmlands through tanks and lakes. In rain shadow regions like Tamil Nadu, communities created sacred groves to induce rainfall through evapotranspiration and cloud seeding. Cropping systems were developed to maintain soil moisture in rainfed areas, while the 'Cauvery' river was named after the essential hydrological role of forests along its banks.

Domestication of plants and animals was tailored to local regions and climates, leading to the development of region-specific crops and animals. Observations of wild plants helped develop suitable cropping techniques and tools, resulting in diverse crops over thousands of years. The rich agricultural knowledge was orally transmitted and documented in paintings, carvings, and texts, becoming a cultural legacy. Soil fertility was maintained through practices like using livestock dung and urine, penning livestock in fallow periods, and incorporating tree leaves and forest biomass into the soil and adding tank silt from lakes and ponds. Various composting techniques originated in India which have global significance today. Indigenous strategies like crop rotation, companion planting, and relay cropping preserved soil fertility.

Traditional practices also dealt with uncertainties using predictive tools like 'Panchangams.' The philosophy of conserving and utilizing resources sustained soil fertility for millennia. However, modernization led to the shift towards industrial agriculture, which was characterized by high productivity with the help of excessive tillage, chemical use, and monocropping.

The "Green Revolution" initially boosted production but resulted in declining soil fertility, leading to increasing cultivation costs. This, in turn, contributed to dwindling farm incomes, with many farmers in debt and vulnerable to market and climate risks. The average income for agricultural households is low, driving farmers to cities or even to suicide. The younger generation is leaving agriculture due to economic hardships, resulting in an aging farming population. The intricate traditional knowledge, passed down through generations, is at risk of being lost. If this trend continues, India might face severe food security challenges in the coming decades. (Annexure 1)

Why Act Now?

As organic matter in soil reduces, it in turn brings down the microbial activity in the soil and results in the loss of soil fertility. Farmers will be compelled to abandon their lands. Unless soil fertility is improved by ensuring there is sufficient organic matter to sustain microbial activity, keeping agriculture alive could become an uphill task.

The situation is grim but there is a window of opportunity. If we act now, we can bring our farmers back to their land in the next 10-15 years. The longer we wait, let us say 20–30 years, the more difficult it will be to turn the soil around because thousands of species of organisms, both micro and macro, are going extinct per year. It is time we, as a generation, act with urgency to restore soil health.

Emergence of Sustainable Agriculture Practices

Over the past 7 decades, several individuals and organizations have recognized the need to revive sustainable agricultural practices in India and worldwide. These efforts have been driven by the understanding that traditional methods are not only environmentally friendly but also hold the key to long-term food security and farmer well-being. Some of the individuals who have created a significant impact on the Indian farmers are:

- Sripad Dabolkar advocated sustainable and chemical-free agriculture as 'Nat-Eco Farming'. His tireless commitment inspired communities to embrace ecologically conscious practices, catalyzing a shift from chemical-intensive methods.

- Nammalwar, also called "Nammalwar Ayya," has significantly influenced organic and natural farming in Tamil Nadu. His dedication has empowered farmers to transition from chemical-intensive to sustainable methods, reviving traditional wisdom and protecting the environment.

- Subhash Palekar, a renowned agriculturist, introduced "Zero Budget Natural Farming" in India. His advocacy for sustainable agriculture encourages farmers to use local resources, promoting soil health and reducing cultivation costs.

Not just in India, but internationally, countless individuals like Masanobu Fukuoka, Bill Mollison, Rudolph Stiener among others have brought forth the idea of farming with nature into the minds of farmers across the globe. The High Level Panel of Experts (HLPE) of the UN Food and Agriculture Organization (FAO) also emphasizes the urgency of transforming agriculture systems, underscoring the need for a return to agroecological principles[1].

[1] https://www.fao.org/3/ca5602en/ca5602en.pdf

With the support of these lead farmers and various other scientists who have been inspired by these natural farming stalwarts and their methods, the Indian Prime Minister on Dec 16, 2021 addressed 8 crore farmers in an online session, urging them to embrace "natural farming" techniques for the sake of their own economic benefit as well as the environment. (Annexure 2)

Recognizing this global need for soil conservation, Sadhguru, founder of Isha Foundation, initiated the Save Soil campaign in 2022. This campaign aimed to rally support from 4 billion people worldwide to advocate for national policies to increase organic matter in the agricultural soils. The campaign reached over 3.91 billion people in 100 days[2], paving the way for a worldwide policy change (Annexure 5) and the expansion of soil regeneration programs in Tamil Nadu through Isha Outreach's Save Soil - Thaimann Kakkum Vyavasayam initiative (Annexure 6) and engaging with various policy makers and implementation agencies in the state.

Many other countless non-governmental organizations also have made a significant effort in this direction in the past few decades. In fact, the NGOs have been the frontrunners in implementing these techniques. Their knowledge and experience in this sector is unparalleled.

Above all, innumerable farmers have shown the way forward across the country in terms of ecological and economical benefits that can be reaped out of this system of agriculture. It's time we bring a concerted effort to transform agriculture as our life and wellbeing depends on it.

[2] https://consciousplanet.org/

Transitioning Towards Sustainable Agriculture

We are clearly seeing the effects of industrial agriculture now. The soil health and farmer economy which are the two pillars of agriculture are collapsing. The need for change is apparent to the general public. We know what are the solutions to overcome this challenge. But are the solutions implementable?

Scientific Basis For Sustainable Agriculture

Agroecological approach to agriculture comes from a sound scientific basis which understands the needs of the current and the future generations. Science is not the issue, the implementation is the only issue that we have. The agroecological approach has been scientifically proven worldwide and in India by our own agricultural research institutions. The fundamental natural farming practices (Annexure 8) that we have seen to be effective worldwide are:

1. Minimum Tillage
2. Cover Cropping
3. Mulching
4. Multi-layer Tree-Crop Integration
5. Livestock Integration
6. Composting And Application Of Natural Bio Inputs
7. Biological Pest Management

The CSE Report in 2022, which was drawn from ICAR's research and 89 scientific studies from 2004-2019, compared three farming methods: Organic, Integrated, and Chemical, considering factors like crop yield, costs, returns, soil health, nutrients, and food quality. Organic farming as opposed to natural farming, often displayed higher costs due to the need to buy external inputs, while it showed better returns, improved soil health, increase in microorganisms, and nutrient content in produce compared to integrated and inorganic approaches. This report sheds light on the advantages of organic farming and the need to improve the practices to reap multiple benefits.[3] (Annexure 3)

The ASHA (Alliance for Sustainable & Holistic Agriculture) Report titled 'Ecological agriculture in India: Scientific evidence on positive impacts & successes' compiled by Kavita Kurungati is also a milestone in this regard. (Annexure 4).

Various efforts are being made by the governmental agencies to elevate natural farming to the mainstream. Some of the major ones are listed below:

- States like Andhra Pradesh[4] and Sikkim[5] in India are embracing agroecological approaches, promoting chemical-free and traditional farming methods to reduce

[3] https://www.cseindia.org/evidence-2004-20-on-holistic-benefits-of-organic-and-natural-farming-in-india-11148
[4] https://azimpremjifoundation.org/content/rythu-sadhikara-samstha-ryss-gunturu
[5] https://www.downtoearth.org.in/news/agriculture/organic-trial-57517

external inputs and enhance sustainability. The Tamil Nadu government has recently created an Organic Farming Policy.(Annexure 12)

- Recently NITI Aayog has also recognised the need to transform the agriculture systems of India. It refers to ecological agriculture as simply 'natural farming'. According to NITI Aayog, natural farming is a chemical-free alternative to traditional farming methods. It is considered as an agroecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity. Similar practices with minor variations, are also now promoted by the NITI Aayog under the 'Bharatiya Prakritik Krishi Paddhati' (BPKP) scheme which is part of the Paramparik Krishi Vikas Yojana.[6] This scheme is aimed at promoting traditional indigenous practices which reduce externally purchased inputs.

- The government of India has constituted various divisions under the Department of Agriculture and Farmer Welfare to promote organic and natural farming nationally. Some of them are Paramparagat Krishi Vikas Yojana (PKVY), Rashtriya Krishi Vikas Yojana (RKVY), National Mission on Sustainable Agriculture (NMSA), Organic Value Chain Development for North Eastern Region (OVCDNER) among others.

However, transitioning a large mass of farmers into sustainable agriculture possess multifaceted challenges spanning awareness gaps, dependence on conventional practices, initial investments, knowledge deficits, market access issues, climate variability, reduced immediate yields, policy limitations, resource constraints, sociocultural influences, limited information access, extended transition periods, and the availability of support services.

Overcoming these obstacles necessitates a comprehensive strategy encompassing education, awareness drives, capacity-building initiatives, policy reforms, market development, and strong support networks through collaboration among government bodies, NGOs, agricultural experts, and local communities to foster an enabling environment for the widespread adoption of sustainable agricultural practices.

[6] https://www.niti.gov.in/natural-farming-niti-initiative

Potential Strategy

Transitioning from chemical-dependent agriculture to sustainable and ecologically conscious natural farming requires a well-structured and coordinated strategy. We know that in the realm of propagating sustainable farming practices in India, farmers have emerged as leaders. They have been pivotal in developing innovative farming systems, crafting methodologies, and delivering them to other farmers. NGOs have played a critical role by providing hands-on guidance, troubleshooting issues, and extending diverse forms of support. Therefore, it is essential to acknowledge that Lead Farmers and NGOs hold a significant role in this landscape.

In contrast, governmental bodies like ICAR and other agencies lack comparable resources and experience in this area. Therefore, this approach should fundamentally be based on farmer-to-farmer interactions. Those who have successfully implemented these practices and possess intricate knowledge of the associated techniques, challenges, and potential risks should be the main contributors. Hence, the focus should be on facilitating interactions between experienced farmers. While training Krish Sewaks and government personnel can be valuable, their role should be primarily supportive. In this, the strategies adopted by the Isha Outreach can serve as a foundation.

Therefore, the suggested strategy is to empower lead farmers, facilitate knowledge exchange, provide governmental support, and ensure the widespread awareness of natural farming practices across various administrative tiers of the agriculture departments, as enumerated below:

1. Collection Of Data
   Data collection is crucial for a comprehensive strategy to transition farmers to natural farming on a large scale. It helps understand the current state of sustainable agriculture, identify target areas, customize interventions, allocate resources efficiently, assess impact, adapt strategies, formulate policies, scale up successes, raise awareness, and ensure long-term sustainability. Essentially, data collection forms the foundation for an informed and adaptable approach, empowering decision-makers to guide the transition effectively and make a lasting impact on India's agricultural landscape.

2. Identifying and Categorizing Lead Farmers
   The foundation of the strategy lies in identifying lead farmers who have successfully implemented natural farming practices. This identification process should be carried out at multiple geographical levels, including district-wise and smaller administrative units. Creating a comprehensive official record of these lead farmers, detailing their expertise and accomplishments, is crucial for effective implementation.

3. Awareness Campaigns and Exposure Visits:
   To initiate the transformation, awareness campaigns should be organized at the state, district, and taluk levels. These campaigns will introduce the principles and

benefits of natural farming to a wider audience. Following this, organized visits to the farms of lead farmers should be arranged, allowing interested individuals to witness successful practices firsthand. These visits will foster a sense of confidence and inspiration among potential practitioners.

4. Intensive Training and Skill Development
   After exposure visits, individuals interested in intensive training should be identified. These individuals can be chosen based on their commitment and enthusiasm. Lead farmers can then provide hands-on training to these aspiring natural farmers on their own lands. This practical training approach ensures effective skill transfer and enhances the trainees' confidence in implementing natural farming techniques. Local NGOs can be involved in the process of organizing such training programs.

5. Ongoing Guidance and Support
   To maintain momentum, a range of communication channels should be integrated into the strategy. This includes creating WhatsApp / Telegram groups, setting up call centers for inquiries, organizing review meetings, conducting frequent farm visits, uploading videos on social media and hosting webinars. These methods will facilitate continuous learning, knowledge exchange, and troubleshooting among farmers and experts.

6. Certification and Marketing Support
   The strategy also encompasses the process of acquiring organic certification and promoting product marketing. The government can play a crucial role in aiding transitioning farmers to obtain organic certification. In regions where conventional chemical usage is minimal, such as rainfed agriculture, those can be designated as default organic zones, farmers or produce.

   Currently, there are only a limited number of retailers and wholesalers like Big Basket, catering to natural producers in the market. The government marketing mechanisms for natural produce are also absent. A vital step in expanding the natural farming community initially, is to provide dedicated marketing support. As the number of natural farmers grows, handling the increasing quantity of produce could become a challenge. Therefore, it is essential to proactively create an exclusive market place for natural farmers which are currently present at very few locations across the country.

   Simultaneously, information technology can play a huge role in connecting farmers with their consumers which will be mutually beneficial. Online platforms must be set up for direct marketing of farmer produce to support natural farmers.

   Furthermore, mechanisms should be established, like the creation of cluster Farmer Producer Organizations (FPOs), to aggregate and market their produce, ensuring that the economic benefits of natural farming directly reach the farmers.

7. Governmental Involvement and Subsidies
   Governmental support is essential for successful implementation. Existing programs such as the National Mission for Sustainable Agriculture (NMSA) and state initiatives can be leveraged to provide subsidies to transitioning farmers. Equipment subsidies and drip irrigation support should be prioritized for natural farming practitioners. To further incentivize adoption, financial assistance, particularly during the initial three years of transition, should be envisaged and suitable streams should be developed at the national level.

8. NGO Collaboration for Enriched Strategy
   To enhance the strategy's effectiveness, collaboration with NGOs operating within the state is recommended. A panel of experienced NGOs can be formed to contribute to strategy formulation, troubleshoot challenges, and facilitate capacity-building at various administrative levels. Their expertise and on-ground experience can enrich the government's efforts and ensure a holistic approach to natural farming promotion.

9. Disincentivization of Chemical Intensive Agriculture:
   If we envisage a chemical free agricultural world, disincentivizing chemicals at the national level is of paramount importance. We understand it has to be done in such a way that the impact is not on the food production because of the learning curve involved in the propagation and adoption of sustainable agriculture.

These comprehensive strategies encompass a range of steps to promote natural farming across India. By identifying lead farmers, raising awareness, providing hands-on training, offering ongoing guidance, and collaborating with governmental bodies and NGOs, the strategy aims to drive the transition towards sustainable and ecologically conscious agricultural practices and prosperous farming communities and healthy consumers. Through this collective effort, India can pave the way for a more harmonious and environmentally responsible future in agriculture.

Capacity Building of Project Implementers

For a successful transition to natural farming, a thoughtfully designed capacity-building plan is key. This chapter offers a suggestion on how to empower various stakeholders involved in the project's implementation, ensuring a smooth adoption of natural farming practices across different levels of governance and leadership.

1. State Level Senior Bureaucrats: Advocacy and Integration
   At the state level, we suggest developing a program to promote sustainable agriculture within a specific timeframe. Organize workshops and seminars that shed light on the principles and benefits of natural farming, while highlighting their alignment with existing government policies. By inviting input from individual expert farmers, Lead NGOs, FPOs, and farmer collectives, we can foster collaboration and integrate natural farming seamlessly into ongoing initiatives. The idea is to empower senior bureaucrats to act as advocates and influencers, encouraging policy alignment and widespread adoption.

2. District Level Officers: Local Engagement and Awareness
   District-level officers are instrumental in translating broader state-level objectives into practical actions. To do so, we recommend engaging in focused discussions with various stakeholders, including department officials, lead NGOs, lead farmers, and experts in marketing and certification. These interactions can provide insights into the readiness and understanding of program implementation at local administrative levels. Additionally, consider data collection for a comprehensive database, aiding informed decision-making. By immersing officers in the intricacies of natural farming through field visits, they can better drive localized implementation.

3. Agricultural Officers and Assistant Agricultural Officers: Grassroots Activation
   Empowering agricultural officers and assistants is essential for grassroots mobilization. We suggest crafting a capacity-building plan that equips these individuals with skills to collect relevant data within their jurisdictions. The plan should also encompass the training of Krishi Sewaks—field-level agricultural workers—to align their efforts with state administration objectives. This dual-focused training approach aims to bridge the gap between policy objectives and practical implementation.

4. Community Leaders: Catalyzing Change at the Grassroots
   This section emphasizes nurturing leadership within the farming community to catalyze knowledge dissemination and adoption. Here's what we propose:

   a. Lead Farmers: Consider initiating a mentorship program where experienced farmers share their success stories and best practices. Arrange workshops to facilitate knowledge exchange among peers.

b. Subject Experts: Organize specialized training workshops to enhance subject experts' ability to communicate specific aspects of natural farming to farmers.

c. NGOs and FPOs: Empower these organizations with communication and mobilization skills, enabling them to engage in capacity building, review meetings, and information dissemination within their operational areas.

d. Krishi Sewaks: Provide training to mobilize farmers and consumers for awareness meetings, exposure visits, training programs, and data collection.

5. Consumers:
   The consumer awareness about natural produce needs to be done at state, district and panchayat level. It must be done through all available forms of media. The state officials can organize awareness campaigns and workshops for consumers to understand the significance of having natural produce, educate them about the benefits of chemical-free produce and encourage their active involvement in promoting it.

Through this multi-tiered capacity-building approach, each stakeholder group can acquire the necessary skills, knowledge, and confidence to effectively implement natural farming practices. This strategy not only ensures successful adoption but also establishes a network of support and expertise that strengthens the overall transition process.

Isha Outreach has had a handson experience in working with the Rajasthan government in this direction in 2017 where the state government invited Isha Outreach members to create a comprehensive strategy for natural farming promotion in the state. (Annexure 10)

Role of Isha Outreach in Transitioning Farmers towards Natural Farming

Save Soil is a global movement initiated by Sadhguru, Yogi, mystic and founder of Isha Foundation, a non-profit organization headquartered at the Velliangiri Foothills in Coimbatore, Tamil Nadu. The objective of Save Soil is to drive policy changes towards raising the organic content of soil to a minimum of 3-6% in all countries across the planet.

To bring global attention to the critical issue of soil extinction, Sadhguru undertook an arduous motorcycle journey spanning 30,000 km from London to Coimbatore in 100 days. The movement has reached over 3.91 billion people, making it the world's largest people's movement, and 81 countries have expressed their commitment to regenerate soil. It has also inspired individuals and institutions across the globe to take the necessary steps to reverse soil degradation in agricultural lands.

Isha Outreach has been silently supporting farmers in implementing soil-friendly agricultural practices on the ground for the past two decades under the banner of "Isha Agro Movement (SS-TKV)". SS-TKV has recently been renamed as "Save Soil - Thaaimann Kaakkum Vivasaayam (SS TKV)" for legal and administrative purposes.

Save Soil (SS TKV) is an initiative to transform agriculture in Tamil Nadu. The focus of this movement is on farm economics and agroecology, to address the problem of vanishing farmers and degrading soils by training and handholding farmers on scientific natural farming techniques. The vision of Save Soil is to make natural farming a mainstream phenomenon in the state through a people's movement.

The mission of Save Soil is to create service platforms for farmer-to-farmer training, model farm creation, consumer awareness campaigns and agri-marketing services. It also focuses on enhancing farmers' knowledge about crop techniques and helping them to increase productivity. This is done through one-to-many and one-on-one programs such as training courses, farm schools, on-farm trials, farmer group review meetings, farm visits to individual practicing farmers, and consultation through WhatsApp and other social media platforms as well as support helplines. The goal is to create model farmers in every district of Tamil Nadu who can demonstrate to other farmers that regenerative agriculture is both profitable and sustainable for them as well as beneficial for the consumers' health and wellbeing.

Save Soil embraces traditional as well as modern methods that are suitable in today's context and farmer conditions. Keeping in mind the farming traditions, it introduces appropriate technology to reduce the farmers' costs and increase yields while regenerating the soil for future generations.

We invite organizations to participate in this on-ground implementation project that has the potential to reverse soil degradation in India in the coming decade. As Sadhguru says, this is a generational responsibility. Let us make it happen.
(Annexure 5, Annexure 6 & Annexure 7)

Isha Outreach

Isha Package of Practices of Major Crops Grown in Tamil Nadu

Agriculture is region specific, farm specific and farmer specific. On this basis, Isha Outreach has developed a deep sense of understanding about the farming conditions in which the farmers operate in this country. We have been working with lead farmers to develop a package of practices (Annexure 10) that addresses the crop cultivation requirement for various major crops grown in Tamil Nadu. Due to the constraint of time, these PoPs were prepared based on our field team's expertise and our own farming experience. These can be improved further to include the different practices adopted by farmers in different regions and climates.

In this document, we have presented the package of practices of major crops cultivated in terms of geographical area in Tamil Nadu. The area under cultivation of these major crops as estimated by various sources from time to time is approximately 70% as under:

Tamil Nadu Major Crops Area And Production

Sn	Major Crops	Area In ha	Data Source
A	Total Foodgrain Area In Tamil Nadu (a)	6,155,731	Tamil Nadu Government Portal, Statistical Handbook On Agriculture
B	Total Of The Major Crops (b)	4,287,841	
i	Cereals	2,909,282	
a	Paddy	2,036,239	Tamil Nadu Government Portal, Statistical Handbook On Agriculture
b	Maize	400,210	
c	Sorghum	405,425	
d	Bajra	67,408	
ii	Pulses	562,755	
a	Black Gram	402,196	
b	Green Gram	160,559	
iii	Vegetables	174,000	
a	Tomato	44,000	The Hindu
b	Small Onion	51,000	TNAU
c	Ladies Fingers	25,000	Covai Mail
d	Chili	54,000	TNAU
iv	Other Crops	641,804	0
a	Groundnut	409,027	Tamil Nadu Government

SAVE SOIL

b	Sugarcane	127,696	Portal, Statistical Handbook On Agriculture
c	Banana	101,000	TNAU
d	Turmeric	4,081	The Hindu
Main Crops as % of Total Foodgrain Area (b/a)		69.66%	

This package of practices has been developed based on farmer experience and on field trials conducted in various locations. In addition to the package of practices, Isha Outreach also trains farmers into livestock management particularly of the native cows which plays an important role in the process of transitioning from chemical based systems. The native cows are important as they have more resilient biological properties in their waste. The cow dung and urine are an important component of many on-farm inputs like Jeevamrutam, Beejamrutam, Ghana Jeevamrutham, Panchagavya etc. In addition, milk also becomes a nutrition and an income source for the farmer. (Annexure 13)

But in the past few decades, due to the introduction of hybrid breeds, we have reduced our pure breed population significantly. Therefore, the focus on the native livestock becomes critical in the context of transitioning a large number of farmers to natural farming. Thus, one of the flagship training programs under Isha Outreach is Natural Input Preparation. Other training programs include honey bee cultivation, pest and disease management, weed management, Urban Terrace Gardening, Cow Products Training and Value Addition Trainings which support the transitioning farmers. (See Annexure 7 : Isha Outreach Farmer Trainings Structure for details)

Conclusion

The major difference between the approaches adopted earlier by us as a nation is that we thought agriculture is a technique of just producing food and that can be tweaked with technology. Indeed technology that we adopted boosted the growth but it came at the cost of our soil health which is the real wealth we leave behind for our future generations. Science and technology must benefit humanity as a whole, not just one generation. It must be an all inclusive process.

Modern agriculture needs to look at the diversity of agricultural practices and processes, the diversity in the form of species of crops that were grown, the many years of accumulated knowledge, the innovation and adaptation capabilities of farmers in this country while we pursue the larger requirement of producing enough food for the nation. Even though there is enough scientific study that has proved that regenerative agriculture methods have been able to produce desired results in terms of yield equal to or more than chemical based agriculture systems, there has been a broad lack of awareness of these aspects which needs to be resolved in order to bring people from all strata of the society to make into a people's movement rather than being a fringe phenomenon.
We need to see beyond our short-term goals and be willing to explore and discover the principles under which nature functions in a more deeper sense. This will bring inclusiveness among the policy makers, bureaucrats, scientific community and non-governmental organizations for the benefit of our farmers and consumers as a whole.

Echoing the theme of India's G20 Presidency 2023, it's about One Earth, One Family and One Future. Let us make it happen.

Annexures

Annexure 1: How soil fertility was maintained for thousands of years in India

R. Ethirajalu

Agriculture in the Indian subcontinent began by 9000 BC by domestication of wild plants and animals and developing cultivation methods, imitating their natural environment. Settled life soon followed with implements and techniques being developed for agriculture. Double monsoons led to multiple harvests being reaped in one year. Over time, land and water management reached a new level of sophistication. Plants and animals, considered essential to our survival, came to be worshiped. Our ancestors considered the five elements as manifestations of the divine and there was a culture of reverence towards them. By observing and imitating the natural environment, they experientially knew how to keep the fertility of the soil intact and passed down the knowledge for the coming generations.

Water

In India, rainfed and glacial rivers have been the major sources of water for irrigation apart from monsoons. Generally, the river water was diverted by using man made channels to the farmland by filling manmade tanks and lakes on the way and draining the water back to the river.

Tamil Nadu is a rain shadow land. In areas where there is no river nearby, they created sacred groves which through evapotranspiration, and seeding the clouds, induced rainfall apart from the monsoon rain. Creating an intricate network of lakes and ponds captured this tree-induced inland rainfall and it was used for agriculture and other purposes. In rainfed areas, they developed cropping systems based on the rainfall patterns. These cropping systems were such that it maintained soil moisture throughout the cropping period.

In Tamil language, 'Ca' means forest and 'Viri' means a big forest. This name was given to the river 'Caviri' because they have understood that the forest on the banks creates the necessary hydrological conditions that makes the river flow throughout the year.

Plants & Animal Integration

Depending upon the region and climate they were in, they domesticated plants and animals and used it for crop cultivation and animal husbandry. Thus, developing region specific crops and animals. Initially, by observing the wild plants in nature, they developed appropriate cropping techniques using tools and equipment and the draught power of the animals.

World's oldest known plowed field has been found in India. The innumerable variety of crops and livestock was developed based on the soil type, water availability, seasons and climate over thousands of years. For example, there were 200,000 varieties of paddy developed by erstwhile farmers mainly through a process of selection and observation.

Culture

Throughout these 11,000 years, our ancestors have been passing down the acquired knowledge orally and documenting it in cave paintings, rock carvings and other means available to them. We also have many recordings and teachings about agricultural practices in our ancient texts. The innumerable varieties of edible plants and useful animals and their methods of cultivation have come from the wisdom of the community which is supported by their skill of observation.

Our forefathers were reverential towards all things which were essential for the sustenance of their lives and the coming generations. This was transmitted through every generation and it became a culture. Agriculture in India until recently attracted the best minds as there was a pride in doing it.

Maintaining Soil Fertility

For maintaining soil fertility, our ancestors made use of livestock dung and urine which improved the biological property of the soil. Penning livestock in crop lands during fallow periods is a common practice in India even today, which supports the soil fertility. They grew trees around the farm and periodically pruned the leaves and incorporated them into the soil. They also harvested the leaves and branches from the surrounding forests. They transferred the silt from the tanks, lakes and dams to the agricultural fields improving the physical property of the soil. They developed the art of composting which is equivalent to creating a fertile soil by using the biomass and dung and urine. This art of composting was first developed in India and it is now practiced throughout the world. They used cultivation techniques like crop rotation, companion planting, and relay cropping maintaining soil fertility.

Dealing With Uncertainties

They created 'Panchangams' which were used in agriculture for predicting floods and droughts. This has been made as an almanac for every year and was also used for agricultural activities like sowing, crop maintenance, harvesting etc.

In this way, with an attitude of conserve and use and a continuance of the practices in the best possible way, we have been able to sustain the soil fertility for thousands of years. But with the advent of the modern age, we decided to transform our traditional agricultural processes into industrial agriculture. Excessive tillage using heavy machinery, excessive use of chemical fertilizers and pesticides, intensive irrigation and low crop diversity have caused the soil fertility to decline at an alarming rate. Plowed soil releases high levels of carbon dioxide and other greenhouse gasses into the atmosphere which are responsible for global warming. Using chemical fertilizers and pesticides depletes the soil of its organic content and biodiversity. We adopted the modern methods of production using chemical fertilizers and pesticides, heavy machinery and large scale monocropping systems to feed our growing populations. This surely increased the production and fed a billion people at one but it has completely ruined our farmer's condition. The 'Green Revolution' that once fed the country has now run its course.

Over the 30-year period from 1990, the cost of crop cultivation in India increased at a faster rate than the increase in the value of the output. This has led to dwindling farm incomes. The average income for agricultural households from cultivation is just Rs.90/day for a family of five.

The main reason for this sharp decline in incomes is the depletion of soil fertility. The minimum organic matter in agricultural soil must be 3-6% to keep the soil fertile. But 62% of India's agricultural soil has less than 0.5% organic matter. When the soil is so severely depleted, farmers are struggling to grow and profit from any crop and hence, nearly 52% of the farm households in India are in debt. This problem is compounded by climate risks and market risks which make the farming community the most vulnerable community in the country.

When farmers cannot pay the debt, either they migrate to cities for employment or they are forced to sell their land and become landless laborers. The landless laborer's population has increased by over 400% in the last 50 years. In fear of becoming landless, nearly 1 farmer commits suicide every hour in India leaving 4-5 members of his family in acute suffering for the rest of their life.

In this condition, there is no pride left in farming. Hardly 2-3% of the farmers want their children to get into agriculture. Most of their children migrate to cities for employment leaving behind only the older generation on farmlands. The average age of Indian farmers has gone up to 50. These farmers have the agricultural skills that we, as a civilization, have acquired over many millennia.

This intrinsic knowledge that our farmers have cannot be passed down through academic training or social media. It is transmitted from generation to generation. But the next generation of farmers are vanishing from our villages. If the status quo remains, in the next 2-3 decades, when this generation of farmers passes, and the thread of traditional knowledge is lost, there will be very few people left to grow food for this nation.

Annexure 2: PM Narendra Modi's address to 8 Crore farmers at the National Conclave of Natural Farming on 16 Dec 2021

Honorable Prime Minister Shri Narendra Modi: We have seen very closely how the growth and direction of farming took place for several decades after independence. Next 25 years journey is to adapt our agriculture according to new requirements and new challenges. Steps taken in the last 6-7 years from seeds to markets to increase the farmers' income: soil testing, preparing hundreds of new seeds, fixing MSP at 1.5 times the cost of production, a strong network of irrigation, Kisan Rails.

Along with agriculture, farmers are constantly being connected with many allied sources of income like animal husbandry, beekeeping, fisheries, solar energy and biofuels. A provision of lakhs of crores of Rupees has been made to strengthen storage, cold chain and food processing in villages. All these efforts are providing resources to the farmers, giving them choices. But some significant questions & challenges lie before us and agriculture world over. What will happen when the soil itself gives in? What will happen when the weather will not support and the water in the womb of Mother Earth will be restricted? It is true that chemicals and fertilizers played an important role in the Green Revolution. But it is equally true that the time has come now to work on alternatives. Billions and trillions of rupees have to be spent on importing large quantities of pesticides and chemical fertilizers - thereby increasing the cost of farming, expenditure of the farmer and the day-to-day expenses of the poor. This problem is also related to the health of the farmers and all the countrymen.

There is a proverb in Gujarati - prevention is better than cure. It is the right time to take important steps before the problems related to agriculture become even worse. We have to take our farming out of the lab of chemistry and connect it with the lab of nature, which is completely based on science. The potential, the strength and quality which exists in fertilizer, is also present in nature in abundance. We just have to increase the soil microorganisms, which in turn increases soil fertility. Many experts say that indigenous cows play an important role in this. Experts say that solutions can be prepared with cow dung & cow urine which improves crop growth and also increases soil fertility.

Everything from seed to harvest ? can be treated in a natural way. This farming requires neither expenditure on chemical fertilizer nor on chemical pesticide. It requires less water & can deal with floods & droughts. Whether it is less irrigated land or land with surplus water, natural farming allows farmers to sow many crops in a year. Also, stubble from wheat, paddy, pulses etc. is used properly in this system. That is, low cost, maximum profit. This is what natural farming is all about.

Modern world is moving towards 'back to basics' - connecting with your roots! In our agricultural country, society has developed, nurtured traditions and festivals around agriculture. Is there anything like the food, lifestyle, festivals or traditions of your area, which is not affected by our agriculture or crops? When our civilization has flourished so much with agriculture, then how rich and scientific our knowledge and science must have been regarding agriculture? When the world talks about organic, it talks about nature.

And when there is a mention about back to basics, its roots are seen linked to India. Many scholars related to agriculture are present here who have done research on this subject. You know from time immemorial, extensive research has been carried out on agriculture in our country and it has even found mention in ancient scriptures and in the works of saints. We need not only to re-learn this ancient knowledge of agriculture, but also to sharpen it for modern times - do research afresh, mold ancient knowledge into the modern scientific frame; institutions like our ICAR, Krishi Vigyan Kendras and agricultural universities can play a big role. We do not have to limit the information to research papers and theories only, but we have to convert it into practical success. These institutions can also start this initiative. You can take a pledge that you will take natural farming to more and more farmers. When you will show that it is possible with success, then ordinary human beings will also connect with it as soon as possible.

Also, we need to unlearn wrong practices that have crept into our agriculture. Experts say that by setting fire to the field, the soil loses its fertile capacity. There is a widespread practice of burning crop residues. Despite knowing that clay once heated becomes brick we continue to burn the soil. Similarly, there is an illusion that crop yield will not be good without chemicals, whereas the truth is quite the opposite. Earlier there were no chemicals, but the harvest was good. History of the development of humanity is witness to this. Despite all the challenges, humanity flourished and progressed the fastest in the agricultural age, because natural farming was done and people constantly learned. Today in the industrial age, we have the power of technology, there are resources and we also have information regarding the weather. Now farmers can create a new history. At a time when the world is concerned about global warming, Indian farmers can provide solutions through their traditional knowledge. Together we can do something. Those who will benefit the most from natural farming will be small farmers (with <2 ha. Of land) who constituted about 80% of the farmers of the country. Most of these farmers spend a lot on chemical fertilizers. If they turn to natural farming, their condition will be better. In recent years, thousands of farmers have adopted natural farming. Many of these are start-ups by the youth. They have also benefited from the Paramparagat Krishi Vikas Yojana launched by the Central Government. Under this scheme, training is being given to the farmers and help is being extended to move towards this farming.

The experiences of lakhs of farmers from some states, who have taken to natural farming, are encouraging. We had started efforts on natural farming long back in Gujarat. Now its positive effects are being seen in many parts of Gujarat. Similarly, the attraction towards this farming is increasing rapidly in Himachal Pradesh too. Today, I will urge every state government to come forward to make natural farming a mass movement - we can make efforts to associate at least one village of every panchayat with natural farming. I would like to tell my farmer brothers not to experiment on the entire land. Take a portion of your field and experiment. If you find benefit, then expand it further. In a couple of years, you will slowly cover the entire field. I also urge investors that this is the time to invest heavily in organic and natural farming and in the processing of their products. Not only the country, but the global market is waiting for us. We have to work today for the future possibilities. India has to give the best solution to the world regarding food security and harmony with nature. Let's take a pledge to make Maa Bharati's land free from chemical fertilizers and pesticides and show the world the way to a healthy planet and a healthy life. India can become self-reliant only when its agriculture becomes self-reliant, every farmer becomes self-reliant. And this can happen only when we enrich the soil of Maa Bharati with cow dung, with natural elements instead of unnatural fertilizers and medicines. We will make natural farming a mass movement in the interest of every countryman and in the interest of every living being.

(Translated from this video: https://www.youtube.com/watch?v=dO9-RJTa6xM)

Annexure 3: Summary Of Results From Research Conducted By ICAR on Organic Farming

The CSE Report[7] is a landmark report on Natural And Organic Farming In India because of the following reasons:

1. The report is based on the results obtained by All India Network Project on Organic Farming (AI-NPOF) conducted by ICAR from 2004 to 2019.
2. It also includes 89 unique scientific studies conducted in India on different aspects of organic and natural farming published or presented during 2010–20.

Also, this comparative study has taken into account the following factors:

- Crop Yield
- Cost of Cultivation
- Gross And Net Returns
- Soil Organic Carbon & Wealth Of Microorganisms
- Plant Available Nutrients
- Nutrition In Food

The comparison is done among three approaches:

1. Organic approach (ORG) categorized into organic method (OF)and organic innovative method (OIN)
2. Integrated approach (INT) categorized into integrated method (IN75); 75% organic 25% inorganic, integrated method (IN50); 50% organic, 50% inorganic
3. Inorganic approach (INO) categorized into inorganic method (IOF) and state recommended method (SR).

Results From Research Conducted By ICAR

Crop Yield

The consolidated evidence reflects that, out of the 504 times that yield results were recorded during 2014–19, 41 per cent of the times yields were highest with organic approach, followed by 33 per cent with integrated and 26 per cent with inorganic approach. In the case of vegetables, oilseeds and cereals, yield with organic approach was highest more times than integrated and inorganic approach. In pulses and spices, it was highest more times with integrated approach than with organic and inorganic approach.

Long-term trends of crop yield revealed that organic approach is better than inorganic and is at par with integrated.

[7] https://www.cseindia.org/evidence-2004-20-on-holistic-benefits-of-organic-and-natural-farming-in-india-11148

Cost Of Cultivation

Among three approaches, out of 63 cropping systems, cost of cultivation was highest in 63 per cent cropping systems with organic approach at 15 centers, 8 per cent with integrated approach at three centers and 29 per cent with inorganic approach at eight centers. With an organic approach, the cost of cultivation was lowest in five per cent cropping systems.

It is evident that the cost of cultivation is higher with an organic approach than an integrated approach. This high cost is explained by the fact that organic and bio-inputs used in the AI-NPOF are largely purchased from the market and not produced on-farm, as the project involves experimental farms. Whereas, organic inputs cost less if produced on-farm by farmers.

Gross Returns

Among three approaches, out of the 61 cropping systems, gross returns are highest in 49 per cent with organic approach at 13 centers, 15 per cent with integrated approach at five centers and 36 per cent with inorganic approach at four centers. The five-year mean gross returns with organic approach are higher than inorganic in 74 per cent cropping systems.

Net Returns

Among all three approaches, out of 61 cropping systems, net returns are highest in 64 per cent with organic approach at 12 centers, 11 per cent with integrated approach at four centers, and 25 per cent with inorganic approach at five centers. The five-year mean net returns with organic approach are higher than inorganic in 67 per cent cropping systems.

It is evident that net returns are much better with organic approaches than with integrated or inorganic approaches. It is also evident that despite the high cost of cultivation with the organic approach, net returns are more favorable than the integrated approach.

Soil Organic Carbon

Among all three approaches, out of 34 cropping systems at nine centers, mean organic carbon in soil is highest in 91 per cent cropping systems with organic approach at all centers. In the remaining nine per cent cropping systems, it is highest with integrated approach.

Soil Bacteria

Among all three approaches, out of 32 cropping systems at eight centers, mean bacteria is highest in 84 per cent cropping systems with organic approach at all centers. In 13 per cent, it is highest with the integrated approach at two centers and three per cent with inorganic approach at one center. The five year mean bacteria with organic approach is higher than inorganic in 91 per cent cropping systems.

Soil Fungi

Among all three approaches, out of 32 cropping systems at eight centers, mean fungi is highest in 72 per cent cropping systems with organic approach at seven centers. In 12 per cent, it is highest with the integrated approach at two centers and 16 percent with inorganic approach at two centers. The five-year mean fungi with organic approach is higher in 78 per cent
cropping systems.

NPK In Soil

In the case of available nitrogen, phosphorus and potassium collectively, mean values of all three macronutrients with organic approach are higher than with inorganic approach in 26 cropping systems (42 per cent) at 10 centers. These centers are Bajaura, Dharwad, Jabalpur, Karjat, Ludhiana, Modipuram, Umiam, Ajmer and Sardarkrushinagar.

Soil Bulk Density

Among three approaches out of 28 cropping systems at seven centers, mean bulk density is lowest in 52 per cent cropping systems with an organic approach at four centers. It is lowest in 34 per cent cropping systems with integrated approach at four centers and it is lowest in 14 per cent with inorganic approach at two centers. The five-year mean bulk density with organic approach is lower in 75 per cent cropping systems

Nutrition In Food

Actual values of 28 different food quality and nutrient parameters in 15 crops cultivated with three approaches and six methods under the AI-NPOF in 2018–19 were compared. Compared with inorganic approach, across 51 sets of test results, in 67 per cent cases, results are higher with organic approach and in 64 per cent cases they are higher with integrated approach.

Annexure 4: Ecological agriculture in India: Scientific evidence on positive impacts & successes

Compiled by: Kavitha Kuruganti

With help from: Ananthasayanan, Parthasarathy VM, Prakash Selvaraj, Shamika Mone and Regional Institute for Organic Farming, GKVK

ASHA (Alliance for Sustainable & Holistic Agriculture) is a nation-wide informal network of more than 400 organizations connected with several lakh people from 23 states of India. The network was created in 2010 through a Kisan Swaraj Yatra, a nation-wide mobilization through a 71-day bus journey around 20 states, to draw attention to issues pertaining to our food, farmers, and freedom. The network consists of farmers' organizations, consumer groups, women's organizations, environmental organizations, organic farming groups, individual citizens and experts who are committed to the cause of sustainable and viable farm livelihoods.

Soft copy of this book is available at : www.kisanswaraj.in

Printed by Alliance for Sustainable & Holistic Agriculture (ASHA)

(with support from INSAF, Save Our Rice Campaign, Living Farms & Jatan Trust)

For more information:

Alliance for Sustainable & Holistic Agriculture (ASHA),

A-124/6, First Floor, Katwaria Sarai, New Delhi 110 016

Phone/Fax: 011-26517814

Website: www.kisanswaraj.in

Email: asha.kisanswaraj@yahoo.in

PREFACE

Very often, when ecological agriculture (whether it goes by the name of organic farming or natural farming or bio-dynamic farming) approaches are advocated for large scale replication in the country - especially in response to the severe agrarian distress in the country, the environmental degradation emerging with natural resources related to farming, the environmental health problems that are cropping up, the economic viability of farming getting eroded and in the context of climate change – there are many questions asked around the viability/profitability of organic farming, the productivity of organic farming, the scientific validation of many practices adopted by organic farmers, the environmental implications of adoption of organic farming, the socio-economic impacts related to organic farming (farm suicides, for example) and so on. This compilation is based on the scientific evidence readily available in India on the various benefits from organic farming, including on productivity and farm economics, on environmental impacts (soil, biodiversity etc.), on validation of various practices as well as on challenges facing organic farming. I chose not to bring in literature from outside India, just to point to the enormous evidence available right here. In this compilation, I also did not include a vast body of evidence on organic agronomic practices for System of Root Intensification (SRI). Similarly, evidence related to non-chemical IPM or NPM is also available as a large body of scientific literature. This is not an exhaustive compilation of all the studies that exist on the subject. As an area of emerging interest, it is seen that many doctoral theses are present in the NARS on the themes listed above, pertaining to Organic Farming. However, I was not able to tap into all such literature. Similarly, while searching for scientific evidence as part of this effort, I came across the abstracts and presentations made in two national seminars related to organic farming within the NARS in 2014 (Navsari and Palampur). However, it is seen that the soft copies of the hundreds of papers available therein are not readily available on the websites of the organizers. In fact it is this lack of ready reference material that this booklet seeks to address. This booklet is a preliminary effort which will be revised and structured better in future, and should be seen as work in progress. This compilation provides ample evidence on the scientific basis that underpins the practice of organic farming in the country. What is missing however is a committed extension that takes the message to farmers. This booklet also shows that organic farming is not to be equated with only traditional farming as is often done, but is a scientific approach that effectively uses nature's processes and products for sustainable management of productive resources for viability and profitability. The papers that were included in the Challenges and Way Forward section also bring up an argument that organic farming needs a different appraisal and analysis framework, with different criteria and parameters to justify its impact on society and ecology. In the Indian agricultural research scenario too, this reorientation is much-required. Papers that compared organic with chemical agriculture were put into the Yields/Productivity section while comparisons between various organic farming practices were categorized under the Scientific Validation section. It is seen that most research efforts are going into INM and very little into organic farming research. I hope this compilation will be made use of, by various stakeholders, to ensure that ecological farming is promoted and practiced on a large scale. Ananthoo of ASHA helped in collecting various papers and sorting them. Shamika Mone of Organic Farming Association of India (OFAI) also pitched in with some studies. I would like to acknowledge with sincere gratitude the support obtained from the Regional Centre for Organic Farming in the University of Agricultural Sciences-Bangalore (Dr N Devakumar in particular) and Prakash Selvaraj, Coimbatore. Parthasarathy VM created the Index painstakingly, crop-wise, practice-wise and location-wise.

Kavitha Kuruganti Alliance for Sustainable & Holistic Agriculture (ASHA)

February 2015

HOW TO USE THIS COMPILATION

The various papers that were pooled for this compilation (an overwhelming majority of the ~375 papers which form part of this book are from the Year 2000 onwards) have been classified under 5 broad categories and arranged in a chronological order (latest studies on top): Yields and Productivity; Validation of Practices; Environmental Impacts; Socio-economic Implications and finally, Challenges and Way Forward. As can be expected, the slotting of papers under different categories is mainly convenience-based since many studies cover a gamut of issues and could fall in more than one category.

A crop-wise index, practice-wise index and location-wise index have also been included so that referring to relevant studies is easier using any of these search parameters. These are in fact good indicators of where research is lacking now.

In the first section on Yields and Productivity, studies which have had organic plots compared with a chemical control in the adopted study protocol have been included. One important point to note here is that those studies which have been conducted for more than 3-5 years have found organic yields on par or higher than conventional farming yields. The ones which have concluded otherwise are ones which were run for just a few seasons. This emphasizes the importance of long term studies.

In the second section on validation of practices, those studies which have looked at various practices like botanicals for pest and disease control, biofertilizers, biodigested manures (panchagavya, jeevamrutha, beejamrutha etc.), green manures, various kinds of composts including vermi-compost, other microorganisms based practices for both fertility and pest/disease management, seed treatment practices, mulching and other practices have been included. This is by far the largest section in this compilation and belies an argument often put forth by Agriculture Extension Departments that they can take the organic farming message to farmers only if adequate agriculture research supports it.

In the third section are studies which capture environmental impacts of ecological agriculture and most of the studies are on the beneficial impacts on Soil, as per various parameters of assessment. Further, studies that have captured the impact of organic farming, or even plain stopping of chemical practices, on biodiversity and ecological balance are also part of this section. Some studies on climate change and organic farming form a small part of this section.

In the fourth section is evidence on socio-economic implications of organic farming: these include studies which found organic farming more profitable for farmers, studies that capture gender-related benefits, have shown better food safety and nutrition than conventionally grown foods, have captured the traditional knowledge and wisdom associated with many ecological practices etc.

In the last section on Challenges and Way Forward, papers that point to challenges for policy makers in terms of scaling up of ecological agriculture, whether it is market support, or training and extension needs or surveys on awareness and beliefs, about emerging areas like organic dairying, about how research should be better organized, about organic seed breeding etc. have been included.

ORGANIC FARMING: YIELDS/ PRODUCTIVITY

During 3-4 years of conversion period, crop yields under organic farming were recorded to be comparable with conventional (chemical) farming in many regions. Some of these crops and their percent improvement in yield are: coarse rice (+2%), garlic (+20.4%), maize (+22.8%), turmeric (+51.5%), fodder crops (+14.4 to 89.9%) and basmati rice (-6%) at Ludhiana; *kharif* French bean (+19.0%), veg. pea (+62.1%), cabbage (+9.5%), garlic (+7.0%) and *kharif* cauliflower (-4.6%) at Bajaura; fodder berseem (+6.5%), chickpea (+1.5%), soybean (-2.3%) and mustard (-6.6%) at Raipur; Rice (+12.9%), Wheat (+24.4%), Potato (+7.3%), mustard (+9.6%) and lentil (+2.5%) at Ranchi, groundnut (+6.9%), *rabi* sorghum (+15.8%), soybean (+9.5%), durum wheat (+32.4%), chilli (+18.8%), cotton (+35.5%), potato (+3.3%), chickpea (+3.2%) and maize (-1.1%) at Dharwad; soybean (+10.7%), isabgol (+11.2%), durum wheat (+1.1%), mustard (+3.1%) and chickpea (+4.2%) at Bhopal; okra (+1.0%), berseem (-0.2%) and veg. pea (+1.8%) at Jabalpur; *Dolichos* bean (+16.6%) at Karjat; maize (+18.2%), cotton (+38.7%), chilli (+8.2%), brinjal (+14.9%) and sunflower (+29.1%) at Coimbatore; rice (+1.9%) at Pantnagar; fodder sorghum (+32.5%), okra (+11.3%), baby corn (+11.8%) and veg. pea (+2.2%) at Modipuram; and carrot (+5.8%), tomato (+30.6%), rice on raised beds (+7.3%), french bean (+17.7%) and potato (+3.0%) at Umiam.

- Vision 2030, Project Directorate for Farming Systems Research, Modipuram. 2011. Indian Council For Agricultural Research (pp14-15), based on the All India Network Project on Organic Farming.

MAIN FINDINGS OF THE ALL INDIA NETWORK PROJECT ON ORGANIC FARMING (13 LOCATIONS) COORDINATED BY PROJECT DIRECTORATE FOR FARMING SYSTEMS RESEARCH, MODIPURAM

Okra, turmeric, cotton, carrot, black pepper and cowpea have recorded more than 20% increase in yield under organic nutrient input systems compared to inorganic systems. The increase in yield of onion, ginger, and dolichos beans are in the range of 10-20% while greengram, sunflower and garlic recorded 5 to 10% increase in yield. An increase of up to 5% was observed in maize, soybean, berseem, brinjal, chili, capsicum, tomato, sorghum and peas across the seasons and locations.

[THESE, THEREFORE, ARE CONSISTENT RESULTS ACROSS LOCATIONS AND SEASONS, FOR 21 OF THE 28 CROPS FOR WHICH RESEARCH IS UNDERTAKEN]

(This is as per a reply received in February 2013, from the Project Directorate, on a Right To Information (RTI) application available on www.kisanswaraj.in)

1

Surekha, K., and Y. S. Satishkumar. (2014). "Productivity, Nutrient Balance, Soil Quality, and Sustainability of Rice (Oryza sativa L.) under Organic and Conventional Production Systems." *Communications in Soil Science and Plant Analysis* 45, no. 4: 415428.

A field experiment was conducted for 5 years (2004–2005 to 2009–2010) covering 10 crop seasons [five wet (WS; *Kharif*) and five dry (DS; *Rabi*)] at the Directorate of Rice Research farm, Hyderabad, India, to compare the influence of organic and conventional farming systems on productivity of fine grain rice varieties, cumulative partial nutrient balance, and soil health/ quality in terms of nutrient availability, physical and biological properties, and sustainability index. Two main plot treatments were with and without plant protection measures, and four subplot treatments were (1) control (CON), (2) inorganic fertilizers (CF), (3) organics (OF), and (4) inorganics + organics (integrated nutrient management, INM). During wet season, grain yields with CF and INM were near stable (5.0 to 5.5 t ha^{-1}) and superior to organics by 15–20% during the first 2 years, which improved with OF (4.8 to 5.4 t ha^{-1}) in the later years to comparable levels with CF and INM. However, during DS, CF and INM were superior to OF for 4 consecutive years and OF recorded yields on par with CF and INM in the fifth year. The partial nutrient balance over 10 crop seasons for N and P was positive and greater with OF and INM over CF and for K it was positive with OF alone and negative with CF and INM. There were increases in SOC and available N, P, and K by 50–58%, 3–10%, 10–30%, and 8–25% respectively, with OF, over CF at the end of 5 years. The sustainability index (SI) of the soil system was maximum with organics (1.63) and CF recorded 1.33, which was just above the minimum sustainability index of 1.30 after 5 years. Thus, organic farming needs more than 2 years to stabilize rice productivity and bring about perceptible improvement in soil quality and sustainability in irrigated rice.

2

Suja G. and J. Sreekumar (2014). Implications of organic management on yield, tuber quality and soil health in yams in the humid tropics. *International Journal of Plant Production* 8, no. 3.

Global consciousness of food safety, health and environmental issues has stimulated interest in alternative agricultural systems like organic farming. Since information on organic farming of tuber crops is meagre, a field experiment was conducted in split plot design over a five-year period at Central Tuber Crops Research Institute, India. The aims were to evaluate the impact of organic, conventional and traditional production systems on yield, proximate composition and mineral content of tubers and soil physicochemical and biological properties in three species of Dioscorea (white yam: D. rotundata, greater yam: D. alata and lesser yam: D. esculenta). The production systems were assigned to main plots and species to subplots. Organic farming (20.34 t ha-1) produced significantly higher yield over conventional practice (18.64 t ha-1) by 9%. All the species responded well to organic management, which lowered the bulk density and particle density slightly and improved the water holding capacity (by 15%) of soil. Tuber quality was improved with significantly higher Ca (72.67 mg 100g-1), slightly higher dry matter, crude protein, K and Mg contents. Organic plots showed significantly higher available K, by 34% and pH, by 0.46 unit and higher soil organic matter by 14%. The dehydrogenase enzyme activity (1.174 µg TPF formed g-1 soil h-1), population of bacteria, fungi and P solubilizers were promoted by 14%, 23%, 17% and 22% respectively. Thus organic farming was found to be an eco-friendly management strategy in yams for sustainable yield of quality tubers besides maintaining soil health. Technology involving farmyard manure, green manuring, neem cake, biofertilizers and ash was standardized.

3
Outcome of Experiments at Model Organic Farm, CAZRI http://www.cazri.res.in/org_farm.php, accessed in June 2014

Contribution of legume: Legumes contributed 25-30% higher yield in the subsequent crop. During Rabi season crops of cumin and psyllium were grown in rotation with sesame and cluster bean. Cumin yield of 566 kg/ha and psyllium yield of 808 kg were obtained in the treatments of organic inputs + cluster bean in rotation.

Crop yield comparison: There is general apprehension that the organic system is a poor yielder. However, finding at CAZRI shows that the initial developmental stage of the organic system there may be low yield by only 20-30% but after 23 year once the system developed the yield levels are comparable to the conventional system. At the third year yield of sesame 886 kg/ha, cluster bean 630 kg/ha, cumin 516 kg/ha and psyllium 808 kg/ha was recorded. This is comparable to the average yield in conventional systems.

Sink Partitioning: As the manure level increased, the percentage of sink to grain increased from 15.7 to 19.8% while it decreased in case of stem and leaf. This shows better partitioning of the sink that increased grain yield, with the application of manure. It may be due to balanced nutrition through compost that is used by plants for grain formation.

Soil properties improvement: Increase in soil moisture retention with the use of organic manure was observed that helped in better growth and yield of crops. Similarly increase in soil organic carbon from 0.23% to 0.31% was recorded after five year application of compost.

Climate resilience: As revealed after five year of experimentation, crop resilience to climatic variability enhanced with the use of organic manure.

Fauna diversity: Enhanced beneficial fauna diversity by 42% in five years. Manly *Coccinellid* beetles, *Chrysoperla*, Syrphid flies, wasps of different types, bumble bees, honey bees etc. population increased while interesting termite population suppressed may be due to use of well decomposed manure.

Pest Management: Pest were kept below Economic threshold level with the integrated use of use of following eco- technologies –

1. Soil application of neem cake
2. Use of well prepared compost
3. *Trichoderma viride* application in soil and seed treatment
4. Use of healthy seed (also free from weed seeds)
5. Hand weeding and mulching
6. Prophylactic spray of neem seed kernel extract solution (5.0%) at regular interval
7. Use of pheromone traps according to the pest

4

Karmakar, Sruti, Koushik Brahmachari, and Aniruddha Gangopadhyay. (2013). "Studies on agricultural waste management through preparation and utilization of organic manures for maintaining soil quality." *African Journal of Agricultural Research* 8, no. 48 (2013): 6351-6358.

Solid waste management has become one of the vital issues to protect health and public safety. Preparation of organic manures like vermicompost, Farm Yard Manure (FYM) etc. from various organic wastes (agricultural wastes) will save our environment from pollution as well as application of these manures in agricultural land prevent those lands from the harmful effect of chemical fertilizers. With these views keeping in background for saving our environment from ill effects of indiscriminate use of chemical fertilizers by substituting them partially or entirely through applying organic manures after converting agricultural wastes into wealth (organic manures), an experiment was carried out in the farmer's field at village Shikarpur (P.O. Bhagirathi Shilpa Ashram, Dist. Nadia, Pin. 741248, W.B., India) during the year 2008 to 2010 with two crops (rice –rainy season and Lentil –winter season). The experiment was laid out in randomized block design with 5 treatments (T_0- without fertilizer or manure, T_1-100% organic through vermicompost, T_2- 100% organic through FYM, T_3-100% chemical through fertilizer and T_4-50% organic through mixed organic manure + 50% chemical through fertilizer) replicated 3 times. It has been found that the vermicompost treated soil showed better results in comparison to that demonstrated by the chemical fertilizers in terms of soil physical and chemical properties as well as productivity of soil.

5

Forster, Dionys, Christian Andres, Rajeev Verma, Christine Zundel, Monika M. Messmer, and Paul Mäder. (2013). "Yield and Economic Performance of Organic and Conventional Cotton-Based Farming Systems–Results from a Field Trial in India." *PloS one* 8, no. 12: e81039.

The debate on the relative benefits of conventional and organic farming systems has in recent time gained significant interest. So far, global agricultural development has focused on increased productivity rather than on a holistic natural resource management for food security. Thus, developing more sustainable farming practices on a large scale is of utmost importance. However, information concerning the performance of farming systems under organic and conventional management in tropical and subtropical regions is scarce. This study presents agronomic and economic data from the conversion phase (2007–2010) of a farming systems comparison trial on a Vertisol soil in Madhya Pradesh, central India. A cotton-soybean-wheat crop rotation under biodynamic, organic and conventional (with and without Bt cotton) management was investigated. We observed a significant yield gap between organic and conventional farming systems in the 1st crop cycle (cycle 1: 2007–2008) for cotton (”29%) and wheat (”27%), whereas in the 2nd crop cycle (cycle 2: 2009–2010) cotton and wheat yields were similar in all farming systems due to lower yields in the conventional systems. In contrast, organic soybean (a nitrogen fixing leguminous plant) yields were marginally lower than conventional yields (”1% in cycle 1, ”11% in cycle 2). Averaged across all crops, conventional farming systems achieved significantly higher gross margins in cycle 1 (+29%), whereas in cycle 2 gross margins in organic farming systems were significantly higher (+25%) due to lower variable production costs but similar yields. Soybean gross margin was significantly higher in the organic system (+11%) across the four harvest years compared to the conventional systems. Our results suggest that organic soybean production is a viable option for smallholder farmers under the prevailing semi-arid conditions in India. Future research needs to elucidate the long-term productivity and profitability, particularly of cotton and wheat, and the ecological impact of the different farming systems.

6

Hari Ram (2013). Grain Yield and Water Use Efficiency of Wheat (Triticum Aestivum L.) in Relation to Irrigation Levels and Rice Straw Mulching in North West India. Agricultural Water Management. Vol.128: 92-101

Continuous cultivation with a rice (*Oryza sativa* L.)–wheat cropping system in north-western India has led to an irrigation water crisis due to excessive withdrawal of underground water. Large scale on-farm burning of surplus rice residue by the farmers has also caused intense air pollution. Retaining rice residue as surface mulch as an alternative to burning could be useful for soil moisture conservation, reducing air pollution and improving soil organic matter level. A field experiment was conducted for three years (2008–09, 2009–10 and 2010–11) to study the effect of four irrigation treatments with irrigations applied at critical growth stages and four rates of rice straw mulching on the grain yield and water use efficiency of wheat in North-west India. The irrigation treatments were irrigations at crown root initiation (CRI) and boot stage (I_2); CRI, tillering, and boot stage (I_3); irrigations at CRI, tillering, boot stage, and milk stage (I_4); and irrigations as CRI, tillering, jointing, boot stage, and milk stage (I_5). Mulch application included no mulch (M_0) and 2 (M_2), 4 (M_4), and 6 (M_6) t ha$^{"1}$. Significant irrigation × mulch interaction effects were observed on grain yield during 2008–09. Rice straw mulching decreased the maximum soil temperature by 2.0–3.3 °C recorded during the emergence of the wheat crop in different years. Mulching at different rates reduced the mean weed dry matter by 12.5–52.7% compared with the no mulch treatment, and increased growth and yield attributes of wheat crop in different years. Protein content decreased from 12.15–13.04% in the I_2 treatment to 11.95–12.58% in the I_5 treatment. Straw mulch at M_6 decreased the water use from 2.1 to 2.9 cm compared with the no mulch treatment in different years. Water use efficiency decreased with the increasing irrigation level but increased with mulching. WUE increased as mulching increased for the I_2, I_3, and I_4 treatments, but not for the I_5 treatment. The increase in water use efficiency with the I_5 treatment compared to no mulch was observed at the M_2 treatment only and no further increase occurred thereafter. After three years of experimentation straw mulching decreased soil bulk density and increased organic carbon content in the 0–15 cm soil layer. It may be concluded from this study that under limited irrigation water conditions, rice straw mulching will be beneficial in increasing yield, soil organic carbon and water use efficiency in wheat.

7

Rizvi, R., I. Mahmood, and S. Tiyagi. (2013). "Potential Role of Organic Matters and Phosphate Solubilizing Bacteria (PSB) on the Growth and Productivity of Fenugreek." *Journal of Agricultural Science and Technology* 15, no. 3 (2013): 639-647.

A field experiment was conducted during 2009-2011 at the Aligarh Muslim University Agricultural Research Farm, India, to evaluate the efficacious nature of some oil-seed cakes such as neem cake and castor cake, a botanical Calotropis procera and phosphate solubilizing bacteria (PSB) Pseudomonas fluorescens singly and in various combinations, on the growth and productivity of Trigonella plant. Growth parameters included fresh and dry weight, pollen fertility (%), pods plant^{-1}, root-nodule index, nitrate reductase activity, and chlorophyll content. Productivity was calculated in terms of N, P, and K in plant as well as in soil. Although all the parameters were significantly increased in these treatments, single application was comparatively less effective than the combined applications. Among oilseed cakes, neem cake was found better in promoting plant growth than castor cake, followed by C. procera and PSB. Root-nodulation also showed a considerable increase in combined treatments. Maximum growth and productivity were observed in the combined inoculation of neem cake, castor cake, C. procera and PSB, as compared to other treatments including inorganic fertilizers and untreated one.

8

Suja, Girija, Sukumaran Sundaresan, Kuzhivilayil Susan John, Janardanan Sreekumar, and Raj Sekhar Misra. (2012). "Higher yield, profit and soil quality from organic farming of elephant foot yam." *Agronomy for sustainable development* 32, no. 3: 755-764.

Alternative agricultural systems, like organic farming, that are less chemical intensive, less exploitative and environment friendly are gaining popularity. Elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson) is an important starchy tuberous vegetable with high nutritive and medicinal values. Since information on the organic farming of tuberous vegetables is scanty, field experiments were conducted in this crop at the Central Tuber Crops Research Institute, India, over a 5-year period. The impact of organic, conventional, traditional and biofertilizer production systems on growth, yield, quality, soil physico-chemical properties and economics were evaluated in elephant foot yam. Our results show that organic farming favoured canopy growth, corm biomass and lowered collar rot disease. Dry matter and starch contents of organic corms were significantly higher than those of conventional corms by 7% and 13%, respectively. Organic corms had 12% higher crude protein and 21% significantly lower oxalate contents. The content of K, Ca and Mg in corms were slightly higher, by 3–7% under organic farming. After 5 years of farming, the organic plots showed significantly higher pH, by 0.77 unit, and higher organic C by 19%. The exchangeable Mg, available Cu, Mn and Fe contents were also significantly higher. Organic management lowered the bulk density by 2.3%, improved the water-holding capacity by 28.4% and the porosity of soil by 16.5%. In short, organic farming proved superior and produced 20% higher yield (57.097 tha^{-1}) over conventional practice (47.609 tha^{-1}). The net profit was 28% higher and an additional income of Indian Rs. 47,716 ha^{-1} was obtained. Thus organic farming was found to be an eco-friendly management strategy in elephant foot yam for sustainable yield of quality tubers and higher profit besides maintaining soil health. Technologies for organic production involving farmyard manure incubated with bioinoculants, green manuring, neem cake, biofertilizers and ash were also standardized.

9

Singh YV, Dhar DW, Agarwal B (2011). Influence of organic nutrient management of Basmati rice (*Oryza sativa*)–wheat (*Triticum aestivum*)-greengram (*Vigna radiate*) cropping system. Indian J Agron 56(3):165–175

In a field experiment conducted at New Delhi during 2003–2009, different organic sources of nutrients such as *multani mitti* based blue green algae (BGA) @ 2.0 kg/ha, *Azolla* @ 1.0 tonne/ha, vermicompost (VC) @ 5.0 tonne/ha and farm yard manure (FYM) @ 5.0 tonne/ha were tested alone or in combinations to find out suitable organic sources of nutrient supply for sustaining the productivity of *Basmati* rice (*Oryza sativa* L.)–wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.]–greengram [*Vigna radiata* (L.) R. Wilczek] cropping systems. In the wheat crop *Azotobacter* replaced *Azolla*, but other treatments remained the same. Green Gram was taken up on residual soil fertility and biomass of this crop was incorporated after picking the pods. Results revealed a significant enhancement in grain yield of rice over absolute control due to the application of different organic sources of nutrient applied alone or in combinations. Grain yield over 4.0 t/ha of Basmati rice ('Pusa Basmati 1') was obtained with the combined application of four (*Azolla*, BGA, FYM and VC) organic sources of nutrients. Grain yield of wheat was lower than 4 t/ha during the first four years even with the combined application of four organic sources of nutrients, but, fourth year onward wheat yield level crossed 4.0 t/ha level with four organic sources of nutrient. A significant increase in uptake of iron, zinc and manganese in the grains of rice, wheat and greengram was recorded when two or more organic sources of nutrient were applied together compared to control. Total uptake of Fe, Zn, Mn and Cu in rice-wheat-green gram cropping system ranged between 177.0.1 to 414.7, 175.0 to 381.0, 177.3 to 420.2 and 71.2 to 181.0 g/ha, respectively. Microbial (actinomycetes, bacteria, fungi and BGA) population was enhanced due to the application of four sources of organic nutrients as compared to absolute control that resulted in a notable enhancement in dehydrogenase enzyme activity. Sustainability yield index (SYI) data indicated that the rice wheat-green gram system (0.93) was most sustainable followed by greengram (0.85), wheat (0.82) and rice (0.81) crop under integrated use of organic sources of nutrients.

10

Patra Partha Sarathi, Sinha AC, Mahesh SS (2011). Yield, nutrient uptake and quality of groundnut (*Arachis hypogaea*) kernels as affected by organic sources of nutrient. Indian Journal of Agronomy. Vol. 56 (3).

A field experiment was conducted during pre-*kharif* seasons of 2008–09 to study the effect of organics on yield and quality of groundnut (*Arachis hypogaea* L.) under *terai* region of West Bengal. The experiment was laid out in randomized block design with 12 treatments and replicated thrice. Results revealed that poultry manure 2.5 t/ha + neem cake 2.5 t/ha + vermicompost 2.5 t/ha + phosphocompost 2.5 t/ha gave 2.08 tonne pod yield/ha, which was 9.47% higher over recommended dose of chemical fertilizer. Combined application of vermicompost 2.5 t/ha + phosphocompost 2.5 t/ha + poultry manure 2.5 t/ha + neem cake 2.5 t/ha brought about significant improvement in N, P and K uptake by groundnut. Application of organic manures resulted in the improvement of soil organic carbon, available soil N, P and K compared to either recommended dose of fertilizers or control. Among the organic treatments, phosphocompost 5 t/ha recorded highest values of oil (46.7%), crude protein (22.4%), soluble protein (10.5%), total sugar (13.1%), starch (14.8%), calcium (143.92 mg/100g) and phosphorus (836.6 mg/100g) during both the years.

11

Jadhao, B.J., Joshi, P.S. and Chaudhari, G.V. (2011). Organic farming of turmeric (*Curcuma longa*) in Central India. *Adv. Res. J. Crop Improv.,* 2(1) : 55-57.

Turmeric is very important spice crop commercially grown throughout the country from last many centuries; it has used in various commercial industries as well as in pharmaceutical industries. It has a great demand in domestic as well as in international markets, due to its wider adaptability and also various schemes sponsored by Spice Board of India and National Horticulture Mission. It's acreage significantly increased in the last few years especially in central India. Considering the importance of this crop, the present experiment was undertaken at Department of Horticulture, Dr.PDKV Akola to explore the possibility of organic farming in turmeric and standardization of organic manures for quality as well as export oriented production of turmeric. The initial results were found promising and it was suppose to confirm that application of vermicompost @ 13.5 t/ha application resulted in better vegetative growth performance, where as application of FYM @ 20 t/ha was found to be better for yield attributing characters in turmeric.

12

Panneerselvam, P., John Erik Hermansen, and Niels Halberg (2010). "Food security of small holding farmers: Comparing organic and conventional systems in India." *Journal of Sustainable Agriculture* 35, no. 1: 48-68.

This study compared farm production, crop yield, input cost, and income in organic and conventional farming systems in three states of India: Uttarakhand, Madhya Pradesh, and Tamil Nadu. The results showed that organic farming reduced the input cost without affecting the net margin in all three states. Total food production was found to be comparable for the two systems in two of three states. While yield of rice and wheat generally was lower under the organic systems, yield from intercropping food crops was generally higher. The number of agro-ecological methods and percentage of farms practicing different agro-ecological methods were higher under organic systems than conventional systems. These results suggest that organic farming has the potential to improve food security of small farmers by reducing indebtedness due to the lower cost of production without affecting total farm production and farm income.

13

Ramesh, P., Raten Panwar, N., Bahadur Singh, A., Ramana, S. and Subba Rao, A. (2009). Impact of organic-manure combinations on the productivity and soil quality in different cropping systems in central India. J. Plant Nutr. Soil Sci., 172 (4): 577–585.

In a field experiment, the effect of combination of different organic manures on the productivity of crops and soil quality were evaluated in deep vertisols of central India. Combinations of cattle dung manure (CDM), poultry manure (PM), and vermicompost (VC) *vis-à-vis* mineral fertilizers were tested in four cropping systems involving soybean (*Glycine max* L.), durum wheat (*Triticum durum* Desf.), mustard (*Brassica juncea* L.), chickpea (*Cicer arietinum* L.), and isabgol (*Plantago ovata* Forsk). The organic manures were applied based on the N-equivalent basis and nutrient requirement of individual crops. The grain yields of durum wheat and isabgol were higher in the treatment that received a combination of CDM + VC + PM whereas in mustard, CDM + PM and in chickpea, CDM + VC recorded the higher yields. The yield levels in these organic-manure combinations were similar to the yields obtained with mineral fertilizers. Among the cropping systems, soybean– durum wheat and among the nutrient sources, the combination of CDM + VC + PM recorded the highest total productivity. At the end of the 3-year cropping cycle, application of organic manures improved the soil-quality parameters *viz.*, soil organic carbon (SOC), soil available nutrients (N, P, and K), soil enzymes (dehydrogenase and alkaline phosphatase), and microbial biomass C in the top 0–15 cm soil. Bulk density and mean weight diameter of the soil were not affected by the treatments. Among the cropping systems, soybean–durum wheat recorded the highest SOC and accumulated higher soil available N, P, and K. In conclusion, the study clearly demonstrated that the manures applied in different combinations improved the soil quality and produced the grain yields which are at par with mineral fertilizers.

14

Rupela, O. P. (2008). "Organic farming: Building on farmers' knowledge with modern science." *Organic farming in rainfed agriculture: Opportunities and constraints* (2008): 28, APAARI.

Most agricultural scientists are trained in crop production and protection that require fertilizers and synthetic pesticides. Scientists have largely evaluated components used by practitioners of organic farming (OF) in isolation, eg. evaluation of compost for replacing fertilizers. The OF system that integrates trees, annual crops and animals in a farming system perspective using locally available biological resources has not been studied in totality. This chapter therefore argues that unless studied in totality, its potential cannot be denied by research institutions. The document discusses some common myths that render agricultural scientists averse to OF. The document also demonstrates that crop yields without agro-chemicals were indeed higher or similar to the treatments receiving agrochemicals, in seven out of nine years, in a large plot study on a rainfed Vertisol in semi-arid conditions at ICRISAT. Comparable or higher yields of cotton and tomato were also harvested in on-farm experiments (involving seven to 21 farmers in a season), in two villages, evaluating low-cost bio-options of crop protection against farmers practice using synthetic pesticides, for at least four years in a row (2004 to 2007/08). Farmers in these on-going studies paid partially for the cost of the materials and advice they received from researchers, suggesting strengths in the biological options of crop protection.

15

Sanwal S.K., Laxminarayana K., Yadav R.K., Rai N., Yadav D.S., Bhuyan Mousumi (2007): Effect of organic manures on soil fertility, growth, physiology, yield and quality of turmeric. Indian Journal of Horticulture. Vol 64 (4): 444-449

Field experiments were conducted to study the effect of various organic manures on yield and quality parameters of turmeric and their effect on residual soil fertility. The results showed that significantly higher rhizome yield was recorded with the application of FYM @ 18 t/ha which was statistically at par with 10 t/ha poultry manure. Application of various organic sources resulted in 16–103 per cent higher rhizome yield over control and also improved the quality parameters. Organic manuring not only produced the highest and sustainable crop yields but also improved the soil fertility and productivity.

16

Eyhorn, Frank. (2007). *Organic farming for sustainable livelihoods in developing countries?: the case of cotton in India*. vdf Hochschulverlag AG, 2007. 223 pages book

Organic farming has experienced considerable growth, not only in industrialized countries. Is it primarily an approach to safeguard consumer health and the environment, or can it also contribute to poverty reduction in developing countries?

Drawing on 3 years of research on organic cotton farms in the Maikaal bioRe® project in central India, this book assesses the potential and the constraints of organic farming for improving rural livelihoods. It further integrates lessons learnt in other organic cotton projects in Asia and Africa, making it the presently most in-depth and comprehensive work on the socioeconomic impact of organic farming in a developing country. The research builds on a conceptual frame that allows investigating rural livelihoods in a holistic and interdisciplinary way. The book not only addresses scientists in the fields of rural development and tropical farming systems, but also provides recommendations for practitioners and policy makers.

17

Singh, K. P., Archna Suman, P. N. Singh, and Menhi Lal. (2007). "Yield and soil nutrient balance of a sugarcane plant–ratoon system with conventional and organic nutrient management in sub-tropical India." *Nutrient Cycling in Agroecosystems* 79, no. 3: 209-219.

A 3-year field trial of sugarcane, comprising 11 treatment combinations of different organic manures with and without *Gluconacetobacter diazotrophicus* (*Gd*), NPK and an absolute control, on an inceptisol was conducted to assess the effect of these treatments on sugarcane total and economic yield, the benefit:cost ratio, nutrient balance and soil quality in a sugarcane plant–ratoon system. The highest cane yield (78.6 t ha^{-1}) was recorded in the plant crop given vermicompost + *Gd*, whereas ratoon yields (first and second) were highest (80.8 and 74.9 t/ha^{-1}, respectively) with sulphitation press mud cake (SPMC) + *Gd*. In both plant and ratoon crops, a number of different organic manures produced the highest cane yield that was also statistically similar to those obtained using the recommended NPK levels (76.1, 78.2 and 71.7 t/ha for plant crop and subsequent two ratoons, respectively). The highest benefit:cost (B:C) ratio in the plant and two ratoon crops (1.28, 2.36, 2.03 respectively) were obtained with the addition of SPMC + *Gd*. The nutrient balance for NPK in the soil was highest in the SPMC + *Gd* treatment. The highest increase in organic C (94%) and total N (87%), in comparison to the initial level, and soil microbial biomass C (113%) and soil microbial biomass N (229%), in comparison to the control treatment, was recorded with the addition of SPMC + *Gd*. The maximum decrease in soil bulk density (BD) (12%) with an increase in soil aggregate (17%) and water infiltration rate (35%) was obtained with the addition of SPMC. Overall, the sugarcane crop responded well to different organic manures in a multiple ratooning system with a better economic output and improved soil quality. Strategic planning in terms of an integrated application of these manures with inorganic chemicals will not only sustain our soils but will also be beneficial for our farmers in terms of reducing their dependence and expenditure on chemical fertilizers.

18

Singh, Y. V.; Singh, B. V.; Pabbi, S. and Singh, P. K. (2007). Impact of Organic Farming on Yield and Quality of Basmati Rice and Soil Properties. Paper at: Zwischen Tradition und Globalisierung - 9. Wissenschaftstagung Ökologischer Landbau, Universität Hohenheim, Stuttgart, Deutschland, 20.-23.03.2007.

The management of soil organic matter is critical to maintain a productive organic farming system. No one source of nutrient usually suffices to maintain productivity and quality control in the organic system. In addition, the inputs to supplement nutrient avail-ability are often not uniform presenting additional challenges in meeting the nutrient requirement of crops in organic systems. With this concept, a field experiment was conducted at the research farm of Indian Agricultural Research Institute, New Delhi, India during 2003-06 in rice-wheat-green gram cropping system. In this experiment, different treatments comprising organic amendments such as Blue Green Algae (BGA) 15kg/ha, Azolla 1.0 tonne/ha, Vermicompost and Farm Yard Manure (FYM) 5.0 tonne/ha each applied alone or in combination were tested in organic crop production. These treatments were compared with absolute control (N0P0K0) and recommended dose of chemical fertilizer (N80P40K40). In the wheat crop Azotobacter replaced Azolla, but other treatments remained the same. For rice, a scented variety 'Pusa Basmati 1' and for wheat and green gram HYVs were taken. Biomass of green gram was incorporated in soil after picking of pods and wheat was sown using zero tillage practice. The obser-vations on grain yield, contents of Fe, Zn, Mn and Cu in rice grains, insect pest inci-dence, soil nutrients and microbial activity were taken.

Results revealed a significant enhancement in grain yield of rice over absolute control due to the application of different organic amendments applied alone or in combina-tions. Rice grain yield increased by 114 to 116.8% over absolute control when all the 4 organic amendments were applied altogether. The rice grain yield (4.0 t ha-1) obtained under combined application of four organic amendments was at par with the yield recorded under recommended dose of chemical fertilizer application. An interesting observation recorded was that there was no serious attack of any insect pest or dis-ease in organically grown crops. Soil microbial population (Actinomycetes, Bacteria, Fungi and BGA) enhanced due to the application of organic amendments in compari-son to absolute control as well as recommended fertilizer application that in turn resulted in a notable enhancement in soil dehydrogenase and phosphatase enzyme activity. Soil organic carbon and available phosphorus contents were also found to be significantly increased due to organic farming practice over control as well as chemical fertilizer application.

Rice grain analysis for nutrients viz. Fe, Zn, Mn and Cu showed a significant increase in Fe and Mn content in the treatments having 2 or more organic amendments over control. Zn and Cu content also increased but the increment was significant with combined application of 3 or 4 organic amendments.

The study revealed that the addition of four organic amendments viz. BGA, Azolla, FYM and Vermicompost could give the optimum yield (4.05 t/ha) of organic Basmati rice and improve grain and soil quality.

19

Singh, K. P., Archna Suman, P. N. Singh, and T. K. Srivastava. (2007). "Improving quality of sugarcane-growing soils by organic amendments under subtropical climatic conditions of India." *Biology and Fertility of Soils* 44, no. 2: 367-376.

A field trial was conducted on an *inceptisol* to assess the effect of different bio-manures on sugarcane yield, cane quality, and changes in soil physicochemical and microbial properties in the plant–ratoon system. Seven treatments, viz. control, vermicompost, farmyard manure (FYM), biogas slurry, sulphitation press mud cake (SPMC), green manuring with intercropped *Sesbania*, and recommended dose of NPK (150:60:60 kg ha^{-1}), were randomized within a block and replicated three times. Improvement in bulk density and infiltration rates was recorded after the addition of various bio-manures. The highest organic C was recorded in the vermicompost (0.54%) and pressmud (0.50%) treatments. The highest increase in soil microbial biomass C (185.5%) and soil microbial biomass N (220.2%) over its initial value was recorded with the addition of FYM. Dry matter production in plant, as well as ratoon crop, was significantly higher by bio-manure application over the control. Plant N uptake was highest in the press mud treatment (227.7 kg ha^{-1}), whereas P and K uptake were highest (41.4 and 226.50 kg ha^{-1}) in vermicompost treatment. The highest number of millable canes (95.6 and 101.0 thousand ha^{-1}) in plant and ratoon crop were obtained with the addition of pressmud. The highest yield (76.7 t ha^{-1}) was recorded in planted cane with vermicompost application, whereas ratoon yield was highest (78.16 t ha^{-1}) with pressmud application. In both planted and ratoon crop, organic amendments produced yields statistically similar to those with recommended NPK (76.1 and 78.1 t ha^{-1} for plant and ratoon cane).

20

Solanki RM and Bhalu VB and Jadav KV (2006). *Organic farming approach for sustaining productivity of rainfed groundnut.* Annals of Agricultural Research, 27 (3): 236-239.

A field experiment was conducted during kharif 1999, 2000 and 2001, in Junagadh, Gujarat, India, to study the effects of organic manures on the yield attributes of rainfed groundnut as well as on the soil nutrient status.

Application of farmyard manure (FYM) at 10 t/ha recorded significantly higher pod yield (2785 kg/ha) and gross return (Rs. 314 471/ha) with the maximum net return of (Rs. 17 597/ha), followed by the application of the recommended dose of fertilizer. FYM at 10 t/ha every year on the same site significantly increased the available N, P2O5 and K2O in the soil.

21

Britto, A., and L. Sorna Girija. (2006). "Investigations on the effect of organic and inorganic farming methods on black gram and green gram." *Indian Journal of Agricultural Research* 40, no. 3: 204-207.

Two pulses namely Black Gram and Green Gram have been tested for the effect of organic farming and it has been compared with inorganic farming too. The morphological parameters were considered and significant differences exist between the two methods. Panchagaviya and biogas slurry not only increased the yield but also controlled the number of pests.

22

Prabhakar, M., and S. S. Hebbar. (2006)."Studies on organic production technology of annual drumstick in a semi-arid agroecosystem." In *the International Conference on Indigenous Vegetables and Legumes. Prospectus for Fighting Poverty, Hunger and Malnutrition 752*: 345-348.

Moringa oleifera Lam. (Drumstick) is the most widely known and utilized species of the family Moringaceae. India is the largest producer of this nutritionally rich, fast growing, drought tolerant, hardy crop capable of getting adapted to varied ecosystems. It can fit very well as a candidate crop for organic cultivation. Hence, the present investigation was carried out to study the performance of annual drumstick (cv. PKM-1) under organic culture for three consecutive years from July 2003 on red sandy loam soil of Indian Institute of Horticultural Research, Bangalore. Five organic nutrient treatments and one conventional nutrient supply as checked were compared. The crop was raised with protective irrigation and warranted plant protection measures were adopted using biopesticides. The results showed that the crop performance with respect to tree growth, yield and yield components were significantly influenced by organic treatments tested. Tree trunk diameter was higher with farm yard manure (FYM) applied at 15 kg/tree or with vermicompost applied at 5 kg/tree along with biofertilizers (Azospirillum and phosphate solubilizing bacteria) at 5 kg/hectare as compared to other organic treatments such as green leaf manuring combinations or reduced FYM application rates. Similar trend was noticed with respect to fresh pod yields which was higher (9.7 t/ha /year) with treatments receiving higher doses of FYM followed by green leaf manuring supplemented with rock phosphate and wood ash (8.5 t/ha/year). These yields were on par with conventional treatment receiving recommended doses of chemical fertilizers and manures (8.6 t/ha/year). The higher yields were mainly due to higher number of pods produced per tree rather than fruit size. It can be concluded that organic drumstick production is feasible and is sustainable economically as well as socially in the present context of reducing pollution of natural resources and cost of farm production.

23

Singh SR (2006). “Response of biofertilizers and pesticides on yield and quality of cabbage, radish and brinjal in vegetable-based rotation system.” *Applied Biological Research* 8, no. 1and2. 33-36.

Microbial biotechnology has emerged as an effective tool in offering tremendous potential to increase productivity under a biodynamic production system. To ascertain the effects of different biofertilizers and biopesticides used in combination with organic nutrients on different vegetable crops viz. cabbage, radish and brinjal, an experiment was planned to find ideal microbial strains for specific crop and suitable biopesticides against major vegetable pests so as to develop a complete package of organic farming. The treatments consisted of five combined sources of microbial fertilizers, including chemical fertilizer, and four sources of microbial pesticides including chemical pesticides. Among the tested biofertilizers, Azospirillum brasilense manifested better response for each included crop under mid-hill conditions of Himachal Pradesh, India. Though the yield in organic produce was at par with produce obtained under conventional methods, the produce was superior in protein and vitamin C contents with better shelf life under ambient storage conditions. The nitrate content, which has an ill effect on health, was also quite low in these treatments. In case of biopesticides Bacillus thuringiensis (Bio-lap & Elcar) and Neem-based pesticide Neemarin were found equally effective in controlling Diamond moth of cabbage, leaf caterpillar of radish and shoot and fruit borer of brinjal as chemical pesticide Endosulfan.

24

Banik, P., P. K. Ghosal, T. K. Sasmal, S. Bhattacharya, B. K. Sarkar, and D. K. Bagchi. (2006). “Effect of Organic and Inorganic Nutrients for Soil Quality Conservation and Yield of Rainfed LowLand Rice in Subtropical Plateau Region.” *Journal of Agronomy and Crop Science* 192, no. 5 (2006): 331-343.

The Effect of Organic Sources of Nutrients and Inorganic Fertilizers, was Studied on Grain Yield of Lowland Rice and some Aspect of Soil Quality Parameters in a Field Experiment at Agricultural Experimental Farm of Indian Statistical Institute, Giridih, Situated at Eastern Plateau Region of India, during Consecutive Years 1997-2002. Chemical Fertilizers and Various Organic Matters were Applied to Two Rice Cultivars, Sabita and Subarna. The Highest Mean Grain Yield was 3.53 T Ha^{-1} and Maximum Agronomic Efficiency was 60.3 % with the Application of Inorganic Fertilizer Followed by Cow Dung, where 3.47 T Ha^{-1} Grain Yield was Recorded with an Agronomic Efficiency of 57.5 %. Grain Yield of Rice Recorded under Organic Sources of Nutrients was not Significantly Different from that of Inorganic Fertilization though there was Improvement in Soil Quality Parameters under Organic Sources. Soil Organic Carbon (0.72 %), Microbial Biomass-c (279.23 ìg G^{-1} Dry Soil), Urease Activity with Buffer (33.54 ìg Urea Hydrolyzed G^{-1} Oven-dry Soil) and Non-buffer (21.97 ìg Urea Hydrolyzed G^{-1} of Oven-dry Soil) Methods and Acid Phosphatase Activity (2.24 ìg Para-nitrophenol Released G^{-1} of Oven-dry Soil) Analysed Following the Harvest of the Crop were Highest under Cow Dung Manure Treatment; the most Efficient Organic Source under the Experiment. Mean Grain Yield of Rice was Significantly Higher in Sabita Cultivar over Subarna. The Regression Analyses among the Variables have Shown that there was Linear Relationship among Soil Parameters and Grain Yield of Rice.

25

Blaise, D. (2006). Yield, boll distribution and fibre quality of hybrid cotton (Gossypium hirsutum L.) as influenced by organic and modern methods of cultivation. *Journal of Agronomy and Crop Science* 192, no. 4: 248-256.

India is the largest cotton-growing country (8.9 million hectares) in the world and most of the area is rain-dependent. Large amounts of pesticides are used for the control of sucking pests and lepidopterans. Increasing demand for clean organic fibre has led to an interest in organic cotton. However, information on the effects of organic cultivation on fibre quality is limited. Seed cotton yield and fibre quality (length, strength, micronaire and uniformity) were determined for an organic and modern method of cultivation during 3 years (2002–2003 to 2004–2005) of a 11-year (1994–1995 to 2004–2005) study. Vertical and horizontal distribution of bolls on a cotton plant was also determined in 2003–2004 and 2004–2005. At the end of year 11, soil samples were collected and analysed for soil organic carbon content, water-stable aggregates (%), and mean weight diameter. Averaged over 3 years, an additional 94 kg seed cotton ha^{-1} was produced in the organic over the modern method of cultivation and the difference was significant. The year × treatment interaction was significant. Seed cotton yield in the organic plots was significantly greater than the modern method of cultivation plots in 2003–2004 because of a well-distributed normal rainfall and low pest incidence. The main stem nodes 13–22 accounted for the largest numbers of bolls present on the plant. Plants of the organic plots had significantly (37–71 %) more balls on nodes 13–27 than those for the plants of the modern method of cultivation. Lateral distribution of bolls on a sympodial (fruiting) branch, was noticed up to fruiting point 11. However, treatment differences were not significant. With regard to fibre quality (length, strength, fineness and uniformity), differences between years were significant. Inferior quality fibre was produced in 2004–2005 because of delayed planting and early cessation of rain. On average, cotton grown under organic conditions compared with the modern method of cultivation had significantly better fibre length (25.1 vs. 24.0 mm) and strength (18.8 vs. 17.9 g tex^{-1}). Soil samples of the organic plots had significantly greater C content, water stable aggregates and mean weight diameter than the modern method of cultivation plots. Differences were restricted to the top layers (0–0.1 and 0.1–0.2 m). Yield benefits of growing cotton in an organic system over the modern method of cultivation are expected to be greater in years receiving normal rainfall and having low pest incidence.

26

Jackson, G. J. “Organic cotton farming in Kutch, Gujarat, India.” *Agrocel, Gujarat, India* (2005).
Jackson, Geoff. “Organic Cotton Farming in Kutch, Gujarat, India.” *Outlooks on Pest Management* 19, no. 1 (2008): 4-6.
These results echo a common finding across India as recorded by Menon: after conversion to organic cotton, farmers find that their yields go down but eventually recover to roughly the same as before; their expenses are far less, they get a premium for their cotton, and their net earnings are substantially higher.

27

Duhoon, S. S., A. Jyotishi, M. R. Deshmukh, and N. B. Singh. (2004). “Optimization of sesame (Sesamum indicum L.) production through bio/natural inputs.” In *4th International Crop Science Congress, Brisbane*. 2004

India ranks first in area (29%), production (26%) and export (40%) of sesame (*Sesamum indicum* L.) in the world. Sesame seeds are a rich source of food, nutrition, edible oil, health care and bio-medicine. Sesame oil has excellent nutritional, medicinal, cosmetic and cooking qualities for which it is known as ‘the queen of oils’. Due to the presence of potent antioxidants, sesame seeds are called ‘the seeds of immortality’. With the growing health consciousness, the international demand and export of sesame are continuously increasing. Consequently, sesame has recently emerged as a valuable export crop, presently earning over Rs. 1000/- crores of valuable foreign exchange from the export of 2.5 lakh tonnes of sesame seed. So much so, India’s share in world’s trade of hulled sesame has gone up to 60 % during 2002-03. However, pesticide residue had been the major problem in the promotion of sesame export. To enhance the production and export of sesame, the technology needs reorientation and refinement with emphasis on the quality of the produce to match with export standards and demands of international markets. The organically produced sesame will suit the tailor-made requirements of the foreign buyers and will get premium in the international market.

The studies on the optimization of sesame production through the use of bio/natural inputs conducted at four centers of All India Coordinated Research Project, during 2002-03 and 2003-04 revealed that among 12 treatments with recommended dose of nutrients through different combinations of bio/ natural inputs, the highest seed yields were recorded with the application of [FYM 3.75 t/ha + Neem cake @ 900 kg/ha + wood ash 75 kg/ha + bone meal 75 kg/ha + ELS 20 kg/ha + PSB 5 kg/ha + *Azotobacter* 5 kg/ha + *Trichoderma viride* (0.4%) seed treatment + Neem oil (2.0%) spray thrice at 15, 30 and 45 DAS/ *Azadirachtin* (0.03% at 30 DAS)]. The mean yield pooled over locations and years (782 kg/ha) recorded in T_2 was on par with the highest yield (786 kg/ha) recorded in T_1 with the application of recommended dose of chemical fertilizers @ 60 N+40 P+20 K+20 S kg /ha and pesticides. The maximum 1000-seed weight (2.63 g) and oil content (52.0 %) and oil yield (406 kg/ha) were also recorded in treatment $T_{2.}$, besides other direct and indirect beneficial effects on agro-ecology, oil, soil and human health. The results confirmed the feasibility of substituting chemical fertilizer and pesticides by organic resources without sacrificing the yield levels in sesame crops. The use of organic sources will reduce dependence on chemical fertilizers and pesticides besides being ecologically sound and eco-friendly in nature. Marginally higher net monetary return and benefit-cost (B:C) ratio observed with the application of chemical inputs were due to the same rate of produce without consideration of premium for organic treatments.

28

Rupela, O. P., C. L. L. Gowda, S. P. Wani, and G. V. Ranga Rao. (2004). "Lessons from non-chemical input treatments based on scientific and traditional knowledge in a long-term experiment." In *Agricultural Heritage of Asia: Proceedings of an International Conference*, pp. 6-8.

A long-term experiment continuing at ICRISAT, Patancheru, India, since June 1999, on a rainfed Vertisol compares four crop-husbandry systems to determine the yield levels a cash-poor (but knowledge-rich) farmer could harvest by using locally available, low-cost technologies and resources. Two of the four systems are low-cost (LC1 and LC2 or T1, T2). The third (Conventional Agriculture – CA or T3) is a control that receives input types and levels as recommended by research institutions for a given crop in the region, and the fourth (CA+biomass, or T4) receives all chemical inputs as applied to CA and biomass as applied to low-cost system 2 (T2). The LC systems depend on inputs based on scientific and traditional knowledge (TK) of farmers, where crop residues, farm-waste, compost, Gliricidia lopping, bacterial inoculants, and herbal extracts are used as nutrients and as biopesticides to manage pests. The TK items involved are cow urine, wash of composted foliage of neem and Gliricidia, and a curd recipe. The experiment will complete 6 years in March/April 2005. Combined yield of rainy and post rainy seasons within a year (annual productivity) of the two low-cost systems was generally similar to that of the conventional system. In some cases, high yield in the low-cost systems was due to less pest damage and not due to high crop growth. At least 5–11 t ha-1 of biomass was produced in-situ by the different crop-husbandry systems, which was returned to the soil in the low-cost systems. The implications of such observations are presented along with data.

29

Sarkar S, SR Singh and RP Singh. (2003). "The effect of organic and inorganic fertilizers on soil physical condition and the productivity of a rice–lentil cropping sequence in India." *The Journal of Agricultural Science* 140, no. 04: 419-425.

A field experiment lasting 9 years was initiated in 1987 to study the effect of integrated nutrient management involving incorporation of wheat straw (WS) or farmyard manure (FYM) alone or in combination with inorganic fertilizer on a fine loamy mixed hyperthermic udic Ustochrept. Soil physical properties and the productivity of a rice-lentil cropping sequence were examined in a dry land farming system.

At the end of the ninth cropping season, addition of organic materials had increased organic carbon, aggregate stability, moisture retention capacity and infiltration rate of the surface soil while reducing the bulk density. Application of inorganic fertilizer alone decreased the stability of macro aggregates and moisture retention capacity but increased the bulk density values. Treatment effects on moisture retentivity were more pronounced in the higher (0·3-1·5 MPa) suction range. During the first six experimental years, sole application of inorganic fertilizers produced 10-17% higher grain yield of rice, compared to sole application of organic sources or combined organic and inorganic sources. Annual applications of wheat straw and farmyard manure gave higher grain yields of rice from the seventh year onwards. Grain yields of lentil were higher with organic sources either alone or combined with inorganic nutrients.

ORGANIC FARMING: VALIDATION OF PRACTICES

30

Pradeep G and Sharanappa (2014). Effect of organic production techniques on the growth, yield, quality and economics of chilli *(Capsicum annuum)* and soil quality in the dry zone of Karnataka. Indian Journal of Agronomy Vol. 59

A field experiment was conducted during the rainy (kharif) season of 2011 and 2012 in sandy clay loam soils at Bengaluru, to study the effect of different sources of organic manures on growth, yield, quality, economics and soil quality of chilli (*Capsicum annuum* L.). There were 13 treatments, comprising basal application of farmyard manure and vermicompost, bio digested and enriched bio digested liquid manures (BDLM and EBDLM applied after transplanting in 3 splits), 3 sprays of 3% panchagavya (PG) and vermiwash (VW). The treatments were replicated thrice. Among the treatments, application of enriched bio digested liquid manure (EBDLM) at 125 kg N equivalent (eq.)/ ha + 3 sprays of panchagavya (3%) recorded significantly higher plant height (87.0 cm), branches/ plant (32.9), leaf-area index (2.00), leaf-area duration (51.9 days), total dry-matter production/ plant (105.7 g), dry fruit yield (0.90 t/ha), fruits/plant (39.0), 100-fruit weight (135.1 g), fruit length (14.4 cm), ascorbic acid (137.3 mg/100 g) capsaicin content (0.64%), total extractable colour (280.8 ASTA units), oleoresin content (15.4%), gross return (₹1,51,668), net returns (96,281), benefit: cost (2.74) ratio, and significantly higher soil organic carbon (0.63%), available nitrogen (377.9 kg/ha), phosphorus (87.3 kg/ha), potassium (206.7 kg/ha), bacteria (37.0×10^6 cfu/g soil), fungi (23.2×10^3 cfu/g soil) and Actinomycetes (13.2×10^3 cfu/g soil) population as compared to the control.

31

Choudhary, K. M., Manish M. Patel, and R. D. Pagar. (2014). "Effect of foliar application of panchagavya and leaf extracts of endemic plants on groundnut (Arachis hypogaea l.)." Legume Research-An International Journal 37, no. 2: 223-226.

The present study was aimed to improve the growth and yield of groundnut (*Arachis hypogaea* L.) under foliar spray of panchagavya and leaf extracts as organic source of nutrient. The experiment was conducted during *Kharif 2010.* The results revealed that foliar application of panchagavya + leaf extract of neem recorded significantly higher number of nodules, number of pods per plant, pod weight per plant, pod yield, haulm yield and harvest index as compared to other treatments. Panchagavya + leaf extracts of neem recorded significantly higher 100 kernels weight, shelling percent, nutrient uptake of N and P, oil content over other sources. Foliar application of panchagavya with leaf extract of plants both at branching and flowering stages was found most effective with respect to nutrient uptake of N and P kernels and haulms as compared to single application either at branching or flowering stage.

32

Singh Awani K, Ranjay K Singh, AK Singh, VK Singh, SS Rawat, KS Mehta, A Kumar, Manoj K Gupta and Shailja Thakur. (2014). "Bio-mulching for ginger crop management: Traditional ecological knowledge led adaptation under rainfed agroecosystems." *Indian Journal of Traditional Knowledge* 13, no. 1: 111-122.

Sustainability of organic farming depends on the organic inputs. As such, other than a few fertilizers and plant protection measures, there have been scanty resources available to farmers for continuing organic farming. Some farmers in India have evolved traditional ecological knowledge (TEK) based location specific practices to sustain their agroecosystems and continue organic farming. In this paper, an attempt has been made to explore TEKled adaptations in bio-mulching to grow ginger (Zingiber officinale Roscoe) as a crop and to test empirically the best practices including identifying the best leaves and local bio-mulching materials applied by farmers. The role of TEK-led adaptive practices for controlling moisture loss, temperature regulation, reduced disease incidence, quality yield and economic aspects of ginger production are examined. The study was conducted in nine randomly selected villages of Champawat district, Uttrakhand (Western Himalaya). Data was collected using open ended questions in association with participatory rural appraisal (PRA) tools. Results indicated that farmers have developed major TEK led adaptive practices for organic ginger production after seeding in the field, namely using the leaves of oak (*Quercus leucotrichophora* A. Camus.), chir pine needles (*Pinus roxburghii* Sarg.), local mixed grasses (e.g., *Chrysopogon fulvus* (Spreng.) Chiov, [*Cymbopogon distans* (Nees ex Steud.) W. Watson], [*Pennisetum glaucum* (L.) R.Br. syn. *Setaria glauca* (L.) P. Beauv],[*Heteropogon contortus* (L.) P.Beauv. ex Roem. & Schult]. shrubs [*Chromolaena odorata* (L.) R.M.King & H.Rob.] syn. *Eupatorium odoratum* L.) and animal wastage. This last consists of mixed oak, bhimal (*Grewia optiva* J.R. Drumm ex Burret), kharik (*Celtis australis* L.), timala (*Ficus auriculata* Lour.syn. *Ficus roxburghii* Stud.) leaves, grasses, paddy and finger millet straw and cow dung and urine. Women were observed to be using more of these TEK led adaptive practices than men. Empirical field studies carried out on TEK led adaptive practices under rain-fed agro ecosystems of farmers revealed significant results including longer rhizome length (up to 6.50 cm), higher number of rhizomes per plant (35.30), higher ginger yield (211.50 q/ha), higher B:C (benefit to cost) ratio (1:2.18) and lower percentage of disease (bacterial wilt; soft rot and leaf spot) incidence (17.5%) in oak leaf mulch. Soil moisture conservation (44.75%) and optimum soil temperature (24.80 0C) were recorded as significantly better under the oak leaves for using bio-mulching as compared to all other TEK led bio mulching practices for organic ginger production. The oak leaves used as bio-mulch in organic ginger increased yield by 43% and net returns by 61% as compared to no mulching (control). It is concluded that, under temperate climate and rain-fed agro ecosystems, TEK led adaptive practices by farmers in growing ginger are economically feasible, energy efficient and ecologically sustainable, through the addition of soil organic carbon. However, there is a need for scientific and institutional promotion in participatory modes for such practices, with a provision for integrating these practices with science and policy on climate adaptation.

33

Gopakkali Pradeep and Sharanappa. (2014). Effect of organic farming practices on growth, yield, quality and economics of onion (*Allium cepa)* in the dry zone of Karnataka. Indian Journal of Agronomy. Vol. 59 (2): 336-340

The field experiment was conducted during summer 2012 and winter season (*rabi*) of 2012–13 to study the effect of different sources of organic manures on growth, yield, quality and economics of onion (*Allium cepa* L.). The experiment was carried out in an organic experimental plot at Zonal Agriculture Research Station, GKVK, Bengaluru, under organic crop production. There were 13 treatments, comprising basal application of farmyard manure, vermicompost, bio digested and enriched bio digested liquid manures (BDLM and EBDLM applied after sowing in 3 splits), 3 sprays of 3% panchagavya (PG) and vermiwash (VW). Application of enriched bio digested liquid manure (EBDLM) at 100 kg N equivalent/ha + 3 sprays of panchagavya (3%) recorded the highest plant height (42.3 cm), leaves/plant (8.1), leaf diameter (1.46 cm), leaf-area index (4.26), total dry matter production/plant (7.59 g), fresh weight of bulb (143.7 g), bulb yield (42.8 tonnes/ha), neck diameter (1.42 cm), bulb diameter (6.02 cm), bulb length (5.36 cm), bulb size index (32.26 cm^2/bulb), ascorbic acid (26.1 mg/100 g), total soluble solid (14.4%), reducing sugar (3.98%), non-reducing sugar (9.05%), total sugar (13.03%), gross returns (Rs. 4,72,000), net returns (Rs. 3,61,557) and benefit: cost ratio (4.27).

34

Paras Jain, Ravi Chandra Sharma, Pradip Bhattacharyya and Pabitra Banik (2014). Effect of new organic supplement (Panchgavya) on seed germination and soil quality. Environmental Monitoring and Assessment. Vol. 186 (4): 1999-2011.

We studied the suitability of Panchagavya (five products of cow), new organic amendment, application on seed germination, plant growth, and soil health.

After characterization, Panchgavya was mixed with water to form different concentrations and was tested for seed germination, germination index, and root and shoot growth of different seedlings. Four percent solution of Panchagavya was applied to different plants to test its efficacy. Panchgavya and other two organic amendments were incorporated in soil to test the change of soil chemical and microbiological parameters. Panchgavya contained higher nutrients as compared to farmyard manure (FYM) and vermicompost. Its application on different seeds has positively influenced germination percentage, germination index, root and shoot length, and fresh and dry weight of the seedling. Water-soluble macronutrients including pH and metal were positively and negatively correlated with the growth parameters, respectively. Four percent solution of Panchagavya application on some plants showed superiority in terms of plant height and chlorophyll content. Panchgavya-applied soil had higher values of macro and micronutrients (zinc, copper, and manganese), microbial activity as compared to FYM, and vermicompost applied soils. Application of Panchagavya can be gainfully used as an alternative organic supplement in agriculture.

35

Radha TK and DLN Rao. (2014). "Plant Growth Promoting Bacteria from Cow Dung Based Biodynamic Preparations." Indian Journal of Microbiology: 1-6.

Indigenous formulations based on cow dung fermentation are commonly used in organic farming. Three biodynamic preparations viz., Panchagavya (PG), BD500 and 'Cow pat pit' (CPP) showed high counts of lactobacilli (109 ml"1) and yeasts (104 ml"1). Actinomycetes were present only in CPP (104 ml"1) and absent in the other two. Seven bacterial isolates from these ferments were identified by a polyphasic approach: *Bacillus safensis* (PG1), *Bacillus cereus* (PG2, PG4 PG5), *Bacillus subtilis* (BD2) *Lysinibacillus xylanilyticus* (BD3) and *Bacillus licheniformis* (CPP1). This is the first report of *L. xylanilyticus* and *B. licheniformis* in biodynamic preparations. Only three carbon sources— dextrose, sucrose and trehalose out of 21 tested were utilized by all the bacteria. None could utilize arabinose, dulcitol, galactose, inositol, inulin, melibiose, raffinose, rhamnose and sorbitol. All the strains produced indole acetic acid (1.8–3.7 ìg ml"1 culture filtrate) and ammonia. None could fix nitrogen; but all except *B. safensis* and *B. licheniformis* could solubilize phosphorus from insoluble tri-calcium phosphate. All the strains except *L. xylanilyticus* exhibited antagonism to the plant pathogen *Rhizoctonia bataticola* whereas none could inhibit *Sclerotium rolfsii*. In a greenhouse experiment in soil microcosms, bacterial inoculation significantly promoted growth of maize; plant dry weight increased by ~21 % due to inoculation with *B. cereus* (PG2). Results provide a basis for understanding the beneficial effects of biodynamic preparations and industrial deployment of the strains.

36

Saravanan T, P Panneerselvam and Pollachi Manakkadavu. (2014). "Effect of organics on growth and economics of Bengal gram cultivation in North Eastern zone of Tamilnadu." International Journal of Advanced Life Sciences. Vol. 7(1): 100-106.

A field experiment was conducted on clay-textured soil at NRPADS Research Station, Namakkal, during rabi season of 2011-12 and 2012-13 to study the effect of organics on growth and yield of Bengal gram (CicerarietinumL.) in clay textured soils of Tamilnadu. The soil application of organic manures and foliar spray of liquid organic manures at flower initiation and 15 days after flowering (DAF) significantly enhanced the growth and yield parameters of Bengal gram viz., plant height, number of branches, Leaf Area Index, Total Dry Matter, number of root nodule, dry weight of nodules, number of pods per plant, 100-seed weight, and grain yield. Among treatment combinations, application of enriched compost 1/3 + vermicompost 1/3 + Dhaincha leaf manure 1/3 equivalent to 100% RDN and foliar spray of panchagavya @ 3% at flower initiation and 15 DAF has recorded significantly higher grain yield (2400 kg/ha), haulm yield (3423 kg/ha), number of pods per plant (66.38) and 100-seed weight (20.91 g) compared to other treatment combinations. While, lowest grain yield (1446 kg/ha), haulm yield (2376 kg/ ha), number of pods per plant (43.91) and 100-seed weight (18.18 g) were recorded in control treatment (water spray – C2). Significantly higher B:C ratio (3.34) was recorded with M2 among organic manures, L1 (3.31) among liquid organic manures and M2La (3.69) among combinations of both.

37

Mohanty M, PP Das and SS Nanda. (2014). "Introducing SSI (Sustainable Sugarcane Initiative) Technology for Enhanced Cane Production and Economic Returns in Real Farming Situations Under East Coast Climatic Conditions of India." *Sugar Tech*: 1-5.

An on-farm trial in a participatory mode was conducted consecutively during 2011–2012 and 2012–2013 cropping seasons at Patuli Sahi village under Odagaon block of Nayagarh district in Odisha with a view to draw a comparative statement of the advantages of sustainable sugarcane initiative (SSI) technology of cane cultivation over the conventional three bud setts planting. Twenty-five day old seedlings were planted at 120 × 60 cm distance in SSI technology as against three bud sets planted at 75 cm row to row spacing in conventional practice. The study thus revealed that by adopting SSI technology of sugarcane cultivation, the farmers could realize a cane yield of 105 t/ha which was 18 % higher as against 89 t/ha obtained from the conventional method of cane cultivation. The cost of cultivation was Rs. 1,69,300/ha in conventional cane cultivation which came down to Rs. 1,51,950/ha when the crop was grown by SSI technology. The gross and net returns were Rs. 2,36,250 and 84,300/ha, respectively by adopting of SSI technology as compared to Rs. 2,00,250 and 30,950/ha in conventional cane farming. Sugarcane planting by SSI technology has thus proved to be more productive and economically viable since it also fetched more net returns per unit area for time invested, and can be a better option for the farmers of east coast zone of India. The SSI technology was also judged as the most sustainable by the farmers in their local agricultural production system.

38

Sridhar, Kandikere R., Bombrana S. Kadamannaya, and Kishore S. Karamchand. (2013). "Nutrient composition of pill millipede manure of the Western Ghats, India." *Journal of Forestry Research* 24, no. 3: 539-545.

Nutrient composition of the manure of four pill millipedes (*Arthrosphaera dalyi, A. davisoni, A. fumosa and A. magna*) inhabiting semi-evergreen forests and plantations of the Western Ghats of Southwest India was evaluated. The quantity and quality of fecal pellets differed between millipedes and their habitats (forest and plantation). Organic carbon content in manure was lower in plantations than in forests, while nitrogen content was elevated in plantations. The carbon to nitrogen (C/N) ratio of manure was lower in plantations compared to forests. The phosphorus content in manure was elevated in plantations in all except for A. dalyi. Calcium content of manure was increased in plantations than in forests. The contents of magnesium, potassium and phenolics in manure showed varied results. The mass of fecal pellets was correlated only with volume in forests ($r=0.882$; $p<0.01$) and pH in plantations ($r=0.616$; $p<0.05$), while the volume of fecal pellets was correlated with nitrogen content in forests ($r=0.751$; $p<0.01$) and calcium in plantations ($r=-0.619$; $p<0.05$). The conductivity was positively correlated with phosphorus and potassium, while magnesium was negatively correlated in forests as well as plantations. Potassium and magnesium were negatively correlated in forests ($r=-0.920$; $p<0.001$) and plantations ($r=0.692$; $p<0.05$). Overall, the physicochemical characteristics and nutrient composition of fecal pellets differed between millipedes as well as habitats. The low carbon to nitrogen ratio and the increased nitrogen, phosphorus and calcium content in the manure of millipedes inhabiting plantations indicates possibilities for successfully employing them for in situ composting of forest or plantation residues.

39

Pathak RK and RA Ram. (2013). "Bio-enhancers: A potential tool to improve soil fertility, plant health in organic production of horticultural crops." *Progressive Horticulture* 45, no. 2: 237-254.

Indiscriminate use of agro-chemicals during the last 5–6 decades has adversely affected the soil fertility, crop productivity, produce quality and particularly the environment. Annually India is losing nearly 0.8 million tonnes of nitrogen, 1.8 millions tonnes of Phosphorus and 26.3 million tonnes of potassium. Soil organic carbon content in most of the Indian soils has been reduced to >0.5 per cent. The green revolution is exhibiting a second generation problem owing to over exploitation and mismanagement of soil. Under these circumstances, maintenance of soil fertility and crop productivity are the major constraints in agriculture. Excessive mining of micronutrients have led to the deficiency of micronutrients in one or the other parts of the country. As a result, fertigation is becoming popular in most parts of the states. It is pertinent to pinpoint that at present, most of the soluble fertilizers are imported in the country and these are very expensive, beyond the reach of the common farmers. For a number of nutrients, soluble fertilizers are not available. Hence, this requires a change in mindset for addressing this issue. After closely working with Organic Farming Systems for over a decade, we are of the view that "Bio enhancers" could be a cheap and alternative tool to resolve many issues including cheap and effective alternatives for fertigation. In organic production systems, there is always a challenge of how to improve soil fertility, crop productivity and management of pests by organic techniques. Use of organic liquid preparations has been an age old practice in India. On farm produced *Kunapajala*, prepared by fermenting animal flesh along with herbal products used to be an established technique in ancient India. As an alternative, a number of organic farmers devised organic boosters based on local experiences and gave specific names such as *Amritpani, Panchagavya, Beejamrita, Jiwamrita* etc. Similarly, in other organic farming systems, few effective preparations such as BD-500, BD-501, Cow Pat Pit, Biodynamic liquid manures and in Homa Organic Farming: Agnihotra ash enriched water and Biosol are effective tools being used by a number of organizations. It is interesting to note that in all these preparations, the basic ingredients are cow-based products. In order to give a generic name, hence forth, these are named as "Bio enhancer" which is almost new to the world and scientific community. Review of available literature with bio enhancer indicates that there is immense scope for its promotion in agriculture. Hence, we have tried to review the available information with objectives to communicate to the scientific community to initiate systematic research, extension agencies to promote these as cheap alternatives of agro chemicals and farmers to prepare their own products and utilize them as per requirement.

40

Saritha, M., B. Vijayakumari, Y. R. Hiranmai, and L. S. Kandari. (2013). "Influence of Selected Organic Manures on the Seed Germination and Seedling Growth of Cluster Bean (*Cyamopsis tetragonoloba* (L.) Taub)." *Science, Tech and Arts Res Journal* 2(2): 16-21.

Organic agriculture is a sustainable and environment friendly production system that offers a wide range of economic, environmental, social and cultural benefits. In the wake of the resources constraints for external farm inputs faced by farmers in developing countries, sustainable agriculture that relies on renewable local or farm resources presents desirable options for enhancing agricultural productivity. The present study was focused on the influence of organic manures such as panchagavya, micro-herbal fertilizer, bio fertilizer, humic acid and farm yard manure (FYM) on the germination and biometric parameters of cluster beans. The panchagavya soil treatment recorded best germination on 7th and 21st days after sowing and in panchagavya leaf treatment on 14th and 28th DAS. The root length on 60th day, shoot length on 30th, 60th and 90th day root volume on 60th day, number of leaves on 60th day, dry weight on 60th day, fresh weight on 60th and 90th day were improved by panchagavya leaf treatment compared to control. The panchagavya soil treatment improved the number of leaves on the 30th day. The dry weight on the 30th day was influenced by FYM, panchagavya soil treatment and panchagavya leaf treatment. The FYM improved root length, number of leaves, root volume and dry weight on the 90th day. It was observed from the study that the treatment containing panchagavya (or) biofertilizer (rhizobium) (or) FYM could be an ideal and suitable potting mixture for better seedling and crop production in clusterbean.

41

Balasubramanian D, K Arunachalam, A Arunachalam and AK Das. (2013). "Effect of Water Hyacinth (*Eichhornia crassipes*) Mulch on Soil Microbial Properties in Lowland Rainfed Rice-Based Agricultural System in Northeast India." *Agri Research* 2, no. 3: 246-257.

Most water bodies in the humid tropical areas of Arunachal Pradesh are infested with gregarious Eichhornia crassipes (Mart.) Solms. Over a period of time, with death and decay, the water bodies are eutrophicated. This natural phenomenon gave forth the idea of using E. crassipes biomass as a compost in agricultural fields for soil nutrients management, using microbial characteristics as potential indicators. The study indicating that water hyacinth as a potential organic substrate can stimulate the growth of diversity of microbial population in agricultural soils. In general, soil respiration and microbial population were significantly ($p < 0.05$) greater in mulched plots compared to control. Among treatments, vermicompost mulched plots recorded for higher bacterial (74.31 CFU $\times 10^4$) and fungal counts (31.09 CFU $\times 10^3$) at both surface and subsurface soil layers. The present study provides baseline information for an ecofriendly approach to management of E. crassipes, especially for the countries where it poses a huge threat to the wetland ecosystems. Nonetheless, nutrient deficient soils in the present study site due mainly to conventional farming practices and nutrient runoff could however be checked by mulching soils with naturally and abundantly growing E. crassipes locally.

42

Choudhary, V. K., and S. P. Kumar. (2013). "Maize production, economics and soil productivity under different organic sources of nutrients in eastern himalayan region, India." *Int. J. Plant Prod* 7, no. 2: 167-186.

Replenishing nutrients through organic sources is essential to maintain the soil health and sustainability in Eastern Himalayan Region, India which is organic by default. Keeping this in mind an experiment was laid out on randomized block design with six treatments viz., T_1: Vermicompost (VC; 2.5 Mg ha^{-1}), T_2: Poultry manure (PM; 1.25 Mg ha^{-1}), T^3: Swine manure (SM; 3.0 Mg ha^{-1}), T_4: Cow dung manure (CDM; 10.0 Mg ha^{-1}), T_5: Farm yard manure (FYM; 10.0 Mg ha^{-1}) and T6: control and replicated thrice to study the effect of applied organic nutrients on growth and yield attributes of maize. The physical parameters like porosity, maximum water holding capacity (MWHC), field capacity (FC), permanent wilting point (PWP), bulk density (BD) and moisture releasing pattern was measured better when the crop was supplied with FYM followed by CDM. Chemical parameters like pH, Soil organic carbon (SOC), available nitrogen (N), phosphorus (P) and potassium (K) were recorded better on VC followed by PM over control. The growth, physiological parameters, yield attributes and yield were recorded higher on VC. The uptake of nitrogen, phosphorus and potassium was higher on VC followed by PM, whereas least nutrients were taken up by control. Similarly the gross and net return was recorded higher on VC followed by PM, whereas, B: C ratio was recorded higher on PM followed by CDM. However the lowest economic returns were recorded on control. Agronomic efficiency was recorded higher on VC followed by PM.

43

Trivedi Amit, SK Sharma, T Hussain and PK Gupta. (2013). "Application of biodynamic preparation, bio control agent and botanicals for organic management of virus and leaf spots of blackgram (Vigna mungo L. Hepper)." Academia Journal of Agricultural Research 1, no. 4: 060-064.

A study was conducted at Instructional Farm, Rajasthan College of Agriculture of Maharana Pratap University of Agriculture and Technology, Udaipur (Rajasthan) during kharif 2010 and 2011. Blackgram or Urad bean is the fourth important pulse crop in India. This study was conducted to develop a package of practice for production of organic blackgram. The objective of this field study was to develop an organic plant protection module for management of yellow mosaic virus and three leaf spot diseases viz Anthracnose (*Colletotrichum lindenuthianum*), Cercospora leaf spot (*Cercospora canescens*) and Alternaria leaf spot (*Alternaria* spp.) of blackgram through biodynamic preparation - BD 501, Biocontrol agent – *Ampelomyce quisqualis* and botanicals viz neem oil, mustard oil and azadirachtin. Neem cake was also used to manage soil borne insects. The pooled data of 2010 and 2011 reveal that viral disease in various treatments ranged between 2.96 to 3.18% while in the untreated control it was 5.94%. The mean minimum percent disease index (PDI) of leaf spots was 28.13% while maximum seed yield was 9.50 q/ha, observed in treatment with spray of BD 501 followed by neem oil 29.38% PDI and seed yield 8.74 q/ha, while maximum PDI could be seen in untreated control (62.75%) with minimum seed yield 7.59 q/ha. Integrated use of biodynamic preparation - BD 501 and botanical neem oil resulted not only in the maximum increase in yield attributes and yield but also significantly reduced the disease incidence of black gram under organic production system.

44

Amalraj E Leo Daniel, G Praveen Kumar, SK Mir Hassan Ahmed, Rasul Abdul, and N Kishore (2013). "Microbiological analysis of Panchagavya, vermicompost, and FYM and their effect on plant growth promotion of pigeon pea (*Cajanus cajan* L.) in India." *Organic Agriculture* 3, no. 1: 23-29.

Organic farming systems are based on principles of nutrient cycling and the minimal use of external inputs. In India, Panchagavya, vermicompost, and farmyard manure are integral components of nutrient management in organic farming systems. The aim of this study was to characterize these three different organic preparations with respect to microbiological quality and impacts on early crop growth. Among the three preparations, Panchagavya had the highest population of total bacteria (2210^9 cfu ml^{-1}), actinomycetes (6010^4 cfu ml^{-1}), phosphate solubilizers (10310^6 cfu ml^{-1}), fluorescent pseudomonas (15110^5 cfu ml^{-1}), and nitrifiers (5.410^6 cfu ml^{-1}). Dehydrogenase activity (6.61 g g^{-1} h^{-1}) and microbial biomass carbon (89.6 g g^{-1}) were also found to be higher in Panchagavya. The short-term plant growth test with Cajanus cajan seeds treated with Panchagavya showed enhanced length of root (19.4 cm) and shoot (16.9 cm), dry mass (147 mg), leaf area (14.57 cm^2), chlorophyll content (23 spad units), and photosynthetic activity (18.8 mol m^{-2} s^{-1}) after 15 days of sowing. Hence, these tests suggest that Panchagavya can be used as a low-cost preparation to support plant growth in organic agriculture.

45

Prasanna, Radha, Vidhi Chaudhary, Vishal Gupta, Santosh Babu, Arun Kumar, Rajendra Singh, Yashbir Singh Shivay and Lata Nain. (2013). "Cyanobacteria mediated plant growth promotion and bioprotection against Fusarium wilt in tomato." *European Journal of Plant Pathology* 136, no. 2: 337-353.

Cyanobacteria - phytopathogenic fungi - tomato plant interactions were evaluated for developing suitable biological options for combating biotic stress (Fusarium wilt) and enhancing plant vigour. Preliminary evaluation was undertaken on the fungicidal and hydrolytic enzyme activity of the cyanobacterial strains (*Anabaena variabilis* RPAN59, *A. laxa* RPAN8) under optimized environmental/nutritional conditions, followed by amendment in compost-vermiculite. Such formulations were tested against Fusarium wilt challenged tomato plants, and the *Anabaena* spp. (RPAN59/8) amended composts significantly reduced mortality in fungi challenged treatments, besides fungal load in soil. Cyanobacteria amended composts also led to an enhancement in soil organic C, nitrogen fixation, besides significant improvement in growth, yield, fruit quality parameters, N, P and Zn content. The tripartite interactions also enhanced the activity of defence and pathogenesis related enzymes in tomato plants. A positive correlation (r=0.729 to 0.828) between P content and pathogenesis/defense enzyme activity revealed their role in enhancing the resistance of the plant through improved nutrient uptake. Light and scanning electron microscopy (SEM) revealed cyanobacterial colonization, which positively correlated with reduced fungal populations. The reduced disease severity coupled with improved plant growth/ yields, elicited by cyanobacterial treatments, illustrated the utility of such novel formulations in integrated pest and nutrient management strategies for Fusarium wilt challenged tomato crop.

46

Rao Hema C, MN Sreenivasa, NS Hebsur, Geetha Shirnalli and HB Babalad (2013). "Influence of microbial enrichment on microbial population and nutrient status of organic manures". *Karnataka Journal of Agricultural Sciences* 25, no. 4.

Among the enriched manures, enriched vermicompost had significantly higher N, P, K and micronutrient contents followed by enriched compost and the least was observed in biogas slurry. Compost enriched with *Azotobacter, Pseudomonas* and rock phosphate had N and P content of 1.75 per cent and 1.61 percent respectively. Enrichement of vermicompost with PSM and FNF significantly increased N P, K, Mg and Mn contents. The nutrient status of composted biogas slurry was 1 per cent N, 0.8 per cent P and 1.5 per cent K. Hence, from this study it can be concluded that there was significant improvement in the microbial population and nutrient concentration (N, P, K and micronutrients) of organic manures due to microbial enrichment. Among the enriched manures, enriched vermicompost had significantly higher microbial load, N, P, K and micronutrient content followed by enriched compost and biogas slurry.

47

Gahukar RT (2013). "Cow urine: A potential biopesticide." Indian Journal of Entomology 75, no. 3: 212-216.

Traditionally, cow urine has been used in medicines in developing and less developed countries. Only recently, its properties as pest control agent have been exploited in plant protection. It is mixed generally with cow dung or plant parts and plant-derived products as these combinations proved effective and cheaper than synthetic pesticides. The action of bioactive constituents is exerted on insect development and survival, cow urine can therefore be considered as a potential biopesticide. However, research on isolation of allelochemicals and mode of action of each of them, whether mixed with cow urine or not, and further field trials on bioefficacy against economically important pests attacking agricultural crops are needed.

48

Thakare, Utkarsha, Neelam Patil, and Nutan Malpathak (2013). "Qualitative and quantitative improvement in the yield of field cultivated chickpea (Cicer arietinum l. Cv. Vijay) using peptone and oxygenated peptone under organic farming condition." International Journal of Bioassays 2, no. 02: 440-444.

Field experiments were conducted to study the impact of soil application of peptone and oxygenated peptone on organically grown chickpea (*Cicer arietinum* L. cv. Vijay). Both the treatments resulted in early flowering and early harvestation, increased number of pods/plant as well as fresh wt. and dry wt. of 100 pods and 100 seeds, with oxygenated peptone showing comparatively higher level. The crop yield was more under oxygenated peptone treatment than under peptone treatment condition. The seeds of peptone treatment showed upper hand as compared to oxygenated peptone in acidity, DNA content and IAA oxidase activity. On the other hand, soil application of oxygenated peptone led to more enhancements in biochemical constituents of seed like total solids, ash, moisture content, crude fiber content, soluble proteins, total carbohydrates, polyphenols, proline, total free amino acids, ascorbic acid and RNA content. This indicates better nutritional quality of seeds. The enzyme activity of catalase, peroxidase, polyphenol oxidase, nitrate reductase and nitrite reductase showed upper hand under oxygenated peptone treatment. The overall picture shows that both peptone and oxygenated peptone were useful for the qualitative and quantitative enhancement in the yield of chickpea under organic farming condition. Oxygenated peptone is more useful in this respect.

49

Kumar, Murugan, Radha Prasanna, Ngangom Bidyarani, Santosh Babu, Brijesh Kumar Mishra, Arun Kumar, Anurup Adak et al. (2013). "Evaluating the plant growth promoting ability of thermotolerant bacteria and cyanobacteria and their interactions with seed spice crops." *Scientia Horticulturae* 164: 94-101.

The potential of eight thermotolerant bacteria (seven *Bacillus* spp. and one actinobacterium *Kocuria* sp.) and two cyanobacteria (*Anabaena laxa* and *Calothrix elenkinii*) as plant growth promoting (PGP) agents was evaluated with seed spices – coriander, cumin and fennel, under controlled conditions in potting mix fortified with microbial cultures. Amendment with *Anabaena* brought about 25% enhanced germination in cumin over control, while *Calothrix* enhanced root/shoot length significantly in all the three crops, especially fennel. Fortification with microbes led to 30–50% increase in shoot/root length, which was reflected as two–three fold enhancement in the vigour index of the plants. Among the bacterial strains, T4 (*Bacillus pumilus*) was most promising in terms of PGP traits in fennel and cumin crop. Plant dry weight and peroxidase activity of shoots and roots were enhanced by 5–10-fold in all the microbe-inoculated treatments, with highest values in *Calothrix* treated coriander seedlings. â-1,3 endoglucanase activity showed twofold enhancement in shoots from *Anabaena* inoculated coriander seedlings. The fungicidal activity of the root extracts from the bacteria treated treatments of coriander seedlings against *Macrophomina phaseolina* was highest, while root extracts of fennel seedlings were able to show largest zones of inhibition against *Fusarium moniliforme.* This study highlighted the promise of fortification with both heterotrophic and photosynthetic microbes in plant growth promotion, and their significant role in enhancing and eliciting peroxidase/endoglucanase enzyme and fungicidal activity of plant extracts of seed spices.

50

Swarnalakshmi K, Dolly Wattal Dhar, M Senthilkumar and PK Singh (2013). "Comparative Performance of Cyanobacterial Strains on Soil Fertility and Plant Growth Parameters in Rice." *Vegetos-An International Journal of Plant Research* 26, no. 2: 227-236.

The diazotrophic cyanobacterial consortium consists of *Anabaena variabilis, Aulosira fertilissima, Nostoc muscorum* and *Tolypothrix tenuis* are widely used to supplement chemical N fertilizers for flooded rice cultivation in India. Our present study was undertaken to evaluate the comparative performance of these individual cyanobacterial species on soil fertility and plant growth in rice at three levels of nitrogenous fertilizer. Significant intergeneric differences were observed with respect to nitrogen fixing potential and other N assimilatory parameters under in vitro conditions. Application of individual cyanobacterial species enhanced N uptake and plant carbon content of rice over uninoculated control. Analyses of soil samples after rice harvest revealed significant differences in soil microbial biomass carbon, organic carbon, available N and increase in grain yields with the cyanobacterial inoculants. Yield increase with *Anabaena variabilis* was comparable with uninoculated control. Correlation coefficient (r) revealed a positive correlation between available nitrogen and soil microbial biomass carbon with N uptake and C content in plants. Our findings revealed functional potential of individual cyanobacterial species in biofertilizer consortia in relation to soil fertility, plant nutrition and yield of rice; however their potential for improving C-N status of flooded rice soils needs to be evaluated at farm level under long-term experimental conditions.

51

Shukla SK, Menhi Lal and Santosh Kumar Singh. (2013). "Improving bud sprouting, growth and yield of winter initiated sugarcane ratoon through tillage cum organic mediated rhizospheric modulation in

Udic ustochrept under subtropical Indian condition." *Soil and Tillage Research* 126: 50-59.

Field experiment was conducted during 2007–2010 at research farm of Indian Institute of Sugarcane (*Saccharum officinarum*) Research, Lucknow. The findings of the investigation revealed that tillage operation performed by Ratoon Management Device (RMD) involving earthing-up from both the sides of sugarcane stubble protects the subterranean buds from cold injury and provides congenial rhizospheric environment for survival and sprouting of buds. Tillage through RMD superimposed with composted trash regulates the soil microbial activities (ex situ soil respiration – 29.52 mg CO_2-C kg^{-1} soil day^{-1} and soil microbial biomass carbon (SMBC) – 187.3 mg C_{microb} kg^{-1} soil day^{-1}). These in turn enhance the sprouting of stubble buds which otherwise fail to sprout under the influence of extremely low temperature. The tillage cum organic treatments creates congenial soil–water–air relations which produce viable and vigorous sprouts.

Translated into practice, it means that the fact 'Tillage is manure' is quite pertinent in winter initiated sugarcane ratoon as mechanical manipulations of soil (tillage) at its optimum moisture level creates favourable physical environment (soil tilth) in root zone (bulk density – 1.35 Mg m^{-3} at 0–15 cm soil depth and infiltration rate – 5.5 mm h^{-1}). Addition of organics further provides congenial substrate/s to soil microbiota and enhances their metabolic activities which along with new activated roots maintain better soil–water– air relations and enhancing their sprouting in cold conditions. This ensures synchronized, early formed adequate number of millable canes (135,000 ha^{-1}), consequently resulting in higher ratoon cane (94.1 Mg ha^{-1}) and sugar yields (8.75 Mg ha^{-1}). The tillage cum organic technology is of immense significance to cane growers by increasing sugar yield in early crushing season from ratoon.

52

Sireesha O and N Venkateswarlu (2013). In-vitro evaluation of botanicals and panchagavya against leaf blast fungus *Pyricularia grisea*. *Asian Journal of Pharmaceutical and Clinical Research* 6, no. 5.

Rice blast caused by *Pyricularia grisea* cav. continues to be a major constraint in rice production. Since, the existing chemical control measures being costly and may favour development of resistance in pathogens, the potential alternative methods have been explored in the present studies. Five plant parts extract namely Neem seed kernel extract, Neem oil, *Asafoetida* spp. and *Pongamia* spp. extracts and Panchagavya, were evaluated for their efficacy against blast of rice in in vitro conditions. The results concluded that the Neem seed kernel showed a significantly more mean suppression value.

53

Kumar Rahul, Amit Kumar, Kuldip Kumar, Vaishnavee Gupta, Triveni Shrivas and Kishu Tripathi (2013). "Synergistic Anthelmintic Activity
Of Different Compositions Of Panchagavya And *Bauhinia Variegata* Linn." International Journal of Phytopharmacology.

Panchagavya, which is an important component of many rituals and Indian traditional systems, is an incredible source for many medicinal substances whose synergistic action has been reported but their scientific data are not available. The main objective is to investigate synergistic anthelmintic activity of panchagavya with ethanolic extract of *Bauhinia variegata* Linn (EEBV). Earthworms were divided into 11 groups & in each group, six earthworms were taken and they were treated with PG1, PG1+10% EEBV, PG1+50% EEBV & PG1+75% EEBV, PG2, PG2+10% EEBV, PG2+50% EEBV &PG2+75% EEBV, Control group with Cow Urine and Standard group with Piperazine Citrate (50 mg/ml and 100 mg/ml concentration) & investigated the role of different composition of Panchagavya and its ethanolic extract of *Bauhinia variegata* Linn (EEBV) for synergistic anthelmintic activity. After drug administration, effect of PG 1, PG 2, PG 1 + EEBV (all composition) and PG 2 + EEBV (all composition) were found to be significant at the level $p<0.01$ as compared to Standard and Control group. The synergistic activity of PG with EEBV might be due to tannin which interferes with energy generation in helminth worm by inhibiting oxidative phosphorylation. Effect of tannin might be potentiated in presence of PG. Other possible mechanism might be that presence of PG could potentiate binding of free protein in GIT of host animal and causes death. This work will open new avenue for the study of various preparations used in worship because this study has showed the synergistic anthelmintic activity. Further studies may reveal some more pharmacological activities like antinociceptive, anti-stress etc. This will give impetus for the study of various materials used in worship of God which will reveal the logic of materials used in worship.

54

Vajantha B, Umadevi M, MC Patnaik and M. Rajkumar. (2013). "Soil fertility status of ashwagandha as influenced by concentrations and methods of application of Panchagavya." *An Asian Journal of Soil Science* 8, no. 1: 143-147.

The field experiments were conducted to study the available N,P,K and S in soil with the effect of Panchagavya made from cow (PG-C) and buffalo (PG-B) products sprayed to plants and applied to soil with different concentrations (3 and 5 per cent to plant and 9 and 15 per cent to soil) at different intervals (3 sprays - 30, 60 and 90 DAS; 4 sprays - 20, 40, 60 and 80 DAS) during Rabi 2007-08 and Kharif 2008. The available nutrients viz., N, P, K, and S was highest with PG-C @ 15% to soil (T10) but it was at par with soil application of PG-B @ 15% to soil and PG-C @ 5% - 4 sprays.

55

Mahanta Dibakar, R Bhattacharyya, KA Gopinath, MD Tuti, BL Mina, BM Pandey, PK Mishra, JK Bisht, AK Srivastva and JC Bhatt. (2013). "Influence of farmyard manure application and mineral fertilization on yield sustainability, carbon sequestration potential and soil property of garden pea–french bean cropping system in the Indian Himalayas." *Scientia Horticulturae* 164: 414-427.

Sustainability of agricultural systems has become an important issue all over the world. Hence, sustainability and climate resilience of garden pea– french bean cropping system was evaluated by yield trends, C sequestration and emission reduction and soil properties as affected by four application rates of farmyard manure (FYM) (5–20 t ha^{-1}) *vis-à-vis* mineral fertilization, integrated nutrient management (INM) practices as 50% recommended NPK + FYM at 5 t ha^{-1} and un-amended control after six years of cropping in the Indian Himalayas. The highest sustainable yield index of 0.606 was achieved with the application of 20 t FYM ha^{-1} (FYM_{20}). The carbon sequestration potential of FYM_{20} plots was about 459 and 193% more than NPK and INM plots, respectively. The same plots reduced 53 and 24% carbon equivalent emission with comparison to NPK and INM application, respectively. The soil cation exchange capacity (CEC) under FYM_{20} plots was 22 and 11% higher than NPK and INM plots. The soil cracking volume under FYM_{20} plots (57 cm^3 m^{-2} area) was very less compared to NPK (324 cm^3 m^{-2} area) and INM (154 cm^3 m^{-2} area) plots. The morning soil temperature (0–15 cm depth) in the coldest week of last year experimentation under FYM_{20} plots was moderated by 0.60 and 0.47 °C than NPK and INM plots, respectively. Successive increase of FYM level improved soil organic C, microbial colony formation unit, dehydrogenase activity, bulk density and soil cracking surface area and the best values for all soil properties were recorded under FYM_{20} plots. Application of 20 t FYM ha^{-1} produced 54 and 29% higher garden pea equivalent pod yield of the system than mineral fertilization and INM, respectively. The principal component analysis revealed that soil CEC was the most important property (among the selected soil parameters) contributing to the pod yield. Soil organic carbon markedly improved other soil properties as evident from correlations. Organic production system with FYM 20 t ha^{-1} could be recommended for climate resilient sustainable yield and better soil property of garden pea–french bean cropping system than mineral fertilization and INM in the Indian Himalayan regions.

56

S Sangeetha, A Balakrishnan and P Devasenapathy (2013). "Influence of Organic Manures on Yield and Quality of Rice (*Oryza sativa* L.) and Blackgram (*Vigna mungo* L.) in Rice-Blackgram Cropping Sequence," *American Journal of Plant Sciences*, Vol. 4 No. 5, pp. 1151-1157.

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during *rabi* and summer seasons of 2007-2008 and 2008-2009 to study the influence of organic manures (enriched farmyard manure compost, vermicompost, farmyard manure+neem cake, enriched farmyard manure compost+vermicompost+farmyard manure, composted poultry manure and enriched poultry manure compost) and recommended NPK fertilizers on yield and quality of rice and blackgram in rice-blackgram cropping sequence. Based on field experiments, it was found that the application of enriched poultry manure compost on equal N basis (2.3 $t \cdot ha^{-1}$) recorded higher yield attributes and grain yield of rice (4675 $kg \cdot ha^{-1}$ in 2007 and 4953 $kg \cdot ha^{-1}$ in 2008), which was however comparable with composted poultry manure. The application of recommended NPK fertilizers recorded higher physical characteristics and cooking qualities of rice, which was comparable with enriched poultry manure compost. Higher sensory score was registered in enriched poultry manure compost as compared to recommended NPK through fertilizers. After harvesting of rice, the residual effect of enriched poultry manure compost and composted poultry manure applied to preceding rice crop improved yield attributes and yield of succeeding blackgram.

57

Yadav SK, Subhash Babu, Y Singh, GS Yadav, Kalyan Singh, Raghavendra Singh, and Harvir Singh. (2013). "Effect of organic nitrogen sources and biofertilizers on production potential and energy budgeting of rice (Oryza sativa)-based cropping systems." *Indian Journal of Agronomy* 58, no. 4: 459-464.

A field experiment was conducted during 2005–06 and 2006–07 at Varanasi, Uttar Pradesh, to find out the effect of organic nitrogen sources and biofertilizers on system productivity and energy budgeting of rice (*Oryza sativa* L.)-based cropping system. Rice–potato [*Solanum tuberosum* (L.)]–onion [*Allium cepa* (L.)] system recorded significantly higher production efficiency (97.5 kg/ha/day), land-utilization efficiency (91.4%), economic efficiency (738/ha/day), energy input (61.08×10^3MJ/ha) and energy output (187.09×10^3MJ/ha). The lowest (39.4×10^3MJ/ha) energy intensiveness was recorded in rice–table pea (Pisum sativum var. hortense)–cowpea [*Vigna unguiculata* (L.) Walp.] cropping system. However, the organic nutrition with biofertilizers (*Azotobacter* and phosphate-solubilizing bacteria) had the highest rice-equivalent grain yield (35.3 t/ha), production efficiency (96.7kg/ ha/day), land utilization efficiency (89.8%), economic efficiency (803 ha/ day) and energy-use efficiency (3.15) of system, followed by organic nitrogen sources alone (3.0). Recommended dose of N @100% through organic nitrogen sources alone was the next best treatment resulting in higher productivity and system efficiency. Rice-potato-onion cropping system was found most productive, profitable and energy efficient with application of 100% recommended dose of nitrogen through organic sources along with biofertilizers.

58

Kumawat RN, Mahajan SS, Santra P (2013). Effect of Panchagavya on soil chemical properties of groundnut (*Arachis hypogea)* rhizosphere and crop productivity in western Rajasthan. Journal of Food Legumes. Vol. 26 (1 and 2): 39-43.

In view of the cost effectiveness and eco-friendly characteristics of the organic amendments, a field experiment was conducted on the high pH soils of arid zone of India to test the efficacy of panchgavya solution as an organic means to ameliorate sodic soil under irrigated condition. Soil application of panchagavya solution @ 3 l/m^2 significantly decreased the soil pH from 9.0 to 8.3 during initial 5 days period whereas it increased soil organic carbon content by 50% and availability of P, Fe, Cu, Zn, and Mn in the rhizosphere by 17% over the control throughout the crop growth stages. The same treatment raised pod yield, haulm yield and biological yield to the tune of 85.3, 93.2 and 89.7% respectively, over the control. Similarly, foliar application of panchagavya in combination with datura (*Datura metel*) leaf extract at 1:1 also enhanced pod yield significantly over control.

59

Chadha Sanjay, JP Rameshwar and Surender Sharma. (2013). "Performance of Different Varieties of Pea (*Pisum Sativum* L.) under Organic Farming Conditions in Mid Himalayas." International Journal of Agriculture and Food Science Technology. Vol. 4 (7): 733-738.
Garden pea (*Pisum sativum* L.) is one of the most important vegetable cash crops of Himachal Pradesh. Growing concern towards pesticides' residues due to their indiscriminate use particularly in vegetable crops has attracted worldwide attention towards organic farming. Choice of right types of varieties for growing under organic farming conditions is of utmost importance as all the recommended/released varieties in present scenario have been developed and evaluated under inorganic farming conditions and it has been often observed that the high input responsive varieties fail to perform better under low input organic farming conditions. Keeping in view the potential of organic farming in India, there is an urgent need to identify the potential genotypes/varieties responsive to low input conditions of organic farming. Trials for evaluation of different varieties of garden pea were conducted consecutively for two years (2011-12 and 2012-13) at Model Organic Farm, CSKHPKV, Palampur for identifying suitable varieties responsive to organic farming systems. Fifty five genotypes of pea including three check varieties viz., Palam Priya, Palam Smool and Punjab-89 were evaluated in Augmented block design with five replicates of check varieties. The seeds were sown at 45 × 10 cm spacing during the second week of November consecutively for two years. Out of 55 genotypes/varieties of garden pea screened during Rabi 2011-12 & 2012-13 for higher productivity under organic farming conditions, EC538008 was recorded the highest yielding (108.58 q/ha) and was statistically at par with Kukumseri-6(101.61 q/ha), IC 267732(101.07 q/ha), DPPM-74 (92.84 q/ha) and DPP-54(91.96 q/ ha). It was also statistically at par with two standard checks viz., Palam Priya (85.24) and Punjab-89 (91.12 q/ha).

60

Yadav SK, Yogeshwar Singh, Yadav MK, Subhash Babu, Kalyan Singh. (2013). Effect of organic nitrogen sources on yield, nutrient uptake and soil health under rice (Oryza sativa) based cropping sequence. The Indian Journal of Agricultural Sciences. Vol. 83 (2).

A two year field experimentation was carried out at Varanasi from 2005– 07 to study the effect of organic nitrogen sources on yield, nutrient uptake and soil health under rice (Oryza sativa) based cropping sequence. The soil was sandy clay loam in the texture with pH 7.4, moderately fertile, being low in organic carbon (0.50%), available nitrogen (185.5 kg/ha). The experiment on rice based cropping sequences with 3 organic N nutrition treatments was laid out in split plot design with three replications. Seven rice based cropping sequences [rice-potato-onion; rice-green pea-onion; rice-potato cowpea (green pod); rice-green pea – cowpea (green pod); rice rajma (green pod)- onion; rice-rajma (green pod)cowpea (green pod) and rice-maize (green cob)-cowpea (vegetable)] were assigned to main plots and three treatments comprising nitrogen application (control; organic manure; organic manure + bio-fertilizer) were allocated to subplots. The system productivity was the highest (355.73 q/ha) with rice–potato–onion cropping sequence under investigation. Among the manurial treatment, organic nitrogen nutrition with biofertilizers had the highest rice grain equivalent yield (353.08 q/ha) and net monetary return (Rs 292454). The application of organic manure alone or along with biofertilizers inoculation significantly improved the N, P, K and S uptake by cropping sequence over control. However maximum improvement in soil health related to soil organic carbon, available nutrient status, soil micro-organism population were observed in organic nitrogen sources alone or along with biofertilizers.

61

Bindhu S, B Vijayakumari and YR Hiranmai. (2013). "Utilization of Biodynamic Farming to Improve Quality Attributes of Soybean (*Glycine max* L. var. Co. Soy)." *Science, Technology and Arts Research Journal* 2, no. 1: 32-35.
Organics must form an indispensable component of the manurial schedule for any crop. The present study was designed to study the effect of bio (BD) compost on biochemical parameters of soya bean plants on 30th, 45th, 60th and 75th day after sowing. The protein content was more in T1 (3.5 kg of BD compost) on biochemical parameters of soya bean plants on 30th, 45th, 60th and 75th day. The total carbohydrate was found to be maximum in T1 (3.5 kg of BD compost) on 30th, 45th, 60th and 75th day. The chlorophyll 'a', 'b' and 'total' chlorophyll were highest in T1 (3.5 kg of BD compost) on 30th, 45th, 60th and 75th day. The ascorbic acid and protein content of the harvested seeds were significantly increased in T1 treatment on 75th day. The biodynamic compost helps in improvement of crop quality and reduces environmental pollution. The study shows that utilization of biodynamic compost is beneficial for legumes to improve the quality of products obtained from the plants.

62

Kumar Manoj and SP Trehan. (2012). "Influence of potato cultivars and N levels on contribution of organic amendments to N nutrition." *Potato Journal* 39, no. 2 (2012).

The field experiment was conducted to quantify the contribution of different organic amendments to N nutrition to potato cultivars of varying efficiency during winter season of 2006–07 and 2007–08 at Central Potato Research Station, Patna, India. All possible combinations of two varieties viz., Kufri Jyoti and Kufri Pukhraj, four nitrogen levels (0, 80, 160 and 240 kg/ha) and five organic amendments (control, rice straw @ 10 t/ha, farm yard manure @ 10 t/ha and 20 t/ha and in situ green manuring with Sesbania aculeata) were replicated thrice in factorial randomized block design. Kufri Pukhraj was better yielder, agronomically more efficient, required less N to produce a given fixed yield in the presence of different organic amendments and derived higher per cent of its N nutrition from organic amendments. This cultivar also showed higher optimum yield level in the presence of all organic amendments and was more eco-friendly with respect to fertilizer N. Green manure added highest amount of N and showed highest efficiency. Kufri Pukhraj utilized more N from green manure and FYM and showed better efficiency than Kufri Jyoti. N equivalent of different organic amendments varied with tuber yield level and it was highest for green manure followed by FYM in both the cultivars. Optimum yield level, net return and benefit cost ratio were also higher for green manure followed by FYM.

63

Sreenivasa MN, Nagaraj Naik and SN Bhat. (2012). "Nutrient status and microbial load of different organic liquid manures." Karnataka Journal of Agricultural Sciences 24, no. 4.

Nowadays organic farming practices are gaining importance as farmers have realized the benefits of organic farming in terms of soil fertility, soil health and sustainable productivity. Farmers are well aware with the use of organic liquid manures such as Panchagavya, Beejamrutha, Jeevamrutha and Biodigester in organic farming. These organic liquid manures play a key role in promoting growth and providing immunity to plant system. The spray of Panchagavya on chillies produce dark green coloured leaves within 10 days. Its role as plant growth promoter has already been reported by Subhashini et al. (2001) and Sreenivasa et al. (2009). The seed dipping in beejamrutha are known to protect the crop from harmful soil-borne and seed-borne pathogens (Sreenivasa et al., 2010). The bio-digester liquid can be used as a botanical pesticide so also as liquid manure. It can be regularly added to the soil along with water at the rate of 200 liter per hectare. Though many farmers are getting better yield by using organic liquid manures, scientific validation has not been carried out so far. Hence an attempt has been made to analyse these organic liquid manures at the Institute of Organic Farming, UAS, Dharwad to know the nutrient status and microbial load during 2010.

64

Jakhar Praveen, D Barman, HC Gowda and M Madhu. (2012)."Multitier cropping system for profitable resource conservation and sustainable management of sloping lands of eastern India." *Indian Journal of Agricultural Research* 46, no. 4: 309-316.

A field experiment was conducted at Research farm of CSWCRTI, Research centre, Sunabeda in District Koraput of Odisha during 2007 -2010 in Kharif season on silty loam red lateritic soil with an objective to access the effect of different Multitier cropping systems on runoff, soil-nutrient loss and economics. The experiment had ten treatments consisting of the combinations of fruit tree papaya (*Carica papaya*) with boundary plantation of forest shrub Le. *Gliricidia sepium* and annual crops ginger (*Zingiber offcinale*), farmers' practice of broadcasting, line sowing of ragi (*Eleusine coracana*) and their intercropping ratios. The treatments were set in a randomized complete block design replicated thrice. In comparison to farmers' practice of broadcasting; line sowing of ragi decreased runoff and erosion by 23 and 15%, respectively. Among different treatments multitier cropping of ginger: pigeonpea yielded minimum runoff of 45.2 mm. Square plantation of papaya in sole ragi and intercropped ragi: pigeonpea (6:2) plots with boundary plantation of Gliricidia on bunds reduced net soil loss by 36 and 45%. Cultivated fallow reported maximum nutrient loss to the tune of 109.9, 0.31 and 10.70 kg ha-1 for Organic carbon (OC, Phosphorus (P) and Potassium, respectively. Sole ginger and ginger intercropped with pigeonpea in papaya+Gliricidia system recorded 58 and 41% lower OC loss than the farmers' practice of ragi broadcasting. Multitier cropping of papaya+Gliricidia with ginger: pigeonpea intercropping recorded highest values enrichment ratio for OC and P to the tune of 2.25 and 4.56, respectively. Ginger, pigeonpea and ragi recorded an increase of 23, 14.4 and 25.8% in Cation Exchange Capacity, when raised under multitier cropping system. In comparison to ragi sole cultivation, its intercropping with pigeonpea under multitier system showed an increase of 14.7 and 34.9% for infiltration and porosity, respectively. In comparison to sole cultivation under papaya intercropping ginger yield improved by 15q and in ginger + pigeonpea intercropping system by 21 qha-1, respectively. Among all treatments, papaya+ gliricidia based multitier cropping system of ginger intercropped with pigeonpea (8:2) gave maximum net returns of Rs. 2.47 lakhs with B: C ratio of 2.55 followed by sole ginger.

65

Devi HL, SK Mitra and SC Poi. (2012). "Effect of Different Organic and Biofertilizer Sources on Guava (Psidium guajava L.)'Sardar'." In III International Symposium on Guava and other Myrtaceae 959, pp. 201-208.

An investigation was conducted under sub-tropical conditions of West Bengal, India at the Horticultural Research Station of the university to standardize the organic nutrient management protocol for guava. In this experiment, various organic sources (Farm yard manure (26 kg/plant/y), poultry manure (10 kg/plant/y), vermicompost (19 kg/plant/y) and neem cake (9 kg/plant/y)) along with various biofertilizer combinations (Azotobacter, Azospirillum, phosphorous solubilizers and potash mobilizers each at 100 g/plant/y) were tested on four-year-old guava cultivar 'Sardar' to study its effect on growth, fruiting and yield. The different doses of organic manures were calculated based on the 50% of potash requirement of the recommended dose of guava for the region. The calculated dose along with biofertilizer was applied in two splits in January and August. The results obtained showed higher fruit weight (230.5 and 224.8 g) by application of neem cake and vermicompost+ Azotobacter+phosphorous solubilizers+potash mobilizers. Maximum number of fruits produced per plant (626.3 fruits/plant) was found from plant fertilized with farmyard manure +Azotobacter+phosphorous solubilizers+potash mobilizers and caused maximum yield of 114 kg/ plant as compared to 18.0 kg per plant in control. Treatment combinations with poultry manure + Azospirillum+phosphorous solubilizers+potash mobilizers showed the highest total soluble solids (12°Brix) and total sugar content of fruit (6.67%), whereas the vitamin C content (172.6 mg/100 g pulp) was recorded maximum by application of neem cake. Application of nutrients through organic along with biofertilizers improve soil health in terms of mean microbial population in the rhizosphere of root zone soil as compared to control. From the present study, it can be concluded that addition of biofertilizers along with organic manure was more effective than use of organic manure alone in enhancing fruit growth parameters in guava. Combined application of biofertilizers, P-solubilizers, K-mobilizers and Nfixers were found more effective in improving the fruit physico-chemical characters as compared to application of any biofertilizers alone. We conclude that for cultivation of

'Sardar' guava organically, application of farmyard manure at (26 kg/tree/year)+Azotobacter (100 g/tree)+ phosphorous solubilizers (100 g/tree)+potash mobilizers (100 g/tree) in two splits (January and August) is the economically profitable treatment.

66

Sadar P.S, NS Kulkarni, SC Aithal, Mukund Bodhankar and JM Dalal (2012). "Effect of Panchagavya Amendment on Plant Growth Performance of *Soyabean Glycine* max (L) in Vertisol." *Journal of Empirical Biology* 1, no. 01: 38-44.

Panchagavya enhances metabolic activity of crop plants. The mixture of cow dung, butter, honey and ghee was reported to be beneficial in maintaining soil fertility and plant growth performance. The increase in population of plant growth promoting rhizobacteria (PGPR) under the influence of Panchagavya, they further suggested that, the possibility of the preferential utilization of nutritional element in the ingredient of Panchagavya. It also reduces the percent Disease incidences of soybean *Glycine max* in pot treated with panchagavya in *Fusarium* sick soil. This indicates the positive use of panchagavaya on plant growth. However, very few reports could be traced in utilization of Panchagavya for amendment of soil. Hence, present investigation will be carried out with major crops of Washim district.

67

Gore, Nileema S and MN Sreenivasa (2012). "Influence of liquid organic manures on growth, nutrient content and yield of tomato (Lycopersicon esculentum Mill.) in the sterilized soil." Karnataka Journal of Agricultural Sciences 24, no. 2.

An experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad to study the influence of liquid organic manures viz., panchagavya, jeevamrut and beejamruth on the growth, nutrient content and yield of tomato in the sterilized soil during kharif 2009. The various types of organic solutions prepared from plant and animal origin are effective in the promotion of growth and fruiting in tomatoes. The Panchagavya is an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate biological reactions in the soil and to protect the plants from disease incidence. Jeevamruth promotes immense biological activity in soil and enhances nutrient availability to crops. Beejamruth protects the crop from soil borne and seed borne pathogens and also improves seed germination. In the present study, significantly highest plant growth and root length was recorded with the application of RDF+Beejamruth+Jeevamrutha+Panchagavya and it was found to be significantly superior over other treatments. The application of Beejamruth+Jeevamrutha+Panchagavya was the next best treatment and resulted in significantly higher yield as compared to RDF alone. The N, P and K concentration of plants was significantly higher in the treatment given RDF+Beejamruth+Jeevamrutha+Panchagavya.

68

Mishra DK, Tailor RS, Paliwal DK, and Deshwal AK (2012). Assessment and Impact of Bio-Management of Diamondback Moth in Cauliflower. Indian Research Journal of Extension Education, Vol. 12 (2).

Diamondback moth [*Plutella Xylostella* (L.)] is the most serious and widely distributed pest of cauliflower (Brassica oleracea var.botrytis) in India, attacking the crop from the nursery level onwards causing up to 52 per cent losses in marketable yield. To manage the menace farmers were using conventional as well as novel pesticides including Flubendiamid, 20 percent WG, Spinosad 2.5 per cent SC and Fipronil 0.30 per cent GR. The problems of insecticide resistance as well as the environmental concerns and consumer health hazards associated with insecticide residues in plant material have focused attention on alternative methods for the management of diamondback moth (DBM) in cauliflower. With the objectives to minimize the use of chemical pesticides and establish the use of eco friendly biocontrol agents, an assessment and front line demonstrations were organized during 2009 and 2010 to evaluate the feasibility and economic viability of recommended bio-control agent i.e. *Beauveria bassiana* for containing DBM in cauliflower under real farm condition. On the basis of result obtained from assessment of recommended technology, frontline demonstrations were organized to disseminate the recommended practice [foliar spray of *Beauveria bassiana* (1x1010 conidia/ml)] a myco-insecticide (@600 ml/ha) amongst the farmers. The recommended technology was found to offer an alternative to insecticides and was feasible, economically viable, environmentally safe and effective for management of DBM in cauliflower.

69

Lembisana Devi H, SC Poi and SK Mitra. (2012). Organic nutrient management protocol for cultivation of Bombai Litchi" *IV International Symposium on Lychee, Longan and Other Sapindaceae Fruits 1029*, pp. 215-224.

An investigation was carried out under subtropical conditions of West Bengal, India (22.43°N latitude, 88.34°E longitude) at the Horticultural Research Station of the University to standardize the organic nutrient management protocol for litchi. Various organic sources viz., farm yard manure at 60 kg/ tree/year, poultry manure at 21.4 kg/tree/year, vermicompost at 42.86 kg/ tree/year and neem cake at 20.28 kg/tree/year along with various biofertilizer combinations (Azotobacter, Azospirillum, phosphorus solubilizers and potash mobilizers each at 100 g/tree/ year) were tested on 32-year-old litchi cultivar 'Bombai'. These trees were not fertilized with any nutrients for five years prior to the experiment. The different doses of nutrients were calculated based on the 50% of the potassium requirement of the crop in this region and were applied in two split doses in January (after fruit set) and July (after fruit harvest). Application of farmyard manure+Azotobacter+phosphorus solubilizers +potash mobilizers resulted in greater fruit weight (24.73 g). The number of fruits (2556) and fruit yield (61.59 kg compared to 23.94 kg in control) per tree were greater with vermicompost Azotobacter+phosphorus solubilizers+potash mobilizers. Treatment combinations with farmyard manure+Azotobacter+phosphorus solubilizers+potash mobilizers showed higher total soluble solids (17.79°Brix) and total sugar content (17.57%), whereas vitamin C content (53.48 mg/100 g pulp) was higher where a combination of neem cake+Azospirillum+phosphorus solubilizers+potash mobilizers was applied. Application of nutrients through organic sources along with biofertilizers improved soil health by increasing the microbial population in the rhizosphere. Addition of biofertilizers along with organic manure was more effective in enhancing fruit growth parameters in litchi than the use of organic manure alone. Application of vermicompost at (42.86 kg/tree/year) +Azotobacter+phosphorus solubilizers+potash mobilizers each at 100 g/ tree/year in two split doses (January and July) is recommended for the organic production of the 'Bombai' litchi.

70

Punam P, Rameshwar Kumar, Sheetal Sharma and D Atul. (2012). "The effect of organic management treatments on the productivity and quality of lemon grass (Cymbopogon citratus)." *Journal of Organic Systems* 7, no. 2: 36-48.

An experiment was conducted at the Model Organic Farm of CSK Himachal Pradesh Agricultural University, Palampur (31°54' N and 76°17' E), Himachal Pradesh, India, to evaluate the effect of various organic management treatments on the productivity and quality of lemon grass (Cymbopogon citratus). Organic inputs (viz. farm yard manure (FYM); vermicompost; agnihotra ash; and neem powder) were added at the time of planting, while Bt + Himbio and the biodynamic preparation BD 500 were sprayed regularly at one month intervals. Crops were sown on dates matching moon and non moon position according to the Biodynamic Planting Calendar. Addition of agnihotra ash along with sowing as per moon position resulted in a higher yield of lemon grass (+124%, +99%) and a higher oil per cent (+155%, +144%) over the control, in both the years of study. Sowing as per moon position may have improved germination rate, water absorption and metabolism of the plants, whereas addition of agnihotra ash may have stabilized the nutrients present in soil.

71

Verma RK, AK Thakur and PS Rajput. (2012). "Effect of organic amendments and plant growth promoting microbes on *Santalum album* in Central India." *Indian Forester* 138, no. 8: 742-746.

Different plant growth promoting microorganisms (PGPM) were screened for their growth promoting activity against *Santalum album* in nursery. A mix of selected organisms, Azospirillum, phosphate solubilising bacteria (fluorescent *Pseudomonas* sp.), *Trichoderma viride*, AM fungi and soil amendment with organic matter were applied in a factorial field experiment to study their effect on survival and growth of sandal (*Santalum album*) saplings. Loam soil, farm yard manure (FYM), un-decomposed teak leaf, *Leucaena* leaf and mix organic matter (mixer of these 3 organic matters in equal ratio) in 3:1 v/v were used for amendment of natural red muram soil. There was 10-20% mortality in un-amended soil as compared to 0-10% in soil amended with organic matter along with PGPM application. No mortality was recorded in soil amended with loam soil, mix of FYM, teak and Leucaena leaves along with application of PGPM. Significant effect of soil amendment and application of PGPM was also observed on the growth of saplings after 2 years and 3 months of planting. Fruit bodies of *Lepiota longicauda*, *L. cristata* and *Scleroderma* sp. were only developed on soil amended with organic matters. Maximum height was recorded in PGPM applied and soil amended with teak leaves (61% more as compared to control) followed by mixed organic matter and loam soil (39% and 38% more, respectively).

72

Sayyed RZ, MS Reddy, K Vijay Kumar, SKR Yellareddygari, AM Deshmukh, PR Patel and NS Gangurde. (2012). "Potential of plant growth-promoting rhizobacteria for sustainable agriculture." In *Bacteria in Agrobiology: Plant Probiotics*, pp. 287-313. Springer Berlin Heidelberg, 2012.

Plants absorb many nutrients and elements from soil. These elements are continuously removed from soil. Therefore, there is a continuous demand for replenishment of these elements, which is usually fulfilled by chemical or biological fertilizers. Biofertilizers have numerous merits over the chemical fertilizers. The fertilizer (NPK) production in India is less than the required amount, and hence biofertilizers are seen as the best alternate source to bridge future gaps. Such an integrated approach will help to sustain soil health and productivity. Hence, the major thrust is being given to nitrogen fixers, phosphate solubilizers, and plant growth-promoting rhizobacteria (PGPR). PGPR are multipotent bioinoculants that promote plant growth, impart resistance to the plant, and provide a pathogen suppressiveness property to the soil and suppress major phytopathogens.

73

Patil SV, SI Halikatti, SM Hiremath, HB Babalad, MN Sreenivasa, NS Hebsur and G Somanagouda. (2012). "Effect of organics on growth and yield of chickpea (*Cicer arietinum* L.) in vertisols." *Karnataka Journal of Agricultural Sciences* 25, no. 3.

A field experiment was conducted on clay textured soil at Agricultural Research Station, Annigeri, UAS, Dharwad During rabi season of 2009-10 and 2010-11 to study the effect of organics on growth and yield of chickpea (Cicer arietinum L.) in vertisols of northern dry zone of Karnataka. The soil application of organic manures and foliar spray of liquid organic manures at flower initiation and 15 days after flowering (DAF) significantly enhanced the growth and yield parameters of chickpea viz., plant height, number of branches, Leaf Area Index, Total Dry Matter, number of root nodule and dry weight of nodules, number of pods per plant, 100-seed weight, grain yield and haulm yield. Among treatment combinations, application of enriched compost 1/3+vermicompost 1/3+gliricidia leaf manure 1/3 equivalent to 100% RDN and foliar spray of panchagavya @ 3% at flower initiation and 15 DAF has recorded significantly higher grain yield (2400 kg/ha), haulm yield (3423 kg/ha), number of pods per plant (66.38) and 100-seed weight (20.91 g) compared to other treatment combinations. While, lowest grain yield (1446 kg/ha), haulm yield (2376 kg/ha), number of pods per plant (43.91) and 100-seed weight (18.18 g) were recorded in control treatment (water spray - C2). Significantly higher B:C ratio (3.34) was recorded with OM2 among organic manures, LM1 (3.31) among liquid organic manures and OM2LM1 (3.69) among combinations of both.

74

Debashri Mondal and Mondal Tamal. (2012) "A Review on efficacy of *Azadirachta indica* A. Juss based biopesticides: An Indian perspective." *Research Journal of Recent Sciences.*

Although both synthetic and natural of pesticides are used extensively in the agricultural fields to control crop pests, it is well known that natural pesticides are eco- friendly and are safe to the non-target organisms. The *Azadirachta indica* A. Juss (neem tree) has long been recognized for its insecticidal properties. Nearly 550 insect pest species are sensitive to azadirachtin, an active compound extracted from the A. indica tree. Nowadays pesticides from A. indica become very much popular because of their biodegradability, least persistence and least toxic to non-target organisms, economic and easy availability. In India, neem products are effective against various pests of both crop fields as well as stored grains like rice, wheat, corn, legumes, potato, tomato, etc. This review put a light on the use and efficacy of A. indica based pesticides against various pests of both crop fields as well as stored grains of India.

75

Gahukar RT. (2012). "Evaluation of plant-derived products against pests and diseases of medicinal plants: A review." Crop Protection 42 (2012): 202-209.

Medicinal plants are attacked regularly by insects, mites, nematodes, bacteria, fungi and viruses. Leaf and seed extracts in water (5–10%), seed cakes (250 kg ha^{-1}), crude oils (0.5–3%) or essential oils (3000 ppm) have been effectively used to control *inter alia*, the sap sucking pests, foliar diseases and root-knot nematodes. Traditional and commercial products, especially those derived from neem (*Azadirachta indica* A. Juss.) leaf or kernel, are common in medicinal crops. Since use of plant products including allelochemicals resulted in reasonably effective, ecofriendly and cheaper pest and disease management, and crude extracts are easy to prepare, they may be integrated in crop protection strategies to enhance global exploration of medicinal plants.

76

Mishra DJ, Singh Rajvir, UK Mishra and Shahi Sudhir Kumar. (2012). "Role of bio-fertilizer in organic agriculture: a review." *Research Journal of Recent Sciences. Vol. 2. 39-41.*

Bio-fertilizers are one of the best modern tools for agriculture. It is a gift of our modern agricultural science. Biofertilizers are applied in the agricultural field as a replacement to our conventional fertilizers. Conventional fertilizers contain compost; household wastes and green manure. Those are not as effective as chemical fertilizers. So, farmers often try to use chemical fertilizers in the field for crop development. But obviously the chemical fertilizers are not environment friendly. They are responsible for water, air and soil pollution and can spread cancer causing agents. Moreover, they may destroy the fertility of the soil in a long run. Scientists have developed Biofertilizers to prevent pollution and to make this world healthy for everybody in a natural way. Bio-fertilizer contains microorganisms which promote the adequate supply of nutrients to the host plants and ensure their proper development of growth and regulation in their physiology. Living microorganisms are used in the preparation of bio-fertilizers. Only those microorganisms are used which have specific functions to enhance plant growth and reproduction. There are different types of micro-organisms which are used in the biofertilizers. Bio-fertilizer being essential components of Organic farming play vital role in maintaining long term soil fertility and sustainability.

77

Vijayakumari B, R Hiranmai Yadav, P Gowri and LS Kandari. (2012). "Effect of Panchagavya, Humic acid and Micro-herbal Fertilizer on the Yield and Post Harvest Soil of Soya Bean". Asian Journal of Plant Sciences. Vol. 11(2): 83-86.

Higher uses of fertilizers reduce the quality of food produced as well as soil fertility. However, combination of inorganic and organic will reduce the environmental hazard due to higher fertilizer use efficiency as well as improvement of the quality of crops. Current status of lack of availability of organic substances makes us to think the other cheap organic resources. The organic matter stimulates plant growth, improves plant resistance under unfavourable condition. A study was conducted to assess the influence of few organic fertilizers to observe their influence on yield and quality of soya bean and the impact of the manures on post harvest soil. The yield obtained on 90 DAS was found to be the maximum in plants applied with panchagavya, humic acid and micro herbal fertilizer (T_3). The maximum pods (10.5), number of seeds (25 seeds plant^{-1}), ascorbic acid (0.72 mg g^{-1}) and protein (1.37 mg g^{-1}) content of the harvested seeds were significantly increased due to the combined inoculation of panchagavya, humic acid and micro herbal fertilizer. The physical characters and macro nutrient contents of the post harvested soil (N (88), P (8.6) and K (325) kg ha^{-1}) were higher in panchagavya, humic acid and micro herbal fertilizer treated soil compared to other treatments.

78

Bhar LM, Kalyan K Mondal and SK Sugha. (2008)."Antibacterial potential of panchagavya -based microbes against bacterial wilt of tomato." *Indian Phytopathology* 61, no. 3: 353-354.

Notably, treatments with *Serratia* and *P. flourescens* resulted in 22 and 32 per cent wilt incidence as compared to control (100%) under soil free water culture assay, respectively. Thus, the present study indicated that the panchagavya being an important source of antagonistic microbes could be exploited in integrated wilt management programme in tomato.

79

Vallimayil J. and R. Sekar. (2012). "Investigation on the Effect of Panchagavya on Southern Sunhemp Mosaic Virus (SSMV) Infected Plant Systems." *Global Journal of Environmental Research* 6, no. 2: 75-79.

Panchagavya is an organic product blended from five different cow products, commonly applied to crop plants in organic farming. It is used as foliar spray, soil application and seed treatment. It can act as growth promoter and immunity booster. Effects of application of panchagavya in the form of seed treatment and foliar spray to Southern Sunnhemp Mosaic Virus infected sunnhemp plants were studied. Growth and biochemical parameters studied showed better growth in panchagavya treated plants. Various concentrations from virus infected plants were tested on cluster bean a local lesion assay host for this virus. Panchagavya treated plants showedlesser viral intensity than control. The effect of foliar spray of panchagavya on virus concentration in the local lesion host also studied, by inoculating the plants with virus of different time intervals after foliarspray. A significant change in viral concentration was observed.

80

Patra PS and AC Sinha. (2012). "Studies on organic cultivation of groundnut (*Arachis hypogaea*) in Cooch Behar." Indian Journal of Agronomy 57, no. 4 : 386-389.

A field experiment was conducted at Cooch Behar, West Bengal during the Pre-Kharif seasons of 2008 and 2009 in a randomized complete block with twelve treatments to study the effect of organic sources of nutrients on physiological characters, yield attributes and pod yield of groundnut (Arachis hypogaea L.). The results showed that groundnut can be organically produced, provided adequate phosphorus is applied as phosphocompost. The highest yield of groundnut obtained with combination of phosphocompost, poultry manure, neem cake and vermicompost. FYM, vermicompost, neem cake and poultry manure applied alone was not able to adequately supply plant nutrients specially phosphorus and gave low yield of groundnut. Net photosynthesis rate recorded the highest correlation coefficient (0.948) with pod yield of groundnut.

81

Davari, Mohammadreza, Shri Niwas Sharma, and Mohammad Mirzakhani. (2012). "Residual influence of organic materials, crop residues, and biofertilizers on performance of succeeding mung bean in an organic rice-based cropping system." International Journal Of Recycling of Organic Waste in Agriculture 1, no. 1: 1-9.
The present investigation was undertaken to assess the residual influence of organic materials and biofertilizers applied to rice and wheat on yield, nutrient status, and economics of succeeding mung bean in an organic cropping system. The field experiments were carried out on the research farm of IARI, New Delhi during crop cycles of 2006 to 2007 and 2007 to 2008 to study the effects of residual organic manures, crop residues, and biofertilizers applied to rice and wheat on the performance of succeeding mung bean. The experiment was laid out in a randomized block design with three replications. Treatments consisted of six combinations of different residual organic materials, and biofertilizers included residual farmyard manure (FYM) and vermicompost (VC) applied on nitrogen basis at 60 kg ha"1 to each rice and wheat crops, FYM+wheat and rice residues at 6 t ha"1 and mung bean residue at 3 t ha"1 in succeeding crops (CR), VC+CR, FYM+CR+biofertilizers (B), VC+CR+B and control (no fertilizer applied). For biofertilizers, cellulolytic culture, phosphate-solubilizing bacteria and *Rhizobium* applied in mung bean.

Results: Incorporation of crop residue significantly increased the grain yield of mung bean over residual of FYM and VC by 25.5% and 26.5%, respectively. The combinations of FYM+CR+B and VC+RR+B resulted in the highest increase growth and yield attributing characters of mung bean and increased grain yield of mung bean over the control by 47% and net return by 27%.

Conclusions: The present study thus indicates that a combination of FYM+CR+B and VC+CR+B were economical for the nutrient need of mung bean in organic farming of rice-based cropping system.

82

Sreenivasa MN (2012). "Organic Farming: For Sustainable Production and Environmental Protection." In *Microorganisms in Sustainable Agriculture and Biotechnology*, pp. 55-76. Springer Netherlands, 2012.
Organic farming, an age old and traditional agriculture system of India is being practiced by several lakh farmers in our country. However it requires scientific outlook to get fruitful results. High cost of chemical fertilizers and indiscriminate use of pesticides has already resulted in environmental pollution. This inturn affected human health, biodiversity and soil health.

Farming community is enthusiastic to use chemical fertilizers instead of organic manures as their preparation is time consuming and laborious. The chemical fertilizers can supply 2–3 nutrients while crop requires 20–25 nutrients for its growth and yield. The organic manures and bioinoculants can meet the crop requirements. Many scientists have come out with the efficient inoculants which can supply not only nutrients to crops but also protect them from pest and disease attack. This chapter deals with the importance of different organic manures, microbial inoculants and bioagents in crop production and crop protection.

Kumawat RN, Mahajan SS, Mertia RS and Meena OP (2012). Green agriculture cultivation of groundnut (Arachis hypogaea) with foliar applied plant leaf extract and soil applied panchgavya. Indian Journal of Agricultural Sciences. Vol. 82 (4).

83

Thoke S, Dr Patil, GSK Swamy and VC Kanamadi (2011). "Response of Jamun (Syzygium cumini Skeels.) to Glomus fasciculatum and Bioformulations for Germination, Graft Take and Graft Survival." Acta horticulturae: 129-134.

An investigation was carried out at the Horticulture Research Station, Bijapur (Tidagundi) to know the combined influence of *Glomus fasciculatum* and bioformulations on germination, graft take and graft survival of jamun. The experiment consisting of 10 treatment combinations with two main plots ($M_1$with *Glomus fasciculatum*, M_{2-} Uninoculated) and five subplots (S_{1-} Amrit pani, S_{2-} Microbial consortia, S_{3-} Panchagavya, S_{4-} Inorganic fertilizer (60:30:90 g N:P:K per plant per year), S_{5-} Control) was laid out in split plot design with three replications. The non-descriptive uniform size jamun seeds obtained from a single tree in the farmer field of Soundatti were sown in polybags of 8×12 cm size containing a potting mixture of soil, sand and FYM in the ratio of 2:1:2. AM fungi inoculation was done by spreading 5 g of inoculum uniformly at 5 cm depth after putting a thin layer of soil on the inoculum. Jamun seeds were placed and covered with soil (2-3 cm). The polybags of respective treatments were labeled and kept apart enough from each other to avoid AM fungal cross contamination. The bioformulations were applied as soil application at 3% at monthly interval and watered daily. The results indicated that seeds inoculated with *Glomus fasciculatum* recorded the highest germination (83.60%), graft take (46.56%) and graft survival (89.10%) as compared to uninoculated seeds wherein germination was 76.40%, graft take 44.17% and graft survival 82.5%. Among different bioformulations, seeds inoculated with microbial consortia registered the highest germination (88.00%) graft take (49.68%) and graft survival (90.94%) as compared to uninoculated control wherein seed germination was 76.00%, graft success 41.42% and graft survival 77.05%.

84

Negi, Yogesh Kumar, Deepti Prabha, Satyendra K Garg and J Kumar. (2011). "Genetic Diversity Among Cold-Tolerant Fluorescent *Pseudomonas* Isolates from Indian Himalayas and Their Characterization for Biocontrol and Plant Growth-Promoting Activities." *Journal of Plant Growth Regulation* 30, no. 2: 128-143.

In Uttarakhand, the Organic State of India, where soils in most farming situations are deficient in nutrients and loss of crops due to soil- and seedborne pathogens is rampant, use of native plant growth-promoting rhizobacteria (PGPRs) possessing biocontrol (BC) activities holds promise. In view of this, 600 native cold-tolerant rhizospheric bacterial isolates were collected from Uttarakhand Himalayas, of which 336 were confirmed as fluorescent *Pseudomonas* spp. On the basis of specific biochemical tests, these were characterized into three major groups: *P. fluorescens* (308 isolates), *P. aeruginosa* (20 isolates), *and P. putida* (8 isolates). Most of the isolates could grow at 8°C after 12 h of incubation, confirming their cold tolerance. In vitro biocontrol assays revealed that of 336 isolates, 74 were antagonistic to *Rhizoctonia solani* and 91 to *Fusarium solani*, the two major pathogens associated with root-rot complex in vegetables widespread in the region. Simultaneously, good HCN producers (33 isolates), siderophore producers (80 isolates), and P solubilizers (49 isolates) were also identified, which could increase the biocontrol and plant growth-promoting efficacies of the putative PGPRs. Among the different species and biovars, *P. fluorescens* biovar-I had the maximum number of potential isolates with BC and plant growth-promoting (PGP) activities. In French bean, under polyhouse and field conditions, five isolates (Pf-173, Pf-193, Pf-547, Pf-551, and Pf572) showed good BC and PGP activities as up to 93% reduction in root rot was achieved. A combination of all five isolates was found to be best with respect to BC and PGP activities. In a set of 59 fluorescent Pseudomonas isolates, RAPD-PCR analysis, using three random oligo decamer primers, revealed high diversity and formed ten distinct clusters, corresponding to the host of origin (annual or perennial) or habitat (farming situations) of the isolates. The amount of diversity revealed in the set of fluorescent Pseudomonas isolates could represent enormous diversity that exists in the wild that could be exploited for improved BC and PGP activities of the PGPRs. For the first time, this study led to a large-scale characterization and repositioning of fluorescent pseudomonads from the Indian Himalayas.

85

Sujatha S, Ravi Bhat, C Kannan and D Balasimha. (2011). "Impact of intercropping of medicinal and aromatic plants with organic farming approach on resource use efficiency in arecanut (*Areca catechu* L.) plantation in India." *Industrial Crops and Products* 33, no. 1: 78-83.

The present investigation was conducted at Vittal, Karnataka, India during 2004-2007 to study the feasibility of intercropping of medicinal and aromatic plants (MAPs) in arecanut plantation. The results revealed that MAPs can be successfully grown as intercrops in a arecanut plantation with increased productivity and net income per unit area. Kernel equivalent yield of MAPs varied between 272 kg ha"1 in case of Piper longum to 1218 kg ha"1 in Cymbopogon flexuosus. Pooled data indicated that Asparagus racemosus produced fresh root yield of 10,666 kg ha"1 of arecanut plantation and contributed to maximum kernel equivalent yield of 1524 kg ha"1 among all medicinal and aromatic plants. Intercropping of MAPs in arecanut was found economical. The net return per rupee investment was highest in C. flexuosus (4.25) followed by Bacopa monnieri (3.64), Ocimum basilicum (3.46) and Artemisia pallens (3.12). The total system productivity of arecanut + MAPs intercropping system varied from 2990 to 4144 kg ha"1. Arecanut + O. basilicum intercropping system registered significantly higher production efficiency 8.2 kg ha"1 day"1 than other systems. Intercropping of MAPs had more positive effect on soil pH in a arecanut based cropping system. The soil pH was 5.6 in 2004 and it was 0.3-0.9 units higher in 2007. Soil organic carbon (SOC) content varied significantly due to intercropping of MAPs at the end of experiment. The SOC content increased in Aloe vera, A. pallens, P. longum and B. monnieri, while it depleted in grasses and rhizomatic MAPs. Based on demand and marketing opportunities for MAPs, farmers are advised to grow aromatic plants in large areas on a community basis to meet huge industrial demand and variety of medicinal crops in small areas to meet the requirement of traditional systems of medicine.

86

Ghosh, B., T. K. S. Irenaeus, S. Kundu, and P. Datta. (2011). "Effect of Organic Manuring on Growth, Yield and Quality of Sweet Orange." In *International Symposium on Tropical and Subtropical Fruits 1024*, pp. 121-125.

An experiment was carried out to study the effect of different organic manures (vermicompost, farm yard manure, neem cake, mustard cake and mahua cake) on 'Mosambi' sweet orange trees aged 8 years at the Horticultural Research Station of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India during 2008 and 2010. The experiment was conducted considering eleven treatments including control (recommended rate of fertilizer
400:300:400 g/plant/year) and all the treatments were replicated thrice.

Among different organic manures, vermicompost at 20 kg/tree resulted maximum plant growth (spread and height) with quality fruits in respect of total soluble solids and vitamin C content but FYM at 40 kg/tree treated plants produced fruits with maximum total sugar content. However, highest yield and maximum sizeable fruits were obtained when the plants were treated with neem cake at 7.5 kg/tree. The avialable nitrogen content of soil was found to be higher (73.39 and 66.32 kg ha-1) with vermicompost and mustard cake at higher doses. Optimum leaf nitrogen (2.22%) and potassium (1.56%) were obtained with neem cake treatment. It can be concluded that vermicompost and neem cake can be applied for higher vegetative growth and higher production of quality fruits in 'Mosambi' sweet orange in West Bengal.

87

Moorthy, S. Krishna, and P. Malliga. (2011). Plant characteristics, growth and leaf gel yield of *Aloe barbadensis* miller as affected by cyanopith biofertilizer in pot culture. *International Journal of Civil & Structural Engineering* 2, no. 3: 884-892.

Biofertilizers are eco friendly and are now most, necessary to support developing organic agriculture and sustainable agriculture. They can provide to the small and marginal farmers an ecofriendly viable weapon to attain the ultimate goal of increasing crop productivity. Cyanobacteria also called blue green algae which are useful to mankind in various ways and constitute a vast potential resource in varied application such as food, feed, fuel, fertilizer, medicine, industrial products and in combating pollution. Coir pith, a light lignocellulosic material which is spongy, highly hygroscopic and extremely compressive having high lignin content, accumulated in tons creating environmental problems. Hence, recycling the waste by using cyanobacteria in order to get pollution free environment and useful products from coir pith will be an economical and purposeful one. The purpose of this study was to evaluate the effect of different amount of coir pith based cyanobacterial biofertilizers named cyanopith individually on the morphological and biochemical characteristics as well as yield of *Aloe barbadensis* Miller (Aloe vera). The pot experiment was conducted at the Model Organic Farm of Bharathidasan University located in Tamilnadu, India. Different treatments of cyanopith (Solid form) fertilizer viz., cyanopith 25g, 50g, 75g, 100g, 125g and 150 g/pot, and the plants without any treatment were considered as control. It was observed that the plant appeared maximum height, number of leaves and leaf weight, leaf breadth, number of offsets and significant improvement in gel and latex yield, as well as Chlorophyll a, chlorophyll b, total chlorophyll, carotenoids, free amino acids and sugar contents were found to be improved with 100g cyanopith over control. Hence, it revealed that 100g of cyanopith fertilizer was the optimum concentration for maximum improvement of the plant characteristics and yield of *A. barbadensis* Miller.

88

Singh YV, Dhar DW and Agarwal B (2011). Influence of organic nutrient management on Basmati rice (Oryza sativa) – Wheat (Triticum aestivum) – Greengram (Vigna radiata cropping system). Indian Journal of Agronomy. Vol. 56 (3).

In a field experiment conducted at New Delhi during 2003–2009, different organic sources of nutrients such as *multani mitti* based blue green algae (BGA) @ 2.0 kg/ha, *Azolla* @ 1.0 tonne/ha, vermicompost (VC) @ 5.0 tonne/ha and farm yard manure (FYM) @ 5.0 tonne/ha were tested alone or in combinations to find out suitable organic sources of nutrient supply for sustaining the productivity of *Basmati* rice (*Oryza sativa* L.) – wheat [*Triticum aestivum* (L.) emend. Fiori & Paol.]–greengram [*Vigna radiata* (L.) R. Wilczek] cropping systems. In wheat crop *Azotobacter* replaced *Azolla*, but other treatments remained same. Greengram was taken up on residual soil fertility and biomass of this crop was incorporated after picking the pods. Results revealed a significant enhancement in grain yield of rice over absolute control due to the application of different organic sources of nutrient applied alone or in combinations. Grain yield over 4.0 t/ha of Basmati rice ('Pusa Basmati 1') was obtained with the combined application of four (*Azolla*, BGA, FYM and VC) organic sources of nutrients. Grain yield of wheat was lower than 4 t/ha during first four years even with the combined application of four organic sources of nutrients, but, fourth year onward wheat yield level crossed 4.0 t/ha level with four organic sources of nutrient. A significant increase in uptake of iron, zinc and manganese in the grains of rice, wheat and greengram was recorded when two or more organic sources of nutrient were applied together compared to control. Total uptake of Fe, Zn, Mn and Cu in rice-wheat-greengram cropping system ranged between 177.0.1 to 414.7, 175.0 to 381.0, 177.3 to 420.2 and 71.2 to 181.0 g/ha, respectively. Microbial (actinomycetes, bacteria, fungi and BGA) population was enhanced due to the application of four sources of organic nutrients as compared to absolute control that resulted in a notable enhancement in dehydrogenase enzyme activity. Sustainability yield index (SYI) data indicated that ricewheat-greengram system (0.93) was most sustainable followed by greengram (0.85), wheat (0.82) and rice (0.81) crop under integrated use of organic sources of nutrients.

89

Saharan BS and V Nehra. (2011). "Plant growth promoting rhizobacteria: a critical review." *Life Sci Med Res* 21 (2011): 1-30.

Plant growth-promoting rhizobacteria (PGPR) are naturally occurring soil bacteria that aggressively colonize plant roots and benefit plants by providing growth promotion. Inoculation of crop plants with certain strains of PGPR at an early stage of development improves biomass production through direct effects on root and shoots growth. Inoculation of ornamentals, forest trees, vegetables, and agricultural crops with PGPR may result in multiple effects on early-season plant growth, as seen in the enhancement of seedling germination, stand health, plant vigor, plant height, shoot weight, nutrient content of shoot tissues, early bloom, chlorophyll content, and increased nodulation in legumes. PGPR are reported to influence the growth, yield, and nutrient uptake by an array of mechanisms. They help in increasing nitrogen fixation in legumes, help in promoting free-living nitrogen-fixing bacteria, increase supply of other nutrients, such as phosphorus, sulphur, iron and copper, produce plant hormones, enhance other beneficial bacteria or fungi, control fungal and bacterial diseases and help in controlling insect pests. There has been much research interest in PGPR and there is now an increasing number of PGPR being commercialized for various crops. Several reviews have discussed specific aspects of growth promotion by PGPR. In this review, we have discussed various bacteria which act as PGPR, mechanisms and the desirable properties exhibited by them.

90

Shukla SK, Singh PN and Chauhan RS (2011). Effect of organic wastes amended with *Trichoderma* and *Gluconacetobacter* on physicochemical properties of soil and sugarcane ratoon yield in *udic ustochrept*. Indian Journal of Agronomy. Vol. 56(3): 254-259.

A field experiment was conducted during 2005–2008 at Lucknow to relate the changes in the water stable aggregates, soil organic carbon (SOC) and nutrient availability to sustaining sugarcane ratoon growth and yield in *udic ustochrept*. Eight combinations (absolute control, control-200 kg N/ha through inorganic fertilizer, 10t/ha farmyard manure (FYM) alone, FYM enriched with 20kg/ha *Trichoderma virde*, FYM enriched with 12.5kg/ha *Gluconacetobacter diazotrophicus*, 7.5t/ha trash mulch, trash mulch enriched with 20kg/ha *Trichoderma viride* and trash mulch enriched with 12.5 kg/ha *Gluconacetobacter diazotrophicus* were applied in sugarcane ratoon (first and second ratoon in succession). Inoculation with *Trichoderma viride* enhanced total water stable aggregates (WSAs) and macro aggregates (>0.25 mm). *Trichoderma* enriched trash significantly increased mean weight diameter (0.71 mm) of aggregates. Higher rate of increase in soil organic carbon (SOC) was observed under inoculation of *Trichoderma* with FYM compared to trash mulch. Inoculation with *Trichoderma* and *Gluconacetobacter* improved N, P and K availability at all the growth stages. Bioagents inoculated FYM gave higher mean sugar yield (8.89 t/ha) as compared to bioagents inoculated trash (7.97 t/ha).

91

Saranraj P, R Suresh Kumar, P Ganesh and K Tharmaraj. (2011). "Growth and development of blackgram (*Vigna mungo*) under foliar application of Panchagavya as organic source of nutrient." *Current Botany* 2, no. 3:9-11.

The present study was aimed to improve the growth and development of Blackgram (*Vigna mungo*) under foliar application of panchagavya as organic nutrient. A pot culture experiment was conducted at the Experimental farm during the March-May 2010 season to evaluate the efficacy of Panchagavya foliar spray and NPK on the physiological growth and yield of Blackgram (*Vigna mungo*) cv. ADT-3. The results of the experiment revealed that foliar application of Panchagavya recorded significant improvement in chlorophyll content, N content of root nodules, plant height, number of branches per plant, leaf area index (LAI) and dry matter production when compared with NPK and control. Yield attributes such as number of pods per plant, number of seeds per pod, test weight and grain yield were also recorded significantly higher under foliar application of Panchagavya over NPK and control. Three percent Panchagavya foliar spray given at 15th, 25th, 35th and 45th days of interval period recorded significantly higher growth and yield of Blackgram than NPK and untreated control.

92

Joseph Baby and P Sankarganesh. (2011). "Antifungal efficacy of panchagavya." *International Journal of Pharm Tech Research* 3, no. 1: 585-588.

Panchagavya is an incredible source for growth promoting substances. All previous research studies were determined its role in medicinal and agricultural field. The current study evaluated its use in microbiological medium. 10μl, 100μl, 500μl and 1000μl of Panchagavya mixed with 1.5% water agar medium and after sterilization, incubated at room temperature. After 5 days of incubation, the initial lower dilution showed 100% fungal growth and middle dilutions showed moderate growth. Though higher dilution axes the significant fungal growth, but sticks the identical bacterial colonies and even no bacterial growth on 10 µl, 100 µl and 500 µl concentrations indicates less growth promotional and more antifungal source. According to these data, the higher dilutions of Panchagavya are promising source for simple and naturally derived less expensive bacteriological media with antifungal effect with growth promotion.

93

Tomar JMS, Das Anup (2011). Influence of trees leaf green manuring on low land rice (*Oryza sativa*) productivity in mid-altitudes of Meghalaya. Indian Journal of Soil Conservation. Vol. 39 (2): 167-170
Field experiments were conducted in the *kharif* seasons for three years (2003–04, 2004–05 and 2005–06) at ICAR Research Complex for NEH Region, Umiam, Meghalaya (950m msl) to study the effect of green leaf manuring (GLM) on soil fertility and productivity of lowland rice (*Oryza sativa* L.). Green leaves of *Erythrina indica* Lamk., *Acacia auriculiformis* A. Cunn. ex Benth., *Alnus nepalensis* D. Don., *Parkia roxburghii* G. Don. and *Cassia siamea* Lam. *were* applied @ 10 t ha^{-1} on a fresh weight basis as green manure and compared with recommended NPK (80:60:40 kg ha^{-1}) and control. In the first year and second year, yield attributes and yield of rice were highest with the recommended NPK (4.82 t ha^{-1} in 2003 and 5.08 t ha^{-1} in 2004, respectively) followed by *E. indica.* In the third year, GLM surpassed the recommended NPK in terms of growth, yield and yield attributes except alder leaves, the highest response being observed with the incorporation of *Erythrina* leaves (grain yield 4.44 t ha^{-1}). At the end of the three cropping cycles, there was significant improvement in soil organic carbon content, soil available nitrogen and phosphorus due to various green leaf manure applications indicating the suitability of green leaf manuring in hills as a means of soil health augmentation.

94

Sharma AR, R Singh, SK Dhyani and RK Dube. (2011). "Agronomic and Economic Evaluation of Mulching in Rainfed Maize—Wheat Cropping System in the Western Himalayan Region of India." *Journal of Crop Improvement* 25, no. 4: 392-408.

Mulching is highly beneficial for resource conservation under rainfed conditions, but non–availability of organic biomass and easy availability of fertilizers and herbicides has led to a gradual discontinuation of this practice. Various vegetative materials, including some troublesome weedy perennials, are available locally, which can be recycled for enhanced soil moisture and nutrient conservation. A field experiment was conducted at Dehradun, India, from 2001–2004 to study the effect of mulching with kudzu (*Peuraria hirsuta*), wild sage (*Lantana camara*), and subabul (*Leucaena leucocephala*) applied at 30 and 60 days of growth of maize (*Zea mays*), maize harvest, and sowing of wheat (*Triticum aestivum*). Application of 10 t/ha (fresh biomass) added 1.6–2.3 t dry matter through *Peuraria*, 2.5–3.2 t through *Lantana*, and 2.9–3.9 t/ha through *Leuceana*, which contributed 47.7–60.9 kg N, 58.4–70.9 kg N, and 118.4–148.4 kg N/ha, respectively. All mulching materials were beneficial and improved productivity of maize significantly by 16.6– 20.6% over no mulching. Wheat yield also increased because of mulching in previous maize (+11.2%), and the beneficial effect was relatively greater (12.4–25.1%) when mulching was done at maize harvest or wheat sowing. Mulching showed improvement in organic C and total N status, and a decrease in bulk density associated with an increase in infiltration rate across three cropping cycles. Wheat gave three to five times more net profit than maize, and the net benefit-cost ratio of the system was the highest (1.34–1.35) when mulching was done at 60 days of maize growth with *Peuraria* and *Leucaena*. It was concluded that mulching with available vegetative materials in standing crop of maize or after harvest was beneficial for improving moisture conservation, productivity, and profitability of a maize– wheat cropping system under Doon valley conditions.

95

Srivastava Rashmi; Berset Estelle; Mäder Paul; Adholeya Alok; Padruot Fred and Sharma Anil K. (2011). Effects of mycorrhiza and plant growth promoting rhizobacteria inoculants on rice crops in

Northern India. In: Becker, Mathias; Kreye, Christine; Ripken, Christina and Tielkes, Eric (Eds.) *Tropentag 2011 - Development on the margin - Book of abstracts*, DITSL GmbH, Witzenhausen, Germany, p. 206.
Mutualistic root microorganisms such as arbuscular mycorrhizal fungi (AMF) and plant growth promoting rhizobacteria (PGPR) can ameliorate plant nutrition through an extended extra-radical hyphal network and by nutrient mobilisation. Running under the Indo-Swiss Collaboration in Biotechnology (ISCB), our project focuses on the integration of AMF and PGPR as biofertilisers in wheat-rice and wheat-black gram systems.

96

Padmavathy K and Poyyamoli G (2011). Alternative farming techniques for sustainable food production. Genetics, Biofuels and Local Farming Systems. *Sustainable Agriculture Reviews*. Vol. 7: 367-424.

Sustainability and food security are the major challenges faced by third world countries for the past several decades. Most of the third world countries are also facing problems of climate change, increasing population, overexploitation of natural resources and resource degradation associated with rapid economic growth. Among the scientific and policy circles there are controversies in using inorganic chemicals and biotechnology for sustaining the agricultural production. There is no critical comprehensive review on sustainability of alternative farming systems and their relative advantages over conventional, chemicalized and hi-tech agriculture for decision making at various levels. This review tries to fulfill the knowledge gap in this vital sector. The first part of the review discuss the current status of agroecosystems, with emphasis on their threats in terms of food security, long term sustainability, impacts on ecosystem services and climate change. We also evaluate the ecological, economic, social and cultural sustainability of inorganic agriculture. This analysis points emerging issues such as environmental degradation, loss of ecosystem services, non-sustainability and threats to food security in the context of global population growth and climate change. Hence there is an urgent need for identifying potential alternative farming strategies to achieve long term sustainability and food security as indicated by several leading workers in the field. The next section traces the background and evolution of alternative farming systems with their scope and importance. Then we classified potential sustainable farming techniques practiced in various parts of the world. For that we review potentials, constraints, strategies and case studies for ten alternatives farming techniques and four innovative endogenous farming techniques from India. The alternative farming techniques that were field tested and perfected over several generations in the past portrayed the following advantages over chemical farming: (1) eco-friendly by protecting and revving life support systems and ecosystem services, (2) higher cost benefit ratio, benefiting the farmers as well as the consumers, (3) control and reduction of bioaccumulation and biomagnification, (4) reduction in air, water and soil pollution caused by various pesticides and other chemicals, (5) control of health hazards in humans and livestock, and (6) conservation and sustainable use of on-farm biodiversity, including traditional cultivated germplasm and natural resources in agrosystems.

97

Suresh Naik KP. (2011). Effect of Farmyard Manure and Biodigester
Liquid Manure on growth and yield of rainfed maize (*Zea mays L.)*. MSc Agriculture Thesis in Agronomy. University of Agricultural Sciences, Bengaluru. PAK 9165.

A field experiment entitled 'Effect of farmyard manure and biodigester liquid manure on growth and yield of rainfed maize (Zea mays L.)' was conducted at Agriculture Research Station, Bhavikere, Tarikere taluk during khairf season of 2010 on red sandy loam soil. The experiment was laid out in a randomized complete block design with thirteen treatments replicated thrice. Higher grain yield (56.2 q/ha) and stover yield (108.9 q/ha) obtained due to higher growth attributing characters like higher plant height (187 cm), number of leaves (12.3), leaf area (4118.2 cm2 per plant) and total dry matter production (360.8 g/plant) and its accumulation into different parts of plant and yield attributing characters like grain weight per cob (105.2 g), number of seeds per cob (421 g), number of rows per cob (15.1), test weight (30.1 g), cob length (17 cm) and cob girth (15.6 cm) of maize was recorded in the treatment combinations of FYM 12.5 t per hectare + biodigester liquid manure equivalent at 150 kg N/ha and it was on par with the treatment combinations of FYM 10 t/ha + biodigester liquid equivalent to 150 kg N/ha and FYM 7.5 t/ha + recommended NPK 100 : 50 : 25 kg N/ha. Higher total nutrient uptake of N, P and K (184.5, 38.5 and 181.1 kg/ha respectively), total microbial population (50.5X10^6 CFU/g, 26.0 X 10^4 CFU/g, 23.8 X 10^3 CFU/ g, bacteria, fungi and actinomycetes respectively and higher net returns Rs. 34989/ha and B:C ratio (3.1) due to application of FYM and biodigester liquid manure which might have improved activity of beneficial microorganisms and also due to increase in the organic carbon besides increasing the availability of NPK in soil.

98

Kumawat RN, SS Mahajan and RS Mertia. (2011). "Growth and yield of clusterbean (*Cyamopsis tetragonoloba*) grown on lighttextured soils with foliar application of fermented panchgavya." *The Indian Journal of Agricultural Sciences* 81, no. 3.

A field study was carried out in rainy (kharif) season of 2006 and 2007 to examine the effect of foliar application of panchgavya plus leaf extracts of neem (*Azadirachta indica* A, Juss.), datura (*Datura metel* L.) and tumba (*Citrullus colocynthis* L.) in 1:1 ratio on dry matter accumulation, nutrient uptake, yield and yield attributes of clusterbean (*Cyamopsis tetragonoloba* L. Taub.) grown on light-textured soils under irrigated conditions. The results showed that the foliar application of neem plus panchgavya increased dry matter accumulation, nutrient uptake, yield and yield attributes significantly compared to control and sole application of panchgavya. Application of neem plus panchgavya recorded higher grain (34%), straw (21%) and biological yield (25%) compared to control. Application of the sources both at branching plus flowering recorded significantly higher dry matter as well as nutrient uptake, yield and yield attributes over the application either at branching or flowering. The grain, straw and biological yields recorded 26, 22 and 23% increase, respectively with dual application of sources both at branching and flowering compared to spray at flowering only.

99

Krishnapriya K and SN Padmadevi (2011). "Effect of panchagavya on the growth and biochemical contents of *Oryza sativa* var. Ponni." *Asian Jour of Bio Science* 6(2): 258-259.

Rice is the most important food crop of India. An experiment was designed to improve the yield and biochemical contents of rice for which panchagavya (an organic fertilizer) was applied. Panchagavya was prepared and applied through flow irrigation on the 15th, 30th, 45th and 60th day. Shoot length, height of the plant, number of grains, 1000 grains weight, number of spikelets, grains protein and carbohydrates were studied. The results showed that in all the parameters studied panchagavya had a positive influence over the control.

100

Sinha Rajiv K, George Hahn, Pancham K Singh, Ravindra K Suhane and Allam Anthonyreddy. (2011). "Organic Farming by Vermiculture: Producing Safe, Nutritive and Protective Foods by Earthworms (Charles Darwin's Friends of Farmers)." *American Journal of Experimental Agriculture* 1, no. 4: 363-399.

Agrochemicals which ushered in the 'green revolution' in the 1950-60's, boosted food productivity, but at the cost of environment and society. It increased food production but also destroyed the 'physical, chemical and the biological properties' of soil over the years of use. It killed the beneficial soil organisms and also impaired the power of 'biological resistance' in crops making them more susceptible to pests and diseases. No farmland of world is free of toxic pesticides today. Over the years it has worked like a 'slow poison' for the soil and society. According to UNEP and WHO nearly 3 million people suffer from 'acute pesticide poisoning' and some 10 to 20 thousand people die every year from it in both the developed and the developing countries. Organic farming by earthworms (Sir Charles Darwin's 'friends of farmers') can provide a sustainable and also highly economical solution to the various problems created by the destructive agrochemicals in farm production. Earthworms vermicompost are scientifically proving to be an 'extraordinary powerful growth promoters and protectors' for crops (57 times over other bulky organic fertilizers and 20-40 % higher over chemical fertilizers). They are rich in NKP, micronutrients, beneficial soil microbes like 'nitrogen-fixing' and 'phosphate solubilizing' bacteria, 'mycorrhizal fungi', humus and growth hormones – auxins, gibberlins and cytokinins. It has very high 'porosity', 'aeration', 'drainage' and 'water holding capacity' and makes the soil soft. More significantly it also protect plants against various pests and diseases either by suppressing or repelling them or by inducing biological resistance in plants to fight them or by killing them by their beneficial microbes (chitin and cellulose degraders). 'Vermiwash' (liquid filtered through the body of worms) and the 'vermicompost tea' (solution of vermicompost) also works as very 'powerful bio-pesticides' eliminating the use of toxic chemical pesticides. Agriculture has also been responsible for huge emissions of greenhouse gases and induction of global warming. Of the increase of atmospheric carbon over the last 150 years, about a third (33.3 %) is thought to have come from agriculture. Chemical agriculture has further augmented GHG emissions. From their production in factories to their transport and use in farms agrochemicals generate huge toxic wastes and pollution and greenhouse gases. Aggressive tillage of compacted soils (due to use of agrochemicals) depletes the 'soil organic carbon' (SOC) and emits large volumes of CO_2. Chemical nitrogen from the soil is oxidised as N_2O which is 312 times more powerful GHG than CO_2. Organic farming by vermicompost 'sequesters' large amount of 'atmospheric carbon' and bury them back into the soil as SOC improving soil fertility and also 'mitigating global warming'. Soil amended with vermicompost have significantly greater 'soil bulk density' and hence porous and lighter and never get compacted needing no or low tillage. Production of vermicompost divert huge amount of wastes from 'landfills' which emit large amount of powerful greenhouse gases like CH_4 and N_2O along with CO_2. Every 1 kg of waste diverted from landfills prevents 1 kg of greenhouse gas emission equivalent to CO_2. It is like a 'win-win situation' for the nation, farmers, environment and the society. The objectives of this review paper is to scientifically prove that vermiculture technology with the aid of earthworms and its metabolic products (vermicast) can boost farm production without agrochemicals (completely organic) and justify the beliefs of Sir Charles Darwin who called the earthworms as 'friends of farmers' centuries ago. Besides, it will provide several social, economic and environmental benefits to the society by way of producing 'chemical-free' safe, 'nutritive and protective' foods (even against some forms of cancers) for the people, salvaging human wastes and reducing the needs for costly landfills, mitigating global warming by sequestering carbon into soil.

101

Kumawat RN, SS Mahajan and RS Mertia. (2011). "Response of cumin (Cuminum cyminum L.) to 'panchgavya' and plant leaf extracts in arid western Rajasthan." *Journal of Spices and Aromatic Crops*. Vol. 18, no. 2.

A field experiment was conducted at Jaisalmer (Rajasthan) to study the effect of foliar appliedneem (*Azadirachta indica*), datura (*Datura metel*) and tumba (*Citrullus colocynthis*) leaf extracts in 1:1 combination with 'panchgavya' on growth and yield of cumin (*Cuminum cyminum*). The results revealed that synthesis of chlorophyll and activity of nitrate reductase in freshleaves increased significantly with application of neem + panchgavya compared to control at55 and 80 days after sowing. Dry matter accumulation, branches plant-1, umbels plant-1, seeds umbel-1 and 100-seed weight also recorded significant increase with application of neem+ 'panchgavya'. Compared to control, neem + 'panchgavya' increased grain, straw andbiological yield by 58%, 72% and 65%, respectively. The content and uptake of N and P inseed and straw also recorded significant increase with application of neem + 'panchgavya'. Application of foliar sources both at branching and flowering stages recorded significantlyhigher accumulation of dry matter, yield and yield attributes, content and uptake of N and Pin seed and straw compared to single application at branching or flowering.

102

Verma Satish K, BS Asati, SK Tamrakar, HC Nanda and CR Gupta. (2011). "Effect of organic components on growth, yield and economic returns in potatoes." *Potato Journal* 38, no. 1: 51-55

An experiment was conducted on potato variety Kufri Jawahar to assess the effect of organic components on growth, yield and economic return in potatoes. The results revealed that combination of crop residues+azotobacter+phosphobacteria+biodynamic approach+microbial culture was the best among all the treatments for most of the growth and yield parameters under study and gave highest net return and B: C ratio. Thus, it can be concluded that the biofertilizers (azotobacter, phosphobacteria, microbial culture and biodynamic approach) are an advantageous source for sustainable organic agriculture, especially for heavy feeder crops like potato.

Bharath, A. C., H. R. Vinod Kumar, M B Shailendra Kumar, M C Rakesh Kumar, and T R Prashith Kekuda (2010). "Insecticidal efficacy of Cow urine distillate (Go-mutra ark)." *Res Rev Biomed Biotech* 1, no. 1: 68-70.

103

Yadav Gulab Singh, Datta M, Babu Subhash, Debnath C and Sarkar P. (2013). "Growth and productivity of lowland rice (Oryza sativa) as influenced by substitution of nitrogen fertilizer by organic sources." The Indian Journal of Agricultural Sciences 83, no. 10.

Field experiment was conducted during rabi and kharif seasons of 2011 and 2012 at research farm of ICAR–RC for NEH Region, Tripura centre, to assess the competence of different organic sources for substituting the 50% N fertilizer in integrated nutrient management system of rice (Oryza sativa L.) production. Data reveals that the substitution of 50% recommended dose of N fertilizer with either FYM@11.2 tonnes/ha or Glyricidia leaves @ 11.6 tonnes/ha significantly improved the growth and yield attributes of both rabi and kharif rice as compared to 100% recommended N fertilizer dose (80 kg N/ha). The maximum values of growth attributes (plant height, tillers/ hill and total dry matter accumulation/hill), yield attributes (productive tillers/ hill, panicle length, filled grains/panicle and 1 000 grain weight) and grain yields of rice was obtained with 50% recommended N fertilizer dose along with either FYM@11.2 tonnes/ha or Glyricidia leaves @ 11.6 tonnes/ha during both the seasons. Therefore, study suggested that the Glyricidia leaves has the competence for substituting the 50% recommended dose of N fertilizers and a suitable option for improving the productivity of lowland rice in Tripura region of North-East India.

104

Sriram S, Savitha MJ, Ramanujam B (2010). Trichoderma-enriched coco-peat for the management of *Phytophthora* and *Fusarium* diseases of chilli and tomato in nurseries. Journal of Biological Control. Vol. 24(4): 311-316.

Coconut coir dust, commercially available as coco-peat, is used in raising the seedlings of vegetable crops in tropical countries. Coir-pith and other derivates of coconut husk have been well recognized as substrates for the multiplication of *Trichoderma* spp. and commercial nurseries use coco-peat for raising the seedlings. In the present study, coco-peat enriched with *Trichoderma harzianum* was used for raising tomato and chilli seedlings to test the effect of the same on managing wilt caused by *Fusarium oxysporum* f. sp. *lycopersici* in tomato and damping off and root rot caused by *Phytophthora capsici* in chillies in nurseries. The enrichment with *T. harzianum*, resulted in reduced wilt incidence (5–7.5%) compared to control (38.75%) in tomato with increased plant growth parameters. Though germination was reduced compared to control (without pathogen), there was reduction in *P. capsici* infection in chillies by up to 50% compared to coco-peat without *Trichoderma* enrichment. The use of coco-peat enriched with *T. harzianum* can be adopted by commercial nurseries for better plant growth and reduced incidence of tomato wilt and chilli root rot while raising disease free and healthy seedlings.

105

Sreenivasa MN, Nagaraj Naik and SN Bhat. (2010). "Beejamrutha: A source for beneficial bacteria." Karnataka Journal of Agricultural Sciences 17, no. 3: 72-77

Use of Beejamrutha, a mix of cow dung, cow urine, water, lime and a handful of soil has been given importance in sustainable agriculture since age old days. It is also one such organic product helpful for the plant growth. The beneficial microorganisms present in beejamrutha are known to protect the crop from harmful soil-borne and seed-borne pathogens. Bacteria were isolated from beejamrutha and tested for their beneficial traits. These isolates were capable of N2-fixation, P-solubilization and IAA, GA production in addition to suppression of Sclerotium. Among the free-living N2-fixers, isolate AzB2 registered highest amount of N2 fixation (13.71 mg/g carbon source utilized) where as BPS3 released maximum amount of Pi (8.15 per cent) among phosphate-solubilizing bacteria isolated from beejamrutha. The isolate BJ5 was found to produce highest amount of IAA (11.36 µg/25 ml) and GA (3.13 µg/25 ml). Inoculation of the bacterial isolates from beejamrutha also resulted in improvement in seed germination, seedling length and seed vigour in soybean. Among the treatments, seeds inoculated with BJ5 has registered significantly higher seedling length and seedling vigour index while the seedling length and seedling vigour index was markedly lowest in control.

106

Gopal, Murali, Alka Gupta, C. Palaniswami, R. Dhanapal, And George V. Thomas (2010). "Coconut Leaf Vermiwash: A Bio-Liquid From Coconut Leaf Vermicompost For Improving The Crop Production Capacities Of Soil." *Current Science* 98, No. 9 : 1202-1210.

Coconut leaf vermiwash (CLV) was produced from actively vermicomposting coconut leaf litter + cow dung substrate (10:1 w/w basis) by Eudrilus sp. It significantly increased the seedling vigour index of cowpea and paddy at 1: 10 and 1:15 dilutions in laboratory trials. Field trials carried out in red sandy loam soil (Arenic Paleustuits) resulted an increase of 36% fresh biomass weight of cowpea with application of CLV at 1: 10 dilution. In maize, increase in cob yield by 5-10% and in bhendi (okra) 22-33% increase in fruit yield were recorded at 1: 5 dilutions of CLV. A concomitant increase in populations of general and plant beneficial microorganisms and soil enzyme activities in the rhizosphere of CLV-applied plants were also recorded. Soil organic carbon content increased in the CLV-applied plots in all the crops studied, but the total N, available P and K content in soil varied in different crops. The study indicated that CLV must be used in graded doses. Its application increased the crop production capacities of soil by (i) enhancing the organic carbon contents in the soil and (ii) increasing the populations of the soil microorganisms, particularly plant beneficial ones, and their activities which would have facilitated increased uptake of the nutrients by the plants resulting in higher growth and yield.

107

Ishfaq Akbar P, Kumar Vijai and Mohan Braj (2010). Influence of Bio-organic nutrition on the performance of cabbage (*Brassica oleracea var. capitata* L.) cv. Pride of India, *Adv. Res. J. Crop Improv.,* 1 (2) : 165-167.

Cabbage (*Brassica oleracea* var. *capitata* L.) belonging to the family *cruciferae* is one of the most important vegetables of the cole group. The cabbage leaves are eaten raw as salad and cooked as well. Literature pertaining to the production of quality cabbage heads through the use of organic nutrition is meagre. Hence, the present investigation was conducted at the Horticultural Research Farm of Ch. S. S. S. (P.G.) college Machhra, Meerut to study the influence of bio-organic nutrition on the performance of cabbage. Results revealed that significantly maximum plant height, plant spread, number of wrapper leaves, and head yield were obtained with the interaction vermicompost 10 t/ha and *Azotobacter* 5 kg/ha. While the maximum number of non-wrapper leaves and head diameter were significantly recorded highest with the combined application of vermicompost 10 t/ha and *Azotobacter* 10 kg/ha.

108

Namrata Kumari (2010). Biochemical efficacy of homa organic farming in soybean crops. PhD Dissertation. University of Agricultural Sciences, Dharwad.

A field experiment laid out in completely randomly block design with eight treatments exposed to Homa atmosphere replicated thrice was conducted during kharif 2009 to study the Biochemical efficacy of Homa Organic Farming in soybean crop (JS 335). The conventional control (CC) and control without Homa (CWH) were maintained 1 km away. Basal treatment to all the Homa treatment (HT) seeds was fresh cow dung and cow urine. Agnihotra Homa (AH) at sunrise and sunset and Om Tryambakam Homa (OTH) performed for 3-4 h daily yielded smoke and ash. Homa ash was used for seed treatment and for furrow application. Biosol prepared, contained AH ash and was used for soil and foliar application. The OTH ash as seed treatment and foliar application of Biosol was superior in plant height, dry matter accumulation (DMA) in leaves, grain and straw yield and 100% seed weight. The AH ash as seed treatment with Biosol as soil application was significantly superior over control in DMA in stem, total biomass per plant, number of pods per plant, nodule count and nodule dry weight wherein Homa ashes and Biosol as furrow application increased nodule count by 55-105 per cent over CC and 106-180 per cent over CWH. The macro and micro nutrients increased in soil with furrow application of both the Homa ashes and Biosol. Soil Zn content and dehydrogenase activity increased (151% and 233%, respectively) over control with soil application of AH ash and Biosol. Rust incidence and insect attack was significantly low (10-30 %) with foliar application of Biosol. Total protein and oil content increased on HT and activities of â-amylase and invertase in soy seeds on soil application of Biosol were superior. Homa smoke, ashes and Biosol thus show promise to the farming community to produce disease free healthy crops with good returns.
http://etd.uasd.edu/abst/th10019.pdf

109

Singh, Gurbax, Navtej Singh, and Gurmeet Singh (2010). "Effect of Mulching, Planting Methods and Bio Fertilizers on Growth and Yield of Gram (*Cicer Arietinum* L.)." *Crop Improvement* 37, no. 2: 202202.

Gram is one of the most important winter pulse crop in India. It can be a good alternative of prevailing non-sustainable, non ecological and cost oriented rice-wheat cropping system. In rice growing area, continuous practice of crop residue burning and other ill practices caused reduction in soil organic matter and edaphic biodiversity. Adverse effect of rice-wheat system on survival of gram symbiotic micro-flora was reported by many workers.

For successful establishment of crop and resource conservation, planting methods, mulching and inoculations are key inputs. The present investigation "Effect of mulching, planting methods and bio fertilizers on growth and yield of gram (Cicer arietinum L.)" was conducted at the Student's Research Farm, Khalsa College, Amritsar during Rabi season 2007–08. The soil of the experimental field was sandy loam in texture, normal in reaction (pH 7.8) and EC of soil is 0.21 dsm-1. The soil tested low in organic carbon (0.39 per cent), organic matter (0.68 percent) and available nitrogen (178 kg ha-1) and medium in available phosphorus (21.4 kg ha-1) and high in potassium (350 kg ha-1). The experiment was replicated thrice in split plot design. Treatments includes mulching and no mulching and three planting methods i.e. Bed planting with two rows, Bed planting with one row and Flat planting in main plot and three bio fertilizer treatments i.e. PSB inoculation, Rhizobium inoculation and dual inoculation of PSB and Rhizobium in sub plots. Recommended cultural practices except for treatments under study were followed throughout the crop growth period. Significant effect of mulching on the crop emergence, growth, yield contributing parameters and grain yield were noted. Mulched plots recorded higher seed yield of gram (16.6 q ha-1) which was 10.6 per cent higher than no mulching. Higher number of nodules per plant was also observed in mulched plots. The effect of different planting methods on emergence was non significant. However effect of different planting methods on growth, yield parameters and yield were significant. Higher seed yield was obtained from bed planting with two rows (16.8 qha-1) followed by bed planting with one row (15.5 qha-1) and flat planting (15.2 qha-1). Effect of bio fertilizers on crop emergence was found to be non significant however its effect on seed yield of gram was significant. Higher seed yield with combined inoculation of Rhizobium and PSB (16.7 q ha-1) over PSB (15.3 q ha-1) and Rhizobium (15.5 q ha-1) alone were observed. Combined inoculation of Rhizobium and PSB produced significantly more number of nodule per plant over PSB and Rhizobium alone. But Rhizobium and PSB remained at par with each other. Effect of different bio fertilizers treatments on harvest index was non significant. Seed protein content was significantly higher in Rhizobium alone and combined inoculation of Rhizobium and PSB over PSB alone. From the present study it was concluded that maximum yield was obtained with mulching over no mulching so we can solve problem of excess residue of proceeding rice crop. Bed planting with two rows produced maximum growth and yield indices of gram over bed planting with one row and flat planting. Maximum seed and straw yield was obtained with combined inoculation of both Rhizobium and PSB over Rhizobium and PSB inoculation alone.

110

Manjunatha GS, SN Upperi, BT Pujari, NA Yeledahalli and VB Kuligod. (2009). "Effect of farm yard manure treated with jeevamrutha on yield attributes, yield and economics of sunflower (*Helianthus annuus* L.)." *Karnataka Journal of Agricultural Sciences* 22, no. 1: 198-99

A field experiment was conducted at the Agricultural Research Station, Bheemarayanagudi, Karnataka, India during Kharif season of 2006 to study the effect of farmyard manure (FYM) treated with Jeevamrutha (desi cow dung, desi cow urine, pulse flour, jaggery, rhizosphere soil solution), on soil properties and yield of sunflower. The yield attributes viz., test weight, seed yield, and stalk yield were significantly influenced by various treatments. FYM at the rate 7.5 t/ha+100% RDF, significantly increased the test weight (49.26 g), seed yield (1774 kg/ha), and stalk yield (4.21 t/ha) compared to control (36.62 g, 851 kg/ha, 2.83 t/ha respectively), except treatment receiving FYM at the rate of 7.5 t/ha+Jeevamrutha treatment. Highest cost of cultivation per hectare was recorded with the application of FYM at the rate of 7.5 t/ ha+100% RDF (recommended dose of fertilizer) (Rs. 8479/ha) due to high cost of FYM and fertilizer, followed by the treatments FYM at the rate of 3.75 t/ha+100% RDF (Rs. 7791/ha) and FYM at the rate of 7.5 t/ ha+Jeevamrutha (Rs. 7345/ha). Lowest cost of cultivation was recorded in control (Rs. 4720/ha). Application of FYM at the rate of 7.5 t/ha+100% RDF recorded highest gross returns (Rs. 35 551/ha) and it was on par with the treatment FYM at the rate of 7.5 t/ha Jeevamrutha (Rs.34729/ha), however, it was significantly superior over other all treatments. The application of jeevamrutha, increased the activity of microbes by solubilization and uptake of nutrients was enhanced.

111

Niranjan Rajeev K, Amit Pal, HK Gupta, Manish K Verma and Dadhibal Prasad Gond. (2010). "Performance of different Vermicomposts on yield and yield components of Mungbean (Vigna radiata L.) in major soils of Bundelkhand region, India." *Journal of Ecophysiology & Occupational Health* 10, no. 1 and 2: 61-70.

Sustainable agriculture is one in which the goal is permanence, achieved through the utilization of renewable resources. This leads to development of concept of organic natural farming. Vermicomposting is one of the important aspects of organic farming. Vermicompost plays a major role in improving growth and yield of different field crops, vegetables, flower and fruit crops. Present study was carried out in major soil group (black soil and red soil) of Bundelkhand region with addition of different vermicompost and their effects on performances of Vigna radiata L. Gorwth and yield parameters were measured 30 days and 60 days after sowing. Significant performances were found in cowdung based vermicompost in black soil in compare to red soil. The result of our experiment showed the application of vermicompost had significant positive effects on growth performances and yield of plant as compare to control.

112

Waghmode BR (2010). "Response of sweet corn (*Zea mays* l. Saccharata) to different sources of organics." MSc Agriculture Thesis in Agronomy. University of Agricultural Sciences, Dharwad, 2010.

A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *kharif* 2009-10 on clay loam soils to evaluate the response of sweet corn to different sources of organic manures and liquid organic manures. The experiment was laid out in a Split-plot design with three replications. The experiment comprised of six manurial treatments M1, M2, M3, M4, M5 and M6 as main plots and three liquid organic manures (S1- Bio-digester liquid @ 10%, S2Panchagavya @ 3% spray, S3- Cow urine @ 10% and a control (S4) as sub-plots.

The results indicated that both organic manures and liquid organic manures had significant effect on growth, yield parameters, quality parameters and nutrient uptake as well as nutrient status of the soil. Significantly higher sweet corn fresh cob yield (6254 and 6222 kg/ha) and stover yield (7.36 and 7.04 t/ha) was recorded with RDF and RPP treatments, respectively. Among the liquid organic manures mainly bio-digester liquid @ 10% spray, panchagavya @ 3% spray and cow urine @ 10% spray recorded significantly higher growth and yield parameters like number of leaves, total dry matter production, cob length, cob girth, number of cobs per plant, fresh and dry grain weight and fresh cob yield over control. Significantly higher fresh cob yield (5594 and 5262 kg/ha) and stover yield (5.41 and 5.67 t/ha) were recorded in the treatment receiving bio-digester liquid @ 10% spray and panchagavya @ 3% spray respectively over rest of the treatments. The interactions effects, showed that, RPP with bio-digester liquid @ 10% spray resulted in significantly higher fresh cob yield (7067 kg/ha) and net returns (35,250 Rs./ha) which was on par with RDF and GLM + EC + VC (top dressing at GGS) with cow urine @10% spray which was found on par.

113

Srivastava Rashmi, Michel Aragno and AK Sharma. (2010). "Cow dung extract: a medium for the growth of pseudomonads enhancing their efficiency as biofertilizer and biocontrol agent in rice." *Indian journal of microbiology* 50, no. 3: 349-354.

Some *Pseudomanas* are being utilized as biofertilizers and biopesticides because of their role in plant growth promotion and plant protection against root parasites, respectively. Two strains of *Pseudomonas, P. jessenii* LHRE62 and *P. synxantha* HHRE81, recovered from wheat rhizosphere, have shown their potential in field bioinoculation tests under rice-wheat and pulse-wheat rotation systems. Normally, pseudomonads are cultivated on synthetic medialike King's B and used for inoculation on seeds/soil drench with talcum or charcoal as carrier material. Cow dung is being used for different purposes from the ancient time and has a significant role in crop growth because of the content in humic compounds and fertilizing bioelements available in it. Here, cow dung extract was tested as a growth medium for strains LHRE62 and HHRE81, in comparison with growth in King's B medium. The log phase was delayed by 2 h as compared to growth in King's B medium. The bacterial growth yield, lower in plain cow dung extract as compared to King's B medium, was improved upon addition of different carbon substrates. Growth of rice var. Pant Dhan 4 in pot cultures was increased using liquid formulation of cow dung extract and bacteria as foliar spray, compared to their respective controls. Biocontrol efficacy of the bioagents was assessed by challenging rice crop with *Rhizoctonia solani*, a sheath blight pathogen. The growth promotion and biocontrol efficiencies were more pronounced in the case of mixed inocula of strains LHRE62 and HHRE81.

114

Mitra SK, MR Gurung and PK Pathak. (2010). "Organic Nutrient Management in High Density Guava Orchard." In *XXVIII International Horticultural Congress on Science and Horticulture for People (IHC2010): International Symposium on 933*, pp. 233-238.

An investigation was carried out under sub-tropical condition of West Bengal, India to standardize the organic nutrient management protocol of 'Sardar' guava under high density (625 plants per ha) planting. Different organic sources of nutrients (neem cake, vermicompost, farm yard manure and poultry manure) and biofertilizers (azotobacter and azospirillium) were tried. The results revealed that application of neem cake along with azotobacter significantly increased yield, fruit size and improve quality of fruit. The treatment also showed the maximum cost/benefit ratio of 3.18 compared with 1.48 in control. Application of organic manures along with bio¬fertilizers substantially increased soil microbial population which

115

Mudigoudra Shrinivas and RA Balikai. (2010). "Evaluation of plant products in combination with cow urine and panchagavya against sorghum shoot fly, *Atherigona soccata* Rondani." *Karnataka Journal of Agricultural Sciences* 22, no. 3.

A study was undertaken in Karnataka, India, to evaluate the effectiveness of different plant products in the management of sorghum (*Sorghum bicolor*) shoot fly (*Atherigona soccata*). The treatments were *Vitex negundo* (5%; VN)+cow urine (5%; CU), neem seed kernel extract (5%; NSKE)+CU, *Adhatoda vesica* [*Justicia adhatoda*] (5%; AV)+CU, *Pongamia glabra* [*P. pinnata*] (5%; PG)+CU, panchagavya [cow milk, curd, ghee, dung and urine] (3%; P), P+VN, P+NSKE, P+AV, P+PG, carbofuran 3G (C) at 30 kg/ha, and untreated control. At 21 days after emergence, P+NSKE recorded the least number of eggs per plant (0.47/plant), followed by NSKE+CU (0.73/plant), P+VN (0.87/plant), VN+CU (0.93/plant), C (0.87/plant), P+PG (1.00/plant) and P (1.00/plant), and were on par with each other. All the treatments were found significantly superior over the untreated control (1.87/plant), which recorded the highest number of eggs per plant. At 28 days after emergence also the same trend existed where P+NSKE recorded significantly the least percentage dead hearts (21.08%) and was on par with NSKE+CU (5%), which recorded 23.68% deadhearts. The highest percentage dead hearts were recorded in the untreated control (67.60%) being statistically inferior to all other treatments. Among different treatments, P+NSKE recorded the highest yield of 14.16 q/ha followed by NSKE+CU (12.59 q/ha), P+VN (12.45) and VN+CU (12.04 q/ha) and P+PG (12.40 q/ha). However, these treatments were found on par with each other and found next best to C (18.43 q/ha).

116

Hegde NK, S Patil and VS Shashidhar. (2010). "Effect of organic nutrition on the performance of betel vine (*Piper betle* L.)'Ambadi'." In *XXVIII International Horticultural Congress on Science and Horticulture for People (IHC2010): International Symposium on 933*, pp. 273-278.

Betel vine (*Piper betle* L.) is a perennial creeper belonging to the family *Piperaceae*, cultivated in India for its leaves, used mainly for mastication. To study the effect of different nutritional sources on growth, yield and quality of betel vine 'Ambadi', a field experiment was conducted at Arabhavi, Gokak taluk, Dist. Belgaum, Karnataka, India, between 2005 and 2007. The experiment was laid out as randomized block design consisting of thirteen treatments replicated thrice. Treatment combinations included organic manures viz., farm yard manure (FYM), neem cake, vermicompost, sheep manure and press mud, as well as the recommended dose of fertilizer (RDF) for betel vine of 200:100:100 kg NPK per ha. Foliar spray of 25% vermiwash was conducted monthly. Farmers practice consisted of application of FYM (15 t/ha) and groundnut cake (0.50 t/ha). Application of FYM (25 t/ ha) along with RDF recorded higher growth and yield attributes resulting in significantly higher annual leaf yield (588.55 leaves/vine), followed by farmers' practice + foliar spray of 25% vermiwash (540.17 leaves /vine) and FYM (25 t/ha) + 2 t/ha of neem cake (512.07 leaves/vine). The lowest yield was obtained in the treatment consisting of farmers' practice alone (279.28 leaves/ vine). Maximum leaf size was obtained in the treatment consisting of farmers' practice + foliar spray of 25% vermiwash (127.30 cm^2) followed by FYM (25 t/ha) along with RDF (117.30 cm^2) and FYM (25 t/ha) + 2 t/ha neem cake (108.48 cm^2). The lowest leaf size was obtained in the treatment consisting of existing farmers' practice alone (78.27 cm^2). Organic nutrition not only produced larger leaf but also recorded higher leaf yield indicating scope for sustainable farming.

117

Patil, R. H., M. N. Santosh, and B. K. Athoni. (2010). "Indigenous technology knowledge components for the management of defoliators in soybean." *Karnataka Journal of Agricultural Sciences* 22, no. 3.

Studies were carried out during kharif 2007 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, India to evaluate the efficacy of indigenous technology knowledge components against major insect pests and their influence on the activity of natural enemies. The bioefficacy studies of herbal asthras and extracts revealed the superiority of NSKE @ 5 per cent which recorded higher larval reduction of *Spodoptera litura* (Fab.) and *Thysanoplusia orichalcea* (Fab.) (62.97, 84.81 and 62.98, 77.35 %, respectively after first and second spray) and least per cent pod damage (23.59 %) with higher seed yield (22.27 q/ha) and C:B ratio (2.59). The next best treatment was *agniastra*.

118

Sritharan N, M Rajavel and CN Chandrasekhar. (2010). "Impact of Bioregulators on Phytochemicals and quality of Black Night shade solanum nigrum." *Madras Agric. J* 97: 93-96.

Studies on influence of bioregulators (Panchagavya, leaf extracts of mukia, moringa, prosophis and root extract of withania) for yield and quality in *Solanum nigrum* indicated that the total drymatter production was favourably increased due to the application of all the bioregulators when compared to the control. Among these bioregulators, Panchagavya four per cent foliar spray registered highest drymatter production of 23.56 g and single plant yield of 73.10 g followed by moringa five per cent foliar spray recording 20.45 g and 69.98 g respectively. The quality parameters like leaf and fruit solasodine content, ascorbic acid, total soluble solids, total phenolics and solasodine content were maximum enhanced with the application of Panchagavya. The High Performance Thin Layer Chromatography (HPTLC) analysis of various compounds present in hexane extract showed the impact of Panchagavya in production of greater number of phytochemicals.

119

Rajanna G A (2010). Effect of different sources and time of application of organic manures on growth and yield of aerobic rice (*Oryza sativa L.). MSc Agri in Agronomy thesis. University of Agricultural Sciences, Bengaluru* (PAK 8143)

A field experiment was conducted at Zonal Agricultural Research Station, VC Farm, Mandya, University of Agricultural Sciences, Bengaluru during Kharif 2009 to study the effect of different sources and time of application of organic manures on growth and yield of aerobic rice. The texture of soil was red sandy loam having neutral pH with organic carbon of 0.45%, available nitrogen 2448.5 kg/ha, phosphorus 26.8 kg/ha and potassium 202.8 kg/ha. The variety used was Thanu (KMP101). The experiment was laid out in a Randomised Complete Block Design.

Significantly higher grain and straw yields (40.49 and 46.35 q/ha respectively) were recorded with recommended dose of fertilizers (100:50:50 kg N:P:K/ ha) + 10 tonnes of FYM/ha. However, it was on par with poultry manure equivalent to 10t FYM + biodigested liquid at 100% N equivalent basis (39.9 and 45.8 q/ha respectively), vermicompost equivalent to 10t of FYM + biodigested liquid at 100% N equivalent basis (39.1 and 45.08 q/ha respectively), poultry manure equivalent to 10 t of FYM + jeevamrutha at 100% N equivalent basis (38.63 and 43.59 q/ha respectively) and vermicompost equivalent to 10 t of FYM + jeevamrutha at 100% N equivalent basis (37.73 and 42.8 q/ha respectively). Similar trend was observed for the growth parameters like plant height, number of leaves, number of tillers, leaf area, leaf area index, leaf area duration and dry matter production. Further yield parameters like number of productive tillers per hill, panicle length, panicle weight, 1000 grain weight and number of filled grains also followed similar trend. Significantly higher gross returns were registered with recommended dose of fertilizers (100:50:50 kg N:P:K/ha) + 10 tonnes of FYM/ha (Rs.43267/), whereas higher net returns (Rs. 28,517) and benefit cost ratio (3.68) were registered with poultry manure equivalent to 10 t of FYM + bio digested liquid at 100% N equivalent basis.

120

Radhakrishnan, Anitha Sarala and Jose Mathew. (2010). "In situ green manuring with dhaincha (Sesbania aculeata Pers.): a cost effective management alternative for wet seeded rice (Oryza sativa L.)." *Journal of Tropical Agriculture* 48.

Two field experiments were conducted on simultaneous growing and incorporation of dhaincha (*Sesbania aculeata* Pers.) in wet seeded rice in the humid tropics of Kerala, India. The objectives were to optimize the stage and method of incorporation of dhaincha, to evaluate N release pattern following green manure addition, and to assess its potential to supplement the nutrient requirement of rice crop, besides evaluating the cost effectiveness of in situ green manuring. Treatments consisted of two stages of incorporation of in situ grown dhaincha (20 and 30 days after sowing), three methods of incorporation (using cono weeder, spraying 2, 4-D at1.0 kg•ha–1, and spraying met sulfuron methyl at 5.0 g•ha–1), and two levels of N application (100 and 75% of the recommended N dose of 90 kg•ha–1). Wet sown rice without dhaincha, receiving 5 Mg•ha–1 farm yard manure and 90, 45, 45 kg N, P, and K ha–1 respectively, served as control. The experiment was laid out in a completely randomized factorial design during 2004 and 2005 and was replicated thrice. Incorporation of dhaincha at 30 days added about 14 Mg•ha–1 of organic matter, reduced weed population by 70% and supplemented about 25% of the N requirement of rice. Peak release of NH4 - N from dhaincha coincided with panicle initiation stage of rice, signifying N availability at the most critical physiological stage (synchrony in the release of green manure held nutrients and nutrient uptake by the rice crop). Green manuring with intercropped dhaincha also enhanced rice yield by 544 kg•ha– 1 and returns by Rs.10220 ha–1, implying the potential of integrated nutrient management systems to augment crop productivity and profitability.

121

Yelleshkumar HS, GSK Swamy, CP Patil, VC Kanamadi and Prasad Kumar. (2010). "Effect of Pre-Soaking Treatments on the Success of Softwood Grafting and Growth of Mango Grafts." *Karnataka Journal of Agricultural Sciences* 21, no. 3: 471-472.

There were significant differences observed among the different bio-organics and chemical treatments. Maximum graft success was noticed in Panchagavya three percent (76.15%) followed by water soaking and GA3 100 ppm (74.17 and 73.73% respectively).

122

Sangeetha V and R Thevanathan. (2010). "Effect of foliar application of seaweed based panchagavya on the antioxidant enzymes in crop plants." *J Am Sci* 6: 185-188.

A modified formulation of panchagavya, amended with thee seaweed extract (*Sargassum wightii*) has been investigated for its effect on the antioxidant enzymes namely, SOD, GR and GPx in the leaves of the seedlings of the pulses, *Vigna radiata, Vigna mungo, Arachis hypogaea, Cyamopsis tetragonoloba, Lablab purpureus, Cicer arietinum* and the cereal *Oryza sativa* var. *ponni*. The seaweed based panchagavya formulation increased the levels of all the three enzymes in the experimental plants when used as a foliar spray. The spray was highly effective at 3% level.

123

Sangeetha V and Thevanathan R. (2010). Effect of panchagavya on nitrate assimilation by experimental plants. The Journal of American Science. Vol. 6 (2). 80-86.

Panchagavya, a vedic formulation for increased productivity and disease resistance in plants and a modified formulation amended with seaweed extract (*Sargassum wightii*) have been investigated for their effect on the enzymes of nitrate reduction and assimilation namely, NR, NiR, GS, GOGAT and GDH in the leaves of the seedlings of the pulses, *Vigna radiata, Vigna mungo, Arachis hypogaea, Cyamopsis tetragonoloba, Lablab purpureus, Cicer arietinum* and the cereal *Oryza sativa* var. *ponni*.

The seaweed based panchagavya formulation increased the levels of all the enzymes in the experimental plants when used as manure at low concentrations i.e 1: 50 and 1: 100 (panchagavya: soil). Traditional panchagavya at 1: 100 dilutions was able to exhibit an increase in the levels of NR and NiR only. The enzymes GS, GOGAT and GDH did not show any response to the use of traditional panchagavya formulation when used as manure.

124

Samoon HA, Showkat A Dar, B Zehra, S Sheraz Mahdi and SAGI Hassan. (2010). "Bio-fertilizers in Organic Agriculture." *Journal of Phytology* 2, no. 10.

Experiencing the adverse effects of synthetic input dependent agriculture the concept of organic agriculture is gaining momentum. Almost 31 million hectares of land are currently managed organically by more than 6, 00, 000 farmers worldwide, constitutes 0.7 per cent of agriculture land. India had brought more than 2.5 m ha land under certification of organics. In these systems production is based in synergism with nature, which makes systems of unending life i.e. sustainable. Deteriorative effects of synthetic chemical inputs are obvious, but, at the same time we need to revive soil health and living which support to sustainable production system. Soil environment needs to be made congenial for living of useful microbial population, responsible for continuous availability of nutrients from natural sources. Biofertilizers being essential components of organic farming play vital role in maintaining long term soil fertility and sustainability by fixing atmospheric dinitrogen (N=N), mobilizing fixed macro and micro nutrients or convert insoluble P in the soil into forms available to plants, there by increases their efficiency and availability. Currently there is a gap of ten million tonnes of plant nutrients between removal of crops and supply through chemical fertilizers. In context of both the cost and environmental impact of chemical fertilizers, excessive reliance on the chemical fertilizers is not viable strategy in long run because of the cost, both in domestic resources and foreign exchange, involved in setting up of fertilizer plants and sustaining the production. In this context, organic manures (bio-fertilizers) would be the viable option for farmers to increase productivity per unit area. The mycorrhizal associations (VAM) in alleviating Al toxicity, increasing N, P and micronutrient uptake, maintaining soil structure by the production specific protein called "Glomulin" has been repeatedly demonstrated. Liquid biofertilizer technology now, shares more advantage over conventional carrier based bio-fertilizers and can be considered as a breakthrough in field of Bio-fertilizer technology and should find greater acceptance by farmers, extension workers and commercial bio-fertilizer manufactures. In this review, the established facts observed and the work carried out by many researchers on bio-fertilizers is discussed.

125

Nain Lata, Anuj Rana, Monica Joshi, Shrikrishna D. Jadhav, Dinesh Kumar, Y. S. Shivay, Sangeeta Paul and Radha Prasanna. (2010). "Evaluation of synergistic effects of bacterial and cyanobacterial strains as biofertilizers for wheat." *Plant and soil* 331(1-2): 217-230.

An investigation was undertaken to screen, select and evaluate a set of bacterial and cyanobacterial isolates from the wheat rhizosphere for their role as biofertilizers in wheat. From an initial set of 23 cyanobacterial strains and 110 bacterial isolates from wheat rhizospheric soil, 3 bacterial and 3 cyanobacterial strains were selected based on their plant growth promoting potential under laboratory and controlled greenhouse conditions. In vitro compatibility studies revealed positive interactions among the six strains. Pot experiments were conducted with wheat variety *HD 2687*, with a total of 51 treatments, along with recommended fertilizer controls. Various combinations of the selected set of three bacterial (PW1, PW5 and PW7) and three cyanobacterial isolates (CW1, CW2 and CW3) were used along with 1/3 N and full dose of P and K fertilizers. Significant enhancement in the soil microbiological (Dehydrogenase activity, FDA hydrolase, Alkaline phosphatase and microbial biomass) and plant growth/yield parameters were recorded. Observations revealed a two-fold increase in panicle weight in selected combinations (PW1+PW7+CW3;
PW1+CW1+CW2/CW1+CW3;
CW2+CW3), as compared to control treatment involving full dose of chemical fertilizers. Such combinations, which also provided N savings of 40–80 kg N/ ha are being further evaluated in field

experiments. This study for first time illustrated the positive and dynamic interactions among bacterial and cyanobacterial strains and their promise in integrated nutrient management of wheat crop.

126

Sangeetha, V and R. Thevanathan. (2010). "Biofertilizer, potential of traditional and panchagavya amended with seaweed extract." *Am Sci* 6, no. 2: 61-67.

The potential of utilizing panchagavya as biofertilizer was tested on the pulses *Vigna radiata, Vigna mungo, Arachis hypogea, Cyamopsis tetragonoloba, Lablab purpureus, Cicer arietinum* and the cereal *Oryza sativa* var. *ponni* by growing in soil amended with dried traditional and seaweed based panchagavya. Experimental seedling recorded higher rates of linear growth of both shoots and roots as compared to controls. These seedlings produced 264 to 390% more lateral roots than the control and maximum lateral root production was always observed in seedlings grown in soil amended with seaweed based panchagavya at low concentrations (1:100; panchagavya:soil). A similar observation was made on the number of leaves produced, leaf area and the number of root nodules formed in the pulses by rhizobia. A marked decrease in Chlorophyll a/b ratio, C/N ratio in the plants grown in seaweed based panchagavya indicating high chlorophyll b levels and a better nitrogen use efficiency in these plants respectively.

127

Naik Nagaraj and MN Sreenivasa. (2010). "Influence of bacteria isolated from panchagavya on seed germination and seed vigour in wheat." *Karnataka Journal of Agricultural Sciences* 22, no. 1.

The effects of bacteria (PB1-PB15) isolated from panchagavya (prepared from cow dung, cow urine, cow's milk, curd from cow milk, ghee made from cow milk, sugarcane juice, tender coconut water and ripened banana) on wheat seed germination and vigour were studied. Wheat seeds were dipped in the broth of the bacterial isolates for 10 minutes and allowed to germinate at 28±20°C for one week. On the 8th day after sowing, the highest percentage of germination (99%) was recorded for seeds treated with PB9 and PB15, while the lowest was registered for the un-inoculated seeds, indicating the role of the bacterial isolates in promoting seed germination. Seeds inoculated with PB9 resulted in the greatest seedling length and seedling vigour index, while seedling length and seedling vigour index were lowest in the control. Seven isolates inhibited the growth of *Sclerotium* sp. *in vitro*.

128

Prabha MR and K Vasantha. (2010). "Effect of organic fertilizer and Panchagavya spray on the growth and biomass of *Cassia angustifolia* Vahl." *Plant Archives* 10(1): 279-280.

The objective of the study is to analyse the effect of organic manures like vermicompost, biodynamic preparation, digested coir pith, and farmyard manure with and without the spray of panchagavya on the growth and biomass of *Cassia angustifolia*. The physical parameters like shoot length, root length, number of branches, number of inflorescence, fresh weight, dry weight and chlorophyll content of *Cassia angustifolia* was recorded at periodic intervals. From the results it was observed that the application of farmyard manure and 2% panchagavya has influenced the growth and biomass more than other treatments.

129

Das Anup, Tomar JMS, Ramesh T, Munda GC, Ghosh PK, Patel DP (2010). Productivity and economics of lowland rice as influenced by incorporation of N-fixing tree biomass in mid-altitude subtropical Meghalaya, North East India. Nutrient Cycling in Agroecosystems. Nutrient Cycling in Agroecosystems. Volume 87. Issue 1. Pp 9-19

The climatic conditions of North East India are favorable for trees to produce biomass in the form of foliage and twigs that are very rich in essential plant nutrients. Effective recycling of this biomass would help meet the nutritional requirement of crops. Field experiment was conducted in *kharif* (June– November) seasons for consecutive 3 years (2003, 2004, and 2005) at a lowland farm, subtropical Meghalaya (950 m asl), India, to study the effect of incorporating N-fixing tree biomass (leaves and twigs) on productivity and economics of rice (*Oryza sativa* L.). Fresh biomass from five tree species including erythrina (*Erythrina indica*), acacia (*Acacia auriculiformis*), alder (*Alnus nepalensis*), tree bean (*Parkia roxburghii*), and cassia (*Cassia siamea*) were applied at a rate of 10 t/ha. A plot with recommended NPK rate (80:60:40 kg/ha) and a control plot were also maintained for comparison. Among the tree species used, the biomass of *E. indica* was superior in terms of N (3.2%), P (0.47%), K (1.5%), and organic C (18.8%) contents. In the first and second year, productivity of rice was high with a recommended NPK rate (4.82 t/ha in 2003 and 5.08 t/ha in 2004) followed by rice with incorporation of *E. indica* biomass. In the third year of the experiment, effects of tree biomass incorporation on growth, yield and yield attributes surpassed those of the recommended NPK rate, with the exception of *A. nepalensis* biomass. In that year, the maximum grain yield was recorded under *E. indica* treatments, exceeding yields under the recommended NPK rate and control by 10.5 and 69.3%, respectively. Incorporation of tree biomass significantly improved (14–19% N and 62–83% P over control) the stocks of soil available N and P. Treatment with *A. auriculiformis* and *E. indica* biomass resulted in significantly higher soil organic C content which exceeded that under the recommended NPK rate by 10.3 and 9.2% and that under the control by 15.2 and 14%, respectively higher by species. The highest net return was recorded with the recommended NPK rate ($ 381/ ha) followed by *E. indica* ($ 303/ha). Since the local farmers are resource poor and rarely use chemical fertilizers, application of plant biomass, particularly that of *E. indica*, to lowland rice is a recommendable option to improve productivity and income, and to sustain soil health.

130

Roy Samiran, Kusum Arunachalam, Biman Kumar Dutta and Ayyanadar Arunachalam. (2010). "Effect of organic amendments of soil on growth and productivity of three common crops viz *Zea mays*, *Phaseolus vulgaris* and *Abelmoschus esculentus*". *Applied soil ecology* 45, no. 2: 78-84.

The study was aimed at understanding the effect of different amendments to soil on the plant growth and productivity. The paddy straw and *Ageratum conyzoides* residues were used as direct mulch, compost, and vermicompost in different plots planted with *Zea mays*, *Phaseolus vulgaris* and *Abelmoschus esculentus,* separately in three experimental plots. The different treatments affected the seed germination of the three test crops significantly. Plant height, basal area, productivity and biomass allocation in above ground parts were highest in vermicompost treated plots and lowest either in control or in mulched plots. The significant positive correlation between biomass accumulation and nutrient mineralization pattern but negative correlation between productivity and available nitrogen was observed. The study revealed that different amendments affected crops differently and the pre-treatment of crop/plant residues like vermicomposting are invariably beneficial and contributed to crop growth and available N in soil.

131

Gupta Suman and AK Dikshit. (2010). "Biopesticides: An eco-friendly approach for pest control." *Journal of Biopesticides* 3, no. 1: 186188.

An ecofriendly alternative to chemical pesticides is biopesticides, which encompasses a broad array of microbial pesticides, biochemicals derived from micro-organisms and other natural sources, and processes involving the genetic incorporation of DNA into agricultural commodities that confer protection against pest damage. Biopesticides fall into three major classes. The potential benefits to agriculture and public health programmes through the use of biopesticides are considerable. The interest in biopesticides is based on the disadvantages associated with chemical pesticides are discussed. The total world production of biopesticides is over 3,000 tons/yr, which is increasing at a rapid rate. India has a vast potential for biopesticides. However, its adoption by farmers in India needs education for maximizing gains. The market share of biopesticides is only 2.5% of the total pesticide market. The stress on organic farming and on residue free commodities would certainly warrant increased adoption of biopesticides by the farmers. Biopesticides being target pest specific are presumed to be relatively safe to non-target organism including humans. However, in India, the registration committee requires the data on chemistry, bioefficacy, toxicity and packaging and labeling, for registration. Pesticide Registration Committee has so far not approved any guidelines for the registration of GM biopesticides. In India, some of the biopesticides like Bt, NPV, neem based pesticides, etc. have already been registered and are being practiced.

132

Roy Somnath, Ananda Mukhopadhyay and Guruswami Gurusubramanian. (2010)."Field efficacy of a biopesticide prepared from *Clerodendrum viscosum* Vent. (Verbenaceae) against two major tea pests in the sub Himalayan tea plantation of North Bengal, India." *Journal of pest science* 83, no. 4: 371-377.

The toxicity of four concentrations (1, 5, 10 and 20% w/v) of an aqueous extract from the weed, *Clerodendrum viscosum* Ventenat (Verbenaceae) was investigated under field conditions of the North Bengal University, Darjeeling, West Bengal, India for managing two major pests of tea, *Camellia sinensis* (L), namely the tea mosquito bug, *Helopeltis theivora* Waterhouse, (Heteroptera: Miridae) and the tea red spider mite, *Oligonychus coffeae* Nietner, (Acarina: Tetranychidae). Four field trials, two for red spider mite and two for tea mosquito bug, were conducted during April–May 2008 and October–November 2009 following a Randomized Block design. The aqueous extract of *C. viscosum* effectively and significantly reduced the mite population as well as infestation of tea mosquito bug by 68–95% and 73–86%, respectively, and their bioefficacy is comparable to synthetic and neem pesticides. No phytotoxic effect (score 0–5% and grade 1) was observed in the tea bushes sprayed with different doses of aqueous extract of *C. viscosum* in the field. Made tea samples were taint free. Organoleptic test revealed leaf-infusions and liquor strength as good, scoring 6.5–7.0 on a 10 point scale. Availability and distribution of this weed (*C. viscosum*) in and around tea-growing areas of sub Himalayan region, along with its processing for the feasibility of including *C. visosum* extracts in the current IPM programme is discussed.

133

Sinha Rajiv K, Dalsukh Valani, Krunal Chauhan and Sunita Agarwal. (2010). "Embarking on a second green revolution for sustainable agriculture by vermiculture biotechnology using earthworms: Reviving the dreams of Sir Charles Darwin." *Journal of Agricultural Biotechnology and Sustainable Development* 2, no. 7: 113-128.

Vermiculture biotechnology promises to usher in the 'Second Green Revolution' by completely replacing the destructive agro-chemicals which did more harm than good to both the farmers and their farmland. Earthworms restore and improve soil fertility and significantly boost crop productivity. Earthworms excreta (vermicast) is a nutritive 'organic fertilizer' rich in humus, NKP, micronutrients, beneficial soil microbes - 'nitrogen-fixing and phosphate solubilizing bacteria' and 'actinomycets' and growth hormones 'auxins', 'gibberlins' and 'cytokinins'. Both earthworms and its vermicast and body liquid (vermiwash) are scientifically proving as both 'growth promoters and protectors' for crop plants. In the experiments with corn and wheat crops, tomato and egg-plants it displayed excellent growth performances in terms of height of plants, colour and texture of leaves, appearance of flowers and fruits, seed ears etc, as compared to chemical fertilizers and the conventional compost. There is also less incidences of 'pest and disease attack' and 'reduced demand of water' for irrigation in plants grown on vermicompost. Presence of live earthworms in soil also makes significant difference in flower and fruit formation in vegetable crops. Earthworms biomass, a byproduct of VBT is rich in 'high quality protein' and source of nutritive feed materials for fishery, poultry and dairy industries and also for human consumption.

134

Sangeetha SP, A Balakrishnan and J Bhuvaneswari. (2010). "Organic nutrient sources on growth and yield of rice." Madras Agricultural Journal 97, no. 7/9 : 251-253.

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during rabi 2007 and 2008 to study the effect of organic sources of nutrients (enriched FYM compost, vermicompost, FYM+neem cake, enriched FYM compost+vermicompost+FYM, composted poultry manure and enriched poultry manure compost) and recommended NPK fertilizers on growth and yield of rice. The results revealed that the application of enriched poultry manure compost on equal N basis (2.3 t ha-1) recorded higher growth parameters, yield attributes and grain yield of 4675 kg ha-1 in 2007 and 4953 kg ha-1 in 2008, which was however comparable with composted poultry manure.

135

Dey HS, K Tayung and AK Bastia. (2010). "Occurrence of nitrogenfixing cyanobacteria in local rice fields of Orissa, India." *Ecoprint: An International Journal of Ecology* 17: 77-85.

Cyanobacterial diversity occurring in some local rice fields of Orissa, India has been studied in two different seasons and influence of pH, organic carbon (%) and conductivity were correlated on their population. At different locations and seasons the pH of the soil varies from 6.30±0.20 to 6.66±0.305. Conductivity and organic carbon (%) varies from 0.6±0.10 to 0.76±0.152 and 0.56±0.045 to 0.70±0.025 respectively. Altogether 58 taxa belonging to 20 genera were obtained and characterized. Out of these 19 forms were heterocystous and 39 were non-heterocystous. Highest abundance of cyanobacteria was found in order Nostocales which was represented by 15 species. Among the species relative abundance of *Oscillatoria chalybea* (9.90%) was found to be highest followed by *Phormidium purpurascens* (8.49%), *Cylindrospermum muscicola* and *Oscillatoria chlorina* (8.01%). Highest Shannon's diversity index was recorded in sampling site 1, followed by site 2. Comparatively the diversity index was more during winter than in summer in all the study sites. Highest similarity index (0.174) was found in summer-summer isolates of site 1 and 3. Among the environmental variables (i.e., soil pH, organic carbon (%), conductivity) highly positive correlation was observed between cyanobacterial population and soil pH (r e" 9) in all the three sampling sites. The study indicates ubiquitous distribution of cyanobacteria in rice fields and could be exploited for biofertilizer in agriculture.

136

Vanitha SC, SR Niranjana, CN Mortensen and S Umesha. (2009). "Bacterial wilt of tomato in Karnataka & its management by *Pseudomonas fluorescens*" *BioControl* 54(5): 685-695

Field surveys undertaken in major tomato growing districts of the Karnataka state, located in southern part of India, revealed a high incidence of bacterial wilt caused by *Ralstonia solanacearum* and it is one of the most destructive bacterial diseases of economically important crops. Across all the tomato cultivars under evaluation, the disease incidence in plants ranged from 9% to 39% whereas the incidence in seeds ranged from 4% to 18%. The effects of tomato seed treatments with Pseudomonas fluorescens in the control of bacterial wilt under greenhouse conditions revealed that the treatments protected plants against soil-borne infections of the bacterial wilt organism. Seed treatment with antagonistic P. fluorescens strain significantly improved the quality of seed germination and seedling vigour. The disease incidence was significantly reduced in plants raised from P. fluorescens treated seeds followed by challenge inoculation with R. solanacearum. Periodic field surveys for the incidence of bacterial wilt of tomato could be recommended to monitor the populations of the bacterial wilt pathogen. Workable measures are presented that could lead to the reduction of the prevalence of this serious disease in affected fields of the small farmholders.

137

Kumawat RN, Mahajan SS and Mertia RS (2009). Growth and development of groundnut (*Arachis hypogea*) under foliar application of panchgavya and leaf extracts of endemic plants. Indian Journal of Agronomy. Vol. 54 (3): 324-331.

A field experiment was conducted at Regional Research Station, CAZRI, Jaisalmer during *kharif* 2006 and 2007 to evaluate the efficacy of foliar applied *panchgavya* on the physiological growth, nutrient uptake, yield and economics of groundnut (*Arachis hypogaea*) with and without mixing leaf extracts of neem (*Azadirachta indica*), datura (*Datura metel*) and tumba (*Citrullus colocynthis*). The results of the experiment revealed that foliar application of *panchgavya*+neem leaf extract (NLE) recorded significant improvement in chlorophyll content, nitrate reductase activity, root nodule weight, leaf area index, dry matter accumulation, nutrient content and uptake of groundnut when compared with control and *panchgavya* alone. Yield attributes (pod weight, pod index, kernel index, shelling per cent) and harvest index were also recorded significantly higher with *panchgavya*+NLE. The pod, haulm and biological yield increased by 54, 25 and 39% with foliar application of *panchgavya*+NLE over the control. Maximum net return (Rs 45,399/ha) and B:C ratio (2.19) was recorded with foliar application of *panchgavya*+NLE over other sources. Foliar application at branching (35 DAS) and flowering (55 DAS) recorded significantly higher growth and yield of groundnut, net return (Rs 42,880/ha) and benefit: cost (2.06) than foliar application of the sources either one of these two stages.

138

Naveen Kumar AT. (2009). Effect of FYM and bio-digested liquid manure on growth and yield of groundnut under rainfed condition. MSc Agriculture Thesis, in Agronomy. University of Agricultural Sciences, Bangalore. PAK 7142

An experiment was conducted during kharif 2008 at Agriculture Research Station, Balajigapade, Chikkaballapur district to know the "effect of different levels of FYM and biodigested liquid manure on growth and yield of groundnut under rainfed condition". The soil is red sandy loam in texture slightly acidic in reaction. The experiment consisted of ten treatments involving different levels of FYM and biodigested liquid manure (based on N equivalent) laid out in Randomized Complete Block Design replicated thrice.

Significantly higher pod yield (1200 kg/ha) and haulm yield (1680 kg/ha) were recorded with the application of 10 tonnes of FYM + biodigested liquid manure equivalent to 30 kg N/ha as a result of higher plant height (29.70 cm), number of branches/plant (5.8), total dry matter accumulation (32 g/plant), number of nodules/plant (52) and yield parameters like number of pods/plant (26), number of pegs/plant (42), peg to pod ratio (1.6), nutrient uptake (84.3:8.4:34.3 kg NPK/ha) and nutrient availability (251: 31.2: 223.5 N, P2O5 and K2O/ha). FYM 10 tonnes + biodigested liquid manure equivalent to 30 kg N/ha was found to be cost effective as it recorded highest net returns (Rs. 15285) and B:C ratio (2.09) compared to all other treatments.

139

Radha Prasanna, Lata Nain, Radhika Ancha, Jadhav Srikrishna, Monica Joshi and Brahma D Kaushik. (2009). Rhizosphere dynamics of inoculated cyanobacteria and their growth-promoting role in rice crop. Egyptian Journal of Biology. Vol. 11. 26-36.

Nitrogen fixing cyanobacteria are the predominant flora in waterlogged paddy fields which contribute significantly towards nitrogen budgeting in these ecosystems. Their establishment and role in plant growth promotion and soil microbial activity is poorly known. Under greenhouse conditions, pots were inoculated with one of a set of twenty cyanobacterial strains isolated from the rhizosphere of diverse rice and wheat varieties. Several strains established in the soil and persisted up to the harvest stage in soil and roots, significantly enhancing soil microbial biomass carbon, available nitrogen, and related soil microbiological parameters, and increased grain yields and grain weight. This can help in selecting promising strains for developing carrier-based inoculants to promote the growth of crop and soil microflora, leading to enhanced soil fertility and crop yields.

140

Manjunath BL and VS Korikanthimath. (2009). "Sustainable rice production through farming systems approach." *Journal of Sustainable Agriculture* 33, no. 3: 272-284.

Field experiments were conducted for three years (from 1999 to 2002) at ICAR Research Complex for Goa, Old Goa, Goa, India, to identify a productive and sustainable cropping system with rice. Three major cropping systems common to the coastal region of India (rice-groundnut, rice-cowpea, and rice-vegetables) were compared with rice-fallow and rice-green manure (sunn hemp) systems. The experiment was conducted in a split-plot design with three replications in fixed plots. Integration of mushroom production and broiler poultry rearing were studied with the cropping systems. Three recycled manures from the integrated systems (FYM, poultry manure, and paddy straw with mushroom spent substrate) were applied to rice during the rainy season and were compared with no recycled manure treatment in main plots with cropping systems as subplots. The highest rice yield (5866 kg/ha) was observed when green manure (sunn hemp) was grown under recycled FYM and was followed by rice-brinjal rotation involving paddy straw and mushroom spent substrate (5761 kg/ha). The mean grain yield was enhanced by 18% (769 kg/ha increase) with groundnut rotation as compared with the rice-fallow system by the third season. Among the manurial resources, recycling of paddy straw with mushroom spent substrate recorded consistently better performance with a mean yield increase of 365 kg/ha compared with no recycling of manure. The rice-groundnut system was found more stable in terms of yield potential as reflected by higher sustainability yield index (0.78) and was followed by the rice-brinjal system (0.75). Paddy straw with mushroom spent substrate recorded the highest SYI (0.75) as compared with others, indicating that the practice is more sustainable. Incorporation of paddy straw along with mushroom spent substrate over a period of years had a beneficial cumulative effect on soil fertility. Although the effect of cropping systems on soil organic carbon was not appreciable, the rice groundnut system was observed to increase the soil organic carbon marginally.

141

Tyagi NS, Singh MP and Kumar Rakesh (2009). Use of organic manure and insecticides in India: In perspective of environment conservation. Bharatiya Vaigyanik evam Audyogik Anusandhan Patrika. Vo; 17 (2). Pp 124-128.

There are sufficient evidences that the organic farming in India is more than 5000 years old. Due to organic farming soil fertility was maintained with continuous crop production for a long period. In India green revolution was started in 1966-67. In green revolution hybrid seeds, chemical insecticides, weedicides and chemical fertilizers were used in heavy quantities for getting more and more crop yield. Consequently, soil fertility, soil productivity, biodiversity and quality of food material were adversely affected along with the environment. A study was carried out to overcome these problems and use of organic manures and insecticides have been recommended in a better scientific way.

142

Shwetha BN, HB Babalad and RK Patil. (2009). "Effect of combined use of organics in soybean-wheat cropping system." *Journal of Soils and Crops* 19, no. 1: 8-13.

A field experiment was conducted during the kharif and rabi seasons of 2006-07 in Dharwad, Karnataka, India, to study the integrated use of organic manures (compost, vermicompost and *Gliricidia* green leaf manure, GLM) and fermented organics (beejamruth, jeevamruth and panchagavya, containing cow dung and urine) in soyabean-wheat cropping system. The recommended dose of NPK (RDF) was applied at the time of sowing in the control plot, whereas the GLM, compost, vermicompost and farmyard manure (FYM) were applied 15 days before the crop sowing as per the treatments. Beejamruth was used for soaking seeds (seed treatment), jeevamruth was applied to the soil at the time of sowing and at 30 days after sowing, and panchagavya was applied as foliar spray at flowering and 15 days after flowering. The grain yield of soyabean, wheat and their soyabean equivalent yield were significantly higher in RDF+FYM and combined use of organic manures+fermented organics. A similar trend was noticed with compost+vermicompost+GLM with respect to nutrient uptake in both crops.

The treatment with compost+vermicompost+GLM recorded yield comparable to RDF+FYM and former treatments. The net return was significantly higher in the treatments receiving compost+vermicompost+GLM and RDF+FYM, but these were on par with organic manures+fermented organics. The benefit:cost (B:C) ratio of soyabean-wheat cropping system was significantly higher in compost+vermicompost+GLM over the rest of the treatments. Similarly in soyabean, the B:C ratio was significantly higher with compost+ vermicompost+GLM and was on par with RDF+FYM, compost+GLM, beejamruth+ jeevamruth, mulching alone and with panchagavya, compost+vermicompost+GLM+beejamruth+jeevamruthand compost+ vermicompost+ GLM+beejamruth+jeevamruth+ panchagavya, whereas, it was at par with only compost+GLM, vermicompost+GLM and beejamruth+ jeevamruth+mulching in wheat.

143

Sumangala K and MB Patil. (2009). “Panchagavya-an organic weapon against plant pathogens.” *Journal of Plant Disease Sciences* 4, no. 2: 147-151.

Panchagavya - an organic formulation, which is prepared out of unique combination of five products of cow viz., cow milk, curd, ghee, urine and fresh dung at appropriate quantities collected from a lactating desi cow. This was evaluated *in vitro* for its antifungal potential through inhibition of spore germination and mycelial growth of *Curvularia lunata* a pathogen of grain discolouration of rice in rice growing tracts of Tungabhadra Project Area and Upper Krishna Project Area of Karnataka state in India comprising Raichur, Koppal and Gulbarga districts during 2007. Although many fungi have been isolated from discolored grains, *Curvularia lunata* was found dominant and located in all the parts of seed. Further, the panchagavya was also tested for its efficacy in strengthening defense mechanism in rice plants through seed treatment. Panchagavya resulted in 86.30 per cent inhibition of mycelial growth and 95.90 per cent inhibition of spore germination of *Curvularia lunata in vitro*. Seed treatment with Panchagavya further enhanced the seed germination with 90.70% and vigor index of 1036.36.

144

Ishfaq Akbar Peerzada, Kumar Vijai, Malik Mohd. Faeem (2009): Effects of Bio-Organic Fertilisers on the performance of cabbage under Western UP conditions. Annals of Horticulture Vol. 2, Issue 2: 204-206

Present experiment was conducted to study the effects of vermicompost and bio-fertilizer *(Azotobacter)* on the performance of cabbage cv. “Pride of India” under western Uttar Pradesh conditions. The trial was laid out at
Horticultural Research Farm of Ch.S.S.Shandilya (P.G.) College, Machhra, Meerut (U.P.) during 2004–05 by following Factorial R.B.D. with three replications. The treatments comprised of three levels of each of vermicompost (0, 5 and 10 t/ha) and *Azotobacter* (0, 5 and 10 kg/ha). Results revealed that application of vermicompost @ 10 t/ha resulted in the tallest plant, maximum plant spread, largest size of head, and highest yield of heads per plant and per hectare, while the number of leaves/plant and number of wrapper leaves/head were maximum with 5 t Vc/ha. Among the various levels of bio-fertilizer inoculation, *Azotobacter* @ 10 kg/ha resulted in maximum plant height and diameter of head, maximum number of leaves/ plant and number of wrapper leaves/head, while the length of head and head yield/plant were maximum with 5 kg *Azotobacter*/ha.

145

Anburani A and M Gayathiri. (2009). "Response of soil and foliar application of organic nutrients on growth in onion (*Allium cepa* var. Aggregatum) cv. Gnanamedu Local." *Asian Journal of Horticulture* 4, no. 2: 467-469.

A pot culture experiment was carried out to study the influence of organic sources of nutrients on growth in onion. The treatments comprised of application of organic manures like FYM (1 kg), press mud (1 kg), vermicompost (1 kg), and VAM (10 g pot^{-1}) as basal application, whereas humic acid (0.2%), vermiwash (1:5 dilution) and panchagavya (3%) were given as foliar spray. Potting mixture was prepared in the ratio of 1:1 (consisting of sand and soil). Observations on growth parameters were recorded and statistically analysed. The results revealed that the growth parameters were significantly influenced due to the application of soil and foliar application of organic nutrients. The highest plant height (54.43 cm), number of tillers (5.12), number of leaves per plant (17.77), leaf area (145.79 cm^2) and dry matter production (9.43 g plant *) were recorded in the treatment that received VAM @ 10 g pot^{-1} combined with humic acid 0.2% followed by the treatment tested with vermicompost @ 1 kg pot^{-1} combined with panchagavya @ 3% when compared to other treatments.

146

Babou C, G Poyyamoli and B Guna. (2009). "Impact of LEISA based system of rice intensification (SRI) practices on rice grain yield and soil properties in rice-rice-rice cropping system in Puducherry region." *International Journal of Agricultural Sciences* 5, no. 1 : 43-45.

A field experiment was conducted on farmers' fields in the Southeastern region of Puducherry, India during *kharif* and *rabi* seasons of 2002 to 2005 to study the effect of LEISA based system of rice intensification practices on rice grain yield and soil properties. The field experiment was laid out in Randomized Block Design with twelve treatments replicated thrice. The treatments include incorporation of farmyard manure @ 12.5 t ha^{-1} and *Sesbania rostrata* @ 6.25 t ha^{-1}, applied alone and in combination with organic mixtures prepared from cow products into plots of a rice-rice-rice system. The results revealed that soils amended with organic manures consistently registered significantly improved organic C, mineral, total N and grain yield compared to the unamended soil.

147

Senthil-Nathan, Sengottayan, Man-Young Choi, Chae-Hoon Paik, Hong-Yul Seo and Kandaswamy Kalaivani (2009). "Toxicity and physiological effects of neem pesticides applied to rice on the *Nilaparvata lugens* Stål, the brown planthopper." *Ecotoxicology and environmental safety* 72, no. 6: 1707-1713.

The effects of two different neem products (Parker Oil™ and Neema®) on mortality, food consumption and survival of the brown planthopper, *Nilaparvata lugens* Stål (BPH) (Homoptera: Delphacidae) were investigated. The LC_{50} (3.45 ml/L for nymph and 4.42 ml/L for adult in Parker Oil™ treatment; 4.18 ml/L for nymph and 5.63 ml/L for adult in Neema® treatment) and LC_{90} (8.72 ml/L for nymph and 11.1 ml/L for adult in Parker Oil™ treatment; 9.84 ml/ L for nymph and 13.07 ml/L for adult in Neema® treatment) were identified by probit analysis. The LC_{90} (equal to recommended dose) was applied in the rice field. The effective concentration of both Parker Oil™ and Neema® took more than 48 h to kill 80% of the *N. lugens*. Fourth instar nymph and adult female *N. lugens* were caged on rice plants and exposed to a series (both LC_{50} and LC_{90}) of neem concentrations. Nymph and adult female *N. lugens* that were chronically exposed to neem pesticides showed immediate mortality after application in laboratory experiment. The quantity of food ingested and assimilated by *N. lugens* on neem-treated rice plants was significantly less than on control rice plants. The results clearly indicate the neem-based pesticide (Parker Oil™ and Neema®), containing low lethal concentration, can be used effectively to inhibit the growth and survival of *N. lugens*.

148

Kumaravelu G and D Kadamban. (2009). "Panchagavya and its effect on the growth of the greengram cultivar K-851." *International Journal of Plant Sciences (Muzaffarnagar)* 4, no. 2: 409-414.

Seeds of greengram [*Vigna radiata* (L.) Wilczek cv. K-851] were selected for Petriplate and pot studies. Experiments were initially conducted in Petriplates using Panchagavya (2, 3, 4, 5, and 6%). The germination study in Panchagavya (pre-soaking) revealed the stimulation of germination at 4%. Under irrigated conditions, the seeds germinated quickly in 2 and 3% Panchagavya treatment. In pot study, Panchagavya was foliar-sprayed at 10 DAS. The growth parameters were studied at 20 DAS. Seed germination was stimulated in pre-soaked condition than under irrigation. In Petriplate culture, under pre-soaked condition, the greengram seedlings showed significant growth increase at 4% Panchagavya treatment, whereas under Panchagavya irrigation, growth was promoted at 2%. Panchagavya promoted epicotyl elongation almost in all the treatments. Panchagavya of 6% irrigation generally inhibited the plant height, fresh and dry mass of the seedlings. In pot study, 3% Panchagavya spray at 10 DAS significantly increased the growth of greengram plants. The lateral roots, number of nodules, fresh and dry mass of the plants increased significantly at 3 and 4% treatment. At 5% foliar spray, growth was comparable to the control. The total leaf area of the plant also increased by 2 and 3% Panchagavya spray.

149

Nagaraj Naik, MN Sreenivasa. (2009). Influence of bacteria isolated from panchagavya on seed germination and seed vigour in wheat. Karnataka J Agric Sci. 22 (1). 231-232.

This study clearly brought out that Panchagavya contains bacteria producing plant growth promoting substances as well as bacteria having biological deterrent activities. Presence of such beneficial microbial biomass might have resulted in improved seed germination, seedling length and seed vigour in wheat indicating panchagavya as an efficient plant growth stimulant.

150

Gopinath KA, Narendra Kumar, Banshi L Mina, Anil K Srivastva and HS Gupta. (2009). "Evaluation of mulching, stale seedbed, hand weeding and hoeing for weed control in organic garden pea (*Pisum sativum* sub sp. Hortens L.)." *Archives of Agronomy and Soil Science* 55, no. 1: 115-123.

Weeds are often recognized as the principal biotic constraint to organic crop production. Development of suitable weed control measures is, therefore, a prerequisite for profitable organic farming. A field experiment was conducted during the winter season of 2003–2004 and 2004–2005 in the Indian Himalayas to evaluate the effect of mulching, stale seedbed, hand weeding and hoeing on weeds and yield of organic garden pea (*Pisum sativum* sub sp. Hortens L.). The weed population ranged from 249–477 m^{-2}, and *Polygonum plebejum* L. (34%), *Melilotus indica* L. (31%) and *Avena ludoviciana* Dur. (17%) were the predominant weeds in the experimental field. Season long weed-crop competition reduced the green pod yield of garden pea by 74% in 2003–2004 and 93% in 2004–2005. All the weed control treatments significantly reduced the population and biomass of weeds resulting in significant increase in green pod yield of garden pea compared to unweeded control. The highest weed control efficiency (84% reduction in weed biomass) was achieved with hand weeding 30 and 60 days after sowing (DAS) closely followed by stale seedbed coupled with one hand weeding (77%). Both these treatments produced significantly higher green pod yield compared to other treatments in both the years. In 2003–2004, hand weeding (30 and 60 DAS) recorded the highest gross margin (Indian Rupees 115,400 ha^{-1}) closely followed by stale seedbed coupled with one hand weeding (Indian Rupees 109,700 ha^{-1}). In the second year, however, the latter treatment gave the highest gross margin (Indian Rupees 56,900 ha^{-1}) compared to other treatments.

151

Sinha Rajiv Kumar, Sunil Herat, K Chauhan and D Valani. (2009). "Earthworms vermicompost: a powerful crop nutrient over the conventional compost & protective soil conditioner against the destructive chemical fertilizers for food safety and security." *American-Eurasian Journal of Agricultural and Environmental Science* 5, no. S: 14-22.

This paper discusses the importance of vermicompost, as a highly nutritive organic fertilizer and plant growth promoter, and its advantages over chemical fertilizers. Vermicompost works as a soil conditioner and its continued application over the years lead to total improvement in the quality of soil and farmland, even the degraded and sodic soils. Some significant properties of vermicompost of significant agronomic values and the factors determining the nutritional quality of vermicompost are discussed. Finally, some important feedbacks from farmers using vermicompost in Bihar, India, are provided.

Sangeetha, V. (2009). "Studies on the antimicrobial and biofertilizer potential of panchagavya–a vedic formulation." PhD diss., Doctoral Thesis. University of Madras.

Venkateswarlu, B. (2008). "Role of biofertilizers in organic farming." Organic Farming in Rainfed Agriculture: Opportunities and Constraints: 84.

Singh KK, Phogat Suman, Tomar Alka and Dhillon RS (2008). Neem, A treatise. (Eds). IK International Publishing, New Delhi.

152

Parthasarathy, V. A., K. Kandiannan, and V. Srinivasan. (2008). "Organic spices." New India Publishing, 2008.

This book on 'Organic Spices' covers all aspects of organic spice production. The topics covered includes historical spice trade and importance of spices in food chain. A brief account on organic agriculture movement in the world and its present status and opportunity for organic spices in the world market are given. The chemistry and different methods of composting are covered in the organic manures chapter. A separate chapter devoted on microbes and plant growth promoting rhizobacteria is included. Topics on biological control of insect pests, nematodes, fungi and bacteria of spices are highlighted in separate chapters, which would be of interest in organic production system. The importance, composition, uses, botany and varieties, organic way of production of spices such as black pepper, cardamom (*Elettaria cardamomum*), ginger, turmeric, chillies and paprika, nutmeg (*Myristica fragrans*), vanilla, seed spices such as cumin (*Cuminum cyminum*), fennel, fenugreek, coriander and their harvest and postharvest processing are enumerated. Chapters on good agricultural practices and organic certification procedures are outlined for adoption. This would serve as a reference book for researchers, teachers and students besides farmers, traders and consumers.

153

Srinivasan R (2008). Integrated Pest Management for eggplant fruit and shoot borer (*Leucinodes orbonalis*) in south and southeast Asia: past, present and future. Journal of Biopesticides 1 (2). 105-112

The integrated pest management (IPM) strategy for the control of eggplant fruit and shoot borer (EFSB) consists of resistant cultivars, sex pheromone, cultural, mechanical and biological control methods. Eggplant accessions EG058, BL009, ISD006 and a commercial hybrid, Turbo possess appreciable levels of resistance to EFSB. Use of EFSB sex pheromone traps based on (E)-11-hexadecenyl acetate and (E)-11-hexadecen-1-ol to continuously trap the adult males significantly reduced the pest damage on eggplant in South Asia. In addition, prompt destruction of pest damaged eggplant shoots and fruits at regular intervals, and withholding of pesticide use to allow proliferation of local natural enemies especially the parasitoid, *Trathala flavo-orbitalis* reduced the EFSB population. The IPM strategy was implemented in farmers' fields via pilot project demonstrations in selected areas of Bangladesh and India and its use was promoted in both countries. The profit margins and production area significantly increased whereas pesticide use and labor requirement decreased for those farmers who adopted this IPM technology. The efforts to expand the EFSB IPM technology to other regions of South and Southeast Asia are underway.

154

Deotale RD, Shraddha R Lende, PS Kamble, Sapana B Baviskar and Ommala D Kuchanwar (2008). "Effectivity of foliar sprays of vermiwash and cowdung wash on morpho-physiological parameters of soybean." *Journal of Soils and Crops* 18, no. 1: 169-175.

The study was conducted to know the efficiency of vermiwash and cowdung wash (100, 150 and 200 ppm) on morpho-physiological parameters of soybean (*Glycine max* L.) during *kharif* 2006-07 at experimental farm of Botany Section, College of Agriculture, Nagpur. Data revealed that foliar sprays of VW and CDW exhibited their significance over control. Treatment 200 ppm vermiwash showed their superiority over control and all other treatments under study and significantly increased plant height, number and dry weight of root nodules, leaf area, total dry matter production, AGR, RGR and yield when compared with control.

155

Shakila, Arumugam and A Anburani. (2008). "Effect of certain organics and pressmud on growth and yield characters of tomato." *Asian Journal of Horticulture* 3, no. 2: 273-276.

An experiment was conducted to study the effect of organic amendments and pressmud on the growth and yield characters of tomato. The treatments comprised 25.0 t farmyard manure/ha, 12.5 t pressmud and 5.0 t vermicompost/ha at two different levels (100 and 50% of the recommended level) and their combinations along with foliar spray of Panchagavya (3%). The combined application of farmyard manure plus vermicompost plus panchagavya as foliar spray resulted in improving the growth characters, i.e. plant height, internodal length, number of branches, number of leaves and leaf area and yield characters such as number of flower clusters per plant, number of flowers per cluster, number of fruits per plant, single fruit weight and fruit yield per plant in tomato followed by the application of 6.25 t pressmud/ha + 2.5 t vermicompost/ha + 3% panchagavya.

156

Kumar NK, PN Moorthy, CM Kalleshwaraswamy and HR Ranganath. (2008). Management of thrips (Thrips tabaci Lindeman) on organically raised rose onion. *Pest Management in Horticultural Ecosystems* 14, no. 2: 128-132.

Rose onion (*Allium cepa* L.) is a special type of onion more pungent than normal onions and cultivated in parts of south India exclusively for export to Malaysia, Singapore, Indonesia, Bangladesh and Sri Lanka. Only medium sized (25 to 35 mm diameter) bulbs are preferred for export. Onion thrips, Thrips tabaci (Lindeman), a regular pest of onions, is often a serious pest on rose onions too. At present, rose onion is grown exclusively under inorganic condition with fertilizer and insecticide regimes. Bulbs that are organically grown are free of pesticide residue, contribute to value addition and fetch premium price in international market. Studies were carried out at the Indian Institute of Horticultural Research, Bangalore from December to April 2004–05 and 2005–06 to compare the management of thrips on rose onion under organic and inorganic cultivation. Organic and inorganic plots received a basal dose of NPK (as farm yard manure or inorganic fertilizers).

Further, neem seed kernel extract 4% for organic plots and acephate 75 SP @ 0.1125% (1.5g/liter) for inorganic plots were sprayed at 15 days interval from the first appearance of thrips. Results indicated that incidence of thrips and total yield was on par in both inorganic and organically raised rose onion. However, bulbs when graded into small 35 mm), significantly higher yield of medium sized (11.33 tonnes/ha) export quality bulbs was recorded in organic cultivation compared to inorganic cultivation (3.68 tonnes/ha). Further, higher number of large and split bulbs were recorded in inorganically raised rose onions. Total soluble solids (TSS) content was higher in organically raised bulbs. Bulbs resulting from organic cultivation were lustrous. The importance of the study on organic farming and export of rose onion is discussed.

157

Saha S, Mina BL, Gopinath KA, Kundu S, Gupta HS (2008). Organic amendments affect biochemical properties of a sub temperate soil of Indian Himalayas. Nutr Cycl Agroecosyst 80:233–242

Evaluation of suitable organic amendments is prerequisite for sustainable agricultural growth in the northwestern Himalayan ecosystem. The effect of organic amendment applications on the activity of exocellular enzymes were examined on a silty clay loam soil of a subtemperate hill-agro ecosystem. The treatments involved addition of equivalent amounts of N through mineral fertilizer (MF) and two organic inputs, composted cattle manure (CM) and vermicomposts (VC), at four different doses. Soil enzymatic activities and fertility at crop harvest were measured after continuous 3 years of application, and its residual effects were also studied. In comparison with the control, CM and VC addition increased soil organic carbon (OC) by 54% and 52% at application rate equivalent to recommended dose, respectively, whereas there was a 12% increase following MF treatment. Bulk density of CM- and VC-treated soil were 1.16 and 1.14 Mg $m^{˝3}$, respectively, compared with 1.32 Mg $m^{˝3}$ in control after 3 years. Dehydrogenase activity was higher in the CM treatments by 44–204%, and by 22–108% in VC treatments than in control. The addition of CM and VC caused different responses in hydrolase enzymes. Protease and cellulase activity increased in both organic treatments significantly across treatments. However, urease and alkaline phosphatase activity was more influenced by application of CM compared with VC. âglucosidase activity was higher in MF treatment and was at par with the highest rate of organic amendment application. Increase in phosphatase activity is attributed to soil pH and microbial stimulation by organic C and is correlated with the increase in dehydrogenase activity (R^2 = 0.923). Differences in activities of all evaluated enzymes were narrowed down in residual treatments compared with control without much change in the trend. Composted CM was found more suitable for sustaining quality of subtemperate soils.

158

Baruah, Rajeev (2008). System Comparisons between Organic, Biodynamic, Conventional and GMOs in cotton production & Organic, Biodynamic, Conventional systems in Soya and Wheat in Central India. Paper at: 16th IFOAM Organic World Congress, Organic Textile Conference, Carpi, Italy, 16-20 June 2008

Over the past 05 years the organic cotton production in India has grown many folds. In the conventional cotton arena the genetically modified cotton is growing at an unprecedented rate. Considering the above factors it was considered necessary to carry out a 'System' comparisons in which the four systems can be compared. Further the research hopes to answer the larger questions; o Put the discussion regarding the benefits and drawbacks of organic agriculture on a rational footing; o Help to identify challenges for organic agriculture that can then be addressed systematically; o Provide physical reference points for stakeholders in agricultural research and development and thus support decision-making and agricultural policy dialogue at different levels.

At the farmers level the following outcomes are expected:What happens to yields of the crops when you stop using fertilizers and pesticides? What happens to the pests when you don't usefertilizers and pesticides? How do the crops grow when only farmyard manure or compost is used? Can we effectively control pests in the organic and biodynamic systems using a range of botanical sprays? Are the biodynamic preparations effective? What are the costs of cultivation of the different systems that we are comparing? What are impacts on the qulaity of the produce in the different systems? What are impacts on t soils of the different systems?

159

Saha S, Mina BL, Gopinath KA, Kundu S, Gupta HS (2008). Relative changes in phosphatase activities as influenced by source and application rate of organic composts in field crops. Biores Technol 99:1750–1757

Potential impact of different levels and sources of organic composts on activities of phosphatases (acid and alkaline phosphatase, phosphodiesterase, and inorganic pyrophosphatase) was studied after three years of continuous application. Enzyme activities were compared with microbial biomass P and available P. Experimental plots were divided based on the organic source into three groups: those receiving farmyard manure (FYM), vermicompost (VC) and *Lantana* compost (LC). Microbial biomass P (11.7 g $kg^{"1}$ soil), available P (24.0 g $kg^{"1}$ soil) and acid phosphatase (1.3 mg $g^{"1}$ p-NP $g^{"1}$ soil $h^{"1}$) was highest in highest dose of VC. Acid phosphatase activity was high in all plots, including those where microbial biomass P levels were low. Most of the phosphatase activities were significantly correlated with available P in FYM and VC. These relationships were negative for LC treatments. Results showed that application of earthworm casts is helpful in faster transformation of organic P by facilitating better environment to microbes and plant roots.

160

Kamaraj C, A Abdul Rahuman and A Bagavan. (2008). "Screening for anti-feedant and larvicidal activity of plant extracts against *Helicoverpa armigera* (Hübner), *Sylepta derogata* (F.) and *Anopheles stephensi* (Liston)." *Parasitology research* 103, no. 6 (2008): 1361-1368.

Plant extracts, especially botanical insecticides, are currently studied more and more because of the possibility of their use in plant protection. Biological activity of five solvent plant extracts were studied using fourth instar larvae of gram pod borer *Helicoverpa armigera* (Lepidoptera: Noctuidae), cotton leaf roller *Sylepta derogata* (Lepidoptera: Pyralidae) and malaria vector *Anopheles stephensi* (Diptera: Culicidae). Antifeedant and larvicidal activity of acetone, chloroform, ethyl acetate, hexane and methanol peel, leaf and flower extracts of *Citrus sinensis*, *Ocimum canum*, *Ocimum sanctum* and *Rhinacanthus nasutus* were used in this study. During preliminary screening, the extracts were tested at 1,000 ppm concentration. The larval mortality was observed after 24 h of exposure. All extracts showed moderate larvicidal effects; however, the highest larval mortality was found in peel chloroform extract of *C. sinensis*, flower methanol extract of *O. canum* against the larvae of *H. armigera* (LC_{50} = 65.10,51.78, LC_{90} = 277.39 and 218.18 ppm), peel methanol extract of *C. sinensis*, flower ethyl acetate extract of *O. canum* and leaf acetone extract of *O. sanctum* against the larvae of *S. derogata* (LC_{50} = 20.27,58.21,36.66, LC_{90} =113.15,285.70 and 668.02 ppm), peel methanol extract of *C. sinensis*, leaf and flower ethyl acetate extracts of *O. canum* against the larvae of *A. stephensi* (LC_{50} = 95.74,101.53,28.96, LC_{90} = 303.20,492.43 and 168.05 ppm), respectively. These results suggest that the chloroform and methanol extract of *C. sinensis,* ethyl acetate flower extracts of *O. canum and* acetone extract of *O. sanctum* have the potential to be used as an ideal eco-friendly approach for the control of the agricultural pests *H. armigera*, *S. derogata* and medically important vector *A. stephensi*.

161

Ansari, Abdullah Adil. (2008). "Effect of Vermicompost and Vermiwash on the Productivity of Spinach (*Spinacia oleracea*), Onion
(*Allium cepa*) and Potato (*Solanum tuberosum*)." *World Journal of Agricultural Sciences* 4, no. 5.

Present investigations were carried out during 1998-2000 at Shivri farm of Uttar Pradesh Bhumi Sudhar Nigam, Lucknow, India, to study the effect of vermicompost and vermiwash in reclaimed sodic soils on the productivity of spinach (Spinacia oleracea), onion (Allium cepa) and potato (Solanum tuberosum). The soil quality was monitored during the experiment followed by productivity. Amongst the combinations of vermicompost @ 6 tonnes and vermiwash (different concentrations), there has been significant improvement in soil qualities in plots treated with vermicompost and vermiwash (1:10 v/ v in water), vermicompost and vermiwash (natural) and vermicompost and vermiwash (1:5 v/v in water). The yield of spinach was significantly higher in plots treated with vermiwash (1:5 v/v in water). The yield of onion was significantly higher in plots treated with vermiwash (1:10 v/v in water), whereas the average weight of onion bulbs was significantly greater in plots amended with vermicompost and vermiwash (1:5 v/v in water). The yield of potato and the average weight of potato tubers were significantly higher in plots treated with vermicompost.

162

Chandrakala M and Hebsur NS (2008): Effect of FYM and fermented liquid manures on yield and quality of chilli (*Capsicum annuum* L.) – Ph D dissertation. University of Agricultural Sciences, Dharwad.

A field experiment was conducted at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad on a Vertisol to study the effect of FYM and fermented liquid manures on yield and quality of chilli during kharif 2007. The experiment consisted of 12 treatment combinations with two factors; factor one consisting of manures (FYM equivalent to RDN (M1), RDF (M2) and FYM equivalent to RDN+RDFYM (M3)) and the factor two liquid manures (Beejamrut + Jeevamrut (L1), Panchagavya (L2), Beejamrut+Jeevamrut + Panchagavya (L3) and Control (L4). The treatments were replicated thrice and experiment was laid out in Randomized Complete Block Design. Application of manures and liquid manures recorded significantly higher growth, yield and quality parameters of chilli. Treatment M2 recorded significantly higher dry chilli yield (8.33 q/ha) over rest of the manures. Among liquid manures, treatments L3 and L2 recorded significantly higher dry chilli yield (8.52 and 8.01 q/ha, respectively) over control (6.40 q/ha), the values for growth and other yield components were also significantly higher in these treatments. Treatments M3 and M1 recorded higher quality parameters *Viz.,* ascorbic acid content, oleoresin and colour value by 14.43: 9.19, 8.40: 5.33 and 14.18: 11.77 per cent, respectively over M2. Among liquid manures, L3 and L2 recorded higher ascorbic acid, oleoresin and colour value by 8.02: 6.74, 7.89: 7.00 and 8.25: 7.17 per cent, respectively over control (121.89 mg/100g, 203.01 ASTA units and 301.71 ASTA units, respectively).

A significantly higher dehydrogenase activity, available macro (N, P and K) and micronutrients (Cu, Zn, Fe and Mn) were recorded with M3 and M1. Dehydrogenase activity was also found to be significantly greater with liquid manures. Greater uptake of nutrients was recorded with M2. However, M2 and L3 recorded significantly higher yield, net returns and B: C ratio.

163

Somasundaram E, M Mohamed Amanullah, K Vaiyapuri, K Thirukkumaran and K Sathyamoorthi. (2007). "Influence of organic sources of nutrients on the yield and economics of crops under maize based cropping system." *J Appl Sci Res* 3: 1774-1777.
Field experiments were conducted from June 2001 to April 2003 at Tamil Nadu Agricultural University, Coimbatore with an objective to evaluate the organic sources of nutrients and *Panchagavya* spray on the yield and economics of crops in the maize-sunflower-green gram cropping system. The experiment consisted of nine treatments comprising six treatments of organic sources of nutrients with and without *Panchagavya* (blend of five products obtained from cow) foliar spray; two treatments were recommended dose of fertilizers with and without recommended foliar spray and one control (neither manured nor fertilizer applied). The treatments were fitted in a randomized block design replicated thrice. The study revealed that higher yield of maize and sunflower was recorded under Biogas slurry (BGS) with *Panchagavya*. Grain yield of greengram was higher under recommended fertilizer treatments but it was comparable to BGS with *Panchagavya*. The economic analysis showed that BGS with *Panchagavya* was commercially viable since it registered the highest net returns and BCR than recommended dose of fertilizers and foliar sprays over years.

164

Ponni C and Arumugam Shakila. (2007). "Effect of certain organic manures and biostimulants on growth and yield of *Phyllanthus niruri*." *Asian Journal of Horticulture* 2, no. 2: 148-150.

Phyllanthus niruri of family Euphorbiaceae, commonly known as
'Bhumyamalaki' is probably native to South America, but it is found worldwide throughout the humid tropics. The roots, leaves, fruits, milky juice and whole plants are used in herbal drug preparations. The present investigation was carried out during 2005-06 in Tamil Nadu, India, to study the effect of certain organic manures and biostimulants on growth and yield of *P. niruri*. The treatments comprised of two organic manures, viz., FYM at 25 t/ha and vermicompost at 5 t/ha and two biostimulants (panchagavya 3% and humic acid 0.2%) and their various combinations. The results revealed that application of FYM at 12.5 t/ha plus vermicompost at 2.5 t/ha along with panchagavya 3% proved to be the best treatment as it was found to record the highest plant height (83.17 cm), number of branches (30.23) and leaves (1115.87) and also recorded the maximum herbage yield (44.21 g/plant).

165

Srivastava Rashmi, David Roseti and AK Sharma. (2007). "The evaluation of microbial diversity in a vegetable based cropping system under organic farming practices." *Applied Soil Ecology* 36, no. 2: 116-123.

Organic farming is becoming a major tool for sustaining the soil quality degraded by intensive use of synthetic chemicals for increasing crop production and therefore, use of bio-agents as biofertilizers or biopesticides is an integral part of organic farming especially in vegetable cultivation. An effort was, therefore, made to see the effect of arbuscular mycorrhizal fungi (AMF) and pseudomonads as the microbial inoculants in vegetable based cropping systems under organic farming practices. Three crops taken in rotation were okra, pea and cowpea in a year. The inoculants used were *Glomus intraradices*, an arbuscular mycorrhizal fungus, and four isolates of *Pseudomonas fluorescens* singly and in combinations. No chemical/organic fertilizer was added during two rotations of chosen vegetables except the crop residues, which was chopped and distributed equally onto the each plot after the harvest of the fruits. A significant increase in yield was observed in the inoculated plots over the control. Culturable microbial diversity was increased compared with the start of the experiment. Total microbial diversity as assessed by Denaturing Gradient Gel Electrophoresis confirmed the results of culturable total and functional diversity analysed using Shannon Weaver's diversity indices (*H*2). Functional diversity assessed in terms of cellulase, xylanase, amylase, protease producers and P-solubilizers showed that the inoculants worked beneficially for maintaining soil health. The mycorrhizal inoculation followed by combination of AMF and pseudomonads proved to be better. Present findings indicated that microbial gene pool especially the key helpers for the maintenance of soil health residing in the vicinity of roots, was positively affected by using pseudomonads and AMF. Under organic farming management practices, inoculated bioagents and crop residues increased the yield of vegetables.

166

Shekar US Chandra, DM Venkata Reddy, S Narayan Swamy, R Siddaraju and Parashiva Murthy. (2007). "Influence of Organic Source of Nutrients on Growth Attributes and Pod Yield in Groundnut (Arachis hypogaea L.)." In *International Conference on 21st Century Challenges to Sustainable Agri-Food Systems: Biotechnology, Environment, Nutrition, Trade and Policy, 15th-17th March, 2007*, p. 184. IK International Pvt Ltd, 2007.
Field study was carried out during Kharif 2005 on a red laterite soil at Seed Technology Research Unit, UAS Bangalore to know the influence of organic sources of nutrients on growth and pod yield of groundnut seed production cv. TMV-2. The trial comprises three organic manure viz., FYM (5 t/ha), vermicompost (1t/ha) and green manure (10t/ha), bio-inoculant (seed treatment with Trichoderma 2g/kg) and two bio-pesticides viz., eco-neem (2ml/l) and NPM (1ml/l) were tested in different treatment combinations. Among the treatment combinations green manure plus seed treatment with Trichoderma and bio-pesticide spray with NPV recorded higher growth parameters like plant height (47.2 cm), number of branches (5.6/plant) and early flowering (days to half bloom). The higher pod yield (954.5 kg/ha) was recorded in the treatment combinations of green manure + Trichoderma (2g/kg) seed treatment coupled with bio-pesticide spray with NPV (@ 1ml/l).

167

Khan Mohammad Saghir, Almas Zaidi and Parvaze A Wani. (2007). "Role of phosphate-solubilizing microorganisms in sustainable agriculture: A review." *Agronomy for sustainable development* 27, no. 1: 29-43.

Compared with the other major nutrients, phosphorus is by far the least mobile and available to plants in most soil conditions. Although phosphorus is abundant in soils in both organic and inorganic forms, it is frequently a major or even the prime limiting factor for plant growth. The bioavailability of soil inorganic phosphorus in the rhizosphere varies considerably with plant species, nutritional status of soil and ambient soil conditions. To circumvent phosphorus deficiency, phosphate-solubilizing microorganisms (PSM) could play an important role in supplying phosphate to plants in a more environmentally-friendly and sustainable manner. The solubilization of phosphatic compounds by naturally abundant PSM is very common under in vitro conditions; the performance of PSM in situ has been contradictory. The variability in the performance has thus greatly hampered the largescale application of PSM in sustainable agriculture. Numerous reasons have been suggested for this, but none of them have been conclusively investigated. Despite the variations in their performance, PSM are widely applied in agronomic practices in order to increase the productivity of crops while maintaining the health of soils. This review presents the results of studies on the utilization of PSM for direct application in agriculture under a wide range of agro-ecological conditions with a view to fostering sustainable agricultural intensification in developing countries of the tropics and subtropics.

168

Das Kuntal, Dang Raman, Shivananda Narayanappa Thippenahalli and Sekeroglu Nazim (2007). Influence of bio-fertilizers on the biomass yield and nutrient content in *Stevia rebaudiana* Bert. grown in Indian subtropics. Journal of Med Plants Res. Vol 1 (1):5-8

A pot culture experiment was conducted at Indian Institute of Horticultural Research, Hessaraghata, Bangalore, India to study the effect of bio-fertilizers on the biomass yield and NPK content in Stevia (*Stevia rebaudiana*). The results show the yield and NPK content in stevia plant has been found to be increased initially and thereafter, the amount of the same decreased with the progress of plant growth up to 60 days with the combined treatment of bio-fertilizers rather than individual treatment. This is due to their ability to fix atmospheric nitrogen (symbiotic and asymbiotic) and transform native soil nutrients likely phosphorus, zinc, copper, iron, sulfur from the nonusable (fixed) to usable form and decompose organic wastes through biological processes which in turn releases nutrients in a form which can be easily assimilated by plants resulting in an increase in biomass production of stevia plant.

169

Ranga Rao GV, OP Rupela, V Rameshwar Rao and YVR Reddy. (2007). "Role of biopesticides in crop protection: present status and future prospects." *Indian Journal of Plant Protection* 35, no. 1: 1-9.

The sharp increase in the use of chemical pesticides in India in recent years has resulted in severe implications in the development of insecticidal resistance in key pest species, pesticide residues in food chain, degradation in the quality of ecosystem and human health. Microbials such as viruses, bacteria, fungi, protozoa, nematodes and plant products are the major biopesticides that were studied mostly to develop alternatives to chemicals. In India, biopesticide science is not anew tool and is as old as human civilization back to prehistoric days. Though biopesticides cover only about 1% of the total plant protection products globally, their number and the growth rate have been showing an increasing trend in the past two decades. In recent years, ICRISAT in collaboration with National Agricultural Research and Extension Systems (NARES) in India have made significant progress in the identification, production and field evaluation of biopesticides. Understanding of ecology has increased to identify the potential problems to work on, the approach, when and where they have maximum impact. The virulence of various bioagents such as nuclear polyhedrosis virus

(NPV), bacteria and plant products was tested under controlled conditions and the selected ones were evaluated under hot spots. Strategic research related to DNA of different HaNPV strains from India indicated their similarities with the presence of four major polypeptides with molecular weight ranging from 30.66-42.32 kilo Daltons.There was significant progress in developing feasible production technologies, efficient storage to enhance the shelf life and filed applications. In this process ICRISAT trained several NARES scientists and farmers on biopesticide production and established 96 village level NPV production units in India and Nepal to encourage their use. On-farm studies in biopesticide front indicated 20-40% increased yields in pigeonpea and chickpea. Bio-intensive cotton 1PM crops realized 1-30% and vegetable farmers obtained 72% increased yields through better management of pests and augmenting natural enemies. The overall goal of biopesticide research is to see that the products are made available at farm level at affordable cost, and that they overcome the existing bottlenecks so as to become potential tools in the armory: of plant protection. To ensure this, there is every need to strengthen the communication between researchers, industry and fanners. The biopesticide science is still young and evolving, hence indepth research is needed in many areas such as production, formulation, delivery and commercialization of these products. On the other hand, more research is needed in integrating biocontrol agents into production systems, such as in sequencing biocontrol with other options and in developing these into forecast models for better timing of effective options. More studies are also needed to determine the environmental effects on the fate of bioagents, new technologies such as micro encapsulation of bioproducts are of high priority in enhancing their potential. The present trends in research include the increased use of biorational screening processes to identify potential agents, evaluation under laboratory and filed conditions, emphasis on integrating these with other control methods in an overall system approach. Even though the organic products are considered less toxic it is important to be careful when using any pesticide and considerable precautions need to be taken while production, processing and utilization. Thus, this manuscript discussed various aspects of biopesticides covering the status, constraints, prospects, integration and the future strategies for their effective utilization to the benefit of human kind.

170

Ranga Rao GV, OP Rupela, SP Wani, SJ Rahman, JS Jyothsna, V Rameshwar Rao and P Humayun. (2007). "Bio-intensive pest management reduces pesticide use in India." *Pesticides News* 76: 16-17.

In Kothapalli village, Andhra Pradesh, insect pests are the prime constraint on crop yields. Complete dependence on chemical control for the past three decades has led to unsatisfactory pest management, followed by diminishing profits. In 2000, bio-intensive pest management technologies were adopted to alleviate the pest problems in major crops like cotton, pigeonpea, chickpea and vegetables. Through improved pest management farmers have increased yields and decreased expenditure.

171

Gahukar RT. (2007). "Botanicals for use against vegetable pests and diseases: A review." *International journal of vegetable science* 13, no. 1: 41-60.

Insect pests, nematodes and plant diseases of vegetables are generally controlled by frequent applications of chemical pesticides with an objective to increase crop productivity and obtain greater profit in conventional farming. With consumers' awareness and perception, vegetables without residue of chemicals are being preferred in local and export markets. For this purpose, plant-derived crude products or formulated pesticides can be eco-friendly, effective and economical for an average producer. Neem *(Azadirachta indica*A. Juss.) is being widely used in the form of water extracts of leaves or seeds and neem oil owing to its effects as an oviposition deterrent, sterilant, antifeedant, repellent and pesticide against insects, and as an inhibitor of spore germination and development of pathogens and affecting penetration by nematodes into roots. Other indigenous plants also show potential in pest management. Further research needs to be focused on the synthesis and commercial formulations of botanicals for control of pests and pathogens.

172

Kavitha R and P Subramanian. (2007). "Bioactive compost-a value added compost with microbial inoculants and organic additives." *J. Appl. Sci* 7, no. 17: 2514-2518.

A study was conducted in the Department of Environmental Science, Tamil Nadu Agricultural University, Coimbatore, to transform the normal compost into bioactive compost through the addition of various substrates, which has multiple benefits to the crop system. The key players in this transformation process were *Azotobacter*, *Pseudomonas*, Phosphobacteria, composted poultry litter, rock phosphate and diluted spent wash. This enrichment process has increased the nutritive value of compost. The highest nitrogen content (1.75%) and phosphorus content (1.16%) was observed in the treatment T_5 (compost enriched with composted poultry litter, spent wash, microbial inoculants and rock phosphate). The beneficial microorganism viz., *Azotobacter*, *Pseudomonas* and Phosphobacteria population were higher in the treatment T_5 where all the inputs (composted poultry litter, microbial consortium, rock phosphate and spent wash) were added to the compost. The plant growth promoters viz., IAA and GA content was more in the treatment applied with spent wash and microbial inoculum. Beneficial microorganisms, composted poultry litter, rock phosphate and diluted spent wash contributes maximum level of nutrients and growth promoters to the compost with small expenses.

173

Appanna, Vikram. "Efficacy of phosphate solubilizing bacteria isolated from vertisols on growth and yield parameters of sorghum." *Res J Microbiol* 2 (2007): 550-559.

Phosphorus is one of the major plant macronutrients and plays an important role in plant metabolism ultimately reflecting on crop yields. Although vertisols contain appreciable amounts of total P, it is not available for crop uptake in adequate amounts due to its insoluble nature. Phosphate Solubilizing Bacteria (PSB) arc a group of organisms that solubilize fixed form of P and make it available to plants. In the present study the ability of 16 PSB isolates to promote growth and yield parameters of sorghum was tested under greenhouse conditions. Among all the treatments tested, inoculation with PSBV-1 recorded the highest earhead weight, grain yield, P content and P uptake in root and grain of sorghum plants. Inoculation of sorghum plants with PSBV-2 recorded the highest shoot length, shoot dry matter and P uptake in shoot. Almost all the PSB isolates tested in the present study were able to improve the growth and yield parameters of sorghum significantly compared to absolute control, rock phosphate control and single super phosphate control. The efficient strains from this study should be tested in field conditions before they can be exploited in a commercial set up. The success of these strains will at least solve some of the problems of P fixation in vertisols.

174

Kumar R Mahender, Ch Padmavathi, K Surekha, PC Latha, P Krishnamurthy and SP Singh. (2007). "Influence of Organic Nutrient Sources on Insect Pests and Economics of Rice Production in India." *Indian Journal of Plant Protection* 35, no. 2: 264-267.

System of Rice Intensification (SRI) method of rice cultivation is being widely accepted among farmers in India in recent times due to the healthy plant growth and resistance to pests and diseases. An attempt was made in the present study to assess the insect pest scenario in SRI and conventional method of rice cultivation. Field experiments were conducted in Rabi 2006 at Directorate of Rice Research, Ramachandrapuram farm in sandy clay loam soil in split-plot design with cultivars as main plots (MTU 1010, Shanti & DRRH2 in Rabi) and three methods of crop husbandry (SRI, Eco-SRI and Conventional) as sub-plot treatments in four replications. Five insect pests viz., whorl maggot, hispa, yellow stem borer, leaf folder and green leaf hoppers were observed at different stages of crop growth period. Maximum per cent white ear heads were observed in SRI (12.5%) followed by conventional (8.9%) and ECOSRI (6.2%). Out of three varieties, Shanti had maximum per cent white ear heads (21.11%). Lowest per cent white ear heads were recorded in both DRRH2 (3.8%) and MTU1010 (2.8%). Among the organic sources, GM/GLM recorded higher B: C ratio than its combinations or vermicompost application as compared to inorganic fertilizer application under irrigated rice across locations. By considering higher price for organically grown rice as 1½ times to ordinary rice, the benefit cost ratio of the treatments GM/GLM, GM/GLM + FYM, GM/GLM + FYM + BGA, GM/ GLM + BGA + Azotobactor, GM/GLM + PSB were higher than the recommended fertilizer dose or neem cake or vermicompost application.

Somasundaram E and P Singaram. (2006). "Modified panchagavya for sustainable organic crop production." In *National Seminar on Standards and Technologies of Nonconventional Organic Inputs*. 2006.

175

Chaman Lal and LR Verma (2006). Use of certain bio-products for insect-pest control. Indian Journal of Traditional Knowledge. Vol. 5(1): 79-82.

The present study was carried out in remote villages of the Mandi, Bilaspur, Shimla, Kinnaur and Lahaul-Spiti districts of the Himachal Pradesh to identify the important Indigenous Technology Knowledge (ITKs) in use, methods for managing the insect-pests of the different crops and to document the same. Farmers commonly use ash against chewing and sucking type of insect pests. Use of cattle litter not only enriches the soil fertility but also reduces the insect-pests of the crops significantly. The bioproducts namely aged cow urine, *Vitex negundo* Linn., *Ferula assafoetida* Linn*,* *Aloe barbadensis* Mill.*, Nicotiana tabacum* Linn. and whey were found to be very effective against the insect pests of cabbage, wheat, peas, grams and other crops. Such an assessment was essential because these are the innovative ecofriendly sprays, which are economically viable for small farmers and have already been adopted by the farmers in some locations. The choice of indigenous bio-insecticides has been found to be effective as well as ecofriendly. This will also help in reducing the load of insecticide on the ecosystem.

176

Karthikeyan C, D Veeraragavathatham, D Karpagam and S Ayisha Firdouse. (2006). Cow-based indigenous technologies in dry farming. Indian Journal of Traditional Knowledge. Vol. 5(1): 47-50.

Indigenous knowledge is the accumulated knowledge, skills and technology of the local people, derived from the direct interaction of human beings and their environment. The study was conducted at Coimbatore and Erode districts, in the western zone of Tamil Nadu with an objective of documenting the indigenous technologies adopted by the dry land farmers. Documentation of indigenous technologies was done adopting both individual and group approach. The paper describes five indigenous technologies involving cowbased products used by farmers for various purposes and an analysis on its impact. It is hoped to help the farmers to understand and exchange the cheaper, viable and reliable technologies in their areas.

177

Yadav, B. K., and A. Christopher Lourduraj. (2006). "Effect of organic manures and panchagavya spray on yield attributes, yield and economics of maize (Zea mays L.) J." *Crop Res* 30, no. 1: 1-5.

Panchagavya spray recorded significantly higher gross returns (Rs 37608/ ha), net returns (Rs. 17822/ha) and benefit-cost ratio (1.92) as compared to without Panchagavya spray (Rs 34612/ha, Rs. 15586/ha and 1.84 respectively). Application of 50 per cent N through composted poultry manure + 50 per cent N through green leaf manure along with panchagavya spray recorded higher net returns (Rs. 17822/ha) followed by recommended NPK through panchagavya spray (Rs.15586) in rice.

178

Umesha S. (2006). Occurrence of bacterial canker in tomato fields of Karnataka and effect of biological seed treatment on disease incidence. Crop Protection. Vol. 25 (4). pp 375-81

Bacterial canker caused by *Clavibacter michiganensis* ssp. *michiganensis* was detected during a survey of tomato fields in the state of Karnataka, India. The disease incidence ranged from 25% to 48%. The pathogen was isolated from infected plant material and seeds. The pathogen was also detected in tomato seeds by laboratory assay and its identity was confirmed by biochemical, physiological, hypersensitivity in four-o'clock plant (*Mirabilis jalapa*) and pathogenicity tests. A seed transmission rate of up to 46% was observed in naturally infested seed. Biological seed treatment with antagonistic *Pseudomonas fluorescens* improved seed quality (p=0.05p=0.05) under laboratory conditions and drastically reduced the bacterial canker incidence in field.

179

Banu J Gulsar and Rohini Iyer. (2006). "Effect of vermiwash on nematodes prevalent in coconut based high-density multispecies cropping system." *Indian Journal of Nematology* 36, no. 2: 176180.

Burrowing nematode, *Radopholus similis*, root-knot nematode, *Meloidogyne incognita*, root lesion nematode, *Pratylenchus coffeae* and spiral nematode, *Helicotylenchus multicinctus* are the major nematode pests of crops in coconut based high-density multispecies cropping system. Vermiwash at different dilutions were tested against these nematodes under *in vitro* conditions and were found to be deleterious to varying extent. Juvenile hatching of *M. incognita* was greatly inhibited by vermiwash. Undiluted vermiwash caused maximum nematode mortality and inhibition in hatching. Among four nematodes tested, *M. incognita* and *H. multicinctus* were found to be highly susceptible to vermiwash, followed by *R. similis* and *P. coffeae*.

Chauhan RS and Lokesh Singhal. (2006). "Harmful effects of pesticides and their control through cowpathy." *International Journal of Cow Science* 2, no. 1: 61-70.

Sugha SK. (2006). "Antifungal potential of panchagavya." Plant Disease Research. Vol. 20 (2): 156.

180

Ram RA and RK Pathak. (2005) "Integration of organic farming practices for sustainable production of guava: a case study." In *I International Guava Symposium 735*, pp. 357-363

In India, four organic farming systems (Biodynamic, *Panchgavya*, *Rishi Krishi* and *Homa* farming) are prevalent in different parts of the country for production of horticultural and other crops. In Biodynamic farming system, maximum reliance is placed on self-regulatory agro-ecosystem locally or 'farm derived' renewable resources. Use of external inputs is as minimized as possible. Experiments were conducted on 3-yrs-old plant of guava cv. Allahabad Safeda using biodynamic preparations, biofertilizers and composts. Maximum number of fruits and yield (92 & 13.69 kg tree^{-1} & 283 & 40.11 kg tree^{-1}) were consistently recorded for 2 years from the trees, applied with 20 kg FYM inoculated with *Azotobacter* in comparison to 21.37 kg tree^{-1} fruit with recommended doses of fertilizer application. Fruit quality parameters, particularly TSS (16.20°Brix) were improved with application of 10 kg FYM along with celrich. On the basis of these observations an experiment was further conducted by integrating four organic farming systems on guava. Fruit yield was maximum (38.88kg tree^{-1}) in trees, which were exposed to *Homa* atmosphere followed by 29.28 kg with *Homa+Rishi Krishi* and *Homa+Panchgavaya*. TSS was maximum (12.0°Brix) with *Homa + Rishi Krishi* and *Homa + Panchgavaya*, while ascorbic acid was more (165 mg 100 g fruit^{-1}) with FYM treated plants.

181

Naik MH and R Sri Hari Babu. (2005). "Feasibility of organic farming in guava (*Psidium guajava* L.)." In *I International Guava Symposium 735*, pp. 365-372.

An investigation was conducted under semi-arid tropics of southern Andhra Pradesh, India, to study the response of guava (*Psidium guajava* L.) cv. L-
49 (Sardar) to different organic manures. The treatments consist of organics, viz. vermi-compost (10 kg tree^{-1}), FYM (25 Kg tree^{-1}), pig, sheep, goat and poultry manures and guava leaf litter (each 20 Kg tree^{-1}), NPK (250:350:200g tree^{-1}) and control (without any treatment). The treatment with vermi-compost resulted in maximum number of shoots plant^{-1}, more number of leaves shoot^{-1} and highest yield. Application of animal manures produced more number of fruits shoot^{-1}. Per cent fruit drop was nil with sheep, goat and leaf litter application, but was higher with vermi- compost and poultry manures. Heaviest fruits were borne under sheep and goat manures. The fruit yield was better with chemical fertilizers and good with poultry manures. TSS was highest with animal manures and least in control. Acidity was highest under FYM treatment closely followed by vermin-compost. Ascorbic acid content was highest in pig manure treatment whereas total sugars and reducing sugars were maximal with goat manure. Irrespective of the treatment, leaf N remained almost the same before and after the trial. On the other hand, the leaf P and K showed an increase after the termination of the trial due to various treatments except control. Soil pH decreased in all treatments, whereas EC increased in all the treatments. Similarly organic carbon increased in all manurial treatments. This trend was almost similar with soil NPK. Thus, the present investigation revealed that the vermicompost was superior over other organic sources and closely followed by poultry manure and leaf litter in improving vegetative growth, flowering, fruiting, yield and fruit attributes and fruit quality along with improvement in soil fertility and leaf nutrient status of the guava plant.

Yadav, B. K., & Lourduaj, A. C. (2005). In A. Kumar (Ed.), *Use of Panchagavya as a growth stimulant and biopesticide in agriculture. Chapter 9. Environment and Agriculture* (pp. 65–70). New Delhi, India: APH publishing corporation.

182

T Saravanan, M Muthuswamy and S Harish. (2005). In A. Kumar
(Ed.), Viability and Effect of *Pseudomonas flourescens* on rice seed and seed infection. *Chapter 8. Environment and Agriculture* (pp. 60–64). New Delhi, India: APH publishing corporation.

A detailed experiment was conducted to find out the effect of Pseudomonas flourescens on rice seed infection and seed germination. The results revealed that seed treatment with P.fluorescens reduced the seed infection due to various fungal pathogens. The treatment also increased the seed germination upto 60 days after storage of the seed and then it shows gradual decrease in germination. However, untreated seed had gradual reduction in seed germination in the storage from the initial days of storage. The seed treated with P.fluorescens had less incidence of seed borne fungi viz., *Alternaria tennis, Curvularia lunata, Fusarium moniliforme, F. gramenearium, Helminthosporium oryzae* upto 40 days after storage and later it shows gradual increase in the level of incidence. Whereas untreated seeds show gradual increase in the incidence from the initial days of storage.

183

Rai Mahendra K. (2005). *Handbook of microbial biofertilizers*. Food Products Press, 2005. 579 pages.

The twenty chapters included in this handbook provides in-depth coverage of all major biofertilizers (rhizobia, arbuscular mycorrhizal fungi and cyanobacteria), as well as new and emerging growth promoters (endophytes). The role of microbes in growth promotion, bioprotectors and bioremediators is examined. In addition, their roles in forestry, stress alleviation, applications in nursery practice, methods for inoculating plants with them, their performance in the field, and their potential future roles are also discussed. The chapters dealing with the easily cultivated cyanobacteria are mainly concerned with the potential for their use in rice fields. Chapters are also included covering free and symbiotic bacteria and their effects on plant health, as well as an interesting chapter on wild rhizobia. A chapter is also devoted to *Piriformospora indica*, an exciting emerging biofertilizer. The chapter on matsutake (*Tricholoma matsutake*) challenges the idea that all ectomycorrhizal fungi are beneficial or whether in fact some have much more complicated trophic relationships.

184

Bhat SS, AK Vinu and R Naidu. (2005). "Association of diverse groups of bacteria with 'Panchagavya' and their effect on growth promotion of coffee seedlings." In *ASIC 2004. 20th International Conference on Coffee Science, Bangalore, India, 11-15 October 2004.*, pp. 1192-1198. Association Scientifique Internationale du Café (ASIC), 2005.

Thirty-seven diverse groups of bacteria were cultured from three formulations of 'Panchagavya'. The formulation PG-III harboured the highest number of bacteria followed by PG-II and PG-I. *Pseudomonas fluorescens*, *Pseudomonas aeruginosa*, *Ochrobactrum anthropi* and species of *Bacillus*,
Deinococcus, *Aeromicrobium*, *Acetobacterium*, *Caryophanon*, *Terrabacter*, *Kurthia*, *Flavobacterium*, *Propionibacterium*, *Brachybacterium*, *Cupriavidus*,
Curtobacterium, *Actinomyces*, *Methylobacterium*, *Bifidobacterium* and *Microbacterium* were identified. All the 37 bacterial isolates of 'Panchagavya' were screened for *in vitro* antagonism in dual culture against coffee pathogens viz., *Poria hypolateritia*, *Colletotrichum gloeosporioides* [*Glomerella cingulata*], *Ceratocystis fimbriata*, *Rhizoctonia solani* and *Ambrosiella xylebori*. *Aeromicrobium* sp. (P5), *Flavobacterium* sp. (MPK7), *Pseudomonas fluorescens* (MPK 13), *Methylobacterium* sp. (MPK II-2), *Bacillus* sp. (OPK 2), MPK3 and MPK16 were identified as potential antagonists against all the five pathogens. Of the 37 bacteria screened for growth promotion on coffee seedlings under green house conditions, *Aeromicrobium* sp. (P5), *Caryophanon* sp. (P9), MPK6, MPK12, *Pseudomonas fluorescens* (MPK 13), MPK II-1 and MPK II-6 treated coffee seedlings recorded higher biomass and vigour index when compared to untreated control and other bacterial isolates.

185

Mishra Upasana and Pabbi Sunil (2004). Cyanobacteria: a potential biofertilizer for rice. *Resonance.* Vol. 9 (6). pp 6-10

Application of high input technologies has resulted in significant increase in agricultural productivity. There is, however, a growing concern about the adverse effects of indiscriminate use of chemical fertilizers on soil productivity and environmental quality. Cyanobacteria offer an economically attractive and ecologically sound alternative to chemical fertilizers for realizing the ultimate goal of increased productivity, especially in rice cultivation. In a wetland rice ecosystem, nitrogen fixation by free living cyanobacteria also significantly supplements soil nitrogen.

Somasundaram E, N Sankaran and TM Thiyagarajan. (2004). "Efficacy of organic sources of nutrients and panchagavya spray on productivity of crops in maize based cropping system." *Journal of Agricultural Resource Management* 3, no. 1: 46-53.

186

Patil SL and MN Sheelavantar. (2004). "Effect of cultural practices on soil properties, moisture conservation and grain yield of winter sorghum (Sorghum bicolar L. Moench) in semi-arid tropics of India." Agricultural water management 64, no. 1: 49-67.

A field experiment was laid out during winter seasons of 1994–1995 and 1995–1996 on deep black clayey soils (Vertisols) at Regional Research Station, Bijapur, in the northern dry zone of Karnataka State (Zone 3) of south India to evaluate the effect of cultural practices on soil moisture conservation, soil properties, root growth and yield of sorghum (*Sorghum bicolar* L. Moench). Lay out of plots with in situ moisture conservation practices reduced bulk density, increased infiltration rate, porosity, improved root growth and grain yield of winter sorghum. Conservation and availability of higher amount of moisture and nutrients during various stages of crop growth with moisture conservation practices resulted in better crop growth with higher amount of dry matter production and its translocation to ear in winter sorghum. Compartmental bunding and ridges and furrows increased the grain yield by 22.8 and 25.6% (mean of 1994–1995 and 1995–1996), respectively, over flat bed with similar trend observed during 1994–1995 and 1995–1996. Among organic sources, incorporation of *Leucaena* loppings improved soil physico-chemical properties, conserved higher amount of moisture and increased winter sorghum yield to a greater extent than farmyard manure and vermicompost. Average grain yield (1994–1995 and 1995–1996) of winter sorghum increased by 11.7% with *Leucaena* application as compared to vermicompost. Grain yield increased significantly by 20% with application of 25 kg N ha^{-1} and further increase in nitrogen dose up to 50 kg ha^{-1}, increased the grain yield by 30.5% in the pooled data.

187

Prakash Anil and Alok Adholeya. (2004). "Effect of different organic manures/composts on the herbage and essential oil yield of *Cymbopogon winterianus* and their influence on the native AM population in a marginal alfisol." *Bioresource technology* 92, no. 3 (2004): 311-319.

Four organic amendments: leaf compost (LC), vegetable compost (VC), poultry manure (PM) and sewage sludge (SSL) applied at four doses (40, 80, 100 and 120 t ha^{-1}) were evaluated for their effect on the herbage yield, essential oil content and inoculum potential (IP) of native arbuscular mycorrhizal fungi (AMF) on three varieties of Java citronella, *Cymbopogon winterianus* Jowitt (Manjusha, Mandakini, and Bio-13). PM applied at 100 t ha^{-1} followed by SSL increased the herbage, essential oil content and dry matter yield significantly. Bio-13 performed better and produced the highest herbage, essential oil and dry matter yield. The type and dose of the various organic amendments also significantly influenced the indigenous AMF infectious propagules in soil. Highest number of AMF propagules were recorded in the LC amended plots in all the three varieties. Amongst the varieties, highest native mycorrhizal inoculum was recorded in the Bio-13. Least number of AM infectious propagules were recorded in the Mandakini plants grown in 40 t ha^{-1} SSL.

188

Choudhury Atma and Kennedy IR (2004). Prospects and potentials for systems of biological nitrogen fixation in sustainable rice production. Biology and Fertility of Soils. Vol. 39 (4): 219-227

The N requirement of rice crops is well known. To overcome acute N deficiency in rice soils, this element is usually supplied to the rice crop as the commercially available fertilizer urea. But unfortunately a substantial amount of the urea-N is lost through different mechanisms causing environmental pollution problems. Utilization of biological N fixation (BNF) technology can decrease the use of urea-N, reducing the environmental problems to a considerable extent. Different BNF systems have different potentials to provide a N supplement, and it is necessary to design appropriate strategies in order to use BNF systems for efficient N supply to a rice crop. Research has been conducted around the world to evaluate the potential of different BNF systems to supply N to rice crops. This paper reviews salient findings of these works to assess all the current information available. This review indicates that the aquatic biota Cyanobacteria and *Azolla* can supplement the N requirements of plants, replacing 30–50% of the required urea-N. BNF by some diazotrophic bacteria like *Azotobacter*, *Clostridium*, *Azospirillum*, *Herbaspirillum* and *Burkholderia* can substitute for urea-N, while *Rhizobium* can promote the growth physiology or improve the root morphology of the rice plant. Green manure crops can also fix substantial amounts of atmospheric N. Among the green manure crops, *Sesbania rostrata* has the highest atmospheric N_2-fixing potential, and it has the potential to completely substitute for urea-N in rice cultivation.

189

Mandal Uttam Kumar, Gurcharan Singh, US Victor and KL Sharma. (2003). "Green manuring: its effect on soil properties and crop growth under rice–wheat cropping system." *European Journal of Agronomy* 19, no. 2: 225-237.

A field experiment was conducted on rice (Oryza sativa L.) and wheat (Triticum aestivum L.) during rainy and winter seasons of 1994–95 in a clay loam soil (Typic Ustochrept) at the experimental farm of Indian Agricultural Research Institute, New Delhi, India. The objectives were to study the influence of different green manuring (*Sesbania rostrata, Sesbania aculeata*, green gram (*Vigna radiata*) residues) and in combination with different levels of nitrogen (0, 60, and 120 kg N ha^{-1}) on physical properties, organic matter and total nitrogen contents of soil and on root growth and spectral response of rice and wheat crop. The organic matter and total soil nitrogen concentrations were found to be higher under green manuring treated plots than summer fallow. The magnitude of reduction in bulk density due to green manuring over fallow was 0.03–0.07 Mg m^{-3} in 0–15 cm soil layer and 0.05–0.09 Mg m^{-3} in 15–30 cm soil layer during the growth of rice and wheat. Green manuring improved the soil physical environments as was evident from higher values of mean weight diameter and saturated hydraulic conductivity than fallow. The better physical and chemical environment in Sesbania (S) and green gram residue incorporated plots influenced higher Normalized Difference Vegetation Index (NDVI) than under fallow. The NDVI attained peak values at 62 days after transplanting of rice and 90 days after sowing of wheat. The root length density (RLD) and yields were higher in green manure plots than in fallow both in rice as well as in succeeding wheat crop. In all cases, in both rice and wheat the application of 120 kg N ha^{-1} treatment resulted in higher RLD than 60 kg N ha^{-1} and no nitrogen treatments. Poor soil conditions were mainly responsible for restricted root growth and its distribution in surface soil layer in summer fallow plots.

Boomiraj GS. (2003). "Effect of Panchagavya foliar spray on fruit yield and quality of okra." *Indian Journal of Agronomy* 45, no. 2: 12-18.

Also related:

K. Boomiraj and A.Christopher Lourduraj. (2004). Impact of organic and inorganic sources of nutrients, panchagavya spray and bontanicals spray on the soil microbial population and enzyme activity in bhendi (*Abelmoschus esculentus* (L.)). Indian j. environ. & ecoplan. 8 (3): 557 - 560.

K. Boomiraj and A.Christopher Lourduraj. (2005). The impact of organic farming practices on fruit quality of okra (*Abelmoschus esculentus* (L.)). Indian j. environ. & ecoplan.10 (2): 529 - 532.

K. Boomiraj and A.Christopher Lourduraj. (2005). Effect of organic manures, panchagavya and herbal leaf extract spray on insect incidence in bhendi (*Abelmoschus esculentus*). J. Ecobiol 18(3):269-276.

K. Boomiraj and A.Christopher Lourduraj. (2006). Organic production bhendi (*Abelmoschus esculentus* (L.)). J. of Ecobiol. 19 (4): 389-3966.

K. Boomiraj and A.Christopher Lourduraj. (2005). Impact of organic and inorganic sources of nutrients, panchagavya spray and bontanicals spray on the soil microbial population and enzyme activity in bhendi (*Abelmoschus esculentus* (L.)). In: Environment and Agriculture, Prof. Aravind Kumar (Eds.). APH publishing corporation, Darya Ganj, New Delhi. Pp- 257-261.

K. Boomiraj and A.Christopher Lourduraj. (2006). The Impact Of Organic Farming Practices On Fruit Quality of okra. In. Green Technologies for
Sustainable Agriculture - Arvind Kumar and Dubey (Eds.) Chapter 53- pp 292-295.

Somasundaram E. (2003). "Evaluation of organic sources of nutrients and Panchagavya spray on the growth and productivity of maize-sunflower-green gram system." PhD diss., Ph. D., Thesis, Tamil Nadu Agricultural University, Coimbatore, 2003.

Boomiraj, K. (2003). "Evaluation of organic sources of nutrients, panchagavya and botanicals spray on Bhendi (Abelmoschus esculentus Monech)." M. Sc.(Agri.) Thesis.

Somasundaram E, N Sankaran, S Thiyagarajan Meena, TM Thiyagarajan and K Chandaragiri and Pannerselvam S. (2003). Response of green gram to varied levels of panchagavya (organic nutrition) foliar spray." *Madras Agric. J* 90, no. 1-3: 169-172. *Solaiappan AR (2002). "Microbiological Studies in Panchagavya."* Biocontrol Laboratory-Official Communication, Chengalput, Tamilnadu, India: 1-2.

190

Kapoor R, B Giri and KG Mukerji. (2002). "Mycorrhization of coriander (*Coriandrum sativum* L) to enhance the concentration and quality of essential oil." *Journal of the Science of Food and Agriculture* 82, no. 4: 339-342.

The effect of association of two vesicular arbuscular mycorrhizal (VAM) fungi, *Glomus macrocarpum* and *G fasciculatum*, on the concentration and composition of essential oil in coriander (*Coriandrum sativum*) was studied. VAM inoculation increased the essential oil concentration in fruits by as much as 43%. Although significant variation in effectiveness of the two fungal species was observed, the quality of essential oil was significantly enhanced on mycorrhization. GC characterisation of essential oil showed increased concentration of geraniol and linalool in plants inoculated with *G macrocarpum* and *G fasciculatum* respectively.

191

Srivastava AK, Shyam Singh and RA Marathe. (2002). "Organic citrus: soil fertility and plant nutrition." *Journal of Sustainable Agriculture* 19, no. 3: 5-29.

Increasing realization of the ill effects of long sustained, exclusive use of chemical fertilizers, and consistent growing demand from the consumers for fruit quality, coupled with unsustainable productivity of citrus, have fostered experimentation with some alternative cultural practices. Organic culture is claimed to be the most benign alternative. Use of organic materials such as farmyard manure, cakes of plant origin, vermicompost, and microbial biofertilizers on one hand, and exploiting the synergism between citrus-vesicular arbuscular mycorrhizal fungus on the other hand, are important components of the bio-organic concept of citrus cultivation. Mycorrhizae were observed to be highly effective in low fertility, coarse textured soils. Mycorrhizaltreated trees had better plant growth and uptake of nutrients like P, Ca, Zn, Cu, and Fe compared to non-mycorrhizal trees. Inoculation of soil with mycorrhizae also helped in regulating the water relations and carbohydrate metabolism of citrus trees. Phosphorus nutrition of mycorrhizal-treated citrus trees was best improved by using rock phosphate as a source of P as opposed to other sources.

192

Bahl GS and NS Pasricha. (2001). "Direct and residual effect of green manuring in relation to fertilizer nitrogen on Toria (Brassica napus L.) and sunflower (Helianthus annuus L.)." *Journal of the Indian Society of Soil Science* 49, no. 1: 113-117.

Field experiment was conducted to study the direct and residual effect of green manuring on toria (*Brassica napus* L.) and sunflower (*Helianthus annuus* L.), respectively. Nitrogen was applied @ 0, 20, 40, 60, 80 and 120 kg $ha^{-1}$with and without green manuring. Green manuring alone (without any fertilizer nitrogen) manifested in a mean yield increase of toria by 122 per cent equivalent to solitary application of 60 kg N ha^{-1}. Residual effect of green manuring on the following sunflower crop resulted in an average 317 kg ha^{-1} higher yield compared to the treatments without any residual green manure. However, the mean response to residual green manure alone was restricted to 50 per cent. Nitrogen-use efficiency varied with N level and the direct or residual effect of green manuring. Value: cost ratio indicated that green manuring with fertilizer N up to 60 kg ha^{-1} resulted in higher economic return. Fallow period after harvesting of sunflower can be utilized productively by sowing cowpea and its incorporation into the soil for green manuring, in this rotation.

193

Vaishampayan A, RP Sinha, DP Hader, T Dey, AK Gupta, U Bhan and AL Rao. (2001). "Cyanobacterial biofertilizers in rice agriculture." *The Botanical Review* 67 (4): 453-516.

Floodwater and the surface of soil provide the sites for aerobic phototrophic nitrogen (N) fixation by free-living cyanobacteria and the Azolla-Anabaena symbiotic N2-fixing complex. Free-living cyanobacteria, the majority of which are heterocystous and nitrogen fixing, contribute an average of 20-30 kg N ha-1, whereas the value is up to 600 kg ha-1 for the Azolla-Anabaena system (the most beneficial cyanobacterial symbiosis from an agronomic point of view). Synthesis and excretion of organic/growth-promoting substances by the cyanobacteria are also on record. During the last two or three decades a large number of studies have been published on the various important fundamental and applied aspects of both kinds of cyanobacterial biofertilizers (the free-living cyanobacteria and the cyanobacterium Anabaena azollae in symbiotic association with the water fern Azolla), which include strain identification, isolation, purification, and culture; laboratory analyses of their N2-fixing activity and related physiology, biochemistry, and energetics; and identification of the structure and regulation of nitrogen-fixing (nif) genes and nitrogenase enzyme. The symbiotic biology of the Azolla-Anabaena mutualistic N2-fixing complex has been clarified. In free-living cyanobacterial strains, improvement through mutagenesis with respect to constitutive N2 fixation and resistance to the noncongenial agronomic factors has been achieved. By preliminary meristem mutagenesis in Azolla, reduced phosphate dependence was achieved, as were temperature tolerance and significant sporulation/spore germination under controlled conditions. Mass-production biofertilizer technology of free-living and symbiotic (Azolla-Anabaena) cyanobacteria was studied, as were the interacting and agronomic effects of both kinds of cyanobacterial biofertilizer with rice, improving the economics of rice cultivation with the cyanobacterial biofertilizers. Recent results indicate a strong potential for cyanobacterial biofertilizer technology in rice-growing countries, which opens up a vast area of more concerted basic, applied, and extension work in the future to make these self-renewable natural nitrogen resources even more promising at the field level in order to help reduce the requirement for inorganic N to the bare minimum, if not to zero.

194

Kumar Vivek and KP Singh. (2001). "Enriching vermicompost by nitrogen fixing and phosphate solubilizing bacteria." *Bioresource Technology* 76, no. 2: 173-175.

The effect of inoculation of vermicompost with nitrogen-fixing *Azotobacter chroococcum* strains, *Azospirillum lipoferum* and the phosphate solubilizing *Pseudomonas striata* on N and P contents of the vermicompost was assessed. Inoculation of N_2 fixing bacteria into vermicompost increased contents of N and P. Enriching vermicompost with rock phosphate improved significantly the available P when inoculated with *P. striata*. During the incubation period, the inoculated bacterial strains proliferated rapidly, fixed N and solubilized added and native phosphate.

195

Bansal Sudha and KK Kapoor. (2000). "Vermicomposting of crop residues and cattle dung with *Eisenia foetida*." *Bioresource Technology* 73, no. 2: 95-98.

We studied vermicomposting with *Eisenia foetida* of mustard residues and sugarcane trash mixed with cattle dung in a 90-day composting experiment. Vermicomposting resulted in significant reduction in C:N ratio and increase in mineral N, after 90 days of composting, over treatments uninoculated with earthworms. Microbial activity, as measured by dehydrogenase assay, increased up to 60 days and declined on further incubation. There was more total N in the compost prepared by earthworm inoculation. However, the differences were not significant. Total P, K and Cu contents did not differ in compost prepared with earthworm inoculation from the uninoculated treatments.

196

Chakrabarti K, Sarkar B, Chakraborty A, Banik P and Bagchi DK. (2000). Organic Recycling for Soil Quality Conservation in a Subtropical Plateau Region. Journal of Agronomy and Crop Science, 184: 137–142.

The long-term effect of organic recycling on some aspects of quality in a lowland rice soil of an Indian plateau region was studied. The experiment was set up at the agricultural experimental farm of the Indian Statistical Institute, Giridih, Bihar, India. Two rice cultivars, and treatments with four organic supplements (cowdung manure, *Leuceana* leaves, decomposed farm residue and *Sesbania*), chemical fertilizers (urea, superphosphate and muriate of potash) and no input were arranged in a factorial randomized block design. Organic supplements improved soil quality parameters such as water holding capacity, total organic C, microbial biomass C, urease and acid phosphatase activities of soils in comparison to chemical fertilizers and no input. Among the organic supplements, cowdung manure gave significantly higher organic C (1.39%), microbial biomass C (276.46 ìg g$^{˝1}$ dry soil), urease activity (32.79 and 21.22 ìg urea hydrolized g$^{˝1}$ dry soil h$^{˝1}$ at 37 °C by the buffer and non-buffer method, respectively) and acid phosphatase activity (1.99 ìmol p-nitrophenol released g$^{˝1}$ dry soil h$^{˝1}$ at 37 °C) than the others. The conversion of organic C into biomass C (2.46%) was highest in *Leuceana*-treated soil.

197

Trenbath BR. (1999). "Multispecies cropping systems in India: Predictions of their productivity, stability, resilience and ecological sustainability." *Agroforestry systems* 45, no. 1-3: 81-107.

Several traditional Indian cropping systems are used as examples of agriculture imitating the multispecies character of natural ecosystems. Modelling of their productivity and dynamics suggests they have potential advantages in production, stability of output, resilience to perturbation, and ecological sustainability, although they are harder to manage. Extra diversity in a cropping system can increase the production of a subsistence diet through either biochemical or ecological complementation. Stability of a cropping system may be improved through the incorporation of more crop species. Within a mixed crop, compensatory growth by the stronger component will tend to increase stability of final total yield. Where a two component intercrop has a regular production advantage, the land area required to produce a person s subsistence with a certain low level of risk of failure may be much less than if the crops are grown separately. Where a crop mixture contains contrasting components, the production penalty due to a disaster may be helpfully spread over time so that resilience of the system is increased. The compensatory growth of less-damaged components makes mixtures more resilient. Multi-species systems under intensification stress may be much less resilient than unstressed ones. Unless they are well managed, they can collapse. Where high output is desired, sustainability can only be attained through an understanding of the underlying processes. Intensification can lead to increased production up to a certain level, but such an increase is usually at the expense of subsequent production.

198

Selvi Ranganathan D, and D Augustine Selvaseelan. (1997). "Mushroom spent rice straw compost and composted coir pith as organic manures for rice." *Journal of the Indian Society of Soil Science* 45, no. 3: 510-514.

In a field study, application of mushroom spent rice straw compost, has resulted in an enhanced grain yield of rice to the tune of 20 per cent over 100% NPK and it was comparable with FYM. Composted coir pith application also recorded higher grain yield over NPK alone. The macro and micronutrients availability was increased considerably by the application of organic manures. Application of mushroom spent compost recorded higher Ca, Mg and Fe uptake by composed coir pith.

199

Jisha MS and AR Alagawadi. (1996). "Nutrient uptake and yield of sorghum (*Sorghum bicolor* L. Moench) inoculated with phosphate solubilizing bacteria and cellulolytic fungus in a cotton stalk amended vertisol." *Microbiological research* 151, no. 2: 213-217.

Interaction of phosphate solubilizing bacteria, *Pseudomonas striata* or *Bacillus polymyxa*, with the cellulolytic fungus, *Trichoderma harzianum* and their influence on the nutrient uptake and yield of *Sorghum* was studied in a vertisol amended with cotton stalks. Combined inoculation of *T. harzianum* and *B. polymyxa* or *P. striata* increased the size and weight of earhead, number of spikelets per ear, straw and grain yield as well as N and P uptake significantly over uninoculated control and single inoculation treatments. Grain yield due to combined inoculation was increased by 6 – 8 per cent over single inoculation of P-solubilizers and by 28 – 30 per cent over single inoculation of *T. harzianum*. The population of both the interacting organisms and soil available phosphorus were highest in combined inoculation treatments indicating a synergistic interaction between the inoculated organisms.

200

Sharma Neeta. (1994). "Recycling of organic wastes through earthworms: An alternate source of organic fertilizer for crop growth in India." *Energy conversion and management* 35, no. 1: 25-50.

Development of an appropriate technology for recovery of resources from non-conventional sources, like organic wastes, is most required to solve part of our energy crisis and environmental degradation. With an immense increase in the human population, industry and agriculture, disposal of these waste materials has become a problem, not only in India, but in other parts of the world as well. Earthworms, with their peculiar habits of feeding, burrowing, etc. are nature's most useful converters of wastes. The present study is an attempt to discuss in detail the availability of organic resources in India, their agricultural value, and the role of earthworms as an alternate source of organic fertilizer. Maize and wheat crops were grown as test crops.

201

Gajri PR, VK Arora and MR Chaudhary. (1994). "Maize growth responses to deep tillage, straw mulching and farmyard manure in coarse textured soils of NW India." *Soil Use and management* 10, no. 1: 15-19.

The effects of deep tillage, straw mulching and farmyard manure on maize growth in loamy sand and sandy loam soils were studied in experiments lasting three years. Treatments included all combinations of conventional tillage (10 cm deep) and deep tillage (35–40 cm deep), two farmyard manure rates (0 and 15 t/ha) and two mulch rates (0 and 6 t/ha), replicated three times in a randomixed block design.

Deep tillage decreased soil strength and caused deeper and denser rooting. Mulching decreased maximum soil temperature and kept the surface layers wetter resulting in better root growth. Farmyard manure also improved root growth, and the crop then extracted soil water more efficiently. All three treatments increased grain yield in the loamy sand, but in the sandy loam only tillage and farmyard manure increased yields significantly. Deep tillage and straw mulch effects varied with soil type and amount of rainfall in the growing season. In the loamy sand the mean responses to deep tillage and mulching were largest in a dry year. A tillage-mulch interaction was significant in the loamy sand.

202

Goyal Sneh, MM Mishra, IS Hooda and Raghubir Singh. (1992). "Organic matter-microbial biomass relationships in field experiments under tropical conditions: Effects of inorganic fertilization and organic amendments." *Soil biology and biochemistry* 24(11): 1081-1084.

The analysis of continuous fertilizer and manurial experiments in tropical conditions of India have shown that soil microbial biomass C and N increased with balanced fertilization. The additions of organic amendments increased microbial biomass even when the organic C content of the soil did not increase. The increase in microbial biomass was attributed to better plant growth resulting in higher rhizodeposition. The crop yields and N uptake were higher with the addition of farm yard manure or Sesbania green manure.

203

Beri V, OP Meelu and CS Khind. (1989). "Biomass production, N accumulation, symbiotic effectiveness and mineralization of green manures in relation to yield of wetland rice." *Tropical agriculture* 66: 11-16.

A two year field experiment on Falehpur Sandy loam, Ludhiana, India to determine the effects sesbania, cowpea clusterbean and sunn hemp as supplements for fertilizer nitrogen in wetland rice. The mean green and dry matter production of shoots of 60-day-old cowpea, sunn hemp, sesbania and clusterbean plants were 24 and 6.9, 21 and 5.4, 20 and 5.0, 17 and 3.8 t/ha respectively corresponding N additions through these green manures were 113, 110, 108 and 87 kg/ha respectively. Sesbania had the most nodules and their highest fresh weight per plant, followed by cowpea, sunn hemp and clusterbean. The symbiotic effectiveness of nodules at 15, 25, 35 and 55 days were 55-100, 60-95, 25-95 and 16-50 '#percent#' in cowpea, sesbania, sunn hemp and clusterbean, respectively. All green manures decomposed rapidly and about 40 '#percent#' of the added carbon was lost as CO_2 in 7-15 days. The mineralization rate constant of green manures was 0.022-0.013/day. A peak in the formation of KCL-extractable NH_4^+-N from the soils amended with different green manures was observed between 7-15 days period. There was not much difference in the mineralization of N among different green manures. Green manures were found equally effective and resulted in significantly higher rice yield compared to fallow treatments. Rice yield with green manuring alone was comparable to 120 kg N/ha; green manuring with 60 kg N/ha resulted in yields equivalent to 180 kg N/ ha. These results indicate a supplementation of 120 kg/ha of fertilizer N with green manuring in rice.

204

Harinikumar KM and Bagyaraj DJ. (1989). Effect of cropping sequence, fertilizers and farmyard manure on vesicular-arbuscular mycorrhizal fungi in different crops over three consecutive seasons. *Biol Fertil Soils* 7:173–175

The influence of cropping sequence with and without fertilizer and farmyard manure application on vesicular-arbuscular mycorrhizae was studied over three consecutive seasons. In the first season maize was grown on all the plots. In the second season cowpea, groundnut and finger millet were raised on the same plots and in the third season, sunflower was grown on all the plots. The groundnut grown in the second season stimulated mycorrhizal root colonization, sporulation and infective propagules in the soil, and these effects were carried over to the next season. The plots cropped to finger millet in the second season had the lowest number of mycorrhizal spores. The application of farmyard manure stimulated vesicular-arbuscular mycorrhizae while fertilizers at the recommended level decreased the mycorrhizal propagules.

205

Singh PK, BC Panigrahi and KB Satapathy. (1981). "Comparative efficiency of Azolla, blue-green algae and other organic manures in relation to N and P availability in a flooded rice soil." *Plant and Soil* 62, no. 1: 35-44.

Pot incubation study with fresh Azolla (*Azolla pinnata*-India and Vietnam isolates,*A. mexicana* and*A. filiculoides*), blue-green alga*Aulosira* sp., green manure*Sesbania cannabina*, Azolla compost, farm yard manure and ammonium sulphate was conducted under flooded condition at CRRI, Cuttack keeping an equivalent amount of 25 ppm N through all the amendments where changes in availability of N and P, C:N ratio and pH were recorded. Application of chemical N-fertilizer recorded a release of about 87% NH_4^+N at 10th day of flooding which gradually decreased and reached the minimum of 6% at 50 days. The C:N ratio of the organic manures ranged between 9-10 favouring release of NH_4^+-N and among the *Azolla* species *A. pinnata* isolates released NH_4^+-N more efficiently than *A. filiculoides* and *A. mexicana*. *A. pinnata* Indian isolate released maximum of 88% NH_4^+-N, whereas Vietnam isolate recorded 77% at 40 days of flooding; green manure on the other hand, reached a maximum of 50% release at 50 days. The blue-green alga recorded a gradual increase and attained the maximum release of 38% at 40 days of flooding. Farmyard manure recorded a highest NH_4^+-N release of 69% at 20 days of flooding and gradual decrease thereafter, whereas Azolla compost released 41% at 40 days of flooding. Soil amended with fresh organic matter achieved reduction upto a pH of 7.2 after 50 days of flooding, whereas the pH in Azolla compost and farmyard manure amendment was <7. The P availability increased from 20th day onwards and reached the highest values of 26 and 18 ppm in the fresh organic matter and compost amended soil respectively after 40-50 days of flooding. The cumulative release of available P was found superior in fresh Azolla incorporation.

ORGANIC FARMING: ENVIRONMENTAL BENEFITS

206

Chinnadurai C, G Gopalaswamy and D Balachandar. (2014). "Impact of long-term organic and inorganic nutrient managements on the biological properties and eubacterial community diversity of the
Indian semi-arid Alfisol." *Archives of Agronomy and Soil Science* 60, no. 4: 531-548.

Intensive cropping with limited nutrient management options in low fertile semi-arid tropical soils will have agricultural sustainability problems in future. A better understanding of soil variables as influenced by long-term nutrient amendments could lead to the identification of more precise indicators to monitor soil fertility that would promote sustainability. Long-term nutrient experiment in semi-arid Alfisol at Coimbatore, India was investigated in two successive years, 2009 and 2010 to assess the enduring effects of organic (OM) and inorganic (IC) nutrient managements on soil variables. The organic amendments induced higher microbial population and enzyme activity compared to IC and control soils. The principal component analysis of observed variables revealed that soil organic carbon, microbial biomass carbon (MBC), dehydrogenase and alkaline phosphatase activity and diazotrophs population could be the possible indicators for predicting soil fertility resulting from long-term nutrient managements. The eubacterial community profile assessed by 16S rRNA gene sequence polymorphism revealed that the abundance and relative ratio of phyla belonging to *Proteobacteria, Actinobacteria, Acidobacteria* and *Firmicutes* were considerably affected due to either organic manures or inorganic fertilizers, and organic nutrient management favours bacterial community diversity. These results emphasize the importance of organic nutrient management to maintain soil biological properties in semi-arid Alfisol.

207

Shinde L V and Phalke GB (2014). Chemical composition of soil from Godavari basin of Beed, India. *Bioscience Discovery*, 5 (1). 15-18

Soil is an important natural resource and plays a crucial role in maintaining environmental balance. Regarding yield of the crops and growth regulation, fertility of soil is most important but today's scenario of agriculture farming in India is not care about it. Without any analysis farmer used unwanted and abundant quantity of fertilizer and water, both results reduce fertility of soil. For sustainable agriculture development and production, analysis of the chemical composition, micronutrient and micro fauna from soil is must. The paper is communicated with the chemical composition of soil from selected location of Godavari basin of Jalna (India). The composition of soil shows as follows pH ranges from 8.3- 8.9, E.C. 0.24-0.38, Organic carbon 0.50-0.93, P2O5 51-83, K2O 680-901, Ca 32.3-40, Mg 11.6-24.0, Na 110125 and CaCo3 10.7-15.4. The above nine parameters play an important role about soil fertility and crop yield. The study helps in determining the values of different chemical parameters and the nutrient concentrations of soil from Godavari Basin region. All the parameters either directly or indirectly influence on the soil eco-system. There is a necessity to minimize the use of chemical fertilizers. It is the right time to take action about soil fertility; otherwise, in few years, soil will have reduced fertility and will impact the agricultural economy.

208

Malik Sudha Sambyal and Ramesh C Chauhan (2014). "Impact of Organic Farming in Enhancing the Soil Microbial Pool." In *Climate Change and Biodiversity*, pp. 183-196. Springer Japan, 2014.

One of the important indicators of soil quality is the soil organic matter which influences the soil microbial population dynamics and enzyme activities, which in turn affect the soil fertility. Present study was conducted in the soil microbiological section, Department of Soil Science, CSKHPKV, Palampur in rice-lentil cropping sequence with organic, integrated and inorganic nutrient management. There were eight treatments with three replications and randomized block design. The surface and subsurface soil samples were collected before sowing and after harvesting from each treatment (0–15 and 15–30 cm) deep samples. The soil samples were analyzed to study how the microbial properties changed with changing the inputs in soil. An addition of organics along with in-organics improved urease and phosphatase activity in the soil. Whereas the application of only organic inputs was found to improve the soil biological properties such as microbial population, biomass carbon, microbial respiration and dehydrogenase activity. These microbial properties play a significant role in nutrient cycling, improvement of soil structure and many other functions, which directly and indirectly improve the soil health.

209

Sudhakaran M, D Ramamoorthy and S Rajesh Kumar. (2013). "Impacts of conventional, sustainable and organic farming system on soil microbial population and soil biochemical properties, Puducherry, India." *International Journal of Environmental Sciences* 4(1): 28-41.

This research under field experimental conditions in agro ecosystem investigated the effects of different farm management practices (Conventional, Sustainable and Organic) on soil biochemical and microbial populations including soil physical, chemical and biological factors. Three composite soil samples were collected from each of the 10 farms from the fall of January 2012 to May 2012. Composite samples were done by sampling approximately 15kg of soil from each of the three farming systems (Conventional, Sustainable and Organic) using augur at 0-15cm cm depth. Soils from organic farms had improved soil chemical parameters (total elements and plant available nutrients) and higher level of total N, total P, total K, total Ca, total Mg ,total Fe, total Cu, organic C, NH4-N, NO3-N, extractable P, SO4-S and soluble Na.In addition, ß- glucosidase activities, soil respiration and microbial population (bacteria, fungi, actinimycetes, beijerinckia, azotobacter, rhizobium, bacillus and phosphobacteria) were higher in soils from organic farming than sustainable and conventional farms. This study shows organic farming was improving the soil health and plant available nutrients without any inorganic external inputs.

210

Padmavathy A and Poyyamoli G (2013). Biodiversity comparison between paired organic and conventional fields in Puducherry, India. *Pak J Biol Sci.* 16 (23): 1675-86.

Modern intensive chemical agriculture and its expansion have caused a dramatic decline in the agro-biodiversity throughout the world. Recently, accumulating evidences indicate that organic farming is a sustainable farming system that can potentially reduce the biodiversity loss and conserve biodiversity. This chapter investigates the impacts on biodiversity in paired organic and conventional agricultural plots, to determine whether organic agriculture can deliver biodiversity benefits including enhanced ecosystem services. The study assessed a wide range of taxa through different methodsplants by quadrates; soil microbes; earthworms by counting; butterflies and dragonflies by pollard walk method; other arthropods by visual searching and pitfall traps; reptiles by hand capture method; molluscs by hand picking and dredging; amphibians-frogs by direct sighted/visual encountered and birds by direct sighting, calls and variable width line-transect method. Habitat area, composition and management on organic fields were likely to favor higher levels of biodiversity by supporting more numbers of species, dominance and abundance across most taxa. Overall organic hedgerows harbored larger biodiversity during both pre-harvest and post harvest period. Species richness, dominance and abundance of most taxa are lost after harvest in both conventional and organic fields due lack of habit, habitat and microclimate. However, the magnitude of the response varied among the taxa. Organic fields are the systems less dependent on external inputs restore and rejuvenate environment resulting in higher biodiversity that promotes higher sustainable production on a long-term basis.

211

Wani Sartaj A, Chand Subhash, Najar GR and Teli MA (2013). Organic Farming as a Climate Change Adaptation and Mitigation Strategy. *Current Agriculture Research Journal.* Vol 1 (1): 45-50.

Organic farming, as an adaptation strategy to climate change and variability, is a concrete and sustainable option and has additional potential as a mitigation strategy. The careful management of nutrients and carbon sequestration in soils are significant contributors in adaptation and mitigation to climate change and variability in several climate zones and under a wide range of specific local conditions. Organic farming as a systematic approach for sustained biological diversity and climate change adaptation through production management, minimizing energy randomisation of non-renewable resources; and carbon sequestration is a viable alternative. The purpose of potential organic farming is therefore to attempt a gradual reversal of the effects of climate change for building resilience and overall sustainability by addressing the key issues. Research is needed on yields and institutional environment for organic farming, as a mitigation and sequestration potential.

212

Anbarashan P, P Gopalswamy. (2013). "Effects of persistent insecticides on beneficial soil arthropod in conventional fields compared to organic fields, puducherry." *Pakistan journal of biological sciences: PJBS* 16, no. 14: 661.

The usage of synthetic fertilizers/insecticides in conventional farming has dramatically increased over the past decades. The aim of the study was to compare the effects of bio-pesticides and insecticides/pesticides on selected beneficial non-targeted arthropods. Orders Collembola, Arachinida/ Opiliones, Oribatida and Coleoptera were the main groups of arthropods found in the organic fields and Coleoptera, Oribatida, Gamasida and Collembola in conventional fields. Pesticides/insecticides had a significant effect on nontargeted arthropods order- Collembola, Arachinida/Opiliones, Hymenoptera and Thysonoptera were suppressed after pesticides/insecticides spraying. Bio-insecticides in organic fields had a non-significant effect on non targeted species and they started to increase in abundance after 7 days of spraying, whereas insecticide treatment in conventional fields had a significant longterm effect on non targeted arthropods and short term effect on pests/ insects, it started to increase after 21 days of the spraying. These results indicate that insecticide treatment kept non-targeted arthropods at low abundance. In conclusion, organic farming does not significantly affected the beneficial-non targeted arthropods biodiversity, whereas preventive insecticide application in conventional fields had significant negative effects on beneficial non targeted arthropods. Therefore, conventional farmers should restrict insecticide applications, unless pest densities reach the thresholds and more desirably can switch to organic farming practices.

213

Tomar JMS, Anup Das and A Arunachalam. (2013). "Crop response and soil fertility as influenced by green leaves of indigenous agroforestry tree species in a lowland rice system in northeast India." *Agroforestry systems* 87, no. 1: 193-201.

Field experiments were conducted during rainy seasons of three consecutive years (2008–2010) to study the effect of green leaf manuring on dry matter partitioning and productivity of lowland rice (*Oryza sativa* L.). Green leaves of five indigenous agroforestry tree species viz., *Erythrina indica*, *Acacia auriculiformis*, *Alnus nepalensis*, *Parkia roxburghii*, and *Cassia siamea* were treated at 10 t/ha on fresh weight basis in rice fields and compared with recommended N–P_2O_5–K_2O (80:60:40 kg/ha) and control treatments. During 2008–2009 year, yield attributes and rice yield were greater in NPK plots as compared to the green-leaf manured ones. However, in the third year, green leaf manuring (except that of *Alnus*) surpassed even the recommended N– P_2O_5–K_2O treatment in terms of dry matter production and yield; better response was however observed with *Erythrina*. The soil available N after final harvest increased by ca. 14–20 % in *Alnus* and *Erythrina* treated plots as compared to the control. Overall, it could be said that management of plant residues can have long-term implications apart from the desired maintenance of soil organic matter and improving crop yield.

214

Manjunatha GR, KV Ashalatha, KR Patil and KP Vishwajith. (2013). "Effect of organic farming on organic carbon and NPK status of soil in Northern Karnataka, India." *Journal of Crop and Weed* 9, no. 1: 79-82.

Increasing consciousness about environmental degradation as well as health hazards caused by inorganic farming and consumer's preference to residue free food are the major concern that have led to the mounting interest in alternate forms of agriculture (Organic farming) worldwide. Hence, present study was conducted with the object to determine the effect of years of practicing organic farming on the status of various soil health indicators by using analysis of variance technique (ANOVA) in the selected Agro Climatic Zones of Northern Karnataka. Data for the analysis was elicited from organic farmers' selected based on multistage purposive random sampling method. The study revealed the significant influence of years of practicing organic farming on various soil health indicators, signaled through highly significant F-ratio. Thus, it can be concluded that by practicing organic agriculture the soil health can be enhanced meanwhile environmental pollution can be reduced.

215

Singh YV. (2013). "Crop and water productivity as influenced by rice cultivation methods under organic and inorganic sources of nutrient supply." *Paddy and Water Environment* 11, 1-4: 531-542.

A field experiment was conducted during the wet seasons of 2010 and 2011 at New Delhi, India to study the influence of organic, inorganic, and integrated sources of nutrient supply under three methods of rice cultivation on rice yield and water productivity. The experiments were laid out in FRBD with nine treatment combinations. Treatment combinations included three sources of nutrient supply viz., organic, integrated nutrient management, and inorganic nutrition and three rice production systems viz., conventional transplanting, system of rice intensification (SRI) and aerobic rice system. Results indicated that the conventional and SRI showed *at par* grain and straw yields but their yields were significantly higher than aerobic rice. Grain yield under organic, inorganic and integrated sources of nutrient supply was *at par* since the base nutrient dose was the same. Plant growth parameters like plant height, tillers, and dry matter accumulation at harvest stage were almost the same under conventional and SRI but superior to aerobic rice systems. Root knot nematode infestation was significantly higher in aerobic rice as compared to SRI and conventional rice. However, organic, inorganic and integrated sources of nutrient supply did not affect nematode infestation. There was a significant advantage in terms of water productivity under SRI over conventional transplanted (CT) rice and less quantity of water was utilized in SRI for production of each unit of grain. A water saving of 34.5–36.0 % in SRI and 28.9–32.1 % in aerobic rice was recorded as compared to CT rice.

216

Lakshmanan A, Sankar A, Geethalakshmi V, Latha P and Sekhar NU (2012). Role of blue green algal system in minimizing methane flux from rice soils. *Asian Journal of Microbiology, Biotechnology and Environmental Sciences*. Vol. 14 (4). pp 617-622

Global warming induced by increasing concentration of greenhouse gases (GHGs) in the atmosphere is a matter of great environmental concern. A field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India during the Rabi seasons of 2010-11, to study the methane emission rates from rice field under different organic amendments using rice variety TNAU (R) TRY1 with the duration of 135 days. Treatments involved were T1- Control, T2-Blue Green Algae, T3Azolla, T4-Farm Yard Manure, T5-Green Leaf Manure, T6-Blue Green Algae + Azolla, T7-Farm Yard Manure + Green Leaf Manure, T8- Blue Green Algae + Azolla + Farm Yard Manure + Green Leaf Manure. Plant-mediated CH4 emission flux from the experimental plots was measured by closed chamber method at 15 days intervals. In the present study, combined application of organics and blue green algae not only recorded higher yield, but found to emit less methane in paddy cultivation than the application of organics alone. Hence, this study reiterates that biofertilization of paddy fields with blue green algae and Azolla is a potential climate change mitigation strategy due to their effect in minimizing methane emission, besides yield enhancement by nitrogen fixation.

217

Ghosh Subhadip, Brian Wilson, Subrata Ghoshal, Nimai Senapati and Biswapati Mandal. (2012). "Organic amendments influence soil quality and carbon sequestration in the Indo-Gangetic plains of India." *Agriculture, Ecosystems & Environment* 156: 134-141.

Soil organic carbon is considered to be of central importance in maintaining soil quality. We assessed the effects of a range of commonly applied organic and inorganic amendments on soil quality in a rice–wheat cropping system in the Indo-Gangetic plains of eastern India and evaluated the carbon sequestration potential of such management approaches using a 25 year old long-term fertility experiment. Results showed that there were significant increases in soil nutrient availability with the application of farm yard manure (FYM @ 7.5 t ha^{-1}), paddy straw (PS @ 10 t ha^{-1}) and green manure (GM @ 8 t ha^{-1}) along with inorganic fertilizer. Both microbial biomass C and mineralizable C increased following the addition of the organic inputs. Continuous cultivation, without application of organic inputs, significantly depleted total C content (by 39–43%) compared with treatments involving the addition of organic amendments. A significant increase in the non-labile C fraction resulted from both organic and inorganic amendments, but only 26, 18 and 6% of the C applied through FYM, PS and GM, respectively was sequestered in soils. A significant increase in yield of *kharif* rice was observed as a result of the addition of these organic amendments.

218

Saha Supradip, Dutta Debashis, Ray Deb Prasad, Karmakar Rajib (2012). Vermicompost and Soil Quality. Farming for Food and Water Security. Sustainable Agriculture Reviews. Vol. 10. Pp 243-264

Sustainability is a major issue for policy makers, researchers and extension workers worldwide. Achievement towards sustainable agriculture has not been satisfactory so far. Negative impacts of industrial agriculture are threa-t-ening biodiversity and biodiversity's role in maintaining a functional biosphere. Vermicomposting is a promising solution for the loss of biodiversity due to recycling of natural resources. Though almost all soil processes are regulated by soil microbes, the role of vermicompost in maintaining microbial diversity and soil functions is not fully understood. Here we review the major advances and benefits of vermicomposting. The major points are the following. Extracellular enzyme activity is increased upon application of vermicompost in soil. Initial enhancement of microbial growth is also observed and explained by the initial activation of the microbial enzymes and intracellular enzyme activity. Upon aging of vermicomposting the enzymatic activity decreases. Higher microbial population in vermin-cast is observed versus the surrounding soil. Major changes in bacterial and fungal communities are observed. Improvement in mineralization of nutrients is reported in most studies. Specifically, C and N mineralization is highly changed by the application of vermicompost. Enhancement of crop yields achieved on soil amended with vermicompost is explained by better mineralization of nutrients.

219

Chaudhry Vasvi, Ateequr Rehman, Aradhana Mishra, Puneet Singh Chauhan and Chandra Shekhar Nautiyal. (2012): "Changes in bacterial community structure of agricultural land due to long-term organic and chemical amendments." *Microbial ecology* 64, no. 2: 450-460.

Community level physiological profiling and pyrosequencing-based analysis of the V1-V2 16S rRNA gene region were used to characterize and compare microbial community structure, diversity, and bacterial phylogeny from soils of chemically cultivated land (CCL), organically cultivated land (OCL), and fallow grass land (FGL) for 16 years and were under three different land use types. The entire dataset comprised of 16,608 good-quality sequences (CCL, 6,379; OCL, 4,835; FGL, 5,394); among them 12,606 sequences could be classified in 15 known phylum. The most abundant phylum were Proteobacteria (29.8%), Acidobacteria (22.6%), Actinobacteria (11.1%), and Bacteroidetes (4.7%), while 24.3% of the sequences were from bacterial domain but could not be further classified to any known phylum. Proteobacteria, Bacteroidetes, and Gemmatimonadetes were found to be significantly abundant in OCL soil. On the contrary, Actinobacteria ana Acidobacteria were significantly abundant in CCL and FGL, respectively. Our findings supported the view that organic compost amendment (OCL) activates diverse group of microorganisms as compared with conventionally used synthetic chemical fertilizers. Functional diversity and evenness based on carbon source utilization pattern was significantly higher in OCL as compared to CCL and FGL, suggesting an improvement in soil quality. This abundance of microbes possibly leads to the enhanced level of soil organic carbon, soil organic nitrogen, and microbial biomass in OCL and FGL soils as collated with CCL. This work increases our current understanding on the effect of long-term organic and chemical amendment applications on abundance, diversity, and composition of bacterial community inhabiting the soil for the prospects of agricultural yield and quantity of soil.

220

Babu M, VR Parama, M Madhan Mohan and M Reddy. (2012). "Carbon Stocks and Enzyme Activities in Soils as Influenced by
Soil Depth, Organic and Conventional Management Systems." *Vegetos: An International Journal of Plant Research* 25, no. 1: 329333.

Organic and conventional farming systems have been compared in terms of soil properties, the world over. A field study was conducted to determine the distribution of different carbon fractions and the activity of acid Phosphatase, alkaline Phosphatase and Dehydrogenase enzymes in four representative soil profiles one each from6 years of organic farming practice and one profile from conventional farming system under central dry zone of Karnataka, India. The activity of dehydrogenase increased significantly in all three organic farming fields irrespective of cropping systems evaluated over conventional farming, with maximum activity being in the profile where organic farming is practicing for > 6years. The organic farming being practiced in < 3 years and 3–6 years fields recorded significantly lower levels of acid and alkaline phosphatase activities in the surface horizon when compared conventional farming system. Depth-distribution studies showed that all the three enzyme activities were concentrated in surface soils and decreased with depth.

221

Padmavathy Anbarasan and Gopalasamy Poyyamoli. (2011). "Enumeration of Arthropods Density in Context to Plant Diversity and Agricultural (Organic and Conventional) Management Systems." *International Journal of Agricultural Research* 6, no. 12.

Arthropods were inventoried in fields and woody hedgerows of organic and conventional agricultural fields situated in Bahour-Puducherry, India. The objective was to access the total abundance, family richness and composition of arthropods in two different agricultural systems (organic and conventional). The study was conducted twice a month from August 2008 to October 2010 by visual searching and pitfall trap methods in crop fields and adjacent hedgerows of organic and conventional fields. A total of 2,59,722 individual's arthropods belonging to 185 families were recorded during the study. The study showed that beneficial and phytophagous arthropods differed in their abundance/richness in organic and conventional sites both in visual searching and pitfall traps methods. Phytophagous arthropods were more abundant in field margins with hedgerows, while beneficial arthropods were abundant in crop fields. The study also demonstrated a strong relationship between plant composition and management strategies. The arthropod species composition was highly influenced by crop species, habitats, total hedgerow length and Shannon diversity index influence. In general, the number of beneficial arthropods was always higher in the organic plots in relation to the conventional ones, reflecting on the Shannon index diversity. Higher population was represented by the individuals belonging to the taxa/order Arachnida (mites, spiders and pseudo-spiders), Oribatida, Collembola (spring tails) and Coleoptera (insects). The prime importance is to consider both local organic management practices and marginal woody hedgerow in conserving beneficial arthropods population, to maintain soil fertility and sustainable productivity in long term.

222

Regupathy A and Ayyasamy R (2011). Impact of withdrawal of pesticide application against papaya mealybug, *Paracoccus marinatus* Williams and Granara de Willink on the biodiversity of natural enemy complex in small scale papaya farming system in Tamil Nadu. Journal of Biological Control. Vol. 25(4): 280-285.

Observations on the incidence of mealybug, *Paracoccus marginatus* Williams and Granara de Willink and spider and ants associated with it were recorded in 10 papaya fields each (total of 30 fields) falling in three categories *viz.* 1) Abandoned and severely infested fields released with parasitoid *Acerophagus papayae*, 2) Infested but yielding fields released with *A. papayae.* and 3) Fields with 2–4 months old crop without parasite release in Tamil Nadu. The *P. marginatus* incidence was reduced to an extent of 7– 33 per cent with very low intensity in parasitoid released fields. Six species of spiders *viz. Clubiona* spp. crab spider*, Thomisus* spp., Jumping spider *Phidippus* sp., *Plexippus* sp.*, Araneus* sp. wolf spider*, Lycosa pseudoannulata* were found and the most predominant one was *Araneus* sp. Nine species of coccinellids, *viz. Brumoides suturalis* (Fabricius)*, Cheilomenes sexmaculata* (Fabricius), *Coccinella septumpunctata* Linnaeus, *Coccinella nigrita* Fabricus*, Cryptolaemus montrouzieri* Mulsant, *Hippodamia variegata* (Goeze), *Hyperaspis maindroni* Sicard, *Nephus regularis* Sicard and *Scymnus coccivora* Ayyar recorded from the fields. Two species of chrysopids, *Chrysoperla zastrowi silemi (carnea)* and *Mallada* sp. were observed. Parasitoids *A. papayae* and *Torymus* sp. (Torymidae) only were found. Four species of ants *viz., Camponotus compressus* (Fabricius), *Camponotus sericeus* (Fabricius), *Camponotus parius* Emery and *Tapinoma melanocephalum* (Fabricius) were found to be associated with mealybug. Avoidance of insecticide spraying resulted in the appearance of notable number of biocontrol organisms in papaya fields in Tamil Nadu.

223

Padmavathy A, G Poyyamoli. (2011). "Effects of Conventional and Organic Management Strategies on Soil." *American-Eurasian J. Agric. & Environ. Sci.* 10(4):644-652

Sixty soil samples were collected from 30 paired agricultural fields (organically vs. conventionally managed) every month from August 2008 to October 2010 in Bahour Puducherry. The soil quality was evaluated by physical, chemical and biological indicators. The results obtained demonstrated that organically managed agricultural soils were characterized by a general increase in all the nutrient matter pools and decrease in heavy metal concentration, thus restoring soil microbes and facilitating various metabolic processes, resulting in higher yield productivity in long term. The soil under organic agricultural system portrayed higher soil nutrient quality, microbial biomass and lower bulk density and heavy metal concentration than the conventional agricultural system. Higher soil microbes/arthropods and enhanced soil fertility found in organic plots render these systems less dependent on external inputs, restore beneficial soil biota and promote higher sustainable production on a long term basis.

224

Saha, Supradip (2010). "Soil functions and diversity in organic and conventional farming." In *Sociology, organic farming, climate change and soil science*, pp. 275-301. Springer Netherlands, 2010.

Intensification of modern agriculture is one of the greatest threats worldwide and it has led to growing concern about conserving biodiversity and its role in maintaining functional biosphere. It is now clear that agricultural intensification can have negative local consequences, such as increased erosion, lower soil fertility, and reduced biodiversity; negative regional consequences, such as pollution of ground water and eutrophication of rivers and lakes; and negative global consequences, including impacts on atmospheric constituents and climate. Concerns about the ability to maintain long-term intensive agriculture are also growing. Organic farming is now seen by many as a potential solution to this continued loss of biodiversity due to recycling of natural resources and no negative impact of synthetics. Though almost all the soil processes are regulated by soil microbes, the link between microbial diversity and soil function is not well understood.

This review article assesses the impacts on biodiversity of organic farming, relative to conventional agriculture, through a review of comparative studies of the two systems, in order to determine whether it can deliver on the biodiversity benefits. It also identifies and assesses soil processes regulated by microbes under organic and conventional management practices. It also highlights changes during conversion from conventional to organic cultivation regarding biological processes as well as abundance of microbes. It emphasized tools to measure functional diversity and activity of microbes including molecular tool. The review also draws attention to four key issues: (1) differences in functional diversity under organic and conventional management practices; (2) variation in soil processes due to organic management practices; (3) molecular tools and comparative studies related to analysis of microbial biomass or characterization; and (4) changes during conversion to organic farming.

Concerning environmental protection, in general, the risk of adverse environmental effects is lower with organic than with conventional farming methods, though not necessarily so; with reference to soil fertility and nutrient management, organic farming is suited to improve soil fertility and nutrient management markedly on the farm level; regarding biodiversity, comparison studies show that organic farming has more positive effects on biodiversity conservation. Organic farming identifies a wide range of soil microbial community that benefit from organic management through increases in abundance and/or species richness. Management practices used in organic farming are particularly beneficial for farmland wildlife. Although the continuing debate on the issue of adoption of organic farming has not come out with clear-cut resolution in many parts of the world, the biodiversity aspect in soil functions will be on the positive side for the foreseeable future.

225

Chhotaray Debasmita, PK Mohapatra and CSK Mishra (2010). "Macronutrient availability and microbial population dynamics of soils under organic and conventional farming of legume crop." *Bioscan* 3: 643-650.

The seasonal dynamics of microbial population, nutrients i.e., OC, N, P, and K; dehydrogenase and protease activity of soil, and the relationship of their activities to soil depth were compared in organically grown legume fields with the conventionally cultivated fields. Significantly higher ($P<0.01$) bacteria and fungi population was observed in organic than in the conventional farming. In both the cultivation systems there was a depth wise decrease of microbial density excepting summer months, where inner soil layers had higher quantity of microbes than the surface soil.The organic carbon and inorganic nutrients as well as dehydrogenase and protease activities of soil were higher in the surface than the sub-surface layers in both the agroecosystems. Positive relationships between soil nutrients and enzyme activities with microbial population showed that organic farming increased microbial activity and carbon turnover in legume crops.

226

Nautiyal Chandra S, Puneet S Chauhan and Chittranjan R Bhatia. (2010). "Changes in soil physico-chemical properties and microbial functional diversity due to 14 years of conversion of grassland to organic agriculture in semi-arid agroecosystem." *Soil and Tillage Research* 109, no. 2: 55-60.

Soil physico-chemical properties, microbial biomass, and functional microbial diversity were investigated in two adjacent fields located in a semi-arid dryland farming region of Maharashtra state, India. In organically cultivated field (OCF) large annual inputs of composted cow manure, no tillage and no removal of crop residues is being practiced for the past 14 years. The neighboring plot which was not cultivated for the same period remained as fallow grassland (FGL) served as check for comparison. Soil samples collected from OCF had higher pH, moisture, total organic carbon and nitrogen, microbial biomass, C and N, and enzymatic activities compared to FGL soil. Microbial community structure in the two soils was assessed, using Biolog Eco and GN2 plates. OCF soil showed significant ($P = 0.01$) increase of microbial diversity and evenness, suggesting an improvement of functional microbial diversity. Principal component analysis (PCA) separates the two soil samples based on 10 most discriminating carbon sources for each with the maximum positive and negative scores. To the best of our knowledge this is the first study on soil quality and microbial functional diversity of soil in a semi-arid region indicating that conversion from FGL to OCF led to significant soil quality improvement due to the enhanced microbial functional diversity.

227

Das Anup, Gour Chandra Munda, Dharmendra Prasad Patel, Probir Kumar Ghosh, Shishomvanao Ngachan and Pankaj Baiswar (2010). "Productivity, nutrient uptake and post-harvest soil fertility in lowland rice as influenced by composts made from locally available plant biomass." *Archives of Agronomy and Soil Science* 56, no. 6: 671-680.

A field experiment was conducted during the *kharif* (rainy) seasons of 2005– 2006 to study the effect of eight composts prepared from four different types of plant biomass (rice straw (*Oryza sativa*), *Eupatorium adhenophorum*, *Lantana camara* and grass/weed mixtures) following two composting procedures: (i) Microbial Enriched Compost (MEC) [biomass+cow dung+compost culture (formulations of cellulose decomposers, P-solubilizing microbes and free-living N-fixers], and (ii) Microbial and Nutrient Fortified Compost (MNFC) [MEC+rock phosphate at 2.5% (w/w)+neem cake 1%] on productivity of lowland rice. Recommended NPK (80:60:40 kg/ha) and farmyard manure (FYM) at 10t/ha (similar to compost dose) treatment were also kept for comparison. In general, the performance of rice under MNFC composts was superior to MEC composts. The results revealed that the grain yield of rice with rice straw MNFC compost and *Eupatorium* MNFC compost were 5% and 3% higher than recommended NPK, respectively.
The nutrient uptake and post-harvest soil fertility status were also significantly higher under these treatments compared to recommend NPK. In the present study, although the increments in grain yield of rice with various composts were not much during two years experimentation, substantial improvement in soil fertility in terms of available NPK was observed.

228

Kumar Pramod, Madhuri Pant and GCS Negi (2009). "Soil physicochemical properties and crop yield improvement following Lantana mulching and reduced tillage in rainfed croplands in the Indian Himalayan mountains." *Journal of Sust Agri* 33, no. 6: 636-657.

In the rainfed crop fields of the Central Himalayan Mountains in India, low soil moisture and low soil fertility are the two major constraints on crop yield. Therefore, an experiment was conducted to test the hypothesis of whether mixing a high-quality (high foliar N, P, and K and low lignin) organic residue (*Lantana camara* leaves) with the relatively low-quality leaf litter of oak (*Quercus leucotrichophora*) and pine (*Pinus roxburghii*) forests, and then mulching the organic residue, would enhance the rate of organic residue decomposition and nutrient release to contribute to the soil fertility and crop yield of wheat and paddy in rainfed crop fields. To achieve the study objectives, *Lantana* residue was mixed with oak and pine leaf litter in four different proportions and applied under three tillage frequencies in 36 experimental plots in a completely randomized block design. These four mulch combinations were also studied for dry matter decomposition and nutrient release pattern.

Results showed that both the decomposition rate (k = 1.86/yr) and rate of nutrient release from decomposing litter (N = 0.208 mg $d^{˝1}$ and P = 0.042 mg/d) for *Lantana* residue were much higher than the other litter combinations. Mixing *Lantana* with other mulch materials positively influenced the decomposition and nutrient release of otherwise slow decomposing oak and pine leaf litter. The 100% *Lantana* mulched plots recorded substantially higher soil moisture among the four mulching treatments. The 100% *Lantana* mulched plots also recorded significantly higher soil nutrients (NO_3^+-N and $PO_4^{˝}$-P under wheat and NH_4^+-N under rice crops) and rate of Nmineralization, and produced significantly higher wheat grain (920 to 1309 kg/ha) and wheat and rice straw yield than the conventional practice of crop cultivation. *Lantana* residue thus proved to be a potential mulch to achieve soil moisture conservation, soil fertility enhancement, and higher crop yields in the region.

229

Suthar Surindra. (2009). "Earthworm communities a bioindicator of arable land management practices: A case study in semiarid region of India." *Ecological indicators* 9, no. 3: 588-594.

The abundances and activities of earthworms in arable lands depend strongly on management practices and; therefore earthworm can act as a potential bioindicator of land use practices. In this study earthworm diversity and abundances was measured in three differently managed agro-ecosystems i.e. conventional, integrated and organic, in some sites of northern semiarid region of India. The maximal numbers of earthworm occurrence were in integrated farming system (100%, all studied sites showed the presence) followed by organically managed (70%) and conventional (18.9%) agroecosystems. A total of six species belonging to four different families were identified during this survey and all recorded earthworm species were present in organically managed agro-ecosystems, while integrated and conventional arable lands exhibited only three earthworm species. The abundance of earthworms in arable system was also directly related to the management practices. The values of ecological indices e.g. Shannon diversity (*H*2), species dominance (*C*), the species richness (*S*) and evenness (*E*) indicated the anthropogenic pressure on earthworm communities in arable lands of northern India.

230

Ravishankar, H., G. Karunakaran, and S. Hazarika. (2008). "Nutrient Availability and Biochemical Properties in Soil as Influenced by Organic Farming of Papaya under Coorg Region of Karnataka." In *II International Symposium on Papaya 851*: 419-424.

In the recent years, papaya cultivation in India has become more popular because of its high yield and nutritive qualities. There also have emerged niche markets for organically produced fruits especially in the urban areas. Keeping in view the emerging trend, a study was conducted at Central Horticultural Experiment Station (IIHR) during 2004-07 in order to organize modules for sustainable production of organic papaya var. 'Coorg Honey Dew' under Coorg region of Karnataka, India. In this study, the effects of seven different treatments viz., recommended dose of NPK fertilizers (250:250:500 g NPK $plant^{-1}$ $year^{-1}$ as check (T_1); FYM 20 kg/plant (T_2), urban compost 13.5 kg/plant (T_3), sun hemp 25 kg/plant (T_4), sun hemp 40 kg/plant+rock phosphate 300 g/plant (T_5), neem cake 4 kg wood ash 2.5 kg/ plant (T_6) and rural compost 35 kg/plant (T_7) applied to 'Coorg Honey Dew' papaya crop were studied on nutrient availability, microbial population and enzyme activities in sandy loam soil in a field experiment laid out in randomized block design with three replications. Soil analysis after three years of study indicated no significant effect of treatments on the status of available P and K and the pH of the soil. Organic matter content in soil was significantly influenced by different treatments with the highest values recorded under T_2 and T_3 treatments. Soils under different organic modules had significantly higher microbial population (bacteria, fungi and actinomycetes) and activities of urease, phosphatase, dehydrogenase and cellulases as compared to that under recommended dose of fertilizers (T_1). Significant positive association between organic matter status, microbial populations and enzyme activities in soil was recorded. Application of FYM 20 kg/plant (T_2) was the best organic module with regard to higher microbial populations and enzyme activities in soil.

231

Deshmukh RS, NA Patil and TD Nikam. (2008): "Influence Of Kunapajala Treatment From Vrikshyaurveda On The Fruits Of Tomato Under Organic Farming Condition And Its Comparision With NPK Farming." *Bioscience Discovery*. Vol. 3(2): 200-206

Kunapajala is a liquid manure of antiquity suggested in *Vrikshayurveda*. It is a fermentation product of easily available ingredients and it can be used for any plant at any growth stage. Experiments were conducted in PG Research Centre, Tuljaram Chaturchand College, Baramati, Dist-Pune (M.S.) India, using pot culture for N.P.K (N = 11g/plant, P= 21.5 g/plant and K= 4.5 g/plant respectively) and *kunapajala* treatment (5 times at interval of 10 days). *Kunapajala* treatment was found to be more effective for inducing early flowering and enhancing fruiting period, size, fresh weight and shelf life of fruit and weight of seeds as compared to N.P.K. farming. Analysis of nutritional value showed that *kunapajala* had upper hand, followed by N. P. K. farming in terms of total solids, fiber content, lycopene, ascorbic acid, carotenoids, soluble proteins, total carbohydrates and proline. It is interesting to know that the antioxidant property of tomato fruit was highest in the plants treated with *kunapajala.* The activity of oxidative enzymes like peroxidase and polyphenol oxidase was also highest (70 % and 78 %), followed by N.P.K. farming (36 % and 65 %) respectively but caloric value of *kunapajala* treated tomato fruits was lower (13 %) which is important from diet point of view for diabetic patients. So, it can be concluded that *kunapajala* treatment is superior to increase the reproductive growth, nutritional value and yield of tomato fruits along with enhancement in antioxidant property as compared to N.P.K. farming, which is very significant from both economic and health point of view.

232

Sharma OP, Garg DK, Trivedi TP, Satpal Chahar, Singh SP (2008). Evaluation of pest management strategies in organic and conventional Taraori Basmati rice (Oryza sativa) farming system. *The Indian Journal of Agricultural Science*. Vol. 78 (10).

Integrated pest management (IPM) strategies based on scientifically proven components in organic fields were found to be more effective and sustainable in comparison to indigenous traditional knowledge (ITK)-based and conventional chemical-based strategies. Significant differences in incidence of key insect pests and diseases showed effectiveness of microbial and botanical pesticides against their target organisms, especially for foliar diseases and leaf folder. The yield data indicated that farmers adopting IPM practices were able to get higher yield and better cost:benefit (C:B) ratio (3.29 tonnes/ha, 1:4.58 and 3.16 tonnes/ha, 1:5.63) in comparison to ITK (3.05 tonnes/ha, 1:4.12 and 2.85 tonnes/ha, 1:4.36) as well as conventional chemical-based farmers' practice (3.12 tonnes/ha 1:3.83 and 3.09 tonnes/ ha, 1:4.45) during 2005–06 rainy (kharif) season. Quantification of soil (organic carbon) and environmental benefits and impact of IPM practices were quite encouraging in contrast to conventional farms. The IPM resulted in better conservation of natural enemies as evident from the presence of numerous predators and parasitoids, like spiders, crickets (egg predators), damselflies, ants, beetles, wasps and mermithids.

233

Shukla SK, RL Yadav, Archna Suman and PN Singh. (2008). "Improving rhizospheric environment and sugarcane ratoon yield through bioagents amended farm yard manure in *udic ustochrept* soil." *Soil and Tillage Research* 99, no. 2: 158-168.

A field experiment was conducted for two crop cycles during 2003–2005 and 2004–2006 at the Indian Institute of Sugarcane Research, Lucknow in subtropical India. *Trichoderma viride* and *Gluconacetobacter diazotrophicus* amended farm yard manure (FYM) increased organic carbon (19.44 Mg/ha) and available nitrogen (260 kg N/ha) content of soil from 14.78 Mg/ha (OC) and 204 kg N/ha observed under farmer's practice (sole N application). Application of bioagents amended FYM improved soil porosity and reduced compaction (bulk density—1.39 Mg m^{-3} over 1.48 Mg m^{-3} under farmer's practice). Sugarcane ratoon crop removed the highest amount of nitrogen (N—165.7 kg/ha), phosphorus (P—24.01 kg/ha) and potassium (K—200.5 kg/ ha) in the plots receiving FYM with *Trichoderma* and *Gluconacetobacter*. Inoculation of FYM with bioagents improved the population of ammonifying and nitrifying bacteria in the soil. Phosphorus and potassium uptake of the crop was greatest in the plots receiving FYM, *Trichoderma* and *Gluconacetobacter*. Bioagents (*Trichoderma* and *Gluconacetobacter*) amended FYM increased ratoon cane (70.2 Mg/ha) and sugar yields (7.93 Mg/ha) compared with control (62.3 and 7.06 Mg/ha ratoon cane and sugar yields, respectively).

234

Masto RE, PK Chhonkar, D Singh and AK Patra. (2008). Alternative soil quality indices for evaluating the effect of intensive cropping, fertilisation and manuring for 31 years in the semi-arid soils of India. *Environ. Monit. Assess.* 136: 419-435.

Soil quality assessment provides a tool for evaluating the sustainability of alternative soil management practices. Our objective was to develop the most sensitive soil quality index for evaluating fertilizer, farmyard manure (FYM), and crop management practices on a semiarid Inceptisol in India. Soil indicators and crop yield data from a long-term (31 years) fertilizer, manure, and crop rotation (maize, wheat, cowpea, pearl millet) study at the Indian Agricultural Research Institute (IARI) near New Delhi were used. Plots receiving optimum NPK, super optimum NPK and optimum NPK+FYM had better values for all the parameters analyzed. Biological, chemical, and physical soil quality indicator data were transformed into scores (0 to 1) using both linear and non-linear scoring functions, and combined into soil quality indices using unscreened transformations, regression equation, or principal component analysis (PCA). Long-term application of optimum inorganic fertilizers (NPK) resulted in higher soil quality ratings for all methods, although the highest values were obtained for treatment, which included FYM. Correlations between wheat (*Triticum aestivum* L.) yield and the various soil quality indices showed the best relationship (highest r) between yield and a PCA-derived SQI. Differences in SQI values suggest that the control (no NPK, no manure) and N only treatments were degrading, while soils receiving animal manure (FYM) or super optimum NPK fertilizer had the best soil quality, respectively. Lower ratings associated with the N only and NP treatments suggest that one of the most common soil management practices in India may not be sustainable. A framework for soil quality assessment is proposed.

235

Chakraborty, Debashis, Shantha Nagarajan, Pramila Aggarwal, V. K. Gupta, R. K. Tomar, R. N. Garg, R. N. Sahoo et al. (2008). "Effect of mulching on soil and plant water status, and the growth and yield of wheat (*Triticum aestivum* L.) in a semi-arid environment." *Agricultural water management* 95, no. 12: 1323-1334.

Mulching is one of the important agronomic practices in conserving the soil moisture and modifying the soil physical environment. Wheat, the second most important cereal crop in India, is sensitive to soil moisture stress. Field experiments were conducted during winter seasons of 2004–2005 and 2005– 2006 in a sandy loam soil to evaluate the soil and plant water status in wheat under synthetic (transparent and black polyethylene) and organic (rice husk) mulches with limited irrigation and compared with adequate irrigation with no mulch (conventional practices by the farmers). Though all the mulch treatments improved the soil moisture status, rice husk was found to be superior in maintaining optimum soil moisture condition for crop use. The residual soil moisture was also minimum, indicating effective utilization of moisture by the crop under RH. The plant water status, as evaluated by relative water content and leaf water potential were favourable under RH. Specific leaf weight, root length density and dry biomass were also greater in this treatment. Optimum soil and canopy thermal environment of wheat with limited fluctuations were observed under RH, even during dry periods. This produced comparable yield with less water use, enhancing the water use efficiency. Therefore, it may be concluded that under limited irrigation condition, RH mulching will be beneficial for wheat as it is able to maintain better soil and plant water status, leading to higher grain yield and enhanced water use efficiency.

236

Briar Shabeg S, Parwinder S Grewal, Nethi Somasekhar, D Stinner and Sally A Miller. (2007). "Soil nematode community, organic matter, microbial biomass and nitrogen dynamics in field plots transitioning from conventional to organic management." *Applied Soil Ecology* 37, no. 3: 256-266.

Dynamics of soil bulk density, organic matter, microbial biomass, nitrogen, and nematode communities were assessed for a period of 4 years in field plots transitioning from conventional to organic farming practices. A rotation of soybeans, corn, oats and hay was used as an organic transitioning strategy and the conventional farming system had a corn and soybean rotation for comparison. Organic corn received raw straw pack beef manure and poultry compost at the rate of 27 and 28 Mg/h, respectively, and organic oats received raw straw pack beef manure and poultry compost at the rate of 18 and 1.8 Mg/h, respectively, while conventional plots received synthetic fertilizers. All crops in the organic system received primary tillage (chisel plow, disked and tined) whereas only corn received primary tillage in the conventional system but soybeans were no-till. Weed control was mechanical (twice diskings, rotary hoeings and row cultivation) in the organic system whereas herbicides were used in the conventional system. Soil bulk density did not differ in the two systems over a 4-year period but organic farming had slightly higher organic matter, mineral associated organic matter and particulate organic matter. Conventional system had more N in the mineral pools as indicated by higher NO_3^--N whereas organic system had higher N in the microbial biomass indicating shifts in nitrogen pools between the two systems. Bacterivore nematodes were more abundant in the organic than the conventional system for most of the study period. In contrast, the conventional system had significantly higher populations of the root lesion nematode, *Pratylenchus crenatus*, than the organic system after completion of the rotation cycle (transition period) in spring 2004. The organic hay plots had the lowest populations of *P. crenatus* compared to corn, soybeans and oats. Nematode faunal profile estimates showed that the food webs were highly enriched and moderately to highly structured and the decomposition channels were bacterial in both systems. The lack of differences in structure index between the organic and conventional systems is probably due to the excessive tillage in the organic farming system, which may have prevented the build up of tillage-sensitive omnivorous and predatory nematodes that contribute to the structure index. We conclude that transition from conventional to organic farming can increase soil microbial biomass-N and populations of beneficial bacterivore nematodes while simultaneously reducing the populations of predominant plant-parasitic nematode, *P. crenatus*. Our findings also underscore the potential benefits of reducing tillage for the development of a more mature soil food web.

237

Singh Gurmeet, MS Brar and SS Malhi. (2007). "Decontamination of chromium by farm yard manure application in spinach grown in two texturally different Cr-contaminated soils." *Journal of plant nutrition* 30, no. 2: 289-308.

Chromium (Cr) is an environmental pollutant and its accumulation up to toxic levels in the soil and plants by applying irrigation with untreated industrial effluents has become a major problem throughout the world, especially in developing countries like India. Various inorganic as well as organic compounds are known for their ability to reduce mobilization of heavy metals in soils for plant uptake and leaching to ground water. The present study was undertaken under controlled glasshouse conditions to assess the effectiveness of farm yard manure (FYM) applications (equivalent to 0, 1, and 2% organic matter on w/w basis) to ameliorate Cr toxicity in spinach grown in two texturally different soils (silty loam and sandy) contaminated artificially with five levels of Cr (0, 1.25, 2.5, 5.0, and 10.0 mg Cr kg^{-1} soil as $K_2Cr_2O_7$). The diethylene triamine pentaacetic acid (DTPA)-extractable Cr in soil (before seeding and after harvest), Cr concentration, and its uptake by shoots and roots of spinach increased with increasing level of applied Cr. Roots accumulated more Cr than shoots, which depicts limited translocation of Cr from roots to shoots. A significant decrease was observed in dry matter yield (DMY) of shoots as well as roots by raising levels of applied Cr (0 to 10 mg Cr kg^{-1} soil) in both soils, but the extent of the DMY decrease was higher in the sandy loam soil. Application of FYM showed mitigating effects on Cr toxicity. The DMY was higher in the presence of FYM, than its absence, at all rates of applied Cr in both soils. The FYM application caused decline in the DTPA-extractable Cr in soil, and concentration of Cr and its uptake by shoots and roots of spinach at a given level of applied Cr. The magnitude of Cr toxicity and its amelioration by FYM application was higher in sandy soil compared to silty loam soil. The results of this study indicated that FYM application to the soil could be used as an effective measure for reducing Cr toxicity to crop plants in Crcontaminated soils irrigated by untreated industrial effluents.

238

Kshirsagar K G (2006). Impact of organic sugarcane farming on economics and water use efficiency in Maharashtra. Gokhale Institute of Politics and Economics. Working Paper 15.

This study examines the impact of organic farming on economics and water use efficiency in sugarcane cultivation in Maharashtra. The study is based on primary data collected from both certified organic sugarcane (OS) and inorganic sugarcane (IS) growing sample farmers in the water scarce and groundwater dependent district of Jalgaon in Maharashtra. The study finds that OS cultivation increases human labour employment by 20.2% and its overall cost of cultivation is also lower by 14.67% than IS farming. Although the yield from OS is 6.2% lower than the conventional crop, it is more than compensated by the price premium received and yield stability observed on OS farms. The OS farming gives 15.72% higher profits and profits are also more stable on OS farms than the IS farms thereby enhancing the economic well-being of OS farmers. Crucially, OS farming substantially enhances the water use efficiency (WUE) measured by different indicators. Thus, OS farming offers ample opportunities for enhancing farmers' income and improving water use efficiency in the cultivation of a highly water-consumptive and important sugarcane crop in the state. Finally, the paper discusses the emerging issues and outlines the task ahead for advancing OS farming in Maharashtra. *www.gipe.ac.in/pdfs/working%20papers/wp15.pdf*

239

Hamza, S. (2006). "Effect of Organic Farming on Soil Quality, Nutrient Uptake, Yield and Quality of Indian Spice." In *The 18th World Congress of Soil Science*. July 9-15, 2006, Philadelphia, USA

Organic Farming (OF) is expanding globally due to increased consumer interest, environmental protection and EU polices. Global trade in organically produced products in 2003 is estimated at US $26 billion and is projected to increase $102 billion by 2020, due to increasing demand in Europe, USA, Japan and Australia. In India attention is being received in Organic agriculture particularly in spices. The project organic farming in spices was conceptualized in 1992 and implemented at IISR and tested in the farmer's fields over a decade. The objectives were to study the best organic fertilizers (plant residues-compost/vermicompost, animal manures/de-oiled cakes that contains nutrients in complex organic forms, bio-fertilizers), its impact on soil quality, quality of major tropical spices and its economics in important spice crops under humid tropical conditions of South India. Soil characteristic, plant analysis, and quality were determined by following standard procedures. The results of the green house and field experiments conducted are discussed. In black pepper the effect of commercial organic manures was evaluated (based on their nutrient equivalents) and compared with NPK chemical fertilizers and farmers practice. The study was taken under green house condition (1993-'96) in CBD design. Investigations revealed that irrespective of the sources, application of organics increased the soil pH, nutrient availability in the soil and crop uptake. Poultry manure followed by goat manure was significantly superior with regard to yield, nutrient uptake, and enhanced piperine and oleoresin content of black pepper. On farm trails conducted in the 51 farmer's holdings in 30,000 vines for five years corroborated the findings. The OF technology was further extended in farmer's fields in three important black pepper growing States of South India viz., Kerala, Karnataka and Tamil Nadu during 2000- '03. Liming acid soils @ half the lime requirement of the soil enhanced the microbial population, nutrient availability, and dehydrogenase enzyme activity. Application of the recommended dose of N as organic (FYM + de-oiled cakes-neem (Azadirachta / pea-nut, P as phosphate rock + bone meal and K as wood ash, in conjunction with bio-fertilizers (Azospirillum and Phosphobacteria each applied @ 40kg per ha per year enhanced the spiking intensity of the vine, yield and nutrient uptake. The FYM application significantly decreased the bulk density irrespective of the soils. Soil quality indicators tested were positively correlated ($p<0.005$) with yield. Among the soil quality attributes, organic carbon and CEC are most discriminating attributes in all the three locations. The soil organic matter and CEC contributed substantially to the ability of the soil to accept, hold, and release nutrients to pepper vines. Adoption of OF was effective in the biomanagement of the Phytophthora disease incidence to around two per cent over the years against 10 percent in the control. Black pepper qualityvolatile oil, oleoresins, boldness of pepper corn (>4 mm diameter) were increased due to OF. Field studies in Cardamom has shown that application of recommended NPK nutrients as organic fertilizers (50 per cent N each as FYM and neem cake + 50 per cent P each as bone meal and phosphate rock + 50 per cent K as wood ash) were effective in increasing the yield and quality of cardamom. Field experiments (1992-95) conducted in ginger and turmeric, using six de-oiled organic cakes in comparison with the recommended FYM and NPK fertilizers showed that in general application of cakes increased not only soil nutrient availability, but also nutrient uptake. Organic cakes enhanced the water holding capacity and reduced soil bulk density. In ginger, among the cakes, pea-nut registered maximum organic C, Bray-P and exchangeable K in the soil and registered maximum dry recovery (4077 kg ha-1). This was followed by neem, cotton, NPK fertilizer. Neem cake registered highest oleoresin production (320 kg ha-1) of ginger. Neem cake was effective in the bio-management of rhizome rot disease incidence in ginger to 5%. In turmeric increased yield and curcumin recovery were observed due to organic OF. Residual effect of organic fertilizers was conspicuous in the successive second crop of turmeric. In Vanilla soil application of organic fertilizers (50 per cent N as FYM/vermicompost + 50 per cent N as de-oiled cakes+ 50 per P as bone meal + 50 per cent K as wood ash+ bio-fertilizers) were effective compared to recommended inorganic NPK fertilizers in increasing the yield and quality of the beans. Pilot study conducted (2001-04) in the high ranges of Western Ghat in the growing of *Garcinia indica* in Wayanad district (Kerala) and clove and nutmeg in Maramalai/ Mahandragiri hill areas in kanyakumari district (Tamil Nadu) revealed that Garcinia is grown as a self sown crop in traditional farming and can be claimed as default organic. Similarly nutmeg and clove grown in the region by following traditional/indigenous agriculture by applying FYM and without any synthetic chemical fertilizers and/or pesticides calls for characterizing the cultivation practices on the lines of national standards for organic production. It can be concluded that organic fertilizers play a significant role in improving soil and crop quality and sustainability. There is, however 10-20 per cent reduction in crop yield that should be compensated by premium pricing of organic produce.

240

Ashwini Krishna M and Kandikere R Sridhar. (2006). "Seasonal abundance and activity of pill millipedes (*Arthrosphaera magna*) in mixed plantation and semi-evergreen forest of southern India." *Acta Oecologica* 29, no. 1: 27-32.

Seasonal occurrence and activity of endemic pill millipedes (*Arthrosphaera magna*) were examined in organically managed mixed plantation and semievergreen forest reserve in southwest India between November 1996 and September 1998. Abundance and biomass of millipedes were highest in both habitats during monsoon season. Soil moisture, conductivity, organic carbon, phosphate, potassium, calcium and magnesium were higher in plantation than in forest. Millipede abundance and biomass were about 12 and 7 times higher in plantation than in forest, respectively ($P<0.001$). Their biomass increased during post-monsoon, summer and monsoon in the plantation ($P<0.001$), but not in forest ($P>0.05$). Millipede abundance and biomass were positively correlated with rainfall ($P=0.01$). Besides rainfall, millipedes in plantation were positively correlated with soil moisture as well as temperature ($P=0.001$). Among the associated fauna with pill millipedes, earthworms rank first followed by soil bugs in both habitats. Since pill millipedes are sensitive to narrow ecological changes, the organic farming strategies followed in mixed plantation and commonly practiced in South India seem not deleterious for the endangered pill millipedes *Arthrosphaera* and reduce the risk of local extinctions.

241

Pandian P Saravana, S Subramanian, P Paramasivam and K Kumaraswamy. (2005). "Organic farming in sustaining soil health- A Review." *Agricultural Reviews-Agricultural Research Communications Centre India* 26, no. 2: 141.

Every one expects development without destruction but unfortunately very often it happens the other way. In the anxiety of increasing food production for ever increasing population of the country for the last 50 years, least attention was given to ecological agriculture. We have been able to keep pace with population and our achievement is in no way small as the production has increased from around 50 to 220 million tonnes by 2000
A.D. However the danger signals have started sooner than expected. Many of our highly productive soils are showing signs of declining productivity. One of the major causes for decline in the productivity of the soils is due to low organic matter content. Wherever the fertilizers has been continuously used without adequate supply of organic manure the decline is faster in addition to creating new problems of insect pests and diseases. To reverse this trend, one of the possible means is to go to organic agriculture. Organic agriculture comprises all those technologies involving using local resources and inputs and preventing losses at every stage, adopting technologies that are ecologically sound and economically sustainable. first and foremost in organic agriculture is to rectify the soil condition to improve the productivity and sustainability. Increasing biomass, pooling all the organic wastes, including agricultural and animal excrete enriching and applying it at right time.

242

Kang GS, V Beri, BS Sidhu and OP Rupela. (2005). "A new index to assess soil quality and sustainability of wheat-based cropping systems." *Biol and Fert of Soils* 41(6): 389-398.

Sustainability index was calculated to assess soil quality under the influence of different fertilizer management practices. It is based on the area of the triangle in which nutrient index, microbial index and crop index of soil represented the three vertices of a triangle. Nutrient index reflected the nutrient status of soil and was calculated from the measurements of various soil chemical parameters. Microbial index was calculated by determining various soil microbial and biochemical activities and crop index by measuring of crop yield parameters. Eighteen soil indicators were determined to assess nutrient index, microbial index and crop index in order to compare the effect of different sources of nutrients such as green manure, farmyard manure and chemical fertilizer in a rice/corn–wheat rotation. The indices were applied to assess the sustainability of five field experiments with respect to the different fertilizer treatments. The long-term application of organic manures in rice/corn–wheat cropping system increased the index value because it increased the nutrient index, microbial index and crop index of soils. The use of only chemical fertilizers in the rice–wheat cropping system resulted in poor soil microbial index and crop index. In corn–wheat system, additional application of FYM at 10 t/ha before sowing corn made the system more sustainable than application of 100%NPK; the sustainability index values were 2.43 (the highest for this system) and 0.93, respectively.

243

Krishnakumar S, Saravanan A, Natarajan SK, Veerabadran V and Mani S (2005). Microbial population and enzymatic activity as influenced by organic farming. *Research Journal of Agriculture and Biological Sciences*. Vol. 1(1). 85-88

The effect of organic farming with various sources of organic manures and their combinations on soil biological fertility the experiment was conducted during July to October 2003. The recommended dose of NPK fertilizer was 90: 40: 40 kg ha and recommended dose of 90 kg N ha substituted through organics viz., FYM, *Sesbania rostrata*, composted coirpith alone and in combination with neem cake and Azolla. The microbial population viz., bacteria, fungi and actinomycetes conspicuously increased with application of different organic N sources compared to the control. Among the organic N sources, application of FYM + neem cake registered maximum population of bacteria (38.6 CFU g), fungi (15.2 CFU g) and actinomycetes (12.2 CFU g). Higher urease and dehydrogenase activities were observed with the application of FYM+neem cake. The value in*Kharif* 0.65, 6.1and *Rabi* was 0.76, 6.4 respectively whereas the phosphatase activity was more in FYM+neem cake+Azolla during *Kharif* was 7.4 and *Rabi* season it was 7.7 over control treatment.

244

Blaise D, JV Singh, AN Bonde, KU Tekale and CD Mayee. (2005). "Effects of farmyard manure and fertilizers on yield, fibre quality and nutrient balance of rainfed cotton (*Gossypium hirsutum*)." *Bioresource technology* 96, no. 3: 345-349.

Two-year field experiments were conducted to evaluate the effect of fertilizer with or without farmyard manure (FYM) application on cotton productivity and fibre quality. A partial nutrient balance was calculated by the difference method (nutrient applied—crop removal). Seed cotton yield was improved with addition of FYM (5 MT/ha). Application of both N and P resulted in significant improvements in seed cotton yield than the control and without N plots (PK). Uniformity ratio and ginning outturn (GOT) was greater in the FYM amended plots than the plots without FYM. Nitrogen and P balance was positive in the fertilizer-N and P applied plots whereas K balance was negative in spite of the addition of fertilizer-K. Potassium balance was positive only when FYM was applied. These studies suggest that it is advantageous to apply FYM as it improves fibre yield by way of improved GOT and maintains a positive nutrient balance.

245

Bhargava Harsh and S Rangarajan. (2005). "Organic Farming in India: A Fad or Environmental Necessity?" *The IUP Journal of Agricultural Economics* 2, no. 4: 71-82.

This paper mainly focuses on certain problems like the consequences of organic farming and four common myths associated with organic farming. The authors also discuss the well-known side effects in organic farming on soil, water, biodiversity and health. This paper also analyzes the impact of organic farming on sustainability issues concerning ecological, social and economic balance. Further, the authors assess the global perspective including land area in different countries across the globe under organic management. The paper also brings out the reasons for cost disadvantage in organic farming and the methods to overcome this problem. In this perspective, this study briefly discusses the international market for organic food products. The authors conclude that organic farming is indeed an environmental necessity for sustenance of our planet.

246

Blaise D, TR Rupa and AN Bonde. (2004). "Effect of organic and modern method of cotton cultivation on soil nutrient status." *Communications in soil science and plant analysis* 35, no. 9-10: 1247-1261.

The main objective of the study was to assess the soil nutrient status of two cotton (Gossypium hirsutum L.) cultivation systems (organic and modern method of cultivation) established in 1994. In general, the data indicate a depletion of the nutrient status with depth (0-0.1, 0.1-0.2, 0.2-0.3, 0.3-0.6, and 0.6-0.9 m). There was a significant build up of organic carbon (C) and nutrients, except iron (Fe) and magnesium (Mg), in the organic cultivation system (OCS) compared to the modern method of cultivation (MMC). Most of the accumulation was noticed in the top 0-0.3 m. The concentration of the mobile nutrient NO3 (-) was significantly greater in the surface as well as in the deeper layers of the OCS plots than the MMC plots. Extractable P was 3.8-fold greater in the OCS than MMC plot in the top 0.1 m soil layer. At 0.3-0.6 m soil depth, it was 3-fold greater. Other immobile nutrients such as zinc (Zn), Fe, manganese (Mn), and copper (Cu) were also significantly greater in the 0.3-0.6 m depth in the OCS plots compared to the MMC plots possibly due to movement of enriched topsoil through the cracks following cultivations.

247

Singh SB (2004). "Comparative Response of Organic and Fertilizer Source of Nutrients to *Terminalia arjuna* in Waterlogged-Sodic Soil." *Indian Forester* 130, no. 8: 893-898.

A field experiment was conducted at Uppardaha village in Allahabad District of Uttar Pradesh, India to compare response of organic and fertilizer source of nutrients to *Terminalia arjuna*, planted on mound in waterlogged sodic soil. Four treatments applied with and without 10.0 g plant., BHC were (i) Control, (ii) 2.0 kg plant^{-1} farm yard manure, (iii) 50 g plant^{-1} each of NPK through urea, single superphosphate and muriate of potash and (iv) farm yard manure plus NPK as treatment 2&3, respectively. Experiment was conducted following Randomised Block Design in triplicate. Comparison of plant height recorded twice in a year under different treatments showed that farmyard manure had no response up to six months, started to maximize height after one year and resulted for significantly higher height after two years. Nutrients applied through urea, single super phosphate and muriate of potash resulted promising effect in the initial stage of growth but slowed down afterwards. After two and half years of treatment, maximum biomass was recorded in farmyard manure treated plants, which was followed by plants receiving farmyard manure plus fertilizers and fertilizers alone. Plants treated with farmyard manure showed maximum and control showed the minimum CBH and survival in plants. Application of BHC, though, increased survival and height of plants but difference in BHC treated and untreated plant was insignificant.

248

Ladha JK, Dawe D, Pathak H, Padre AT, Yadav RL, Singh B, et al. (2003). "How extensive are yield declines in long-term rice–wheat experiments in Asia?". *Field Crops Research, 81*, 159–180.

The rice–wheat cropping system, occupying 24 million hectares of the productive area in South Asia and China, is important for food security. Monitoring long-term changes in crop yields and identifying the factors associated with such changes are essential to maintain and/or improve crop productivity. Long-term experiments (LTE) provide these opportunities. We analyzed 33 rice–wheat LTE in the Indo-Gangetic Plains (IGP) of South Asia, non-IGP in India, and China to investigate the extent of yield stagnation or decline and identify possible causes of yield decline. In treatments where recommended rates of N, P and K were applied, yields of rice and wheat stagnated in 72 and 85% of the LTE, respectively, while 22 and 6% of the LTE showed a significant ($P<0.05$) declining trend for rice and wheat yields, respectively. In the rice–wheat system, particularly in the IGP, rice yields are declining more rapidly than wheat. The causes of yield decline are mostly location-specific but depletion of soil K seems to be a general cause. In over 90% of the LTE, the fertilizer K rates used were not sufficient to sustain a neutral K input–output balance. Depletion of soil C, N and Zn and reduced availability of P, delays in planting, decreases in solar radiation and increases in minimum temperatures are the other potential causes of yield decline. A more efficient, integrated strategy with detailed data collection is required to identify the specific causes of yield decline. Constant monitoring of LTEs and analysis of the data using improved statistical and simulation tools should be done to unravel the cause–effect relationships of productivity and sustainability of rice–wheat systems.

249

Sharma Pradeep K, JK Ladha, TS Verma, RM Bhagat and AT Padre. (2003). "Rice-wheat productivity and nutrient status in a lantana- (Lantana spp.) amended soil." *Biology and fertility of soils* 37, no. 2 : 108-114.

Imbalanced and inadequate use of chemical fertilizers is responsible for low rice- (*Oryza sativa* L.) wheat (*Triticum aestivum* L.) productivity in many resource-poor farmers' fields. Wheat yields in post-rice soils are also constrained due to soil conditions created by puddling in rice, especially in fine to medium textured soils. Organic amendments are known to improve soil productivity under rice-wheat cropping by way of improving physical conditions and nutrient status of the soil, but their availability is restricted. There is a need to identify locally available and cost-effective organic materials, which have minimal alternate uses as fodder and fuel. We evaluated lantana (*Lantana* spp. L.) residues, a fast-growing weed in nearby wastelands, as a potential soil organic amendment. Yield trends, and soil and crop nutrient status in a 12-year rice-wheat experiment at Palampur, India, involving four levels (0, 10, 20, and 30 Mg ha^{-1} $year^{-1}$ fresh mass) of lantana addition were investigated. Chopped lantana was incorporated into soil 10–15 days before puddling. Lantana additions at 10, 20 and 30 Mg ha^{1} increased rice yields on average by 18%, 23% and 30%, wheat yields by 11%, 14% and 20%, and total system productivity (rice + wheat) by 15%, 20% and 26% over controls, respectively, and at the same time saved NPK fertilizer. Linear regression analyses over 12 years did not show any change in yield trends of rice and wheat at P =0.05. Continuous cultivation of rice wheat significantly increased total C, labile C, and other C indices of soils. Total N, Olsen's P, and NH_4OAc-extractable K in the lantana-amended plots were higher than in the controls. Nutrient concentrations in crop biomass, however, remained generally unaffected by lantana treatments. Results suggest that lantana residues, which improved the nutrient status of soil and system yield, have the potential for resource conservation and sustaining rice-wheat productivity.

250

Bhagat, R. M., A. K. Bhardwaj, and Pradeep K. Sharma. (2003). "Long-term effect of residue management on soil physical properties, water use and yield of rice in North-Western India." *Journal of the Indian Society of Soil Science* 51, no. 2 : 111-117.

Destruction of aggregates and damage to soil structure during puddling for lowland rice cultivation makes it difficult to bring the soil back to its original condition during the following upland crop. Besides, this type of rice cultivation consumes an enormous amount of water, labour and energy. Field experiments were conducted at the experimental farm of Himachal Pradesh Agricultural University, Palampur, India (32°6' N, 76°3' E; altitude 1300 m above msl) for twelve years starting from the wet season of 1988 to study the effect of four levels of lantana (*Lantana camara* L.) residue incorporation [0 (M0), 10 (M1), 20 (M2) and 30 (M3) Mg ha^{-1} and three levels of nutrients on soil physical properties, water use and yield of rice. Soils of the study area are classified as Typic Hapludalf with pH 5.6, organic carbon 6.6 g kg^{-1} and cation exchange capacity 12 cmol(p^+)kg^{-1}. After twelve annual additions of lantana residue, water stable aggregates increased significantly (P= 0.05) at 20 and 30 Mg ha^{-1} levels compared to control. However, bulk density values decreased significantly with an accompanying increase in total porosity at all levels of lantana addition compared to control. The available water capacity increased by 3– 6 per cent by the addition of different levels of lantana. Resistance to penetration decreased with an increase in lantana addition, the energy required to plough different plots also decreased (5.14 to 2.98 GJ ha^{-1}) with the highest rate of lantana addition as compared to control. Addition of lantana @ 10, 20 and 30 Mg ha^{-1} increased rice yields by 17.5, 23.4 and 30 per cent, respectively, over control. The trend analysis indicated that the rice yields were maintained under control as well lantana-amended plots. Also, the improvement in physical properties would also favourably affect the succeeding upland wheat crop.

251

Singh RB. (2000). "Environmental consequences of agricultural development: a case study from the Green Revolution state of Haryana, India." *Agriculture, ecosystems & environment* 82, no. 1: 97-103.

The Green Revolution in India has achieved self-sufficiency in food production. However, in the state of Haryana this has resulted in continuous environmental degradation, particularly of soil, vegetation and water resources. Soil organic matter levels are declining and the use of chemical inputs is intensifying. Newly introduced crop varieties have been responsive to inputs but this has necessitated both increased fertiliser application and use of irrigation resulting in water contamination by nitrate and phosphate and changes in the ground water table. With 82% of the geographic area already under cultivation, the scope for increased productivity lies in further intensification which is crucially dependent on more energy-intensive inputs. Declining nutrient-use efficiency, physical and chemical degradation of soil, and inefficient water use have been limiting crop productivity, whilst the use of monocultures, mechanisation and an excessive reliance on chemical plant protection have reduced crop, plant and animal diversity in recent years. About 60% of the geographical area faces soil degradation (waterlogging, salinity and alkalinity) which threatens the region's food security in the future. Since 1985, the water table has risen more than 1 m annually, and patches of salinity have started to appear at the farm level. The situation is worse in higher rainfall areas where waterlogging follows shortly after the rains. Apart from affecting agricultural crops, a high water table causes floods even following slight rains due to the reduced storage capacity of the soil. Such ecological impacts are motivating farmers to reduce fertiliser and pesticides use. This has led to an increased investment in alternative technology and products including an interest in Integrated Pest Management. The paper discusses major physical, hydrological, chemical and biological constraints relating to soil and water resources for ecosystem sustainability.

252

Parasharya BM, JF Dodia, KL Mathew and DN Yadav. (1994). "Natural regulation of white grub (Holotrichia sp: Scarabidae) by birds in agroecosystem." *Journal of Biosciences* 19, no. 4: 381-389

The white grub (Holotrichia sp: Scarabidae) is an important subterranean pest damaging root systems of several crops. Experiments conducted during I985 and I986 showed that at least I4 species of birds picked up the grubs exposed during ploughing operation. The important bird predators were mynas Acridotheres tristis (Linnaeus) and Acridotheres ginginianus (Latham), crows Corvus splendens (Vieillot), Corvus macrorhynchos (Sykes), drongo Dicrurus adsimilis (Hodgson) and cattle egret Bubulcus ibis. The birds were found to reduce 45 to 65% grub population during 3 subsequent ploughings. The plant stand of second crop raised in bird exposed field was higher in experimental plot compared to the control. The number of birds attracted to the plough was not consistent with the density of grubs exposed but oh many extraneous factors. Factors affecting the extent of bird predation were presence of insectivorous birds in the surroundings, proximity to their breeding sites and timing of ploughing. White grub control by birds is economically cheaper and environmentally safe compared to the chemical control.

253

Nemes, Noémi. (2009). "Comparative analysis of organic and nonorganic farming systems: A critical assessment of farm profitability." *Natural Resources Management and Environment Department (Ed.) Department (Ed.), FAO, Rome*.

The last decades have seen a proliferation of economic studies that have compared the economic performance of organic and non-organic farming systems. Several criticisms were formulated questioning the validity of such comparisons, partly because of the inherent difference between the two systems (in terms of complexity, diversity and objectives other than yield maximization), and partly due to the difficulty in excluding 'non-system' determined factors that also have an influence on profitability. Furthermore, the adequate selection of a reference group for comparisons has proved to be fundamental for relative profitability: which organic farms are put on the profit measuring scale by researchers with which conventional farms The list of profitability studies compiled in this paper involve more than 50 different cases, mostly from U.S.A, where several universities started long-term experimental field studies in the eighties and from European countries. Just over a dozen shorter-term studies have been collected from developing countries on high-value export crops. Most studies have used a case-study approach selecting between five up to hundreds of farms for the collection of data on farms. The following main conclusions are evidenced by analysing the studies:

- The overwhelming majority of cases show that organic farms are more economically profitable, despite of frequent yield decrease;
- Organic crop yields are higher in cases of bio-physical stress (e.g. drought);
- The higher outcomes generated by organic agriculture are due to premium prices and predominantly lower production costs;
- The different value and accountability given to labour costs, including both hired and family labour, differs through countries, thus yielding to opposite results;
- The major difference in the profitability of the two systems is very often determined by the different management skills of the farmers thus, accounting for these seem to be fundamental for correct interpretations of results;
- There is a wide range of discrepancies among studies related to what variable and fixed costs entail and without agreeing upon which input costs shall be included under which circumstances in economic studies, no clear-cut conclusion on profitability can be drawn when analysing available literature.

Nevertheless, the analysis of the compiled studies demonstrates that, in the majority of cases, organic systems are more profitable than non-organic systems. There are wide variations among yields and production costs, but either higher market price and premiums, or lower production costs, or the combination of these two generally result in higher relative profit in organic agriculture in developed countries. The same conclusion can be drawn from studies in developing countries but there, higher yields combined with high premiums are the underlying cause for higher relative profitability.

Finally, this paper draws attention to the fact that existing economic comparisons are heavily-biased because they do not internalize externalities nor account for the fact that nonorganic farms receive higher governmental support and better research and extension services. This paper argues that the profitability of a farming system must balance economic costs against environmental, social and health costs, as these costs have delayed impacts and indirect implications on farm economics.

254

Vanitha M, SR Radha and B Vijayakumari. (2014). "Herbals and biofertilizer as a nutrient supplement for improving biochemical parameters of cluster bean (Cyamopsis tetragonoloba L. Var. PNB)." *Journal of Natural Product & Plant Resources* 4, no. 1.

In India, agriculture forms main occupation of majority of the population. Organic manures such as Farm Yard Manure, green manure in the form of leaf extracts, etc. when incorporated into the soil not only add the nutrients such as nitrogen etc. but the soil is enriched by the fixation of the atmospheric nitrogen. An experiment was carried out with to assess the influence of herbals and biofertilizer on the biochemical parameters of cluster bean (*Cyamopsis tetragonoloba* L. Var. PNB). The experiment consisted of six treatments. A study was conducted to assess the effect of Herbals (*Vitex negundo*, *Curcuma longa, Acorus calamus, Ribes uva-crispa, Acalypha indica*, *Ocimum basilicum and Lantana camara*) and bio fertilizer (Rhizobium). The biochemical parameters like Protein, Chlorophyll, Carbohydrates and Ascorbic acid were tested on 30th, 45th, 60th and 75th day. The Herbals and biofertilizer were used to observe the change in biochemical parameters. The biochemical parameters of cluster bean were recorded on 30th, 45th, 60th and 75th day. After sowing Chlorophyll 'a', 'b' and 'total' chlorophyll were higher in biofertilizer treatment (T6) on all the days. The maximum protein content was shown on 30th day by T3 on 45th and 60th it was higher in T5 and on 75th it was higher in T6. The highest carbohydrates were found in T6 on 30 and 45 DAS (79.24 mg/g and 79.95 mg/g) on 60th. The highest carbohydrates content had been observed in T5 and on 75th in T6. The highest ascorbic acid content had been observed in T6 on 45th and 60th and 75th. Application of biofertilizer with herbals favoured the biochemicals of cluster bean.

255

Yadav SK, Subhash Babu, Yadav MK, Yogeshwar Singh, Kalyan Singh (2014). Profitability of high value crops with organic nitrogen sources under rice (Oryza sativa) cropping sequence. The Indian Journal of Agricultural Sciences. Vol. 84 (3).

A field experiment was conducted during 2005-06 and 2006-07 at Campus Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to identify a suitable high value cropping sequence with organic nitrogen sources under rice (Oryza sativa L.) based cropping system. The experiment was laid out in split plot design with three replications. Seven rice based cropping sequences, viz. rice-potato-onion; rice-green pea-onion; rice-potatocowpea (green pod); rice-green pea-cowpea; rice-rajmash (green pod)-onion; rice-rajmash-cowpea and rice-maize (green cob)-cowpea were assigned to main plots and three organic treatments (control; 100% RDN through organic manure along with biofertilizers and 100% RDN through organic manure alone) were allocated to sub plots. Among the cropping sequences, rice-potato-onion gave the highest rice grain equivalent yield (35.57 tonnes/ha), maximum net return (Rupees 268 656/ha), profitability (Rupees 738/ha/day) and labour employment generation (469 man days/ha/ year). However rice yield and soil fertility status was not significantly affected by cropping sequences. Application of 100% recommended dose of through organic manure along with biofertilizers (Azotobacter and PSB) had the highest rice equivalent grain yield (35.31 tonnes/ha), production efficiency (96.74 kg/ha/day), net monetary return (Rupees 292 454/ha), profitability (Rupees 803/ha/day) and labour employment generation (419 man days/ha/ year). Inclusion of pulses in sequence with proved superior due to its viable favorable effect on soil fertility. Thus organic nitrogen nutrition with biofertilizers had the highest rice equivalent grain yield, production efficiency, net monetary return and profitability.

256

Ranjana Verma, P Choudhary, R Modgil, YS Dhaliwal and Sanjay Chadha (2014). Nutritional quality evaluation of organically grown vis-à-vis conventionally grown broccoli (*Brassica oleracea).* Under Organic Production & Protection Inputs and Technologies. National Seminar on Organic Agriculture-Challenges and Prospects. CSKHPKV, Palampur. May 26-27, 2014.

Organically grown and labeled produce is considered to be healthier and nutritious than conventionally grown produce by the consumrs. An attempt was made to acertain the nutritional quality of organically and conventionally grown broccoli mainly in terms of macronutrients, vitamins, phytochemicals and minerals. Fresh and optimally mature organically grown broccoli (var Palam Samridhi) was procured from the Department of Organic Agriculture, CSK HPKV, Palampur and the same variety was grown conventionally using inorganic inputs. Results revealed that the dry matter content of organic broccoli was higher (13.11%) than that of conventionally grown broccoli (11.15%).

The crude protein, crude fat, ash and total carbohydrate contents of organically grown broccoli were higher and were to the tune of 4.28, 0.23, 2.25 and 6.25 respectively whereas, the corresponding values for conventionally grown broccoli were slightly lower and were 3.23, 0.19, 1.88 and 5.81 per cent respectively. The crude fiber, NDF, ADF and hemicullulose contents of organically grown broccoli were more when compared with inorganically grown broccoli. Similarly, the digestible and indigestible carbohydrate contents of organic broccoli were more when compared with inorganic broccoli. The total and available energy contents of organically grown broccoli were also slightly higher than those of inorganically grown counterparts. The ascorbic acide content of organic broccoli was 90.00 mg/ 100 g which was comparatively higher than that of inorganic broccoli (85.20 mg/100g). The values for total, reducing and non-reducing sugars of organic broccoli were also slightly higher when compared with conventionally grown broccoli. The total phenols, simple phenols and tannin contents were 1.03, 0.23, 0.08 and 1.33, 0.29, 0.13 mg GAE/100g for organic and inorganic broccoli respectively. The beta carotene content of organic broccoli (11.18 ppm) was slightly higher than conventionally grown broccoli (8.72 ppm). The chlorophyll content of inorganic broccoli was slightly higher and was to the tune of 5.90 mg/l when compared with organic broccoli where corresponding value was 4.91 mg/l. The flavonoid and oxalate contents of organic and inorganic broccoli were 10.79, 1.08 and 12.42, 1.55 mg/100 g, respectively. The calcium, magnesium, copper, zinc and iron content of organic and inorganic broccoli were 3.42, 2.43, 0.03, 0.35, 1.75 and 2.57, 1.68, 0.01, 0.35, 0.95 mg/100 g, respectively. The study concluded with the findings that in general the broccoli samples grown with organic inputs contained comparatively higher levels of dry matter, macronutrients, vitamins and minerals when compared to conventionally grown counterparts.

257

Nair, Chellappan Mohanakumaran, Krishna Rugmini Salin, Juliet Joseph, Bahuleyan Aneesh, Vaidhyanathan Geethalakshmi, and Michael Bernard New. (2014). "Organic rice–prawn farming yields 20% higher revenues." *Agronomy for Sustainable Development* 34, no. 3: 569-581.

Rice–prawn farming in Asian countries is a sustainable practice using less fertilizers. Organic farming of rice and giant river prawns in rotational crops was tested in the waterlogged paddy fields of Kuttanad, Kerala as part of the Indian Organic Aquaculture Project. Rice was cultivated during November to February, followed by a crop of freshwater prawns in the same field from March to September. Here, we study the production of four certified farms growing organic rice and organic prawns compared with four conventional farms growing rice and prawns in rotational crops. We evaluate the economic viability by cost-return and partial budgeting analysis. Our results show that farming rice organically reduced yields by 23 %, from 5,690 kg/ha in conventional farming compared to 4,376 kg/ha in organic farming. However, the organic prawn crop yield of 396 kg/ha was 10 % higher than the yield of the conventional system, of 360 kg/ha, although the differences were not significant. Furthermore, total investment for organic rice was approximately 20 % greater than for the non-organic rice crop. Total investment for organic prawns was 17 % greater than for the non-organic prawn crop. Net revenue was 11 % lower for organic rice than for conventional rice. Organic prawns realized 117 % higher net revenue than conventional prawns. Although organic rice farming realized lower returns than conventional, its combination with organic prawn farming enhanced net revenue by 20 % over conventional rice/conventional prawn production.

258

Abrol Dharam P, Uma Shankar. (2014). Pesticides, Food Safety and Integrated Pest Management." In *Integrated Pest Management*, pp. 167-199. Springer Netherlands

A rapidly growing human population has resulted in a demand for increased food production. In ancient times, traditional agriculture could meet human food needs when the size of human population was small. As human population grew, the demand for food increased, which was met by increasing the land area under cultivation. As the land resources became limited, efforts were made to increase productivity by fighting the losses inflicted by insects, weeds, and plant pathogens through the discovery of pesticides. At the same time, pesticides proved to be more dangerous due to their indiscriminate and excessive use, contaminating food (milk, honey, cereals, vegetables, and fruits) and the environment (ground water, soil, etc.), resulting in pest resistance, pest resurgence, and pest outbreaks. Consequently, the need arose for eco-friendly integrated pest management strategies to produce food safe from the negative impact of pesticide residues. The present chapter addresses information on the pesticide usage and their negative impacts on food safety leading to the development of integrated pest management (IPM). In this chapter, IPM for food safety through eco-friendly pesticides is discussed.

259

Suja G, J Sreekumar, K Susan John and S Sundaresan (2013). "Organic production of tuberous vegetables: Agronomic, nutritional and economic benefits." *Journal of Root Crops* 38, no. 2: 135.

Global awareness of health and environmental issues has stimulated interest in alternative agricultural systems like organic farming. Elephant foot yam (*Amorphophallus paeoniifolius*) and yams (*Dioscorea* spp.) are ethnic starchy vegetables with high energy, nutritive and medicinal values. Field experiments were conducted at the Central Tuber Crops Research Institute, Thiruvananthapuram, India, during 2004-2011 to assess the agronomic, nutritional and economic advantages of organic farming over conventional system in these crops. Organic farming resulted in 10-20% higher yield over conventional practice in these crops. A net profit of Rs 2,15,776 ha-1, which was 28% higher over chemical based farming was obtained under organic management in elephant foot yam. Elite and local varieties responded equally well to organic and conventional farming in elephant foot yam. White yam, greater yam and lesser yam responded similarly to both the systems, with slightly higher yield under organic practice. Soil physico-chemical properties and microbial count were also improved under organic management. Organic farming scored significantly higher soil quality index (1.93) than conventional practice (1.46). The soil quality index was driven by water holding capacity, pH and available Zn followed by soil organic matter. Tuber quality was improved with higher dry matter, starch, crude protein and lower oxalate contents. Cost effective technologies were field validated.

260

Padmavathy A and M Anbarasan. (2013). "Ethnobiology of unconcerned floras in organic and inorganic agricultural fieldsBahour, Puducherry-India." *Journal of Medicinal Plants Research* 7, no. 44: 3254-3262.

Agriculture is a very important sector in the world which includes and fulfills major human need and supports major life systems. Agriculture has to meet goals that include profitability and environmental integrity, and production of ecosystem services beyond food, fuel, and fiber requires a comprehensive, systems-level research approach that is a long-term and geographically scalable. Agricultural unconcerned plants like weeds plays a key role in bund stabilization and restoration, a part from this their unique important medicinal values remains unexplored to most of the people, thus results in total destruction and removal of them by weedicides. This communication addresses the composition and distribution of useful medicinal floras diversity in organic and inorganic agricultural fields; they were surveyed during March to December, 2010 by direct interviews with ethnic groups of farmers, native traditional healers, Ayurvedic practitioners and botanists dealing with medicinal wild plants. Results enumerated with a total of 52 species belonging to 25 families. Poaceae found to be most dominant family and majority of the medicinal plants were herbs. These floras were under constant anthropogenic pressure due to rapid elimination by using inorganic chemicals like weedicides and hebicides; as a result its associated indigenous knowledge with them is also gradually disappearing. Such biodiversity rich and useful ecosystems need immediate restoration and conservation actions.

261

Sudheer P. (2013). "Economics of organic versus chemical farming for three crops in Andhra Pradesh, India." *Journal of Organic Systems* 8, no. 2: 36-49.

To tackle the challenge of food grain production and food security, chemical agriculture advocates call for the continuing or higher use of chemical fertilizers and synthetic pesticides. However, the continuous use and higher reliance on these inputs can lead to a reduction in crop productivity, deterioration in the quality of natural resources and the eco-system. Organic farming offers a solution for sustainable agricultural growth and safeguarding the ecosystem. A conversion from chemical farming to organic farming can be a lengthy process, and during its course the farmer may incur a loss in income. The farmer will switch over only when he is convinced that in the long run, the benefits from organic farming are more than from chemical farming. A study of the economics of organic versus chemical farming may help policy makers to take appropriate measures for the spread of organic farming, which in turn has a bearing on the incomes of farmers, health conditions of the people and the environment. The present study compared the economics of organic farmers (N=350) and chemical farmers (N=200) for three crops, paddy, redgram, and groundnuts, in the state of Andhra Pradesh, a south eastern coastal state of India. It was found that organic farmers are earning a gross income of 5%, 10% and 7% more compared to the chemical farmers of paddy, redgram and groundnut, respectively, and with lower input costs the profits earned by the organic farmers are higher by 37%, 33% and 59% for the selected crops respectively. Organic farming is generally more profitable in terms of financial costs and returns than chemical farming, irrespective of the crop or the size of farm (the exceptions being small redgram farms and large goundnut farms). An analysis of the farmers' perception of organic farming reveals that electronic media (television) is the prime motivator for farmers to adopt organic practices.

Farmers believed that organic farming improves soil fertility and their profits in the long run.

262

Forster Cionys; Andres Christian; Rajeev Verma; Zundel Christine; Messmer Monika M and Mäder Paul. (2013). Productivity and Profitability of a Cotton-based Production System under Organic and Conventional Management in India. In: Tielkes, Eric (Ed.) *Tropentag 2013 - Agricultural development within the rural-urban continuum - Book of abstract*, p. 294.

The debate on the relative benefits of conventional and organic farming systems is more topical than ever. The achievements of conventional highinput agriculture were largely brought about at the cost of deteriorating soil fertility; furthermore, they were based to a large extent on fossil fuels. Developing more sustainable farming practices on a large scale is of utmost importance. However, information about the performance of agricultural production systems under organic and conventional management in tropical and subtropical regions is largely lacking. This study aimed to assess agronomic and economic data from a long-term farming systems comparison trial under semi-arid conditions in central India. Four two-year crop rotations comprising cotton-soybean-wheat under biodynamic, organic and conventional management were investigated, including one conventional system with and one without transgenic Bt cotton, between 2007 and 2010. Results showed 13% lower yields in organic compared to conventional systems. Yields in cotton, soybean and wheat were on average 14 %, 7% and 15% lower, respectively. However, production costs of organic systems were on average 32% lower than those of conventional systems, which led to similar gross margins in all systems. To our knowledge, this is the first long-term field trial comparing the agronomic and economic performance of organic, conventional and conventional+Bt cotton-based farming systems. The results of our study suggest that organic farming is a promising alternative to conventional farming in cotton-based production systems in central India. The less capital intensive nature of organic systems may be particularly interesting for smallholder farmers as it decreases dependence on loans for farm inputs. Therefore, our findings have the potential to be useful for decision-making and in turn may lead to a redirection of agricultural policies.

263

Ramakrishnappa V. (2012). "Economic and environmental aspects of organic paddy cultivation in India: A case study from Mysore district of Karnataka state." *Asian Journal of Development Matters* 6, no. 2: 271-281.

Modern agriculture is finding itself in increasing difficulties. The adverse impact of agriculture based on chemical fertilizers and pesticides is visible in the degradation of soil fertility, environmental damage, quality of food, taste of food and so on. People across global are becoming more conscious for their health and environment. Organic farming system largely excludes the use of synthetically compounded fertilizers and pesticides with aims to promote the sustainable health and productivity of the local ecosystem. There is dearth of information on organic paddy farming in India in general and in Karnataka in particular. Hence, the present study was conducted to analyse the economic and environmental issues in organic paddy cultivation. A sample of 40 farmers pursuing organic paddy farming was selected randomly for the study. The study was conducted in irrigation region of Mysore district. The results show that the farmers carried out organic farming in a relatively smaller proportion of their land holding. Respondents of the study were inclined to have favorable beliefs towards organic farming and practicing their own interest. The economic analysis shows that for every 100 rupees spent for organic paddy cultivation, an average farmer in the study area has obtained Rs. 25.43 as profit. The net income of the cultivation of paddy under organic system was found to be Rs. 2375.2 per acre. The results clearly indicate that the cultivation of paddy under organic farming is economically profitable. The respondents, by and large, revealed clean interest on organic farming in the study area. Therefore, government should make policies and provide financial support for farmers to promote organic farming,

264

Panneerselvam P, Niels Halberg, Mette Vaarst and John Erik Hermansen (2012). "Indian farmers' experience with and perceptions of organic farming." *Renewable Agriculture and Food Systems* 27, no. 02: 157-169.

In India, the number of farmers converting to organic farming has increased in the recent past despite the lack of government support in providing knowledge and extension to the farmers. The aim of this article is to investigate the perceived relevance, benefits and barriers to a conversion to organic agriculture in three different Indian contexts"in Tamil Nadu, Madhya Pradesh and Uttarakhand states. In each state, 40 farmers from both organic and conventional systems were interviewed. The findings indicated that conventional producers identified production and marketing barriers as the main constraints to adopting organic farming, while the age and education of the farmer were not deemed a problem. Lack of knowledge and lack of institutional support were other barriers to conversion. Some farmers were, however, interested in converting to organic farming in the near future in Madhya Pradesh due to the low cost of production, and in Tamil Nadu and Uttarakhand due to the price premium and health benefits. On the other hand, organic farmers were more concerned with health, environmental and production factors when institutional support was available. The years under conversion were positively associated with reduced input costs in all three states and with increased income in Tamil Nadu and increased yield in Madhya Pradesh. Both organic and conventional farmers found the two production factors, low yield and pest control, to be of major concern. However, organic farms in Madhya Pradesh and Uttarakhand experienced yield increases because most of the farms were in the post-conversion period, while the farms in Tamil Nadu were in the conversion period and experienced yield reduction. The study suggests that the government scheme for compensating yield loss during the conversion period and a price premium may help farmers adopt organic agriculture on a large scale in India.

265

Padmavathy A and G Poyyamoli. (2012). "Provisioning ecosystem services income extend comparison between organic and conventional agricultural fields in Puducherry-India." *Journal of Agricultural Extension and Rural Development* 4, no. 6: 120-128.

Agriculture supplies provisioning services-food, fodder, fuel, timber, medicine and ornamental in ecosystem service parlance. Management of ecosystem services is vital to maintain and improve the productivity of agricultural systems in order to meet the food demands of the growing human population. However, conventional management practices can severely reduce the ecological and financial contribution of agriculture, which in the longer term can offset the ability of farming to produce large amounts of commodities for more economic return. In the current work, a novel bottom-up experimental approach is used to quantify the economic value of provisioning ecosystem services between conventional and organic agriculture fields in Kuruvinatham and Soriankuppam villages of Bahour commune, Puducherry during September 2008 to October 2010; we investigated 30 farms - 15 Organic and 15 Conventional agricultural fields with varying species composition and degree of commercialization. Data were gathered through interviews among selected farmers and we identified 51 species utilized a food, fodder, fuel, timber and medicine. Species retention is governed by species relative importance. Conventional fields were found to be less diverse with reduced density resulting in low annual gross income. Thus it has less ecological and socioeconomic advantages, as compared to organic fields. Practice of traditional organic agriculture systems plays significant roles in both ecological and economic terms by livelihood improvement, biodiversity conservation, soil fertility enhancement and poverty reduction. Therefore it is important to conserve and promote organic agriculture to achieve sustainable production and economic terms.

266

Reddy YTN, SR Shivu Prasad, Reju M Kurian, AN Ganeshamurthy and P. Panneerselvam. (2012). "Effect of organic practices on fruit quality in papaya cv. Surya." *Journal of Horticultural Sciences*. Vol. 7(1): 88-90.

A field experiment was conducted during 2009-10 at Indian Institute of Horticultural Research, Bangalore using papaya cv. 'Surya'. Ten organic nutrient treatments along with recommended dose of fertilizers and control (no manure/fertilizer) were used totaling twelve treatment combinations of FYM, biofertilizers and vermicompost. Fruit quality parameters such as total carotenoids, lycopene, TSS, average fruit weight and ascorbic acid content were analyzed. Among the treatments, application of 50% recommended dose of fertilizers in the form of farm yard manure (FYM) applied as *Azospirillum*+Phosphate solubilizing bacteria+Mycorrhiza+Vermicompost showed high level of carotenoids, lycopene and low levels of ascorbic acid. TSS and average fruit weight were not affected by various organic nutrient treatments.

267

Patil Shivaji B and S Vishal. (2012). "Economics Of Organic Farming:
A Case Study Of Dhule District (MS)." *Indian Streams Research Journal* 2, no. 8.

The present paper is to investigate the economics of organic farming. The concept of organic farming or natural farming came forward from Asian countries. This art of farming is already preserved and cultivated by Indian and Chinese farmers. Before the invention of chemical fertilizer farming was cultivated in an organic farming way. Even today organic farming is increasing all over the world due to environmental point of view, health point of view and as well as economic point of view. Thus in the present paper it is found out the economical benefit of organic farming compared to chemical farming.

268

Purushothaman Seema, Sheetal Patil and Ierene Francis. (2012). "Impact of policies favouring organic inputs on small farms in Karnataka, India: a multicriteria approach." *Environment, Development and Sustainability* 14, no. 4: 507-527.

Over 56% of the population of Karnataka state in India depends on agriculture for its livelihood. A majority of these are small and marginal farmers, with land under 2 ha, responsible for nearly half the food production in the state. The increasing rate of farmers' suicides in the state is reportedly fuelled among others, by increasing input costs, crop failure and accumulating debt. This triggered several policy measures, intended to improve the sustainability of farm livelihoods including those promoting organic practices in farming. The paper presents the results of a multicriteria analysis conducted to comprehend the effects of two different practice–policy scenarios on smallholders in Karnataka—one scenario 'with policy' (WP) to support organic agricultural practices and the other a 'business as usual' (BAU) scenario that continues to stress on market-based, synthetic inputs for cultivation. The paper integrates results from quantitative and participatory techniques to compare and project effects on ecological, economic and socio-cultural indicators. Ecological and economic indicators in WP are projected to be significantly higher than BAU in a majority of the study sites, while sociocultural indicators show mixed outcomes, depending on regional and social characteristics. Across the study sites, small and rain-fed farms are benefitted better in WP compared to large and irrigated farms, respectively. Among small and rain-fed farms, soil fertility, water quality, agro-diversity, net income and freedom from indebtedness improve considerably, while there is slight reduction in collective activities and no perceivable change in land-based subsistence.

269

Chandramohanan, K. T., and K. V. Mohanan. (2012). "Kaipad rice farming in North Kerala-An indigenous saline resistant organic farming system." *Indian Journal of Traditional Knowledge* 11, no. 1: 185-189.

Rice, the most important cereal and staple carbohydrate source of Asia is cultivated in diverse ecological conditions and many such agro-ecosystems are fragile and critically endangered. Some such systems are very special in terms of their ecological singularity and subsistence value and their conservation would invariably add to availability of food and protection of genetic diversity. The present study is an investigation in to a very unique rice farming system in Kerala state of India in which rice is cultivated in the first crop season in saline wetlands that are subjected to regular tidal action, taking advantage of the heavy South west monsoon which results in flushing out the salt content from the farmland. In Central Kerala the system is known as pokkali and in North Kerala as kaipad. Kaipad system of rice farming has been studied presently, based on specialities of the area, soil and water conditions and the varieties used. The study showed that soil salinity of the area in summer varied from 10.9 mmhos/cm to 19.9 mmhos/ cm and water salinity in summer varied from 35.9 mmhos/cm to 49.9 mmhos/ cm and in the month of July in the middle of the South west monsoon it varied from 1.6 mmhos/cm to 4.7 mmhos/cm. Soil pH during April ranged from 4.9 to 6.6. Water pH ranged between 6.71 and 7.45 in April and in July it ranged from 6.15 to 6.71. Availability of NPK in the soil ranged as follows in April: N: 1.12% to 2.0%; P: 7.2 kg/ha to 34.2 kg/ha; K: 480 kg/ha. The major rice varieties cultivated in the area are the native cultivars Kuthiru, Orkazhama, Kuttusan, Orthadiyan and Chovverian among which Kuthiru is the most popular and the best performing.

270

Agoramoorthy Govindasamy, Minna J. Hsu and Pochuen Shieh. (2012). "India's Women-led Vegetable Cultivation Improves Economic and Environmental Sustainability." *Scottish Geographical Journal* 128, no. 2: 87-99.
India's food security is heavily dependent on irrigation, yet large rural areas of irrigated land are threatened by increasing salinity and decreasing ground water resources. Therefore, the Johannesburg Plan of Implementation agreed at the World Summit on Sustainable Development in 2002 gives importance to sustainable rural development in developing countries. The plan mandates socio-economic development within the carrying capacity of local ecosystems. One way to increase food productivity is to encourage agriculture-based vegetable cultivation often practiced by women farmers. This paper presents data on the role of tribal women-led organic vegetable farming, which improves the livelihoods of women while enhancing environmental sustainability across India's drylands.

271

Bodapati Subrahmanyeswari and Mahesh Chander. (2011). "Organic Agriculture: A Way Forward to Achieve Gender Equality in India." *Journal of Organic systems* 6, no. 3: 13-19.

Among several benefits of organic agriculture, emphasis on gender equality is one important aspect which makes it unique as it is believed that it empowers women. This can be contrasted with conventional agriculture, which is said to marginalise women. To understand gender dynamics in organic farming, 111 men and 69 women registered organic farmers were studied using a semi-structured interview schedule and on-farm observations in the context of livestock production activities during 2006-07 in the North Indian state of Uttarakhand, which has embraced organic agriculture by declaring itself as first organic state in India. Land and livestock ownership was mostly with men, whereas income was jointly managed by both men and women followed by women members alone in most of the households. Animal husbandry activities were performed by both men and women, followed by women members of the family, whereas, decision making in animal husbandry activities though reflected plurality, the final decisions in most of the cases rested with men only. This study was not designed to compare the gender dimensions in conventional/traditional farms against organic farms, yet it was observed that women's formal involvement was being encouraged through appropriate policy interventions in the state of Uttarakhand. In particular, the gender sensitisation training imparted by the Uttarakhand Organic Commodity Board (UOCB) appeared to have played key role in making women's participation more proactive and visible. The authors recommend that studies should made to compare the conventional and organic agricultural systems along gender dimensions so as to know to what extent organic agriculture is helping in achieving the millennium goal of gender equality and women's empowerment.

272

Poyyamoli, Gopalswamy, and Anbarashan Padmavathy. (2011). "Analysing innovative sustainable practices extend and income generation in organic farming and GRA fields in Bahour, Puducherry, India." *Journal of Dev and Agri Economics* 3, no. 6: 252-260.

In past decades, agricultural development majorly focused on short term productivity based on external inputs resulting in neglect and improper use of natural resources. Thus, it leads to ecosystem damage and loss of food security. This has forced the farmers, scientists and the policy makers to look at sustainable farming techniques through organic farming. In India there is greater possibility of bringing green revolution agricultural areas under the gambit of sustainable farming/organic farming. Research and development is necessary to better understand the complex ecological processes as well as the management capacity of farmers. Hence, this research study was done to analyze the reach and adaptation level of sustainable farming techniques by organic farmers and non- adoption (sustainable farming techniques) reasons among the Green Revolution Agriculture (GRA) farmers at farm level. This will help us to find different strategies to popularize sustainable organic farming among the farmers in order to overcome food crisis.

273

Dadhwal KS, NK Sharma and BN Ghosh. (2011). "Organic farming for resource conservation and soil health improvement in the Himalayan region, India." *Indian J of Soil Conservation* 39, no. 3: 243-250.

A review was made on certified organic farms in the Indian Himalayan states to ascertain the real benefits and feasibility of organic farming in terms of the production potential, economics and soil health in comparison to the conventional farms. The review study revealed that organic farming, in spite of the reduction in crop productivity by 14.6%, provided higher net profit to farmers by 21.5% compared to conventional farming. This was mainly due to the availability of premium price (20–40%) for the certified organic produce and reduction in the cost of cultivation by 15.9%. In cases, where such premium prices were not available and the cost of cultivation was higher primarily due to purchased off-farm inputs, organic farming was not found economically feasible. However, there was an overall improvement in soil quality in terms of various parameters, viz. physical, chemical, biological properties, availability of macro- and micronutrients, indicating an enhanced soil health and sustainability of crop production in organic farming systems.

274

Kharde PB, SS Patil and MC Ahir. (2010). Livelihood Security Through Organic Finger Millet Production And Processing. *Ind J of Ext Edu and Rural Dev*. No. 17-18: 17-20.

Farmers in the developing country like India are realizing the potential for organic produce and subsequent prices. Finger millet (Eleusine coracana L. Gaertn) is one of the important millets grown in India. In the year 20022003, the area under this crop in India was 14.22 lakh ha. whereas, the total production was 14.45 lakh tons. The Maharashtra State accounts for about 50 per cent area and more than 2/3rd production under this crop. The present study was undertaken with the specific objective to study the nutritive value of organic finger millet and efforts to enhance rural livelihood through organic finger millet production and processing. The study highlights the importance of finger millet, (locally called nagli or ragi) as a major food grain crop especially of the tribals with an excellent fodder for cattle. It contains important Vitamins viz. Thiamine, Riboflavin and Niacin. The Farm Science Centre, i.e. Krishi Vigyan Kendra (KVK) of the Mahatma Phule Agricultural University located at Dhule is making an all round effort to train the women on production and processing of different organic finger millet products. It is evident from the data that a total of 3019 women of Self Help Groups (SHGs) have been trained on processed products of finger millet through 110 training programmes during the last 3 years. Thus, through the intervention of KVK, the women SHGs have started the production of different finger millet products for income generation. This has contributed for their sustainable livelihood. It can be concluded that the organic finger millet has tremendous scope and potential as food in domestic and world market. It is essential to popularize and promote the organic products of finger millet among the society. Livelihood Security through organic finger millet production and processing is possible especially in remote tribal areas; hence our efforts need to be concentrated in this direction.

275

Guruswamy K and Gurunathan K Balanaga (2010). A need for organic farming in India. *Journal of Contemporary Research in Management*. January-March 2010

India is one of the agricultural based Nation with more than 58% of the population out of 1150 million, pertaining to agricultural sector. Before 1960, in India only OF practice was followed without chemical fertilizers and pesticides. During late 1960s, there was threaten to food security due to population raise and frequent draughts. Government of India had entered collaboration with USA for reforming farming practices by adding chemical products for cultivation, diseases and weed management. There was increase in production and productivity in chemical or conventional farming and our country was able to satisfy partly the food security. After 30-40 years, production and productivity reduced drastically with abnormal input costs and the farming sector turned to be unfavorable occupation to all concerned. Soil degradation, more diseases, uncontrollable weeds, high water consumption, unfavorable price and with several natural and manmade issues, conventional farming turned to be unworthy for farmers.

A study on need for OF practice which is an emerging practice in several countries upto 20% all over the world for the last 15 years, is taken. In this article, study is done about types, present status, productivity, management of diseases, weeds, manures, harvesting, post harvesting, marketing and advantages of organic farm practices which will overcome the current issues of the CF. It is concluded that OF practice, our own indigenous technology is to be reintroduced from the current 1 to 2% to the possible extend to get rid off difficulties in conventional farming. OF will solve the food shortage and crisis in our country permanently and can encash heavily by exporting to needy countries of having severe food shortages.

Concluding Remarks: The OF method is found to be superior than CF method on account of increased human labour employment, lower cost of cultivation, higher profits, better input use efficiency and reduced risk leading to increased income, enhanced self reliance and livelihood security of the farmers.

276

Saha Supradip, KA Gopinath, BL Mina, S Kundu, Ranjan Bhattacharyya and HS Gupta. (2010). "Expression of soil chemical and biological behavior on nutritional quality of aromatic rice as influenced by organic and mineral fertilization." *Communications in soil science and plant analysis* 41, no. 15: 1816-1831.

The aim of the study was to evaluate changes in the yield and nutritional characteristics of aromatic rice as influenced by organic versus mineral fertilization. Aromatic rice was grown on four levels of cattle manure (CM; 5, 10, 15, and 20 Mg $ha^{˝1}$). Other treatments were equivalent amounts of nitrogen (N), phosphorus (P), and potassium (K) in different levels of manure fertilizer and mineral fertilizer. After 6 years of cropping, organically managed plots were superior to mineral-fertilized plots in terms of grain yields of rice at 5, 10, and 15 Mg $ha^{˝1}$. Cattle manure at 20 Mg $ha^{˝1}$ and its equivalent NPK through mineral-fertilizer treatment provided 41.1% and 37.9% increases in average grain yield (5.2 and 5.1 Mg $ha^{˝1}$) over the unamended control.
Protein content was greater in mineral-fertilized rice grains at all levels of CM. Soil dehydrogenase, â-glucosidae, urease, and acid phosphatase activities were greater in soil treated with CM than soil treated with the corresponding mineral fertilizer at all levels. There was buildup of soilavailable N, K, and iron (Fe) in soils treated with CM. Grain hardness increased with increasing rates of nutrient application for both mineralfertilized and organically grown rice; in contrast, amylose content was lower in treatments receiving more nutrients, irrespective of nutrient sources. In terms of functional property, phenol content in rice grain increased with increasing nutrient supply. Potassium and Fe contents were more in CMtreated rice than in mineral-fertilized treatments at greater rates of application. Results suggest that after building up the soil nutrient status, comparable yield and better nutritional and functional qualities of rice can be achieved in organically managed soils than in mineral-fertilized soils.

277

Ramesh P, Panwar NR, Singh AB, Ramana S, Yadav Sushil Kumar, Shrivastava Rahul and Subba Rao A. (2010). Status of organic farming in India. Current Science. Vol. 98 (9).

A survey was made on certified organic farms in the country to ascertain the real benefits and feasibility of organic farming in terms ofthe production potential, economics and soil health in comparison to the conventional farms. The study revealed that organic farming, in spite of the reduction in crop productivity by 9.2%, provided higher net profit to farmers by 22.0% compared to conventional farming. This was mainly due to the availability of premium price (20-40%) for the certified organic produce and reduction in the cost of cultivation by 11.7%. In cases, where such premium prices were not available and the cost of cultivation was higher primarily due to purchased on-farm inputs, organic farming was not found economically feasible. However, there was an overall improvement in soil quality in terms of various parameters, viz. physical, chemical, biological properties, availability of macroand micronutrients, indicating an enhanced soil health and sustainability ofcrop production in organic farming systems.

278

Das Anup, JMS Tomar, T Ramesh, GC Munda, PK Ghosh and DP Patel. (2010). "Productivity and economics of lowland rice as influenced by incorporation of N-fixing tree biomass in mid-altitude subtropical Meghalaya, North East India." *Nutrient cycling in agroecosystems* 87, no. 1: 9-19.

The climatic conditions of North East India are favorable for trees to produce biomass in the form of foliage and twigs that are very rich in essential plant nutrients. Effective recycling of this biomass would help meet the nutritional requirement of crops. Field experiment was conducted in *kharif* (June– November) seasons for consecutive 3 years (2003, 2004, and 2005) at a lowland farm, subtropical Meghalaya (950 m asl), India, to study the effect of incorporating N-fixing tree biomass (leaves and twigs) on productivity and economics of rice (*Oryza sativa* L.). Fresh biomass from five tree species including erythrina (*Erythrina indica*), acacia (*Acacia auriculiformis*), alder (*Alnus nepalensis*), tree bean (*Parkia roxburghii*), and cassia (*Cassia siamea*) were applied at a rate of 10 t/ha. A plot with recommended NPK rate (80:60:40 kg/ha) and a control plot were also maintained for comparison. Among the tree species used, the biomass of *E. indica* was superior in terms of N (3.2%), P (0.47%), K (1.5%), and organic C (18.8%) contents. In the first and second year, productivity of rice was high with recommended NPK rate (4.82 t/ha in 2003 and 5.08 t/ha in 2004) followed by rice with incorporation of *E. indica* biomass. In the third year of the experiment, effects of tree biomass incorporation on growth, yield and yield attributes surpassed those of the recommended NPK rate, with the exception of *A. nepalensis* biomass. In that year, the maximum grain yield was recorded under *E. indica* treatments, exceeding yields under the recommended NPK rate and control by 10.5 and 69.3%, respectively. Incorporation of tree biomass significantly improved (14–19% N and 62–83% P over control) the stocks of soil available N and P. Treatment with *A. auriculiformis* and *E. indica* biomass resulted in significantly higher soil organic C content which exceeded that under the recommended NPK rate by 10.3 and 9.2% and that under the control by 15.2 and 14%, respectively higher by species. The highest net return was recorded with the recommended NPK rate ($ 381/ ha) followed by *E. indica* ($ 303/ha). Since the local farmers are resource poor and rarely use chemical fertilizers, application of plant biomass, particularly that of *E. indica*, to lowland rice is a recommendable option to improve productivity and income, and to sustain soil health.

279

Gopinath K.A, Supradip Saha, BL Mina, Harit Pande, AK Srivastva and HS Gupta. (2009). "Bell pepper yield and soil properties during conversion from conventional to organic production in Indian Himalayas." *Scientia horticulturae* 122, no. 3: 339-345.

A conversion period of at least two years is required for annual crops before produce may be certified as organically grown. There is a need for better understanding of the various management options for implementing from conventional to organic production. The purpose of this study was to evaluate the effects of three organic amendments on growth and yield of bell pepper (*Capsicum annuum* L.), the benefit:cost ratio, soil fertility and enzymatic activities during conversion to organic production. For that purpose six treatments were established: composted farmyard manure (FYMC, T_1); vermin-compost (VC, T_2); poultry manure (PM, T_3) along with biofertilizers (BF) [*Azotobacter* + phosphorus solubilizing bacteria (*Pseudomonas striata*)] and mix of three amendments (FYMC+PM+VC+BF, T_4); integrated crop management (FYMC+NPK, T_5) and unamended control (T_6). The bell pepper yield under organic management was markedly lower (33–53% and 18– 40% less in first and second year of conversion, respectively) than with the integrated crop management (FYMC 10 Mg/ha+ NPK – 100:22:41.5 kg/ha) treatment (T_5). Combined application of three organic amendments (FYMC 10 Mg/ha+ PM and VC each 1.5 Mg/ha + BF, T_4) and T_1 produced similar but significantly higher bell pepper yield (27.9 and 26.1 Mg/ha, respectively) compared with other organic amendment treatments. Both T_4 and T_1 greatly lowered soil bulk density (1.15–1.17 Mg m^{-3}), and enhanced soil pH (7.1) and oxidizable organic carbon (1.2–1.3%) compared with T_5 and unamended control (T_6) after a two-year transition period. However, the N, P and K levels were highest in the plots under integrated management. T_1 plots showed higher dehydrogenase activity values. However, acid phosphatase and â-glucosidase activities were higher in T_6 plots whereas urease activity was greater in T_5 plots compared with other treatments. Among the treatments involving organic amendments alone, T_1 gave a higher gross margin (US $ 8237.5/ha) than other treatments. We conclude that T_1 was found more suitable for enhancing bell pepper growth and yield, through improved soil properties, during conversion to organic production.

280

Barooah Madhumita and Pathak Ajit. (2009). Indigenous knowledge and practices of Thengal Kachari women in sustainable management of bari system of farming. *Indian Journal of Traditional Knowledge*. Vol 8(1): 35-40.

The Thengal-Kacharis, belonging to the Boro-Kachari ethnic groups are one of the most ancient inhabitants of Assam with rich tradition and cultural history. The bari or homestead gardening has had great significance from the point of conservation, consumption and management of biodiversity. Women of this community have played a key role in sustainable use of bari bioresources through various practices and knowledge systems that have been passed from generation to generation. In the paper, the crops diversity and their arrangement in a Thengal Kachari's bari along with some the traditional practices followed in sustainable management of bari- bioresources have been discussed.

281

Mande JV and GS Ankush. (2009). "A case study of Vasundhara bio-products." *Agriculture Update* 4, no. 3/4: 448-450.

This case study examines the personal and socio-economic characteristics of the women entrepreneurs, identifies the motivating factors responsible to start agri-business, studies the innovative technology of vermicompost production, examines the economics of production, and the constraints encountered in production. Surveys were conducted on women entrepreneurs. Findings show that women entrepreneurs can be job creators.
About 50% of women can play a role in rural development.

282

Vijayakumar Lakshmi and R Satheesh-Babu. (2009). "Does 'no pesticide' reduce suicides?." *International journal of social psychiatry* 55, no. 5: 401-406.

Introduction: Ingestion of pesticides is the most common method of suicide, particularly in China, Sri Lanka and India. Reported pesticide suicides in India numbered 22,000 in the year 2006.

Method: Four villages in the state of Andhra Pradesh in India that had stopped using chemical pesticides in favour of non-pesticide management (NPM) were visited to assess any change in suicide incidence before and after discontinuation of chemical pesticides. Four similar villages in the same region that continued to use chemical pesticides were used as controls for comparison.

Results: In the pesticide-free villages there were 14 suicides before introduction of NPM and only three suicides thereafter. The percentage of suicides not reported to authorities was 47%.

Conclusion: Restriction of pesticide availability and accessibility by NPM has the potential to reduce pesticide suicides, in addition to psychosocial and health interventions.

283

Lukas Martin and Cahn M. (2008). Organic agriculture and rural livelihoods in Karnataka, India. At: Cultivating the Future Based on Science: 2nd Conference of the International Society of Organic Agriculture Research ISOFAR, Modena, Italy, June 18-20, 2008

The research explored the effects a change from conventional to organic farming had on the livelihoods of a group of farmers in Karnataka, South India. It involved semi-structured interviews with organic farmers, NGOs, consumers, marketing organisations, and the State Agricultural Department. The farmers in the case study perceived that they had improved their livelihoods over the long term by the conversion from conventional to organic farming. Reduced costs for external inputs and reduced labour requirements together with similar or higher yields and premium prices resulted in higher net-farm incomes. The conversion to organic farming reduced the reliance on credits and the risk of crop failure due to pests, diseases and droughts, thereby reducing vulnerability. In addition, the farmers mentioned enhanced natural assets, reduced risk of pesticide poisonings, improved food safety, higher levels of self-sufficiency, and the access to networks supporting knowledge exchange and political participation as important benefits of the conversion. However, almost all the case study farmers noted that the conversion period was difficult due to temporarily declining yields and a lack of information and experiences. This is likely to be a major constraint preventing asset-poor farmers from adopting organic agriculture.

284

Kshirsagar KG (2008). Impact of organic farming on economics of sugarcane cultivation in Maharashtra. *Gokhale Institute of Politics and Economics, Working Paper 15*.

Organic farming is a system of farm management to create an eco-system which can achieve sustainable productivity without the use of artificial external inputs such as chemo-synthetic fertilizers and pesticides. The potential of organic farming in generating socially and environmentally beneficial effects are impressive. However, it is essential to assess its performance in terms of its economics which ultimately influences the adoption. Therefore, the primary goal of this paper is to examine the impact of organic farming on economics of sugarcane cultivation in Maharashtra. The study is based on primary data collected from two districts covering 142 farmers, 72 growing Organic Sugarcane (OS) and 70 growing Inorganic Sugarcane (IS) in Maharashtra. The study finds that OS cultivation enhances human labour employment by 16.90 per cent and its cost of cultivation is also lower by 14.24 per cent than IS farming. Although the yield from OS is 6.79 per cent lower than the conventional crop, it is more than compensated by the price premium received and yield stability observed on OS farms. The OS farming gives 15.63 per cent higher profits and profits are also more stable on OS farms than the IS farms. The paper concludes by suggesting some key policy measures for rapid advancement of OS farming in selected regions of the state.

285

Saha S, Pandey AK, Gopinath KA et al (2007). Nutritional quality of organic rice grown on organic composts. *Agron Sustain Dev* 27:223–229.

The use of organic nutrient sources in improving crop quality can be a viable alternative to traditional farming. Organic farming encourages the reduction of agrochemicals and promotes soil conservation principles. Although crop quality depends on several factors, among which the nutrient source plays a great role, there is little information available on how rice quality is affected by different organic composts. Here we grew aromatic rice on two levels of four organic composts made from kudzu vine (*Pueraria lobata*) at 5 and 10 Mg ha^{-1}, *Urtica* sp. (nettle) at 5 and 10 Mg ha^{-1}, *Lantana* sp. at 5 and 10 Mg ha^{-1}, winter weeds at 2.5 and 5 Mg ha^{-1}, and two other organic amendments of poultry at 2.5 and 5 Mg ha^{-1} and farmyard manure at 5 and 10 Mg ha^{-1}. We studied the effect of these organic sources on nutritional and physico-chemical properties, and on the cooking quality of the rice, using a fertilized, chemical treatment as positive control. Our results show that grain yield was significantly influenced by the supply of major plant nutrients. The highest rice yield of 4.0 Mg ha^{-1} was obtained from the inorganically fertilized treatment. The protein content in grains was the highest, 8.98%, in the inorganic treatment (100:60:40 kg N, P, K ha^{-1}) and lowest, 7.55%, in the control. Among organic treatments, farmyard manure at 10 Mg ha^{-1} contributed the least in terms of the protein content of the rice (7.78%). Significantly higher iron content, of 52.2 ìg g^{-1}, was recorded with organic fertilization than inorganic fertilization (42.1 ìg Fe g^{-1}). However, inorganic fertilization was superior in terms of copper content, of 4.1 ìg Fe g^{-1}, compared with organic treatments: 3.1–4.0 ìg Fe g^{-1}. Quality attributes indicated that cooked kernel length was positively correlated with the kernel elongation ratio. Winter weed compost provided comparative benefits for rice yield (3.87 Mg ha^{-1}) and quality in terms of protein (8.42%), iron (48.31 ìg g^{-1}) and head rice recovery (49.39%) compared with other sources of nutrients. The results of this study suggest that organic nutrient sources can perform comparatively well as regards chemical and physico-chemical properties, and cooking quality of rice, if not better in some parameters than inorganic fertilization.

286

Eyhorn Frank, Mahesh Ramakrishnan and Paul Mäder. (2007). "The viability of cotton-based organic farming systems in India." *International Journal of Agricultural Sustainability* 5(1): 25-38.

Cotton farmers in many developing countries are facing decreasing marginal returns due to stagnating yields and high input costs. Conversion to organic management could offer an alternative. In a two year comparative study in central India covering 170 cotton fields, organic farms achieved cotton yields that were on par with those in conventional farms, whereby nutrient inputs and input costs per crop unit were reduced by half. Due to 10–20% lower total production costs and a 20% organic price premium, average gross margins from organic cotton fields were 30–40% higher than in the conventional system. Although the crops grown in rotation with cotton were sold without premium, organic farms achieved 10–20% higher incomes from agriculture. In addition to these economic benefits, the organic farming system does not burden soil and groundwater with synthetic fertilizers and pesticides. However, in this study only minor differences were detected in soil fertility parameters of organic and conventional fields. Altogether, the results suggest that conversion to organic farming can improve livelihoods of smallholders while protecting natural resources. Income loss due to reduced yields in initial years of transition, however, constitutes a major hurdle, especially for poorer farmers. It is thus important to support farmers in overcoming the obstacles of the conversion period.

287

Naik SN and R Prasad. (2006). "Pesticide residue in organic and conventional food-risk analysis." *Journal of Chemical Health and Safety* 13, no. 6: 12-19.

During the era of green revolution in the late sixties, introduction of high yielding varieties, expansion of irrigated areas, increased use of nitrogen, phosphorous, potassium (N, P and K) fertilizers; chemical pesticides and higher cropping intensity drove India toward self-sufficiency in food production. Use of chemical pesticides to control various insects, pests and diseases over the years destroyed many naturally occurring effective biological agents. Increased quantities of nutrients and pesticides in agricultural run off waters in recent years has caused serious problem of water pollution. The ill effects of green revolution include residues of extensively used chemical pesticides in various environmental components. Several studies showed that pesticides could cause health problem such as birth defects, nerve damage and cancer. Keeping in mind the problem of pesticide residues in various components of environment, the present study was conducted on different organic farms and market samples (conventional farms). Four groups of pesticides, i.e., organochlorine, carbamates, organophosphorous and pyrethrites were analyzed in wheat and rice samples. Presence of organochlorine pesticide residue was observed in two out of ten organic farms, which were converted from conventional to organic practices few years ago. This was attributed to excessive use of synthetic pesticides. Wheat and rice samples taken from market (conventional farm) showed significant level of pesticide residues. Method used for extraction of pesticides was validated with recovery studies, which showed more than 80% recoveries for organochlorine, organophosphorous, carbamates and pyrithroids, respectively. Pesticide residue contamination of food was assessed for risk analysis.

288

Natrajan M and Santha Govind. (2006). "Indigenous agricultural practices among tribal women." *Indian J Traditional Knowledge* 5, no. 1: 118-121.

The tribal women living In the Kalrayan Hills have rich knowledge about the indigenous practices, especially in post harvest and cultivation aspects on paddy (*Oryza sativa* Linn.) and tapioca (*Manihot esculenta* Crantz). Indigenous knowledge has evolved within the community and has been passed on from one generation to another. The role of indigenous knowledge in sustainable agricultural production in developing countries is beginning to gain recognition within scientific circles. Tribal women are generally noted for the wealth of indigenous knowledge. Hence, a study on adoption of indigenous farm practices among tribal women of the Kalrayan hills was taken up to assess the extent of adoption of identified indigenous farm practices in paddy and tapioca. The study was conducted in the Kalrayan hills of district Villupuram, Tamil Nadu. A total of 120 tribal women selected based on proportionate random sampling technique. The data were collected from the respondents with the help of a well-structured pre-tested interview schedule and suitable statistical tools were used to analyze the data.

289

Sofia PK, Prasad Rajendra and Vijay VK (2006). Organic Farming – Tradition Reinvented. Indian Journal of Traditional Knowledge. Vol. 5 (1): 139-142

Organic farming has been practised since ancient times. The only diversion came when we blindly started using chemicals for agricultural purposes. Our forefathers used all the techniques that now we are reverting back to; coming close to nature again. So it would not be wrong in saying that we are reinventing tradition or traditional methods. Far too often organic agriculture is defined or described in terms of what it is not. The most common example of this is the notion that 'organic farming is farming without chemicals'. The problem is not only one of logistics and supply chains though. Organic farming brings into picture a diverse, healthy and sustainable crop production system which is the need of the hour. The paper brings into focus a few traditional methods that were used for farming, which are now,once again coming back to the forefront.

290

Naik MH and R Sri Hari Babu. (2005). "Feasibility of organic farming in guava (Psidium guajava L.)." In *I International Guava Symposium 735*, pp. 365-372.

An investigation was conducted under semi-arid tropics of southern Andhra Pradesh, India, to study the response of guava (*Psidium guajava* L.) cv. L49 (Sardar) to different organic manures. The treatments consist of organics, viz. vermi-compost (10 kg tree^{-1}), FYM (25 Kg tree^{-1}), pig, sheep, goat and poultry manures and guava leaf litter (each 20 Kg tree^{-1}), NPK (250:350:200g tree^{-1}) and control (without any treatment). The treatment with vermi-compost resulted in maximum number of shoots plant^{-1}, more number of leaves shoot^{-1} and highest yield. Application of animal manures produced more number of fruits shoot^{-1}. Per cent fruit drop was nil with sheep, goat and leaf litter application, but was higher with vermi- compost and poultry manures. Heaviest fruits were borne under sheep and goat manures. The fruit yield was better with chemical fertilizers and good with poultry manures. TSS was highest with animal manures and least in control. Acidity was highest under FYM treatment closely followed by vermin-compost. Ascorbic acid content was highest in pig manure treatment whereas total sugars and reducing sugars were maximal with goat manure. Irrespective of the treatment, leaf N remained almost the same before and after the trial. On the other hand, the leaf P and K showed an increase after the termination of the trial due to various treatments except control. Soil pH decreased in all treatments, whereas EC increased in all the treatments. Similarly organic carbon increased in all manurial treatments. This trend was almost similar with soil NPK. Thus, the present investigation revealed that the vermicompost was superior over other organic sources and closely followed by poultry manure and leaf litter in improving vegetative growth, flowering, fruiting, yield and fruit attributes and fruit quality along with improvement in soil fertility and leaf nutrient status of the guava plant.

291

Raj DA, K Sridhar, Arun Ambatipudi, H Lanting and S Brenchandran. (2005). "Case study on organic versus conventional cotton in Karimnagar, Andhira Pradesh, India." In *Second International Symposium on Biological Control of Arthropods, Davos, Switzerland, 12-16 September, 2005:*302-317. United States Department of Agriculture, Forest Service.
Cotton (*Gossypium hirsutum*) yields, profits and pest incidence at fields of farmers participating in an export-oriented organic cotton production programme were compared with yields of conventional cotton production in the same village in Karimnagar district, Andhra Pradesh, India, during a bad

cotton season (2004). Late season drought reduced actual yield by 42% compared to the estimated yield in October 2004 and usual average yields. Organic cotton yielded on par at 232 kg seed cotton/acre against conventional cotton at 105 kg/acre. Organic cotton was more profitable at plus Rs 559/ acre (approx. US$ 13) (1 US$=Rs. 44) versus minus Rs 1307/acre (minus US$ 30) in conventional cotton and had significantly less problems with *Helicoverpa armigera* (Lepidoptera, Noctuidae) and *Pectinophora gossypiella* (Lepidoptera: Gelechiidae). Pest control in organic cotton was about Rs. 220 (US $ 5) per acre (5% of total production costs of organic cultivation) compared with Rs. 1624 (US $ 37) per acre (30% of total production costs of conventional cultivation) in conventional cotton. Pest management in organic cotton was based on prevention: balanced nutrient management, intercrops and early spray of HaNPV. Thirty-four farmers, part of a large organized group (over 200 farmers), volunteered to test organic cotton on part of their farm, allotting 79 acres for organic farming though owning about 296 acres. For certification purposes, a contiguous area of about 40 acre should go organic. The 34 farmers were organized in two groups for training, credit and savings, maintenance of certification administration and marketing purposes. Farmer Field School sessions (FFS) were conducted on weekly basis during the season but also after the season to deal with postharvest handling and marketing. As a result of this year's experience, all participating farmers will bring their total cotton under organic management, another 70 farmers will join and 10 neighboring villages are interested, but have been asked to wait because of lack of training manpower. Farmers of the old and new groups will be trained to become farmer trainers. Packages used for training are based on the FAO IPM-FFS and long term experience of ETC India and its staff in cotton cultivation in Southern India. Linkages are maintained with CIPMC, national cotton research programme and universities. The latter mainly for the selection of cultivars. Inputs are purchased from the private sector. Yearly, a meeting will be organized in which representatives of farmers from the whole organic cotton programme (240 in 2004) will interact with researchers, input suppliers, banks, ginners and spinners. This is meant to create synergy in the whole chain.

292

Eyhorn Frank; Mäder Paul and Ramakrishnan Mahesh (2005). The Impact of Organic Cotton Farming on the Livelihoods of Smallholders. Evidence from the Maikaal bioRe poject in central India. Research Report. Forschungsinstitut für biologischen Landbau (FiBL) CH-Frick.

This research report analyses the impact of conversion to organic cotton farming on the livelihoods of smallholders in the Maikaal bioRe organic cotton project in Madhya Pradesh, central India. For that purpose, it compares farm profile data, material and financial input/output and soil parameters of organic and conventional farms over two cropping periods (2003 – 2005). The results show that organic farms achieve cotton yields that are on a par with those in conventional farms, though nutrient inputs are considerably lower. With less production costs and a 20% organic price premium, gross margins from cotton are thus substantially higher than in the conventional system. Even if the crops grown in rotation with cotton are sold without organic price premium, profits in organic farms are higher. In the perception of most organic farmers, soil fertility significantly improved after conversion. However, the analysis of soil fertility parameters in soil samples from organic and conventional cotton fields has shown only minor differences in organic matter content and water retention. The research indicates that organic cotton farming can be a viable option to improve incomes and reduce vulnerability of smallholders in the tropics. To use this potential it is important to find suitable approaches to enable marginalised farmers managing the hurdles of conversion to the organic farming system.

293

Victor TJ and R Reuben. (2000). "Effects of organic and inorganic fertilisers on mosquito populations in rice fields of southern India." *Medical and Veterinary Entomology* 14 (4): 361-368.

The effects of nitrogenous (inorganic) fertilisers, organic manures and bluegreen algae (BGA) biofertiliser on mosquito populations (Diptera: Culicidae) were studied in rice fields of Madurai, Tamil

Nadu, south India, with particular attention to *Culex vishnui* Theobald, *Cx. pseudovishnui* Colless and *Cx. tritaeniorhynchus* Giles, the vectors of Japanese encephalitis (JE). The application of urea, a nitrogenous fertiliser, in rice fields significantly increased the grain yield and the population densities of mosquito larvae and pupae (anophelines as well as culicines) in a dose-related manner. Fields treated with inorganic fertilisers (N, P, K) had significantly higher population densities of mosquito immatures than fields treated with organic manures (farmyard manure and green manure). Without nitrogenous fertiliser, BGA increased paddy yield without enhancing mosquito production. Therefore, the use of BGA with less nitrogenous fertiliser is recommended, which is beneficial economically and agronomically to the farming community and also significantly reduces mosquito production in rice fields. Increased use of nitrogenous fertiliser over the past two decades may have contributed to the increased severity of Japanese encephalitis epidemics, vectors of which breed in rice fields.

294

Economics of Banana Plantation under Organic and in- organic Farming Systems: Dr Gangadhar Banerjee, General Manager, NABARD, Head Office, Mumbai. 2001(?)
Organic farming/ agriculture is a unique production management system, which promotes and enhances agro-eco system of health including bio diversity, biological cycles and soil biological activity. It has been systematically followed on a large scale in the developed countries including the United Kingdom and Canada. Different people in different countries have perceived organic farming/agriculture differently. In our country, the major problem of low productivity of soils is attributed to low organic matter content of the soil particularly in areas where fertilizer is being used in increasing quantity year after year without adequate supplement of organic matter. The organic farming today is not traditional agriculture. The principles governing organic farming are more scientific than even the principles followed in modern agriculture. These being the case how are we going to reach the target of around 240 million tons in 2010 that is the minimum quantity needed for growing population of the country? The present paper makes an attempt to study the yield, inputs used, cost of production, income accrued, gross and net income of banana crops under both organic and inorganic farming systems.

https://www.nabard.org/pdf/paperoneconomicsoforganicfarming.pdf

295

Kumar Anil and PS Ramakrishnan. (1990). "Energy flow through an Apatani village ecosystem of Arunachal Pradesh in northeast India." *Human Ecology* 18, no. 3: 315-336.

The energy flow through the ecosystem of a typical Apatani village in Arunachal Pradesh in northeastern India was studied. The energy and economic efficiency of the rice agro-ecosystem of this region is exceptionally high, and rice is exported after meeting local needs. The cropping pattern varies depending upon the amount of organic residues recycled into the system. Where recycling is more efficient and substantial, pisciculture is integrated with rice cultivation. Dry land cultivation of millet and mixed cropping in home gardens contribute toward meeting the diverse needs of the people. Swine and poultry husbandry is an important link with agroecosystems through the detritus food chain. Mithun (Bos frontalis) husbandry, which is dependent upon large forested grazing lands, is important for social and religious reasons, as well as being a source of food. Fuelwood is extracted from the natural forest and from the cultivated bamboo gardens; the latter also provide construction materials. This village ecosystem with high overall energy efficiency is based on tight recycling of resources.

296

Patil Sheetal, Pytrik Reidsma, Pratik Shah, Seema Purushothaman and Joost Wolf. (2014). "Comparing conventional and organic agriculture in Karnataka, India: Where and when can organic farming be sustainable?." *Land Use Policy* 37: 40-51.

Karnataka is one of the south-western Indian states where agrarian distress as a major problem. Crop yields have been stagnant in the last decade, and coupled with increased input costs, this has led to reduced incomes and debts. There is an urgent need to study options to improve the sustainability of farming systems in Karnataka. One adopted strategy to stabilize agriculture in the state is organic farming, which is less dependent on external inputs. In this paper, we assess the sustainability of conventional and organic farming practices using the model TechnoGIN. TechnoGIN calculates inputs and outputs of farming practices, allowing assessment of its impacts on economic and environmental indicators. Data on inputs and yields have been collected in two districts in 2009 from farms with conventional and organic cultivation at the same time. Additional data were collected from literature and experts. Next, the current situation was assessed and projections were made towards 2015 for two scenarios per village, using either conventional or organic practices.

Modeling results show that for the study site situated in a dry region, Chitradurga, profits with organic farming are higher than in conventional farming, except for rotations that include onion. Input costs are lower resulting in lower financial risks with organic farming. Nutrient balances in organic agriculture were however found to be negative for all crop rotations indicating imbalanced supply of nutrients. This suggests it may not be possible to sustain current yields in the long term with current nutrient applications. In the second site situated in a transition zone with intensive cultivation of commercial crops, Mysore, yields and profits are similar in organic farming compared to those under conventional practice, except for commercial crops like cotton and coconut where the profits are lower. The debt risk in case of crop failure appears to be practically similar for both types of farming practices in Mysore. Nutrient balances are generally positive, indicating that NPK supplies are not the main yield limiting factor.

It is concluded that organic farming can be a sustainable farming practice in Karnataka depending on regional conditions and the crops cultivated.
Policies stimulating organic farming should therefore consider the regional differences and farmer's preferences.

297

Murthy MRK and V Murali. (2013). "Organic farming and community managed sustainable agricultural produce, need of retail market in Andhra Pradesh, India." *Asian Journal of Research in Business Economics and Management* 3, no. 1: 312-322.
Pests and pesticides contribute to the major economic and ecological problems affecting the farmers, crops and their living environment. Two decades of experience in Andhra Pradesh on Non Pesticide Management shows that pest is a symptom of ecological disturbance rather than a cause and can be effectively managed by using local resources and timely action. The sustainable agriculture shows that the new knowledge synthesized from traditional practices supplement with modern science can bring in ecological and economic benefits to the farmers. The cost of cultivation could be brought down significantly without reduction in yield. The Institutional base of Community Based Organizations like Federations of Women Self Help Groups (SHGs) provides a good platform for scaling up such ecological farming practices. This experience also shows how the grass root extension system when managed by the community can bring in change and help the farming community to come out of the crisis. The key issues emerging in organic farming include yield reduction in conversion to organic farm, soil fertility enhancement, integration of livestock, certification constraints, ecology, marketing and policy support. The potential for organic farming, especially in the dry land regions has been discussed. It has been argued that organic farming is

productive and sustainable, but there is a need for strong support to it in the form of subsidies, agricultural extension services and research.

298

Panneerselvam P, John Erik Hermansen, Niels Halberg and P Murali Arthanari. (2013). "Impact of large-scale organic conversion on food production and food security in two Indian states, Tamil Nadu and Madhya Pradesh." *Renewable Agriculture and Food Systems* : 1-11.

The millions of food insecure people in India are not solely due to inadequate food production, but also because some people are simply too poor to buy food. This study assessed how a large-scale conversion from conventional to organic production would impact on the economics of marginal and small farmers in Tamil Nadu and Madhya Pradesh, and on the total food production in these states. This study also considered a situation where fertilizer subsidies would be discontinued, with farmers having to carry the full cost of fertilizer. Results show that conversion to organic improved the economic situation of farmers although food production was reduced by 3–5% in the organic situation. Thus, the estimated economic values were higher in the organic system (5–40% in fertilizer subsidy scenario and 22–132% in no fertilizer subsidy scenario) than in the conventional system, whereas the total state-level food productions were lowered by 3–5% in the organic compared to the conventional system. Food production was higher when rainfed, and lower in the irrigated situation in the large-scale organic scenario. Although the study addresses short-term perspectives of large-scale conversion to organic farming, more research is needed to understand the long-term impact of organic conversion on food production, nutrient supply, food security and poverty reduction.

299

Kumar, Sunil, B. Gangwar, A. K. Prusty, and Mohmmad Shamim. (2013). "Prospects of organic agriculture in eastern himalayan region-A case study of Mizoram." *Progressive Agriculture* 13, no. 2: 139-150.

The role of organic agriculture, whether in farming, processing, distribution, or consumption, is to sustain and enhance the health of ecosystems and organism from the smallest microbe in the soil to the human beings. The broad objectives of organic farming in India can be sustainable agriculture, environmental protection, increasing agriculture production, conservation of natural resources, food self-sufficiency and rural development in the light of the adverse effects of the conventional farming system the country practiced for about 30–40 years and the potential benefits of the organic methods. The North-East constitutes eight states and covers an area of 2.62 lakh sq.km. accounting for 7.9% of total geographical area of the country. With a total population of 39 million, it accounts for 3.8% of total population of India. It is a region with strong natural and human resources. The agricultural productivity is the lowest, irrigation facility almost non-existent in many of the areas and consumption of fertilizer is extremely low in the region. The region provides considerable scope and opportunity for organic farming due to least utilization of chemical inputs. It is estimated that 18 million hectare of such land is available in the North-East, which can be exploited for organic production. The paper discusses the progress and the present status of organic agriculture in the North Eastern state of Mizoram with reference to status and prospects of organic agriculture in the state from farming system perspective.

300

Gills Reshma, Rashmi Singh and Manjeet Singh Nain. (2013). "Extent of Adoption and Perceived Reasons for Organic Cardamom Production in Idukki District of Kerala." *Journal of Community Mobilization and Sustainable Development* 8, no. 1 (2013): 41-47.

Organic agriculture in developing countries is becoming a tool for socioeconomic development and is supported by various international and national development initiatives. In India spices being major contributors to national income, are gaining attentions regarding the organic farming practices. Present study conducted in Idukki district of Kerala was aimed to identify the extent of adoption of various recommended practices and reasons for adopting organic cultivation practices of cardamom. Data were collected from 120 respondents, comprising 90 organic and 30 inorganic cardamom farmers' which were selected through multistage sampling procedure. The results of the study on different aspects of extent of adoption in case of organic and inorganic farmers clearly showed that most of the practicing farmers were innovative in the complete adoption of the relevant technologies. Organic cardamom growers were found to be more innovative in the adoption of practices like planting material selection, the water and soil conservation technologies, and plant protection measures contributing higher benefit for the overall improvement of their farmland and the income generating capacity of farmers. The apprehension for the pollution free environment, chemical free produce, and increased demand for the organic cardamom in the international and the domestic markets horde farmers briskly to adopt organic farming practices in cardamom.

301

Shetty PK, MB Hiremath and M Murugan. (2013). "Status of Organic Farming in Agro Ecosystems in India." Indian Journal of Science and Technology 6, no. 8: 5083-5088.

Organic farming is the form of crop growing that relies on techniques like crop rotation, green compost, manure and biological pest control. This study was an initial attempt to know the status of organic farming in pesticide use predominant 28 districts in 12 Indian states. Doctors, pesticide vendors and agricultural officers of regions were interviewed to study the status of organic farming in the selected areas. Data were collected through pre-tested schedules by trained field investigators. A total of 1577 samples from 290 randomly selected villages were keyed in to Visual Basic front end in MS Access data base. In this study only 3% of the respondents across the country reported that they had practiced organic farming only, whereas 51% of respondents practiced chemical farming and 46% of respondents had taken up both organic and chemical farming. Appropriate research and extension services need to be developed to make available to farmers all the relevant information on organic farming.

302

Bodapti Subrahmanyeswari, and Mahesh Chander. (2013). "Integrating indigenous knowledge of farmers for sustainable organic farming: An assessment in Uttarakhand state of India." *Indian Journal of Traditional Knowledge* 12, no. 2: 259-264.

Success of organic farming largely depends on farmers' knowledge of ecological systems, environment and on-farm renewable resources, as per the principles of organic farming. A study has been conducted to know the traditional knowledge and indigenous practices being followed by farmers in agriculture and animal husbandry to assess the possibility of integrating with organic farming in Uttarakhand, which is the first state in India promoting organic farming in a systematic way. The farmers of Uttarakhand especially women possessed a vast pool of indigenous knowledge with regards to livestock management leading to reduced dependence on externally purchased inputs as required under organic farming systems. And the farmers were in the practice of utilizing renewable farm resources. The Uttarakhand Organic Commodity Board (UOCB) had taken initiatives like compiling farmers' age old knowledge, "sayings" and "practices" relating to natural resource management in the form of booklets to protect it from gradual extinction and integrating it successfully with organic production methods. Such knowledge and practices of farmers is worth validating and exchanging with the other parts of the world to make organic agriculture sustainable.

303

Archana K. (2013). Role of Indian government in the development of organic agriculture. *IOSR Journal of Agriculture and Veterinary Science.* Vol. 2, Issue 6: 32-39.

The growth of organic agriculture production and trade has been accompanied by an increase in national legislation in order to set the minimum requirements for organic agriculture and create the institutional framework for certification, thus giving the organic label greater credibility. Government intervention can take the form of public inspection and certification, or the accreditation of private inspection and certification bodies. Legislation also ensures fair competition among producers and facilitates equivalence with other countries for international trade. Because of the health and environmental benefits and trade opportunities associated with organic agriculture, governments may pass regulations that encourage farmers to shift to organic methods, through tax reductions/exemptions, subsidies, or support in research and marketing. In India with the introduction of NPOP programme, minimum standards for organic products have been set up. But the measures taken are not adequate. The paper throws light on the development of different agencies in setting standards for Organic Agriculture.

304

Singh Surabhi. (2013). "Organic Products: Marketing Practices and Problems in the Plains and Hilly Regions of Uttarakhand." *Indian Journal of Marketing* 43, no. 2: 37-49.

In the present study, the investigator explored the problems perceived in marketing of organic products by farmers in Uttarakhand state of India. Descriptive research design with survey method, wherein data were collected through face-to-face structured interviews with 72 farmers in the plains and hilly regions of Uttarakhand was adopted for the present investigation. Data were analyzed with descriptive statistics and Chi square test to provide additional information about the effect of the selected variables on perceived problems. The objectives focused on the prevalent marketing practices adopted by the farmers for organic crops and to ascertain marketing related problems perceived by them with reference to organic crops. The most prominent problem in marketing of organic crops reported by the respondents in the plain areas of the state of Uttarakhand was related to 'High Production Cost' that led to low profit, or no profit; while the largest proportion of the respondents from the hills reported 'Unavailability of an earmarked market place/shop for organic crops' to be their biggest cause for concern. The paper further deals with the market place for transaction, distribution channels, satisfaction of the sample of farmers, information on organic crops grown, perceived problems of farmers and implications of the study.

305

Yadav SK, Subhash Babu, MK Yadav, Kalyan Singh, GS Yadav and Suresh Pal. (2013). "A Review of Organic Farming for Sustainable Agriculture in Northern India." *International Journal of Agronomy*.

In the post independence period, the most important challenge in India has been to produce enough food for the growing population. Hence, highyielding varieties are being used with infusion of irrigation water, fertilizers, or pesticides. This combination of high-yielding production technology has helped the country develop a food surplus as well as contributing to concerns of soil health, environmental pollution, pesticide toxicity, and sustainability of agricultural production. Scientists and policy planners are, therefore, reassessing agricultural practices which relied more on biological inputs rather than heavy usage of chemical fertilizers and pesticides. Organic farming can provide quality food without adversely affecting the soil's health and the environment; however, a concern is whether large-scale organic farming will produce enough food for India's large population. Certified organic products including all varieties of food products including basmati rice, pulses, honey, tea, spices, coffee, oilseeds, fruits, cereals, herbal medicines, and their value-added products are produced in India. Non edible organic products include cotton, garments, cosmetics, functional food products, body care products, and similar products. The production of these organic crops and products is reviewed with regard to sustainable agriculture in northern India.

306

Yadav Dinesh Singh, Pankaj Sood, Surender Kumar Thakur and AK Choudhary. (2013). "Assessing the training needs of agricultural extension workers about organic farming in the North-Western Himalayas." *Journal of Organic Systems Vol 8(1):* 17.

Agricultural extension organizations worldwide face challenges of professional competence among their employees. Planning, training and management of human resources within extension organizations are essential to increase the capabilities and overall effectiveness of extension personnel. This paper examines the training needs of agricultural extension workers in the state of Himachal Pradesh, India, regarding organic farming. Random sampling was used to select 65 extension personnel of the Himachal Pradesh State Department of Agriculture (HPSDA) from within ten districts of the state. The data are self reported scores collected with a structured instrument in which ten aspects of organic farming were addressed. The results revealed that the majority of extension workers reported medium to high training needs in seven specific areas: biodynamic farming, homa farming, biorational pest management techniques, biological methods of pest control, bio-fertilizer technology, record keeping/certification standards, and grading/ packing and marketing of organic produce. The majority of extension workers reported low or no training needs in the areas of composting/ vermicomposting, green manuring/green leaf manuring, and crop rotations. There was no significant relationship between age, educational qualifications, or service experience with identified training needs. To achieve the potential for the uptake and successful implementation of organic farming amongst Himachal Pradesh farmers, the training of HPSDA agricultural extension workers could concentrate on improving their knowledge in the seven identified areas of organic farming skills.

307

Malhi Sukhdev S, Sahota Tarlok S and Gill Kabal S (2013). Chapter 5: Potential of management pratices and amendments for preventing nutrient deficiencies for crops under organic cropping systems. Agricultural Sustainability, Progress and Prospects in Crop Research. Eds GS Bhullar and NK Bhullar, Academic Press/Elsevier. Pp 77-101

Food produced in organic production systems is usually considered better for human health than that produced under conventional systems. Nutrient deficiencies are one of the major limiting factors for sustainable yields under organic cropping systems, because synthetic fertilizers/chemicals are not permitted. Application of compost/manure, alfalfa pellets, thin stillage, distiller grain, and fish food additive can provide nitrogen (N), phosphorus (P), and other nutrients lacking in the soil. Green manuring or crop rotations with legumes improve yields of the succeeding crops. Intercropping annual cereals/oilseeds with grain legumes and perennial forage grass–legume mixtures also provide beneficial effects on crop yields. Liming can reduce soil acidity and improve crop yields. Wood ash can boost yield of crops, by correcting P, sulphur (S), potassium (K), and micronutrients deficiencies and also by increasing pH of acid soils. Gypsum and rapid-release elemental S could be used to prevent S deficiency in organic crops. Organic amendments and crop management practices could increase input of crop residues to soil and thereby improve organic carbon (C) and N storage in soil, and also soil fertility. However, with compost/manure applied at rates much greater than the crop N requirements, or if deficiencies of other nutrients are not corrected, excessive nitrate-N can accumulate in the soil profile. Granular rock phosphate and/or *Penicillium bilaiae* have shown small but inconsistent effects on increasing labile P in soil and crop yields. In conclusion, organic producers may consider integration of crop management practices and amendments to improve soil quality and fertility to increase sustainability of organic crop production systems. Long-term studies are required to determine the feasibility of management practices and amendments for preventing nutrient deficiencies and contributing to sustainable production in organic cropping systems.

308

Vanaja T, KP Mammootty and M Govindan. (2013). "Development of organic indica rice cultivar (Oryza sativa L.) for the wetlands of Kerala, India through new concepts and strategies of crop improvement." *Journal of Organic Systems* 8 (2): 18-28.

Developing crop varieties that are less dependent on the heavy application of synthetic fertilizers is essential for the sustainability of agriculture. Here we report the development of a new rice cultivar, the first of its kind possessing the general criteria for an organic rice variety, at the same time suitable for chemical agriculture as well, and with favourable cooking and nutritive qualities. The method adopted for cultivar development was a combined strategy of pedigree breeding, organic plant breeding, and farmer participatory breeding approaches. Considering its high grain and straw yield potential even under organic management and unfavorable soil conditions, and its other favorable quality and organic varietal traits, farmers have started large scale cultivation of this cultivar even before its commercial release. The cultivar, namely culture MK 157, is at the pipe end of variety release in the Kerala state of India.

309

Gawade Vijay And VV Kulkarni. (2013). "Sustainable Agriculture: Modern Method With Ancient Roots." Laxmi Book Publication.

Agriculture in India is not of recent origin but has a long history dating back to Neolithic age of 7500 – 6500 B.C. It changed the life style of early man from nomadic hunter of wild berries and roots to cultivator of land. Agriculture is benefited from the wisdom and teachings of great saints. The wisdom gained and practices adopted have been passed down through generations. The traditional farmers have developed the nature friendly farming systems and practices such as mixed farming, mixed cropping, crop rotation etc. The great epics of ancient India convey the depth of knowledge possessed by the older generations of the farmers of India. The modern society proves refinement through generations of experience. The ecological considerations shown by the traditional farmers in their farming activities are now a day is reflected in the resurgence of organic agriculture.

310

Behera Kambaska Kumar, Afroz Alam, Sharad Vats, Hunuman Pd Sharma and Vinay Sharma. (2012). "Organic Farming History and Techniques." In *Agroecology and Strategies for Climate Change*, pp. 287-328. Springer Netherlands, 2012.

Organic farming involves holistic production systems that avoids the use of synthetic fertilizers, pesticides and genetically modified organisms, thereby minimizing their deleterious effect on environment. Agriculture area under organic farming ranges from 0.03% in India to 11.3% in Austria. Organic farming is beneficial for natural resources and the environment. Organic farming is a system that favors maximum use of organic materials and microbial fertilizers to improve soil health and to increase yield. Organic farming has a long history but show a recent and rapid rise. This article explains the development stages, techniques and status of organic farming worldwide. The sections are: the development and essential characteristics of organic farming; the basic concepts behind organic farming; historical background; developmental era of organic farming; methods of organic farming; relevance of organic farming in the Indian context; comparative account between organic farming and conventional farming; importance of organic farming in environmentally friendly approaches; working with natural cycles; relevance of organic crop production in food security; yield potential and trends of organic farming; rural economic linkage its scope and limitations; and legislation procedures adopted by various countries. Organisations and financial aspects of organic farming are briefly discussed.

311

Adithi Rao and Rajeswari S Raina (2012). "Organic AgricultureCoarse Cereal Production and Marketing in Bijapur District in Karnataka.", Revitalising Rainfed Agriculture Network. Christ College and NISTADS

Coarse cereal production is picking up in Bijapur and in Karnataka as a whole partly because of a consumer preference for traditional and nutritious foods. But the farmers face no incentive to produce organic certified coarse cereal for consumption continues in many parts. The state government's OA policy and schemes do help increase awareness and gives farmers an opportunity to reduce cost of cultivation by using more locally produced or own farm inputs. But OA markets need to be developed carefully, with adequate support to OA farming skills and time management as well as support to aggregators or farmers groups who can collectively sell their produce at a good price, may be even after some primary processing.

312

Pandey Jitendra and Ashima Singh. (2012). "Opportunities and constraints in organic farming: an Indian perspective." *J Sci Res* 56: 47-72.

Organic farming follows the principle of circular causation and has emerged in response to questions on health, environment and sustainability issues. In this review, we assess the status, opportunities and C- sequestration potentials of OF in India. We identify constraints that impede adoption of OF especially for small farm holders who constitute over 70% of farming community in India. With large land area and climate diversity, India has a considerable potential to contribute to C-sequestration. The soil organic carbon (SOC) in cultivated soils is less than 5 mg g-1 compared to 15-20 mg g-1 in uncultivated soils. This available potential of 10-15 mg g-1 soil– C sink could balance net emission from fossil fuel combustion. Although India occupies second position in terms of number of certified organic farms (44,926), it is 13th in terms of area under OF representing only 0.3 % of total agricultural lands. This scenario appears poor compared to many other countries. Farmers apprehension towards OF in India is rooted in nonavailability of sufficient organic supplements, bio fertilizers and local market for organic produce and poor access to guidelines, certification and input costs. Capital-driven regulation by contracting firms further discourages small farm holders. An integrated effort is needed from government and nongovernment agencies to encourage farmers to adopt OF as a solution to climate change, health and sustainability issue.

313

Joshi CP, BB Singh and OP Mishra. (2012). "Communication Strategy for Promoting Organic Farming in a Hilly State of India." *Journal of Global Communication* 5, no. 2: 172-180.

The pace of development has been accelerated with the effectiveness of communication. Communication can be made effective by designing communication strategy in line with the source, content of the message, channel and the target audience. Organic farming involves modern and traditional agricultural practices. Farmers in the Kumaon hills of Uttarakhand follow farming in traditional way, and these farming systems, therefore, can be easily converted into organic farming, as the soil and environment there is almost free of the residuals of synthetic chemicals. Organic farming will convert the subsistence farming in hilly areas to sustainable agriculture. This study aims at designing a communication strategy to popularise organic farming by using mass media, interpersonal channels and farmers' participation. This paper makes a case for the use of participatory communication, involving farmers, for promoting organic farming practices.

314

Purushothaman Seema, Sheetal Patil and Ierene Francis. (2012). "Impact of policies favouring organic inputs on small farms in Karnataka, India: a multicriteria approach." *Environment, Development and Sustainability* 14, no. 4: 507-527.

Over 56% of the population of Karnataka state in India depends on agriculture for its livelihood. A majority of these are small and marginal farmers, with land under 2 ha, responsible for nearly half the food production in the state. The increasing rate of farmers' suicides in the state is reportedly fuelled among others, by increasing input costs, crop failure and accumulating debt. This triggered several policy measures, intended to improve the sustainability of farm livelihoods including those promoting organic practices in farming. The paper presents the results of a multicriteria analysis conducted to comprehend the effects of two different practice–policy scenarios on smallholders in Karnataka—one scenario 'with policy' (WP) to support organic agricultural practices and the other a 'business as usual' (BAU) scenario that continues to stress on market-based, synthetic inputs for cultivation. The paper integrates results from quantitative and participatory techniques to compare and project effects on ecological, economic and socio-cultural indicators. Ecological and economic indicators in WP are projected to be significantly higher than BAU in a majority of the study sites, while sociocultural indicators show mixed outcomes, depending on regional and social characteristics. Across the study sites, small and rain-fed farms are benefitted better in WP compared to large and irrigated farms, respectively. Among small and rain-fed farms, soil fertility, water quality, agro-diversity, net income and freedom from indebtedness improve considerably, while there is slight reduction in collective activities and no perceivable change in land-based subsistence.

315

Jayawardana JKJP and AK Sherief. (2012). "Influence of sociopsychological characteristics in adoption of organic farming practices in coconut based homesteads in humid tropics." In *COCOS*, vol. 19, no. 2: 101-104.

A study was conducted to find out the influence of socio-psychological characteristics in adoption of organic farming practices in coconut-based homesteads. The study was conducted in Kalliyoor, Venganoor and Kuzhumilum panchayats of Nemom, Adiyanoor and Chirayin keezh blocks respectively in Thiruvananthapuram district in Kerala state, India. Multistage random sampling technique was administered to select 105 coconut based homesteads farmers, 35 per each block. Data were collected through pretested structured interview schedule and the relationship between the dependent variables and adoption was studied using correlation analysis. Correlation coefficient indicated that education, innovativeness, risk orientation, market perception, self confidence, information seeking behavior, awareness, knowledge and attitude towards organic farming practices showed significant correlation with adoption. However age, experience in coconut cultivation, livestock possession, training attended and environmental orientation had negative and non significant correlation with adoption of organic farming practices among the coconut based homestead farmers.

316

Desai Suseelendra, Minakshi Grover, E Leo Daniel Amalraj, G Praveen Kumar and SK Mir Hassan Ahmed. (2012). "Exploiting plant growth promoting rhizomicroorganisms for enhanced crop productivity." In *Microorganisms in Sustainable Agriculture and Biotechnology*, pp. 227-241. Springer Netherlands, 2012.

The increasing pressure on land resources has made it imperative for vertical growth through enhanced crop intensity and productivity. To meet this challenge, appropriate integrated nutrient and pest management packages must be configured for different agro-ecological conditions. By 2050, the crop nitrogen demand is expected to reach 40–45 million tonnes. To meet such enormous nitrogen requirements through chemical fertilizers, would not only be expensive but also could severely degrade soil health. Similar is the situation with other macro- and micro-nutrients. The rhizosphere environment, at the interface between root and soil, is a major habitat for soil processes. Rhizosphere biology is approaching a century of investigations, wherein growth-promoting rhizomicroorganisms such as *Rhizobium*, *Azotobacter, Pseudomonas, Bacillus, Azospirillum, Frankia* and mycorrhizal fungi have attracted special attention on account of their beneficial activities. Plant growth promoting rhizomicroorganisms (PGPR) include diverse microbes that influence plant health by colonizing roots, enhancing plant growth, reducing plant pathogen populations and activating plant defenses against biotic stresses. PGPRs promote plant growth in different ways such as influencing plant hormonal balance, antagonistic to pathogens through various modes, stimulation of plant resistance/defense mechanisms, effects nutrient uptake by secretion of organic acids or protons to solubilize nutrients, atmospheric N_2 fixation and by modifying rhizospheric soil environment by exo-polysaccharides production. Though research was going on in isolation in the above areas, with the advent of a core group for PGPR research, the pace in this direction has significantly increased. The primary emphasis on exploiting the vast biodiversity of microorganisms to identify the beneficial strains has yielded very good results. However, most of the research is yet to reach the end-users. For effective transfer of these technologies, there is a need for functional networking of research, industry and extension systems. In this paper, we describe the recent advances in PGPR research and the future needs to strengthen PGPR research and development that will transfer the benefits to the end-users for enhanced and sustainable farm productivity hence contributing towards food security challenges.

317

Nazeerudin (2012). "Organic agriculture in rural development:a paradigm shift". *Asian Journal of Research in Social Sciences and Humanities.* Vol. 2 (3)

The role of Organic Farming in India Rural Economy can be leveraged to mitigate the ever-increasing problem of food security in India. With rapid industrialization of rural states of India, there has been a crunch for farmland. Further, with the exponential population growth of India, the need for food sufficiency has become the need of the hour. Furthermore, the overuse of plant growth inhibitor, pesticides and fertilizers for faster growth of agricultural produce is detrimental to human health and the environment as a whole. The proposition of Organic Farming in India Rural Economy holds good, as an alternative to arrest this problem. Rural development policy of India can be featured by multispectral and integrated approach. The introduction of the process of Organic Farming in India's Rural Economy is a very new concept. Against this backdrop, this paper made an attempt to critically analyse the role of organic farming in rural development; further it also examined the global and Indian scenario trends of organic farming at the country and global level.

318

Arora Saurabh. (2012). "Farmers' Participation in Knowledge Circulation and the Promotion of Agroecological Methods in South India." *Journal of Sustainable Agriculture* 36, no. 2: 207-235.

In the context of widespread agrarian distress in rural India, finding ways to secure livelihood sustainability of small farmers have become urgent concerns. Agroecological methods (AEMs) are considered by some to be effective in solving structural problems with farmers' production processes engendered by the use of resource-intensive technologies. AEMs generally require extensive participation by farmers for further development through on-farm experimentation and collective learning. This article studies learning through the lens of knowledge circulation between farmers and "experts" in a local innovation system. In particular, it analyzes farmers' participation in knowledge circulation using network data on problem-solving knowledge flows to and from an innovative south Indian village. The findings suggest that farmers' participation was restricted by formal and informal institutions governing the knowledge interactions between the development organizations that promoted AEM and the farmers. Any new ways of working (technological and institutional innovations) are argued to be filtered through the sediments of extant techno-institutional context, leading to the profusion of hybrid forms of technology and organization. However, despite this profusion, or perhaps because of it, epistemological and sociocultural hierarchies continue to operate in avowedly participatory projects organized to promote AEMs based on farmers' "traditional knowledge."

319

Roner T; Messmer MM; Finckh M; Forster D; Verma R; Baruah R and Patil SS. (2012). Participatory cotton breeding for organic and low input farming in Central India. In: Tielkes, E. (Ed.) *Tropentag 2012 - Resilience of agricultural systems against crises - Book of abstracts*, Cuvillier Verlag, Göttingen, Germany.

Up to 80% of world's organic cotton is produced in India. However, involved producers are facing increased difficulties to find suitable cultivars. Few hybrids selected for high input farming and genetically-modified (GM) cotton, which is explicitly excluded in organic farming, are presently dominating the Indian seed market. In addition farmers have lost their traditional knowledge on seed production and hybrid seed needs to be purchased each season.

320

Singh Surabhi and Rachel George. (2012). "Awareness and Beliefs of Farmers in Uttarakhand, India." *J Hum Ecol* 37, no. 2: 139-149.

Agriculture sector contributes a major portion in gross production of India. In spite of this, agriculture today is finding itself in increasing difficulties. The adverse impact of agriculture based on synthetic fertilizers and herbicides is visible in the degradation of soil fertility, quality of food, taste of food and so on. Organic agriculture may prove to be a boon to curb these adverse effects. There is dearth of information on organic farming in India in general and in Uttarakhand in particular. Hence, the present study was conceived with the broad objective of building authentic database on demographic profile of farmers pursuing organic farming, their belief and awareness regarding organic farming in this hill state of North India. Purposive random sampling was adapted to select districts, blocks and villages. A sample of 72 farmers pursuing organic farming was selected randomly for the study. The study was conducted in plain and hills regions of Uttarakhand. The results showed that the farmers carried out organic farming in a relatively smaller proportion of their land holding. While the respondents were cognizant about some basic facts of organic farming, they were not aware of all the aspects related to certification and standards given by different agencies. Respondents of the study were inclined to have favorable beliefs towards organic farming. The respondents, by and large, revealed good faith in organic farming. To promote organic farming, government should make policies and plan training and educational modules for farmers.

321

Nagnur Shobha, Vijaya Hosamani and Anitha Shapur. (2012). "Training on organic farming practices for women–An impact study." *Karnataka Journal of Agricultural Sciences* 25, no. 2.

The world over, human health is at risk. While on one hand people are dying due to scarcity of food, on the other they are slowly being poisoned by the chemicals used for growing food. Organic farming is therefore the need of the hour. Women in India are as much farmers as men are; and being equal contributors in food production, need to be educated about organic farming concepts. The present study was conducted on 150 farm women of five villages of Dharwad taluk of Karnataka. Lectures, exhibitions and demonstrations were conducted to train women on organic farming concepts and the use of farm and animal wastes. The findings revealed that women's knowledge before intervention was low. The 'T' test applied to knowledge scores before and after the exhibitions, lectures and demonstrations showed significant results indicating that the training programmes were effective in educating rural women on organic farming. It is assumed that the knowledge gained will be helpful in practicing organic farming using agriculture and animal wastes available on their own farm. Women may also play a significant role in influencing men in adopting organic farming.

322

Siddaraju VG (2011). "Impact of Non-governmental organization on organic agriculture development-An empirical analysis from Karnataka." *Asian Journal of Development Matters* 5, no. 3: 288-293.

Agriculture, the primary activity on the globe and in every society, has the most critical role to play in sustainable life for living beings. In agriculture, sustainability means development not only in quantity of output but also qualitative improvement in socioeconomic conditions. It is observed that many countries across the world provide support for modern agriculture, mainly to increase the productivity for commercial purpose without considering the environment sustainability. Development economists have adopted the term sustainability, which means development that meets the needs of the present generation without compromising the ability of future generation to meet their own needs. Organic agriculture is one of the diversified traditional farming systems aimed at agricultural sustainability. While some of the study focused only on macro level without much empirical evidence. In this direction, the study has following two fold objectives. Firstly to study the role of Non-governmental organization in promoting organic agriculture in Karnataka. Secondly, to estimate the resource utilization in the organic agriculture. For the present study, four NGOs and two Organic Farmers have been selected randomly for detailed investigation and relevant information was collected by personal visits. The government of Karnataka was the first to frame the Organic Farming policy in India in the year of 2004. The over all analysis of the study highlights that the third sector (NGOs) has an important role to achieve the sustainable development through the organic agriculture. Sustainable Development through the effective utilization of natural resources is by organic agriculture. Organic agriculture is one of the best approach to get sustainability in the crop production.

323

Goswami Rupak and Md Nasim Ali. (2011). "Use of Participatory Exercise for Modelling the Adoption of Organic Agriculture." *Journal of Extension* 49, no. 3.

Participatory methods may prove helpful at the exploratory phase of developing a working adoption model for organic agriculture. A study carried out in selected areas of West Bengal, India employed innovative participatory methods for identifying farmers' perception regarding the attributes of organic agriculture and several farm- and farmer-related factors. Analysis of participatory exercises facilitated the development of a potential pool of factors that may be used for developing an effective adoption model for organic agriculture. The process helps develop econometric models that study the transition of chemical agriculture to organic agriculture.

324

Aher Satish B, B Sengupta and Swami Bhaveshanada. (2011). "Organic agriculture: Way towards sustainable development." *International Journal of Environmental Sciences*. Vol. 3(1):209-216

Organic agriculture has a potential to fulfill the food requirement of the world with sustainable resource utilization. This review illustrates how organic agriculture plays a role towards sustainable utilization of resources in food production as well as development with less pollution and contribution to the green house gases; ultimately climate change. Recent research in the field concluded that organic farming is better equipped to feed us now and well into the ever changing future. As Organic yields match conventional yields, Organic outperforms conventional in years of drought, Organic farming uses 45% less energy and is more efficient, Conventional systems produce 40% more greenhouse gases, Organic farming systems are more profitable than conventional and most important organic farming systems build rather than deplete soil organic matter which supports the soil micro, meso and macro fauna and makes the soil a living body; making it a more sustainable system. Organic agriculture offers a unique combination of environmentallysound practices with low external inputs while contributing to food availability. To avoid ill effects of the conventional farming system it's an urgent need to adopt the organic farming practices, it not only improves the health of human community by providing safe food but also has the potential to mitigate climate change mostly claimed on the basis of assumptions concerning the soil carbon sequestration potential of organic management. Organic agriculture is the way towards sustainable development of mankind.

325

Poyyamoli Gopalswamy and Anbarashan Padmavathy. (2011). "Analysing innovative sustainable practices extend and income generation in organic farming and GRA fields in Bahour, Puducherry, India." *Journal of Development and Agricultural Economics* 3, no. 6: 252-260.

In past decades, agricultural development majorly focused on short term productivity based on external inputs resulting in neglect and improper use of natural resources. Thus, it leads to ecosystem damage and loss of food security. This has forced the farmers, scientists and the policy makers to look at sustainable farming techniques through organic farming. In India there is greater possibility of bringing green revolution agricultural areas under the gambit of sustainable farming/organic farming. Research and development is necessary to better understand the complex ecological processes as well as the management capacity of farmers. Hence, this research study was done to analyze the reach and adaptation level of sustainable farming techniques by organic farmers and non- adoption (sustainable farming techniques) reasons among the Green Revolution Agriculture (GRA) farmers at farm level. This will help us to find different strategies to popularize sustainable organic farming among the farmers in order to overcome food crisis.

326

Padmavathy K and Poyyamali G (2011). "Alternative Farming Techniques for Sustainable Food Production. Genetics, Biofuels and Local Farming Systems". *Sustainable Agriculture Reviews*. Vol. 7. Pp 367-424

Sustainability and food security are the major challenges faced by third world countries for the past several decades. Most of the third world countries are also facing problems of climate change, increasing population, overexploitation of natural resources and resource degradation associated with rapid economic growth. Among the scientific and policy circles there are controversies in using inorganic chemicals and biotechnology for sustaining the agricultural production. There is no critical comprehensive review on sustainability of alternative farming systems and their relative advantages over conventional, chemicalized and hi-tech agriculture for decision making at various levels. This review tries to fulfill the knowledge gap in this vital sector. The first part of the review discuss the current status of agroecosystems, with emphasis on their threats in terms of food security, long term sustainability, impacts on ecosystem services and climate change. We also evaluate the ecological, economic, social and cultural sustainability of inorganic agriculture. This analysis points emerging issues such as environmental degradation, loss of ecosystem services, non-sustainability and threats to food security in the context of global population growth and climate change. Hence there is an urgent need for identifying potential alternative farming strategies to achieve long term sustainability and food security as indicated by several leading workers in the field. The next section traces the background and evolution of alternative farming systems with their scope and importance. Then we classified potential sustainable farming techniques practiced in various parts of the world. For that we review potentials, constraints, strategies and case studies for ten alternatives farming techniques and four innovative endogenous farming techniques from India. The alternative farming techniques that were field tested and perfected over several generations in the past portrayed the following advantages over chemical farming: (1) eco-friendly by protecting and revving life support systems and ecosystem services, (2) higher cost benefit ratio, benefiting the farmers as well as the consumers, (3) control and reduction of bioaccumulation and biomagnification, (4) reduction in air, water and soil pollution caused by various pesticides and other chemicals, (5) control of health hazards in humans and livestock, and (6) conservation and sustainable use of on-farm biodiversity, including traditional cultivated germplasm and natural resources in agrosystems.

327

Oruganti Madhuri. (2011). "Organic Dairy Farming–A New Trend in Dairy Sector." *Veterinary World* 4, no. 3: 128-130.

Organic Dairy farming means raising animals on organic feed (i.e. pastures cultivated without the use of fertilizers or pesticides), have access to pasture or outside, along with the restricted usage of antibiotics and hormones. Products obtained from Organic dairy farm are the organic dairy products. Organic farming is a system of production, a set of goal-based regulations that allow farmers to manage their own particular situations individually, while maintaining organic integrity. In this article, the benefits, conditions required, constraints involved, and managemental practices of organic dairying, along with information about the regulatory authorities concerned with the organic dairy farming were reviewed briefly to make students and farmers aware of organic dairy farming.

328

Biradar CS, MS Dodamani, BK Inamadar and AJ Murasalogi. (2011). "Organic Poultry Farming in India-issues and approaches." *Veterinary World* 4, no. 6: 273-277.

In the last few decades poultry industry has transformed from mere back yard poultry to commercial farm, but the issues of food safety and quality remains unaddressed. Hence, organic poultry farming has become as an approach to address these issues. This paper attempts to discuss the various issues of organic farming along with necessary interventions required in poultry breeding, feeding, housing and health care management under Indian Scenario. Further, necessary policy interventions were also suggested in order to promote organic poultry farming.

329

Singh Inder Pal and DK Grover. (2011). "Effects of green revolution: and recent development of organic farming with special reference to Indian Punjab." *Journal of Progressive Agriculture* 2, no. 1: 4-14.

The high nutritional requirements of paddy and wheat, the major crop rotation in the state has exhausted the soil of nutrients. Resultantly, Punjab state which has just around 3% of cultivated area accounts for about 10 percent of total chemical fertilizer consumption in the country. The state is adding 1332 thousand tonnes of nitrogen, 379 thousand tonnes of phosphorus and 57 thousand tonnes of potassic fertilizers to the soil annually. The use of chemical fertilizers in the state has gone up many times from 213 thousand tonnes in 1970–71 to 1768 thousand tonnes in 2008–09. The fertility of Punjab soils has diminished over the years with deficiency in nitrogen and phosphorus. Thus, it is clear that the present farming system is not sustainable as the soil is deficient of all the micro and macronutrients. Now, the area under organic farming in India too has increased from 37000 ha to 103, 000 ha during 2002–03 to 2007–08. Similarly, organic farming has been introduced in the state of Punjab recently and gaining wide popularity. The study concluded that only 67 ha (0.016 percent of the total certified area in India) area was certified and about 3253 ha (0.70 percent of the total in conversion area in India) area is under conversion for organic farming during 2008 in Punjab. The total area under organic farming (certified +inconversion) was about 3320 ha (0.38 percent of the total area under organic farming in India) during 2008 in Punjab. The present paper highlighted the effect of green revolution over the years in respect to chemical fertilizer and pesticide consumption, contamination of food, deterioration of soil fertility and also highlighted the recent developments of organic farming in respect to area, export, infrastructure set up etc in the world as well as India with special reference to Indian Punjab by taking secondary information from different sources as well as primary information from the farmers.

330

Roy S and KN Dhumal. (2011). "Organic Agriculture: The Indian Scenario." *Agricultural Reviews* 32, no. 1: 70-74.

India witnessed self-sufficiency in food production due to the grand success of Green revolution introduced in 1960's. Ignoring the fact that the revolution will do nothing but rob off all the wealth of the soil, India marched off making new innovations in the agricultural sector. By the advent of the 20th century, the soil health was completely lost due to the rampant use of the agrochemicals. Instead of undertaking a new anthropogenic venture to deal with the problem, it was suggested that the farmers should go back to the arms of the nature and take up organic farming to restore the loss. While few farmers readily took up this suggestion, some of them showed a great deal of reluctance as the problems of productivity, costs and profits overshadowed their decisions. The Indian government is actively participating to promote organic agriculture. Recent statistics point India to be amongst the top 10 countries, having maximum land under organic cultivation. The organic market in India looks quite promising but it needs an additional backup from the Indian government to combat the reluctance of Indian farmers towards organic farming.

331

Kumara Charyulu D and Subho Biswas. (2010). Economics and Efficiency of Organic Farming vis-à-vis Conventional Farming in India. *No. 2010-04. Working Paper,* 2010. IIM-Ahmedabad
Organic farming systems have attracted increasing attention over the last one decade because they are perceived to offer some solutions to the problems currently besetting the agricultural sector. Organic farming has the potential to provide benefits in terms of environmental protection, conservation of non-renewable resources and improved food quality. India is bestowed with lot of potential to produce all varieties of organic products due to its diverse agro-climatic regions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic market related to the export market. In India, the land under certification is around 2.8 million ha. But, there is considerable latent interest among farmers in conversion to organic farming. However, some farmers are reluctant to convert because of the perceived high costs and risks involved in organic farming. Despite the attention which has been paid to organic farming over the last few years, very little accessible information actually exists on the costs and returns of organic farming in India. The empirical evidences of efficiency analysis of organic and conventional farming systems are scarce or even absent. So, the present paper focuses mainly on the issues like economics and efficiency of organic farming vis- à-vis conventional farming in India. Four states namely Gujarat, Maharashtra, Punjab and U.P were purposively selected for the present study. Similarly, four major crops i.e., cotton, sugarcane, paddy and wheat were chosen for comparison. A model based non-parametric Data Envelopment Analysis (DEA) was used for analyzing the efficiency of the farming systems. The crop economics results showed a mixed response. Overall, it is concluded that the unit cost of production is lower in organic farming in case of cotton and sugarcane crops where as the same is lower in conventional farming for paddy and wheat crops. The DEA efficiency analysis conducted on different crops indicated that the efficiency levels are lower in organic farming when compared to conventional farming, relative to their production frontiers. The results conclude that there is ample scope for increasing the efficiency under organic farms.

332

Gupta Mukesh (2010). "Organic Agriculture Development in India by Government". *Financing Agriculture*. Vol. 42, No. 11. Pp.6

The First Initiative: Steering Group In late nineties, a Steering Group was constituted by Government of India under the Chairmanship of Dr. M.s. Swaminathan to give its recommendation for organic farming in India. This Committee gave following recommendations: • Organic Farming can be a major thrust area for promotion in NE region and rainfed areas having low consumption of agro chemicals.

333

Chandrashekar HM. (2010). "*Changing scenario of organic farming in India: An overview". International NGO Journal*, 5 (2): 34-39

India produces a large variety of food crops including cereals, pulses and oilseeds. Diversified agriculture is the priority of the Central Government, and technical and financial support is being extended to farmers to encourage diversification especially in the areas of horticulture, floriculture, medicinal and aromatic plants, apiculture (pee-keeping) and sericulture. The government is continuously working towards the development of the agribusiness sector through considerable emphasis on infrastructure and food processing. However, there is still a scope for further development and up-gradation of technology and agri-infrastructure to attain world-class standards. The main emphasis is on quality enhancement, infrastructure development and the use of modern technology. Organic farming was practiced in India since thousands of years. The great Indian civilization thrived on organic farming and was one of the most prosperous countries in the world, till the British ruled it. Increasing pesticide residues in food materials, eutrophication of surface and ground-waters and increasing nitrous oxide emissions which are detrimental to the ozone layer of the atmosphere, drew attention towards the harmful effects of modern agriculture and environmentalists pressed hard for a more sustainable agriculture. The role of organic farming in India rural economy can be leveraged to mitigate the ever-increasing problem of food security in India. With rapid industrialization of rural states of India, there has been a crunch for farmland. Further, with the exponential population growth of India, the need for food sufficiency has become the need of the hour. Furthermore, the overuse of plant growth inhibitor, pesticides and fertilizers for faster growth of agricultural produce is detrimental to human health and the environment as a whole. An attempt is made to analyze the importance of organic farming, principle of organic farming, Organic farming in rural economy, consumption pattern and export of organically produced products in India.

334

Das Kasturi (2010): Conventional Farming to Organic Agriculture. *Financing Agriculture*. Vol. 42. No. 11: 14

Even as the sustainability of the chemical intensive agricultural practices promoted by the Green Revolution in India is increasingly being called into questions, organic agriculture seems to be emerging as an alternative farming model. This is evident from the recent trend among an increasing number of farmers in the Green Revolution belts of the country to voluntarily switch over to organic agriculture from the 'hybrid seeds-agrochemicals and irrigation' based conventional farming technologies.

335

Surabhi Singh and Rachel George (2010): "Inputs in organic farming: are they factual in plain and hill regions of Uttarakhand?". *Journal of Human Ecology*. Vol. 32 (1): 55-61.

Agriculture sector contributes a major portion in gross production of India. In spite of this, agriculture today is finding itself in increasing difficulties. The adverse impact of agriculture based on synthetic fertilizers and herbicides is visible in the degradation of soil fertility, quality of food, taste of food and so on. Organic agriculture may prove to be a boon to curb these adverse effects. There is dearth of information on inputs of organic farming in Uttarakhand in general, and in the plain and hill regions of Uttarakhand in specific. Hence, the present exploratory study was conceived with the broad objective of building authentic data based on input aspect used in organic farming by farmers in Uttarakhand. Purposive random sampling was adopted to select districts, blocks and villages. A sampling frame was prepared after conducting census survey. A sample of 72 farmers pursuing organic farming was selected randomly for the study. The study was conducted in plain and hill regions of Uttarakhand. It was evident from the present research that local sources of information such as Sarpanch, Gram-sabha members and so on lacked to facilitate farmers, pursuing organic farming. No farmer used certified organic seed. It was observed in present investigation that instead of different types of composts, DAP and Urea were also used by good number of farmers, which were not allowed in NPOP guidelines. Farmers in the hill faced more irrigation problems as compared to plain farmers. It can be concluded from the research that farmers were not following NPOP guidelines stringently. To encourage organic farming, its awareness should be increased among farmers. To promote organic farming government should make policies and plan training and educational modules for farmers.

336

Reddy B Suresh. (2010). "Organic Farming: Status, Issues and Prospects–A Review" *Agricultural Economics Research Review* 23, no. 2: 343-358.

This review paper attempts to bring together different issues in the light of recent developments in organic farming. The after effects of green revolution have encouraged the farmers to take up organic farming. This paper has reviewed the global and Indian scenario with reference to organic farming. In India, the cultivated land under certification is 2.8 Mha only. The key issues emerging in organic farming include yield reduction in conversion to organic farm, soil fertility enhancement, integration of livestock, certification constraints, ecology, marketing and policy support. The potential for organic farming, especially in the dryland regions has been discussed. It has been argued that organic farming is productive and sustainable, but there is a need for strong support to it in the form of subsidies, agricultural extension services and research.

337

Mahajan A and RD Gupta. (2009). "Bio-fertilizer: their kinds and requirements in India." *Integrated Nutrient Management (INM) in a sustainable rice-wheat cropping system. Springer Netherland* (2009).

After the Green Revolution agriculture was mainly based upon a package of various agricultural inputs, namely the use of high-yielding varieties of different crops, water, pesticides and chemical fertilizers. Excessive use of nitrogenous fertili zers in many rice- and wheat-producing states in comparison to phosphatic and potassic fertilizers has not only deteriorated the soil health but has also impaired the health of human beings and animals (Gupta and Singh, 2006). Similarly indiscriminate and excessive use of pesticides produced health hazards in animals and human beings and soil macro/micro flora and fauna (Gupta and Singh, 2008). Thus, to reinforce the development of sustainable agriculture, use of bio-fertilizers has assured great promise to mete out the nutrient demand. The term 'biofertilizers' denotes nutrient supplement inputs for plant growth which are biological in origin. The role of biofertilizers in agricultural production assumes special significance, particularly in the present context of expensive chemical fertilizers. Moreover, it can provide the farmers with a new strategy which is helpful for achieving the goal of increasing productivity. Keeping in mind the environment safety, food security and availability of resources, it becomes obligatory to harness the full potential of the available bio-fertilizers.

338

Aulakh CS, Surjit Singh, SS Walia and Gurpreet Kaur. (2009). "Farmers' perceptions on organic farming in Punjab." *Journal of Research, Punjab Agricultural University* 46, no. 1/2: 9-13.

A survey of forty seven organic growers was conducted during 2007-08 to get information on crops being grown and organic manures being used by the organic growers and to know the farmers' perception about organic farming and constraints in its adoption. The survey indicated that 38.3 per cent of the organic growers were large farmers, 23.4 per cent medium and semi medium each and 14.9 per cent small. In Ferozepur district, majority of the organic growers were large farmers (78%) where as in Ropar district, 75 per cent organic growers were small farmers. Rice, wheat, pulses and vegetables were the prominent crops being grown under organic farming using organic manures like farmyard manure and vermicompost. The most of the organic growers were managing insect pest and diseases by using neem based pesticides. Though the productivity level of organic crops was low yet the majority of organic farmers (62%) were satisfied with organic farming and practising it mainly due to the perception that organic farming improves the soil health, environment and human health (69.5%). The improved market infrastructure for organic foods and the availability of quality biopesticides to farmers can help in adoption of organic farming in Punjab as lack of market facilities (67.1 %) and difficulty in control of insect pest and diseases (60.2 %) were the top most constraints expressed by the organic growers.

339

Prasad Kamta and MS Gill. (2009). "Developments and strategies perspective for organic farming in India." *Indian Journal of Agronomy* 54, no. 2: 186-192.

Organic agriculture is a production system that avoids or largely excludes the use of synthetic compound fertilizers, pesticides, growth-regulators and livestock-feed additives, and thus offers some solutions to the problems currently besetting the agricultural sector of industrialized or green revolution countries. The broader aims of organic farming are: sustainability of natural resources, minimize the cost of cultivation, provide healthy food, augment farm profits and improve soil health. Although in the market place to provide clarity on the organic claim, the organic agriculture requires certification, but broadly any system using the methods of organic agriculture and being based on four basic principles (the principle of health, ecology, fairness and care) may be classified as organic agriculture. Presently organic farming is practised on 30.42 million ha land and global market of US $ 38.6 billion is expected to reach US $ 70 billion by 2012. Area under certified organic farming in India during 2006–07 exceeded 2.55 million ha, with a total production of 586,000 tonnes and it is estimated that at least an equivalent share in the country may be under non-certified organic systems. The total export of certified organic products was 195,000 tonnes, worth Rs 3,012 million. At present there are 16 accredited inspection and certification agencies. Despite several benefits of organic agriculture reported elsewhere, there are some apprehensions that need to be answered, and the Indian scientific community has to strive hard to provide answers to some of these questions through hard-core research in organic farming under tropical and subtropical environments that exit in the country. There is greater need to undertake basic and applied research on these aspects, for which more resources in the form of dedicated team of scientists, better lab facilities and working capital would be required. On the contrary, farmers are also reluctant to convert to organic production because of constraints in availability of adequate quantities of organic manures and other organic inputs in the local market, lack of complete knowledge about organic farming principles, practices and advantages, complex and costly procedures of certification and the risks of marketing of organic produce at premium rates in domestic markets. Strategies needed to promote organic faming in India include adequate research and extension support by the government, quantification of role of organic agriculture in improving the resource sustainability and in mitigating the climate change by the researchers, acknowledgement of organic agriculture as an effective mechanism to reduce greenhouse gases and sequester carbon, recognition of organic agriculture in Kyoto Protocol carbon credit mechanisms, organic market development, mission-mode programmes for on-farm demonstrations and capacity building of all stakeholders, with full research back-up and government support for cheaper access to organic certification of farms.

340

Lal Rattan. (2009). "Soils and sustainable agriculture: A review." In *Sustainable agriculture*, pp. 15-23. Springer Netherlands, 2009.

Enhancing food production and supporting civil/engineering structures have been the principal foci of soil science research during most of the nineteenth and the first seven or eight decades of the twentieth century. Demands on soil resources during the twenty first century and beyond include: (1) increasing agronomic production to meet the food needs of additional 3.5 billion people that will reside in developing countries along with likely shift in food habits from plant-based to animal-based diet, (2) producing lignocellulosic biomass through establishment of energy plantations on agriculturally surplus/marginal soils or other specifically identified lands, (3) converting degraded/desertified soils to restorative land use for enhancing biodiversity and improving the environment, (4) sequestering carbon in terrestrial (soil and trees) and aquatic ecosystems to off-set industrial emissions and stabilize the atmospheric abundance of CO_2 and other greenhouse gases, (5) developing farming/cropping systems which improve water use efficiency and minimize risks of water pollution, contamination and eutrophication, and (6) creating reserves for species preservation, recreation and enhancing aesthetic value of soil resources. Realization of these multifarious soil functions necessitate establishment of inter-disciplinary approach with close linkages between soil scientists and chemists, physicists, geologists, hydrologists, climatologists, biologists, system engineers (nano technologists), computer scientists and information technologists, economists, social scientists and molecular geneticists dealing with human, animal and microbial processes. While advancing the study of basic principles and processes, soil scientists must also reach out to other disciplines to address the global issues of the twenty first century and beyond.

341

Jaganathan D, Ram Bahal and RN Padaria. (2008). "Prospects of Organic farming in India: An appraisal." *Global Communication*: 181.

The Indian farming is traditionally organic and farmers were following organic cultivation till the middle of the twentieth century. After independence we gradually started practicing chemical farming to increase food production to meet the needs of growing population. With the introduction of high yielding varieties programme the chemical farming attained higher production by using various inputs like improved seeds, fertilizers, pesticides etc. Later on in the 1980s realizing the adverse impact of chemical farming, various farming and consumer groups worldwide began pressing for government regulation of organic production. In recent years, explosive organic market growth has encouraged the participation of agribusiness interest. Organic farming uses nature as the best role model for agriculture and considers soil as a living system. In India, the Ministry of Commerce and Ministry of Agriculture are promoting organic farming in a big way. The demand for organic produce increases year after year in India and in international trade market. Organic products produced in India are tea, spices, fruits and vegetables, rice, coffee, cashew nuts, oilseeds, wheat, pulses, cotton and herbal extracts. Organic farming is the only way farmers can escape from the vicious cycle of debt and a negative economy. It is also necessary from the point of view of small producers. Organic farming is a food system that raises income and increases food and food safety at both ends. It is one in which the environment is preserved, farmers and workers have fair access to the means of food production while receiving a fair return for their labour and consumers have their food at fair prices. Several studies reported that if all the outputs and all the inputs are taken into account, organic farming which relies on internal inputs has higher productivity than external input chemical agriculture. Keeping these potentials in mind, farmers in various states of India have started practicing organic farming but at the same time they are facing several constraints. So the efforts from various players like policy makers, researchers, extension workers, farmers' representatives, input suppliers, marketing personnel and consumers are needed to promote organic farming in a big way to tackle the present agrarian crisis. This is deliberated in this paper. It is hoped that organic farming will emerge as an important component of sustainable agriculture and congenial environment in years to come.

342

Rupela, O. P. (2008). "Organic farming: Building on farmers' knowledge with modern science." *Organic farming in rainfed agriculture: Opportunities and constraints* (2008), Eds Venkateswarlu B, Balloli SS and Ramakrishna YS (185 pages), Central Research Institute for Dryland Agriculture (CRIDA): 28.

Most agricultural scientists are trained in crop production and protection that require fertilizers and synthetic pesticides. Scientists have largely evaluated components used by practitioners of organic farming (OF) in isolation, eg. evaluation of compost for replacing fertilizers. The OF system that integrates trees, annual crops and animals in a farming system perspective using locally available biological resource has not been studied in totality. This chapter therefore argues that unless studied in totality, its potential cannot be denied by research institutions. The document discusses some common myths that render agricultural scientists averse to OF. The document also demonstrates that crop yields without agro-chemicals were indeed higher or similar to the treatments receiving agrochemicals, in seven out of nine years, in a large plot study on a rainfed Vertisol in semi-arid conditions at ICRISAT. Comparable or higher yields of cotton and tomato were also harvested in on-farm experiments (involving seven to 21 farmers in a season), in two villages, evaluating low-cost bio-options of crop protection against farmers practice using synthetic pesticides, for at least four years in a row (2004 to 2007/08). Farmers in these on-going studies paid partially for the cost of the materials and advice they received from researchers, suggesting strengths in the biological options of crop protection, without synthetic pesticides.

The paper provides data/citations to suggest that production of sufficient quantities of biomass as a source of crop nutrients can come close to the recommended levels of fertilizers in rainfed agriculture. Botanicals to protect crops and the biomass can be strategically produced on the very field where we grow crops without seriously affecting productivity of unit land area. Overall, it argues in favor of developing agro-technologies that are low-cost, use/recycle locally available natural resource (land, water, plant biomass etc.) in order to empower small- holder farmers instead of increasing their dependence on purchased external inputs.

The author concedes that there will be situations where micro quantities of some elements would be needed as crop nutrients. Since mainstream system, even when working in a farming system perspective, has almost always involved agrochemicals there are few comparative situations to challenge/ support this argument of the author. Therefore the author has liberally used experience of practitioners of OF to understand and assemble data/ information in support of his opinion.

Instances have been shared indicating that to sustain crop production and productivity per unit area, we need to build upon the foundations of traditional knowledge by articulating modern science. The author however is not a supporter of OF that requires certification by internationally accredited agencies.

343

Mitra SK. (2008). "Organic Tropical And Subtropical Fruit Production In India-Prospects And Challenges." In *IV International Symposium on Tropical and Subtropical Fruits 975*, pp. 303-307. 2008.

Organic farming is gaining gradual momentum across the world. Growing awareness of health and environmental issues in agriculture has demanded production of organic food, which is emerging as an attractive source of rural income generation. While trends in rising consumer demand for organic products are becoming discernible, sustainability in production of crops has become the prime concern in agriculture development. Worldwide organic agribusiness is expanding fast. Currently the area under organic cultivation is 30.4 million ha and the value of trade has reached US$ 38.6 billion (which was only US$ 18 billion in 2000). Organic products are almost entirely (over 95%) consumed in developed countries. Major producers and importers of organic products are the EU, USA and Japan. Categories of major organic products include fresh fruits and vegetables (non-tropical and tropical), cereals (wheat, rice, corn, maize), coffee, tea, cocoa, spices, herbs, oilseeds, pulses, milk products, honey, meat, edible nuts, semi-processed fruits, etc. Organic agricultural methods are internationally regulated and legally enforced by many nations, based in large part on the standards set by the International Federation of Organic Agriculture Movements (IFOAM), an international umbrella organization for organic cultivation established in 1972 (Anon., 2008).

344

Subrahmanyeswari B and M Chander. (2008). "A scale to measure attitude of registered organic farmers towards organic livestock farming." *Livestock Research for Rural Development*. Vol. 20 (2).

Organic farming an innovative area gaining importance worldwide and became a boon to the areas which are organic by default and far from the reach of green revolution technologies. Uttarakhand state in India, where most of its farming is organic by default, promoting organic farming in a systematic way through creation of special institutions like UOCB. As attitudes assist individuals in processing complex information and to make decisions, an instrument has been developed to measure attitude of organic farmers towards organic livestock farming, for which 'Likert method of summated ratings' was followed. A total of 102 statements were developed from the subject matter of organic animal husbandry standards, worked out by the Ministry of Commerce and Ministry of Agriculture, Government of India (GOI), and published by the Agriculture Processed Food and Exports Development Authority (APEDA).

A total of 94 statements resulted after edition of 102 statements as per the criteria suggested by Edwards (1969), and were sent to 101 extension specialists working in various Indian Council of Agriculture Research (ICAR) and State Agriculture and Veterinary Universities throughout India for the critical evaluation of statements on a 3 point continuum. Of the responses received from 50 out of 101 judges, a total of 47 statements were selected basing on relevancy weightage, percentage and mean relevancy scores, and these were subjected to item analysis by administering to 60 farmers from a non-sample area. A total of 21 statements were selected based on the't' values (above 2.75) resulted from the item analysis and included in the final scale. Thus, the instrument developed to measure attitude of farmers towards organic livestock farming consists of 13 positive and 8 negative attitude statements representing the various areas of organic animal husbandry standards (NSOP, 2000) viz. sustainability, ecology, environment, animal health and welfare, animal production, certification, quality of organic products including philosophical and ideological views of organic farmers.

345

Venkateswarlu B, SS Balloli and YS Ramakrishna. (2008). "Organic Farming in Rainfed Agriculture: Opportunities and Constraints." *Central Research Institute for Dryland Agriculture, Hyderabad* (2008).

Very few well replicated field trials were conducted on organic farming involving major rainfed crops, except for a six year trial on cotton in Maharashtra which showed reduction in cost of cultivation and increased gross and net returns compared to conventional cotton cultivation (Rajendran et al 2000). However, extensive information is available on the yield and economics with a number of rainfed crops and cropping systems where complete organic manures or organics as part of INM packages have been used (Lomte et al 2004). Intercropping systems have also recorded low pest loads and emerged as a key component of IPM modules in pulse and oilseeds based cropping systems in large number of trials conducted under NATP (CRIDA, 2003). Therefore the cropping systems concept has to be built in, while designing the organic production protocols for rainfed crops.

346

Kesavan PC and MS Swaminathan. (2008). "Strategies and models for agricultural sustainability in developing Asian countries." *Philosophical Transactions of the Royal Society B: Biological Sciences* 363, no. 1492: 877-891.

The green revolution of the 1960s and 1970s which resulted in dramatic yield increases in the developing Asian countries is now showing signs of fatigue in productivity gains. Intensive agriculture practiced without adherence to the scientific principles and ecological aspects has led to loss of soil health, and depletion of freshwater resources and agrobiodiversity. With progressive diversion of arable land for non-agricultural purposes, the challenge of feeding the growing population without, at the same time, annexing more forestland and depleting the rest of life is indeed daunting. Further, even with food availability through production/procurement, millions of marginal farming, fishing and landless rural families have very low or no access to food due to lack of income-generating livelihoods. Approximately 200 million rural women, children and men in India alone fall in this category. Under these circumstances, the evergreen revolution (pro-nature, pro-poor, pro-women and pro-employment/livelihood oriented ecoagriculture) under varied terms are proposed for achieving productivity in perpetuity. In the proposed 'biovillage paradigm', eco-friendly agriculture is promoted along with on- and non-farm eco-enterprises based on sustainable management of natural resources. Concurrently, the modern ICT-based village knowledge centres provide time- and locale-specific, demand-driven information needed for evergreen revolution and ecotechnologies. With a system of 'farm and marine production by masses', the twin goals of ecoagriculture and ecolivelihoods are addressed. The principles, strategies and models of these are briefly discussed in this paper.

347

Sherief AK, AS Anilkumar, AS Husain, JKJP Jayawardana, D Neuhoff, N Halberg, T Alföldi et al. (2008). "Socio-psychological characteristics of farmers in the adoption of organic farming practices in coconut based homesteads of humid tropics." In
Cultivating the future based on science. Volume 1: Organic Crop Production. Proceedings of the Second Scientific Conference of the International Society of Organic Agriculture Research (ISOFAR), held at the 16th IFOAM Organic World Conference in Cooperation with the International Federation of Organic Agriculture Movements (IFOAM) and the Consorzio ModenaBio in Modena, Italy, 18-20 June, 2008., pp. 767-770. International Society of Organic Agricultural Research (ISOFAR), 2008.

A study was conducted to find out the socio-psychological characteristics of farmers in the adoption of organic farming practices in coconut-based homesteads of the humid tropics. Multistage random sampling technique was followed to select 105 'coconut based homestead farmers' in Thiruvananthapuram district of Kerala state, India. A pre-tested structured interview schedule was administered to elicit data. The study revealed that the farmers' socio-psychological characteristics such as education, innovativeness, risk orientation, market perception, self-confidence, information seeking behavior, awareness, knowledge and attitude towards organic farming practices have significant correlation with their adoption behaviour.

348

Bodapati Subrahmanyeswari and Mahesh Chander. (2008). "Compatibility of animal husbandry practices of registered organic farmers with organic animal husbandry standards (OAHS): an assessment in Uttarakhand." *The Indian Journal of Animal Sciences* 78, no. 3: 322-327.
Organic fanning is increasingly being seen as one sustainable option to farmers, among the alternatives to conventional input intensive farming systems. Uttarakhand in India is promoting organic agriculture state state through registering the farmers and providing them necessary support including marketing in crop sector. However, these registered organic farmers, who maintain two or more than two livestock species under crop-livestock mixed farming systems, not yet geared to organic livestock production per se. As 'organic' is a process claim rather than a product claim, the study on the compatibility of animal husbandry practices of registered organic farmers with the recommended organic livestock production standards, may provide an idea of the existing situation to the stakeholders of organic farming, to explore possibility of organic livestock production in the state. Hence, this study was carried out with 180 registered organic fanners selected from 3 districts of Uttarakhand. Majority of the animal husbandry practices followed by the farmers were favorable to or closer to the recommended organic livestock production standards. Besides, the Indigenous Technical Knowledge (ITK) of registered organic farmers, if scientifically validated, may be further useful towards promoting organic animal husbandry in the state.

349

Gahukar RT. (2007). "Contract farming for organic crop production in India." *Current Science* 93, no. 12: 1661-663.

There is an increasing demand throughout world for organic food and fibre. In India, efforts are being made for organic crop production through contract farming. Experiences showed that farmers are benefited from technical guidance, supply of quality farm inputs and assured purchasing at remunerative price. This venture, executed by a tripartite agreement, would bring about favourable changes in the present conventional agriculture to make it sustainable and commercial. Likewise, consumers would get certified organic products at reasonable price.

350

Kalra A and Khanuja SPS. (2007). Research and development priorities for biopesticide and biofertiliser products for sustainable agriculture in India. In P. S. Teng (ed.), *Business potential for agricultural biotechnology* (pp. 96–102). Tokyo: Asian Productivity Organisation

This paper discusses the different aspects of biofertilizers and biopesticides research for sustainable agriculture in India, the demands of organic farming, the current status of biofertilizer production and use, the critical factors influencing their effectiveness, their advantages and benefits, effects of adopting biopesticides and biological control agents for pest control in India, availability of biopesticides in India, constraints in widespread adoption of biopesticides, steps for improving biopesticide adoption, and marketing constraints and strategies. Detailed examples of the effects of biopesticides against pests and diseases are also provided.

351

Das Kasturi. (2007). "Towards a smoother transition to organic farming." *Economic and Political Weekly*: 2243-2245.

Organic farming, mainly for export markets, has made significant progress in many parts of India. However, this ecological form of agriculture faces several obstacles. Institutional support by the government can help overcome the hurdles and promote faster growth of this sector.

352

Chandra Satish and Sowmya Shankar. (2007). "Organic Farming in India: Its Opportunity and Challenges in the Context of Globalization." *Indian Journal of Marketing* 37, no. 8.

Organic farming is a system of crop and livestock production that promotes and enhance the health of agriculture, eco-system and while producing pure and healthy food. The annals of organic farming exist ever since the birth of this godly planet. It was Sir. Albert Howard how was the first man to cultivate organically in India at Pusa, and published the article on organic farming during the year 1900. But the history shows that the presence of organic farming even in the Vedic period, Ramayana and Mahabharata this shows the evidence that there is a practice of organically cultivated lands in India in olden days. But after Sir Albert Howard published his article, a German philosopher Rudolph Steinar builds biodynamic method of organic farming. Later to popularize this concept Europeans developed a guideline called 'Codex'. Approximately 120 countries adopted this guidelines and cultivating organically with an area of 31.1 million ha. Among this countries Australia stands first with 21.1 million ha. Though in India, organic farming is in its relatively old practiced it is not practicing at large. This is mainly due to the challenges and constrains faced in Indian market. But the bigger challenges before organic food is marketing, though the demand for organic product is increasing there is a many major obstacles to the further development of the organic market which need to be removed. To remove these obstacles this paper highlights and focuses on the opportunities and constrains in organic marketing, consumer attitude towards organic goods and policy consideration in developing organic food. Entering this lucrative market is not easy however there is a growing demand for organic food in major urban cities. But organic agriculture is facing major challenges as it is not an automatically an alternative food. It has to go a long way before it zips and zooms.

353

Kshirsagar KG. (2006). "Organic sugarcane farming for development of sustainable agriculture in Maharashtra." *Agricultural Economics Research Review* 19: 145-153.

The economics of organic sugarcane farming (OSF) and inorganic sugarcane farming (ISF) have been examined and the OSF has been assessed with respect to important sustainability indicators such as conservation of soil, water, power and farmers'economic well-being and livelihood security. The study is based on data for 2004–05 collected from 30 certified OSF and 30 ISF sample households from the Jalgaon district of Maharashtra. The OSF households have been found younger and more educated having larger landholdings and better resources. The OSF is labour-intensive, but its cost of cultivation is lower due to savings on chemical fertilizers, irrigation, seeds and agrochemicals. The yield on OSF has been reported lower but it is more than compensated by the price premium received and the yield and profit stability observed on the OSF. In addition, the OSF has been found superior in terms of economic well-being and livelihood security of the farmer. The study has revealed that OSF has enormous potential for improving sustainability of agriculture and has suggested that organic farming should receive prime attention from all stakeholders to realize its full potential in increasing and providing the much sought after sustainability to agriculture.

354

Ramesh P, Mohan Singh and A Subba Rao. (2005). "Organic farming: Its relevance to the Indian context." *Current Science* 88, no. 4: 561568.

Increasing consciousness about conservation of environment as well as health hazards associated with agrochemicals and consumers' preference to safe and hazard-free food are the major factors that lead to the growing interest in alternate forms of agriculture in the world. Organic agriculture is one among the broad spectrum of production methods that are supportive of the environment. The demand for organic food is steadily increasing both in the developed and developing countries with an annual average growth rate of 20–25%. Organic agriculture, without doubt, is one of the fastest growing sectors of agricultural production. However, there are certain issues that should be clarified before we go for a large-scale conversion to organic agriculture. The most important issues are –

Can organic farming produce enough food for everybody? Is it possible to meet the nutrient requirements of crops entirely from organic sources? Are there any significant environmental benefits that accrue from organic farming? Is the food produced by organic farming superior in quality? Is it economically feasible? In this article, we review these aspects of organic farming. In India, vast

stretches of arable land, which are mainly rain-fed and found in the Northeastern region where negligible amount of fertilizers and pesticides are being used and have low productivity, could be exploited as potential areas for organic agriculture. Considering the potential environmental benefits of organic production and its compatibility with integrated agricultural approaches to rural development, organic agriculture may be considered as a development vehicle for developing countries like India, in particular.

355

Rao NH, JC Katyal and MN Reddy. (2004). "Embedding the sustainability perspective into agricultural research: implications for research management." *Outlook on Agriculture* 33, no. 3: 167176.

Concerns for long-term food security and the sustainability of agriculture are forcing international and national agricultural research organizations to reorient their research goals, programmes and projects to ensure that the sustainability perspective underlies all of them. This requires a major paradigm shift in agricultural research planning and management. This paper develops an analytical framework for agricultural research management that can guide a transition from research directed towards productivity goals alone to that which addresses productivity issues, keeping sustainability concerns in sight. The framework is built on a realistic assessment of food demands and supplies, trade-offs between agricultural production increases and the quality of the natural resource base, the capabilities of emerging technologies and the overall profitability of agriculture. The development of such a framework is illustrated by considering the situation in India as a case study. It is suggested that, in the Indian context, embedding sustainability concerns into agricultural research requires interactions between research with a cropping systems perspective at the farm level, a regional natural resource management perspective with a relatively short-term focus on profitabilty, and a longer-term focus on environmental health at the agroecosystem level. The implications for management of such research are discussed.

356

Ghosh Nilabja. (2004). "Reducing dependence on chemical fertilizers and its financial implications for farmers in India." *Ecological Economics* 49, no. 2: 149-162.

The fertilizer intensive technology so long promoted in agriculture produced a green revolution but has brought long-term damages to soil quality. The technology now appears unsustainable for future agricultural development in India both on account of its ecological implications and the burden on the budget. There is now a need to revisit the traditional methods once used in agriculture and to look for a judicious blend of chemical fertilizer based technology with organic manure.

Since manures are relatively less productive in the short run there is an alarm that a shift in technology away from the chemical fertilizer towards organic manure may mean a compromise in production or may hurt the incomes of farmers. This paper emphasizes the environmental benefits of a possible shift in agricultural technology, while keeping in view the importance of sustaining crop yield levels and protecting farmers' incomes. Considering two major crops in India in specific states the paper finds that over time while fertilizer use intensified several times over, the use of manure in agriculture either stagnated or declined. The manure market remained localized, limited and unorganized and its price was significantly higher than fertilizer in terms of nutrients in contrast to the organized and state supported fertilizer market. The paper estimates quadratic yield functions based on cross-section household level data and using the prices faced by farmers as reported by official survey finds that in majority of the cases there will not be any financial loss resulting from a small shift in technology towards organic manure. Such a shift can however be considered feasible if the losing households are compensated and if manure price is kept in control by promoting a more dynamic manure market.

357

Garibay Salvador V and Jyoti Katke. (2003). Market Opportunities and Challenges for Indian Organic Products. Research Institue of Organic Agriculture FiBL, CH-Frick

Organic agriculture offers trade opportunities for farmers in the developing and developed countries. This market of organic products is expected to grow globally in the coming years and high growth rates over the medium term (from 10-15 to 25-30 %) are expected (Yussefi and Willer, 2002). This organic market expansion makes it possible for farmers to reap the benefits of a trade with relatively high price premiums (Yussefi and Willer, 2002). However, this market is not very well known to most farmers, especially those living in the developing countries. Furthermore, information about it is not readily available to farmers in the developing countries. The absence of sufficient technical and market information and financial support also means that few farmers will risk changing their method of production. In developing countries it is therefore essential for major key players (e.g. NGOs, farmer organizations, traders, exporters etc.) that promote organic farming to have up-to-date information on the available opportunities (market requirements) and trends of the organic market. One example is India, a country with a huge number of small farmers who still use traditional methods and do farming with few agricultural inputs. NGOs that promote organic farming and other organizations support farmers in these aspects. An organic movement is now emerging in India on different levels (producer groups, trainers and advisors, certification bodies and processors and traders). So dissemination of information about the opportunities and challenges for Indian organic products on the domestic and international market is of fundamental concern in order to allow continued development of the organic agriculture movement in this country.

358

Sukhpal Singh. (2004). Marketing of Indian Organic Products: Status, Issues, and Prospects, No WP2004-10-01, IIM-Ahmedabad Working Papers

Organic farm production and trade has emerged as an important sector in India as in other parts of the developing world, and is seen as an important strategy of facilitating sustainable development. This paper locates the rationale for organic farming and trade in the problems of conventional farming and trade practices, both international and domestic, and documents the Indian experience in organic production and trade. It explores the main issues in this sector and discusses strategies for its better performance from a marketing and competitiveness perspective.

http://www.iimahd.ernet.in/assets/snippets/workingpaperpdf/2004-1001sulhpal.pdf

359

Nampoothiri KUK (2001). Organic farming – its relevance to plantation crops. *Journal of plantation crops*. Vol. 29 (1): 1-9.

This paper discusses the relevance of organic farming in crops i.e., coconut, arecanut, rubber, coffee, tea, spices, cashew and oil palm. Recycling organic wastes from plantations and the use of biopesticides are also discussed. Certification, constraints, and future strategies in organic farming are mentioned.

360

Alam Ghayur (2000). A study on biopesticides and biofertilizers in Haryana, India. Gatekeeper Series – Sustainable Agriculture and Rural Livelihoods Programme. IIED, UK. No. 93. pp 24
The use of chemical pesticides and fertilizers in Indian agriculture has seen a sharp increase in recent years, and in some areas has reached alarming levels with grave implications for human health, the ecosystem and groundwater. It is therefore increasingly urgent that environmentally friendly methods of improving soil fertility and pests and disease control are used. The potential of biopesticides and biofertilizers for promoting sustainable agriculture has been known for many years. A number of government agencies, including the Ministry of Agriculture and the Department of Biotechnology, are engaged in supporting research, production and application of these agents. However, in spite of these efforts, their use in India is small. The paper investigates the potential of and constraints in the use of biopesticides and biofertilizers, taking the state of Haryana as a case study. It explores the factors responsible for the limited use of these agents, based on detailed discussions with a large number of farmers, various agencies engaged in the promotion of biopesticides and biofertilizers, State Agricultural Department officials, and shopkeepers. The study found that for the use of biopesticides, a key problem was that departments promoting Integrated Pest Management (IPM) have very little knowledge and experience of biopesticides, and most state agricultural universities, on whose recommendations pest control methods are promoted, do not tend to recommend biopesticides. In the absence of active promotion by the agriculture department, the demand for these products has not developed, and most private shops and dealers do not stock and sell biopesticides. The paper recommends that the agricultural departments and universities pay greater attention to the promotion of biopesticides, that IPM training is improved, and that there is a greater focus on cropping techniques and varieties which do not require such a dependence on pesticides. In the case of biofertilizers, their poor quality and performance is a major factor in their limited uptake by farmers. This is primarily linked to inappropriate strains and inefficient production technology. As a result it is recommended that research and development to identify more suitable strains, to develop better production technology and quality control methods is greatly increased, and that in the meantime the various grants and subsidies on biofertilizers are diverted to support these R&D programmes.

isha OUTREACH

Annexure 5: Save Soil: A Movement That Began 24 Years Ago

In 2022, Sadhguru's Save Soil Campaign[8] gained significant momentum as a vital platform for advocating soil conservation and sustainable agricultural practices. This campaign was marked by a series of initiatives, events, and educational endeavors that aimed to create widespread awareness about the urgent need to protect and rejuvenate soil health.

At the heart of the Save Soil Campaign in 2022 was the Save Soil Rally, a unique and impactful event that drew attention to the pressing issue of soil degradation. The Save Soil Rally involved a massive gathering of people from various walks of life, including farmers, environmentalists, policymakers, students, and concerned citizens. This collective assembly symbolized a unified effort to highlight the importance of soil as a finite and essential resource.

The campaign utilized various platforms, including seminars, workshops, webinars, and social media, to disseminate knowledge about sustainable farming techniques, soil enrichment strategies, and the detrimental effects of chemical-intensive practices. Sadhguru's impassioned talks and discussions resonated with audiences, inspiring them to recognize their role in nurturing the Earth's soil for future generations.

The Save Soil Campaign in 2022 also emphasized the role of regenerative agriculture in mitigating climate change by promoting carbon sequestration in the soil. It showcased success stories of farmers who had adopted organic and natural farming methods, demonstrating the positive impact on soil health, crop yields, and overall well-being.

Additionally, the campaign actively engaged with educational institutions to integrate soil conservation into curricula, fostering a sense of responsibility among the youth towards environmental sustainability. It encouraged students to take an active interest in soil health and become advocates for change in their communities.

Save Soil Campaign Updates

- Ten Indian states – Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra, Telangana, Andhra Pradesh, Karnataka, Goa and Assam – have signed MoUs to Save Soil.
- The UN World Food Programme, India signed an MoU with Save Soil.
- The Govt of India announced a budget of INR 19,000 crore (2.5 billion USD) to rejuvenate 13 major rivers through soil and tree-based interventions, in line with the Rally for Rivers draft policy recommendations given to the Hon'ble Prime Minister Shri Narendra Modi by Sadhguru.
- Banas Dairy (Asia's largest milk cooperative) located in Gujarat state of India is seeking advice from the Save Soil Movement to help its dairy farmers manage their soils sustainably.

[8] https://www.youtube.com/watch?v=kalp_iT6Zs4&t=5s

SAVE SOIL

- Commonwealth Nations Secretary General Rt Hon Baroness Patricia visited and appreciated Save Soil in action at an Agroforestry Farm in Pollachi India.
- In an article published in a column of the Indian Express, Former Vice President of India, Sri. M Venkaiah Naidu wrote, “Without soil conservation, there is no food security. The need of the hour is to adopt agro-ecological practices that create sustainable food production systems.”
- Sadhguru was presented the Water Champion award by TERI (The Energy and Resources Institute) for his ecological initiatives which address the urgent need to grow the green cover, revitalize Indian rivers and restore soil health
- One of the most significant events under the Save Soil banner was the 'Score for Soil' campaign. 'Kicked off' by Sadhguru on the World Soil Day i.e. 5th of December 2022; 'Score for Soil' was a reminder that even the most serious of activities can be done in a fun way. The campaign encouraged people to post a video of their best football shot with the hashtag #ScoreForSoil. Launched in the backdrop of the Football World Cup, #ScoreForSoil turned into a global bandwagon, with responses from across the world.
- Mitti Ki Chitthi campaign - Mitti ki Chitthi is an ode to soil and an appeal to all to write to their respective leaders, letting them know how important the issue of soil degradation is for each individual and why bringing back at least 3-6% organic matter in the soil is an urgent need. The campaign reached more than 26.5 million views in total, with 10.3 million on Instagram,16.2 million on YouTube.
- "Save Soil: Our Very Body", a documentary film about soil extinction, premiered on Discovery India on 29 May.
- "Bandeya", a soulful T-series song about the pricelessness of soil, to which Sadhguru lent his voice, was launched.

Onground Updates in the Cauvery Basin

- Since 1998 Cauvery Calling has enabled the plantation of 8.85 Cr trees and has helped 172,600 farmers transition to tree-based agriculture.
- In the year 2022, Cauvery Calling has enabled the planting of 2.32 Cr trees across 46 districts across Karnataka and Tamil Nadu with the overwhelming participation of 48,700 farmers. Out of this, the Government of Karnataka produced and distributed 1.3 Cr+ trees where Cauvery Calling volunteers were able to support in creating the necessary on-ground awareness and handholding farmers for them to take up tree-based agriculture.
- In 2022, over 5700 farmers have been trained in regenerative agriculture, some of them being handheld and guided closely.
- Active phone helpline - Answered over 118,100 calls from farmers
- Velliangiri Uzhavan, an FPO operating under the guidance of Isha Outreach received special recognition: Best Emerging FPC 2021-2022. Velliangiri Uzhavan also witnessed a turnover of Rs. 17.7 cr for FY 2021-22, a 26% increase in year-on-year turnover and a 165% increase in earnings per share for the year. Another such FPO - Arulmigu Someshwarar FPO, promoted by Isha, sells 14 tons of nutmeg worth 76 lakhs in maiden sale. These initiatives represent a significant step in enhancing

farmer livelihood on the back of sustainable agriculture and farm management practices.

India Takes Steps To Save Its Soil

1. Rs 2,200 crores allocated for disease-free horticulture crops in the budget of the year 2023-24 agriculture budget of GoI.
2. India's National Agricultural Development Programme (NADP) has set a target of turning 1,500 hectares of barren land into arable land through incentivization in Coimbatore.
3. More than 25 million saplings were planted in Uttar Pradesh as part of government's 'Vriksharopan Jan Andolan-2022' initiative

Global Impact of Save Soil

1. 81 nations are in the process of framing soil policies.

2. International organizations that are leading ecological action, such as the International Union of Conservation of Nations (IUCN) and United Nations (UN) agencies - United Nations Convention to Combat Desertification (UNCCD), World Food Programme (WFP), Food and Agriculture Organization (FAO) and United Nations Environment Programme's Faith for Earth (UNEP) have come forward to partner with the movement.

3. At the 15th session of the Conference of Parties (COP15) to the United Nations Convention to Combat Desertification (UNCCD), Sadhguru addressed 197 parties, distilling out one overarching objective - to ensure a minimum of 3-6% organic content in agricultural soil and provided a three-pronged strategy to achieve this.

4. Save Soil experts engaged at the International Conference on the Social, Economic and Institutional Aspects of Land and Ecosystem Restoration of G20 Global Land Initiative in April 2023 in Bangalore.

5. At the United Nations Climate Summit (COP 27) in Egypt, the Save Soil movement was featured in the G20 Global Land Initiative Panel discussion, as one of the promising global initiatives that can contribute to the G20's aspiration of reducing degraded lands by 50% by 2040.

6. The Govt of Guyana will allocate 100 sq. km of land and, with the help of the Save Soil team, work with the farmers to increase the soil organic matter to 3-6%, and create a demonstrable model for the world

7. The Save Soil movement hosted a digital Experts roundtable on World Soil Day 5-Dec-2022 to collectively discuss the most urgent questions around revitalizing soil through policy. 155 soil experts from 31 countries joined Sadhguru at the International Round Table.

8. Over 40 cities in North America stand for soil, with proclamations from Mayors recognizing March 21st as Save Soil Day at New York City, New Washington DC, Edmonton, Calgary, Charlotte, Cincinnati, Indianapolis, Rainer, San Ramon and many more.

9. The Ministry of Environment and Ministry of Agriculture for Government of Nepal presented Letter of Solidarity thus coming onboard to the Save Soil movement. The Ministry of Environment in the Nepal government also committed to plant 30,000 trees to Save soil.

10. Rt Hon Lord Benyon, Parliament Under Secretary of State at the Department of Environment, Food and Rural Affairs has welcomed the work of Sadhguru and the Save Soil movement to raise awareness of the importance of healthy soil across the world and they are already taking steps to improve soil health in England which are very much in line with the objective of the Save Soil movement.

11. Countries including the Czech Republic, Slovakia, Bulgaria, Italy, the Vatican, the Republic of Suriname, Nigeria and organizations such as the Commonwealth of Nations and the Muslim World League have come forward to support the Save Soil movement.

12. Sadhguru's message on Carbon and Soil Management played during the 'Expert seminar on carbon agriculture' in Slovakia

13. Save Soil received Letters of Support from United States Senator Cory Booker, Republic of Namibia and many more

14. Global Save Soil policy handbooks released for seven regions (Africa, Asia, Europe, Latin America and Caribbean, Middle East and North Africa, North America, Oceania). Furthermore, the individual sustainable soil management solution catalogs (for farmers) for 193 nations made available on the website

15. Italian research organization CREA invited Save Soil to be an official stakeholder in the European Joint Program for Soil

16. The movement has been lauded by international soil experts such as Dr. Jane Goodall (UN Messenger of Peace), Ibrahim Thiaw (Executive Secretary, UNCCD), David Beasley (Executive Director, WFP), Maria Helena Semedo (Deputy Director-General, FAO), Dr. Rattan Lal (Renowned soil scientist), and many others.

17. 800+ articles published in the EU about the Save Soil movement. Publications have coverage in Spain, UK, Ireland, France, Italy, Bulgaria, Netherlands, Slovenia, Poland, Romania, Austria, Serbia, Croatia, Czech Republic, Greece, Montenegro, Belgium, Luxembourg, Ireland, Switzerland.

18. Across the world, a total of 564 Walk for Soil, Stand for Soil, Cycle for Soil, and Save Soil Awareness events took place, with the participation of nearly 60,000 Earth Buddies and volunteers.

19. 50 iconic locations including Niagara Falls, Burj Khalifa (UAE), Jet d'Eau (Geneva, Switzerland) donned Save Soil colors since the movement's launch

20. On World Environment Day 2022, over 40 musicians from North and Latin America came together to spread awareness about Save Soil and pledged their support to the movement.

21. Save Soil was selected as a Webby People's Voice Winner in the category of Social Media - Sustainability & Environment, recognizing the awareness created through social media

content focused on sustainability, climate, and environmental issues. Webby received 14,000 entries from over 70 countries, and over 2.5 million votes cast by over 600,000 people in the Webby People's Voice. The award reflects the movement's wide reach in educating people across the globe about Soil.

22. Save Soil representatives are part of the Steering Committee on the Drought Response team set up by Kenya.

Save Soil Global Action To Save Soil

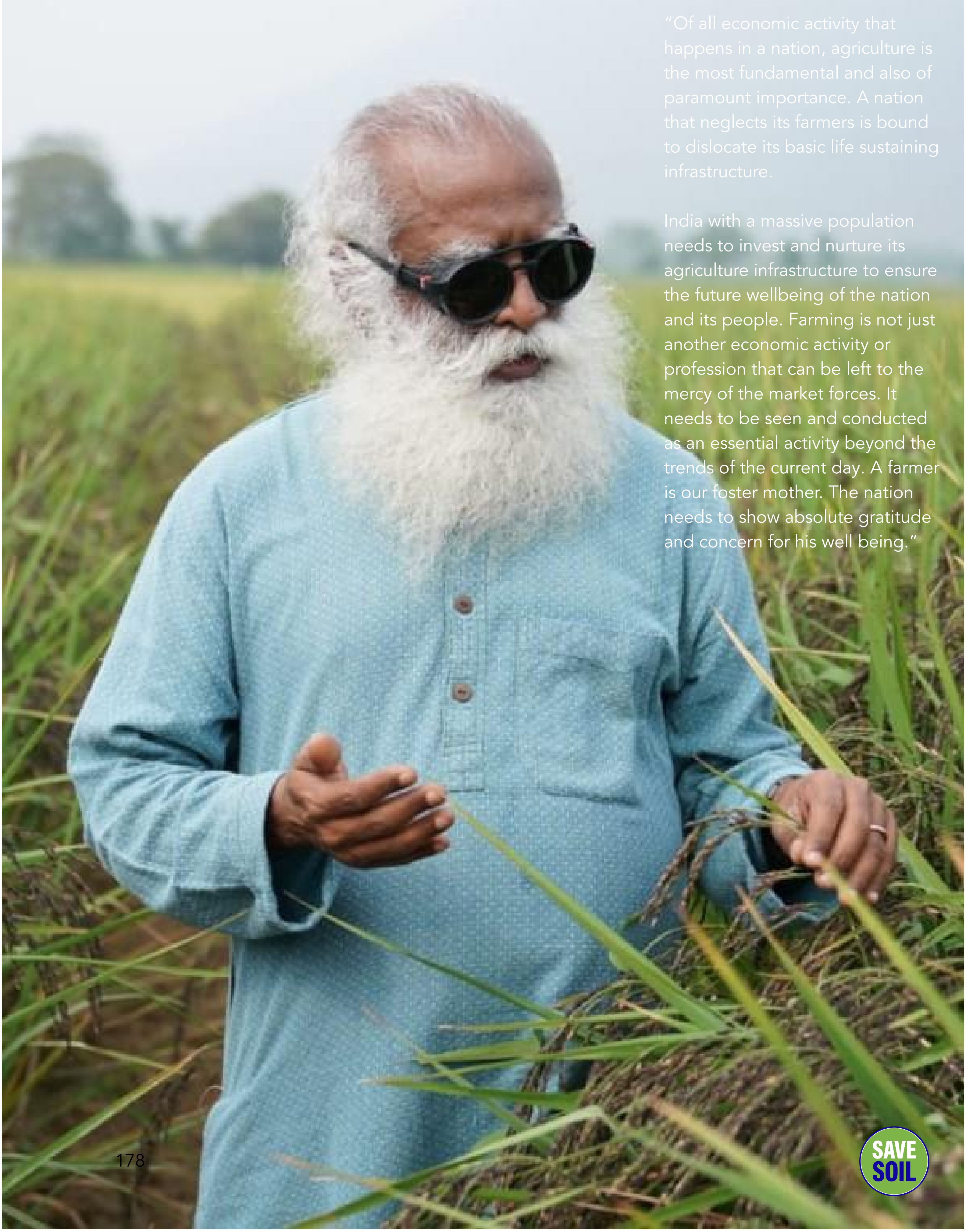
1. At the G20 Bali Summit in November 2022, the Leader's Declaration contained a major agreement on reducing degraded lands by 50% by 2040.

2. COP 27 leaders urged to kick-start restoration of soil ecosystems. They have arranged for the first-ever Food Systems Pavilion to be featured at a UN Climate Change Conference, which represents an enormous opportunity towards ensuring soil health

3. 2023 has been designated the Year of Millets by the UN.

Therefore, Sadhguru's Save Soil Campaign in 2022 successfully galvanized a diverse array of individuals and groups to unite in their commitment to preserving soil health. By raising awareness, providing actionable solutions, and inspiring collective action, the campaign underscored the vital role each person plays in safeguarding the Earth's most fundamental resource – the soil – and highlighted the imperative to transition towards regenerative agricultural practices for the well-being of the planet and its inhabitants.

Annexure 6: Save Soil- Thaaimann Kaakkum Vivasaayam



"Of all economic activity that happens in a nation, agriculture is the most fundamental and also of paramount importance. A nation that neglects its farmers is bound to dislocate its basic life sustaining infrastructure.

India with a massive population needs to invest and nurture its agriculture infrastructure to ensure the future wellbeing of the nation and its people. Farming is not just another economic activity or profession that can be left to the mercy of the market forces. It needs to be seen and conducted as an essential activity beyond the trends of the current day. A farmer is our foster mother. The nation needs to show absolute gratitude and concern for his well being."

Background

The most fundamental need of a human being is food. Food is an existential issue. As a nation, India has many achievements that we can be proud of. But our greatest achievement is that our farmers, with little infrastructure, almost no technology, with traditional knowledge, have been producing food for more than a billion people. Even though every one of us is dependent on the farmer for our survival, we have treated them with utter disrespect and neglect, to a point that only a fraction of our farmers want their children to continue farming.

The reason is simple. Farming, in the last decade has become unprofitable for the farmer. 82% of indian farmers earned only ₹90 per day[9] in 2013 from his cultivation which would have increased to approximately ₹114 per day in 2020. Nearly 52% of the farm households in India are in debt.[10] To pay this debt, farmers are forced to sell their land and become landless laborers. Landless agricultural labor population has increased from 27.3 million (7.8% of the entire population) to 144.3 million (11.4% of the entire population) since 1951.[11] The fear of becoming landless makes nearly one farmer commits suicide every hour.[12] Before we finish our meal, one of the farmers who grew it, is preparing to hang himself and throw the life of at least four people dependent on him into unimaginable suffering and hunger for the rest of their life. Lack of income and poverty has led to large-scale migration from villages to the cities in search of employment. The youth who migrate to cities have to engage themselves in non-agricultural jobs. Thus, the thread of the traditional knowledge of farming that was passed down from generation to generation is being broken irrevocably. To grow food for a billion people we need our farmers. The average age of our farmers in 2016 was 50.1[13]. So, the biggest question is when this generation passes, who will do the farming. If this is not a disaster, then what is?

It is our fundamental responsibility to act now. The prime concern is to increase the net income of the farmer. We need to look at the reasons why agriculture is not profitable to the farmer and how to find solutions.

One fundamental reason is that agriculture is not a lab science. It is a natural phenomena that requires only a certain minimal human intervention. With this understanding, the culture of Bharat always relied on nature for solutions. Observing nature and being in tune with it was the key element in every farmer's life. But now, because of excessive modernisation in agriculture, farming has become a highly input intensive process where every input has to be purchased from the market, every technique has to be given to him from an expert. This has led to extreme financial stress as well as physical and mental drudgery upon the farmer. Given that the average agricultural landholding is only a hectare,

[9] https://www.downtoearth.org.in/news/agriculture/you-may-pay-a-steep-price-but-does-the-farmer-make-any-money--62364

[10] 70th round: National Sample Survey (Report titled 'Situation Assessment Survey of Agricultural Households' January–December 2013).

[11] https://www.firstpost.com/india/indias-landless-poor-amid-rising-rural-poverty-and-lower-access-to-land-empowering-this-group-must-be-priority-5338711.html#:~:text=In%201951%2C%20the%20'landless%20agriculture,or%2014.4%20crore)%20in%202011.&text=With%20a%20mean%20household%20size,Shocking!

[12] National Crime Record Bureau, Accidental Deaths and Suicides in India 2018, https://ncrb.gov.in/sites/default/files/chapter-2-suicides-2018.pdf

[13] https://www.downtoearth.org.in/blog/agriculture/farmers-ageing-new-generation-disinterested-who-will-grow-our-food--65800#:~:text=In%202016%2C%20the%20average%20age,Indian%20farmer%20was%2050.1%20years.

all farmers do not have the capacity to go through this. Hence they fail. The input intensive green revolution, which once brought prosperity to the nation has run its course.

Secondly, farmers have lost the connection with the consumers with the advent of urbanization. The middlemen are profiteering many times more than the producer. The consumers are also paying more than the fair price. This also has changed the social dynamics where farmers are considered as just laborers. They do not have any social significance and there is no pride left in the profession.

Thirdly, the most important aspect of farming which is the soil is being degraded at a tremendous rate in all parts of the country by soil erosion due to extensive tillage, chemical usage, reduction of usage of farmyard manure and loss of green cover in farmlands. As a consequence, the farms have become fallow. Nearly 15% of total agricultural land in India is declared fallow.[14]

Also, needless to say that the nutrition of the food has gone down significantly. Consumers have no option than to consume food contaminated with harmful toxic chemicals that are responsible for extremely chronic and degenerative diseases.

In the above context, Sadhguru initiated the "Isha Agro Movement" in 2007 with an objective to create economic well being for the farmers. He also emphasized on improving soil fertility for the overall wellbeing of humanity. To do so, he focussed on the promotion of tree based agriculture and envisioned that thirty percent of our farmland must be under shade. Since then SS-TKV has been ceaselessly operating to change farmer mindsets, identify and provide economically more beneficial and ecologically holistic farming methods, create model farms and farmers and develop a platform for farmer to farmer knowledge sharing across Tamil Nadu and UT of Pondicherry.

The overall area under non-chemical farming in Tamil Nadu is only about 30,000 hectares.[15] This shows that today chemical farming or 'conventional agriculture' is the mainstream phenomena while chemical-free farming is at best a fringe phenomena. The vision of SS-TKV is to make chemical-free farming a mainstream phenomena.

The reason why SS-TKV choses natural farming over chemical farming is that chemical farming has increased the dependence of farmers on expensive external inputs, reducing fertility in the long run and creating natural imbalances in the farm ecosystem. The natural farming methods improve fertility and also reduce input costs while producing high quality produce which is free from toxic chemicals. The yield in SS-TKV natural farms in most cases has been found to be similar to chemical farming if not more.

[14] https://data.gov.in/catalog/land-use-pattern?filters%5Bfield_catalog_reference%5D=88749&format=json&offset=0&limit=6&sort%5Bcreated%5D=desc
[15] https://www.cseindia.org/state-of-organic-and-natural-farming-in-india-10346

The farming practices adopted by SS-TKV do not have any specific ideology or a particular philosophy behind it. Rather it follows a practical approach. There are many systems of sustainable farming available nowadays but the fundamental approach adopted in SS-TKV is to find a suitable method that works for the farmer in his current situation and his mindset and at the same time solves the problems of fertility of soil and scarcity and depletion of resources in farmlands. Our approach is to decrease the input costs for the farmer without decreasing the yields so that there is a stable net income for the farmer.

The fundamentals of natural farming is to grow crops among trees. Trees extract nutrients from deep soils, create biomass, improve the microclimate and also provide substantial incomes in the long run among other innumerable benefits. They act as fixed deposits that grow over time and provide insurance like support to the farmer. Around 168 trees on the boundary of an acre which covers 10-20% of the land, at ₹10,000 per tree after 15 to 20 years will build an insurance of ₹16.8 Lakhs, which a farmer can never build by any other means. It's similar to keeping aside 10-20% of the annual income every year as savings for future requirements.

The fastest way to achieve this is by making SS-TKV into a people's movement and showcasing it to government so as to create suitable policies and ground action for sustainable agriculture. Therefore, SS-TKV has been structured as a movement from the start, rather than just a project or a program. Creating volunteers is a key aspect of a movement. So we will always be creating volunteers.

Also, the strategy for implementation is to first transition the farmers with semi medium and medium landholding to natural farming because they are found to have reasonable risk taking capacity, perseverance and capability to understand. They also can become volunteers for the movement. Once they adopt it and become successful, it spreads from farmer to farmer through our training and farmer connect programs. The propagation of farming techniques in SS-TKV is done from farmer to farmer based on their experience of using the traditional methods in a modernized way which is appropriate for current times. These techniques are modified and adapted according to the practicing farmer's farming conditions, needs and capabilities.

SS-TKV also envisions creating an online repository of traditional natural farming techniques that are tried and tested by farmers across the spectrum which can be readily available to interested farmers so that they need not reinvent the wheel.

SS-TKV also gains first hand experience by setting up farms in suitable locations and practicing farming as a part of the movement. Also SS-TKV will be creating consumer ambassadors for the promotion of the produce.

Different Phases Of The Movement

SS-TKV is divided into 3 phases. The first phase was focused on identifying and transforming a core group of passionate and willing farmers into natural farming. This core group of farmers have become volunteers and we expect them to be a source of inspiration for a larger group of farmers in the second phase. In this process, SS-TKV also envisions to create consumer awareness and provide the necessary marketing support as this is vital for the success of the movement in the second phase.

This larger farmer base along with proper documentation will form the basis for a draft policy for natural farming that will be presented to the state government. Since no single organization can fulfill the objective of the movement by themselves, the movement has to be led by the government in the 3rd phase with support from organizations who promote natural farming. By adopting it as a state policy for natural farming, the government is expected to ensure the implementation of the vision of natural farming becoming a mainstream phenomena while SS-TKV will be continuing to transition farmers to natural farming.

Building The Organisation

For the success of the movement, SS-TKV will be run by a dedicated set of lead farmers, consumer ambassadors and volunteers and an equally committed set of staff who are willing to dedicate their life and energy in making this happen. The movement will be driven by the passion of these people and the inspiration from Sadhguru.

The volunteers will be identified and engaged from the various SS-TKV programs. Similarly, lead farmers will be identified from field visits and various marketing endeavors. Consumer volunteers will be mostly Isha meditators.

Volunteers and staff members will be adequately trained for their individual roles and responsibilities. Proper guidance from a highly experienced core team will be ensured for all field personnel. They will be given adequate challenges to learn and understand the nuances of the process.

An internship training program will be designed to inspire more youth to join the movement as volunteers/staff. Opportunities will be created for employment into the organization, placement in various SS-TKV farms or setting up new farms. These intensive training programs will benefit the trainees as well as the people within the organization to sharpen their skills and understanding of the natural farming process.

A culture of innovation will be fostered among the people engaged in the movement. Enough opportunities will be created to conduct field experiments that are aimed at reducing costs and improving productivity while adhering to natural farming practices. Above all, the entire management will be designed to make the process into a celebration rather than just being a work for the people involved.

Need For Generation Of Funds

For such a movement to happen, we must have the capacity to generate the funds for the planned activities. In this context, various new funding sources will be explored that creates financial stability in all aspects of the movement. The farms are well designed to generate their own incomes. This will always be maintained. The training programmes are expected to be funded by the following sources:

A. Crowdfunding

B. CSR donations
C. General Donations
D. Commitment fees by program participants.
E. In-kind donations

The scope of the activities of the movement will depend on the amount of funding that we can collect from the above sources. Therefore it is essential to have a robust funding platform for SS-TKV.

First Phase : Happenings so far

In the first phase starting from 2007 until 2020 SS-TKV has developed optimal farming techniques or crop wise package of practices and conducted various training programmes, farmer to farmer knowledge sharing sessions, farm visits, hand holding as well as visiting model farmers from Maharashtra, Karnataka, Andhra Pradesh, Telangana, Kerala and Tamil Nadu in the first 8 years of inception. In the past 7 years SS-TKV has trained approximately 18,000 farmers out of which 3,000 farmers have transitioned to natural farming. One in three farmers have changed their practices after going through our programmes. These are our core farmers who are spread across 39 districts of Tamil Nadu and Pondicherry.

SS-TKV has also invested considerable time and energy in field trials, experimentation and collecting and bringing back the traditional knowledge into farming in the past decade in a variety of crops, cropping patterns, natural pesticides, natural soil nutrients, irrigation and sales of produce, incorporating the learnings quickly into the next cropping cycle and fine tuning the process. Soil care, soil enrichment, soil generation, irrigation management, farmer training, model farm creation, identifying lead farmers and experiential training programs have been the point of focus in the first phase.

SS-TKV has also been extensively using electronic means to document, troubleshoot and spread the information on various farming practices. It has been providing continuous and ongoing support to existing farmers via whatsapp community groups thereby drawing new farmers to the natural farming fold.

There has been invaluable insights into the mindsets and problems of the farmer which has been useful to devise the modifications for the second phase.

Key features of SS-TKV activities

The strength of SS-TKV is that it has developed farmer friendly methods that fulfill the objectives of the movement in an efficient manner. The methods adopted by SS-TKV to help transition the farmers from 'conventional farming' to natural farming are mentioned below.

Following the 'raindrop model' to reach farmers

Since Isha was not well known as an agricultural organization in the first phase, SS-TKV was set up as a 'raindrop model' where individual farmers from across the state were trained into natural farming. Few other farmers from their locality joined these farmers. And this continues until there is a pool of farmers in various parts of the state. It is expected that they would spread the idea to more and more farmers and then there would be a visible stream of farmers practicing natural farming.

Farmer To Farmer Knowledge Sharing Sessions

The traditional method of transmitting agricultural knowledge from farmer to farmer has been found to be most effective. It gives the farmer confidence to adopt the method and reduces the lead time to their individual success in the new methods by preventing the reinvention of the wheel.

The lead farmers as they get inspired by the SS-TKV also bring back the traditional knowledge thread that got broken due to the advancement of the 'green revolution'. This once lost knowledge is also becoming part of the training process and it's shared directly by the lead farmer himself. All of this is being documented and applied by the participating farmer according to his farming needs based on local cropping patterns, soil and weather conditions.

Experiential Training Style

Isha Agro Movement training sessions are unique in that it prioritizes field training using experiential training techniques, group discussions and strong visual cues by conducting the program in a model farm. SS-TKV offers basic Natural Farming Training, Crop Intensive Training, Pest Management, Livestock Management, Integrated Farming, Water & Soil Management, Farm Designing and Cost Cutting Techniques.

Mentorship

Farmers who have been practicing natural farming successfully for many years, will be identified from farm visits and will be encouraged to become lead farmers. SS-TKV will conduct farm training in their farms. In building this rich subtext of the farmer-to-farmer interaction, SS-TKV enables a bond where the lead farmers become de-facto mentors to the newcomers. At the end of the training and the model farm visit, a visible bond of mutual reliance develops and the farmers exchange information/experiences to stay in touch. This enables their transition journey to be smooth as they rely on each other for lessons learnt & past experiences.

Electronic Connect

SS-TKV organizes all the trained farmers into mini online communities. Through the use of simple technology such as Whatsapp, Farmers raise queries, post pictures of their crops and pests, have their issues resolved, and share notes on success stories with ease. The collective serves as a type of knowledge repository, tapping into one another and where necessary into SS-TKV. Also farmer helplines are being maintained for queries that are handled by a core group of experts.

Awareness Generation Social Media

The objective of awareness generation is to attract farmers into training programs and spread the success stories of farmers for inspiration to participants as well as generating pride for successful and lead farmers by making them more visible. It is also to engage consumers and spread awareness about safe food. This effort will create goodwill for the movement and thereby enroll more people into the training programs. SS-TKV has been routinely featuring successful farmers in various social media forums via blogs, articles, A-V stories. Also the youtube channel provides valuable information for the farmers in their cultivation methods. This is an effective medium to spread the idea to the masses and bring awareness to larger audiences.

Isha Model Farms

SS-TKV is also directly involved in farming. SS-TKV has been cultivating a host of crops in 54 acres of land in 4 different locations of Tamilnadu for the past ten years. The goal of these farms is to showcase self reliance in farm inputs and stable net incomes. This farming activity has been undertaken with a clear purpose and resolve to understand real-time farming, issues arising from natural farming, crop specific learnings, marketplace issues, mechanization and field trials. The journey has been an evolving one with tremendous learning being incorporated back into the farm activity. These learnings have been of enormous use in understanding farmer issues and also in creating and developing training programs. We are also incorporating various tools to improve the performance of SS-TKV farms. These tools will also help document all the processes that are conducted to grow the crops along with the financial aspects. This will enhance the understanding of the trainees and give them the needed clarity of the operations that are required in natural farming.

In the past ten years SS-TKV has cultivated Paddy, Banana, Sugarcane, Turmeric, Groundnut, Millets and a host of vegetables. This wide variety has also enabled us to develop a crop wise understanding of inputs, weather impact, pests, soil conditions, irrigation patterns and market conditions. Also the farms are now financially independent, thereby presenting a practical model for farmers which they can implement considering their farming conditions. The SS-TKV farms has also made it possible to conduct many training activities as a farmer to farmer sharings and also provide experiential learning for SS-TKV members and farmers.

Thus, the main objective of setting up SS-TKV farms is to show that if farmers improve their quality of soil through natural farming practices and grow crops by following the package of practices for the crops compiled by SS-TKV, they can get consistently high yields of good quality and higher and stable net incomes.

Learnings From The First Phase

In this way SS-TKV has been successful in sharing knowledge and creating a farmer base. At the same time there have been some observations of the problems that deter the farming community into large scale adoption of natural farming practices.

Farm Inputs

Organic farming, which is also a chemical free farming method, relies more on the external organic inputs like farmyard manure, vermicompost and commercial organic inputs like biofertilizers. A farmer is required to purchase these inputs since he is unable to produce the required quantity himself. We have found that the external organic inputs are not cost effective. The price and the quality of these inputs has been of concern in our experience.

The cost of these inputs are usually high for the yield improvement it has given for the crop. Also, the other option of purchasing the farmyard manure locally is also very unsustainable because it is usually contaminated with non-biodegradable material and soil particles which are not easy to separate. The cost and effort of transporting these inputs to the field is also high as compared to inputs prepared in the farm itself.
In natural farming which SS-TKV adopts, to avoid costs and drudgery of handling organic inputs and avoid chemicals altogether, all the bio-inputs are prepared in the farm itself. Even though it's much easier and cost effective, it contradicts the current practices of the farmer, which is buying all farm inputs from outside. This takes substantial effort on our part to convince the farmers to change their mindset.

Labour Requirement

In natural farming methods for the preparation and application of bio-inputs and weed management, more labor is required initially than 'conventional agriculture'. This deters a lot of farmers where labor availability is an issue.

Weed Management

There is a common misconception that in natural farming there is a greater propensity for weeds.

Livestock Management

For successful natural farming the presence of cattle plays a crucial role. With over 5 decades of chemical farming, farmers have lost touch with cattle rearing. Farmers have grown to believe that rearing cattle would involve more work, additional labor and could be cumbersome. This is a strong deterrent when it comes to making the transition.

Initial Yield

The general myth with regards to yields in natural farming is that it apparently is less than 'conventional agriculture'. But it is not so. Our experience has been that the farmer is capable of getting similar yields in the first year of transition itself. It depends on the way it is presented to the farmer and the guidance and support that is provided. If the soil that is degraded is revitalized using natural farming techniques and the farmer is provided with necessary support on a real time basis regarding other aspects such as pest and weed management, irrigation and crop maintenance, value addition and marketing, the yields have not reduced to a large extent. Above all due to natural farming the fertility increases steadily and input costs reduce over a period of time. Thereby there is an increase in yield as well as net income.

Marketing Of Produce At Fair Price

There also exists a number of practical difficulties in marketing the produce directly to the end consumer. The presence of middlemen in this scenario means reduced price realization and thereby reduced net income. In most cases, the farmer is forced to sell his organic produce at the conventional prices. Also, even if the farmers follow all the procedures and get organic certification, they end up selling their produce at the general market price.

Government Initiatives and Generational Issue

Government for long has been incentivizing chemical farming as opposed to natural farming, making chemical farming a far more lucrative option. The 2016 Zero Cost Natural Farming Report to FAO seems to be the first departure from this longstanding chemical farming line. The other fact appears to be a natural resistance to change, given that an entire generation of farmers have now only been used to chemical farming.

Community Perception
Natural farming is seen in villages as a regressive step. There has been a clear inculcation among farming communities in the supremacy of chemical farming and therefore when farmers return to natural farming there is often resistance from the community sometimes amounting to ridicule.

Youth & Continuity
The financially unviable conditions of farming has ensured that an entire generation has now been pushed out from agricultural activity. Village youth have in large part moved away from agricultural activity which is considered a loss making proposition. Youngsters cannot get a bride if they are farmers. Such is the extent of stigma attached to this life-giving field. With the youngsters moving away from this we are truly staring down a crisis of enormous proportions; loss of traditional knowledge, continuity and loss of farm labor and good quality farmers.

Second Phase: Multiplying the efforts

The second phase which begins from 2021 until 2025 envisions transitioning a critical mass of SS-TKV farmers that will be vital to initiate the 3rd phase of the movement. SS-TKV proposes to train 100,000 farmers across the state in natural farming and tree based agriculture. It will also facilitate the organization of these farmers for optimal production and connect farmers with consumers thereby increasing the net income, avoiding middlemen for better price realization and offering good quality produce. In addition to this SS-TKV will leverage the government agricultural schemes and organic certification programmes to the farmers.

Therefore, SS-TKV plans to consolidate the learning and growth from phase 1 through extensive documentation and overcoming the shortcomings learnt from the first phase.

As envisioned, the farmers who are targeted in the 2nd phase will be from the semi medium (2-4 ha) to medium category (4- 10 ha). The number of semi medium and medium farmers in TN alone is 5.81 lakhs as per latest agricultural census 2015. These farmers hold 30% of agricultural land and are 7% of the farmer population. The economic situation of these farmers is also better than the small and marginal farmers and they are more open to new ideas than the small and marginal farmers. Hence they are more likely to change from conventional farming to natural farming and tree based agriculture.

For phase 2 to operationalize, the 2,000 practicing natural farmers will be handy as they will turn into natural farming champions and their farms into model farms taking this message across the state. For phase 3 to become a reality in addition to these 2000 farmers another

35,000 (going by the current conversion ratio) farmers can be expected to fully undertake natural farming out of the 100,000 farmers who will receive various training. SS-TKV will undertake the following actions during this phase:

Creating and identifying various models for tree based agriculture
In this phase, SS-TKV will move steadily towards taking farmers from short duration crops to long gestation crops in the form of trees. In this regard, SS-TKV will set up various models where existing crops can be intercropped with trees of high economic value. Trees will be promoted in SS-TKV training programs as an insurance option as well as lifelong assets. Also, the ecological benefits of growing regular crops among trees will be shown through practical field trials and various tree based models will be explored that suit the various farmer mindsets. The long term objective is to have at least 30% of the land under tree cover. Tree based models are created in SS-TKV farms for experiential training and also proposes to identify tree based farms through farm visits and include them as a part of the promotion for the movement.

Farmer awareness campaigns for enrollment
Newsletters, press releases, AVs of success stories, tutorials by leading farmers aimed at not only increasing awareness about natural farming but also enthusing more farmers to join the natural farming bandwagon.

Farmer cluster formations
The SS-TKV has been operating in a 'raindrop model' wide across the state in phase 1. This is to create credibility for the SS-TKV brand across the state. This has been largely achieved in the first phase. In the second phase, for reasons of showcasing to the government and ease of marketing of produce, a 'cluster approach' is chosen. The cluster model will be formed around the Isha Model Farms location in Thanjavur, Tiruvannamalai, Erode and Coimbatore. It will help our volunteers to effectively reach a large group of farmers at a time with effective training conducted in SS-TKV model farms and also facilitate the handholding and marketing process.

In this context, it is to be noted that a similar program called 'Bhartiya Prakritik Krishi Paddhati (BPKP)' which is a new sub mission to be introduced under Paramparagat Krishi Vikas Yojana (PKVY) Scheme. This sub mission aims at promotion of natural farming practices on pilot basis in clusters of 2,000 ha in all blocks of the country.

Cultivation assistance

The training that has been conducted in the first phase will continue with improvements as needed. It will be scaled up to reach the targets of the second phase.

1. Technical Trainings

   Following trainings are planned to be conducted in SS-TKV:

   a. Crop based training.
   b. Natural soil enrichment training.
   c. Plough less, weed less cultivation technique.
   d. Insect, Pest management training.
   e. Water & irrigation training.
   f. Native cows management training.
   g. Integrated farming training.
   h. Tree cultivation as boundary plantation or alley cropping or tree based agriculture.
   i. Farm designing for efficient use of resources.
   j. Documentation of farm activities for effective planning and showcasing of the farm.
   k. Value addition training.
   l. Organic certification training.
   m. Mechanization training for drudgery reduction.

2. Hand holding for transition

   As in phase 1, SS-TKV will facilitate and handhold the farmers for effective conversion of the farmers from conventional method to natural farming. Handholding will include formation of whatsapp groups after the training. All notifications of future events will be sent via this group. Periodical review meetings will be organized to discuss individual aspects of natural farming such as input preparation, seed treatment, pest control etc in detail, and clarify doubts. Farmer suggestions regarding the improvements in the training will be noted in the review meetings and course corrections will be done along with the designing of fresh training programs. Also, the helpline set up will be enhanced further to address farmer queries.

Collaboration in marketing of natural produce

Direct marketing of natural farming produce is one of the key areas that need our urgent attention. We have around 2,000 farmers growing a variety of produce in various districts of Tamil Nadu. Although the produce is chemical-free it does not generally find a higher market value.

Some SS-TKV farmers having organic certification are involved in direct marketing as guided by us. The major bottleneck in the promotion of natural produce is to gain the trust of the consumers. Our farmers do not have the ability to market their products at the price in which the other large organic producers do. They are forced to sell a large portion of their natural produce to local vendors at the general market price. Even if they sell it to the large organic produce businesses they still do not get the fair price. Even now, a large chunk of profits is taken over by the middlemen and companies. To get our farmers out of this situation we have planned to get into marketing and support our farmers and in turn attract more farmers into the movement.

Currently, data is being collected from SS-TKV farmers across the state and being analysed. We propose to start with the facilitation of collection and marketing of produce in Coimbatore City from farmers within the district and nearby district farmers. Also in the long run it will be possible to scale up this process by forming district wise farmer clusters. This will make the process of aggregating, transporting and marketing the produce efficient and economical. Therefore a self sustaining marketing model run by farmers themselves needs to be worked out for implementation in the second phase of the movement. Some models that seems to be viable in the present scenario are:

1. Farmer Collectives
   SS-TKV proposes to form farmer collectives and support the collection, packaging and redistribution of organic produce to organic shops, wholesale buyers and if needed export. They will also run organic retail shops to gain practical experience of consumer preferences.

2. Online Producer Consumer Market
   In order to create a relationship between the producer and consumers without the involvement of the middleman and to scale up when necessary, a robust online platform is essential. Today the consumer is doubtful about the genuineness of the product while the producer is doubtful about getting the payment. Therefore an online presence facilitated by SS-TKV is expected to build trust among consumers and pride and recognition in the producers.

3. Urban Shanties For Natural Produce
   The SS-TKV proposes to establish urban shanties which will play a huge role in connecting the consumers directly with the producers. This is expected to create long lasting relationships and trust between the farmers and the consumer for the sustainability of the movement.

Awareness to the general public

The general awareness regarding SS-TKV, poison free food and online marketing of natural produce will be majorly done through social media platforms, print media etc. SS-TKV will identify consumer champions who will be volunteers to promote consumer awareness to the general public. The consumer champions will be mostly Isha meditators. The consumer champions will play a significant role in promoting the produce and the producers to the general public by engaging in various social and online platforms. This will be designed as a crowdfunding model.

Reinstilling the lost pride among farmers

One of the major problems in agriculture today is that farmers have lost their pride in the work that they do. The younger generation is moving away from farming because they are looking for higher prospects. Agriculture, due to various reasons, is failing to provide a stable income with good economic returns for the farmers. The possibility of the country moving rapidly towards a food crisis is quite high because we are losing our farmers. The only way to address this problem is by turning agriculture into a lucrative and socially uplifting process.

On the other hand a significant number of consumers have been yearning for safe and chemical free food. This demand-supply gap which is very obvious is being hindered by complex rules and regulations imposed on the natural farmers by various governmental bodies. Therefore there is a need to connect the consumer and the producer on a deeper level and bridge the gap between them.

To make this happen, SS-TKV is proposing to create a whole new model of interaction between the farmers and the consumers through various mediums with an objective to introduce the farm life to the consumers. The idea is to develop a relationship between them and a culture of respect towards the farmers while ensuring them stable incomes. Also it will ensure quality produce for the consumers while adding credibility and trust in the movement. To do this we will require consumer champions who will forward this cause among the urban communities. Therefore the following programs will be conducted for generating consumer champions:

1. Farm Vacations
   SS-TKV will actively promote farm vacations whereby individuals / families disconnected from natural surroundings can benefit through farm activity. This plan will allow them to stay in a farm for a stipulated time, actively engaging in farm activity. This will also increase awareness of food cultivation among urbanities. This will also create another revenue stream for the farm & also an easy market for produce sale.

2. Volunteering Opportunities
   SS-TKV will enable volunteers to participate in a variety of ways in this significant movement.

   - Volunteers will become among the first of SS-TKV's consumers.
   - Volunteers will champion this cause in their localities.
   - Volunteers can undertake Prithvi Prema Seva through this program.

3. Natural Farming Trainings For Urbanites
   In urban locales SS-TKV will promote training for creating their terrace gardens and become trainers for other urban consumers. This will further strengthen the consumer awareness for consumption of poison free food.

4. Recognition And Awards

Suitable ways of recognizing farmers and instituting awards will be done so as to instill pride in them.

Internship training program

An internship training program will be designed to inspire more youth to join the movement as volunteers/staff. Opportunities will be created for employment in SS-TKV, placement in various farms associated with SS-TKV and setting up their own Natural farms. These intensive training programs will benefit the trainees as well as the people within the organization to sharpen their skills and understanding of the natural farming process.

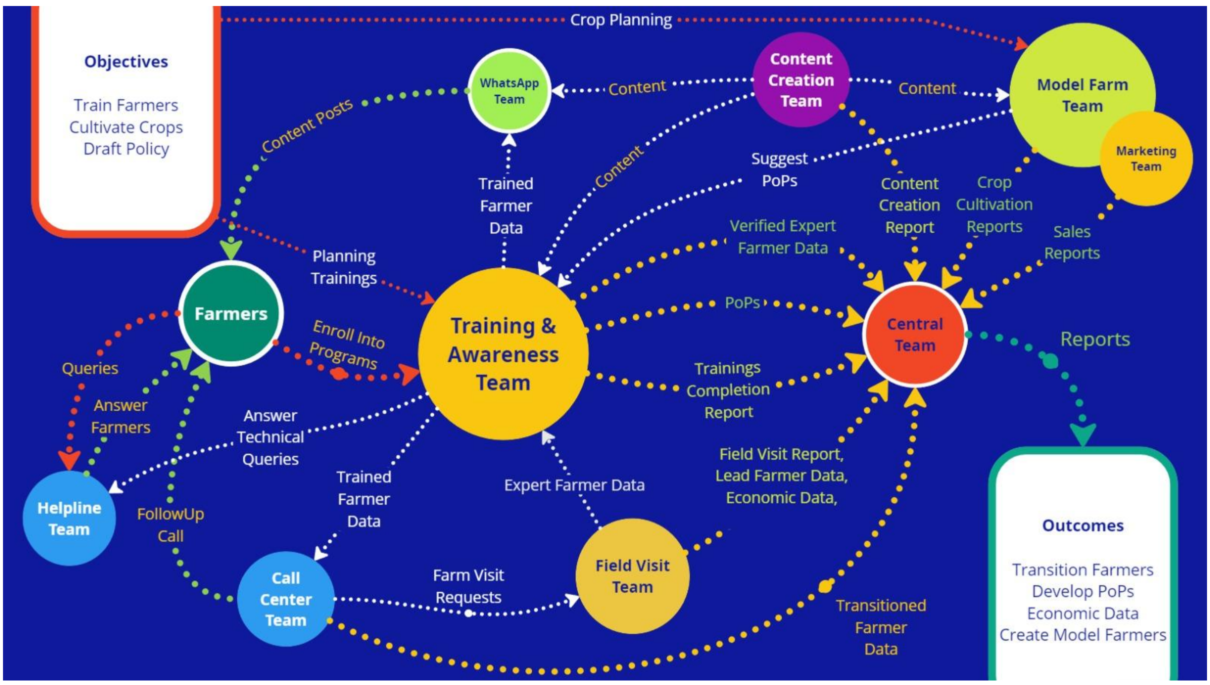
Documentation

Another important objective of the second phase is to collect and collate enough information and experiences from the SS-TKV farmers and SS-TKV farms ,for creating the basis of a draft policy on Natural Farming for the state. The following documentation will be done for this purpose. This list is not exhaustive:

1. Consolidation of benefits derived by farmers.
2. Number of farmers converted to natural farming methods.
3. Acreage under natural farming.
4. Type of produce & estimated volume of production.
5. Survey of natural farming on the lives of farmers.
6. Number of consumers consuming poison free food.

Operations

The SS-TKV has an organic administration and operations structure which is explained from the following diagram:



Creating a draft policy recommendation

SS-TKV will showcase the work done until then through documentation and submit a 'Draft Policy for Natural Farming in Tamil Nadu' to the government. We also envisage, Sadhguru will take up the SS-TKV cause in the state and across the nation similar to "Rally For Rivers" and "Cauvery calling".

Third Phase: Continuing the efforts

The experience of first phase and second phase will have given SS-TKV a good idea of what it takes to transition farmers from chemical to natural farming. The SS-TKV will continue the transition of farmers as in the second phase with necessary course correction with respect to the situation at that point in time.

The third phase after 2025, is going to be a steady state for SS-TKV and the extent of the programmes will be determined by the organization's resources, capacity and capability. By this time, it is expected that the focus will shift from semi medium and medium farmers, who have better risk taking abilities, to small and marginal farmers who would have seen and understood the benefits of natural farming. It is expected that by then, the large acreage farmers also will find the economic benefits of natural farming and tree based agriculture and hence shift from conventional farming to Natural Farming.

Currently the government seems to be in favor of natural farming at the NITI Aayog level. So we expect the environment to be very favorable for transitioning the current chemical farmers to natural farmers. SS-TKV will be taking it up with the government with necessary documentation and with support of the lead farmers and consumer champions. This will help the government to implement the program in a focussed manner. When the Government adopts the Natural Farming Policy and starts implementing it statewide, the vision of Sadhguru will fructify.

Annexure 7: Scientific Basis For SSM Agri Practices and Agri Extension Services

R. Ethirajalu

Introduction

The objective of this document is to establish the scientific basis for agri-practices promoted in the training programs of Isha Outreach as well as the scientific basis of the agri-extension services. It also presents a few sharings of farmers who have benefited from the ongoing agri-extension services. In addition to that, it presents scientific papers that have been published in support of the natural farming practices followed by farmers across the country.

Isha Outreach is a non-profit organization, setup for the upliftment of the rural communities in Tamil Nadu. It acts on the various aspects related to the local communities ranging from health and education to economy and ecology. To uplift the farming community from the cycles of debt and hardships, Isha Outreach has been working ceaselessly since 2007 to better understand the problems and find solutions for the farmers in Tamil Nadu.

It has been a common observation that the majority of farmers do not want their children to get into agriculture simply because it is now failing to fulfill their needs. Major reasons for this have been the loss of soil fertility, water scarcity, rise in agricultural input costs, falling farm incomes, climatic risks among many others.

In the effort to support the farmers to find other innovative approaches to crop cultivation, Isha Outreach has been conducting its on-ground crop cultivation and agri-extension services effectively over the past decade and has shifted about 2,000 farmers to 'natural farming'. 'Natural farming' is a nature based solution to agriculture which is based on the concept of agroecology which has gained prominence in scientific, agricultural and political discourse in recent years.

According to a HLPE report published by Food And Agriculture Organisation (FAO), "agroecology embraces a science, a set of practices and a social movement and has evolved over recent decades to expand in scope from a focus on fields and farms to encompass whole agriculture and food systems. It now represents a transdisciplinary field that includes all the ecological, sociocultural, technological, economic and political dimensions of food systems, from production to consumption."

Being in tune with this, various agro-ecological methods and practices have been designed and promoted by Isha Outreach under the banner of "Isha Agro Movement" and "Cauvery Calling" to foster the well-being of both producers and consumers as well as the farm ecology. In a nutshell, the agroecological practices adopted by Isha Outreach for crop cultivation are:

7. Minimum Tillage

8. Cover Cropping
9. Mulching
10. Multi-layer Tree-Crop Integration
11. Livestock Integration
12. Composting And Application Of Natural Bio Inputs
13. Biological Pest Management

The above agri-practices have been scientifically validated by various scientific organizations worldwide. The United States Dept of Agriculture (USDA) actively promotes regenerative agriculture for food safety and conservation of agricultural soils. The Indian Council For Agricultural Research (ICAR) and it's sister institutions have conducted various trials on various natural farming practices and the NITI Aayog has begun promoting it actively in the past few years under the 'Bharatiya Prakritik Krishi Paddhati' (BPKP) scheme which is part of the Paramparik Krishi Vikas Yojana.

To promote these practices, Isha Outreach conducts and operates one-to-many and one-on-one programs such as training courses, farm schools, on-farm trials, farmer group review meetings, farm visits to individual practicing farmers, farmer consultation through Whatsapp and other social media platforms and helplines.

Farmer training covers a broad area including crop-based training, input preparation, better livestock management, efficient water management, weed and pest management among others. Where appropriate, Isha Outreach is planning to help build up local farmers' groups or clusters so that they can benefit from all the activities, thereby, providing the valuable elements that farmers need to improve and stabilize their agricultural productivity and stable net incomes through natural farming systems.

The scientific basis adopted in Isha Outreach is designed to be in tune with the guidelines presented by FAO in its HLPE report on agroecology and other innovative approaches for sustainable agriculture and food systems that enhance food security and nutrition. The extension services of Isha Outreach are similar to those conducted by the Krishi Vigyan Kendra (KVK).

Scientific Basis For Natural Farming Systems

Agriculture is the backbone of human civilization. Human beings have been mimicking nature to produce food for thousands of years.[16] Indian agriculture began by 9,000 BC by domestication of wild plants and animals and developing cultivation methods, imitating their natural environment. Settled life soon followed with implements and techniques being developed for agriculture. Double monsoons led to multiple harvests being reaped in one year. Over time, land and water management reached a new level of sophistication. Plants and animals, considered essential to our survival, came to be worshiped.

[16] https://en.wikipedia.org/wiki/History_of_agriculture

Our ancestors considered the five elements as manifestations of the divine and there was a culture of reverence towards them. By observing and imitating the natural environment, they experientially knew how to keep the fertility of the soil intact and passed down the knowledge for the coming generations. In this way, with an attitude of conserve and use and a continuance of the practices in the best possible way, we have been able to sustain the soil fertility and productivity for thousands of years.

This application of these ecological concepts and principles in farming is now globally termed as agroecology. According to the HLPE report of FAO, agroecology is a dynamic set of principles that ensures a regenerative use of natural resources and provides ecosystem services while creating socially equitable food systems that envelops a transdisciplinary field that includes ecological, sociocultural, technological, economic and political dimension of our food systems, from production to consumption.[17]

Agroecology emerged as a concept in the 1930s, expanded as a science during the 1970s and 1980s, and became institutionalized and consolidated in the 1990s.[18] The 'natural farming' practiced in the Isha Agro Movement is an adoption and extension of these agro-ecological principles. There has been enormous amounts of scientific research across the world over these principles till date and various methods have been developed for their practical application in farmlands.

The overall objective of agro-ecology identified by Gliessman (2007) in making agroecological transitions towards more sustainable food systems are summarized in the 5 phases mentioned below:

The first three operate at the agroecosystem level and involve:
(i) increasing input use efficiency;
(ii) substituting conventional inputs and practices with agroecological alternatives; and
(iii) redesigning the agroecosystem on the basis of a new set of ecological processes.

The remaining two steps operate across the whole food system and involve:
(iv) re-establishing a more direct connection between producers and consumers; and
(v) building a new global food system based on participation, localness, fairness and justice.

Much scientific research has gone into the field of agroecology in the past decade.[19] According to the International Institute for Environment and Development (IIED) (Silici, 2014), examples of agroecology in practice include:

- Conservation tillage: no or minimum tillage improves soil structure and organic matter;

[17] http://www.fao.org/agroecology/overview/en/
[18] https://portals.iucn.org/library/sites/library/files/documents/2020-017-En.pdf
[19] https://portals.iucn.org/library/sites/library/files/documents/2020-017-En.pdf

- Mixing crops in a single plot, such as intercropping / polycultures: biological complementarities improve nutrient and input efficiency, use of space and pest regulation, thus enhancing crop yield stability;
- Crop rotation and fallowing: nutrients are conserved form one season to the next, and the life cycles of insect pests, diseases and weeds are interrupted;
- Cover crops and mulching: reduce erosion, provide nutrients to the soil and enhance biological control of pests;
- Crop-livestock integration: allowing for optimal nutrient recycling, beyond economic diversification;
- Integrated nutrient management: the use of compost, compost teas, organic manure, manure teas and nitrogen-fixing crops allows the reduction or elimination of the use of chemical fertilizers;
- Biological management of pests, diseases and weeds, such as integrated pest management, push and pull methods and/or allelopathy: decrease long-term incidence of pests and reduce environmental and health hazards caused by the use of chemical control;
- Efficient water harvesting, reducing the need for irrigation;
- Agroforestry: maximizes the use of sunlight and other resources, maintains and improves soil fertility and structure, also modifying the microclimate for crops;
- Use of local resources and renewable energy sources, composting, and waste recycling: allows a reduction in the use of some external inputs such as synthetic and chemical pesticides and fertilizers, as well as reducing pressure on the natural resource base;
- Holistic landscape management: around the field (e.g. windbreaks, insect strips and living fences), across fields (mosaic of crop types) and at the landscape level (e.g. river buffers, woodlots, pastures).

Therefore, agriculture is a fundamental human activity that depends intrinsically on natural processes, including soil fertility, water recycling, and pollination. But today, we have heavily mechanized and industrialized agriculture to feed 7 billion people. Although industrial agriculture with the use of inorganic chemicals and hybrid seeds have produced enough food, it has also led to enormous consequences for our natural resources, climate, biodiversity and human health. More than half of all agricultural soils have degraded since the advent of industrial agriculture and water has become scarce for 3.2 billion people who live in agricultural areas.[20] And despite the growth in production of food, 821 million people are undernourished[21] and one person in three is malnourished worldwide.[22]

Therefore, it is now widely accepted that we must return to the age-old principles of agroecology in order to produce food for us. The report of the High Level Panel Of Experts (HLPE)[23]of the UN Food And Agriculture Organisation (FAO) clearly states the urgent need to transform our agriculture systems. But 'natural farming' based on agroecological principles is currently a fringe phenomena across the planet. We need to act on a war

[20]https://www.unccd.int/high-level-dialogue-desertification-land-degradation-and-drought
[21]http://www.fao.org/3/ca5602en/ca5602en.pdf
[22]https://www.weforum.org/agenda/2016/11/one-in-three-people-worldwide-suffer-from-malnutrition
[23]http://www.fao.org/cfs/cfs-hlpe/hlpe-reports/en/

footing to make this a mainstream phenomena to reverse the ill effects of industrial agriculture in the coming decades. It will need the participation of governments, farmers and the people to make this happen.

Already, many national and international organizations are working towards this cause. Recently NITI Aayog has also recognised the need to transform the agriculture systems of India. It refers to ecological agriculture as simply 'natural farming'. According to NITI Aayog, natural farming is a chemical-free alias traditional farming method. It is considered as an agroecology based diversified farming system which integrates crops, trees and livestock with functional biodiversity.[24] Similar practices with minor variations, are also now promoted by the NITI Aayog under the 'Bharatiya Prakritik Krishi Paddhati' (BPKP) scheme which is part of the Paramparik Krishi Vikas Yojana.[25] This scheme is aimed at promoting traditional indigenous practices which reduce externally purchased inputs.

Also, the Andhra Pradesh and Sikkim governments have been engaged in transforming agriculture through natural farming. The Andhra Pradesh Community Managed Natural Farming (APCNF) has been operational since 2016 and it has been providing extension services to 500,000 farm households across the state.[26] Sikkim on the other hand has already been declared as the first organic state in India back in 2016.[27] Recently in Dec 2021, the Prime Minister also addressed a farmer's meet and appealed to farmers in Gujarat to adopt "natural farming" techniques as a way to serve mother earth.[28]

The main strategy adopted by these organizations to reach out to farmers to promote 'natural farming' is that of agri extension services (AES). This strategy has also been recognised and promoted by the FAO.[29] The AES division of Indian Council Of Agricultural Research (ICAR), the apex agricultural organization in the country, operates through a network of 11 Agricultural Technology Application Research Institutes (ATARIs) and 721 Krishi Vigyan Kendras (KVKs). The overall objective of AES is:

- To transmit the latest technical knowledge to farmers about agriculture.
- To enhance their knowledge and make their profession more productive.
- To provide feedback from farmers to extension service providers / trainers on their problems and constraints.
- To provide real time troubleshooting for the farmers.
- To enhance professional competence of extension functionaries.
- To motivate farmers and create healthy competition among themselves.

In this context, Isha Outreach launched a movement under the banner of "Isha Agro Movement" in 2008 to promote natural farming in Tamil Nadu and more recently "Cauvery Calling" in 2019 to promote tree based agriculture. The goal of this is to make tree-based natural farming a mainstream phenomena in Tamil Nadu in the next decade. To make this

[24] https://www.niti.gov.in/natural-farming-niti-initiative
[25] https://www.niti.gov.in/natural-farming-niti-initiative
[26] https://azimpremjifoundation.org/content/rythu-sadhikara-samstha-ryss-gunturu
[27] https://www.downtoearth.org.in/news/agriculture/organic-trial-57517
[28] https://www.thehindu.com/sci-tech/agriculture/zero-budget-natural-farming-back-on-top-of-government-agenda/article37948720.ece
[29] http://www.fao.org/3/t0060e/T0060E03.htm

happen, Isha Outreach has chosen to do this through various scientific argi-extension service platforms such as farmer trainings, farm schools, consumer awareness campaigns and agri-marketing services.

The AES also focuses on enhancing farmers' knowledge about crop techniques and helping them to increase productivity. This is done through one-to-many and one-on-one programs such as training courses, farm schools, on farm trials, farmer group review meetings, farm visits to individual practicing farmers, consultation through whatsapp and other social media platforms and helplines.

Isha Outreach AES are carried out by extension volunteers or extension staff members. They always play a crucial role in promoting natural farming technologies to enhance agricultural productivity and promoting agriculture as an economically lucrative process for the farmers.

Isha Outreach AES covers a broad area including crop based training, input preparation, better livestock management, efficient water management, weed and pest management among others. Where appropriate, Isha Outreach is planning to help build up local farmers' groups or clusters so that they can benefit from the AES. The AES, therefore, provides the valuable elements that farmers need to improve and stabilize their agricultural productivity and stable net incomes through natural farming systems.

As natural farming has been already established as a scientific process worldwide, the Isha Outreach follows natural farming practices that are practical and scientifically proven. The strategy is to find a suitable scientific natural farming method that works for the farmer in his current situation and his mindset and at the same time solves the problems of loss in fertility of soil and scarcity and depletion of resources in farmlands for future generations.

Over the past decade, Isha Outreach has been quietly uplifting hundreds of farmers from the vicious cycle of industrial agriculture. Currently it is the largest natural farming movement in Tamil Nadu and it has also come to the notice of the state government. Recently they have invited a member of Isha Outreach to a high level panel discussion on implementation of 'natural farming' in the state. Isha Outreach Farmer Training Personnel has also been invited to train farmers in a couple of programs for the state government. Also, the UN Food Systems Summit had invited a member of Isha Outreach to participate in the pre-summit held in the month of July this year. Isha Outreach has been participating and contributing in these events with much zeal and enthusiasm.

Economic Basis For Natural Farming

Natural farming conserves and regenerates the very asset that is necessary to generate farm incomes, which is the soil. Soil health has been depleted considerably worldwide since the advent of modern agriculture and population explosion. Depletion in soil health is synonymous with depletion in the soil organic content. The soil organic content in most agricultural soil in India is less than 0.5%[30]. The minimum organic content in agricultural soil needs to be 3%. Therefore, to address the problem of farm loss, Isha Outreach has focussed on regenerating the soils.

Regenerating soils have the following benefits:

1. Reduction in pest and diseases
2. Reduction in propensity of weeds
3. More resilient crops
4. Higher yields

The above benefits result in reduction of agri-inputs in the form of fertilizers and pesticides both organic and inorganic thereby reducing cost of production. Higher yields secure higher incomes. In some cases, with the help of direct marketing, farmers are able to get higher prices for their produce. Isha Outreach also aims to connect producers and consumers directly in future, thereby creating stable marketing possibilities for farmers and affordable nutritious food for consumers. With these interventions, farmers trained under Isha Outreach have demonstrated that by following agroecological practices, they are able to get stable net incomes.

Isha Outreach Farmer Trainings Structure

Isha Outreach has been ceaselessly operating to change farmer mindsets, identify and provide economically more beneficial and ecologically holistic farming methods through the various scientifically designed training programs.

The training programs are conducted by either a resource person who is an expert on the subject or a lead farmer who has the experience of that aspect and has the necessary skills to conduct a training program. The organizing of the programs is done by Isha Outreach staff and volunteers.

The program is conducted professionally and all possible data is collected. All participants are required to fill a registration form and they receive a name tag which they have to wear during the course of the program. There are two ways of registration; online and spot. After due check-in the participants are seated in the venue and the program begins with a game. The game is conducted to refresh the participants and make them receptive to the training as well as allow time for the late comers to join in. After the game, the program begins with

[30]https://www.thehindu.com/news/cities/Tiruchirapalli/decline-in-soil-organic-carbon-content-worries-icar/article6678512.ece

a brief self- introduction of the participants, a short invocation, followed by an introduction to the Isha Agro Movement.

Hereafter, the program is handed over to the lead farmer/resource person who briefly introduces the topic of discussion and begins to dwell into the subject in detail. This talk includes:

1. The experience of the lead farmer/resource person.
2. What was he doing before becoming a full time natural farmer?
3. Why did he choose natural farming over conventional agriculture?
4. What are the changes he made and how did he arrive at it?
5. The practices he currently uses and the benefits he derives from it.
6. How easy or difficult is it compared to the old methods?
7. Why does he want to inspire other farmers to follow the same practices?

Thereafter, the participants are given a short herbal tea break.

After the break, the participants are taken to the farm to demonstrate what has been explained during the first half of the program. The lead farmer/resource person explains the process in detail by showing it and requests everyone to observe carefully and note down their observations and questions which will be discussed later in the next session. After this session the participants are served a delicious meal prepared on the spot by Isha Outreach staff and volunteers.

The next session begins after the lunch break. In this session the participants are divided into groups for a group discussion on what they have learned so far. One of the participants is appointed as a spokesperson in each group and he is asked to present the sharings of his group with the entire class.

After this, there is a question and answer session where participants are allowed to ask any doubts they have to the lead farmer/resource person. Once these questions are answered the participants are provided with a printed sheet which has the package of practices that were part of the training. They can use it as a reference after they begin their new set of practices. The program then ends with the experience sharing of the participants and a vote of thanks by the organizers.

These trainings are modified or new programs are added occasionally as per needs of the farmers. It can be divided into two categories.

A. Basic Training Programs

1. Input / Natural Soil Enrichment
2. Insect / Pest Management
3. Integrated Farming Technique
4. Weed Management Program
5. Urban - Natural Farming
6. Honey Bee
7. Native Cows Management

8. Farm Tours

B. Crop Specific Training Programs
1. Agroforestry
2. Banana
3. Coconut With Inter Crop
4. Pepper
5. Paddy
6. Sugarcane
7. Turmeric
8. Vegetables And Greens

Basic Training Programs

The training offered by Isha Outreach is holistic in its approach. It allows the participants to understand vital topics with ease. They are advised to go through these basic training programs before crop specific training to natural farming principles.

A. Input / Natural Soil Enrichment

The most important aspect of shifting farmers to natural farming is the preparation of natural inputs for improving yields. Farmers who have been practicing natural farming for many years find it difficult to prepare inputs in the farms and apply it effectively. They have concerns of yield, costs, time and effort. The SS-TKV input training is designed to effectively address these concerns and help farmers shift to natural farming gradually but permanently.

The farmers are taught the following:

1. To select the right mix of raw materials required to prepare the inputs.
2. To prepare 12 different types of solutions to various problems such as infertility, pests and diseases.
3. To apply the input with the right tools, at the correct doses and at the right time.
4. To store the prepared inputs properly and how long it can be stored in given conditions.

After undergoing this training, farmers are required to make these inputs themselves in the farm where the training is conducted. This allows the farmers to gain hands-on experience and also it helps them acquire skills that allows them to teach the methods to other farmers.

This program is considered a gateway to natural farming in the sense that it addresses most of the concerns and provides vital skills and knowledge that is needed for a farmer to shift to natural farming.

B. Insect / Pest Management

Pest management training is designed to create awareness among farmers about the nature of pests in the farm and the effect of pesticides on all farm life including humans. It also raises awareness about the role of beneficial insects that are also exterminated due to the use of these chemicals which further amplifies the problem.

The approach in this training is to show the life cycles of various common pests and their predators. The training takes place in the classroom to discuss a few points about pests and then the farmers are taken to the field for observation. The pests are shown to them through a magnifying glass and their life cycles from eggs to insects are closely observed. Even the nightlife of these pests are observed by conducting night classes. Following questions are asked to the participants to help them observe:

1. What are the pests in the field?
2. What time do the insects arrive?
3. Where do those insects come from?
4. Which pests are present in the crop?
5. What is that pest doing to the crop?
6. What is the difference between one insect and another?
7. How do insects reproduce?
8. Where are those pests when there is no crop?

After careful observation, the farmers know the way the pests function and then they are shown pest management techniques that protect the beneficial insects and repel or kill the harmful ones.

This training shifts the farmer's mindset completely as they can see that there are more friendly insects in their farm than the enemies. They come to realize that they have been destroying all the insects irrespective of their function. This makes them adopt integrated pest management techniques which are also discussed in the training. Managing pests in this way reduces the need for pesticides and genetically modified crops. Therefore, an overall understanding of pest management is provided in this training program.

C. Farm Designing & Documentation

This program has not been conducted by Isha Outreach yet. It is in the planning stage.

D. Integrated Farming Technique

An integrated farming technique is based on the principle of integrating plants and livestock for a stable net income. The farm has to be designed in such a way that there is a diversity in the sources of income whether it's weekly, monthly or annual.

The farmers are taught to :

1. Integrate cows, goats, hens and fish into the existing system where the output of one is input for another. For example, the hen excreta is fed to the fish, the fish is used to prepare inputs for crops, the crops are used as fodder for animals and the animal waste is used to prepare compost. In this way the symbiotic relationship is created within the farm to reduce operating costs.
2. Grow various fruit trees, bamboo, herbal and medicinal plants and plants for biomass and fodder. This gives farmers incomes from various sources and thus the risk of net income loss is avoided.
3. Use the system to regenerate the soil and improve fertility.

Hence, an effective way of increasing stable farm income is the objective of this training.

E. Weed Management Program

Weed management is perceived as a major challenge in Natural Farming. In this training the types of weeds, their characteristics and how it spreads etc is discussed. Farmers are made aware of the following measures to control weed naturally in this program:

1. Summer plowing before planting maincrop helps to control weeds to some extent. This practice is generally adopted by farmers.
2. In addition to this, it is advised to flood the field and allow the weeds to germinate. Once sufficient weeds have germinated, the field is plowed again. This reduces the weed population significantly during the cropping period. This method reduces the cost of weeding for the crops.
3. Other measures for weed control include intercropping, bio mulching and husk mulching. These methods not only control weeds but also improve soil fertility and reduce irrigation requirements.

F. Urban - Natural Farming (Grow Your Own Food)

Isha Outreach also offers urban people a natural farming training that helps them to grow vegetables on their terraces. The training guides how to use coconut coir-pith instead of soil.

The trainees are provided with pot mix made of coconut fiber which are required for planting so that they can set up the terrace garden immediately. The pot mix is made up of a mixture of coconut fiber, ghana jeevamirtham, goat manure and leaf litter, and is also arranged for native seeds and bags. Coconut fiber retains water for a longer duration. Plants can be grown in 30 bags using 10 to 20 liters of water daily. It only takes about 15 minutes to maintain these plants.

The person who wants to create a terrace garden is trained to select and cultivate vegetables and herbs. These vegetables include tomatoes, lentils, eggplant, bitter gourd, beans, coriander, mint, onions, spinach etc. They are taught the intricacies of planting and maintaining the herbs they need at home, such as flowers, short-lived fruit trees, and so on.

G. Honey Bee

The training module of Honey Bee is under preparation. Isha Outreach proposes to conduct training on Honey Bees in the near future.

H. Native Cows Management

Dr. Punnia Moorthy, a PhD veterinarian in the field of Ethnoveterinary medicine (EVM), provides training on the traditional care of animals with herbal medicines. Just as organic farming depends on natural inputs, animal husbandry also depends on inexpensive natural inputs.

The ingredients required to make these medicines are also commonly available and inexpensive. Most of it can be found in the kitchen itself such as pepper, cumin, turmeric and betel etc. These medicines have been recognised by the National Dairy Development Board (NDDB) as ethnoveterinary medicines.[31]

I. Farm Tours

Farm Tours are conducted for farmers to see for themselves the extraordinary model farms that have been developed by farmers over 7-10 years. These farms act as eye openers for skeptics as well as beginners.

These farm tours showcase farms with various kinds of trees, shrubs and herbs planted in between high yielding coconut trees. Most of the principles of agroecology are demonstrated in these farms. Once a participant sees this kind of model, he is very likely to shift to natural farming.

The following points are observed in the farm tours:

1. The multi layers of trees and other crops.
2. The bio-input based irrigation systems which are integrated with the cattle shed.

[31] https://www.dairyknowledge.in/sites/default/files/pdfs/EVM_Brochure_Eng.pdf

3. The strategy of digging pits in between coconut trees that absorb nutrients from the mulch and transfer it into the soil.
4. The size, weight, taste and count of yield per tree.
5. The marketing methodology and net incomes.
6. The condition of adjacent fields during droughts and floods as compared to the farm.
7. The non-existence of pests and diseases in this method of agriculture.
8. The design of the rainwater harvesting structures.

Above all, the model farmer is willing to share all his challenges that he went through and his current status of income and the time he spends on the farm. This has had a very significant impact on all farmers who have visited these farms.

Crop Specific Training Programs

The crop specific training programs mentioned here include the package of practices that are followed by the lead farmers themselves who come and share their knowledge to the participants.

A. Agroforestry

Agroforestry is a simple method of converting arable land to tree-based agriculture. It requires some careful planning and designing particularly in mixed cropping systems as the systems have to evolve over time. In this sense, farmers should be made aware of a few things during the design and the implementation phase. Also, proper hand holding is required to be given for successful adoption of the system. The main advantage of agroforestry systems is the resilience it provides to the farm economics and supports the farmers with stable net incomes. In Isha Outreach Trainings, farmers are made aware of the following:

a. The soil conditions needed for different species of trees.
b. The water requirement of different species of trees.
c. The proper techniques for rainwater harvesting, tree spacing, pruning, intercropping, cover cropping and input application.
d. The govt rules regarding felling and transporting of timber and procedures for obtaining subsidies.
e. The economic benefits of different species upon maturity of the trees.
f. Additional benefits from bark, leaves, fruit and seeds.

The specific practices needed for the farm and the farmer have to be in such a way that they should be able to modify the practices that are given in the training to suit their conditions. Therefore, a continuous handholding is done for farmers over many years to assist them in various stages. This training is being conducted under the banner of "Cauvery Calling".

B. Banana

Banana cultivation is widely practiced by farmers in Tamil Nadu. Usually it is practiced as a monocrop. As a way of naturally growing bananas, farmers in the training are suggested to plant moth beans as intercrops for the following reasons:

a. Banana is a spore plant and moth bean is a bisexual plant. By planting a spore plant and a bisexual plant together, mulching is easier.
b. Mulching and intercropping with moth beans also prevents excess weeds.
c. Moth bean plants attract beneficial insects, so bananas will grow without being affected by pests.
d. The required amount of nitrogen and other micronutrients for bananas is easily obtained through moth plants because it fixes nitrogen in the soil.

The package of practices to be followed in a nutshell is as under:

1. Moth bean seeds have to be sown at the rate of 20kgs/acre before the plantation of bananas.
2. The banana suckers selected must be dipped in beejamritam before plantation.
3. After plantation, inputs like jeevamrutham, groundnut cake, panchgavya etc should be applied either as a foliar spray over each plant or with the irrigation at regular intervals.
4. The suckers that come out should be removed from the roots leaving only 1-2 per plant so that the plant gets enough nutrition from the soil.
5. If necessary weeding can be done before the final harvest.
6. After the harvest is over, the ratoon will become the next set of crops while the plant will be cut and kept as mulch.

The banana plantation, if done in the above manner, reduces the cost of cultivation significantly while increasing the yields.

C. Coconut With Inter Crop

Coconut is another major crop in Tamil Nadu. The general practice is to have monocrops. The empty spaces between coconut trees are subject to heavy weed growth and therefore application of weedicides in most farms across Tamil Nadu. The training on coconut provides farmers with a deeper understanding of how we can integrate many other crops such as fruit trees, timber trees, medicinal trees, banana, pepper, arecanut, vegetables and tubers in between coconut trees.

The package of practices of doing intercrops with coconuts is as under:

1. This is to be done on existing coconut farms. The coconut trees have a spacing of about 15-30 feet in most farms. A suitable size trench is dug between coconut trees which acts as a rainwater harvesting structure.
2. These pits are connected to the drip system with drip lines that can dispense bio-inputs with the irrigation water.

3. The leaves of the coconut trees are piled up in these pits and left to decompose.
4. The center of each section where coconut trees are in the corners are planted with either a fruit tree or a high value medicinal tree like nutmeg.
5. Other timber trees are planted in this section as pump plants that will transfer nutrients from deep soils to the surface through their leaves either by shedding or by periodical pruning.
6. Few fruit trees which have a small canopy can be planted randomly in the section as well.
7. Rest of the area is covered with cover crops which can be used as fodder for livestock or fix nitrogen and add biomass.

The benefits of this system of multi cropping are manyfold. Weeds are suppressed as sunlight harvesting is maximum. Moisture is stored in the soil. The farms generated enough biomass to be used as manure alongwith the animal waste. The pits between coconut trees store biomass and decompose there to form rich humus. Also irrigation is done through these pits and not on individual trees. This makes the coconut trees extend their roots towards the pits and hence they are more stable during storms and hurricanes. Above all, the intercrops add significantly to the farm income.

The farmers see this in our model farms during the training and get to know about the model from the farmer himself. This boosts their confidence and desire to do similar practices because it is fairly simple in design once it's seen

D. Pepper

Pepper is considered by farmers to be a crop that can only be grown in the hills. But Isha Outreach has been imparting training through model farmers who are successfully cultivating pepper in the plains.

Microclimate environment is essential for pepper to grow i.e. half shade and half sun is needed. It can be planted in good shade coconut and arecanut plantations and other tree based farming systems. It grows well on red soil but does not grow on sandy and loamy soils. We advise planting varieties like Karimunda and Panniyur-1 in the plains.
The important aspects of this training covers the different techniques of cultivating, pruning and harvesting pepper.

The package of practices is as under:

1. Pepper plants are planted at the tree base and the creeper is gradually tied to the tree as it grows.
2. The vine also has roots in the stem to help it climb higher which must be stopped at 8 feet since it's hard to harvest after that height.
3. The immature non-flowering vines must be removed regularly so that the younger shoots can grow.

4. The pepper plants must be irrigated well and regular doses of bio-inputs must be applied. The vines normally start producing after 3 years. The yield will increase gradually from 0.5 - 1 kg per plant in 3-7 years.

Farmers sometimes can get better income from pepper than the main crop. Through this training many farmers are successfully cultivating pepper in the plains of Tamil Nadu.

E. Paddy

Rice being the staple food, paddy is a major crop in Tamil Nadu. Normally paddy is cultivated using enormous quantities of water and an excess amount of seeds. In SS-TKV Paddy Training, farmers learn the SRI method of cultivation with the use of natural inputs.

The package of practices is as under:

1. The seed bed is prepared in the traditional method except using only 1.5 kg seeds per acre because one can get the same or more yield in SRI method than conventional usage of seeds.
2. Seedlings are then transplanted in a 1 feet spacing using markers, after 9-12 days of sowing the seed in the mother bed. This allows more shoots to come compared to the conventional method of transplanting at a close spacing after 25-30 days of sowing.
3. This spacing allows for much easier weeding and maintenance. Weeding can be done as needed.
4. In this method, the water level needs to be very low compared to conventional methods where it's 6-8 inches.

Paddy grown in this method reduces cost of seeds, labor and increases productivity.

F. Sugarcane

Sugarcane is among the most cultivated crops in Tamil Nadu. Generally sugarcane is cultivated with only 2.5 feet spacing. But Isha Outreach farmers have reaped better yields with 4 feet spacing using natural farming methods. In Isha Outreach Trainings, farmers are informed how to:

1. Produce quality cuttings.
2. Sow multi grains as cover crops before planting the seedlings to enhance the fertility of the land.
3. Grow intercrops for upto 3 months in between the sugarcane.
4. Plant sugarcane at wider spacing to harvest more sunlight as well as produce enough intercops to recover a major part of the cultivation costs.
5. Plant maize, kambu, moth bean, marigold and mustard along the boundary for pest control.

6. Prepare natural insect repellent in the farm for application in case of pest attacks.
7. Use lighting traps and parasitic cards for pest management.
8. Use all the biomass generated as mulch.
9. Prepare natural growth stimulants.
10. Engage in value addition of sugarcane into jaggery.
11. Use the crop as a ratoon crop for cultivation in the next year.

The above is suggested to increase yields of sugarcane naturally and hence have better income through value addition.

G. Turmeric

Although turmeric is cultivated by farmers in Tamil Nadu, weed management in turmeric is a major challenge. Turmeric can be grown in partial shade, with cover crop as live mulch and also as a nitrogen fixer. Most farmers do not use cover crops and partial shade shrubs with turmeric. This training is about educating farmers for seed selection, seed treatment, planting, application of inputs to protect from pests and diseases, application of dead mulch to avoid weeds and conserve moisture or growing cover crops as live mulch and partial shade providing shrubs.

The package of practices is as under:

1. After land preparation, turmeric is planted at a spacing of 1x1.5 feet on raised beds.
2. Cover crops seeds are sown a few days later in the entire area.
3. The bio-inputs such as Jeevamrutham, Panchagavya, Fish tonic, 3G Spray etc are applied in specific intervals to minimize pest attacks and help plant growth.
4. Bund repairing and weeding should be done as necessary.
5. The produce is harvested once it's ready. It can be value added to turmeric powder for extra income.

These are the points that need to be considered while growing turmeric naturally.

H. Vegetables And Greens

Vegetables are high income generating crops for the farmers if they are able to increase their yields. Also it can be grown and sold throughout the year. Therefore it generates a stable net income for the farmers.

Usually farmers grow vegetables with a very high amount of chemical usage. The pests are a major issue with most of the vegetables. Land preparation cost is also high as farmers do it before planting each crop.

To produce better yields with natural techniques, Isha Outreach advises farmers the following techniques:

1. Use of permanent beds which reduces the cost of land preparation. These beds can be used for upto two years.

2. Cultivation of intercrops such as greens and tubers between main crops reduces the cost of weed management, controls pests and diseases and generates extra incomes.
3. Cultivation of periphery plants that attract beneficial insects is advised. These plants include maize, marigold, flat beans etc. These are planted at the periphery of the vegetable plots.

The package of practices vary according to the vegetables. Therefore, it has not been mentioned here.

அன்பழகன்

அண்ணா நகர்,ஆத்தூர், சேலம்.

மூன்று ஆண்டுகளுக்கு முன்பு பூக்கள், பழங்கள், காய்கறிகள் என பல பயிர்களை இரசாயன முறையில் சாகுபடி செய்து சரியான வருமானம் கிடைக்காமல் விவசாயத்தை விட்டு வெளியேறி விடலாம் என்று எண்ணியிருந்த வேளையில் ஈஷா விவசாய இயக்கம் ஏற்பாடு செய்து இருந்த திரு. நாகரத்தின நாயுடு நெல் சாகுபடி (திருவண்ணாமலை) பயிற்சி பற்றிய தகவல் எனது மகன் மூலமாக கிடைத்தது. அவரும் என்னை இந்த பயிற்சியில் கலந்து கொள்ள ஊக்கப்படுத்தியதால் இந்தப் பயிற்சியில் பங்கு கொண்டேன். பெரும்பாலான விவசாயிகள் 45(40) மூட்டை மகசூல் எடுப்பதற்கே கஷ்டப்படும் போது, இவர் 92 மூட்டை வரை மகசூல் எடுத்திருக்கிறார், அதுவும் 75 கிலோ கொண்ட நெல் மூட்டை! எப்படி சாத்தியமானது என்று அறிய திருவண்ணாமலை நோக்கி பயணப்பட்டேன். அந்த நிமிடம் இந்த பயிற்சி எனது வாழ்வை தலைகீழாக மாற்றும் என்பதை துளியும் நான் அறிந்திருக்கவில்லை. இந்தப் பயிற்சியில் 9 நாளுடைய இளம் நாற்று, நாற்று பறிக்கும் முறை, நாற்று நடும் முறை, சரியான இடைவெளி, நீர் நிறுத்தும் அளவு இந்த விஷயங்களை சரியாக செய்தால் நல்ல மகசூல் நிச்சயம் வரும் என்பதை பயிற்சியின் போது நான் அறிந்துகொண்டேன். நான் ஏழாம் வகுப்பு வரை மட்டுமே படித்திருந்தாலும் இந்த பயிற்சி என்னால் சுலபமாக கற்றுக் கொள்ளக் கூடிய வகையில் வடிவமைக்கப்பட்டிருந்தது. ஒரு ஏக்கருக்கு 2 கிலோ விதை நெல்லே போதுமானது. 9 நாள் நாற்று சரியான வயதுடையது என்று பயிற்சியில் சொல்லி தந்தார்கள். இதற்கு முன் 30 To 45 நாள் வளர்ந்து முற்றிப்போன நாற்றையே பயன்படுத்தி வந்தோம் அதில் நாற்றுக்கான வீரியத் தன்மையே இருக்காது என்பதையும் நாற்றை ஆழமாக நட்டால் தூர்களின் எண்ணிக்கை குறைந்து விடும் என்பதை பயிற்சிக்கு பின்னர் தான் அறிந்து கொண்டோம். மாட்டு சாணத்தையும், கோமியத்தையும் பயன்படுத்தி இடுபொருட்கள் செய்துகொண்டோம். ஆமணக்கு இரண்டு கிலோ இடித்து எடுத்து பசுஞ்சாணத்துடன் கலந்து வயலில் தூவும்போது பயிர் நன்கு பச்சை கட்டி வந்தது, அவ்வளவுதான் நாங்கள் செய்த பராமரிப்பு. பயிற்சியின் போது பார்த்த கோனா வீடரை இங்கு பட்டறையில் நானே வடிவமைத்து கொண்டேன். ஈஷா விவசாய இயக்க YouTube channel ல் பதிவேற்றம் செய்யும் வீடியோவை எனது மகன் போட்டு காட்டும் போது நான் உன்னிப்பாக கவனிப்பது வழக்கம். ஒரு வீடியோவில் பூச்சி செல்வம் சார் சொல்லி தந்தபடி நான் தென்னை மட்டையை ஆங்காங்கே வயலில் நட்டு வைத்ததால் எலி மற்றும் பூச்சி தொல்லை குறைந்திருந்தது. ஈஷா விவசாய இயக்கத்தின் யூட்யூபில் உள்ள வீடியோக்கள் ஒவ்வொன்றும் ஏதோ ஒரு வகையில் என்னைப்போன்ற படிப்பறிவில்லாத விவசாயிகளுக்கு உபயோகமாக உள்ளது.

நெல்லை நான் நெல்லாக ஒரு போதும் விற்பது இல்லை விதைத் தேவை தவிர்த்து பெரும்பாலும் நெல்லை நான் அரிசியாக மாற்றி நேரிடையாக நுகர்வோருக்கு விற்பதால் எனக்கு மூன்று முதல் நான்கு மடங்கு லாபம் கிடைக்கிறது. இதற்கு தேவைப்படும் அரவை மிஷினை 50 ஆயிரம் ரூபாய் செலவில் நானே வடிவமைத்துள்ளேன். இந்த மதிப்புக்கூட்டல் உத்தியும் எனக்கு இந்த பயிற்சியின் மூலமே வாய்த்தது.

(Translation)

Anbazhagan

Anna Nagar, Aathur, Salem.

I cultivated many crops like flowers, fruits and vegetables chemically and left the farming without getting proper income. Three years ago I got the information from my son about Nagarathinam Naidu's paddy training organized by Isha Agro Movement. While most of the farmers struggle to harvest 45 bags, Nagarathinam Naidu has harvested up to 95 bags, which is up to 7500 kgs of paddy per acre. I traveled to Tiruvannamalai To find out how it was possible. At that moment I did not know that this training would turn my life upside down.

During this training I learnt, 9 days Young seedling, seedling Plucking method, seedling Plantation method proper Spacing Watering Rate it will definitely give Good yield If these things are done correctly. Although I studied until the 7th grade this Training design was easy for me to learn.

2 kg of seed paddy per acre is sufficient. At 9 days the seedlings were the right age that they were told in training. Prior to this, we had been using mature seedlings for 30 to 45 days and only after training did we learn that the seedlings would not have any potency and if the seedling was planted deeper the number of shoots would decrease.

We made inputs using cow dung and cow urine. Then we took two kilos of castor oil and mixed it with green manure and sprayed it in the field, the crop turned green and that was all we did. I designed the Kona Weeder I saw during training in the workshop myself.

I used to watch meticulously when my son put up a video uploading on the Isha Agro Movement youtube channel. As Poochi Selvam sir said in a video, I planted coconut husks in the field to reduce rat and insect infestation. Each of the videos on the Isha Agro Movement youtube is in some way useful to farmers like me.

I never sell paddy as paddy, except for the need for seeds. Most of the time I convert paddy into rice and sell it directly to consumers, which gives me three to four times the profit. I designed the grinder for this at a cost of 50 thousand rupees. This value-added strategy was also taught to me through this tutorial.

Currently with the help of Isha Agro Movement training my yield has increased and most of the debt has been settled. I am currently buying my own car and renovating my house with this income. I used to go by moped and now it is a pleasure to go in my own car.

All this is due to the training of the Isha Agro Movement and the guidance of Nagaratnam Ayya. I am proud to have come for this training. Expressed gratitude for that.

கருணாகரன்.க

திருவண்ணாமலை மாவட்டம்

மொத்தத்தில் ஏழு ஏக்கர்ல சொந்தமான பூமி உள்ளது. அதில் சுழற்சி முறையில் வருடத்திற்கு 3 ஏக்கர் வாழை பயிர் பண்ணுவேங்க. ரகம் பார்த்தீங்கன்னா மொந்தன் வாழை, கற்பூரவள்ளி இரகங்கள் தோட்டத்தில் உள்ளது. நான் பயிற்சிக்கு வருவதற்கு முன்பு எல்லாம் களை மேலாண்மை என்பது எனக்கு ஒரு பெரிய சவாலாக இருந்தது. காரணம் வாழையில் மூன்று களை வெட்டணும், பிறகு மண் அணைக்கணும். ஒவ்வொரு களை எடுக்கவும், மிகுந்த செலவும் ஆட்கள் கிடைப்பதில் சிரமமும் இருந்தது. இவ்வளவும் செய்தாலும் சரியான விலை கிடைக்குமா என்பது மிகப்பெரிய கேள்விக்குறி தான். அந்த சமயத்தில் தான் ஈஷாவின் வாழை சாகுபடி பயிற்சி பற்றிய அறிவிப்பு வந்தது. நானும் இந்த பயிற்சி யில் கலந்து கொண்டேன்.

பயிற்சியில் வாழை உழவு முதல் உற்பத்தி வரை அனைத்து தொழில் நுட்பங்களையும் ஈஷா விவசாய இயக்கத்தினர் விஞ்ஞான பூர்வமாக எளிமையான முறையில் சொல்லி தந்தனர். கட்டை விதைநேர்த்தி, குழியெடுத்தல், இடைக்கட்டை விடுதல், உர மற்றும் நோய் மேலாண்மை, கூன்வண்டு கட்டுப்படுத்தும் முறை எல்லாம் விளக்கமாக பயிற்சியில் கற்று தரப்பட்டது. பயிற்சிக்கு முன்பெல்லாம் வயலில் வாழைக்கட்டைகளை மட்டுமே குழியெடுத்து நடுவோம்.

ஆனால் பயிற்சியில் தட்டைப்பயிறை ஊடுபயிராக போட சொல்லி தந்தார்கள். இதனால் களையும் கட்டுப்படும் என்பதை தெரிந்து கொண்டேன். ஒரே கல்லில் இரண்டு மாங்காய் என்பது போல இந்த இரு வித்திலை தாவரம் நைட்ரஜனை மண்ணில் நிலை நிறுத்துவதால் யூரியா செலவும் இல்லை. மூணு மாசம் கழிச்சு அதை ரொட்டவேட்டர் வைத்து ஓட்டி பசுந்தாள் உரமாக வாழைக்கு போட்டு மண் அனைத்து விடும் தொழில் நுட்பத்தை அங்கு தான் கற்று கொண்டேன். இதனால் பயிருக்கு முன்பு கொடுத்து கொண்டு இருந்த இரசாயன உரத்தேவை சுத்தமாக இல்லாமலே போனது. அதுமட்டுமின்றி பயிருக்கு தரும் ஜீவாமிர்தம் மேலும் சிறப்பாக வேலை செய்கிறது, இதனுடன் போனஸாக மொந்தன் வாழையில் வர்ற சருகுநோய், கற்பூர வாழை இலை வரும் வாடல் நோய், முடிக்கொத்து நோய் என்னுடைய தோட்டத்தில் அவ்வளவா பெரிய பாதிப்பை ஏற்படுத்துவதில்லை இயற்கை முறையில் விளையுற மொந்தன் வாழைத்தார்களை நான் அதிக நாட்கள் சேமிக்கிறேன். தரமும் அருமையாக இருக்குங்க. பக்கத்து தோட்டத்தில் தார் 300 ரூபாய்க்கு எடுத்தால் என்னோட கற்பூரவள்ளி வாழைத்தார் 450 ரூபாய் வரைக்கும் விற்க முடியுது.

நோய்த் தடுப்பு, உரச்செலவுகுறைப்பு, களை மேலாண்மை என எல்லா விதத்திலும் இந்த பயிற்சி எனக்கு உதவியாக இருந்தது. எங்கள் பகுதியில் அதிக விலைபோகும் தார் என்ற பெருமையும் கிடைத்ததற்கு இந்த பயிற்சிக்கு பெரும்பங்கு உண்டு. ஈஷா விவசாய இயக்கத்திற்கு நன்றி.

(Translation)

Karunakaran. K

Thiruvvanamalai.

There are seven acres of land in total. Cultivate 3 acres of banana crop per year in rotation. Monthan Banana and Camphor banana Varieties are in the garden.

Weed management was a big challenge for me before I came into training. The reason is to cut three weeds in the banana and then level the soil for the banana. There was difficulty in getting people to pick each weed, which was very expensive. The biggest question is whether you will get the right price even if you do so much.

At that time I got information about banana training and I participated in this.

In the training, Isha Agro Movement explained all the techniques from banana plowing to production in a simple manner. Seed treatment, composting, intercropping, fertilizer and disease management, beetle control methods were all taught in the training. Before training, we will dig and plant only bananas in the field.

But in the training, they told me to put the moth bean as an intercrop. Thus I learned that weeds are also controlled. There is no cost of urea as these bisexual plants give nitrogen to the soil. Three months later I learned the technique of putting it in a rotavator and driving it into green manure and putting it all in the soil.

Thus the chemical fertilizer requirement given before the crop was not needed anymore. In addition, the jeevamirtham that works for the crop is even better. As a bonus, commodity disease in monthan bananas and dry infections in camphor bananas do not cause much damage to my garden. The quality is also fantastic. If you take the tar in the adjoining garden for 300 rupees, I'm selling camphor bananas for up to 450 rupees.

This training was helpful to me in all aspects like disease prevention, fertilizer reduction, weed management. This training has played a major role in making us proud to be the most expensive tar in our area. Thanks to the Isha Agricultural Movement.

சுமதி,

வாரணவாசி ,அரியலூர் மாவட்டம்

அரியலூர் மாவட்டத்தில் சொந்தமாக கிளினிக் வைத்து இருக்கிறேன். அங்கு நான் பிசியோதெரபி மருத்துவராக பணிபுரிந்து வருகிறேன். என்னுடைய மருத்துவமனைக்கு வரும் நோயாளிகளுக்கு நோய்க்கான அடிப்படை காரணம் என்ன என்று நீண்ட நாட்களாக நான் ஆராய்ந்ததில் அவர்கள் உண்ணும் உணவில் இரசாயன கலந்த விஷம் உள்ளதை கண்டு அதிர்ந்தேன். நாமும் அதே உணவைத்தானே உண்டு வருகிறோம் என உணர்ந்து அந்த நொடியில் இருந்து எனக்கு இயற்கைக்கான தேடலை ஆரம்பித்தேன். 5 ஏக்கர் நிலம் வாங்கி என் குடும்பத்திற்கான உணவுப் பொருட்களை உற்பத்தி செய்ய நானே விவசாயம் செய்ய ஆரம்பித்தேன். பெரும்பாலும் விஷமானது பூச்சிக்கொல்லி மற்றும் வளர்ச்சி ஊக்கிகளின் வாயிலாகவே உணவில் கலக்கும் விசயமறிந்தேன். அப்போதுதான் பேஸ்புக் மற்றும் சமூக வலைதளங்களின் வழியாக ஈஷாவின் "பூச்சிகளை கவனிங்க' பயிற்சி பற்றி தெரியவந்தது. நானும் இரண்டு நாள் பயிற்சி யில் கலந்து கொண்டேன். மருத்துவ தொழிலில் நான் இருந்தாலும் என்னுடைய மனதிலும் பூச்சிகள் என்றால் தேனீயைத் தவிர மீதி எல்லாம் தீமை செய்யும் என்ற எண்ணமே ஊறி இருந்து. இப் பயிற்சிக்கு பின்னரே பூச்சிகளின் உலகம் பற்றிய புரிதல் வந்தது.

1. அதிலும் குறிப்பாக வயலுக்கு நன்மை செய்யும் பூச்சிகள் எவை அதனை எப்படி கவர்வது?
2. வரப்புகளில் பூச்சிகளைக் கவர என்ன பயிர் செய்வது?
3. பூச்சிகளை அடையாளம் காண்பது எப்படி, பயிர் சேதார நிலை என்பது என்ன?

எனப் பலவிதமான ஆச்சரியம் ஊட்டும் தகவல்கள் எனக்கு பயிற்சியில் கிடைத்தது. அதன்பிறகு என்னுடைய நிலத்தில் பயிற்சியில் சொல்லிகொடுத்த யுக்திகளை செய்து அதில் நிறைய மாற்றங்களை நான் என் அனுபவத்தில் உணர்ந்தேன். இந்த பயிற்சி என் இயற்கை விவசாய முறையில் நிறைய மாற்றங்களை ஏற்படுத்தியது. அதில் முக்கியமானது ஒருங்கிணைந்த பூச்சி கட்டுப்பாடு. நன்மை செய்யும் பூச்சி எது தீமை செய்யும் பூச்சி எது என்று தெரிந்ததால் சிலந்தி, பெருமாள் பூச்சி ,தட்டான், கொலைகார நாவாய் பூச்சி போன்ற நன்மை செய்யும் பூச்சிகளை கண்டு தற்போது நான் நடுங்குவதில்லை. பயிற்சிக்கு முன் பூச்சிகளை கண்டால் நானும் பூச்சிக்கொல்லி கொண்டு ஸ்பிரே செய்தால் தான் கட்டுப்படுமென நினைத்து இருந்தேன். ஆனால் பயிற்சிக்கு பிறகு பூச்சிகளை எப்படி சமாளிப்பது என்பதைப் பற்றிய புரிதல் ஏற்பட்டுள்ளது. வயல் வரப்புகளில் மூன்று அடுக்குகளில் ஊடு பயிர் செய்ய வேண்டும் என புரிந்துகொண்டேன். வரப்புகளில் முதல் வரிசையில் தட்டைப்பயிர், இரண்டாவது அடுக்கில் சோளம் கம்பு அடர்த்தியாக, அதன் பிறகு 8 அடி இடைவெளியில் ஆமணக்குச் செடியை நடனும் என சொன்னாங்க. இந்த செடியின் இலைகள் தீமை செய்யும் பூச்சிகளை கவர்ந்து இழுக்கும் எனவும், இதனால் நமது வயலில் உள்ள பிரதான பயிர் தப்பி விடும் என தெரிஞ்சுது. வயலில் மஞ்சள் கலர் பூக்கள் பூக்கிற கேந்தி, கடுகு ஆகியவை நன்மை செய்யும் பூச்சிகளை கவரும் என புரிஞ்சுகிட்டேன். பூச்சி கொல்லிகளுக்கு மாற்றாக வேப்பங்கொட்டை, வெள்ளை பூண்டு கரைசல், அக்னி அஸ்திரம், மூலிகைப் பூச்சிவிரட்டி தயாரிக்கவும் கற்று கொண்டேன் இப்பயிற்சியின் வாயிலாக. எனது நெல் வயல்களில் கற்று கொண்ட அனைத்து முறைகளையும் (தட்டை பயிர் வரப்புகளில் நடுவது முதல்)செய்து பார்த்து நல்ல வித்தியாசம் உணர்ந்தேன். இந்த பயிற்சியின் முக்கிய அம்சமாக இருப்பது இரண்டு நாட்கள் பண்ணையில் நேரடி களப் பயிற்சியாக நடத்தியது மற்றும் பயிற்சி கொடுத்தவர் பூச்சியியல் துறையின் புலமை பெற்ற விஞ்ஞானி என்று தெரிந்த பொழுது இன்னும் நம்பிக்கையாக இருந்தது. மாற்றம் ஒன்றே மாறாதது. என் எண்ணத்தை மாற்ற பயிற்சி அளித்த ஈஷா விவசாய இயக்கதிற்கும் செல்வம் அண்ணாவிற்கும் நன்றி கலந்த வணக்கம்.

(Translation)

Sumathy

Varanavasi, Ariyalur District

I have my own clinic in the Ariyalur district. There I work as a Physiotherapy doctor. For a long time, I researched what the underlying cause of the disease was for the patients who came to my hospital and was shocked to find that there was a chemical poison in the food they ate. Realizing that we were eating the same food, I started searching for nature from that moment.

I bought five acres of land and started farming myself to produce food for my family. I learnt that the poison is often mixed with food through pesticides and growth stimulants. That's when I found out about Isha's Insect training via Facebook and social media and I attended a two-day training.

Even though I am in the medical profession, I still have in my mind the idea that insects are harmful to everything except bees. It was only after this training that the understanding of the world of insects came.

What are the pests that are especially beneficial to the field?
What are the pests that do harm, and what is the spray for those pests?
What to do to attract pests in the range?
How to identify pests and what is the crop damage?

I got a variety of surprising information in the training. After that, I did the tricks taught in the training in my land and realized a lot of changes in it, in my experience. This training made a lot of changes in my natural farming system. The key is integrated pest control.

Now I am not scared away from seeing beneficial insects like spiders, Perumal insects, dragonflies, killer naval insects as I know what is a beneficial insect and what is a harmful insect. If I saw insects before training I thought I would be controlled if I sprayed them with pesticides. But there has been an understanding of how to deal with pests after training.

I understood that weeds should be planted in three layers in the field boundaries. Suppose that the first row is moth bean, the second layer is corn rye dense, and then the castor plant is planted at 8 feet intervals. It is known that the leaves of this plant attract harmful insects and thus the main crop in our field escapes. I realized that the yellow flowers that bloom in the field, such as marigold, mustard, attract beneficial insects.

I also learned how to make neem solution, white garlic solution, Agni asthram, and herbal insecticides as an alternative to pesticides. I did all methods I learned in my paddy field(from planting in flat crop fields) and felt a good difference.

Change is the only thing that doesn't change. Thanks to Isha Agro Movement and Poochi Selvam anna for training me to change my mind.

திருமதி. நாகரத்தினம்

இல்லத்தரசியாக இருந்த நான் இயற்கை விவசாயத்தில் ஆர்வம் கொண்டு கடந்த 15 வருடங்களாக விவசாயம் செய்து வருகிறேன். கோவை மாவட்டம் தொண்டாமுத்தூர் பகுதியில் 25 ஏக்கர் சொந்தமான விவசாய நிலம் உள்ளது.

மொத்தம் உள்ள 25 ஏக்கரில் தென்னை, கோகோ, வாழை, சப்போட்டா, மா போன்ற பயிர்கள் மற்றும் வேம்பு தேக்கு மகோகனி போன்ற டிம்பர் மரங்கள் உடைய வேளாண்காடுகள் உள்ளது. ஆரம்பத்தில் அதில் வேறு ஏதாவது சாகுபடி செய்யலாம் என்ற எண்ணம் இருந்தது. ஆனால் என்ன பயிர் எப்படிசெய்வதென்ற குழப்பம் மட்டும் நீங்கவில்லை.

இந்நிலையில் தான் சமவெளியில் மிளகு சாகுபடி பயிற்சி புதுக்கோட்டை மாவட்டம் வடகாட்டில் ஈஷா விவசாய இயக்கத்தின் மூலம் ஏற்பாடு செய்யப்பட்டிருந்தை பற்றி அறிந்தேன். ஆனால் சமவெளிப் பகுதியில் மிளகு வளருமா என்ற சந்தேகம் இருந்தது.

ஆனால் பயிற்சிக்கு சென்ற பிறகுதான் தெரிந்தது சமவெளிப்பகுதியில் சிறப்பாக மிளகு சாகுபடி செய்கின்றனர் என்று. இந்த பயிற்சியில் ரகங்களை தேர்வு செய்வது மற்றும் நடவு செய்வது பயிர் பராமரிப்பு போன்ற நுட்பங்களைப் பயிற்சி மூலம் தெரிந்து கொண்டேன்.

இந்த பயிற்சிக்குப் பிறகு கரி முண்டா, பனியூரா ரகங்கள் சமவெளிக்கு ஏற்றது என்பதால் மரப்பயிர்களில் ஊடுபயிராக நடவு செய்தேன்.

சமவெளியில் மிளகுக் கொடிகளை பயிரிடும் போது மழைக்காலங்களில் நடவு செய்தால் தான் எளிதில் உயிர் பிடித்து வளரும் என்பதை பயிற்சிக்குப் பிறகு தான் தெரிந்து கொண்டேன். இந்த பயிற்சியில் கொடிகள் 6-7 அடி வளர்ந்த பிறகு மூன்றடி வைத்து முறித்து விட்டால் தான் அதிகளவில் கிளைகள் வெடித்து வளர்ந்து நல்ல மகசூல் கிடைக்கும், ஒரு கிளையை மட்டும் கீழே எடுத்து பற்று செடியை சுற்றி பதியம் போடும் போதுதான் அடிசெடியில் இருந்து புதிய கிளைகள் கிளைத்து வளரும் என்று சொல்லி தந்தார்கள். செயற்கை உரங்கள் மிளகில் நோய் தாக்குதலை அதிகப்படுத்தும் என்று சொன்னதால் மிளகு கொடிகளுக்கு ஜீவாமிர்தம், தொழு உரம் போன்ற இயற்கை இடுபொருட்களை கொடுத்து வளர்த்து வருகிறேன். செடிகளை நடவு செய்து நான்கு வருடங்கள் ஆகிறது, செடிகள் நன்றாக வளர்ந்து தற்போதுதான் மகசூல் வர ஆரம்பித்துள்ளது. இனி வரும் காலங்களில் நல்ல மகசூல் கிடைக்கும் என நம்பிக்கை உள்ளது.

மலைப்பிரதேசங்களில் வளரும் மிளகு எங்கள் சமவெளிப் பகுதியிலும் நன்றாக வளர்ந்துள்ளது மிகுந்த மகிழ்ச்சி அளிக்கிறது. இந்த வகை வேளாண் காடுகளை தென்னை வாரியம் பரிந்துரை செய்கிறது. அதில் நடைமுறை சாத்தியமாக இந்த பயிற்சியில் பல அடுக்கு பல பயிர் சாகுபடி அறிவியல் பூர்வமாக சொல்லிக் கொடுக்கப்படுகிறது.இப்போது நானும் ஓரளவு ஊடுபயிராக மிளகு சாகுபடியில் வருமானம் ஈட்டி வருவதோடு என் குழந்தைகளுக்கு நல்லதொரு முதலீட்டை செய்து வைத்த திருப்தி. இதற்கு எப்போதும் ஈஷா விவசாய இயக்கத்திற்கு நாங்கள் கடமைப்பட்டுள்ளோம்.

(Translation)

Mrs. Nagarathinam

Thondamuthur, Coimbatore

As a housewife, I have been interested in organic farming and have been farming for the last 15 years. There are 25 acres of agricultural land in the Thondamuthur area of the Coimbatore district. A total of 25 acres are cultivated with crops such as coconut, cocoa, banana, sapota, mango and timber trees such as neem, teak, mahogany. Initially, I thought that something else could be cultivated in it. But the confusion has not gone away of what crop to make and how to do it.

At this point, I came to know about the pepper cultivation training in the plains organized by the Isha Agro Movement in the north of Pudukkottai district. But it was doubtful whether pepper would grow in the plains.

But it was only after going for training that it became clear that they were cultivating pepper better in the plains. In this tutorial, I learned techniques like selecting varieties and planting and crop care techniques.

After this training, I planted Kari Munda and Baniyura varieties as intercrops in the woods as they are suitable for the plains.

It was only after training that I learned that when growing pepper vines in the plains, they can easily survive if planted in the rainy season. In this exercise, the vines were told to break off by three feet after they had grown 6-7 feet, and most of the branches would have sprouted and grown to good yields. I have been cultivating pepper vines with natural inputs like bio-fertilizer and manure as it is said that chemical fertilizers increase the risk of disease in pepper.

It has been four years since the plants were planted, and the plants have grown well and are just beginning to yield. It is hoped that there will be better yields in the years to come.

It is very pleasing that the pepper that grows in the hills also grows well in our plains. If it weren't for this training I would have left the land barren too. We have now brought a nice cool microclimate to our garden. Now I too earn an income from intercropping pepper cultivation and the satisfaction of having made a good investment for my children. For this, we are always indebted to the Isha Agro Movement.

பத்ரி நாராயணன்

வணக்கம் நான் பத்ரி நாராயணன். நான் ஈஷா விவசாய இயக்கம் ஏற்பாடு செய்திருந்த தென்னையில் ஒருங்கிணைந்த பண்ணை மற்றும் தென்னைக்குள் பலபயிர் சாகுபடி செய்யும் வெற்றி விவசாயிகளை சந்திக்கும் விவசாய சுற்றுலாவில் கலந்து கொள்ள ஒரு வாய்ப்பு கிடைத்தது. இந்த நிகழ்ச்சியானது ஒரு களப் பயணமாக மட்டும் அல்லாமல் ஒரு கற்றுக்கொள்ளும் பேரனுபவமாகவும் அமைந்தது. என்னுடன் சேர்த்து மொத்தம் 53 பங்கேற்பாளர்களுடன் உற்சாகமாக துவங்கிய எங்கள் பயணம் உடுமலைப்பேட்டை அருகில் சாமராயபட்டியில் அமைந்துள்ள பண்ணையின் உரிமையாளர் திரு வெங்கடபதி ஒருங்கிணைந்த விவசாய பண்ணையில் ஆரம்பித்தது. அங்கு தென்னைக்குள் வாழை, நெல்லி, பப்பாளி, ஜாதிக்காய் என ஊடு பயிர்கள், பண்ணைக்குட்டையில் மீன் வளர்ப்பு, ஆட்டுப்பண்ணை, நாட்டு மாடுகள் வளர்ப்பு, மற்றும் தானியங்கி இடுபொருள் கொடுக்கும் அமைப்பு ஆகியவற்றை பார்வையிட்டோம். இங்கு விளைபொருட்களை மதிப்புக்கூட்டி விற்பது குறித்து பண்ணையின் உரிமையாளர் திரு வெங்கடபதி அவர்கள் விரிவாக எடுத்துரைத்தார். இது என்னால் தென்னைக்குள் இத்தனை ஊடுபயிர்களுடன் கால்நடை வளர்ப்பையும் சேர்த்து என்னுடைய பண்ணையையும் வெற்றிகரமாக நடத்த முடியும் என்ற நம்பிக்கையை என்னுள் விதைத்தது.

அடுத்து பொள்ளாச்சி அருகில் உள்ள கோவில் பாளையம் கிராமத்தில் அமைந்துள்ள திரு புனிதன் அவர்களின் பண்ணையில் தென்னைக்குள் ஐந்தடுக்கு முறையில் பல பயிர் சாகுபடி மற்றும் தானியங்கி சொட்டு நீர் பாசன அமைப்புகள் பற்றிய பண்ணை பார்வையிடல் நடைபெற்றது. நீர் பாசன முறையில் தற்போது உள்ள நவீன தொழில்நுட்பங்களை நாங்கள் தெரிந்துகொள்ளும் விதமாக இந்த நிகழ்வு அமைந்தது. இங்கு தான் நான் தென்னைக்கு சரியான முறையில் நீர் பாய்ச்சுவது எப்படி என்பதை புரிந்து கொண்டேன். பயிற்சிக்கு முன்பு நாங்கள் வாய்க்கால் வழியாக அடிமரத்தின் வேருக்கடியில் நன்கு தழும்ப நீர் கட்டி வந்தோம். ஆனால் தென்னை தன் நுனிமட்டை நிழல் விழுமிடத்தில் உள்ள சல்லிவேர்கள் மூலம் தான் நீர் எடுக்கும் என்பதையே பயிற்சிக்கு பின்னர் தான் தெரிந்து கொண்டேன். இவர் தோப்பில் விழும் அவ்வளவு சூரிய ஒளியை யும் ஐந்தடுக்கு முறையில் அறுவடை செய்து வருவது ஆச்சரியம் அளித்தது. இரண்டாம் நாள் காலையில் மணக்கடவு அருகே ஆற்றில் ஆனந்த குளியல் போட்டு ஆற்றங்கரையில் சிற்றுண்டி மற்றும் விளையாட்டுகளை முடித்தோம். இது மறுபடியும் எங்களை எங்களுடைய பால்ய பிரயாயத்திற்கு இட்டு சென்றது. பயிற்சியோடு இந்த இளைப்பாறுதலும் எங்களை இன்னும் புத்துணர்ச்சியாக்கியது.

அடுத்ததாக பொள்ளாச்சி அருகே சின்னப்பம்பாளையத்தில்கடந்த 20 வருடமாக வெற்றிகரமாக இயற்கை விவசாயம் செய்து வரும் தென்னையில் கொக்கோ மற்றும் தேனீ வளர்ப்பு பற்றிய தங்களது அனுபவத்தை முன்னோடி இயற்கை விவசாயிகளான திரு சுரேந்திரன் மற்றும் திரு சுப்ரமணியம் அவர்கள் எங்களோடு பகிர்ந்து கொண்டனர். தேனீக்களைப் பற்றிய பயம் போனதுடன் அதைக் கையாளும் விதமும் அறிந்தேன். இறுதியாக ஆனைமலை அருகில் வேட்டைகாரன் புதூரில் அமைந்துள்ள சத்குரு சந்நதி இயற்கை விவசாய பண்ணையின் முன்னோடி இயற்கை விவசாயி திரு வள்ளுவன் அவர்கள் தென்னையில் ஜாதிக்காய், மிளகு, டிம்பர் மரங்கள், வாழை, பாக்கு மற்றும் பலவகையான ஊடுபயிர்கள் செய்வது பற்றிய தனது அனுபவங்களையும் தென்னையில் நீர் மேலாண்மை பற்றியும் எடுத்துரைத்தார். இந்த பண்ணையை பார்வையிட்டது அடர்ந்த காட்டுக்குள் சென்று வந்த உணர்வை எங்களுக்கு ஏற்படுத்தியது.

இந்த இரண்டு நாள் பண்ணைச் சுற்றுலா எங்களுடைய பண்ணையை பல பயிர் சாகுபடி செய்வதற்க்கும் மற்றும் ஒருங்கிணைந்த பண்ணையாக வடிவமைப்பதற்கும் தேவையான ஒரு நல்ல அறிவை வளர்க்கும் பயணமாக இருந்ததை மறுக்க இயலாது. வழக்கமான பயிற்சி பட்டறையாக இந்நிகழ்வு இல்லாமல் ஒரு நல்ல பயணமாக பலவிதமான அறிவியல் தொழில்நுட்பங்களும் அனுபவ விவசாயிகளின் அனுபவப் பகிர்வு மற்றும் ஈஷாவின் வழிகாட்டுதலுடன் விஞ்ஞான பூர்வமாக இருந்தது. இந்த

பண்ணையில் பயன்படுத்திய யுக்திகள் பெரும்பாலான அவைகளை அரசாங்கம் வலியுறுத்தி வருகிறது என்றும் அறிந்தோம்.

எங்களை புதுப்பித்துக் கொள்ளவும் எங்களுக்குள் ஒளிந்திருந்த குழந்தைத்தனத்தை வெளிக்கொண்டு வரும் நிகழ்வாக இருந்ததும் இரட்டிப்பு மகிழ்ச்சி. நன்றி ஈஷா விவசாய இயக்கம்

No

(Translation)

Badri Narayanan

Namaskaram I am Badri Narayanan. I had the opportunity to attend an integrated farm organized by the Isha Agro Movement and an agricultural tour to meet successful farmers cultivating multi-crops within the coconut. The event was not only a field trip but also a learning experience.

Our journey started enthusiastically with me and a total of 53 participants at Mr Venkatapathy Integrated Agricultural Farm, the owner of a farm located at Samarayapatti near Udumalaipettai. There we visited coconut, banana, nelly, papaya, nutmeg, fish farms, sheep farms, cattle breeding, and automated inputs. Mr Venkatapathy, the owner of the farm, elaborated on the value-added sale of the produce here. This instilled in me the hope that I would be able to successfully run my farm with so many intercrops in the coconut along with animal husbandry.

Next, a visit was made to Mr Punithan's farm located at Kovil Palayam village near Pollachi on a five-tiered system of multi-crop cultivation of coconut and automatic drip irrigation systems. The event was a way for us to get acquainted with the latest technologies currently available in the field of irrigation. It was here that I learned how to properly water the coconut. Before training, we came across well-drained water under the root of the tree through the canal. But it was only after training that I learned that coconut takes water only through the salivary glands in its pointed shadow fall. Surprisingly, he harvests five layers of sunlight that fall on the grove.

On the morning of the second day, we took a blissful bath in the river near Manakadavu and finished snacks and games on the river bank. This again led us back to our youth. This relaxation with training also made us even more refreshed.

Next, pioneer nature farmers Mr Surendran and Mr Subramaniam shared with us their experience of cocoa and beekeeping in coconut, which has been successfully cultivated for the past 20 years at Chinniampalayam near Pollachi. The fear of bees was gone and I knew how to handle it.

Finally, Mr Valluvan, a pioneer nature farmer at the Satguru Sannathi Nature Farm located at Vettaikaran Puthur near Anaimalai, shared his experiences of growing nutmeg, pepper, timber trees, banana, pepper and various intercrops in coconut and water management in coconut. Visiting this farm gave us the impression of going into the dense forest.

There is no denying that this two-day farm tour was a journey to develop the good knowledge needed to cultivate our farm into a multi-crop and integrated farm. It was doubly gratifying to be able to refresh ourselves without this event as a regular training workshop and to unleash the hidden childhood within us.

விக்ரவாண்டி, விழுப்புரம்

நான் விவசாயத்துடன் கால்நடை வளர்ப்பையும் கலந்து என்னுடைய பண்ணையில் ஒருங்கிணைந்த பண்ணையாக நடத்தி வருகிறேன். நான் இங்கு நடந்த ஈஷா விவசாய இயக்கம் ஏற்பாடு செய்திருந்த முனைவர் திரு புண்ணியமூர்த்தி ஐயா அவர்களின் மரபு வழி சிகிச்சை பயிற்சியில் கலந்து கொண்டேன்.

பயிற்சிக்கு முன்பு மரபுவழி மருத்துவம் என்பது ஏதோ மூலிகைகள் அரிய செடிகள் ஆகியவற்றை பயன்படுத்தி கால்நடைகளுக்கு சிகிச்சை அளிக்க சொல்லித் தருவார்கள் என்று எண்ணி தான் இந்த பயிற்சிக்குப் போனேன். ஆனால் கைக்கெட்டும் தூரத்தில் உள்ள நமது சமையலறையில் பயன்படுத்தும் சுலபமான பொருட்களைக் கொண்டே பெரும்பாலான நோய்களுக்கு தீர்வை வழங்கினார்.

எனது ஆடு மாடுகளுக்கு உன்னி மற்றும் பேன் தொல்லை அதிகமாக இருந்தது. அவர் வசம்பை குழைத்து நீரில் கலந்து கால்நடைகள் மேல் தடவை சொன்னார். அடுத்த சில மணி நேரத்தில் அத்துணையும் பூச்சிகளும் கொட்டி விட்டன. அதேபோல கால்நடைகளின் உயிரைப் பறிக்கும் கோமாரி நோய் வயிற்றுப்போக்கு உப்புசம் கால் குளம்பு நோய் இவை இவை அனைத்திற்கும் எளிய முறையில் வைத்தியங்களை கற்றுக்கொடுத்தார். நான் நாட்டுக்கோழி வளர்ப்பையும் செய்து வருகிறேன். அதில் வரும் வெள்ளை கழிச்சல் நோய்க்கு எளிய முறையில் தீர்வு சொன்னார். பசுமாட்டிற்கு வரும் மடி நோய் மற்றும் மடி வீக்கத்திற்கு மஞ்சள் பூசணி இலை இதை வைத்து மருத்துவம் செய்ய கற்றுக்கொண்டேன்.

இந்த மருத்துவத்திற்கு தேவையான பொருட்கள் ஏற்கனவே நம் வீட்டில் உள்ள அஞ்சறைப் பெட்டிக்குள்ளேயே இருப்பது கவனிக்கத்தக்கது. வருமுன் காப்போம் என்ற அடிப்படையில் நோய் வருவதற்கு முன்பே நமது கால்நடைகளுக்கு மசால் உருண்டை மூலம் எதிர்ப்பு சக்தியை உருவாக்குவது பற்றியும் இந்த பயிற்சியில் கற்றுக்கொண்டேன். முன்பெல்லாம் ஒரு சின்ன சிகிச்சை என்றாலும் கால்நடை மருத்துவமனையையோ மருத்துவரையோ நாட வேண்டியிருந்தது. அவர்கள் சரியான நேரத்திற்கு நம்முடைய தோட்டத்திற்கு வருவதும் சிகிச்சை பெறுவதும் சவாலாக இருந்தது. இதனால் சில சமயங்களில் கால்நடைகளின் உயிரிழப்பும் வருமானம் இழப்பும் இருந்து வந்தது. இந்த மரபு வழி மருத்துவம் விஞ்ஞான பூர்வமாக நிரூபிக்கப்பட்டு இன்று உலக அளவில் விஞ்ஞானிகள் மத்தியில் போற்றப்படுகிறது என்பதை கேள்விப்பட்ட பொழுது மிகவும் பெருமையாக உள்ளது.

தற்போது பெரும்பாலான நோய்களை நாங்களே சமாளிக்க முடியும் சரி செய்ய முடியும் என் நம்பிக்கையை இந்த பயிற்சி கொடுத்தது. சினைப் பிடிப்பதில் உள்ள சிக்கலைத் தீர்க்கும் முறைகளை இந்த பயிற்சியில் அறிந்துகொள்ள முடிந்தது. உண்மையிலேயே நாங்களும் அரை வைத்தியர் ஆனதுபோல் மகிழ்ச்சியாக உள்ளது. புண்ணியமூர்த்தி ஐயாவிற்கும் ஈஷா விவசாய இயக்கம் எங்களது மனமார்ந்த நன்றிகள்.

(Translation)

Babu

Vikravandi, Villupuram

I mix agriculture with animal husbandry and run my farm as an integrated farm. I attended the Dr. Punyamurthy Ayya Traditional Healing Training organized by the Isha Agro Movement.

Before the training, I thought that traditional medicine is something that will be used to treat animals using herbs and rare plants. But he provided the solution to most ailments with the easy-to-use ingredients in our kitchen. My goats and cows were more prone to fleas and lice infestation. He dipped the measles and mixed it with water and told me to apply it over and over again to the cattle. Over the next few hours the aphids and insects poured out. As well as the deadly disease of cattle, cholera, diarrhea, bloating, hoof disease, he taught the simple remedies for all these. I also do country chicks breeding. He said the simple solution to the disease of white diarrhea. I learned to treat this with yellow pumpkin leaf which is used with cow's milk to reduce disease and swelling.

It is worth noticing that the ingredients for this medicine are already in the pantry in our house. In this training I also learned about building immunity for our livestock with spice balls before they get sick on the basis that we will protect them before they come. Previously it was a minor treatment but I had to visit a veterinary hospital or doctor. Getting them to our farm on time and getting treatment was a challenge. This sometimes resulted in the loss of livestock and loss of income.

I am very proud to hear that this traditional medicine has been scientifically proven and is admired by scientists all over the world today. The medicines he prescribed are fully medicinal properties and also it was used for humans in siddha. This training gave me hope that most of the diseases we are currently dealing with can be corrected by ourselves. In this training I was able to learn how to solve the problem of cramps. Really happy as we became half doctors too. Our heartfelt thanks to Punniamurthy Ayya and the Isha Agro Movement.

ரமேஷ்
வேப்பிலைபட்டி,வாழப்பாடி, சேலம்.

என் தந்தையின் காலம்தொட்டு நாங்கள் பூக்கள் சாகுபடியை இரசாயன முறையில் செய்து ஓரளவு வருமானம் ஈட்டி வந்தோம். இந்த நிலையில் கொரோனாவால் விஷேசங்கள் எதுவும் நடக்காததாலும் பஸ் போக்குவரத்து இல்லாமலும் முற்றிலும் வருமானம் இழந்து விவசாயத்தை விட்டு வெளியேறி விடலாம் என்று எண்ணியிருந்த வேளையில் ஈஷா விவசாய இயக்கம் சென்ற ஆண்டு ஏற்பாடு செய்து இருந்த திரு. ஜெகதீஸ் அண்ணாவின் (தாராபுரம்) காய்கறி பயிற்சியில் நான் பயிற்சி எடுத்தது ஞாபகம் வந்து அதை கையில் எடுத்தேன். அந்த முடிவு மிகவும் சரியானது என்பதை மூன்றாவது மாதமே நாங்கள் அறிந்து கொண்டோம்.
இந்தப் பயிற்சியில் பல்வேறு காய்கறிகளை எப்படி இயற்கை முறையில் சாகுபடி செய்வது, பயிரிட்ட காய்கறிகளை எப்படி சந்தைப்படுத்துவது, காய்கறி வகைகளை எப்படி தேர்ந்தெடுப்பது வருடத்தில் ஒரே ஓர் உழவில் பலமுறை விதைப்பும் அறுவடை யும் போன்ற விசயங்களை சரியாக கற்று தந்தார்கள். இயற்கை இடுபொருட்களை சரியான முறையில் கொடுத்தால் நல்ல மகசூல் நிச்சயம் வரும் என்பதை பயிற்சியின் போது நான் அறிந்துகொண்டேன். இந்த பயிற்சி என்னால் சுலபமாக கற்றுக் கொள்ளக் கூடிய வகையில் இருந்தது.

காய்கறி சாகுபடியில் பூச்சி தாக்குதல் தான் மிகப்பெரிய சவால். அதை கட்டுப்படுத்த பல்வேறு முறைகளை சொல்லி தந்தார்கள். பயிற்சிக்கு வந்த விவசாயிகளும் தங்கள் அனுபவங்களை பகிர்ந்து கொண்டது மிகவும் பயனுள்ளதாக இருந்தது. இதற்கு முன் பூ சாகுபடியை முழுவதும் இரசாயனத்தை கொண்டு தான் செய்து வந்தோம். இப்போது அது எவ்வளவு செலவு பிடிக்கும் செயல் என்பதும், தவறானது என்பதையும் பயிற்சியின் மூலம் அறிந்து கொண்டோம்.

பயிற்சியில் கற்று கொண்டதைப் போலவே ஒருமுறை உழவிட்டு பல காய்கறிகளை கலந்து பயிர் செய்தேன். விற்பனைக்கும் காய்கறி கமிசன் மண்டியை நாடாமல் நேரடியாக நுகர்வோருக்கே சந்தைப்படுத்தினேன். இதனால் எனக்கு விற்பனையில் லாபம் மட்டும் அல்லாமல் திருப்தியும் கிடைத்தது. ஈஷா விவசாய இயக்க YouTube channel ல் பதிவேற்றம் செய்யும் வீடியோவை நான் பார்த்து பிற விவசாயிகள் பகிர்ந்துள்ள தகவல்களையும் உள்வாங்கி கொள்கிறேன். ஈஷா விவசாய இயக்கத்தின் யூட்யூபில் உள்ள வீடியோக்கள் ஒவ்வொன்றும் ஏதோ ஒரு வகையில் என்னைப் போன்ற விவசாயிகளுக்கு உபயோகமாக உள்ளது.

நான் கீரை சாகுபடி மற்றும் பப்பாளி சாகுபடியையும் இப்போது செய்து வருகிறேன். இதனால் தோராயமாக ஒரு நாளைக்கு ஆயிரம் ரூபாய் வருமானம் கிடைக்கிறது. இந்த மதிப்புக்கூட்டல் உத்தியும் எனக்கு இந்த பயிற்சியின் மூலமே வாய்த்தது. இந்த காய்கறி விவசாயப் பயிற்சியில் என்னை மிகவும் கவர்ந்த அம்சம் ஒரு முறை உழவு செய்து விட்டு பல தடவை காய்கறி சாகுபடி செய்வதாகும் இது கிட்டத்தட்ட உழவில்ல விவசாயமாகும். இன்று உலகளவில் போற்றப்படும் பரிந்துரைக்கப்படும் No till farming முறையானது விஞ்ஞான அறிவியல் சார்ந்தது.

தற்போது ஈஷா விவசாய இயக்கத்தின் உதவியால் இந்த பயிற்சியின் துணையோடு எனது பயிர் சாகுபடி முறையினை நான் மாற்றிகொண்டதோடு நல்ல வருமானமும் எடுத்து வருகிறேன். இதற்கெல்லாம் காரணம் ஈஷா விவசாய இயக்க பயிற்சியும், ஜெகதீஸ் அண்ணாவின் அவர்களின் வழிகாட்டுதலும்° தான், இந்த தருணத்தில் இவர்கள் இருவருக்கும் என் நன்றி.

(Translation)

Ramesh

Veppilaipatti, Vaazhapadi,Salem

From the time of my father, we used to cultivate flowers chemically and earn some income. In this stage due to corona, no functions have been conducted and there is no transport also. So we lost our income and also thought of quitting agriculture. Then I remembered the vegetable training of Jagadeesh Anna (Dharapuram) which was conducted by the Isha Agro Movement. Within three months of time, I felt that this decision was absolutely right.

In this training, they were taught exactly how to cultivate different vegetables naturally, how to market the cultivated vegetables, how to select the varieties of vegetables, sowing and harvesting several times in a single plow in a year. During training I learned that good yields are guaranteed if natural inputs are given in the right way. This training was in a way that I could easily learn.

Pest attack is the biggest challenge in vegetable cultivation. They told me different methods to control it. The farmers who came for training also shared their experiences which was very useful. Prior to this, we do all the flower cultivation chemically. Now we know through training how costly and wrong it is.

I plowed once and mixed many vegetables as I learned in the training. I marketed the vegetables directly to the consumer without resorting to the sales in commision mandi. Thus I got not only profit in sales but also satisfaction.

I watched the video uploaded on the Isha Agro Movement YouTube channel and absorbed the information shared by other farmers. Each of the videos on the Isha Agro Movement on YouTube is useful to farmers like me in some way. I am also doing lettuce cultivation and papaya cultivation now. Thus an income of approximately one thousand rupees per day is available. This value-added strategy was also taught to me through this tutorial. The thing that impressed me the most in this vegetable farming training is that it is almost non-plowing farming with one plowing and several times cultivating vegetables. The recommended “No till farming” method that is universally acclaimed today is based on scientific method.

Currently with the help of Isha Agro Movement I have changed my crop cultivation method with the help of this training and am earning good income. The reason for all this is Isha's Agro Movement training and guidance from Jagadees Anna. My thanks to both of them at this moment.

Appendix: Recent Engagements of Isha Outreach with the UN and TN State Government

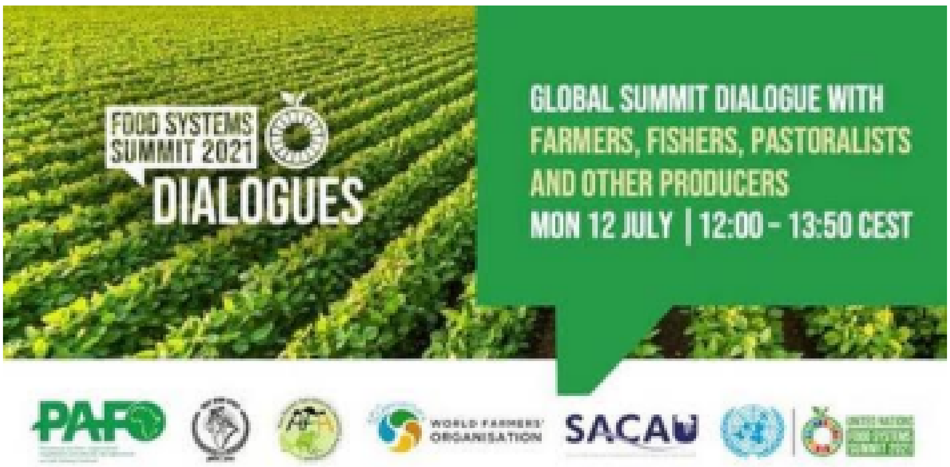
Invitation to Isha Outreach from UN Food Systems Summit Vice-Chair for a dialogue on Sustainable Consumption & UN Food Champion

From: Ajay Jakhar <aj@bks.org.in>
Date: Wed, 7 Jul 2021, 19:42
Subject: Invite to Global Summit Dialogue with Farmers, Fishers, Pastoralists and Other Producers
To: Ethirajalu Rengarajan> <ethirajalu.r@ishaoutreach.org>

Dear Colleagues,

We hope this email finds you well. We would like to invite you to participate in the UN Food Systems Summit Global Summit Dialogue with Farmers, Fishers, Pastoralists and other Producers. The Dialogue will take place virtually on the 12th of July 2021, from 12:00 to 13:50 CET (15:30 to 17:20 IST) .

This Global Dialogue is being co-convened by Dr. Agnes Kalibata, UN Secretary General's Special Envoy to the Food Systems Summit, together with the World Farmers' Organisation (WFO), Pan-African Farmers' Organization (PAFO), Southern African Confederation of Agricultural Unions (SACAU), Asian Farmers' Association for Sustainable Rural Development (AFA), and our organization, Bharat Krishak Samaj (Farmers' Forum India). Curated by Dr. David Nabarro, the Dialogue will build upon the outcomes of a series of producer-led independent dialogues and will examine the challenges, contributions, responsibilities and expectations of farmers, fishers, pastoralists and others in transforming our food systems with regards to nutrition, climate, biodiversity, livelihoods, resilience and other areas. The outcomes of this Global Dialogue will contribute to the UN Food Systems Summit (UNFSS), including the emerging solution clusters, to advance the achievement of the 17 Sustainable Development Goals (SDGs)



Convened by producer organizations, the Dialogue aims to invite and engage multi stakeholders in a robust consultation on emerging thinking, major challenges and proposed pathways of farmers, fishers, pastoralists and others, with a vision to jointly build more equitable, sustainable and resilient food systems. Adopting a standardized dialogue approach, the heart of the event is facilitated discussions in small groups composed of individuals with diverse backgrounds. Dialogues are hosted in a way that offers a safe space for sharing perspectives openly. For example, the outcomes of discussions are shared in plenary but without attributing statements to a particular person. We therefore encourage you to come with your ideas, experience, enthusiasm, and to make yourself available for the whole duration of the Dialogue.

This event is by invitation only. Please confirm your participation by completing this registration link by July 9th. Looking forward to your presence at the event.

On behalf of the Dialogue Co-Convenors,

Thanking you and regards,

Ajay Vir Jakhar
Chairman, Bharat Krishak Samaj (Farmers' Forum, India)
Vice Chair - Sustainable Consumption & UN Food Champion, UN #FoodSystems Summit
Chairman, Punjab State Farmers' & Farm Workers' Commission
EAT Forum, Advisory Board Member
@AjayVirJakhar Twitter Facebook LinkedIN Instagram Perspectives

Isha OUTREACH

Invitation letter by TN Government to Isha Outreach for training farmers.

வேளாண்மை மற்றும் உழவர் நலத்துறை

அனுப்புநர்,	பெறுநர்,
திருமதி இரா.சித்ராதேவி, பி.எஸ்சி.(விவ), எம்.பி.ஏ.,	வேளாண்மை இயக்குநர்,
வேளாண்மை இணை இயக்குநர்,	சென்னை.
கோவை.	

கடித எண் இ1/5539 /2021, நாள் 05.08.2021

ஐயா,

பொருள்: வேளாண்மை திட்டம் தனி நிதி நிலை அறிக்கை மாநில அளவிலான கருத்துக் கேட்பு கூட்டம் 08.08.2021 அன்று வேளாண்மை இயக்குநர் அலுவலகம், சென்னையில் நடைபெறுதல் கோவை மாவட்டத்திலிருந்து கலந்து கொள்பவர்களின் விபரம் சமர்ப்பித்தல் தொடர்பாக.

பார்வை:
1. வேளாண்மை இயக்குநர், சென்னை அவர்களின் கடித எண் திட்டம்2/65441/2021-1, நாள் 04.08.2021.
2. வேளாண்மை இயக்குநர், சென்னை அவர்களின் கடித எண் திட்டம்2/65441/2021-2, நாள் 04.08.2021.
3. வேளாண்மை இயக்குநர், சென்னை அவர்களின் கடித எண் திட்டம்2/65441/2021-2, நாள் 05.08.2021.

****

பார்வை 1ல் காணும் கடிதத்தில் கோரியுள்ளவாறு கோவை மாவட்டத்தில் கீழ்கண்ட விவசாய சங்க பிரதிநிதி கலந்துகொள்கிறார் என்பதை பணிவுடன் தெரிவித்துக்கொள்கிறேன்.

வ.எண்	விவசாயின் பெயர் மற்றும் முகவரி	அலைபேசி எண்	தொடர்பு அலுவலர்	நேரம் மற்றும் நாள்
1.	திரு.மெடிக்கல் பரமசிவம், திட்டக்குழு தலைவர், பாசன விவசாயிகள் சங்கம், பரம்பிக்குளம் ஆழியார் பாசனத்திட்டம் கோயம்புத்தூர் மாவட்டம்	7402465735 & 9443998776	திரு.வி.மதனகோபால் உதவி வேளாண்மை அலுவலர், வேளாண்மை உதவி இயக்குநர் அலுவலகம், பொள்ளாச்சி (வடக்கு) 7904739420	08.08.2021 முற்பகல் 9.30 முதல் பிற்பகல் 1.00 வரை

SAVE SOIL

isha OUTREACH

மேலும், பார்வை 2ல் காணும் கடிதத்தில் கோரியுள்ளவாறு கோவை மாவட்டத்தில் கீழ்கண்ட இயற்கை வேளாண்மையில் ஈடுபட்டுள்ள முன்னோடி விவசாயிகள் / இயற்கை விவசாய அமைப்புகளிலிருந்து கலந்துக்கொள்ளும் விவசாய பிரதிநிதிகள் விபரம் பணிவுடன் தெரிவித்துக்கொள்கிறேன்.

வ.எண்	விவசாயின் பெயர் மற்றும் முகவரி	அலைபேசி எண்	தொடர்பு அலுவலர்	நேரம் மற்றும் நாள்
ஈஷா இயற்கை வேளாண்மை அமைப்பு பிரதிநிதிகள்				
1	திரு.ஆனந்த் எத்திராஜுலு ஈஷா இயற்கை வேளாண்மை அமைப்பு, ஈஷனா விகார், வெள்ளிகிரி அடிவாரம், கோயம்புத்தூர்	9443154580	திரு.முகமது தாரிக், வேளாண்மை அலுவலர், வேளாண்மை உதவி இயக்குநர் அலுவலகம், தொண்டாமுத்தூர் 9500896541	08.08.2021 முற்பகல் 9.30 முதல் பிற்பகல் 1.00 வரை
2	திரு.சுவாமி ஸ்ரீமுகா, ஈஷா இயற்கை வேளாண்மை அமைப்பு, ஈஷனா விகார், வெள்ளிகிரி அடிவாரம், கோயம்புத்தூர்	9442590020		
பாலேக்கர் / Zero budget farming – இயற்கை வேளாண்மை அமைப்பு பிரதிநிதிகள்				
1	திரு.வி.டி.வள்ளுவன், 23, டாடா நகர், வடவள்ளி, கோயம்புத்தூர் – 641014	9843059597	திரு.வி.மதன கோபால், உதவி வேளாண்மை அலுவலர், வேளாண்மை உதவி இயக்குநர் அலுவலகம், பொள்ளாச்சி (வடக்கு) 7904739420	08.08.2021 முற்பகல் 9.30 முதல் பிற்பகல் 1.00 வரை
2	திரு.ஏ.கே.விஸ்வநாதன், 1/30 வலைகொம்பு, அம்பராம்பாளையம், பொள்ளாச்சி, கோயம்புத்தூர் – 642103	9486685365		

ஓம்/- இரா.சித்ராதேவி
வேளாண்மை இணை இயக்குநர்,
கோவை.

நகல் - இயக்குநர், விதைச்சான்று மற்றும் அங்ககச் சான்று துறை, கோவை.
நகல் - வேளாண்மை உதவி இயக்குநர்கள், பொள்ளாச்சி (வடக்கு) மற்றும் தொண்டாமுத்தூர்.

//உத்தரவுப்படி//

வேளாண்மை அலுவலர்

Scanned with CamScanner

SAVE SOIL

Annexure 1: National And International Organisations In Support Of Natural & Tree Based Farming

International Center for Research in Agroforestry (ICRAF)[32]

The very concept of agroforestry has been inextricably linked to ICRAF since their co-creation in the 1970s; indeed, the word itself was coined to describe our work.

In facilitating the emergence of a new paradigm for agriculture and forestry over the last four decades, World Agroforestry (ICRAF) has drawn on a vast body of local wisdom and traditional knowledge from all over the planet. There are numerous examples of traditional farming communities cultivating tree species in intimate combination with agricultural crops to create a healthy, harmonious symbiosis.

For example, farmers in Central America have been known to plant more than 20 different species of plants on plots of no more than one-tenth of a hectare, each with a different form, together corresponding to the layered configuration of mixed tropical forests. These plots may contain coconut or papaya, with a lower layer of bananas or citrus, a shrub layer of coffee or cacao, tall and low annuals such as maize, and finally a spreading ground cover of plants such as squash. Such systems have multiple benefits, providing a diverse range of food, with trees providing shade and preventing erosion and water evaporation.

Numerous other examples can be found in traditional farming systems around the world, with many involving the integration of cultivated land with original forests that provide food, medicines, construction wood and cosmetics, in addition to their protective services.

The use of trees in agriculture to meet local, national and international goals is becoming increasingly accepted, thanks largely to ICRAF working with farmers, governments, and research and training institutions to provide the evidence for the multiple benefits of agroforestry.

This has involved high-level policy engagement at international and national levels to develop guiding documents, policies, frameworks, laws and regulations; participatory design and management of farm trials; building the capacity of agricultural and forestry extension services, combining their separate knowledge for mutual benefit; and creating methods for designing, measuring, monitoring and evaluating carbon, water, systems and landscapes.

Agroforestry, as evidenced by the activities of ICRAF and our partners, contributes directly to SDGs) 1 (no poverty), 2 (zero hunger), 3 (good health and wellbeing), 6 (clean water and sanitation), 7 (affordable and clean energy), 8 (decent work and economic growth), 11 (sustainable cities and communities), 12 (responsible consumption and production), 13

[32] https://www.worldagroforestry.org/about-us

(climate action), and 15 (life on land) and indirectly through implementation approaches to Goals 4 (quality education), 5 (gender equality), 9 (industry, innovation and infrastructure),10 (reduced inequalities), 14 (life below water), 16 (peace, justice and strong

institutions) and 17 (partnerships for the goals).

Impact has been felt all over the planet, particularly, in recent times with increased awareness of the need to build resilience to climate change, which is seeing governments, non-governmental organizations and farmers demanding enhanced knowledge to expand the scale of agroforestry for food security and climate resilience.

For example, we have supported the demand of the Association of Southeast Asian Nations (ASEAN) for this purpose by playing a leading role in the creation of the ASEAN Guidelines for Agroforestry Development, supported by the Swiss Development Cooperation Agency, that were endorsed by the ASEAN Ministers on Agriculture and Forestry in 2018, with initial implantation underway across the region of 650 million people.

The Regreening Africa project, led by ICRAF with support from the European Union, is restoring over 1 million hectares of degraded land on the continent using agroforestry systems and practices in eight Sub-Saharan countries. Partners include African Forest Landscape Restoration Initiative of the African Union and other regional and international entities.

ICAR – Central Agroforestry Research Institute

Central Agroforestry Research Institute (ICAR-CAFRI), formerly the National Research Centre for Agroforestry, is a multidisciplinary premier research institute of the Indian Council of Agricultural Research (ICAR) with a major focus on integrating trees, crops and livestock on the same farmland. The Institute is in Jhansi, Uttar Pradesh, India and has a total area of 254.859 acres (214.079 research farms and 40.78 office & residential area). CAFRI is the only dedicated research institute of the country working on key research areas of agroforestry with 31 scientists, 16 technical, 12 administrative and 8 skilled supporting staff as its sanctioned cadre strength. CAFRI has developed robust agroforestry models and packages of practices for different agro climatic conditions covering small and marginal farmers, and provides technical backstopping to the States and stakeholders.

The vision of ICAR-CAFRI is to improve the quality of life of rural people by integrating perennial crops in the agricultural landscape for harnessing social, economic and environmental benefits. The mission is the integration of woody perennials in the farming system to improve land productivity through conservation of soils, nutrients and biodiversity by augmenting natural resource conservation, restoration of ecological balance, alleviation of poverty and mitigating risks of weather vagaries.

Annexure 2: Indian Government Schemes For Natural & Tree Based Agriculture

The Sub-Mission on Agroforestry

The Sub-Mission on Agroforestry (Har Medh Par Ped) Scheme[33] was launched in 2016-17 to encourage tree plantation on farm land along with crops/ cropping systems to help the farmers get additional income and make their farming systems more climate resilient and adaptive. The scheme is being implemented in 20 States viz. Andhra Pradesh, Bihar, Chhattisgarh, Gujarat, Haryana, Himachal Pradesh, Jharkhand, Karnataka, Kerala, M.P., Maharashtra, Odisha, Punjab, Rajasthan, Tamil Nadu, Telangana, U.P., Mizoram, Meghalaya, Nagaland and 2 UTs viz. J&K and Ladakh with funding pattern of 60:40 between Centre and State Govt. for all States accepting NE & Hilly states, where it is 90:10 and 100% in case of UTs & National Level Agencies.

Under the scheme, assistance to farmers is given through the State Govt. for nursery development, boundary plantation and block plantation of prominent tree species to promote, inter-alia, fruits bearing tree borne oilseeds, medicinal & aromatic plants, silk & lac rearing host plants, in addition to timber species, so that farmers get early returns.

In case of promotion of horticulture and orchards, the Mission for Integrated Development of Horticulture (MIDH), a Centrally Sponsored Scheme is being implemented w.e.f. 2014-15, for holistic growth of the horticulture sector covering fruits, vegetables, root and tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa and bamboo. All States and UTs are covered under MIDH.

Apart from the above, the state governments have their own schemes for tree-based agriculture such as KAPY in Karnataka.

Bhartiya Prakritik Krishi Padhati

The central government scheme for Bhartiya Prakritik Krishi Paddhati (BPKP) as a sub scheme of Paramparagat Krishi Vikas Yojana (PKVY) was launched in 2020-21 for the promotion of traditional indigenous practices. The scheme mainly emphasizes on exclusion of all synthetic chemical inputs and promotes on-farm biomass recycling with major stress on biomass mulching; use of cow dung-urine formulations; plant-based preparations and time to time working of soil for aeration. Under BPKP, financial assistance of Rs 12200/ha for 3 years is provided for cluster formation, capacity building and continuous hand holding by trained personnel, certification and residue analysis.[34]

---

[33] https://pib.gov.in/PressReleasePage.aspx?PRID=1705520
[34] https://pib.gov.in/PressReleasePage.aspx?PRID=1737751

Annexure 3: Renowned People In The Field Of Agriculture In Support Of Tree-Based Agriculture

Wangari Maathai (1940–2011)

Wangari Maathai was awarded the Nobel Peace Prize in 2004 for her work on community-based tree planting and its role in democratization and peacebuilding. The first woman in East and Central Africa to earn a doctorate degree, Professor Maathai founded the Green Belt Movement in 1986 as a grassroots organization, whose main focus is poverty reduction and environmental conservation through tree planting. Professor Maathai was internationally recognized for her persistent struggle for democracy, human rights and environmental conservation.

Paper: Agroforestry, Climate Change and Habitat Protection

Abstract

The agricultural systems most vulnerable to climate change are those already affected by unsustainable management and land and resource degradation. Trees have an important role to play not only in climate change mitigation but also in reducing vulnerability to climate-related risks. The value, role and contributions of agroforestry and the protection of endemic habitats, in the light of current global environmental challenges, cannot be overemphasized. African negotiators in global discussions must form a unified position and show how important agroforestry and indigenous agricultural practices are for climate change mitigation and adaptation on the continent.

Achim Steiner

Achim Steiner is the executive director of UNEP and under-secretary-general of the United Nations since 2006. Before joining UNEP, Mr Steiner served as director general of the International Union for Conservation of Nature (IUCN) from 2001 to 2006, and prior to that as secretary general of the World Commission on Dams.

Paper: Agroforestry and the Transition to the Future

Abstract

Humanity all too often thinks in boxes, but all too often this can lead to simplistic, short-term solutions.. Complexity needs to be embraced in which the best of indigenous, traditional, and farmers' knowledge is aligned and woven with empirical scientific evaluation. Agroforestry is a shining example of this approach, merging centuries-old knowledge with modern science. The future of global land use is no longer just about land – it is about the future of the atmosphere, of biodiversity, and of water, fuel, and food.

Dennis Garrity

Dennis P. Garrity was the Director General of World Agroforestry Centre (ICRAF) for 10 years until 2011. Currently, he is distinguished board research fellow at ICRAF and UNCCD (UN

Convention to Combat Desertification) drylands ambassador. He was the chair of the Global Organizing Committee of the 2nd World Congress of Agroforestry, Nairobi, 2009.

Paper: Agroforestry and the Future of Global Land Use

Abstract

Positive forest transitions are now occurring in many countries in both the tropical and temperate zones. During the 1990s, 38% of the world's countries experienced increases in forest cover, particularly in Europe, North America, and East and South Asia. Evidence is also mounting that the number of trees on farms is increasing the world over. About 1 billion ha of agricultural land has more than 10% tree cover. Concerns about the availability and cost of wood resources, the growing awareness about environmental issues, and the opportunities for agroforestry to better address food insecurity will enhance expansion of tree planting on farms in many tropical countries. A substantial increase of trees on croplands, or what we now call EverGreen Agriculture, will be going to be an inevitable phenomenon in the future. The future of trees (and forests) is on farms.

P. K. R. Nair

P. K. Ramachandran Nair is an Indian American agricultural scientist, Distinguished Professor of Agroforestry and International Forestry at the School of Forest Resources and Conservation, University of Florida. He is known for his pioneering contributions to the science of agroforestry, for which he received global recognition including the Humboldt Prize (2006). The specific areas of his research include: agroforestry in the tropics and subtropics, integrated farming systems, soil carbon sequestration and climate change mitigation, ecosystem services, and soil fertility management. He has written over 200 peer-reviewed articles, 17 books and over 75 book chapters.

Paper: Climate Change Mitigation: A Low-Hanging Fruit of Agroforestry

Abstract

Agroforestry systems (AFS) have attracted special attention in climate change mitigation and adaptation (M&A) discussions. Various reports on carbon (C) sequestration (and therefore climate change mitigation) potential of different AFSs have been reported from different ecological regions. However, the site-specific nature of AFS and lack of uniformity in C sequestration estimation methods make it difficult to compare the reported in into five subgroups – tree intercropping,multistrada, protective, silvopasture, and tree woodlots – and the global areas under each are estimated as 700, 100, 300, 450, and 50 million ha, respectively. Tillage, crop residue management, and plant diversity are reported as the major management operations that influence the role of land-use systems in climate change mitigation. The extent of influence of these operations varies considerably in various AFS subgroups; representative values (range) are reported for each. Based on this

evaluation, the "strengths, weaknesses, opportunities, and threats" of the role of agroforestry in climate change M&A are presented as a SWOT analysis. On a global scale, while existing multistrada and tree-intercropping systems will continue to provide substantial climate change mitigation benefits, large-scale initiatives in grazing land management, working trees in drylands, and establishment of vegetative riparian buffer and tree woodlots are promising agroforestry pathways for climate change M&A. Clearly, climate change mitigation is a low-hanging fruit of agroforestry; enabling policies and rigorous long-term research are essential for facilitating its timely and sustainable harvests.

Annexure 4: Scientific Papers In Support Of Natural Farming Systems

These scientific paper abstracts in support of the natural farming practices have been taken from the report published by Alliance for Sustainable & Holistic Agriculture (AHSA) . These studies have been conducted all over the country and we have categorized these abstracts on the basis of crop specific training that are provided by Isha Outreach. The studies that are on the basic principles of natural farming techniques are part of the same papers as indicated at the beginning of the abstract. This collection of papers provides an insight into the scientific research and knowledge that is available with the scientific community and agricultural universities which is commonly practiced and spread through various organizations and institutions as agri-extension to the farmers.

Abstract Of Scientific Papers, Books, Journals And Stories On Agro-Ecological Agriculture on Paddy

Paper: Gopal, Murali, Alka Gupta, C. Palaniswami, R. Dhanapal, And George V. Thomas (2010). "Coconut Leaf Vermiwash: A Bio-Liquid From Coconut Leaf Vermicompost For Improving The Crop Production Capacities Of Soil." Current Science 98, No. 9 : 1202-1210.[35]

Farming Technique: Input/ Natural Soil Management

Coconut leaf vermiwash (CLV) was produced from actively vermicomposting coconut leaf litter + cow dung substrate (10:1 w/w basis) by Eudrilus sp. It significantly increased the seedling vigor index of cowpea and paddy at 1: 10 and 1:15 dilutions in laboratory trials. Field trials carried out in red sandy loam soil resulted in an increase of 36% fresh biomass weight of cowpea with application of CLV at 1: 10 dilution. In maize, increase in cob yield by 5-10% and in bhendi (okra) 22-33% increase in fruit yield were recorded at 1: 5 dilutions of CLV. A concomitant increase in populations of general and plant beneficial microorganisms and soil enzyme activities in the rhizosphere of CLV-applied plants were also recorded. Soil organic carbon content increased in the CLV-applied plots in all the crops studied, but the total N, available P and K content in soil varied in different crops. The study indicated that CLV must be used in graded doses. Its application increased the crop production capacities

[35] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page no. 69

of soil by (i) enhancing the organic carbon contents in the soil and (ii) increasing the populations of the soil microorganisms, particularly plant beneficial ones, and their activities which would have facilitated increased uptake of the nutrients by the plants resulting in higher growth and yield.

Paper: Radha Prasanna, Lata Nain, Radhika Ancha, Jadhav Srikrishna, Monica Joshi and Brahma D Kaushik. (2009). Rhizosphere dynamics of inoculated cyanobacteria and their growth-promoting role in rice crop. Egyptian Journal of Biology. Vol. 11. 26-36.[36]

Farming Technique: Input/ Natural Soil Management
Nitrogen fixing cyanobacteria are the predominant flora in waterlogged paddy fields which contribute significantly towards nitrogen budgeting in these ecosystems. Their establishment and role in plant growth promotion and soil microbial activity is poorly known. Under greenhouse conditions, pots were inoculated with one of a set of twenty cyanobacterial strains isolated from the rhizosphere of diverse rice and wheat varieties. Several strains established in the soil and persisted up to the harvest stage in soil and roots, significantly enhancing soil microbial biomass carbon, available nitrogen, and related soil microbiological parameters, and increased grain yields and grain weight. This can help in selecting promising strains for developing carrier-based inoculants to promote the growth of crop and soil microflora, leading to enhanced soil fertility and crop yields.

Paper: Manjunath BL and VS Korikanthimath. (2009). "Sustainable rice production through farming systems approach." Journal of Sustainable Agriculture 33, no. 3: 272-284.[37]

Farming Techniques: Input/ Natural Soil Management,
Integrated Farming Technique
Field experiments were conducted for three years (from 1999 to 2002) at ICAR Research Complex for Goa, Old Goa, Goa, India, to identify a productive and sustainable cropping system with rice. Three major cropping systems common to the coastal region of India (rice-groundnut, rice-cowpea, and rice-vegetables) were compared with rice-fallow and rice-green manure (sunn hemp) systems. The experiment was conducted in a split-plot design with three replications in fixed plots. Integration of mushroom production and broiler poultry rearing were studied with the cropping systems. Three recycled manures from the integrated systems (FYM, poultry manure, and paddy straw with mushroom spent substrate) were applied to rice during the rainy season and were compared with no recycled manure treatment in main plots with cropping systems as subplots. The highest rice yield (5866 kg/ha) was observed when green manure (sunn hemp) was grown under recycled FYM and was followed by rice-brinjal rotation involving paddy straw and mushroom spent substrate (5761 kg/ha). The mean grain yield was enhanced by 18% (769 kg/ha increase)

[36] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page no: 88
[37] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page no. 88

with groundnut rotation as compared with a rice-fallow system by the third season. Among the manure resources, recycling of paddy straw with mushroom spent substrate recorded consistently better performance with a mean yield increase of 365 kg/ha compared with no recycling of manure. The rice-groundnut system was found more stable in terms of yield potential as reflected by higher sustainability yield index (0.78) and was followed by the rice-brinjal system (0.75). Paddy straw with mushroom spent substrate recorded the highest SYI (0.75) as compared with others, indicating that the practice is more sustainable. Incorporation of paddy straw along with mushroom spent substrate over a period of years had a beneficial cumulative effect on soil fertility. Although the effect of cropping systems on soil organic carbon was not appreciable, the rice-groundnut system was observed to increase the soil organic carbon marginally.

Paper: Singh YV. (2013). "Crop and water productivity as influenced by rice cultivation methods under organic and inorganic sources of nutrient supply." Paddy and Water Environment 11, 1-4: 531-542.[38]

Farming Technique: Input/ Natural Soil Management,
Integrated Farming Technique

A field experiment was conducted during the wet seasons of 2010 and 2011 at New Delhi, India to study the influence of organic, inorganic, and integrated sources of nutrient supply under three methods of rice cultivation on rice yield and water productivity. The experiments were laid out in FRBD with nine treatment combinations. Treatment combinations included three sources of nutrient supply viz., organic, integrated nutrient management, and inorganic nutrition and three rice production systems viz., conventional transplanting, system of rice intensification (SRI) and aerobic rice system. Results indicated that the conventional and SRI showed at par grain and straw yields but their yields were significantly higher than aerobic rice. Grain yield under organic, inorganic and integrated sources of nutrient supply was at par since the base nutrient dose was the same. Plant growth parameters like plant height, tillers, and dry matter accumulation at harvest stage were almost the same under conventional and SRI but superior to the aerobic rice system. Root knot nematode infestation was significantly higher in aerobic rice as compared to SRI and conventional rice. However, organic, inorganic and integrated sources of nutrient supply did not affect nematode infestation. There was a significant advantage in terms of water productivity under SRI over conventional transplanted (CT) rice and less quantity of water was utilized in SRI for production of each unit of grain. A water saving of 34.5–36.0 % in SRI and 28.9–32.1 % in aerobic rice was recorded as compared to CT rice.

Paper: Lakshmanan A, Sankar A, Geethalakshmi V, Latha P and Sekhar NU (2012). Role of blue green algal system in minimizing methane flux from rice soils. Asian

[38]Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 130.

Journal of Microbiology, Biotechnology and Environmental Sciences. Vol. 14 (4). pp 617-622[39]

Farming Technique: Input/ Natural Soil Management
Global warming induced by increasing concentration of greenhouse gases (GHGs) in the atmosphere is a matter of great environmental concern. A field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India during the Rabi seasons of 2010-11, to study the methane emission rates from rice fields under different organic amendments using rice variety TNAU (R) TRY1 with a duration of 135 days. Treatments involved were T1- Control, T2-Blue Green Algae, T3-Azolla, 4-Farm Yard Manure, T5-Green Leaf Manure, T6-Blue Green Algae + Azolla, T7-Farm Yard Manure + Green Leaf Manure, T8- Blue Green Algae + Azolla + Farm Yard Manure + Green Leaf Manure. Plant-mediated CH4 emission flux from the experimental plots was measured by closed chamber method at 15 days intervals. In the present study, combined application of organics and blue green algae not only recorded higher yield, but found to emit less methane in paddy cultivation than the application of organics alone. Hence, this study reiterates that biofertilization of paddy fields with blue green algae and Azolla is a potential climate change mitigation strategy due to their effect in minimizing methane emission, besides yield enhancement by nitrogen fixation.

Paper: Ghosh Subhadip, Brian Wilson, Subrata Ghoshal, Nimai Senapati and Biswapati Mandal. (2012). "Organic amendments influence soil quality and carbon sequestration in the Indo-Gangetic plains of India." Agriculture, Ecosystems & Environment 156: 134-141.[40]

Farming Technique: Input/ Natural Soil Management
Soil organic carbon is considered to be of central importance in maintaining soil quality. We assessed the effects of a range of commonly applied organic and inorganic amendments on soil quality in a rice–wheat cropping system in the Indo-Gangetic plains of eastern India and evaluated the carbon sequestration potential of such management approaches using a 25 year old long-term fertility experiment. Results showed that there were significant increases in soil nutrient availability with the application of farm yard manure (FYM @ 7.5 t ha"1), paddy straw (PS @ 10 t ha"1) and green manure (GM @ 8 t ha"1) along with inorganic fertilizer. Both microbial biomass C and mineralizable C increased following the addition of the organic inputs. Continuous cultivation, without application of organic inputs, significantly depleted total C content (by 39–43%) compared with treatments involving the addition of organic amendments. A significant increase in the non-labile C fraction resulted from both organic and inorganic amendments, but only 26, 18 and 6% of the C applied through FYM, PS and GM, respectively was sequestered in soils. A significant increase in yield of kharif rice was observed as a result of the addition of these organic amendments.

[39] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 131
[40] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 131

Paper: Kumar Pramod, Madhuri Pant and GCS Negi (2009). "Soil physicochemical properties and crop yield improvement following Lantana mulching and reduced tillage in rainfed croplands in the Indian Himalayan mountains." Journal of Sust Agri 33, no. 6: 636-657.[41]

Farming Technique: Input/ Natural Soil Management
In the rainfed crop fields of the Central Himalayan Mountains in India, low soil moisture and low soil fertility are the two major constraints on crop yield. Therefore, an experiment was conducted to test the hypothesis of whether mixing a high-quality (high foliar N, P, and K and low lignin) organic residue (Lantana camara leaves) with the relatively low-quality leaf litter of oak (Quercus leucotrichophora) and pine (Pinus roxburghii) forests, and then mulching the organic residue, would enhance the rate of organic residue decomposition and nutrient release to contribute to the soil fertility and crop yield of wheat and paddy in rainfed crop fields. To achieve the study objectives, Lantana residue was mixed with oak and pine leaf litter in four different proportions and applied under three tillage frequencies in 36 experimental plots in a completely randomized block design. These four mulch combinations were also studied for dry matter decomposition and nutrient release pattern. Results showed that both the decomposition rate (k = 1.86/yr) and rate of nutrient release from decomposing litter (N = 0.208 mg d"1 and P = 0.042 mg/d) for Lantana residue were much higher than the other litter combinations. Mixing Lantana with other mulch materials positively influenced the decomposition and nutrient release of otherwise slow decomposing oak and pine leaf litter. The 100% Lantana mulched plots recorded substantially higher soil moisture among the four mulching treatments. The 100% Lantana mulched plots also recorded significantly higher soil nutrients (NO3 +-N and PO4 "-P under wheat and NH4 +-N under rice crops) and rate of N mineralization, and produced significantly higher wheat grain (920 to 1309 kg/ha) and wheat and rice straw yield than the conventional practice of crop cultivation. Lantana residue thus proved to be a potential mulch to achieve soil moisture conservation, soil fertility enhancement, and higher crop yields in the region.

Paper: Nair, Chellappan Mohanakumaran, Krishna Rugmini Salin, Juliet Joseph, Bahuleyan Aneesh, Vaidhyanathan Geethalakshmi, and Michael Bernard New. (2014). "Organic rice–prawn farming yields 20% higher revenues." Agronomy for Sustainable Development 34, no. 3: 569-581.[42]

Farming Technique: Integrated Farming Technique
Rice–prawn farming in Asian countries is a sustainable practice using less fertilizers. Organic farming of rice and giant river prawns in rotational crops was tested in the waterlogged paddy fields of Kuttanad, Kerala as part of the Indian Organic Aquaculture Project. Rice was cultivated during November to February, followed by a crop of freshwater prawns in the same field from zMarch to September. Here, we study the production of four certified farms growing organic rice and organic prawns compared with four conventional farms growing

[41] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 138
[42] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 161

rice and prawns in rotational crops. We evaluate the economic viability by cost-return and partial budgeting analysis. Our results show that farming rice organically reduced yields by 23 %, from 5,690 kg/ha in conventional farming compared to 4,376 kg/ha in organic farming. However, the organic prawn crop yield of 396 kg/ha was 10 % higher than the yield of the conventional system, of 360 kg/ha, although the differences were not significant. Furthermore, total investment for organic rice was approximately 20 % greater than for the non-organic rice crop. Total investment for organic prawns was 17 % greater than for the non-organic prawn crop. Net revenue was 11 % lower for organic rice than for conventional rice. Organic prawns realized 117 % higher net revenue than conventional prawns. Although organic rice farming realized lower returns than conventional, its combination with organic prawn farming enhanced net revenue by 20 % over conventional rice/conventional prawn production.

Paper: Sudheer P. (2013). "Economics of organic versus chemical farming for three crops in Andhra Pradesh, India." Journal of Organic Systems 8, no. 2: 36-49.[43]

Farming Technique: Input/ Natural Soil Management

To tackle the challenge of food grain production and food security, chemical agriculture advocates call for the continuing or higher use of chemical fertilizers and synthetic pesticides. However, the continuous use and higher reliance on these inputs can lead to a reduction in crop productivity, deterioration in the quality of natural resources and the ecosystem. Organic farming offers a solution for sustainable agricultural growth and safeguarding the ecosystem. A conversion from chemical farming to organic farming can be a lengthy process, and during its course the farmer may incur a loss in income. The farmer will switch over only when he is convinced that in the long run, the benefits from organic farming are more than from chemical farming. A study of the economics of organic versus chemical farming may help policy makers to take appropriate measures for the spread of organic farming, which in turn has a bearing on the incomes of farmers, health conditions of the people and the environment. The present study compared the economics of organic farmers (N=350) and chemical farmers (N=200) for three crops, paddy, redgram, and groundnuts, in the state of Andhra Pradesh, a south eastern coastal state of India. It was found that organic farmers are earning a gross income of 5%, 10% and 7% more compared to the chemical farmers of paddy, redgram and groundnut, respectively, and with lower input costs the profits earned by the organic farmers are higher by 37%, 33% and 59% for the selected crops respectively. Organic farming is generally more profitable in terms of financial costs and returns than chemical farming, irrespective of the crop or the size of farm (the exceptions being small red gram farms and large groundnut farms). An analysis of the farmers' perception of organic farming reveals that electronic media (television) is the prime motivator for farmers to adopt organic practices. Farmers believed that organic farming improves soil fertility and their profits in the long run.

[43] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 163

Paper: Ramakrishnappa V. (2012). "Economic and environmental aspects of organic paddy cultivation in India: A case study from Mysore district of Karnataka state." Asian Journal of Development Matters 6, no. 2: 271-281.[44]

Modern agriculture is finding itself in increasing difficulties. The adverse impact of agriculture based on chemical fertilizers and pesticides is visible in the degradation of soil fertility, environmental damage, quality of food, taste of food and so on. People across the globe are becoming more conscious of their health and environment. Organic farming system largely excludes the use of synthetically compounded fertilizers and pesticides with aims to promote the sustainable health and productivity of the local ecosystem. There is dearth of information on organic paddy farming in India in general and in Karnataka in particular. Hence, the present study was conducted to analyse the economic and environmental issues in organic paddy cultivation. A sample of 40 farmers pursuing organic paddy farming was selected randomly for the study. The study was conducted in the irrigation region of Mysore district. The results show that the farmers carried out organic farming in a relatively smaller proportion of their land holding. Respondents of the study were inclined to have favorable beliefs towards organic farming and practicing their own interest. The economic analysis shows that for every 100 rupees spent for organic paddy cultivation, an average farmer in the study area has obtained Rs. 25.43 as profit. The net income of the cultivation of paddy under organic system was found to be Rs. 2375.2 per acre. The results clearly indicate that the cultivation of paddy under organic farming is economically profitable. The respondents, by and large, revealed clean interest in organic farming in the study area. Therefore, the government should make policies and provide financial support for farmers to promote organic farming.

Paper: Natrajan M and Santha Govind. (2006). "Indigenous agricultural practices among tribal women." Indian J Traditional Knowledge 5, no. 1: 118-121.[45]

The tribal women living In the Kalrayan Hills have rich knowledge about the indigenous practices, especially in post harvest and cultivation aspects on paddy (Oryza sativa Linn.) and tapioca (Manihot esculenta Crantz). Indigenous knowledge has evolved within the community and has been passed on from one generation to another. The role of indigenous knowledge in sustainable agricultural production in developing countries is beginning to gain recognition within scientific circles. Tribal women are generally noted for the wealth of indigenous knowledge. Hence, a study on adoption of indigenous farm practices among tribal women of the Kalrayan hills was taken up to assess the extent of adoption of identified indigenous farm practices in paddy and tapioca. The study was conducted in the Kalrayan hills of district Villupuram, Tamil Nadu. A total of 120 tribal women selected based on proportionate random sampling technique. The data were collected from the respondents with the help of a well-structured pre-tested interview schedule and suitable statistical tools were used to analyze the data.

---

[44] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 164

[45] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 179

Paper: Victor TJ and R Reuben. (2000). "Effects of organic and inorganic fertilisers on mosquito populations in rice fields of southern India." Medical and Veterinary Entomology 14 (4): 361-368.[46]

Farming Technique: Input/ Natural Soil Management

The effects of nitrogenous (inorganic) fertilisers, organic manures and blue green algae (BGA) bio fertilizer on mosquito populations (Diptera: Culicidae) were studied in rice fields of Madurai, Tamil Nadu, south India, with particular attention to Culex vishnui Theobald, Cx. pseudovishnui Colless and Cx.tritaeniorhynchus Giles, the vectors of Japanese encephalitis (JE). The application of urea, a nitrogenous fertiliser, in rice fields significantly increased the grain yield and the population densities of mosquito larvae and pupae (anophelines as well as culicines) in a dose-related manner. Fields treated with inorganic fertilisers (N, P, K) had significantly higher population densities of mosquito immatures than fields treated with organic manures (farmyard manure and green manure). Without nitrogenous fertiliser, BGA increased paddy yield without enhancing mosquito production. Therefore, the use of BGA with less nitrogenous fertiliser is recommended, which is beneficial economically and agronomically to the farming community and also significantly reduces mosquito production in rice fields. Increased use of nitrogenous fertiliser over the past two decades may have contributed to the increased severity of Japanese encephalitis epidemics, vectors of which breed in rice fields.

Paper: Singh Inder Pal and DK Grover. (2011). "Effects of green revolution: and recent development of organic farming with special reference to Indian Punjab." Journal of Progressive Agriculture 2, no. 1: 4-14.[47]

Farming Technique: Input/ Natural Soil Management

The high nutritional requirements of paddy and wheat, the major crop rotation in the state has exhausted the soil of nutrients. Resultantly, Punjab state, which has just around 3% of cultivated area, accounts for about 10 percent of total chemical fertilizer consumption in the country. The state is adding 1332 thousand tonnes of nitrogen, 379 thousand tonnes of phosphorus and 57 thousand tonnes of potassic fertilizers to the soil annually. The use of chemical fertilizers in the state has gone up many times from 213 thousand tonnes in 1970–71 to 1768 thousand tonnes in 2008–09. The fertility of Punjab soils has diminished over the years with deficiency in nitrogen and phosphorus. Thus, it is clear that the present farming system is not sustainable as the soil is deficient of all the micro and macronutrients. Now, the area under organic farming in India too has increased from 37000 ha to 103, 000 ha during 2002–03 to 2007–08. Similarly, organic farming has been introduced in the state of Punjab recently and is gaining wide popularity.

The study concluded that only 67 ha (0.016 percent of the total certified area in India) area was certified and about 3253 ha (0.70 percent of the total in conversion area in India) area is under conversion for organic farming during 2008 in Punjab. The total area under organic

[46] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 182

[47] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 203

farming (certified +inconversion) was about 3320 ha (0.38 percent of the total area under organic farming in India) during 2008 in Punjab. The present paper highlighted the effect of green revolution over the years in respect to chemical fertilizer and pesticide consumption, contamination of food, deterioration of soil fertility and also highlighted the recent developments of organic farming in respect to area, export, infrastructure set up etc in the world as well as India with special reference to Indian Punjab by taking secondary information from different sources as well as primary information from the farmers.

Paper: Kumara Charyulu D and Subho Biswas. (2010). Economics and Efficiency of Organic Farming vis-à-vis Conventional Farming in India. No. 2010-04. Working Paper, 2010. IIM-Ahmedabad[48]

Organic farming systems have attracted increasing attention over the last one decade because they are perceived to offer some solutions to the problems currently besetting the agricultural sector. Organic farming has the potential to provide benefits in terms of environmental protection, conservation of non-renewable resources and improved food quality. India is bestowed with a lot of potential to produce all varieties of organic products due to it's diverse agro-climatic regions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic market related to the export market. In India, the land under certification is around 2.8 million ha. But, there is considerable latent interest among farmers in conversion to organic farming. However, some farmers are reluctant to convert because of the perceived high costs and risks involved in organic farming. Despite the attention which has been paid to organic farming over the last few years, very little accessible information actually exists on the costs and returns of organic farming in India. The empirical evidence of efficiency analysis of organic and conventional farming systems are scarce or even absent. So, the present paper focuses mainly on the issues like economics and efficiency of organic farming vis- à-vis conventional farming in India. Four states namely Gujarat, Maharashtra, Punjab and U.P were purposely selected for the present study. Similarly, four major crops i.e., cotton, sugarcane, paddy and wheat were chosen for comparison. A model based non- parametric Data Envelopment Analysis (DEA) was used for analyzing the efficiency of the farming systems. The crop economics results showed a mixed response. Overall, it is concluded that the unit cost of production is lower in organic farming in case of cotton and sugarcane crops whereas the same is lower in conventional farming for paddy and wheat crops. The DEA efficiency analysis conducted on different crops indicated that the efficiency levels are lower in organic farming when compared to conventional farming, relative to their production frontiers. The results conclude that there is ample scope for increasing the efficiency under organic farms.

[48]Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 204

Abstract Of Scientific Papers, Books, Journals And Stories On Agro-Ecological Agriculture on Sugarcane

Paper: Singh, K. P., Archna Suman, P. N. Singh, and Menhi Lal. (2007). "Yield and soil nutrient balance of a sugarcane plant–ratoon system with conventional and organic nutrient management in sub-tropical India." Nutrient Cycling in Agroecosystems 79, no. 3: 209-219.[49]

Farming Technique: Input/ Natural Soil Management

A 3-year field trial of sugarcane, comprising 11 treatment combinations of different organic manures with and without Gluconacetobacter diazotrophicus (Gd), NPK and an absolute control, on an inceptisol was conducted to assess the effect of these treatments on sugarcane total and economic yield, the benefit:cost ratio, nutrient balance and soil quality in a sugarcane plant–ratoon system. The highest cane yield (78.6 t ha"1) was recorded in the plant crop was given vermicompost + Gd, whereas ratoon yields (first and second) were highest (80.8 and 74.9 t/ha"1, respectively) with sulphitation press mud cake (SPMC) + Gd. In both plant and ratoon crops, a number of different organic manures produced the highest cane yield that was also statistically similar to those obtained with using the recommended NPK levels (76.1, 78.2 and 71.7 t/ha for plant crop and subsequent two ratoons, respectively). The highest benefit:cost (B:C) ratio in the plant and two ratoon crops (1.28, 2.36, 2.03 respectively) were obtained with the addition of SPMC + Gd. The nutrient balance for NPK in the soil was highest in the SPMC + Gd treatment. The highest increase in organic C (94%) and total N (87%), in comparison to the initial level, and soil microbial biomass C (113%) and soil microbial biomass N (229%), in comparison to the control treatment was recorded with the addition of SPMC + Gd. The maximum decrease in soil bulk density (BD) (12%) with an increase in soil aggregate (17%) and water infiltration rate (35%) was obtained with the addition of SPMC. Overall, the sugarcane crop responded well to different organic manures in a multiple ratooning system with a better economic output and improved soil quality. Strategic planning in terms of an integrated application of these manures with inorganic chemicals will not only sustain our soils but will also be beneficial for our farmers in terms of reducing their dependence and expenditure on chemical fertilizers.

Paper: Singh, K. P., Archna Suman, P. N. Singh, and T. K. Srivastava. (2007). "Improving quality of sugarcane-growing soils by organic amendments under subtropical climatic conditions of India." Biology and Fertility of Soils 44, no. 2: 367-376.[50]

Farming Technique: Input/ Natural Soil Management

A field trial was conducted on an inceptisol to assess the effect of different bio-manures on sugarcane yield, cane quality, and changes in soil physicochemical and microbial properties

[49] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 13

[50] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 15

in the plant–ratoon system. Seven treatments, viz. control, vermicompost, farmyard manure (FYM), biogas slurry, sulphitation press mud cake (SPMC), green manuring with intercropped Sesbania, and recommended dose of NPK (150:60:60 kg ha"1), were randomized within a block and replicated three times. Improvement in bulk density and infiltration rates was recorded after the addition of various bio-manures. The highest organic C was recorded in the vermicompost (0.54%) and pressmud (0.50%) treatments. The highest increase in soil microbial biomass C (185.5%) and soil microbial biomass N (220.2%) over its initial value was recorded with the addition of FYM. Dry matter production in plants, as well as ratoon crop, was significantly higher by bio-manure application over the control. Plant N uptake was highest in the press mud treatment (227.7 kg ha"1), whereas P and K uptake were highest (41.4 and 226.50 kg ha"1) in vermicompost treatment. The highest number of millable canes (95.6 and 101.0 thousand ha"1) in plant and ratoon crop were obtained with the addition of pressmud. The highest yield (76.7 t ha"1) was recorded in planted cane with vermicompost application, whereas ratoon yield was highest (78.16 t ha"1) with pressmud application. In both planted and ratoon crops, organic amendments produced yields statistically similar to those with recommended NPK (76.1 and 78.1 t ha"1 for plant and ratoon cane).

Paper: Mohanty M, PP Das and SS Nanda. (2014). "Introducing SSI (Sustainable Sugarcane Initiative) Technology for Enhanced Cane Production and Economic Returns in Real Farming Situations Under East Coast Climatic Conditions of India." Sugar Tech: 1-5.[51]

An on-farm trial in a participatory mode was conducted consecutively during 2011–2012 and 2012–2013 cropping seasons at Patuli Sahi village under Odagaon block of Nayagarh district in Odisha with a view to draw a comparative statement of the advantages of sustainable sugarcane initiative (SSI) technology of cane cultivation over the conventional three bud setts planting. Twenty-five day old seedlings were planted at 120 × 60 cm distance in SSI technology as against three bud sets planted at 75 cm row to row spacing in conventional practice. The study thus revealed that by adopting SSI technology of sugarcane cultivation, the farmers could realize a cane yield of 105 t/ha which was 18 % higher as against 89 t/ha obtained from the conventional method of cane cultivation. The cost of cultivation was Rs. 1,69,300/ha in conventional cane cultivation which came down to Rs. 1,51,950/ha when the crop was grown by SSI technology. The gross and net returns were Rs. 2,36,250 and 84,300/ha, respectively by adopting of SSI technology as compared to Rs. 2,00,250 and 30,950/ha in conventional cane farming. Sugarcane planting by SSI technology has thus proved to be more productive and economically viable since it also fetched more net returns per unit area for time invested, and can be a better option for the farmers of the east coast zone of India. The SSI technology was also judged as the most sustainable by the farmers in their local agricultural production system.
Paper: Shukla SK, Menhi Lal and Santosh Kumar Singh. (2013). "Improving bud sprouting, growth and yield of winter initiated sugarcane ratoon through tillage cum organic

[51]Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 27

mediated rhizospheric modulation in Udic ustochrept under subtropical Indian condition." Soil and Tillage Research 126: 50-59.[52]

Farming Technique: Input/ Natural Soil Management,
Integrated Farming Technique
Field experiment was conducted during 2007–2010 at the research farm of Indian Institute of Sugarcane (Saccharum officinarum) Research, Lucknow. The findings of the investigation revealed that tillage operation performed by Ratoon Management Device (RMD) involving earthing-up from both the sides of sugarcane stubble protects the subterranean buds from cold injury and provides congenial rhizospheric environment for survival and sprouting of buds. Tillage through RMD superimposed with composted trash regulates the soil microbial activities (ex situ soil respiration – 29.52 mg CO2-C kg"1 soil day"1 and soil microbial biomass carbon (SMBC) – 187.3 mg Cmicrob kg"1 soil day"1). These in turn enhance the sprouting of stubble buds which otherwise fail to sprout under the influence of extremely low temperature. The tillage cum organic treatments create congenial soil–water–air relations which produce viable and vigorous sprouts.

Translated into practice, it means that the fact 'Tillage is manure' is quite pertinent in winter initiated sugarcane ratoon as mechanical manipulations of soil (tillage) at its optimum moisture level creates favourable physical environment (soil tilth) in root zone (bulk density – 1.35 Mg m"3 at 0–15 cm soil depth and infiltration rate – 5.5 mm h"1). Addition of organics further provides congenial substrate/s to soil microbiota and enhances their metabolic activities which along with new activated roots maintain better soil–water– air relations and enhance their sprouting in cold conditions. This ensures synchronized, early formed adequate number of millable canes (135,000 ha"1), consequently resulting in higher ratoon cane (94.1 Mg ha"1) and sugar yields (8.75 Mg ha"1). The tillage cum organic technology is of immense significance to cane growers by increasing sugar yield in early crushing season from ratoon.

Paper: Shukla SK, Singh PN and Chauhan RS (2011). Effect of organic wastes amended with Trichoderma and Gluconacetobacter on physicochemical properties of soil and sugarcane ratoon yield in udic ustochrept. Indian Journal of Agronomy. Vol. 56(3): 254-259.[53]

Farming Technique: Input/ Natural Soil Management
A field experiment was conducted during 2005–2008 at Lucknow to relate the changes in the water stable aggregates, soil organic carbon (SOC) and nutrient availability to sustaining sugarcane ratoon growth and yield in udic ustochrept. Eight combinations (absolute control, control-200 kg N/ha through inorganic fertilizer, 10t/ha farmyard manure (FYM) alone, FYM enriched with 20kg/ha Trichoderma viride, FYM enriched with 12.5kg/ha Gluconacetobacter diazotrophicus, 7.5t/ha trash mulch, trash mulch enriched with 20kg/ha Trichoderma viride and trash mulch enriched with 12.5 kg/ha Gluconacetobacter diazotrophicus were applied in sugarcane ratoon (first and second ratoon in succession). Inoculation with Trichoderma

[52] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 36
[53] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 59

viride enhanced total water stable aggregates (WSAs) and macro aggregates (>0.25 mm). Trichoderma enriched trash significantly increased mean weight diameter (0.71 mm) of aggregates. Higher rate of increase in soil organic carbon (SOC) was observed under inoculation of Trichoderma with FYM compared to trash mulch. Inoculation with Trichoderma and Gluconacetobacter improved N, P and K availability at all the growth stages. Bioagents inoculated FYM gave higher mean sugar yield (8.89 t/ha) as compared to bioagents inoculated trash (7.97 t/ha).

Paper: Shukla SK, RL Yadav, Archna Suman and PN Singh. (2008). "Improving rhizospheric environment and sugarcane ratoon yield through bioagents amended farm yard manure in udic ustochrept soil." Soil and Tillage Research 99, no. 2: 158-168.[54]

Farming Technique: Input/ Natural Soil Management

A field experiment was conducted for two crop cycles during 2003–2005 and 2004–2006 at the Indian Institute of Sugarcane Research, Lucknow in subtropical India. Trichoderma viride and Gluconacetobacter diazotrophicus amended farm yard manure (FYM) increased organic carbon (19.44 Mg/ha) and available nitrogen (260 kg N/ha) content of soil from 14.78 Mg/ha (OC) and 204 kg N/ha observed under farmer's practice (sole N application). Application of bioagents amended FYM improved soil porosity and reduced compaction (bulk density—1.39 Mg m"3 over 1.48 Mg m"3 under farmer's practice). Sugarcane ratoon crop removed the highest amount of nitrogen (N—165.7 kg/ha), phosphorus (P—24.01 kg/ha) and potassium (K—200.5 kg/ ha) in the plots receiving FYM with Trichoderma and Gluconacetobacter. Inoculation of FYM with bioagents improved the population of ammonifying and nitrifying bacteria in the soil. Phosphorus and potassium uptake of the crop was greatest in the plots receiving FYM, Trichoderma and Gluconacetobacter. Bioagents (Trichoderma and Gluconacetobacter) amended FYM increased ratoon cane (70.2 Mg/ha) and sugar yields (7.93 Mg/ha) compared with control (62.3 and 7.06 Mg/ha ratoon cane and sugar yields, respectively).

Paper: Kshirsagar K G (2006). Impact of organic sugarcane farming on economics and water use efficiency in Maharashtra. Gokhale Institute of Politics and Economics. Working Paper 15.[55]

This study examines the impact of organic farming on economics and water use efficiency in sugarcane cultivation in Maharashtra. The study is based on primary data collected from both certified organic sugarcane (OS) and inorganic sugarcane (IS) growing sample farmers in the water scarce and groundwater dependent district of Jalgaon in Maharashtra. The study finds that OS cultivation increases human labour employment by 20.2% and its overall cost of cultivation is also lower by 14.67% than IS farming. Although the yield from OS is 6.2% lower than the conventional crop, it is more than compensated by the price premium received and yield stability observed on OS farms. The OS farming gives 15.72% higher

[54]Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 142
[55]Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 145

profits and profits are also more stable on OS farms than the IS farms thereby enhancing the economic well-being of OS farmers. Crucially, OS farming substantially enhances the water use efficiency (WUE) measured by different indicators. Thus, OS farming offers ample opportunities for enhancing farmers' income and improving water use efficiency in the cultivation of a highly water-consumptive and important sugarcane crop in the state. Finally, the paper discusses the emerging issues and outlines the task ahead for advancing OS farming in Maharashtra.

Paper: Kshirsagar KG (2008). Impact of organic farming on economics of sugarcane cultivation in Maharashtra. Gokhale Institute of Politics and Economics, Working Paper 15.[56]

Organic farming is a system of farm management to create an ecosystem which can achieve sustainable productivity without the use of artificial external inputs such as chemo-synthetic fertilizers and pesticides. The potential of organic farming in generating socially and environmentally beneficial effects are impressive. However, it is essential to assess its performance in terms of its economics which ultimately influences the adoption. Therefore, the primary goal of this paper is to examine the impact of organic farming on economics of sugarcane cultivation in Maharashtra. The study is based on primary data collected from two districts covering 142 farmers, 72 growing Organic Sugarcane (OS) and 70 growing Inorganic Sugarcane (IS) in Maharashtra. The study finds that OS cultivation enhances human labour employment by 16.90 per cent and its cost of cultivation is also lower by 14.24 percent than IS farming. Although the yield from OS is 6.79 percent lower than the conventional crop, it is more than compensated by the price premium received and yield stability observed on OS farms. The OS farming gives 15.63 per cent higher profits and profits are also more stable on OS farms than the IS farms. The paper concludes by suggesting some key policy measures for rapid advancement of OS farming in selected regions of the state.

Paper: Kumara Charyulu D and Subho Biswas. (2010). Economics and Efficiency of Organic Farming vis-à-vis Conventional Farming in India. No. 2010-04. Working Paper, 2010. IIM-Ahmedabad[57]

Organic farming systems have attracted increasing attention over the last one decade because they are perceived to offer some solutions to the problems currently besetting the agricultural sector. Organic farming has the potential to provide benefits in terms of environmental protection, conservation of non-renewable resources and improved food quality. India is bestowed with a lot of potential to produce all varieties of organic products due to its diverse agro-climatic regions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic

[56] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 177

[57] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 204

producers to tap the market which is growing steadily in the domestic market related to the export market. In India, the land under certification is around 2.8 million ha. But, there is considerable latent interest among farmers in conversion to organic farming. However, some farmers are reluctant to convert because of the perceived high costs and risks involved in organic farming. Despite the attention which has been paid to organic farming over the last few years, very little accessible information actually exists on the costs and returns of organic farming in India. The empirical evidence of efficiency analysis of organic and conventional farming systems are scarce or even absent. So, the present paper focuses mainly on the issues like economics and efficiency of organic farming vis- à-vis conventional farming in India. Four states namely Gujarat, Maharashtra, Punjab and U.P were purposely selected for the present study. Similarly, four major crops i.e., cotton, sugarcane, paddy and wheat were chosen for comparison. A model based non- parametric Data Envelopment Analysis (DEA) was used for analyzing the efficiency of the farming systems. The crop economics results showed a mixed response. Overall, it is concluded that the unit cost of production is lower in organic farming in case of cotton and sugarcane crops whereas the same is lower in conventional farming for paddy and wheat crops. The DEA efficiency analysis conducted on different crops indicated that the efficiency levels are lower in organic farming when compared to conventional farming, relative to their production frontiers. The results conclude that there is ample scope for increasing the efficiency under organic farms.

Paper: Kshirsagar KG. (2006). "Organic sugarcane farming for development of sustainable agriculture in Maharashtra." Agricultural Economics Research Review 19: 145-153.[58]

The economics of organic sugarcane farming (OSF) and inorganic sugarcane farming (ISF) has been examined and the OSF has been assessed with water, power and farmers economic well-being and livelihood security. The study is based on data for 2004–05 collected from 30 certified OSF and 30 ISF sampled households from the Jalgaon district of Maharashtra. The OSF households have been found younger and more educated having larger landholdings and better resources. The OSF is labour-intensive, but its cost of cultivation is lower due to savings on chemical fertilizers, irrigation, seeds and agrochemicals. The yield on OSF has been reported lower but it is more than compensated by the price premium received and the yield and profit stability observed on the OSF. In addition, the OSF has been found superior in terms of economic well-being and livelihood security of the farmer. The study has revealed that OSF has enormous potential for improving sustainability of agriculture and has suggested that organic farming should receive prime attention from all stakeholders to realize its full potential in increasing and providing the much sought after sustainability to agriculture.

[58]Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 217

Paper: MAIN FINDINGS OF THE ALL INDIA NETWORK PROJECT ON ORGANIC FARMING (13 LOCATIONS) COORDINATED BY PROJECT DIRECTORATE FOR FARMING SYSTEMS RESEARCH, MODIPURAM[59]

Okra, turmeric, cotton, carrot, black pepper and cowpea have recorded more than 20% increase in yield under organic nutrient input system compared to an inorganic system. The increase in yield of onion, ginger, and dolichos beans are in the range of 10-20% while greengram, sunflower and garlic recorded 5 to 10% increase in yield. An increase of up to 5% was observed in maize, soybean, berseem, brinjal, chili, capsicum, tomato, sorghum and peas across the seasons and locations. [THESE, THEREFORE, ARE CONSISTENT RESULTS ACROSS LOCATIONS AND SEASONS, FOR 21 OF THE 28 CROPS FOR WHICH RESEARCH IS UNDERTAKEN]

Paper: Jadhao, B.J., Joshi, P.S. and Chaudhari, G.V. (2011). Organic farming of turmeric (Curcuma longa) in Central India. Adv. Res. J. Crop Improv., 2(1) : 55-57.[60]

Turmeric is a very important spice crop commercially grown throughout the country from the last many centuries; it has been used in various commercial industries as well as in pharmaceutical industries. It has a great demand in domestic as well as in international markets, due to its wider adaptability and also various schemes sponsored by Spice Board of India and National Horticulture Mission. Its acreage significantly increased in the last few years especially in central India. Considering the importance of this crop, the present experiment was undertaken at the Department of Horticulture, Dr.PDKV Akola to explore the possibility of organic farming in turmeric and standardization of organic manures for quality as well as export oriented production of turmeric. The initial results were found promising and it was supposed to confirm that application of vermicompost @ 13.5 t/ha application resulted in better vegetative growth performance, whereas application of FYM @ 20 t/ha was found to be better for yield attributing characters in turmeric.

Paper: Sanwal S.K., Laxminarayana K., Yadav R.K., Rai N., Yadav D.S., Bhuyan Mousumi (2007): Effect of organic manures on soil fertility, growth, physiology, yield and quality of turmeric. Indian Journal of Horticulture. Vol 64 (4): 444-449[61]

Farming Technique: Input/ Natural Soil Management
Field experiments were conducted to study the effect of various organic manures on yield and quality parameters of turmeric and their effect on residual soil fertility. The results showed that significantly higher rhizome yield was recorded with the application of FYM @

[59] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 1
[60] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 10
[61] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 12

18 t/ha which was statistically at par with 10 t/ha poultry manure. Application of various organic sources resulted in 16–103 percent higher rhizome yield over control and also improved the quality parameters. Organic manuring not only produced the highest and sustainable crop yields but also improved the soil fertility and productivity.

Book: Parthasarathy, V. A., K. Kandiannan, and V. Srinivasan. (2008). "Organic spices." New India Publishing, 2008.[62]

This book on 'Organic Spices' covers all aspects of organic spice production. The topics covered include historical spice trade and importance of spices in the food chain. A brief account on the organic agriculture movement in the world and its present status and opportunity for organic spices in the world market are given. The chemistry and different methods of composting are covered in the organic manures chapter. A separate chapter devoted to microbes and plant growth promoting rhizobacteria is included. Topics on biological control of insect pests, nematodes, fungi and bacteria of spices are highlighted in separate chapters, which would be of interest in the organic production system. The importance, composition, uses, botany and varieties, organic way of production of spices such as black pepper, cardamom (Elettaria cardamomum), ginger, turmeric, chilies and paprika, nutmeg (Myristica fragrans), vanilla, seed spices such as cumin (Cuminum cyminum), fennel, fenugreek, coriander and their harvest and postharvest processing are enumerated. Chapters on good agricultural practices and organic certification procedures are outlined for adoption. This would serve as a reference book for researchers, teachers and students besides farmers, traders and consumers.

Paper: Hamza, S. (2006). "Effect of Organic Farming on Soil Quality, Nutrient Uptake, Yield and Quality of Indian Spice." In The 18th World Congress of Soil Science. July 9-15, 2006, Philadelphia, USA.[63]

Farming Technique: Input/ Natural Soil Management
Organic Farming (OF) is expanding globally due to increased consumer interest, environmental protection and EU policies. Global trade in organically produced products in 2003 is estimated at US $26 billion and is projected to increase $102 billion by 2020, due to increasing demand in Europe, USA, Japan and Australia. In India attention is being received in Organic agriculture particularly in spices. The project organic farming in spices was conceptualized in 1992 and implemented at IISR and tested in the farmer's fields over a decade. The objectives were to study the best organic fertilizers (plant residues-compost/vermicompost, animal manures/de-oiled cakes that contains nutrients in complex organic forms, bio-fertilizers), its impact on soil quality, quality of major tropical spices and its economics in important spice crops under humid tropical conditions of South India. Soil characteristic, plant analysis, and quality were determined by following standard procedures. The results of the greenhouse and field experiments conducted are discussed.

---

[62] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 94
[63] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 146

In black pepper the effect of commercial organic manures was evaluated (based on their nutrient equivalents) and compared with NPK chemical fertilizers and farmers practice. The study was taken under greenhouse conditions (1993-'96) in CBD design. Investigations revealed that irrespective of the sources, application of organics increased the soil pH, nutrient availability in the soil and crop uptake. Poultry manure followed by goat manure was significantly superior with regard to yield, nutrient uptake, and enhanced piperine and oleoresin content of black pepper. On farm trials conducted in the 51 farmer's holdings in 30,000 vines for five years corroborated the findings. The OF technology was further extended in farmer's fields in three important black pepper growing States of South India viz., Kerala, Karnataka and Tamil Nadu during 2000- '03. Limiting acid soils @ half the lime requirement of the soil enhances the microbial population, nutrient availability, and dehydrogenase enzyme activity. Application of the recommended dose of N as organic (FYM + de-oiled cakes-neem (Azadirachta / pea-nut, P as phosphate rock + bone meal and K as wood ash, in conjunction with bio-fertilizers (Azospirillum and Phosphobacteria each applied @ 40kg per ha per year enhanced the spiking intensity of the vine, yield and nutrient uptake. The FYM application significantly decreased the bulk density irrespective of the soils. Soil quality indicators tested were positively correlated ($p<0.005$) with yield. Among the soil quality attributes, organic carbon and CEC are most discriminating attributes in all the three locations. The soil organic matter and CEC contributed substantially to the ability of the soil to accept, hold, and release nutrients to pepper vines. Adoption of OF was effective in the biomanagement of the Phytophthora disease incidence to around two per cent over the years against 10 percent in the control. Black pepper quality volatile oil, oleoresins, boldness of pepper corn (>4 mm diameter) were increased due to OF. Field studies in Cardamom has shown that application of recommended NPK nutrients as organic fertilizers (50 per cent N each as FYM and neem cake + 50 per cent P each as bone meal and phosphate rock + 50 per cent K as wood ash) were effective in increasing the yield and quality of cardamom. Field experiments (1992-95) conducted in ginger and turmeric, using six de-oiled organic cakes in comparison with the recommended FYM and NPK fertilizers showed that in general application of cakes increased not only soil nutrient availability, but also nutrient uptake. Organic cakes enhanced the water holding capacity and reduced soil bulk density. In ginger, among the cakes, pea-nut registered maximum organic C, Bray-P and exchangeable K in the soil and registered maximum dry recovery (4077 kg ha^{-1}). This was followed by neem, cotton, and NPK fertilizer. Neem cake registered the highest oleoresin production (320 kg ha^{-1}) of ginger. Neem cake was effective in the bio-management of rhizome rot disease incidence in ginger to 5%. In turmeric increased yield and curcumin recovery were observed due to organic OF. Residual effect of organic fertilizers was conspicuous in the successive second crop of turmeric. In Vanilla soil application of organic fertilizers (50 per cent N as FYM/vermicompost + 50 percent N as de-oiled cakes + 50 per P as bone meal + 50 per cent K as wood ash + bio-fertilizers) were effective compared to recommended inorganic NPK fertilizers in increasing the yield and quality of the beans. Pilot study conducted 2001-04) in the high ranges of Western Ghat in the growing of Garcinia indica in Wayanad district (Kerala) and clove and nutmeg in Maraimalai/ Mahendragiri hill areas in kanyakumari district (Tamil Nadu) revealed that Garcinia is grown as a self sown crop in traditional farming and can be claimed as default organic. Similarly nutmeg and clove grown in the region by following traditional/indigenous agriculture by applying FYM and without any synthetic chemical fertilizers and/or pesticides calls for characterizing the cultivation practices on the lines of national standards for organic production. It can be concluded that organic fertilizers play a significant role in improving soil and crop quality and sustainability. There is, however, a 10-20 per cent reduction in crop yield that should be compensated by premium pricing of organic produce.

Abstract Of Scientific Papers, Books, Journals And Stories On Agro-Ecological Agriculture on Greens

Paper: Kumar, Murugan, Radha Prasanna, Ngangom Bidyarani, Santosh Babu, Brijesh Kumar Mishra, Arun Kumar, Anurup Adak et al. (2013). "Evaluating the plant growth promoting ability of thermotolerant bacteria and cyanobacteria and their interactions with seed spice crops." Scientia Horticulturae 164: 94-101.[64]

Farming Technique: Input/ Natural Soil Management
The potential of eight thermotolerant bacteria (seven Bacillus spp. and one actinobacteria Kocuria sp.) and two cyanobacteria (Anabaena laxa and Calothrix elenkinii) as plant growth promoting (PGP) agents was evaluated with seed spices – coriander, cumin and fennel, under controlled conditions in a potting mix fortified with microbial cultures. Amendment with Anabaena brought about 25% enhanced germination in cumin over control, while Calothrix enhanced root/shoot length significantly in all the three crops, especially fennel. Fortification with microbes led to 30–50% increase in shoot/root length, which was reflected as two–three fold enhancement in the vigour index of the plants. Among the bacterial strains, T4 (Bacillus pumilus) was most promising in terms of PGP traits in fennel and cumin crop. Plant dry weight and peroxidase activity of shoots and roots were enhanced by 5–10-fold in all the microbe-inoculated treatments, with highest values in Calothrix treated coriander seedlings. â-1,3 endoglucanase activity showed twofold enhancement in shoots from Anabaena inoculated coriander seedlings. The fungicidal activity of the root extracts from the bacteria treated treatments of coriander seedlings against Macrophomina phaseolina was highest, while root extracts of fennel seedlings were able to show largest zones of inhibition against Fusarium moniliforme. This study highlighted the promise of fortification with both heterotrophic and photosynthetic microbes in plant growth promotion, and their significant role in enhancing and eliciting peroxidase/endoglucanase enzymes and fungicidal activity of plant extracts of seed spices.

Book: Parthasarathy, V. A., K. Kandiannan, and V. Srinivasan. (2008). "Organic spices." New India Publishing, 2008.[65]

This book on 'Organic Spices' covers all aspects of organic spice production. The topics covered include historical spice trade and importance of spices in the food chain. A brief account on the organic agriculture movement in the world and its present status and opportunity for organic spices in the world market are given. The chemistry and different methods of composting are covered in the organic manures chapter. A separate chapter devoted to microbes and plant growth promoting rhizobacteria is included. Topics on biological control of insect pests, nematodes, fungi and bacteria of spices are highlighted in separate chapters, which would be of interest in the organic production system. The importance, composition, uses, botany and varieties, organic way of production of spices such as black pepper, cardamom (Elettaria cardamomum), ginger, turmeric, chilies and

[64] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 34
[65] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 94

paprika, nutmeg (Myristica fragrans), vanilla, seed spices such as cumin (Cuminum cyminum), fennel, fenugreek, coriander and their harvest and postharvest processing are enumerated. Chapters on good agricultural practices and organic certification procedures are outlined for adoption. This would serve as a reference book for researchers, teachers and students besides farmers, traders and consumers.

Paper: Kapoor R, B Giri and KG Mukerji. (2002). "Mycorrhization of coriander (Coriandrum sativum L) to enhance the concentration and the quality of essential oil." Journal of the Science of Food and Agriculture 82, no. 4: 339-342.[66]

Farming Technique: Input/ Natural Soil Management
The effect of association of two vesicular arbuscular mycorrhizal (VAM) fungi, Glomus macrocarpum and G fasciculatum, on the concentration and composition of essential oil in coriander (Coriandrum sativum) was studied. VAM inoculation increased the essential oil concentration in fruits by as much as 43%. Although significant variation in effectiveness of the two fungal species was observed, the quality of essential oil was significantly enhanced on mycorrhization. GC characterisation of essential oil showed increased concentration of geraniol and linalool in plants inoculated with G macrocarpum and G fasciculatum respectively.

Paper: Ansari, Abdullah Adil. (2008). "Effect of Vermicompost and Vermiwash on the Productivity of Spinach (Spinacia oleracea), Onion (Allium cepa) and Potato (Solanum tuberosum)." World Journal of Agricultural Sciences 4, no. 5.[67]

Farming Technique: Input/ Natural Soil Management
Present investigations were carried out during 1998-2000 at Shivri farm of Uttar Pradesh Bhumi Sudhar Nigam, Lucknow, India, to study the effect of vermicompost and vermiwash in reclaimed sodic soils on the productivity of spinach (Spinacia oleracea), onion (Allium cepa) and potato (Solanum tuberosum). The soil quality was monitored during the experiment followed by productivity. Amongst the combinations of vermicompost @ 6 tonnes and vermiwash (different concentrations), there has been significant improvement in soil qualities in plots treated with vermicompost and vermiwash (1:10 v/v in water), vermicompost and vermiwash (natural) and vermicompost and vermiwash (1:5 v/v in water). The yield of spinach was significantly higher in plots treated with vermiwash (1:5 v/v in water). The yield of onion was significantly higher in plots treated with vermiwash (1:10 v/v in water), whereas the average weight of onion bulbs was significantly greater in plots amended with vermicompost and vermiwash (1:5 v/v in water). The yield of potato and the average weight of potato tubers were significantly higher in plots treated with vermicompost.

[66] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 117
[67] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 99

Paper: Singh Gurmeet, MS Brar and SS Malhi. (2007). "Decontamination of chromium by farm yard manure application in spinach grown in two texturally different Cr-contaminated soils." Journal of plant nutrition 30, no. 2: 289-308.[68]

Farming Technique: Input/ Natural Soil Management

Chromium (Cr) is an environmental pollutant and its accumulation up to toxic levels in the soil and plants by applying irrigation with untreated industrial effluents has become a major problem throughout the world, especially in developing countries like India. Various inorganic as well as organic compounds are known for their ability to reduce mobilization of heavy metals in soils for plant uptake and leaching to groundwater. The present study was undertaken under controlled glasshouse conditions to assess the effectiveness of farm yard manure (FYM) applications (equivalent to 0, 1, and 2% organic matter on w/w basis) to ameliorate Cr toxicity in spinach grown in two texturally different soils (silty loam and sandy) contaminated artificially with five levels of Cr (0, 1.25, 2.5, 5.0, and 10.0 mg Cr kg-1 soil as K2Cr2O7). The diethylene triamine pentaacetic acid (DTPA)- extractable Cr in soil (before seeding and after harvest), Cr concentration, and it's uptake by shoots and roots of spinach increased with increasing level of applied Cr. Roots accumulated more Cr than shoots, which depicts limited translocation of Cr from roots to shoots. A significant decrease was observed in dry matter yield (DMY) of shoots as well as roots by raising levels of applied Cr (0 to 10 mg Cr kg-1 soil) in both soils, but the extent of the DMY decrease was higher in the sandy loam soil. Application of FYM showed mitigating effects on Cr toxicity. The DMY was higher in the presence of FYM, than its absence, at all rates of applied Cr in both soils. The FYM application caused decline in the DTPA-extractable Cr in soil, and concentration of Cr and its uptake by shoots and roots of spinach at a given level of applied Cr. The magnitude of Cr toxicity and its amelioration by FYM application was higher in sandy soil compared to silty loam soil. The results of this study indicated that FYM application to the soil could be used as an effective measure for reducing Cr toxicity to crop plants in contaminated soils irrigated by untreated industrial effluents.

[68] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 145

Cabbage

Paper: Singh SR (2006). "Response of biofertilizers and pesticides on yield and quality of cabbage, radish and brinjal in vegetable-based rotation system." Applied Biological Research 8, no. 1and2. 33-36.[69]

Farming Technique: Input/ Natural Soil Management,
Insect/ Pest Management
Microbial biotechnology has emerged as an effective tool in offering tremendous potential to increase productivity under a biodynamic production system. To ascertain the effects of different biofertilizers and biopesticides used in combination with organic nutrients on different vegetable crops viz. cabbage, radish and brinjal, an experiment was planned to find ideal microbial strains for specific crops and suitable biopesticides against major vegetable pests so as to develop a complete package of organic farming. The treatments consisted of five combined sources of microbial fertilizers, including chemical fertilizer, and four sources of microbial pesticides including chemical pesticides. Among the tested biofertilizers, Azospirillum brasilense manifested better response for each included crop under mid-hill conditions of Himachal Pradesh, India. Though the yield in organic produce was at par with produce obtained under conventional methods, the produce was superior in protein and vitamin C contents with better shelf life under ambient storage conditions. The nitrate content, which has an ill effect on health, was also quite low in these treatments. In case of biopesticides Bacillus thuringiensis (Bio-lap & Elcar) and Neem-based pesticide Neemarin were found equally effective in controlling Diamond moth of cabbage, leaf caterpillar of radish and shoot and fruit borer of brinjal as chemical pesticide Endosulfan.

Paper: Ishfaq Akbar P, Kumar Vijai and Mohan Braj (2010). Influence of Bio-organic nutrition on the performance of cabbage (Brassica oleracea var. capitata L.) cv. Pride of India, Adv. Res. J. Crop Improv., 1 (2) : 165-167.[70]

Farming Technique: Input/ Natural Soil Management
Cabbage (Brassica oleracea var. capitata L.) belonging to the family Cruciferae is one of the most important vegetables of the cole group. The cabbage leaves are eaten raw as salad and cooked as well. Literature pertaining to the production of quality cabbage heads through the use of organic nutrition is meagre. Hence, the present investigation was conducted at the Horticultural Research Farm of Ch. S. S. S. (P.G.) college Machhra, Meerut to study the influence of bio-organic nutrition on the performance of cabbage. Results revealed that significantly maximum plant height, plant spread, number of wrapper leaves, and head yield were obtained with the interaction vermicompost 10 t/ha and Azotobacter 5 kg/ha. While the maximum number of non-wrapper leaves and head diameter were

[69] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 17
[70] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 69

significantly recorded highest with the combined application of vermicompost 10 t/ha and Azotobacter 10 kg/ha.

Paper: Chaman Lal and LR Verma (2006). Use of certain bio-products for insect-pest control. Indian Journal of Traditional Knowledge. Vol. 5(1): 79-82.[71]

Farming Technique: Insect/ Pest Management
The present study was carried out in remote villages of the Mandi, Bilaspur, Shimla, Kinnaur and Lahaul-Spiti districts of the Himachal Pradesh to identify the important Indigenous Technology Knowledge (ITKs) in use, methods for managing the insect-pests of the different crops and to document the same. Farmers commonly use ash against chewing and sucking type of insect pests. Use of cattle litter not only enriches the soil fertility but also reduces the insect-pests of the crops significantly. The bioproducts namely aged cow urine, Vitex negundo Linn., Ferula assafoetida Linn, Aloe barbadensis Mill., Nicotiana tabacum Linn. and whey were found to be very effective against the insect pests of cabbage, wheat, peas, grams and other crops. Such an assessment was essential because these are the innovative eco friendly sprays, which are economically viable for small farmers and have already been adopted by the farmers in some locations. The choice of indigenous bio-insecticides have been found to be effective as well as eco-friendly. This will also help in reducing the load of insecticide on the ecosystem.

Cauliflower

Paper: Mishra DK, Tailor RS, Paliwal DK, and Deshwal AK (2012). Assessment and Impact of Bio-Management of Diamondback Moth in Cauliflower. Indian Research Journal of Extension Education,Vol. 12 (2). [72]

Farming Technique: Insect/ Pest Management
Diamondback moth [Plutellaxylostella (L.)] is the most serious and widely distributed pest of cauliflower (Brassica oleracea var.botrytis) in India, attacking the crop from the nursery level onwards causing up to 52 per cent losses in marketable yield. To manage the menace farmers were using conventional as well as novel pesticides including Flubendiamid, 20 per cent WG, Spinosad 2.5 per cent SC and Fipronil 0.30 per cent GR. The problems of insecticide resistance as well as the environmental concerns and consumer health hazards associated with insecticide residues in plant material have focused attention on alternative methods for the management of diamondback moths (DBM) in cauliflower. With the objectives to minimize the use of chemical pesticides and establish the use of eco friendly biocontrol agents, an assessment and front line demonstrations were organized during 2009 and 2010 to evaluate the feasibility and economic viability of recommended bio-control agent i.e. Beauveria bassiana for containing DBM in cauliflower under real farm conditions.

[71] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 108
[72] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 46

On the basis of result obtained from assessment of recommended technology, frontline demonstrations were organized to disseminate the recommended practice [foliar spray of Beauveria bassiana (1x1010 conidia/ml)] a myco-insecticide (@600 ml/ha) amongst the farmers. The recommended technology was found to offer an alternative to insecticides and was feasible, economically viable, environmentally safe and effective for management of DBM in cauliflower.

Chili

Paper: Pradeep G and Sharanappa (2014). Effect of organic production techniques on the growth, yield, quality and economics of chili (Capsicum annuum) and soil quality in dry zones of Karnataka. Indian Journal of Agronomy Vol. 59[73]

Farming Technique: Input/ Natural Soil Management,
Insect/ Pest Management
A field experiment was conducted during the rainy (kharif) season of 2011 and 2012 in sandy clay loam soils at Bengaluru, to study the effect of different sources of organic manures on growth, yield, quality, economics and soil quality of chili (Capsicum annuum L.). There were 13 treatments, comprising basal application of farmyard manure and vermicompost, bio digested and enriched bio digested liquid manures (BDLM and EBDLM applied after transplanting in 3 splits), 3 sprays of 3% panchagavya (PG) and vermiwash (VW). The treatments were replicated thrice. Among the treatments, application of enriched bio digested liquid manure (EBDLM) at 125 kg N equivalent (eq.)/ ha + 3 sprays of panchagavya (3%) recorded significantly higher plant height (87.0 cm), branches/ plant (32.9), leaf-area index (2.00), leaf-area duration (51.9 days), total dry-matter production/ plant (105.7 g), dry fruit yield (0.90 t/ha), fruits/plant (39.0), 100-fruit weight (135.1 g), fruit length (14.4 cm), ascorbic acid (137.3 mg/100 g) capsaicin content (0.64%), total extractable colour (280.8 ASTA units), oleoresin content (15.4%), gross return (1,51,668), net returns (96,281), benefit: cost (2.74) ratio, and significantly higher soil organic carbon (0.63%), available nitrogen (377.9 kg/ha), phosphorus (87.3 kg/ha), potassium (206.7 kg/ha), bacteria (37.0 × 106 cfu/g soil), fungi (23.2 × 103 cfu/g soil) and Actinomycetes (13.2 × 103 cfu/g soil) population as compared to the control.

Paper: Chandrakala M and Hebsur NS (2008): Effect of FYM and fermented liquid manures on yield and quality of chili (Capsicum annuum L.) – Ph D dissertation. University of Agricultural Sciences, Dharwad.[74]

Farming Technique: Input/ Natural Soil Management
A field experiment was conducted at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad on a Vertisol to study the effect of FYM and fermented liquid manures on yield and quality of chili during kharif 2007. The experiment consisted of

[73] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 23
[74] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 100

12 treatment combinations with two factors; factor one consisting of manures (FYM equivalent to RDN (M1), RDF (M2) and FYM equivalent to RDN+RDFYM (M3)) and the factor two liquid manures (Beejamrut + Jeevamrut (L1), Panchagavya (L2), Beejamrut+Jeevamrut + Panchagavya (L3) and Control (L4). The treatments were replicated thrice and experiment was laid out in Randomized Complete Block Design. Application of manures and liquid manures recorded significantly higher growth, yield and quality parameters of chili. Treatment M2 recorded significantly higher dry chili yield (8.33 q/ha) over rest of the manures. Among liquid manures, treatments L3 and L2 recorded significantly higher dry chili yield (8.52 and 8.01 q/ha, respectively) over control (6.40 q/ha), the values for growth and other yield components were also significantly higher in these treatments. Treatments M3 and M1 recorded higher quality parameters Viz., ascorbic acid content, oleoresin and colour value by 14.43: 9.19, 8.40: 5.33 and 14.18: 11.77 per cent, respectively over M2. Among liquid manures, L3 and L2 recorded higher ascorbic acid, oleoresin and colour value by 8.02: 6.74, 7.89: 7.00 and 8.25: 7.17 per cent, respectively over control (121.89 mg/100g, 203.01 ASTA units and 301.71 ASTA units, respectively). A significantly higher dehydrogenase activity, available macro (N, P and K) and micronutrients (Cu, Zn, Fe and Mn) were recorded with M3 and M1. Dehydrogenase activity was also found to be significantly greater with liquid manures. Greater uptake of nutrients was recorded with M2. However, M2 and L3 recorded significantly higher yield, net returns and B: C ratio.

Sweet Corn

Paper: Waghmode BR (2010). "Response of sweet corn (Zea mays l. Saccharata) to different sources of organics." MSc Agriculture Thesis in Agronomy. University of Agricultural Sciences, Dharwad, 2010.[75]

Farming Technique: Input/ Natural Soil Management
A field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during kharif 2009-10 on clay loam soils to evaluate the response of sweet corn to different sources of organic manures and liquid organic manures. The experiment was laid out in a Split-plot design with three replications. The experiment comprised of six manurial treatments M1, M2, M3, M4, M5 and M6 as main plots and three liquid organic manures (S1- Bio-digester liquid @ 10%, S2- Panchagavya @ 3% spray, S3- Cow urine @ 10% and a control (S4) as subplots. The results indicated that both organic manures and liquid organic manures had significant effect on growth, yield parameters, quality parameters and nutrient uptake as well as nutrient status of the soil. Significantly higher sweet corn fresh cob yield (6254 and 6222 kg/ha) and stover yield (7.36 and 7.04 t/ha) was recorded with RDF and RPP treatments, respectively. Among the liquid organic manures mainly bio-digester liquid @ 10% spray, panchagavya @ 3% spray and cow urine @ 10% spray recorded significantly higher growth and yield parameters like number of leaves, total dry matter production, cob length, cob girth, number of cobs per plant, fresh and dry grain weight and fresh cob yield over control. Significantly higher fresh cob yield (5594 and 5262 kg/ha) and stover yield (5.41 and 5.67 t/ha) were recorded in the treatment receiving

[75] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 73

bio-digester liquid @ 10% spray and panchagavya @ 3% spray respectively over rest of the treatments. The interactions effects, showed that, RPP with bio-digester liquid @ 10% spray resulted in significantly higher fresh cob yield (7067 kg/ha) and net returns (35,250 Rs./ha) which was on par with RDF and GLM + EC + VC (top dressing at GGS) with cow urine @10% spray which was found on par.

Paper: Sinha Rajiv K, Dalsukh Valani, Krunal Chauhan and Sunita Agarwal. (2010). "Embarking on a second green revolution for sustainable agriculture by vermiculture biotechnology using earthworms: Reviving the dreams of Sir Charles Darwin." Journal of Agricultural Biotechnology and Sustainable Development 2, no. 7: 113-128.[76]

Farming Technique: Input/ Natural Soil Management

Vermiculture biotechnology promises to usher in the 'Second Green Revolution' by completely replacing the destructive agro-chemicals which did more harm than good to both the farmers and their farmland. Earthworms restore and improve soil fertility and significantly boost crop productivity. Earthworms excreta (vermicast) is a nutritive 'organic fertilizer' rich in humus, NKP, micronutrients, beneficial soil microbes - 'nitrogen-fixing and phosphate solubilizing bacteria' and 'actinomycetes' and growth hormones 'auxins', 'gibberellins' and 'cytokinins'. Both earthworms and its vermicast and body liquid (vermiwash) are scientifically proven as both 'growth promoters and protectors' for crop plants. In the experiments with corn and wheat crops, tomato and egg-plants it displayed excellent growth performances in terms of height of plants, colour and texture of leaves, appearance of flowers and fruits, seed ears etc, as compared to chemical fertilizers and the conventional compost. There are also less incidences of 'pest and disease attack' and 'reduced demand of water' for irrigation in plants grown on vermicompost. Presence of live earthworms in soil also makes a significant difference in flower and fruit formation in vegetable crops. Earthworm biomass, a byproduct of VBT, is rich in 'high quality protein' and source of nutritive feed materials for fishery, poultry and dairy industries and also for human consumption.

Drumstick

Paper: Prabhakar, M., and S. S. Hebbar. (2006)."Studies on organic production technology of annual drumstick in a semi-arid agroecosystem." In the International Conference on Indigenous Vegetables and Legumes. Prospectus for Fighting Poverty, Hunger and Malnutrition 752: 345-348.[77]

Farming Technique: Input/ Natural Soil Management

---

[76] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 84

[77] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 16

Moringa oleifera Lam. (Drumstick) is the most widely known and utilized species of the family Moringaceae. India is the largest producer of this nutritionally rich, fast growing, drought tolerant, hardy crop capable of getting adapted to varied ecosystems. It can fit very well as a candidate crop for organic cultivation. Hence, the present investigation was carried out to study the performance of annual drumsticks (cv. PKM-1) under organic culture for three consecutive years from July 2003 on red sandy loam soil of Indian Institute of Horticultural Research, Bangalore. Five organic nutrient treatments and one conventional nutrient supply as checked were compared. The crop was raised with protective irrigation and warranted plant protection measures were adopted using biopesticides. The results showed that the crop performance with respect to tree growth, yield and yield components were significantly influenced by organic treatments tested. Tree trunk diameter was higher with farm yard manure (FYM) applied at 15 kg/tree or with vermicompost applied at 5 kg/tree along with biofertilizers (Azospirillum and phosphate solubilizing bacteria) at 5 kg/hectare as compared to other organic treatments such as green leaf manuring combinations or reduced FYM application rates. Similar trend was noticed with respect to fresh pod yields which was higher (9.7 t/ha /year) with treatments receiving higher dose of FYM followed by green leaf manuring supplemented with rock phosphate and wood ash (8.5 t/ha/year). These yields were on par with conventional treatment receiving recommended doses of chemical fertilizers and manures (8.6 t/ha/year). The higher yields were mainly due to the higher number of pods produced per tree rather than fruit size. It can be concluded that organic drumstick production is feasible and is sustainable economically as well as socially in the present context of reducing pollution of natural resources and cost of farm production.

Okra

Paper: Srivastava Rashmi, David Roseti and AK Sharma. (2007). "The evaluation of microbial diversity in a vegetable based cropping system under organic farming practices." Applied Soil Ecology 36, no. 2: 116-123.[78]

Farming Technique: Input/ Natural Soil Management

Organic farming is becoming a major tool for sustaining the soil quality degraded by intensive use of synthetic chemicals for increasing crop production and therefore, use of bio-agents as biofertilizers or biopesticides is an integral part of organic farming especially in vegetable cultivation. An effort was, therefore, made to see the effect of arbuscular mycorrhizal fungi (AMF) and pseudomonads as the microbial inoculants in vegetable based cropping systems under organic farming practices. Three crops taken in rotation were okra, pea and cowpea in a year. The inoculants used were Glomus intraradices, an arbuscular mycorrhizal fungus, and four isolates of Pseudomonas fluorescens singly and in combinations. No chemical/organic fertilizer was added during two rotations of chosen vegetables except the crop residues, which were chopped and distributed equally onto each plot after the harvest of the fruits. A significant increase in yield was observed in the inoculated plots over the control. Culturable microbial diversity was increased compared

[78] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 102

with the start of the experiment. Total microbial diversity as assessed by Denaturing Gradient Gel Electrophoresis confirmed the results of culturable total and functional diversity analysed using Shannon Weaver's diversity indices (H2). Functional diversity assessed in terms of cellulase, xylanase, amylase, protease producers and P-solubilizers showed that the inoculants worked beneficially for maintaining soil health. The mycorrhizal inoculation followed by a combination of AMF and pseudomonads proved to be better. Present findings indicated that microbial gene pool, especially the key helpers for the maintenance of soil health residing in the vicinity of roots, was positively affected by using pseudomonads and AMF. Under organic farming management practices, inoculated bioagents and crop residues increased the yield of vegetables.

Pea

Paper: Mahanta Dibakar, R Bhattacharyya, KA Gopinath, MD Tuti, BL Mina, BM Pandey, PK Mishra, JK Bisht, AK Srivastva and JC Bhatt. (2013). "Influence of farmyard manure application and mineral fertilization on yield sustainability, carbon sequestration potential and soil property of garden peas–french bean cropping system in the Indian Himalayas." Scientia Horticulturae 164: 414-427.[79]

Farming Technique: Input/ Natural Soil Management
Sustainability of agricultural systems has become an important issue all over the world. Hence, sustainability and climate resilience of garden pea–french bean cropping system was evaluated by yield trends, C sequestration and emission reduction and soil properties as affected by four application rates of farmyard manure (FYM) (5–20 t ha"1) vis-à-vis mineral fertilization, integrated nutrient management (INM) practices as 50% recommended NPK + FYM at 5 t ha"1 and un-amended control after six years of cropping in the Indian Himalayas. The highest sustainable yield index of 0.606 was achieved with the application of 20 t FYM ha"1 (FYM20). The carbon sequestration potential of FYM20 plots was about 459 and 193% more than NPK and INM plots, respectively. The same plots reduced 53 and 24% carbon equivalent emission with comparison to NPK and INM application, respectively. The soil cation exchange capacity (CEC) under FYM20 plots was 22 and 11% higher than NPK and INM plots. The soil cracking volume under FYM20 plots (57 cm3 m"2 area) was very less compared to NPK (324 cm3 m"2 area) and INM (154 cm3 m"2 area) plots. The morning soil temperature (0–15 cm depth) in coldest week of last year experimentation under FYM20 plots was moderated by 0.60 and 0.47 °C than NPK and INM plots, respectively. Successive increase of FYM level improved soil organic C, microbial colony formation unit, dehydrogenase activity, bulk density and soil cracking surface area and the best values for all soil properties were recorded under FYM20 plots. Application of 20 t FYM ha"1 produced 54 and 29% higher gardenpea equivalent pod yield of the system than mineral fertilization and INM, respectively. The principal component analysis revealed that soil CEC was the most important property (among the selected soil parameters) contributing to the pod yield. Soil organic carbon markedly improved other soil properties as evident from correlations. Organic production system with FYM 20 t ha"1 could be

[79]Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 38

recommended for climate resilient sustainable yield and better soil property of garden pea–french bean cropping system than mineral fertilization and INM in the Indian Himalayan regions.

Paper: Chadha Sanjay, JP Rameshwar and Surender Sharma. (2013). "Performance of Different Varieties of Pea (Pisum Sativum L.) under Organic Farming Conditions in Mid Himalayas." International Journal of Agriculture and Food Science Technology. Vol. 4 (7): 733-738.[80]

Garden pea (Pisum sativum L.) is one of the most important vegetable cash crops of Himachal Pradesh. Growing concern towards pesticides' residues due to their indiscriminate use particularly in vegetable crops has attracted worldwide attention towards organic farming. Choice of right types of varieties for growing under organic farming conditions is of utmost importance as all the recommended/released varieties in present scenario have been developed and evaluated under inorganic farming conditions and it has been often observed that the high input responsive varieties fail to perform better under low input organic farming conditions. Keeping in view the potential of organic farming in India, there is an urgent need to identify the potential genotypes/varieties responsive to low input conditions of organic farming. Trials for evaluation of different varieties of garden pea were conducted consecutively for two years (2011-12 and 2012-13) at Model Organic Farm, CSKHPKV, Palampur for identifying suitable varieties responsive to organic farming systems. Fifty five genotypes of pea including three check varieties viz., Palam Priya, Palam Smool and Punjab-89 were evaluated in Augmented block design with five replicates of check varieties. The seeds were sown at 45 × 10 cm spacing during the second week of November consecutively for two years. Out of 55 genotypes/varieties of garden pea screened during Rabi 2011-12 & 2012-13 for higher productivity under organic farming conditions, EC538008 was recorded the highest yielding (108.58 q/ha) and was statistically at par with Kukumseri-6(101.61 q/ha), IC 267732(101.07 q/ha), DPPM-74 (92.84 q/ha) and DPP-54(91.96 q/ha). It was also statistically at par with two standard checks viz., Palam Priya (85.24) and Punjab-89 (91.12 q/ha).

Paper: Gopinath KA, Narendra Kumar, Banshi L Mina, Anil K Srivastva and HS Gupta. (2009). "Evaluation of mulching, stale seedbed, hand weeding and hoeing for weed control in organic garden peas (Pisum sativum sub sp. Hortensis L.)." Archives of Agronomy and Soil Science 55, no. 1: 115-123.[81]

Farming Technique: Weed Management Program
Weeds are often recognized as the principal biotic constraint to organic crop production. Development of suitable weed control measures is, therefore, a prerequisite for profitable

[80] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 40
[81] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 93

organic farming. A field experiment was conducted during the winter season of 2003–2004 and 2004–2005 in the Indian Himalayas to evaluate the effect of mulching, stale seedbed, hand weeding and hoeing on weeds and yield of organic garden pea (Pisum sativum sub sp. Hortensis L.). The weed population ranged from 249–477 m”2, and Polygonum plebejum L. (34%), Melilotus indica L. (31%) and Avena ludoviciana Dur. (17%) were the predominant weeds in the experimental field. Season-long weed-crop competition reduced the green pod yield of garden pea by 74% in 2003–2004 and 93% in 2004–2005. All the weed control treatments significantly reduced the population and biomass of weeds resulting in significant increase in green pod yield of garden peas compared to unweeded control. The highest weed control efficiency (84% reduction in weed biomass) was achieved with hand weeding 30 and 60 days after sowing (DAS) closely followed by stale seedbed coupled with one hand weeding (77%). Both these treatments produced significantly higher green pod yield compared to other treatments in both the years. In 2003–2004, hand weeding (30 and 60 DAS) recorded the highest gross margin (Indian Rupees 115,400 ha”1) closely followed by stale seedbed coupled with one hand weeding (Indian Rupees 109,700 ha”1). In the second year, however, the latter treatment gave the highest gross margin (Indian Rupees 56,900 ha”1) compared to other treatments.

Paper: Srivastava Rashmi, David Roseti and AK Sharma. (2007). “The evaluation of microbial diversity in a vegetable based cropping system under organic farming practices.” Applied Soil Ecology 36, no. 2: 116-123.[82]

Farming Technique: Input/ Natural Soil Management

Organic farming is becoming a major tool for sustaining the soil quality degraded by intensive use of synthetic chemicals for increasing crop production and therefore, use of bio-agents as biofertilizers or biopesticides is an integral part of organic farming especially in vegetable cultivation. An effort was, therefore, made to see the effect of arbuscular mycorrhizal fungi (AMF) and pseudomonads as the microbial inoculants in vegetable based cropping systems under organic farming practices. Three crops taken in rotations were okra, pea and cowpea in a year. The inoculants used were Glomus intraradices, an arbuscular mycorrhizal fungus, and four isolates of Pseudomonas fluorescens singly and in combinations. No chemical/organic fertilizer was added during two rotations of chosen vegetables except the crop residues, which were chopped and distributed equally onto each plot after the harvest of the fruits. A significant increase in yield was observed in the inoculated plots over the control. Culturable microbial diversity was increased compared with the start of the experiment. Total microbial diversity as assessed by Denaturing Gradient Gel Electrophoresis confirmed the results of culturable total and functional diversity analysed using Shannon Weaver’s diversity indices (H2). Functional diversity assessed in terms of cellulase, xylanase, amylase, protease producers and P-solubilizers showed that the inoculants worked beneficially for maintaining soil health. The Mycorrhizal inoculation followed by a combination of AMF and pseudomonads proved to be better. Present findings indicated that microbial gene pool, especially the key helpers for

[82] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 102

the maintenance of soil health residing in the vicinity of roots, was positively affected by using pseudomonads and AMF. Under organic farming management practices, inoculated bioagents and crop residues increased the yield of vegetables.

Papers: Somasundaram E and P Singaram. (2006). "Modified panchagavya for sustainable organic crop production." In National Seminar on Standards and Technologies of Nonconventional Organic Inputs. 2006. AND Chaman Lal and LR Verma (2006). Use of certain bio-products for insect-pest control. Indian Journal of Traditional Knowledge. Vol. 5(1): 79-82.[83]

Farming Technique: Input/ Natural Soil Management

The present study was carried out in remote villages of the Mandi, Bilaspur, Shimla, Kinnaur and Lahaul-Spiti districts of the Himachal Pradesh to identify the important Indigenous Technology Knowledge (ITKs) in use, methods for managing the insect-pests of the different crops and to document the same. Farmers commonly use ash against chewing and sucking type of insect pests. Use of cattle litter not only enriches the soil fertility but also reduces the insect-pests of the crops significantly. The bioproducts namely aged cow urine, Vitex negundo Linn., Ferula assafoetida Linn, Aloe barbadensis Mill., Nicotiana tabacum Linn. and whey were found to be very effective against the insect pests of cabbage, wheat, peas, grams and other crops. Such an assessment was essential because these are the innovative eco friendly sprays, which are economically viable for small farmers and have already been adopted by the farmers in some locations. The choice of indigenous bio-insecticides have been found to be effective as well as eco-friendly. This will also help in reducing the load of insecticide on the ecosystem.

Paper: Yadav SK, Subhash Babu, Yadav MK, Yogeshwar Singh, Kalyan Singh (2014). Profitability of high value crops with organic nitrogen sources under rice (Oryza sativa) cropping sequence. The Indian Journal of Agricultural Sciences. Vol. 84 (3).[84]

Farming Technique: Input/ Natural Soil Management,
Integrated Farming Technique

A field experiment was conducted during 2005-06 and 2006-07 at Campus Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to identify a suitable high value cropping sequence with organic nitrogen sources under rice (Oryza sativa L.) based cropping system. The experiment was laid out in split plot design with three replications. Seven rice based cropping sequences, viz. rice-potato-onion; rice-green pea-onion; rice-potato cowpea (green pod); rice-green pea-cowpea; rice-rajma (green pod)-onion; rice-rajma-cowpea and rice-maize (green cob)-cowpea were assigned to main plots and three organic treatments (control; 100% RDN through organic manure along with biofertilizers and 100% RDN through organic manure alone) were allocated to subplots. Among the cropping sequences, rice-potato-onion gave the highest rice grain equivalent

[83] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 108
[84] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 159

yield (35.57 tonnes/ha), maximum net return (Rupees 268 656/ha), profitability (Rupees 738/ha/day) and labour employment generation (469 man days/ha/ year). However rice yield and soil fertility status was not significantly affected by cropping sequences. Application of 100% recommended dose of through organic manure along with biofertilizers (Azotobacter and PSB) had the highest rice equivalent grain yield (35.31 tonnes/ha), production efficiency (96.74 kg/ha/day), net monetary return (Rupees 292 454/ha), profitability (Rupees 803/ha/day) and labour employment generation (419 man days/ha/ year). Inclusion of pulses in sequence with proved superior due to its viable favorable effect on soil fertility. Thus organic nitrogen nutrition with biofertilizers had the highest rice equivalent grain yield, production efficiency, net monetary return and profitability.

Potato

Paper: Verma Satish K, BS Asati, SK Tamrakar, HC Nanda and CR Gupta. (2011). "Effect of organic components on growth, yield and economic returns in potato." Potato Journal 38, no. 1: 51-55[85]

Farming Technique: Input/ Natural Soil Management
An experiment was conducted on potato variety Kufri Jawahar to assess the effect of organic components on growth, yield and economic return in potato. The results revealed that the combination of crop residues+azotobacter+phosphobacteria+biodynamic approach+microbial culture was the best among all the treatments for most of the growth and yield parameters under study and gave highest net return and B: C ratio. Thus, it can be concluded that the biofertilizers (azotobacter, phosphobacteria, microbial culture and biodynamic approach) are an advantageous source for sustainable organic agriculture, especially for heavy feeder crops like potato.

Paper: Ansari, Abdullah Adil. (2008). "Effect of Vermicompost and Vermiwash on the Productivity of Spinach (Spinacia oleracea), Onion (Allium cepa) and Potato (Solanum tuberosum)." World Journal of Agricultural Sciences 4, no. 5.[86]

Farming Technique: Input/ Natural Soil Management
Present investigations were carried out during 1998-2000 at Shivri farm of Uttar Pradesh Bhumi Sudhar Nigam, Lucknow, India, to study the effect of vermicompost and vermiwash in reclaimed sodic soils on the productivity of spinach (Spinacia oleracea), onion (Allium cepa) and potato (Solanum tuberosum). The soil quality was monitored during the experiment followed by productivity. Amongst the combinations of vermicompost @ 6 tonnes and vermiwash (different concentrations), there has been significant improvement in soil qualities in plots treated with vermicompost and vermiwash (1:10 v/v in water), vermicompost and vermiwash (natural) and vermicompost and vermiwash (1:5 v/v in water).

[85] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 67
[86] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 99

The yield of spinach was significantly higher in plots treated with vermiwash (1:5 v/v in water). The yield of onion was significantly higher in plots treated with vermiwash (1:10 v/v in water), whereas the average weight of onion bulbs was significantly greater in plots amended with vermicompost and vermiwash (1:5 v/v in water). The yield of potato and the average weight of potato tubers were significantly higher in plots treated with vermicompost.

Radish

Paper: Singh SR (2006). "Response of biofertilizers and pesticides on yield and quality of cabbage, radish and brinjal in vegetable-based rotation system." Applied Biological Research 8, no. 1 and 2. 33-36.[87]

Farming Technique: Input/ Natural Soil Management,
Insect/ Pest Management
Microbial biotechnology has emerged as an effective tool in offering tremendous potential to increase productivity under a biodynamic production system. To ascertain the effects of different biofertilizers and biopesticides used in combination with organic nutrients on different vegetable crops viz. cabbage, radish and brinjal, an experiment was planned to find ideal microbial strains for specific crops and suitable biopesticides against major vegetable pests so as to develop a complete package of organic farming. The treatments consisted of five combined sources of microbial fertilizers, including chemical fertilizer, and four sources of microbial pesticides including chemical pesticides. Among the tested biofertilizers, Azospirillum brasilense manifested better response for each included crop under mid-hill conditions of Himachal Pradesh, India. Though the yield in organic produce was at par with produce obtained under conventional methods, the produce was superior in protein and vitamin C contents with better shelf life under ambient storage conditions. The nitrate content, which has an ill effect on health, was also quite low in these treatments. In case of biopesticides Bacillus thuringiensis (Bio-lap & Elcar) and Neem-based pesticide Neemarin were found equally effective in controlling Diamond moth of cabbage, leaf caterpillar of radish and shoot and fruit borer of brinjal as chemical pesticide Endosulfan.

Tomato

Paper: Gore, Nileema S and MN Sreenivasa (2012). "Influence of liquid organic manures on growth, nutrient content and yield of tomato (Lycopersicon esculentum Mill.) in the sterilized soil." Karnataka Journal of Agricultural Sciences 24, no. 2.[88]

Farming Technique: Input/ Natural Soil Management
An experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad to study the influence of liquid organic manures viz., panchagavya, jeevamrut and beejamruth on the growth, nutrient content and yield of

[87] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 17
[88] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 46

tomato in the sterilized soil during kharif 2009. The various types of organic solutions prepared from plant and animal origin are effective in the promotion of growth and fruiting in tomatoes. The Panchagavya is an efficient plant growth stimulant that enhances the biological efficiency of crops. It is used to activate biological reactions in the soil and to protect the plants from disease incidence. Jeevamruth promotes immense biological activity in soil and enhances nutrient availability to crops. Beejamruth protects the crop from soil borne and seed borne pathogens and also improves seed germination. In the present study, significantly highest plant growth and root length was recorded with the application of RDF+Beejamruth + Jeevamruth +Panchagavya and it was found to be significantly superior over other treatments. The application of Beejamruth + Jeevamruth + Panchagavya was the next best treatment and resulted in significantly higher yield as compared to RDF alone. The N, P and K concentration of plants was significantly highest in the treatment given RDF + Beejamruth + Jeevamruth + Panchagavya.

Paper: Bhar LM, Kalyan K Mondal and SK Sugha. (2008)."Antibacterial potential of panchagavya -based microbes against bacterial wilt of tomato." Indian Phytopathology 61, no. 3: 353-354.[89]

Farming Technique: Input/ Natural Soil Management

Notably, treatments with Serratia and P. fluorescens resulted in 22 and 32 per cent wilt incidence as compared to control (100%) under soil free water culture assay, respectively. Thus, the present study indicated that the panchagavya being an important source of antagonistic microbes could be exploited in integrated wilt management programmes in tomato.

Paper: Sriram S, Savitha MJ, Ramanujam B (2010). Trichoderma-enriched coco-peat for the management of Phytophthora and Fusarium diseases of chili and tomato in nurseries. Journal of Biological Control. Vol. 24(4): 311-316.[90]

Farming Technique: Insect/ Pest Management

Coconut coir dust, commercially available as coco-peat, is used in raising the seedlings of vegetable crops in tropical countries. Coir-pith and other derivatives of coconut husk have been well recognized as substrates for the multiplication of Trichoderma spp. and commercial nurseries use coco-peat for raising the seedlings. In the present study, coco-peat enriched with Trichoderma harzianum was used for raising tomato and chili seedlings to test the effect of the same on managing wilt caused by Fusarium oxysporum f. sp. lycopersici in tomato and damping off and root rot caused by Phytophthora capsici in chilies in nurseries. The enrichment with T. harzianum, resulted in reduced wilt incidence

[89] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 51
[90] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 68

(5–7.5%) compared to control (38.75%) in tomatoes with increased plant growth parameters. Though germination was reduced compared to control (without pathogen), there was reduction in P. capsici infection in chilies by up to 50% compared to coco-peat without Trichoderma enrichment. The use of coco-peat enriched with T. harzianum can be adopted by commercial nurseries for better plant growth and reduced incidence of tomato wilt and chili root rot while raising disease free and healthy seedlings.

Paper: Shakila, Arumugam and A Anburani. (2008). "Effect of certain organics and pressmud on growth and yield characteristics of tomato." Asian Journal of Horticulture 3, no. 2: 273-276.[91]

Farming Technique: Input/ Natural Soil Management
An experiment was conducted to study the effect of organic amendments and pressmud on the growth and yield characteristics of tomatoes. The treatments comprised 25.0 t farmyard manure/ha, 12.5 t pressmud and 5.0 t vermicompost/ha at two different levels (100 and 50% of the recommended level) and their combinations along with foliar spray of Panchagavya (3%). The combined application of farmyard manure plus vermicompost plus panchagavya as foliar spray resulted in improving the growth characters, i.e. plant height, internodal length, number of branches, number of leaves and leaf area and yield characters such as number of flower clusters per plant, number of flowers per cluster, number of fruits per plant, single fruit weight and fruit yield per plant in tomato followed by the application of 6.25 t pressmud/ha + 2.5 t vermicompost/ha + 3% panchagavya.

Paper: Deshmukh RS, NA Patil and TD Nikam. (2008): "Influence Of Kunapajala Treatment From Vrikshayurveda On The Fruits Of Tomato Under Organic Farming Condition And Its Comparison With NPK Farming." Bioscience Discovery. Vol. 3(2): 200-206[92]

Farming Technique: Input/ Natural Soil Management
Kunapajala is a liquid manure of antiquity suggested in Vrikshayurveda. It is a fermentation product of easily available ingredients and it can be used for any plant at any growth stage. Experiments were conducted in PG Research Centre, Tuljaram Chaturchand College, Baramati, Dist-Pune (M.S.) India, using pot culture for N.P.K (N = 11g/plant, P= 21.5 g/plant and K= 4.5 g/plant respectively) and kunapajala treatment (5 times at interval of 10 days). Kunapajala treatment was found to be more effective for inducing early flowering and enhancing fruiting period, size, fresh weight and shelf life of fruit and weight of seeds as compared to N.P.K. farming. Analysis of nutritional value showed that kunapajala had the upper hand, followed by N. P. K. farming in terms of total solids, fiber content, lycopene, ascorbic acid, carotenoids, soluble proteins, total carbohydrates and proline. It is interesting to know that the antioxidant property of tomato fruit was highest in the plants treated with kunapajala. The activity of oxidative enzymes like peroxidase and polyphenol oxidase was

[91] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 96
[92] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 141

also highest (70 % and 78 %), followed by N.P.K. farming (36 % and 65 %) respectively but caloric value of kunapajala treated tomato fruits was lower (13 %) which is important from diet point of view for diabetic patients. So, it can be concluded that kunapajala treatment is superior to increase the reproductive growth, nutritional value and yield of tomato fruits along with enhancement in antioxidant property as compared to N.P.K. farming, which is very significant from both economic and health point of view.

Elephant Yam

Paper: Suja G. and J. Sreekumar (2014). Implications of organic management on yield, tuber quality and soil health in yams in the humid tropics. International Journal of Plant Production 8, no. 3.[93]

Farming Technique: Input/ Natural Soil Management
Global consciousness of food safety, health and environmental issues has stimulated interest in alternative agricultural systems like organic farming. Since information on organic farming of tuber crops is meagre, a field experiment was conducted in split plot design over a five-year period at Central Tuber Crops Research Institute, India. The aims were to evaluate the impact of organic, conventional and traditional production systems on yield, proximate composition and mineral content of tubers and soil physicochemical and biological properties in three species of Dioscorea (white yam: D. rotundata, greater yam: D. alata and lesser yam: D. esculenta). The production systems were assigned to main plots and species to subplots. Organic farming (20.34 t ha-1) produced significantly higher yield over conventional practice (18.64 t ha-1) by 9%. All the species responded well to organic management, which lowered the bulk density and particle density slightly and improved the water holding capacity (by 15%) of soil. Tuber quality was improved with significantly higher Ca (72.67 mg 100g-1), slightly higher dry matter, crude protein, K and Mg contents. Organic plots showed significantly higher available K, by 34% and pH, by 0.46 unit and higher soil organic matter by 14%. The dehydrogenase enzyme activity (1.174 µg TPF formed g-1 soil h-1), population of bacteria, fungi and P solubilizers were promoted by 14%, 23%, 17% and 22% respectively. Thus organic farming was found to be an eco-friendly management strategy in yams for sustainable yield of quality tubers besides maintaining soil health. Technology involving farmyard manure, green manuring, neem cake, biofertilizers and ash was standardized.

Paper: Suja, Girija, Sukumaran Sundaresan, Kuzhivilayil Susan John, Janardanan Sreekumar, and Raj Sekhar Misra. (2012). "Higher yield, profit and soil quality from organic farming of elephant foot yam." Agronomy for sustainable development 32, no. 3: 755-764.[94]

[93] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 3
[94] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 8

Alternative agricultural systems, like organic farming, that are less chemical intensive, less exploitative and environment friendly are gaining popularity. Elephant foot yam (Amorphophallus paeoniifolius (Dennst.) Nicolson) is an important starchy tuberous vegetable with high nutritive and medicinal values. Since information on the organic farming of tuberous vegetables is scanty,field experiments were conducted in this crop at the Central Tuber Crops Research Institute, India, over a 5-year period. The impact of organic, conventional, traditional and biofertilizer production systems on growth, yield, quality, soil physico-chemical properties and economics were evaluated in elephant foot yam. Our results show that organic farming favoured canopy growth, corm biomass and lowered collar rot disease. Dry matter and starch contents of organic corms were significantly higher than those of conventional corms by 7% and 13%, respectively. Organic corms had 12% higher crude protein and 21% significantly lower oxalate contents. The content of K, Ca and Mg in corms were slightly higher, by 3–7% under organic farming. After 5 years of farming, the organic plots showed significantly higher pH, by 0.77 units, and higher organic C by 19%. The exchangeable Mg, available Cu, Mn and Fe contents were also significantly higher. Organic management lowered the bulk density by 2.3%, improved the water-holding capacity by 28.4% and the porosity of soil by 16.5%. In short, organic farming proved superior and produced a 20% higher yield (57.097 tha”1) over conventional practice (47.609 tha”1). The net profit was 28% higher and an additional income of Indian Rs. 47,716 ha”1 was obtained. Thus organic farming was found to be an eco-friendly management strategy in elephant foot yam for sustainable yield of quality tubers and higher profit besides maintaining soil health. Technologies for organic production involving farmyard manure incubated with bioinoculants, green manuring, neem cake, biofertilizers and ash were also standardized.

Paper: Suja G, J Sreekumar, K Susan John and S Sundaresan (2013). "Organic production of tuberous vegetables: Agronomic, nutritional and economic benefits." Journal of Root Crops 38, no. 2: 135.[95]

Farming Technique: Input/ Natural Soil Management

Global awareness of health and environmental issues has stimulated interest in alternative agricultural systems like organic farming. Elephant foot yam (Amorphophallus paeoniifolius) and yams (Dioscorea spp.) are ethnic starchy vegetables with high energy, nutritive and medicinal values. Field experiments were conducted at the Central Tuber Crops Research Institute, Thiruvananthapuram, India, during 2004-2011 to assess the agronomic, nutritional and economic advantages of organic farming over conventional systems in these crops. Organic farming resulted in 10-20% higher yield over conventional practice in these crops. A net profit of Rs 2,15,776 ha-1, which was 28% higher over chemical based farming was obtained under organic management in elephant foot yam. Elite and local varieties responded equally well to organic and conventional farming in elephant foot yam. White yam, greater yam and lesser yam responded similarly to both the systems, with slightly higher yield under organic practice. Soil physico-chemical properties and microbial count

[95]Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page 162

were also improved under organic management. Organic farming scored significantly higher soil quality index (1.93) than conventional practice (1.46). The soil quality index was driven by water holding capacity, pH and available Zn followed by soil organic matter. Tuber quality was improved with higher dry matter, starch, crude protein and lower oxalate contents. Cost effective technologies were field validated.

Abstract Of Scientific Papers, Books, Journals And Stories On Agro-Ecological Agriculture on Pepper

Book: Parthasarathy, V. A., K. Kandiannan, and V. Srinivasan. (2008). "Organic spices." New India Publishing, 2008.[96]

This book on 'Organic Spices' covers all aspects of organic spice production. The topics covered include historical spice trade and importance of spices in the food chain. A brief account on the organic agriculture movement in the world and its present status and opportunity for organic spices in the world market are given. The chemistry and different methods of composting are covered in the organic manures chapter. A separate chapter devoted to microbes and plant growth promoting rhizobacteria is included. Topics on biological control of insect pests, nematodes, fungi and bacteria of spices are highlighted in separate chapters, which would be of interest in the organic production system. The importance, composition, uses, botany and varieties, organic way of production of spices such as black pepper, cardamom (Elettaria cardamomum), ginger, turmeric, chilies and paprika, nutmeg Myristica fragrans), vanilla, seed spices such as cumin (Cuminum cyminum), fennel, fenugreek, coriander and their harvest and postharvest processing are enumerated. Chapters on good agricultural practices and organic certification procedures are outlined for adoption. This would serve as a reference book for researchers, teachers and students besides farmers, traders and consumers.

Paper: Hamza, S. (2006). "Effect of Organic Farming on Soil Quality, Nutrient Uptake, Yield and Quality of Indian Spice." In The 18th World Congress of Soil Science. July 9-15, 2006, Philadelphia, USA[97]

Farming Technique: Input/ Natural Soil Management

Organic Farming (OF) is expanding globally due to increased consumer interest, environmental protection and EU policies. Global trade in organically produced products in 2003 is estimated at US $26 billion and is projected to increase $102 billion by 2020, due to increasing demand in Europe, USA, Japan and Australia. In India attention is being received in Organic agriculture particularly in spices. The project organic farming in spices was conceptualized in 1992 and implemented at IISR and tested in the farmer's fields over a

[96] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page no: 94
[97] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page no: 146

decade. The objectives were to study the best organic fertilizers (plant residues-compost/vermicompost, animal manures/de-oiled cakes that contains nutrients in complex organic forms, bio-fertilizers), its impact on soil quality, quality of major tropical spices and its economics in important spice crops under humid tropical conditions of South India. Soil characteristic, plant analysis, and quality were determined by following standard procedures. The results of the greenhouse and field experiments conducted are discussed. In black pepper the effect of commercial organic manures was evaluated (based on their nutrient equivalents) and compared with NPK chemical fertilizers and farmers practice. The study was taken under greenhouse conditions (1993-'96) in CBD design. Investigations revealed that irrespective of the sources, application of organics increased the soil pH, nutrient availability in the soil and crop uptake. Poultry manure followed by goat manure was significantly superior with regard to yield, nutrient uptake, and enhanced piperine and oleoresin content of black pepper. On farm trials conducted in the 51 farmer's holdings in 30,000 vines for five years corroborated the findings. The OF technology was further extended in farmer's fields in three important black pepper growing States of South India viz., Kerala, Karnataka and Tamil Nadu during 2000- '03. Limiting acid soils to half the lime requirement of the soil enhances the microbial population, nutrient availability, and dehydrogenase enzyme activity. Application of the recommended dose of N as organic (FYM + de-oiled cakes-neem (Azadirachta / pea-nut, P as phosphate rock + bone meal and K as wood ash, in conjunction with bio-fertilizers (Azospirillum and Phosphobacteria each applied @ 40kg per ha per year enhanced the spiking intensity of the vine, yield and nutrient uptake. The FYM application significantly decreased the bulk density irrespective of the soils. Soil quality indicators tested were positively correlated ($p<0.005$) with yield. Among the soil quality attributes, organic carbon and CEC are the most discriminating attributes in all the three locations. The soil organic matter and CEC contributed substantially to the ability of the soil to accept, hold, and release nutrients to pepper vines. Adoption of OF was effective in the biomanagement of the Phytophthora disease incidence to around two per cent over the years against 10 percent in the control. Black pepper quality volatile oil, oleoresins, boldness of pepper corn (>4 mm diameter) were increased due to OF. Field studies in Cardamom has shown that application of recommended NPK nutrients as organic fertilizers (50 per cent N each as FYM and neem cake + 50 per cent P each as bone meal and phosphate rock + 50 per cent K as wood ash) were effective in increasing the yield and quality of cardamom. Field experiments (1992-95) conducted in ginger and turmeric, using six de-oiled organic cakes in comparison with the recommended FYM and NPK fertilizers showed that in general application of cakes increased not only soil nutrient availability, but also nutrient uptake.

Organic cakes enhanced the water holding capacity and reduced soil bulk density. In ginger, among the cakes, pea-nut registered maximum organic C, Bray-P and exchangeable K in the soil and registered maximum dry recovery (4077 kg ha-1). This was followed by neem, cotton, and NPK fertilizer. Neem cake registered the highest oleoresin production (320 kg ha-1) of ginger. Neem cake was effective in the bio-management of rhizome rot disease incidence in ginger to 5%. In turmeric increased yield and curcumin recovery were observed due to organic OF. Residual effect of organic fertilizers was conspicuous in the successive second crop of turmeric.

In Vanilla soil application of organic fertilizers (50 per cent N as FYM/vermicompost + 50 percent N as de-oiled cakes + 50 per P as bone meal + 50 percent K as wood ash + bio-fertilizers) were effective compared to recommended inorganic NPK fertilizers in increasing the yield and quality of the beans. Pilot study conducted (2001-04) in the high ranges of Western Ghat in the growing of Garcinia indica in Wayanad district (Kerala) and clove and nutmeg in Maraimalai/ Mahendragiri hill areas in Kanyakumari district (Tamil Nadu) revealed that Garcinia is grown as a self sown crop in traditional farming and can be claimed as default organic. Similarly nutmeg and clove grown in the region by following traditional/indigenous agriculture by applying FYM and without any synthetic chemical fertilizers and/or pesticides calls for characterizing the cultivation practices on the lines of national standards for organic production. It can be concluded that organic fertilizers play a significant role in improving soil and crop quality and sustainability. There is, however, a 10-20 per cent reduction in crop yield that should be compensated by premium pricing of organic produce.

Paper: MAIN FINDINGS OF THE ALL INDIA NETWORK PROJECT ON ORGANIC FARMING (13 LOCATIONS) COORDINATED BY PROJECT DIRECTORATE FOR FARMING SYSTEMS RESEARCH, MODIPURAM[98]

Okra, turmeric, cotton, carrot, black pepper and cowpea have recorded more than 20% increase in yield under organic nutrient input system compared to an inorganic system. The increase in yield of onion, ginger, and dolichos beans are in the range of 10-20% while greengram, sunflower and garlic recorded 5 to 10% increase in yield. An increase of up to 5% was observed in maize, soybean, berseem, brinjal, chili, capsicum, tomato, sorghum and peas across the seasons and locations. [THESE, THEREFORE, ARE CONSISTENT RESULTS ACROSS LOCATIONS AND SEASONS, FOR 21 OF THE 28 CROPS FOR WHICH RESEARCH IS UNDERTAKEN]

[98] Ecological Agriculture In India: Scientific Evidence on Positive Impacts & Successes, Page no. 1

Annexure 8: Scientific Principles Behind Natural Farming Techniques

Objective

The major objective of the Save Soil Campaign is to raise and maintain 3-6% organic content in all agricultural soils across the planet. 3% organic content is the minimum to sustain life in the soil.

A healthy soil has good physical, chemical and biological properties. Modern agriculture has significantly destroyed the biological property of the soil through use of inorganic chemicals as pesticide, insecticide, herbicides and excessive tillage with heavy equipment. Therefore, one of the most widely recognised and scientifically proven approaches for improving soil fertility globally, has been the enhancement of the soil's biological properties. Just by bringing back proper soil biology, the return of soil fertility has been achieved in more than 5 mha of commercial farms worldwide. We plan to adopt these techniques in our farms on a pilot basis to solve the problems mentioned above, thereby increasing the yields.

In this context, we know that there is a diverse set of microorganisms broadly classified as beneficial and harmful. The beneficial microorganisms have a symbiotic relationship with the root system in the rhizosphere. The non-beneficial organisms create problems of excess weeds, pests and diseases whereas the beneficial ones solve these problems. Therefore, our strategy is to identify the right soil biology with a balanced soil food web and multiply them in our soils.

A balanced soil food web assists in nutrient cycling, creating soil structures in the form of soil aggregates, suppress weeds, inhibit pests and diseases and store carbon in the soil and thereby improving the yields. Here's how.

Nutrient Cycling

Soil has a vast amount of nutrients in the form of crystalline structures. Plants are not capable of directly accessing the nutrients in the soil. Bacteria and fungi, however, produce enzymes that break-down these structures of nutrients in the soil, and help to release it in plant absorbable form. Plants release various kinds of exudates through their roots to feed the microorganisms, and trade specific nutrients with them as and when they require.

Building Soil Structure

Beneficial organisms produce enzymes and glues that break soil parent material as well as facilitate the formation of microaggregates which are made of small clumps of bacteria, organic matter and soil particles (sand, silt and clay). Fungal hyphae then bind these microaggregates together forming larger clumps, known as macroaggregates. As more materials are bound together, pore spaces are created and a soil structure is formed. These pore spaces draw water which then creates a vacuum that draws air into the soil. This process improves infiltration rate, water holding capacity and aeration in the soil which facilitates root penetration and controls soil erosion.

Suppressing Weeds

A bacterial dominated soil is more favorable for weeds. When the soil becomes fungal dominated the weed growth is discouraged. A balanced soil food has an appropriate fungal to bacterial ratio that prevents the conditions favorable for weed growth and hence we can suppress weeds. Fungal to bacterial ratio is the key parameter to suppress weed growth.

Controlling Pests

The vast majority of disease causing microorganisms are anaerobes. They thrive only in low oxygen conditions. The opposite is true for beneficial microorganisms. A well-structured soil allows air to flow in, creating an aerobic condition supporting beneficial microorganisms and producing healthy plants. With a balanced soil food web in place, the plant is nutrient rich and therefore better able to protect itself.

These aspects of the soil food web helps in restoring degraded soils, increase soil fertility and reduce operating costs for farmers. This naturally increases yields. Thus, a balanced soil food web creates healthy plants, in turn healthy produce and healthy human beings. Above all, the real benefit is that topsoil can be created in a very short period of time, breaking the myth that it takes centuries to do it. All it takes is a microscope to observe the right set of microorganisms and employ methods to multiply them.

Natural Farming Methods To Multiply Beneficial Microorganisms In The Soil

The process of creating a balanced soil food web involves infusing the soil with beneficial microorganisms, increasing crop diversity for microorganisms to thrive under and reducing tillage to minimize the destruction of the soil structure. This can be done by following these simple steps:

a. Preparing and applying compost that has a diverse set of beneficial microorganisms upon a plowed field as one-time application.
b. Seeding and growing a diverse set of cover crops over the field where the compost has been applied.
c. Preparing manure teas and compost teas and applying it as soil and foliar spray on cover crops.
d. Crimping the cover crops and seeding the main crop using a no-till seed drill upon the crimped cover crops.
e. Cultivation of the main crop with a no-till seeder and applying manure and compost teas and other natural inputs for repelling pests and controlling diseases.

The major components of this method are briefly described below.

Compost Preparation

The objective of composting is to make compost that can be used as an inoculant of beneficial microorganisms for the soil. The strategy is to create a pile of biomass with the right greens and browns ratio and 50% moisture, so that the pile has the right habitat and food for microbes to grow. As microbes grow in number and decompose the biomass, the pile begins to heat up. This heat pasteurized the weed seeds and pathogens but after a certain point it begins to affect the beneficial organisms as well. Therefore the pile heat needs to be monitored daily and when it reaches 160 degree F, it must be turned. Turning the pile releases extra heat and also mixes fresh oxygen into the pile. Also care must be taken to maintain 50% moisture by sprinkling water as the pile is turned. This process is repeated until the pile is decomposed fully and doesn't heat up any further. This process of hot composting as shown by Dr. Elaine Ingham of the Soil Food Web School[99]usually takes 30-45 days to complete this process. Compost can also be made using static composting methods propagated by Dr. David Johnson called as Johnson-Sue bioreactor. It takes 10-12 months to create this static compost.

Compost application is done only once in the field where cover crops are to be grown. After that the microbes establish themselves using the exudates from cover crops and main crops to thrive perpetually.

Cover Crop Selection And Growing

The role of cover crops is to feed the soil with carbon-based compounds or sugars. It also adds biomass which when crimped covers the soil and functions as mulch. It takes roughly 60 days to grow a cover crop which will then be crimped before it goes into the seed setting stage. The more diversity of cover crops, the higher is the biomass generated and the larger is the soil microbial biodiversity. A set of 30 varieties (cereals, pulses and oilseeds etc) of cover crops similar to multi-seed sowing is needed that can function as soil biology enhancers, biomass producers, nitrogen fixers and habitat providers. The cover crops also help in protecting the soil from erosion, suppressing weeds, retaining soil moisture and reducing soil temperature.

Aerated Compost/Manure Tea Preparation

Compost/manure teas are a microbial soup. The objective of teas is to extract and multiply the beneficial organisms present in the compost/manure into the water which can be applied as soil or foliar spray. Since the compost/manure contains aerobic microbes, this aerated water also creates the right conditions for them to propagate. This tea when sprayed inoculates the soil with these beneficial organisms. This has to be applied on cover crops as well as main crops to maintain the number and species of soil microorganisms over time.

No-Till Seeder

Non-tillage is a major aspect of repairing damaged soils. A no-till seed drill cuts open the soil without turning it and sows the seed into the soil directly. The no-till seed drill must be

[99]https://www.soilfoodweb.com/

capable of seeding over the crimped cover crops. It condenses the time and labor involved in plowing, leveling and seeding into one single operation.

Key Component: Microscope

The most important part of this method will be to identify the beneficial microorganisms that need to be present in the compost, compost tea and in the soil. The compost and compost tea "works" only because of their biology in them. There are also certain aspects that need to be calculated like microbial biomass, fungal to bacterial ratio etc, to fine-tune the biology that needs to be applied in any given soil for any given crop. With proper training, this can be done by a farmer himself using a compound microscope.

Conclusion

All the activities and components mentioned above are integral to the soil regeneration process because it is needed to advance and promote the diversity of soil microorganisms. The crop productivity depends on the balanced soil organisms and highly correlates to the higher fungal-bacterial ratio instead of the soil organic content present. Although any agricultural method that enhances the soil microbial count and diversity is regenerative in nature, the above mentioned approach has shown best results. Research has shown that this process can increase soil organic carbon by 10 tons/ha/year while maintaining the crop yields. This level of sequestration is enough to sequester all the atmospheric carbon into the world's agricultural soils in just 12-15 years.

Annexure 9: Save Soil- Taimanin Kakkum Vivasayam Annual Report 2022-23

Problem Statement

Over the 30-year period from 1990, the cost of crop cultivation in India increased at a faster rate than the increase in the value of the output. This has led to dwindling farm incomes. The average income for agricultural households from cultivation is just Rs.90/day for a family of five.

The main reason for this sharp decline in incomes is the depletion of soil fertility. The minimum organic matter in agricultural soil must be 3-6% to keep the soil fertile. But 62% of India's agricultural soil has less than 0.5% organic matter. When the soil is so severely depleted, farmers are struggling to grow and profit from any crop and hence, nearly 52% of the farm households in India are in debt. This problem is compounded by climate risks and market risks which make the farming community the most vulnerable community in the country.

When farmers cannot pay the debt, either they migrate to cities for employment or they are forced to sell their land and become landless laborers. The landless laborer's population has increased by over 400% in the last 50 years. In fear of becoming landless, nearly 1 farmer commits suicide every hour in India leaving 4-5 members of his family in acute suffering for the rest of their life.

In this condition, there is no pride left in farming. Hardly 2-3% of the farmers want their children to get into agriculture. Most of their children migrate to cities for employment leaving behind only the older generation on farmlands. The average age of Indian farmers has gone up to 50. These farmers have the agricultural skills that we, as a civilization, have acquired over many millennia. This intrinsic knowledge that our farmers have cannot be passed down through academic training or social media. It is transmitted from generation to generation. But the next generation of farmers are vanishing from our villages. If the status quo remains, in the next 2-3 decades, when this generation of farmers passes, and the thread of traditional knowledge is lost, there will be very few people left to grow food for this nation.

isha OUTREACH

Why Act Now?

As organic matter in soil reduces, it in turn brings down the microbial activity in the soil and results in the loss of soil fertility. Farmers will be compelled to abandon their lands. Unless soil fertility is improved by ensuring there is sufficient organic matter to sustain microbial activity, keeping agriculture alive could become an uphill task.

The situation is grim but there is a window of opportunity. If we act now, we can bring our farmers back to their land in the next 10-15 years. The longer we wait, let us say 20–30 years, the more difficult it will be to turn the soil around because thousands of species of microbes are going extinct per year. It is estimated that if the microbial population goes below a certain level, no effort of ours can revive their numbers. It is time we, as a generation, act with an urgency to restore soil health.

Solution

We need to make corrections in the way we grow, market and consume our food. Our food is grown using conventional methods which employ tillage with heavy machinery, monoculture farming and the excessive use of chemicals. These practices have a huge impact on the very basis of the entire process - the soil. Soil degradation is caused when the soil is depleted of organic matter upon which the soil organisms depend. In order to reverse this, we need to replenish the soil with organic matter and beneficial microorganisms.

The second part of the problem is that the farmers are apprehensive about changing their practices on a large scale because they are accustomed to the conventional ways of farming and their economic situation is too fragile for risk-taking. They need methods that do not deviate much from their current practices, are economical compared to conventional systems, and allow better yields and higher incomes.

The only way to address the ecological and economical issues together is by combining a scientific approach with traditional wisdom. In this context, Save Soil chose regenerative agriculture because it reduces the dependence of farmers on expensive external inputs, increases soil fertility and balances the farm ecosystem. It also gives high-quality farm produce which is free from toxic chemicals. The yield in Save Soil natural farms in most cases has been found to be similar to conventional agriculture, if not more.

The crop yield, soil health, nutrition and farmer income under natural and organic farming in India has been proven to be higher than in conventional agriculture as documented by the Indian Council Of Agricultural Research (ICAR) from stations across India over a period of 20 years and reported by the Centre for Science And Environment (CSE).

About Save Soil

Sadhguru initiated Save Soil - Thaaimann Kaakkum Vivasaayam in 2007 with the objective of creating economic well being for the farmers. He also emphasized the need to improve soil fertility for the overall wellbeing of humanity. Since then Save Soil has been ceaselessly operating to change farmer mindsets, identify and provide holistic farming methods that are beneficial both economically and ecologically, create model farms and farmers, and develop a platform for farmer-to-farmer knowledge sharing across Tamil Nadu and the Union Territory of Pondicherry.

The objective of Save Soil is to create service platforms that encompass farmer training, farm schools, consumer awareness campaigns, and agri-marketing services. The organization places significant emphasis on improving farmers' understanding of crop techniques and assisting them in enhancing their productivity. This is accomplished through a variety of programs, including one-to-many and one-on-one initiatives such as training courses, farm schools, on-farm trials, group review meetings for farmers, farm visits to individual practicing farmers, and consultations via social media platforms such as WhatsApp and helplines.

Save Soil offers support to farmers in several areas, including crop-based training, input preparation, better livestock management, efficient water management, and weed and pest management among others. Where appropriate, Save Soil is planning to help build local farmers' groups or clusters so that they can benefit from the offerings. Save Soil, therefore, provides the valuable elements that farmers need to improve and stabilize their agricultural productivity and net incomes through regenerative agriculture systems.

Since 2008, Save Soil has created model farmers who have successfully transitioned to regenerative agriculture from conventional agriculture. By doing so, they have drastically reduced their dependence on external inputs and increased their incomes significantly. These model farmers have also become farmer volunteers, and now share their experience with fellow farmers through training programs conducted by Save Soil. Their farms have also become model farms, where live sessions are conducted for farmers on various crop cultivation aspects. The farmer-to-farmer sharing is the bedrock of the movement as it is the most effective means of transmitting knowledge about regenerative agriculture. When farmers see and hear the success stories of other farmers, they are willing to try it out with much more confidence.

Recognizing that soil degradation is not limited to Tamil Nadu or India but the entire world, and drawing on the experience and insight obtained through Save Soil's initiatives, Sadhguru launched the Save Soil campaign. The single-point agenda of this campaign was to garner the support of 4 billion people across the globe to pitch for national policies that will support the enhancement of organic matter in agricultural soil to a minimum of 3-6%. With the campaign reaching over 3.91 billion people in 100 days, Sadhguru now sees the need and opportunity to scale up Save Soil's soil regeneration pilot programs.

Strategy

Rather than following a specific ideology or a particular philosophy, Save Soil takes a practical approach in adopting farming practices. There are many systems of sustainable farming available nowadays but the fundamental approach adopted in Save Soil is to find a method that works for the farmer given their current situation and mindset while simultaneously solving the problems of soil fertility and scarcity and depletion of resources in farmlands. Our approach is to decrease the input costs for the farmer without decreasing the yields so that there is a stable net income for the farmer.

The fastest way to scale the sustainable farming practices is by making Save Soil into a people's movement and showcasing the benefits to the government so they can create suitable policies and undertake on-ground action. Therefore, Save Soil has been structured as a movement from the start, rather than just a project or a program. Creating volunteers is a key aspect of any movement, and Save Soil is no different. Save Soil is and will continue to nurture volunteers.

Also, the strategy for implementation is to first transition farmers with semi-medium and medium landholdings to regenerative agriculture because they are found to have better risk-taking capacity, perseverance and capability to understand. They can also become volunteers for the movement. Once they adopt it and become successful, it spreads from farmer to farmer through our training and farmer connect programs. The propagation of farming techniques in Save Soil is done from farmer to farmer based on their experience of using the traditional methods in a modernized way, which is appropriate for current times. These techniques are modified and adapted according to the farming conditions, needs and capabilities of individual farmers. The farmers go through training and are handheld throughout the transition period through WhatsApp, helplines, and online and in-person review meetings.

Save Soil also envisions creating an online repository of traditional regenerative agriculture techniques that are tried and tested by farmers across the spectrum which can be readily available to interested farmers so they need not reinvent the wheel. Apart from being a resource for farmers on various farming techniques, Save Soil volunteers also gain first-hand experience by setting up model farms in suitable locations and practicing farming as part of the movement.

Finally, Save Soil envisions creating general awareness regarding chemical-free food and online marketing of natural products through social media platforms, print media, etc. Save Soil will also identify consumer champions who will volunteer to promote consumer awareness amongst the general public.

Highlights

- In the last 13 years, Save Soil has been developing optimal farming techniques or a crop-wise package of practices for transitioning all categories of farmers.
- In the last 6 years, Save Soil has directly trained approximately 15,000 farmers.
- One in five farmers has fully transitioned to regenerative agriculture after going through our programs. Out of that, over 200 lead farmers have become champions of regenerative agriculture in the state and are spearheading the movement.
- Save Soil has been supported by regenerative agriculture stalwarts like Late Nammalvar Ayya, Padma Shri Subhash Palekar, Alangudi Perumal, Nagarathinam Naidu, etc., and subject experts like Dr Punniyamurthy, Dr Saravanan and Poochi. N. Selvam.
- Save Soil is well equipped with a dedicated set of volunteers and experienced field teams.
- Save Soil has a continuously growing presence on YouTube with over 1.84 lakh subscribers and 12.4 million views.
- Save Soil is the largest movement of its kind in Tamil Nadu, larger than any program by the government or agriculture university.

5-Year Plan

From 2007 to 2020, Save Soil has been developing optimal farming techniques or crop-wise package of practices and conducted various training programs, farmer-to-farmer knowledge sharing sessions, farm visits, hand held farmers and visited model farmers from Maharashtra, Karnataka, Andhra Pradesh, Telangana, Kerala and Tamil Nadu.

From 2021 to 2025, Save Soil aims to train farmers in every taluk across Tamil Nadu in regenerative agriculture and tree-based agriculture. It will also facilitate the organization of these farmers into farmer clusters for managing production, and sales by connecting farmers with consumers, thereby increasing the farmers' net income and offering good quality produce to consumers. In addition to this, Save Soil will leverage the government agricultural schemes and organic certification programs for farmers.

Year 2022-23

Trainings

Despite the COVID-19 situation, Save Soil continued to work with farmers across Tamil Nadu for the promotion of regenerative agriculture through online mediums. About 13200 farmers are now actively part of 150 WhatsApp groups that enable farmer sharings. 1400 consumer members are part of 13 WhatsApp groups to facilitate marketing.

We trained 5742 new farmers in regenerative agriculture techniques this year through 54 programs and our field teams visited 226 transitioning farmers for handholding and guidance. We also answered 4583 calls from farmers seeking advice through our helpline. 31 new videos were posted on YouTube and our Facebook page started off with 118 posts this year. Our YouTube videos generated 17 million impressions while our Facebook page had a reach of 5 million.

Model Farms

In the model farms, 62 acres were cultivated using regenerative agriculture techniques. A little over 8000 days of farm employment was generated for local men and women.

A total of 20 different crops were cultivated in all the 4 model farms combined. This crop cultivation has given us valuable insights on the regenerative agriculture practices we adopted, including the problems that will arise in large-scale implementation as well as the most effective solutions that are at our disposal right now.

Our Team

The Save Soil has a dedicated team to handhold farmers who have attended the Save Soil training sessions to facilitate continuous knowledge sharing, clearance of questions through electronic means such as farmers' WhatsApp groups, field visits and farmer helplines to ensure that farmers are able to make a smooth transition to regenerative agriculture. The on-ground operations are managed by a dedicated team of people. Here is a list of people who are involved in project management:

Project Members:

Save Soil Team		
A	Core Team	Designation
1	Anand Ethirajalu	Project Director / Volunteer
2	Swami Srimukha	Project Lead / Volunteer
3	Swami Lavana	Communications Coordinator / Volunteer
4	Muthukumaran T.	Operations Coordinator / Volunteer
5	Prabhakaran	Trainer / Staff
6	Ethirajalu R	Technical Advisor / Volunteer
B	Resource Leaders	Expertise
1	Dr Saravanan R	Soil Scientist / Volunteer
2	Dr N Punniamurthy	Ethnoveterinary Expert / Volunteer
3	Sri Selvam N	Integrated Pest Management Expert / Volunteer
C	Supporting Volunteers	Role
1	Dev Raj	MIS Executive & Relationship Coordinator / Volunteer
2	Aditya Tated	Financial Planner & Accounts Executive / Volunteer
3	Elambharathy Kaliyanaraman	Field Coordination / Volunteer

Apart from farmer volunteers, the above people are supported by 20-member field teams working in various capacities and 10 farmer resource leaders for our training programs.

We plan to hire 49 new staff members to support the additional responsibilities proposed by the Core Team for this year.

Farmer Sharings

Intercropping with Bananas

"I cultivate bananas. Monthan and Camphor varieties grow in rotation as they do in my neighboring farms. But I had the problem of excess weed and I wanted a solution for that. I found that Save Soil was conducting training on banana cultivation. So I decided to go.

The training covered all aspects of cultivation and gave easy, simple solutions for weeds and pests such as growing moth beans in between bananas. This proved to be a significant step in improving the quality and quantity of my bananas. The moth beans gave fertility to the soil, thereby reducing the need for urea and also brought down pests significantly.

My bananas have become popular in the area and I get 150% of the prevailing market price. I thank Save Soil for offering this to me."

Karunakaran K
Thiruvvanamalai

Insects are Not a Problem

"I came into farming after realizing and pondering enough upon the fact that the food that we eat is the major reason for current day ill-health. Although I am a physiotherapist by profession, I decided to get into agriculture myself and try to bring some change in my food.

As I experimented with natural ways of growing crops, I could not handle the pest attacks effectively. I knew nothing about the insects on the farm. I began thinking all insects are harmful except for bees. This is when I came across Integrated Pest Management Training conducted by Save Soil.

This changed my entire perspective about insects. I saw that there are more beneficial insects than the non-beneficial ones. There are ways to attract beneficial insects and control the non-beneficial ones. I was fascinated by the information shared and I started applying it on my farm. There is a significant difference in the pest problems after trying out the solutions offered by Save Soil. Above all, I don't see insects in the same light as before.

I thank the Save Soil and Poochi Selvam anna for changing my mind."

Sumathy
Varanavasi, Ariyalur District

Pepper in the Plains

"My journey into regenerative agriculture started 15 years ago when I started wondering what I can do with my 25-acre land which was already planted with crops such as coconut, cocoa, banana, sapota, mango and timber trees such as neem, teak, mahogany. Fortunately, I came to know about the pepper cultivation training conducted by Save Soil. At that time, I was of the opinion that pepper cannot be grown in the plains as it needs a cooler climate which is in high altitudes. I was intrigued by the program because they were proposing otherwise.

After going through the program, it became clear to me that this is worth experimenting with because they showed live examples. The resource person in the training clearly explained all the nuances of the cultivation and armed with this knowledge, I started growing pepper with natural inputs and biofertilizer. In fact, I learned that pepper cultivation doesn't need any chemicals.

Today my pepper plants have grown well and are now beginning to yield. I am fascinated by the fact that pepper, which is a very lucrative cash crop, can be grown in my location. If not for Save Soil, my land would have been barren under the trees and there was no stable source of income. My family and I are forever indebted to the Save Soil for making this happen for us."

Mrs. Nagarathinam
Thondamuthur, Coimbatore

From Chemically Grown Flowers to Organic Vegetables

"I cultivated flowers using chemicals ever since I started farming. I had gone through the vegetable cultivation training from Save Soil a long time back. But I didn't practice it.

During Covid-19, my flower sales dwindled. I sat for a while and remembered the Save Soil training on vegetables conducted on Jagadeesh Anna's farm. I immediately switched over to vegetables and cultivated them in a similar fashion as it was imparted in the training.

To my surprise, everything went very well and the vegetable crop was a success. The most amazing part was that I plowed the land only once and got multiple crops out of it. Pest attack was a major challenge earlier, which I have overcome using regenerative agriculture techniques discussed during the training. I found that good yields are possible if natural inputs are given in the right manner and quantity. I opted for direct marketing to consumers because that gives me extra income as well as the pride in being a farmer.

I am really grateful to Save Soil who made this possible for me. I thank Save Soil and Jagdeesh Anna for their guidance."

Ramesh
Veppilaipatti, Vaazhapadi, Salem

Income Increase from 2 to 10 Lakhs

"I own four and a half acres of land. I have been doing regenerative agriculture for the past seven years. I am constantly focusing on vegetable cultivation. Because of this, my soil is very fertile. The soil in our area is a little hard, but because of regenerative practices, my soil is very soft and alive. The yield is increasing year on year, not decreasing.

I am now earning 10 lakh rupees per year in vegetable cultivation compared to 2 lakh rupees per annum initially. I am also involved in creeper cultivation. There is no doubt that regenerative agriculture can reduce costs and generate income. Among the vegetables, I regularly grow tomatoes, small onions, bitter gourd, ridge gourd, snake gourd and brinjal."

Jagadish
Dharapuram, Tiruppur

Our Heartfelt Gratitude

This report is dedicated to all our donors and volunteers who have made Save Soil – Thaaimann Kaakkum Vivasaayam happen. It is thanks to their generous support and contributions that we are able to reach out and touch the lives of so many in rural India. We express our heartfelt gratitude to each one of them.

An Appeal

It is also our dream and vision to scale up these initiatives in the coming years and improve the quality of life for millions of farmers in Tamil Nadu. Large-scale agricultural transformation cannot happen without the continuous and consistent support of a substantial group of committed people and organizations who are willing to put the wellbeing of the farmers before themselves. We require your support in creating a better world for our future generations by revitalizing the soil, which is the fundamental aspect of all life on this planet.

Reach out to us if you wish to know more or get involved.

Donations

general.donations@ishaoutreach.org
donations@cauverycalling.org

CSR opportunities
csr.grants@ishaoutreach.org
csr@cauverycalling.org

Annexure 10: Package Of Practices Of Major Crops In Tamil Nadu

Natural Farming Approach For Paddy Cultivation

Introduction

Paddy, scientifically known as Oryza sativa, holds profound significance as a staple food crop for over half the world's population, providing vital nutrients, energy, and cultural heritage. Its adaptability, economic importance, and versatility in global cuisines contribute to food security, rural livelihoods, and cultural exchange. Beyond sustenance, paddy embodies a shared narrative of nourishment, unity, and economic stability, shaping landscapes and enriching lives worldwide.

Paddy Seed Preparation and Treatment

In the world of paddy cultivation, the journey begins with the seeds – the tiny capsules that hold the potential for a bountiful harvest. Understanding the nuances of paddy seed selection, drying, and treatment is essential for ensuring a successful crop. Let's delve into the intricacies of this package of practices crafted by experts and farmers alike.

Starting with the Right Seed:

Traditionally, it's always been preferred to use seeds from your own fields. However, if you're considering purchasing seeds, the wise choice is naturally grown paddy seeds. These seeds have shown to possess a natural resilience to diseases and pests, setting the stage for a healthier crop.

Selecting the Best Seeds:

The journey towards a thriving paddy crop begins with the selection of high-quality seeds. Vigilance is key – regularly monitoring your crops is essential to spot those with exceptional attributes. Look for characteristics such as abundant branches, freedom from diseases and pests, and multiple rice buds. This careful scrutiny should be conducted twice a week after the flowering stage. To mark the chosen ones, tie a vibrant red ribbon around them. After maturation, carefully extract the mature seeds, dry them meticulously, and store them in jute sacks. This process is particularly important for maintaining the purity of non-mixed single variety seeds.

A Precise Drying Process:

Once harvested, the paddy seeds contain about 25% moisture. To ensure their vitality, these seeds should be dried until their moisture content reaches 12%. Timing matters – the ideal drying hours are from 9.00 AM to 11.00 AM. Shield the seeds from the harsh sun, as drying them under its intense rays can impact their germination potential. Consistently maintaining the humidity at 12% is crucial to protect the seeds from insects as well as keeping its vitality. Storing the thoroughly dried seeds in cloth bags dipped in a cow dung solution is recommended. Additionally, drying the seeds during consecutive Amavasya days increases germination rates.

The Right Seed Quantity:

A crucial aspect of paddy cultivation is determining the right quantity of seeds. For a sal planting system, using 10 kg of seed paddy per acre is optimal. This quantity corresponds to a four-cent nursery area. If you're working with only one-cent nursery, use 3 kg of seed paddy for the best results.

Ensuring Seed Quality with Salt Water Solution:

No matter the source of your seeds, ensuring seed quality is paramount. To weed out the undesirable ones, employ a salt water solution. By mixing 1 kg of salt with 10 liters of water, you create a solution where lightweight seeds float to the top while the heavier, quality seeds sink to the bottom.

To perfect the salt solution's density, a simple yet effective test is employed. Place 20 liters of water in a 30-liter plastic bucket. Add an egg to the water and gradually mix in salt until the egg starts to float. Once the top of the egg is visible, resembling the size of a rupee coin, the solution is ready. With the solution's density appropriately balanced, immerse 10 kg of seed paddy. Remove the floating seeds and use the submerged, higher quality seeds for sowing.

Seeds treated with salt water often have a salty coating. To eliminate this, wash the seeds thoroughly in clean water, repeating the process 5 to 6 times. This step is vital to ensure proper germination. After washing, dry the seeds gently in the shade.

Effective Seed Treatment:

Preventing seed-borne diseases is integral to a successful paddy crop. This can be achieved through seed treatment using Beejamirtham or biofertilizers.

Create a solution by combining 20 liters of Beejamirtham with 200 liters of water. Soak the seed paddy in this solution for 30 minutes before sowing. Beejamirtham, a concoction of cow dung(5 kg), cow urine(5 Liters), soil(a handful), clinching lime(50 gms), and water(20 liters), plays a crucial role in seed treatment.

Bundle the treated seeds in a sack and soak them in water at 6 AM. After 24 hours, remove the sack, drain the water, and cover the sack with paddy straw to retain the moisture. Store the sack in a dark space, occasionally sprinkling water to maintain the humidity. In 24 hours, you'll witness the seeds germinate, as the sprout turns white. This is the perfect time to sow them in the nursery, adhering to local practices and conditions.

Optimal Practices for Paddy Nursery Management: Cultivating Robust Seedlings

Establishing the Nursery

To ensure the growth of healthy seedlings, it's important to choose a location with well-draining soil that contains a bit of sand. After watering and removing weeds, waiting about a week before tilling again can help prevent unwanted weed growth later. Creating a level raised area for the nursery is essential, avoiding any depressions where water could accumulate, potentially causing poor seed germination.

During the initial plowing, incorporating leaves like Neem and Bungan into the soil is recommended. These leaves will decompose over the following week, enhancing soil quality. After this period, performing a second plowing and adding 20 kg of ghana Jeevamrutham will further enrich the soil.

For conventional planting methods, approximately 12 kg of seeds are necessary for an acre of land for which the nursery area must be equivalent to about 4 cents. Utilizing 3 kg of seeds per cent is advisable. During seed sowing, ensuring the right spacing between seeds is crucial to provide ample room for seedling growth and development.

Jeevamrutham, Ghana Jeevamrutham, or compost are excellent options for enriching the soil. A crucial step is to apply Jeevamrutham, twice before sowing the seeds. When applying Ghana Jeevamrutham, ensure it's finely ground to promote optimal nutrient absorption. Maintaining a powdery texture of the soil is essential as it facilitates better nutrient uptake. Generally, a dosage of around 5 kg of Ghanajeevamrutham is suitable for a one-cent nursery.

Once the seedlings are transplanted into the nursery, their well-being continues to be a priority. Provide them with nourishing care to encourage robust growth. After transplantation, consider giving the seedlings Jeevamrutham or finely powdered Ghana Jeevamrutham. To ensure consistent nourishment, spray a mixture of Jeevamrutham (250 ml) and water (10 liters) on the 7th day post-sowing. Repeating this process on the 15th day sustains the seedlings' nutrient intake and development.

As the seedlings progress, the threat of pests like aphids and sap-sucking insects becomes a concern. To deter pests, consider using Neemastra. Applying this natural solution on the 10th or 12th day after sowing acts as a preventive measure against pests. Create a mixture by combining 300 ml of fermented buttermilk solution with 10 liters of water. To reinforce pest resistance, spray this mixture three days prior to picking the seedlings. By the 18th and 20th days, the seedlings should be ready for picking, showcasing their sturdy and vibrant growth.

Optimum Field Preparation Of Paddy

Green Manures: Boosting Soil Fertility

One of the foundational steps in field preparation involves enriching the soil's fertility. Green crops like thakkaipoondu and hemp can be sown and plowed before they reach the flowering stage. Additionally, cultivating trees such as Agathi and Gliricidia in the upcoming seasons allows for the collection and composting of their leaves. This process effectively introduces nutrient-rich organic matter into the soil, promoting its overall fertility.

Addition of Leaves During Plowing

At the time of plowing, leaves from plants like bungan, neem, and eruku can be harvested and composted. These leaves contribute valuable nutrients to the soil while simultaneously curbing the growth of pathogenic microbes. Furthermore, this practice aids in boosting the levels of essential micronutrients within the soil, which is beneficial for the overall health of the crop. Additionally, effective plowing serves as a measure to control weeds and mitigate the risk of root rot.

The planting field is deliberately dried out, allowing weeds to germinate, and subsequently plowed again. During the final plowing, an application of 200 kg per acre of Ghana Jeevamrutham or 100 kg of fortified manure mixed with Jeevamrutham, or 200 liters of Jeevamrutham is recommended. This infusion of nutrients not only fosters a nutrient-rich environment but also aids in weed control. It's noteworthy that the use of green manures or the incorporation of plowed green crops can result in a slight reduction in the need for conventional fertilizers. When opting for multigrain cultivation, KanaJeevamrutham application may be omitted.

An imperative component of planting field preparation is ensuring a well-leveled terrain. Ridges and ditches should be meticulously addressed, as ditches can lead to excessive water retention and uneven surface can create weed proliferation. Achieving a level planting field provides an even playing field for your paddy crop to flourish.

Optimal Seedling Uprooting and Planting: Ensuring Vigorous Growth

It's essential to pay meticulous attention to seedling uprooting and planting to facilitate robust growth and maximize yields.

When it comes to seedling uprooting, precision and timing is paramount. It's advisable not to uproot the seedlings on the first day; rather, the ideal moment for uprooting is during the actual planting process. The growth of seedlings is best when they are uprooted just before they are planted. Swift uprooting and immediate replanting expedite their transition to active growth and vibrant greenery. If uprooted and planted a day before the actual planting, the seedlings might take around 6 to 7 days to fully regain their vitality.

Proper spacing of seedlings forms the bedrock of successful paddy cultivation. In the context of sal planting, a spacing of 9 x 9 inches is recommended. Straight rows of plantation can be achieved by using a rope as a guide. If the intention is to employ a Cono Weeder for weeding, the space between two seedlings must be a minimum of three-quarters of a foot. On the 12th day following transplanting, weeding with Cono Weeder should be undertaken.

It's crucial to recognize that the seedlings in sal planting predominantly exhibit a uniform orientation. As a result, the Cono Weeder can only be efficiently maneuvered in that particular direction. In areas where the Cono Weeder cannot be utilized, manual weeding should be undertaken. Depending on the variety's life cycle, the ideal spacing ranges from 6 to 9 inches. Shorter life cycle paddy varieties can be transplanted conventionally without the need for spacing.

Seedlings destined for planting should first be soaked in beejamirtham to invigorate their root system. During planting, it is advised to place only 2 or 3 seedlings per bush. However, the specific number of seedlings to be planted varies in accordance with the paddy variety and the cultivation methodology.

During the planting process, meticulous attention should be paid to the alignment and orientation of the seedlings. Ensuring the seedlings are upright and the roots are not bent is crucial. Bent roots can hinder proper root growth and delay the development of new roots. As a rule of thumb, the root should not be planted any deeper than the visible white area between the root and the stem of the seedling.

Mastering Water Management and Weed Control

Water Management

Strategic watering is a cornerstone of successful paddy cultivation. Commencing on the second day of planting, the irrigation cycle should persist until the second weeding day. After the second weeding, allowing the field to remain dry for two to three days before resuming irrigation is advisable. Once 80 percent of the crops have reached their growth phase, it's prudent to cease watering.

Understanding the nuances between "fever" and "flow" is pivotal. Water must be consistently supplied during dry spells, the throat ray season, and milking periods. Failing to do so during these critical phases could result in diminished yields.

Engaging skilled personnel to ensure proper leveling is necessary to reduce the time required for irrigation. An hour of irrigation on level terrain should be enough.

Mastering Weed Management

Weeds pose a consistent challenge to successful paddy cultivation. Interestingly, withholding water for 20 days post-planting can deter weed germination. Overwatering is best avoided, and a level field with controlled water levels offers enhanced weed control.

The introduction of Azolla can further aid in weed reduction. Cono weeder weeding facilitates soil aeration and stimulates optimal root growth.

Hand weeding within the first 20 days of planting, followed by a second session within 35 days, is essential. For those utilizing Cono Weeder, running it thrice at 10-day intervals, beginning on the 15th day post-planting, can effectively curb weeds. For stubborn weeds that resist the Cono Weeder, manual uprooting and trampling can expedite their decomposition, enriching the soil as a natural green manure.

Nurturing Crop Nutrition and Defense: An Integral Approach

Ensuring crop vitality requires meticulous attention to both nutrition and protection. Administering 200 liters of Jeevamrutham per acre twice a week is essential. However, it's prudent to discontinue Jeevamrutham application two weeks prior to harvest. The 15th day after planting calls for a Jeevamrutham spray of 500 ml in 10 liters of water, followed by a second spray on the 21st day, mixed at a ratio of one liter to 10 liters of water. Fish amino acids can also be judiciously introduced to enhance vibrant growth.

As the 20-25 day mark typically witnesses the onset of blackfly attacks, pre-emptive measures are crucial. Spraying neem solution or insect repellent before an anticipated attack can ward off pests. Long gestation crops may necessitate two to three rounds of insecticide application. During the throat ray season and milking season, a fermented buttermilk spray is indispensable.

While natural cultivation often deters pest attacks, it's prudent to remain vigilant during inclement weather. Anticipatory measures, such as Agni astra and insect repellent, can be employed. Preparing and applying natural pesticides in advance rather than reacting to infestations is advised. Embracing summer tillage typically yields a decrease in pest infestations.

Seed Setting Stage: Nurturing Growth and Warding off Pests

In paddy cultivation, when the rice plants are in the reproductive phase, specifically when the stems become slightly bulky in appearance and flowers start forming within the stem, the plants require proper care, including adequate water supply and nutrients, to ensure optimal grain formation and yield.

This state demands daily vigilance in the fields. To harness the full potential of this phase, the utilization of fermented buttermilk solution is imperative. This potent concoction, derived from curd and sour buttermilk, houses gibberellin—a growth promoter that spurs robust crop development. Notably, the application of fermented buttermilk also doubles up as a fungal control measure. Diluting 500 ml of fermented buttermilk with 10 liters of water and gently sprinkling it across the fields is recommended.

Sustaining adequate moisture levels in the field without allowing it to dry out is paramount during the throat ray season. Neglecting this balance could lead to diminished yields. As the monsoon season sets in, preemptive measures are key to fending off insect infestations.

Having insect repellents on standby is prudent. A continued regimen of fermented buttermilk sprinkling remains essential during the milking season as well.

Determining the appropriate frequency of growth promoter application is a nuanced endeavor. For crops with shorter growth cycles (up to 75 days), administering Jeevamrutham every 15 days is ideal. In contrast, long-duration crops (up to 90 days) can benefit from the same treatment over an extended timeline. Striking this equilibrium is pivotal to ensuring uniform rice grain sizes, preventing the development of uneven growth.

Harnessing nature's mechanisms to combat pests is an eco-friendly strategy. Planting moth bean crops along the borders acts as a natural deterrent to pests. Complementary flora such as castor, corn, and marigold should be strategically positioned along fences to discourage pest infestations. The presence of scarecrows interspersed within the fields further reinforces this ecological approach.

An innovative touch lies in the use of yellow solar lights, ingeniously integrated to thwart pests naturally. These measures collectively create an ecosystem that naturally resists the onslaught of pests, fostering a healthier paddy crop without resorting to harmful chemicals.

Strategic Input Schedule: Guiding Growth

Effective paddy cultivation hinges on a well-structured input schedule. This comprehensive timetable ensures optimal nurturing of both the nursery and planting field, maximizing the potential yield. Let's delve into the intricate timeline of inputs for a successful harvest.

Nursery Applications

1. 7th Day Spray: Begin the journey by administering a thoughtful blend of water (10 liters) and Jeevamrutham (300 ml). This concoction lays the groundwork for healthy seedlings.

2. 15th Day Enrichment (If Seedling Growth is Sluggish): Should the seedling growth lag, a proactive measure involves immersing 2 kg of groundnut cake in 200 liters of water. Allow this infusion to soak for two days, infusing vitality into the seedlings.

3. Combatting Sap-Sucking Insects on Day 15: The appearance of sap-sucking insects necessitates swift action. A safeguarding solution lies in the application of insect repellent, effectively thwarting potential threats.

Planting Field Applications

It is essential to apply 200 liters of Jeevamrutham with irrigation water twice a month and discontinue it two weeks prior to harvest. Additionally the following input schedule is advised:

1. 15th Day Post-Planting: The 15th day sees the application of Jeevamrutham spray, comprising 500 ml within 10 liters of water.
2. 36th Day Post-Planting: Building upon the foundation, another spray of Jeevamrutham, amplified to 750 ml within 10 liters of water is required.
3. 57th Day After Planting: As the journey progresses, day 57 witnesses a heightened Jeevamrutham spray, now comprising 1 liter within 10 liters of water.
4. Jeevamrutham spray during the flowering season is essential with a consistent blend of 1 liter within 10 liters of water.
5. 20th Day Post-Planting: On the 20th day after planting, safeguard the crop's by applying the requisite natural pesticide against potential threats.
6. As the throat ray season emerges, a mixture of 10 liters of water and 500 ml of fermented buttermilk is needed.
7. Regular applications of fermented buttermilk, the same blend of 10 liters of water and 500 ml, is needed throughout the throat ray season.

This timetable acts as a helpful guide to navigate the input application at various steps of nursery preparation and crop cultivation. The balance between nourishment and protection is at the core of a successful paddy harvest, and this well-structured input schedule is well tested.

Navigating Paddy Pest Challenges: Understanding and Remedying Risks

Common Pest In Paddy

In the intricate landscape of paddy cultivation, pest management stands as a pivotal challenge. Dr. Saminathan elucidates the risks posed by specific pests, shedding light on their modes of attack and the potential consequences for the crop.

Yellow Stem Borer (Scirpophaga incertulas)

The yellow stem borer, a long-standing adversary, poses a significant threat. Its infestation spans two seasons: Kuruvai and Samba. Kuruvai season acts as the breeding season for this pest, laying the foundation for the ensuing menace during the Samba season. As the pest proliferates from the nursery to the flowering phase, telltale signs include dried centers, whitened rays, and dislodged rays upon slight touch. Alas, by the time symptoms emerge, intervention becomes futile. Eggs give rise to the stem borer, while a glimmer of hope rests in Trichogramma parasitoid wasps. Employing these wasps, which lay eggs to control stem borer reproduction, can yield a 60 to 70 percent success rate.

White backed plant hopper (Sogatella furcifera)

The white backed plant hopper appears mosquito-like and predominates during the vegetative growth season (September to November). Its attack transforms leaves into onion-like leaves, hindering growth and causing deformation. Vigilance aids early detection, as these insects swarm the pumpset area, days before the assault. Swift action is needed, employing insecticides upon identification to shield the crop.

Whorl maggot (Hydrellia sasakii, Hydrellia philippina)

The elusive whorl maggot finds a breeding ground in uneven fields and hollow ridges. These areas witness stunted seedling growth, reduced foliage, and dried leaves. The fly's presence delays crop growth, as eggs and maggots hamper development. An alarming consequence emerges—a 100-day crop elongates to a 110-day journey to harvest.

Leaf folder-: Cnaphalocrocis medinalis / Marasmia patnalis

The mother leaf folder displays a yellow coloration and exhibits wavy lines during the terminal phase of its life cycle. In chemical agriculture, excessive use of urea has been identified as the primary catalyst for leaf folder attacks. Elevated levels of urea application tend to correlate with heightened incidents of caterpillar infestations. Among the leaf varieties, designated as A and B, an overabundance of urea results in the proliferation of type B leaves, causing them to turn black and attract insects. Notably, attacks by these caterpillars are more prevalent during overcast weather conditions. Additionally, crops situated in shaded areas beneath trees are at an increased susceptibility to such infestations.

Rice case worm (Nymphula depunctalis)

Delta regions, during the rainy season, witness the prevalence of rice case worms, especially in waterlogged areas. Tender crops bear the brunt, marked by stunted growth and the telltale presence of tubular cages on leaves. These persistent caterpillars maneuver through water channels, infiltrating adjacent fields and compounding the problem.

Thrips (Stenchaetothrips biformis)

As water scarcity and summer's heat grip the land, the thrips might emerge, curling leaves in its wake. While it primarily ravages nurseries, its reach extends to planting fields as well. The crux lies in addressing both its occurrence and prevalence, warranting proactive measures to counteract its impact.

Brown plant leafhopper (Nilaparvata lugens)

The flowering season usually ushers in the brown plant leafhopper, clustering at the stem base's water level. The magnitude of its destruction belies its diminutive size, comparable to cumin. This pest, with a knack for impairing water-carrying xylem tubes, leaves a telltale mark on the plant's vitality. Vigilance and prompt action are imperative to curtail its progress, as water channels serve as conduits for its expansion.

Green leafhopper (Nephotettix virescens)

Under the sun's gaze, sometimes one can discern the darting flight of green leaf hopper, heralding their menace. The green leaf beetle inflicts rust-like patterns on leaves, disrupting photosynthesis and inducing continuous leaf yellowing. The implications cascade further as these pests facilitate ‘tungro’ virus attacks. Recognizing these subtle saboteurs is the first step in devising targeted countermeasures.

Black Rice Bug (Scotinophara coarctata)

The aftermath of the 2004 Tsunami witnessed the rise of the black rice bug, aptly termed the "Tsunami bug." Its onslaught results in yellowish-brown leaves, withering stems, and charred crops. Wielding its might from the base, this marauder can scorch entire fields, rendering a chiling spectacle known as "mite burn." Swift identification and timely intervention can avert its destructive path.

Mealybug (Brevennia rehi)

The white-hued mealybug mainly emerges as summer's heat intensifies, wreaking havoc on parched fields. The landscape bears testimony to its onslaught, manifested in patchy, yellowing crops. It thrives particularly where water is scarce, hinting at the highlands as its favored domain. Addressing this adversary necessitates a multi-pronged approach, encompassing water management and diligent field maintenance.

Spiny beetle (Rice hispa,Dicladispa armigera)

Despite its modest stature akin to a moth bean, the spiny beetle’s thorny body belies its destructive prowess. As it devours the crop, it triggers desiccation, manifesting as white streaks and sieve-like holes on the leaves. To thwart its advance, cultivating resilience through vigilant monitoring and early intervention is imperative.

Rice Earhead Bug (Leptocorisa acuta)

The rice earhead bug inflicts subtle yet ruinous damage. The milk is absorbed from the grain by this pest which renders the paddy blighted, leaving a trail of withering crops. A perpetual threat, its attacks intensify during fruit setting periods, casting a vegetable-like smell over the field. It lives on weed grass seeds. If weeds are not managed properly even in the adjacent fields, this insect attack becomes a possibility.

Spider Mites

Incidents of attacks by spider mites escalate during periods characterized by elevated temperatures and water scarcity. This phenomenon often leads to the yellowing of leaves and the presence of these minuscule spider mites.

Swarming caterpillar: Spodoptera mauritia

The swarming caterpillar, scientifically known as Spodoptera mauritia, is a significant pest that primarily affects crops during the months of July to September. This pest is particularly active during the nighttime hours. It is responsible for causing damage to rice crops, and in maize, it acts as an American aphid. The presence of this pest has been documented in

India's rice cultivation practices for the past 60 years. Notably, if the nursery lacks adequate water supply, the caterpillar can devastate the seedlings, akin to a grazing goat. Severe infestations of this pest can lead to substantial losses of seedlings within the nursery.

Rice Rainfed Termites

While termite infestations are geographically localized in specific Tamil Nadu regions, their impact is far-reaching. Areas like Ramanathapuram and Sivagangai, operating under rainfed systems, witness their onslaught. The lifecycle's intricacies unfold as paddy is sown before the monsoon's arrival, sprouting with the initial rains. However, irregular rainfall disrupts this rhythm, triggering land deterioration and, subsequently, termite attacks. The ramifications of this infestation can be profound.

Remedial Actions

A strategic arsenal of agronomic practices can serve as the vanguard against these adversaries. Summer tillage, simultaneous planting, precise variety selection, meticulous cultivation, and adept water and fertilizer management offer a multi-pronged defense. Crafting planting patterns, embracing crop rotation, deploying seed treatments, harnessing biofertilizers, and fortifying defenses with scarecrows, neem solutions, and natural insect repellents form a formidable line of defense.

Natural Farming Practices for Maize Cultivation

Introduction:
Maize, a versatile and staple crop, plays a vital role in global agriculture. Embracing natural farming practices for maize cultivation ensures sustainable and productive yields while promoting ecological harmony. This comprehensive guide elucidates the steps and insights necessary for successful maize cultivation through natural farming, providing farmers with a blueprint for healthy and bountiful harvests.

Seed Management:

For direct row sowing, 8 kg of high-quality maize seeds are required. Opt for seeds from high-yielding varieties suited to the local climate and soil conditions. Select mature maize ear heads for seed extraction. Separate the seeds from the ear heads at the time of sowing to optimize germination.

Green Manuring and Incorporation:

Kickstart the process with soil enrichment through green manuring. Begin with plowing using a 9-tip (Tyne) plow, followed by rotavator plowing. Introduce a diverse mix of seeds, including cereals, pulses, oilseeds, green manure seeds, spices, and herbs, totaling 25 kg. After 45 to 60 days of growth, integrate this vegetation into the soil using the rotavator, enhancing soil fertility.

Land Preparation:

Prepare the land by first conducting two rounds of plowing using a 9-tip (Tyne) plow. Subsequently, employ rotavator plowing to establish raised beds. Create 3/4-foot wide raised beds with a 5-tip (Tyne) plow, ensuring optimal conditions for root development.

Seed Sowing:

Adopt a direct sowing method for maize cultivation. Plant seeds with a spacing of 3/4 foot between rows and 2 feet between plants. This arrangement facilitates efficient growth and maximizes yield potential.

Irrigation:

After sowing, initiate irrigation immediately to support germination. Maintain a watering cycle of once every 10 days, adapting to the crop's moisture needs. Whether employing drip or flood irrigation, this approach ensures proper hydration.

Crop Management:

Exercise caution during sowing to avoid excessive depth in clay soils. Plant seeds at a depth of 2 cm. In sandy loam soils, increase the planting depth to 4 cm, facilitating suitable conditions for seed germination.

Weed Management:

Timely weed management is critical. Conduct the first weeding 30 days after seeding. Follow this with the application of Ghana Jeevamrutham (200 kg) and Neem cake (50 kg) per acre as basal application after the first weeding. These measures suppress weed competition and enhance soil fertility.

Growth Promoters:

Boost maize growth with growth promoters. Administer Jeevamirtham, a fermented herbal preparation, every 15 days, applying 200 liters through irrigation. On the 25th day, bolster growth by spraying 100 ml of fish acid (fish hydrolysate) mixed with 10 liters of water per tank, at a rate of 15 tanks per acre.

Insect Management:

Effective pest management safeguards crop health. Between the 15th and 21st days after seeding, spray 500 ml of 3G – neem solution mixed with 10 liters of water per tank, targeting stem worms. Address pod worms by applying 350 ml of Agni Astra mixed with 10 liters of water per tank between the 28th and 35th days. While natural farming minimizes insect issues, preemptively apply 1 liter of 3G – neem solution mixed with 10 liters of water per tank as a preventive measure against Ash weevils.

Disease Management:

Combat viral concerns such as yellow patch disease using a mixture of buttermilk (1 liter), turmeric powder (10 gm), and asafoetida powder (5 gm) mixed with 10 liters of water per tank. Administer this solution at a rate of 15 tanks per acre upon observing disease symptoms.

Trap Crops around Border:

Enhance beneficial insect populations through trap crops along the field's borders. Plant castor seeds in a single row with 5 feet spacing between plants or sow Toor Dal seeds in two rows (spacing of half a foot) in a zigzag pattern, with a spacing of 3 feet between plants. These attract beneficial insects that curtail pest populations.

Light Traps and Sticky Traps:

Counter harmful insects using light and sticky traps. Install a solar light trap seven days after seeding, positioning it at the field's center. Remove it when the crop reaches a height of 3 feet.

Harvest and Yield:

Harvest maize approximately 120 days after planting. Expect yields of up to 2500 kg per acre, a testament to the success of holistic natural farming practices.

Natural Farming Practices for Sorghum Cultivation

Introduction:
Sorghum, a resilient and versatile cereal crop, holds immense importance in global agriculture. Employing natural farming practices for sorghum cultivation ensures sustainable yields while promoting ecological balance. This in-depth guide outlines the steps and insights required for successful sorghum cultivation through natural farming, offering farmers a comprehensive strategy for prosperous and eco-friendly harvests.

Seed Management:

For direct row sowing, 5 kg of high-quality sorghum seeds are required. Opt for seeds from high-yielding varieties suited to the local climate and soil conditions. Select mature sorghum earheads for seed extraction. Separate the seeds from the ear heads at the time of sowing to optimize germination.

Green Manuring and Incorporation:

Initiate soil enrichment through green manuring. Commence with plowing using a 9-tip (Tyne) plow, followed by rotavator plowing. Introduce a diverse mix of seeds, including cereals, pulses, oilseeds, green manure seeds, spices, and herbs, totaling 25 kg. After 45 to 60 days of growth, integrate this vegetation into the soil using the rotavator, enhancing soil fertility.

Land Preparation:

Prepare the land by first conducting two rounds of plowing using a 9-tip (Tyne) plow. Subsequently, employ rotavator plowing to establish raised beds. Create 3/4-feet wide raised beds with a 5-tip (Tyne) plow, ensuring optimal conditions for root development.

Plantation:

Utilize the direct sowing method for sorghum cultivation. Plant seeds on the ridge of the raised bed, maintaining a spacing of 3/4 feet between rows and 1/2 feet between plants. This arrangement supports effective growth and yield potential.

Irrigation:

Initiate irrigation immediately after sowing to support germination. Maintain a watering cycle of once every 10 days, adapting to the crop's moisture requirements. Whether employing drip or flood irrigation, this practice ensures proper hydration.

Crop Management:

In sorghum cultivation, flowering and maturing stages are pivotal. Rainfall during these phases can negatively impact yield. Plants will begin flowering around the 30th day after sowing, with maturation beginning around the 90th day. Manage these stages with care to safeguard yield potential.

Weed Management:

Timely weed management is essential. Conduct the first weeding on the 30th day after sowing. Follow this with the application of Ghana Jeevamrutham (200 kg) and Neem cake (50 kg) per acre as basal application after the first weeding. These measures suppress weed competition and enhance soil fertility.

Growth Promoters:

Boost sorghum growth with growth promoters. Administer Jeevamirtham, a fermented herbal preparation, every 15 days, applying 200 liters through irrigation. On the 25th day, bolster growth by spraying 100 ml of fish acid (fish hydrolysate) mixed with 10 liters of water per tank, at a rate of 15 tanks per acre.

Insect Management:

Effective pest management safeguards crop health. On the 30th day from seeding, apply 500 ml of 3G – neem solution mixed with 10 liters of water per tank to control stem borers. Address grasshopper infestations by spraying 350 ml of Agni Astra mixed with 10 liters of water per tank on the 60th day. Although natural farming minimizes insect issues, preemptively apply buttermilk solution as a preventive measure against Downy mildew.

Disease Management:

Combat viral concerns such as yellow patch disease using a mixture of buttermilk (1 liter), turmeric powder (10 gm), and asafoetida powder (5 gm) mixed with 10 liters of water per tank. Administer this solution at a rate of 15 tanks per acre upon observing disease symptoms.

Trap Crops around Border:

Enhance beneficial insect populations through trap crops along the field's borders. Plant castor seeds in a single row with 5 feet spacing between plants or sow Toor Dal seeds in two rows (spacing of half a foot) in a zigzag pattern, with a spacing of 3 feet between plants. These attract beneficial insects that curtail pest populations.

Light Traps and Sticky Traps:

Counter harmful insects using light and sticky traps. Install a solar light trap seven days after seeding, positioning it at the field's center. Remove it when the crop reaches a height of 3 feet.

Harvest and Yield:

Harvest sorghum approximately 120 days after planting. Expect yields of up to 1000 kg per acre, a testament to the effectiveness of holistic natural farming practices.

Conclusion:
Sorghum cultivation, guided by natural farming practices, offers a harmonious approach to agriculture. This detailed package encompasses various stages, from seed selection to harvest, ensuring both productive yields and environmental preservation. By adhering to these principles, farmers can cultivate sorghum sustainably, fostering a balanced ecosystem while reaping the benefits of healthy, robust harvests.

Natural Farming Practices for Bajra Cultivation

Introduction:
Bajra, a resilient millet crop, holds a significant place in agricultural practices due to its adaptability and nutritional value. By integrating natural farming principles, farmers can

achieve sustainable and ecologically friendly bajra cultivation. This comprehensive guide elucidates the steps and insights required for successful bajra cultivation, providing a roadmap for productive and environmentally conscious harvests.

Seed Management:

For direct row sowing, 5 kg of high-quality bajra seeds are required. Alternatively, for the transplanting method, 2 kg of seeds is needed. Opt for seeds from high-yielding bajra varieties suitable for the local climate and soil conditions. Collect mature bajra earheads for seed extraction. Separate the seeds from the ear heads before sowing to ensure optimal germination.

Nursery Management:

For transplanting, initiate nursery management through the raised bed method. Cover the bed with shade net or paddy straw for the first three days after sowing to create a conducive environment for germination. Irrigate the nursery using a spray bucket every two days. Seven days after sowing, apply 3G neem solution (100 ml mixed with 10 liters of water). On days 15 and 23, administer fish acid (50 ml with 10 liters of water) or panchagavya (50 ml mixed with 10 liters of water). Seedlings will be ready for transplanting by the 25th day.

Green Manuring and Incorporation:

Prepare the soil for enrichment by first plowing with a 9-tip (Tyne) plow, followed by rotavator plowing. Sow a diverse mix of seeds weighing 25 kg, comprising cereals, pulses, oilseeds, green manure seeds, spices, and herbs. After 45 to 60 days of growth, incorporate this vegetation into the soil using the rotavator, enhancing soil fertility.

Land Preparation:

Begin land preparation by conducting two rounds of plowing using a 9-tip (Tyne) plow. Follow this with rotavator plowing to establish raised beds. Create 3/4-feet wide raised beds using a 5-tip (Tyne) plow, providing an optimal growth environment for the bajra crop.

Plantation:

For direct sowing, plant seeds with a spacing of 3/4 foot between rows and 1/4 foot between plants. Alternatively, for the transplanting method, wet the raised bed thoroughly before planting. Dip seedlings in beejamirtham and plant them, maintaining a distance of 0.5 feet between plants and 3/4 feet between rows.

Irrigation:

For direct sowing, initiate irrigation immediately after planting. For the transplanting method, irrigation can be conducted after 3 days. Subsequently, irrigate once every 10 days, adapting to the crop's moisture requirements, regardless of whether drip or flood irrigation systems are used.

Crop Management:

In the case of direct sowing, conduct plowing of the raised bed on the 30th day after planting, utilizing a bullock-drawn plow. This practice stimulates tiller growth, enhancing yield potential.

Weed Management:

Ensure effective weed management through timely interventions. Conduct the first weeding on the 15th day after planting and the second on the 30th day. After the second weeding, apply Ganajivamirtham (200 kg) and Neem cake (50 kg) per acre as basal application, suppressing weed competition and enriching soil fertility.

Growth Promoters:

Enhance bajra growth by administering growth promoters. Administer Jeevamirtham, a fermented herbal preparation, every 15 days, applying 200 liters through irrigation. On the 25th day, bolster growth by spraying 100 ml of fish acid (fish hydrolysate) mixed with 10 liters of water per tank, at a rate of 15 tanks per acre.

Insect Management:

Combat insect pests to ensure crop health. On the 30th day from seeding, apply 500 ml of 3G – neem solution mixed with 10 liters of water per tank to control stem borers. Address grasshopper infestations by spraying 350 ml of Agni Astra mixed with 10 liters of water per tank on the 60th day. Employ a buttermilk solution preventively to manage Downy mildew.

Disease Management:

Mitigate viral issues like yellow patch disease by applying a mixture of buttermilk (1 liter), turmeric powder (10 gm), and asafoetida powder (5 gm) mixed with 10 liters of water per tank. Apply this solution at a rate of 15 tanks per acre upon disease symptom detection.

Trap Crops around Border:

Boost beneficial insect populations by establishing trap crops along the field's borders. Plant castor seeds in a single row with 5 feet spacing between plants or sow Toor Dal seeds in two rows (spacing of half a foot) in a zigzag pattern, spacing plants 3 feet apart. These trap crops attract beneficial insects, curbing pest populations.

Light Traps and Sticky Traps:

Counteract harmful insects through light and sticky traps. Install a solar light trap seven days after planting, positioning it at the field's center. Remove the trap once the crop reaches a height of 3-3 feet.

Harvest and Yield:

Harvest bajra approximately 120 days after planting. Depending on the cultivation method, expect yields of up to 800 kg per acre for direct sowing and 1000 kg per acre for the transplanting method.

Natural Farming Practices for Black Gram Cultivation

Introduction:
Natural farming, an eco-friendly and sustainable approach to agriculture, focuses on harmonizing with nature's rhythms for optimal crop growth and minimal environmental impact. This detailed guide outlines essential practices for cultivating black gram using natural farming principles.

Seed Management:

Seed quality is a cornerstone of successful black gram cultivation. Farmers should select seeds from well-adapted, high-yielding varieties suitable for their specific regions and conditions. If opting for native varieties, ensure seeds are sourced from pods of high quality. Store seeds in a glass jar with ash, allowing a minimum 30-day hibernation period before sowing. This practice enhances germination rates and establishes a strong foundation for healthy plant growth.

Green Manuring and Incorporation:

Green manuring boosts soil fertility and promotes sustainable crop growth. Commence cultivation by plowing with a 9-tip (Tyne) plow, followed by rotavator plowing for improved soil structure. Sow a diverse mix of 25 kg seeds encompassing various categories, such as cereals, pulses, oilseeds, green manure, spices, and herbs, and subsequently incorporate these seeds using a rotavator after 45 to 60 days of growth. This incorporation enhances soil health and nutrient availability.

Land Preparation:

Preparing the land sets the stage for healthy crop establishment. Begin by plowing once with a 5-tip (Tyne) plow, followed by two rounds of plowing with a 9-tip (Tyne) plow. Employ the rotavator for further soil refinement. Create raised beds measuring 1.5 feet in width, promoting effective drainage and root penetration.

Plantation:

Precise plantation techniques contribute to uniform growth and optimal resource utilization. Soak seeds in beejamirtham solution for a maximum of 30 minutes before planting. Arrange seeds in a zig-zag pattern along the ridges, maintaining a distance of 10 cm from plant to plant within the row. This arrangement optimizes plant spacing and promotes healthy growth.

Irrigation:

Water management plays a pivotal role in black gram cultivation. After seeding, initiate the first watering immediately. Subsequently, maintain a regular irrigation schedule, providing water every 10-15 days as needed, irrespective of the chosen irrigation system.

Crop Management:

Cultivating black gram on raised beds enhances drainage and root health. Adequate drainage prevents waterlogging, safeguarding the crop against potential diseases and stress-induced issues. Ensuring appropriate drainage is pivotal for a successful natural farming approach.

Weed Management:

Effective weed management conserves resources and minimizes competition. Initiate the first weeding within 25 days of planting. Following the first weeding, apply a basal application of 500 kg of Farmyard Manure (FYM) per acre. This practice enriches soil fertility and supports crop growth.

Growth Promoters:

Promote robust plant growth through targeted growth promoters. Administer Jivamirtam at a rate of 200 liters through water every 15 days to provide essential nutrients and encourage beneficial microbial activity. On the 25th day, apply a solution of 100 ml fish acid (fish hydrolysate) mixed with 10 liters of water per tank at the rate of 15 tanks per acre. As the plants approach flowering on the 35th day, spray a solution of 1 liter coconut-butter milk mixture mixed with 10 liters of water per tank at the same rate. These treatments enhance plant vigor and productivity.

Insect Repellents:

Managing pests is a vital aspect of natural farming. Combat sucking pests by applying a solution of 500 ml 3G-neem mixed with 10 liters of water per tank on the 7th and 15th days after seeding. Address stem-eating worms by spraying 350 ml of Agni Astra mixed with 10 liters of water per tank on the 21st and 40th days. These treatments provide a proactive approach to pest management.

Disease Management:

Protecting against viral diseases like yellow patch disease is crucial. Prepare a solution of 1 liter buttermilk, 10 gm of turmeric powder, and 5 gm of asafoetida powder mixed with 10 liters of water per tank. Apply this solution at the rate of 15 tanks per acre to mitigate disease risks.

Trap Crops around Border:

Promote biodiversity and pest control by integrating trap crops around the field's borders. Plant maize seeds in three rows with half-foot spacing between rows and two feet spacing between plants. The outer fourth row should consist of cowpea seeds with a plant-to-plant spacing of 3 feet. Plant yellow-flowering plants like mustard or marigold between the cowpea rows to attract beneficial insects.

Light Traps and Sticky Traps:

Enhance pest control with light traps and sticky traps. Install solar light traps 7 days after planting, positioning one per acre around 4 feet in height at the field's center. Employ 10 yellow sticky traps and 3 purple sticky traps per acre, each attached to a 2-foot wooden stick. These traps contribute to pest population management.

Harvest and Yield:

A successful culmination of natural farming efforts results in a bountiful harvest. Black gram can typically be harvested in 90 days, yielding approximately 300 kg per acre. This reward reflects the synergistic relationship between sustainable practices and productive outcomes.

Natural Farming Practices for Green Gram Cultivation

Introduction:
Green gram, commonly known as mung bean, is a vital pulse crop known for its rich nutritional content and versatility. Employing natural farming practices enhances its growth while preserving the environment. This comprehensive guide elaborates on the steps and techniques for successful green gram cultivation, providing a roadmap for bountiful and eco-friendly harvests.

Seed Management:

For optimal results, allocate 8 kg of high-quality green gram seeds per acre. Prioritize good yielding varieties suitable for local climate and soil conditions. If native varieties are chosen, extract seeds from premium-quality pods. Store seeds in a glass jar layered with ash and keep them in hibernation for at least 30 days before sowing.

Green Manuring and Incorporation:

Start by plowing the land using a 9-tip (Tyne) plow, followed by rotavator plowing. Introduce a mixture of 25 kg diverse seeds comprising cereals, pulses, oilseeds, green manure seeds, spices, and herbs. After 45 to 60 days of growth, incorporate this vegetation into the soil using the rotavator, enriching the soil's nutrient profile.

Land Preparation:

Initiate land preparation by conducting one round of plowing using a 5-tip (Tyne) plow. Proceed with two rounds of plowing using a 9-tip (Tyne) plow. Follow this with rotavator plowing, ultimately creating a 2-feet wide raised bed. This bed structure provides optimal conditions for green gram growth.

Plantation:

For successful plantation, dip the seeds in beejamirtham, a natural seed treatment solution. Plant the seeds in a zigzag pattern on the ridges, maintaining a distance of 10 cm between plant-to-plant placements along the rows.

Irrigation:

Commence irrigation immediately after seeding. Subsequently, irrigate every 10-15 days, aligning with the crop's moisture requirements. This watering regime remains consistent for both drip and flood irrigation systems.

Crop Management:

Cultivate green gram exclusively on raised beds, ensuring adequate drainage facilities to prevent waterlogging and ensure plant health.

Weed Management:

Conduct the first weeding within 25 days of planting. After the initial weeding, apply farmyard manure (500 kg per acre) as basal application to further suppress weed growth and boost soil fertility.

Growth Promoters:

Promote robust growth through carefully selected natural solutions. Administer Jivamirtham, a fermented herbal preparation, every 15 days, applying 200 liters through irrigation. On the 25th day, enhance plant vigor by spraying 100 ml of fish acid (fish hydrolysate) mixed with 10 liters of water per tank, at a rate of 15 tanks per acre. As the plants approach the flowering stage on the 35th day, apply a solution of 1 liter coconut-butter milk mixed with 10 liters of water per tank, maintaining a rate of 15 tanks per acre.

Insect Management:

Combat insect pests to safeguard crop health. Administer 500 ml of 3G – neem solution mixed with 10 liters of water per tank on the 7th and 15th days after seeding to control sucking pests. To curb pod-eating worms, apply 350 ml of Agni Astra mixed with 10 liters of water per tank on the 21st and 40th days.

Disease Management:

Prevent viral infections like yellow patch disease by employing a mixture of buttermilk (1 liter), turmeric powder (10 gm), and asafoetida powder (5 gm) mixed with 10 liters of water per tank. This solution should be sprayed at a rate of 15 tanks per acre upon disease symptom detection.

Trap Crops around Border:

Attract beneficial insects to regulate harmful pests by planting trap crops along the field's borders. Create three rows of maize with half a foot spacing between rows and two feet between plants. The outermost row should be planted with cowpea, maintaining a plant-to-plant spacing of 3 feet. Intercrop yellow-colored flowering plants like mustard or marigold between the two cowpea rows.

Light Traps and Sticky Traps:

Counteract harmful insects through light and sticky traps. Install a solar light trap seven days after planting, placing it at the field's center. Utilize 10 yellow sticky traps and 3 purple sticky traps per acre, attached to 2-feet length wooden sticks.

Harvest and Yield:

Harvest green gram approximately 90 days after planting. Expect yields of around 300 kg per acre, contributing to a productive and sustainable harvest.

Natural Farming Practices for Tomato Cultivation

Introduction:
Tomatoes are a staple in many cuisines, and cultivating them using natural farming methods not only ensures a healthy harvest but also promotes environmental sustainability. This comprehensive guide offers a detailed package of practices for successful tomato cultivation, encompassing essential steps and insights for achieving robust yields while adhering to natural farming principles.

Seed Management:

Selecting the right seeds is pivotal for a successful tomato harvest. With a requirement of 20,000 seeds (approximately 200 seeds per 1 gram), choose high-yielding varieties suitable for your region. If opting for native tomato varieties, collect seeds from fruits between the

5th and 10th picks. Store the seeds in a glass jar with ash for at least 60 days before sowing to enhance germination and growth.

Nursery Management:

Establishing a healthy nursery is crucial for strong seedling growth. Sow the tomato seeds in a raised bed or tray. Cover the bed or tray with shade netting or paddy straw for three days, ensuring optimal moisture retention and protection. Irrigate every two days using a spray bucket. Administer 3G neem solution (a mix of 100 ml solution with 10 liters of water) within seven days after sowing. On the 15th and 23rd days, apply fish acid or panchagavya as directed. Seedlings should be ready for transplanting by the 25th day.

Green Manuring and Incorporation:

Prioritize soil enrichment through green manuring. Plow the land using a 9-tip (Tyne) plow followed by rotavator plowing. Sow a diverse mix of 25 kg of various seed varieties, including cereals, pulses, oilseeds, green manure seeds, spices, and herbs. After 45 to 60 days of growth, incorporate this vegetation into the soil using the rotavator, enhancing soil fertility and structure.

Land Preparation:

Prepare the land meticulously to ensure optimal growth conditions. Commence with a single plowing using a 5-tip (Tyne) plow, followed by two rounds of plowing using a 9-tip (Tyne) plow. Conclude with rotavator plowing, creating raised beds with a width of 3 feet to facilitate water drainage and root development.

Plantation:

Ensure successful transplanting through careful techniques. Prior to transplanting, irrigate the raised beds. Dip the roots of the tomato seedlings in beejamirtham solution and plant them in a zig-zag pattern, maintaining a spacing of 1.5 feet between plants. This configuration fosters efficient air circulation and sunlight exposure for optimal growth.

Irrigation:

Regular and proper irrigation is essential for tomato cultivation. Initiate irrigation on the third day after transplanting and maintain a schedule of watering every five days, regardless of the chosen irrigation method (drip or flood).

Crop Management:

Boost plant vigor and immunity by applying a mixture of 5 kg of neem powder and 200 liters of water within seven days of planting. Neem's natural properties contribute to pest control and overall plant health.

Weed Management:

Effective weed control is crucial to minimize competition for resources. Complete the first weeding within 12 days of planting and the second weeding within 25 days. After the second weeding, apply a basal application of Farmyard Manure (FYM), Neem cake, Groundnut cake, and a special nitrogen substance to enrich the soil and support plant growth.

Growth Promoters:

Facilitate robust plant growth through growth promoters. Administer Jivameertam, a fermented herbal preparation, every 10 days by applying 200 liters through irrigation. Alternatively, apply fish acid or panchagavya every 15 days by spraying on the field to enhance plant vitality and resilience.

Insect Management:

Maintain a balanced insect population for a healthy crop. Apply neem solution mixed with water to control pests on the 7th and 15th days after planting. For leaf and stem-eating worms, use Agni Astra mixed with water on the 21st and 28th days. While natural farming systems typically experience fewer insect problems, applying Agni Astra as a preventative measure can be beneficial.

Disease Management:

Prevent and manage diseases through proactive measures. For viral problems like yellow patch disease, prepare a mixture of buttermilk, turmeric powder, and asafoetida in water and spray it to mitigate the issue.

Trap Crops around Border:

Improve the ecological balance by planting trap crops around the field's borders. Plant maize seeds in three rows with spacing between rows and cowpea seeds in the outer row. Intermingle yellow-flowering plants like mustard or marigold between the cowpea plants to attract beneficial insects that regulate pest populations.

Light Traps and Sticky Traps:

Control harmful insects with light and sticky traps. Install solar light traps seven days after planting, positioning them at the field's center. Implement yellow and purple sticky traps per acre to attract and capture harmful insects, promoting a healthier crop environment.

Trellis Construction:

Support tomato plants' vertical growth with a sturdy trellis. Place 5-feet high wooden sticks at 8-feet spacing along the bed's length. Secure 10-gauge wires to the top ends of the poles, anchoring both ends of the bed with wooden stays for stability. When the plants have two branches, tie them to the wire using hemp threads by the 30th day.

Harvest and Yield:

Timely and careful harvesting is essential. Start harvesting on the 48th day, continuing every two days for the next 120 days. This schedule can yield up to 20 tons.

Natural Farming Practices for Small Onion Cultivation

Introduction:
Small onions are a versatile and widely used vegetable in various cuisines. Adopting natural farming practices for their cultivation not only ensures a bountiful harvest but also aligns with environmentally friendly methods. This comprehensive guide provides a detailed package of practices for successful small onion cultivation, encompassing essential steps and insights to ensure robust yields while adhering to natural farming principles.

Seed Management:

Small onion cultivation begins with selecting high-quality seed onions. Aim for onions that are at least 150 days old, displaying good color and maturity. Storing these seeds is crucial. Construct a box-like structure using bamboo-made sheets, 2 feet wide by 4 feet high and 15 feet long, to facilitate optimal ventilation and prevent moisture accumulation.

Green Manuring and Incorporation:

Boost soil fertility through green manuring. Commence with a plowing using a 9-tip (Tyne) plow, followed by rotavator plowing. Sow a mix of 25 kg of various seed varieties, encompassing cereals, pulses, oilseeds, green manure seeds, spices, and herbs. After 45 to 60 days of growth, incorporate this vegetation into the soil using the rotavator, enriching the soil's nutrient content.

Land Preparation:

Prepare the land diligently to ensure conducive growth conditions. Begin with a single plowing using a 5-tip (Tyne) plow, followed by two rounds of plowing using a 9-tip (Tyne) plow. Conclude with rotavator plowing, creating raised beds with a width of 2 feet to facilitate drainage and root development.

Plantation:

Successful plantation requires careful attention to detail. Prior to planting, ensure thorough wetting of the raised bed. Dip the small onion seeds in beejamirtham solution before immediate planting to prevent rotting. Plant four rows of seeds along the bed with 10 cm spacing between seeds. Alternate two rows along the ridges and two rows in between, maintaining a half-foot spacing.

Irrigation:

Initiate irrigation on the third day after sowing to support seed germination. Maintain a watering frequency of once every seven days, adapting to the needs of the crop, regardless of the chosen irrigation method (drip or flood).

Crop Management:

Cultivate small onions exclusively on raised beds with adequate drainage to prevent waterlogging and root rot. Ensure proper drainage facilities to avoid water stagnation and resultant crop damage.

Weed Management:

Minimize weed competition through effective management. Conduct the first weeding within 20 days of planting and the second weeding within 30 days. After the second weeding, apply a basal application of Farmyard Manure (FYM), Neem cake, Groundnut cake, and a special nitrogen substance to enhance soil fertility and support plant growth.

Growth Promoters:

Stimulate healthy growth through growth promoters. Administer Jivameertam, a fermented herbal preparation, every 10 days by applying 200 liters through irrigation. Additionally, apply fish acid or panchagavya every 15 days by spraying onto the field to enhance plant vigor and resilience.

Insect and Disease Management:

While small onions cultivated through natural farming methods generally experience fewer pest and disease issues, preventative measures are still important. Apply 3G neem solution mixed with water on the 7th and 15th days after seeding to control sucking pests. Combat leaf and stem-feeding worms using Agni Astram mixed with water on the 21st and 28th days. For diseases like chicken foot disease and yellow patch disease, use a mixture of turmeric powder, asafoetida, and buttermilk solution. This should be applied at the first signs of disease emergence.

Trap Crops around Border:

Enhance beneficial insect populations through trap crops around the field's borders. Plant maize seeds in three rows with half-foot spacing between rows and two feet spacing between plants. The outer fourth row should be planted with cowpea seeds, maintaining a 3-foot spacing between plants. Intermingle yellow-flowering plants like mustard or marigold between the cowpea plants to attract beneficial insects that regulate pest populations.

Light Traps and Sticky Traps:

Combat harmful insects with light and sticky traps. Install solar light traps seven days after planting, positioning them at the field's center. Implement yellow and purple sticky traps per acre to attract and capture harmful insects, thereby promoting a healthier crop environment.

Harvest and Yield:

Harvest small onions approximately 70 days after planting. Continuous harvesting can yield between 4 to 5 tons per acre. The harvested small onions can be stored without quality loss for up to six months using the storage method described above.

Natural Farming Practices for Chili Cultivation

Introduction:
Natural farming is an ecologically conscious and sustainable approach to agriculture that emphasizes working with nature's rhythms to ensure healthy crops and minimal environmental impact. This comprehensive guide outlines a step-by-step package of practices for cultivating chilies using natural farming principles.

Seed Management:

Seed quality is pivotal to a successful chili harvest. Aim for approximately 150 seeds per gram, and procure around 20,000 seeds for an acre. Opt for high-yielding varieties well-suited to your region and land. Select chili pods with a stocking capacity of at least 100 days, and let them mature for at least 60 days before sowing. Seeds should be extracted from pods just before sowing to ensure optimal germination.

Nursery Management:

For successful seedling establishment, begin by sowing seeds in raised beds or trays. Cover these with shade netting or paddy straw for three days, then remove the cover. Irrigate every two days using a spray bucket. On the 7th day, apply a 3G neem solution by mixing 100 ml with 10 liters of water. On days 15 and 23, consider applying fish acid (50 ml with 10 liters of water per tank) or panchagavya (50 ml mixed with 10 liters of water per tank). By the 25th day, your seedlings will be ready for transplanting.

Green Manuring and Incorporation:

Kickstart the process with plowing using a 9-tip (Tyne) plow, followed by rotavator plowing for soil improvement. Sow a variety of seeds, including cereals, pulses, oilseeds, green manure seeds, spices, and herbs, totaling 25 kg. After 45 to 60 days of growth, these plants will be incorporated into the soil using a rotavator, enhancing soil health.

Land Preparation:

Prepare the land meticulously to optimize crop growth. Begin with a single plowing using a 5-tip (Tyne) plow, followed by two rounds of plowing with a 9-tip (Tyne) plow. Employ the rotavator to refine the soil further. Create raised beds measuring 2 feet in width to facilitate proper drainage and root growth.

Plantation:

Before transplanting seedlings, irrigate the raised beds. Soak the roots of the seedlings in beejamirtham solution and plant them in a zig-zag pattern along the ridges, maintaining a one-foot distance between plants. This pattern encourages healthy growth and resource utilization.

Irrigation:

Initiate irrigation three days after transplanting and maintain a regular schedule of watering every three days as needed. This schedule applies to both drip and flood irrigation methods.

Crop Management:

Within seven days of planting, mix 5 kg of neem powder with 200 liters of water and administer through irrigation to enhance plant health.

Weed Management:

Prioritize weed management to prevent competition for resources. Perform the first weeding within 12 days of planting and the second within 25 days. After the second weeding, apply a basal application of 500 kg of Farmyard Manure (FYM), 50 kg of Neem cake, 50 kg of Groundnut cake, and 50 kg of special nitrogen substance per acre.

Growth Promoters:

Promote vigorous plant growth with growth promoters. Administer Jivameertam at a rate of 200 liters through water every 10 days. Apply either 100 ml of fish acid (mixed with 10 liters of water per tank) or 200 ml of Panchagavya (mixed with 10 liters of water per tank) every 15 days by spraying on the field.

Insect Management:

Maintain insect balance through vigilant management. Apply 500 ml of 3G neem solution mixed with 10 liters of water per tank on the 7th and 15th days after planting to control pests. For leaf and stem-eating worms, use 350 ml of Agni Astra mixed with 10 liters of water per tank on the 21st and 28th days. In case of leaf aphid attack, apply 500 ml of vajravalli (adamant creeper) or aloe vera solution mixed with 10 liters of water per tank on 15 tanks per acre.

Disease Management:

Combat leaf curling disease with a proactive approach. If viral diseases like yellow patch disease are observed, create a solution by mixing 1 liter of buttermilk, 10 gm of turmeric powder, and 5 gm of asafoetida powder with 10 liters of water per tank. Spray this solution at the rate of 15 tanks per acre.

Trap Crops around Border:

Boost ecological balance through trap crops around the field's borders. Plant maize seeds in three rows with half-foot spacing between rows and two feet spacing between plants. The outer fourth row should include cowpea seeds spaced 3 feet apart. Intersperse yellow-flowering plants like mustard or marigold between the cowpea rows to attract beneficial insects.

Light Traps and Sticky Traps:

Enhance pest control with light and sticky traps. Place solar light traps in the field's center at a rate of 1 per acre, 7 days after planting. Incorporate 10 yellow sticky traps and 3 purple sticky traps per acre, each attached to a 2-foot wooden stick, to attract and capture harmful insects.

Harvest and Yield:

Harvesting begins on the 48th day and continues every three days for the next 150 days. Over this period, harvest approximately 3 tons of green chilies or 3-harvests of ripened red chilies, yielding around 600 kg of dried chili pods.

Natural Farming Practices for Lady Finger Cultivation

Introduction:
Cultivating ladyfinger, also known as okra, through natural farming methods is a sustainable and environmentally friendly approach that emphasizes harmony with nature, minimal chemical intervention, and optimal yield. This comprehensive guide provides a detailed package of practices for successful lady finger cultivation, incorporating step-by-step instructions and insights to ensure a bountiful harvest.

Seed Management:

Selecting high-quality seeds is the first step towards a productive lady finger crop. With a recommended seed rate of 2.5 kg per acre, farmers should opt for varieties suited to their region and land conditions. When choosing native lady finger varieties, harvest seeds from well-developed fruits between the 5th and 10th picks. Store the seeds in a glass jar with ash and let them rest for a minimum of 60 days before sowing to enhance germination and growth.

Green Manuring and Incorporation:

Healthy soil is crucial for optimal crop growth. Begin land preparation by plowing with a 9-tip (Tyne) plow, followed by rotavator plowing. Introduce diversity into the soil by sowing a mix of 25 kg different seed varieties, including cereals, pulses, oilseeds, green manure seeds, spices, and herbs. After 45 to 60 days of growth, incorporate this vegetation into the soil using a rotavator, enriching the soil with organic matter and nutrients.

Land Preparation:

Well-prepared soil forms the foundation of successful cultivation. Start with a single plowing using a 5-tip (Tyne) plow, followed by two rounds of plowing with a 9-tip (Tyne) plow. Conclude with rotavator plowing and create raised beds with a width of 2.5 feet, optimizing drainage and root penetration.

Plantation:

Careful transplanting ensures healthy growth. Soak the seeds in beejamirtham solution and plant them in a zig-zag pattern along the ridges of the raised beds, maintaining a spacing of 1.5 feet between plants. This configuration enables proper air circulation and sunlight exposure, crucial for disease prevention and overall plant health.

Irrigation:

Regular and consistent irrigation is essential for lady finger cultivation. Initiate irrigation on the third day after seeding, and maintain a schedule of watering every three days, regardless of the chosen irrigation method (drip or flood).

Crop Management:

Enhance plant vitality by applying a mixture of 5 kg of neem powder and 200 liters of water within seven days of planting. Neem's natural properties act as a deterrent to pests and promote plant growth.

Weed Management:

Effective weed control prevents resource competition and encourages healthy plant growth. Perform the first weeding within 12 days of planting and the second weeding within 25 days. After the second weeding, apply a basal application of Farmyard Manure (FYM), Neem cake, Groundnut cake, and a special nitrogen substance to enrich the soil and support plant development.

Growth Promoters:

Facilitate robust plant growth with growth promoters. Administer Jivameertam, a fermented herbal preparation, every 10 days by applying 200 liters through water. Alternatively, apply fish acid or panchagavya every 15 days by spraying on the field to enhance plant vigor and resilience.

Insect Management:

Maintain a balanced insect population to safeguard crop health. Apply a neem solution mixed with water to control pests on the 7th and 15th days after planting. For leaf and stem-eating worms, use Agni Astra mixed with water on the 21st and 28th days. While natural farming systems generally experience fewer insect problems, be prepared to address leaf aphid attacks with vajravalli or aloe vera solution.

Disease Management:

Prevent and manage diseases through proactive measures. Combat leaf curling disease by maintaining overall crop health. For viral problems like yellow patch disease, apply a mixture of buttermilk, turmeric powder, and asafoetida in water to mitigate the issue.

Trap Crops around Border:

Enhance the natural balance of the ecosystem by planting trap crops around the field's borders. Plant maize seeds in three rows with spacing between rows and cowpea seeds in the outer row. Intersperse yellow-flowering plants like mustard or marigold between the cowpea plants to attract beneficial insects that regulate pest populations.

Light Traps and Sticky Traps:

Manage harmful insects with light and sticky traps. Install solar light traps seven days after planting, positioning them at the field's center. Implement yellow and purple sticky traps per acre to attract and capture harmful insects, contributing to a healthier crop environment.

Harvest and Yield:

Harvesting ladyfinger involves careful timing. Begin harvesting on the 48th day, and continue every two days for the next 120 days. This harvesting schedule results in an approximate yield of 4 tons per acre.

Natural Farming Approach for Sugarcane Cultivation

Introduction

Sugarcane, a versatile and vital crop known for its role in sweetener and byproduct production, can be cultivated sustainably through a well-designed natural farming approach. This comprehensive guide aims to elucidate the step-by-step methodology from land preparation to harvest, ensuring not only successful yields but also an environmentally friendly and economically viable sugarcane cultivation experience.

Preparing the Field: Enhancing Soil Fertility and Health

The journey towards sustainable sugarcane cultivation starts with preparing the land. Sowing 20 kg of multi-grain or green manure, such as Sanapu or Thakkai Poondu, per acre serves as an effective means to enhance soil fertility. This practice enriches the soil with organic matter and beneficial microorganisms, promoting healthy root development and nutrient availability. The subsequent plowing within 50 to 60 days helps to integrate the green manure into the soil, fostering a nutrient-rich environment for the upcoming crop.

Preparing the Seedbed: Disease-Free Setts and Nutrient Boost

The choice of a fertile seedbed is crucial for healthy sett development. Allocating 5 cents of land per acre for seedbeds provides ample space for disease-free setts to flourish. Selecting setts from the sixth or seventh month ensures their maturity and robustness. The employment of a 3-foot bar (Ridger) during seedbed preparation enhances soil aeration, promoting optimal root growth. The application of 100 kg of Ghana Jeevamrutham further enriches the soil with essential nutrients, setting the stage for healthy sett growth. The treatment of setts with beejamirtham guarantees a strong and vibrant start for the crop, while regular irrigation with 20 liters of jeevamirtham mixed with 100 liters of water supports consistent growth. The judicious use of insect repellent on the 30th day post-planting, based on pest observation, showcases a proactive approach to pest management.

Preparing the Planting Field: Creating an Ideal Environment

The planting field is prepared meticulously to provide an optimal environment for sugarcane growth. The use of a 5 masonry plow (Kothu Kalappai) during the initial plowing, followed by two rounds of rotavator plowing, ensures a well-tilled and aerated soil structure. The strategic application of one ton of Ghana Jeevamrutham per acre during the second plowing fosters soil health and microbial activity. The careful arrangement of bars allows the creation of channels (Vaaikaal) every four feet, accommodating the setts and facilitating proper planting.

Sett Treatment: Ensuring Robust Beginnings

The care taken during sett treatment significantly influences crop success. Soaking setts in Beejamirutham and adhering to the recommended treatment process fortifies the setts, ensuring vigorous growth upon planting. This attention to detail in the early stages sets the foundation for a productive crop.

Planting: Optimizing Sett Placement

Precise sett planting plays a pivotal role in crop development. Placing setts closely within the channels (Vaaikaal) established by the bars maximizes space utilization and nutrient availability. This method, requiring 10,000 to 12,000 kg of setts per acre, showcases the meticulous approach adopted in this natural farming practice.

Water Management: Balancing Moisture Needs

Effective water management contributes to healthy sugarcane growth. Watering every four days during the first three months supports sett establishment, while transitioning to weekly watering afterward caters to the changing moisture requirements. The consideration of moisture levels minimizes water wastage and optimizes resource utilization.

Germination Phase: Nurturing Stubborn Growth

By snapping the mother sprout at the 40th day post-planting, the germination phase is strategically managed. This action redirects energy towards the development of more stubbles (Thoor), promoting vigorous growth and multiple shoots from a single sett.

Weed Management: Aiding Crop Dominance

The introduction of 10 kg of Moth Bean (Nari Payiru) during the last plowing while planting serves as a natural ally in weed management. Manual weeding at specific intervals, including 20 days, 40th day, and 60th day post-planting, reflects a proactive stance in creating an environment conducive to crop dominance.

Earthing Up or Hilling: Supporting Root Stability

Within three months of planting, earthing up the sugarcane provides vital root support. This practice fosters root stability, prevents tilting, and ensures optimal nutrient and water absorption.

Detrashing: Promoting Crop Health and Yield

Detrashing, conducted twice during the fifth and seventh months, enhances aeration and contributes to healthy yields. By minimizing the habitat for pests like the Internode Borer, this practice reinforces the robustness of the crop.

Inputs: Nourishing the Crop

Thoughtful inputs play a pivotal role in sustaining crop health and productivity. The consistent provision of inputs for six months post-planting nurtures the crop. Integrating 200 liters of Jeevamrutham per acre with irrigation water, administered bi-monthly, ensures a continuous nutrient supply. The incorporation of 3 liters of Fish Amino Acid during the initial four months further bolsters nutrient availability.

Monthly spraying of 300 ml of Panchagavya mixed with 10 liters of water or 1 liter of Jeevamrutham mixed with 10 liters of water underscores the commitment to promoting biological vigor. This practice enhances plant health and resistance, contributing to sustained crop vitality.

Pest Management: Proactive Pest Control

The natural farming approach involves proactive pest management based on observation and understanding of pest dynamics. Employing insect repellent on the 30th day post-planting and utilizing insect repellants during regular monitoring demonstrate an adaptive approach that minimizes chemical intervention.

Harvest: Rewarding Sustainable Efforts

After 10-12 months of nurturing the crop through holistic natural farming practices, the harvest phase marks the culmination of sustained efforts. With the potential yield projected between 40 to 50 tons per acre, this approach showcases the viability of natural farming in achieving robust harvests.

Natural Farming Approach for Turmeric Cultivation

Introduction:
Turmeric, with its diverse culinary and medicinal uses, is a valuable crop. By following natural farming practices, turmeric cultivation can be not only productive but also sustainable. This comprehensive guide outlines every step, from land preparation to harvest, ensuring a successful and eco-friendly turmeric farming experience.

Land Preparation:
Prior to turmeric planting, enrich the land by sowing multi-grain or green manure crops like *sanapu* or *thakkaipundu* at a rate of 20 kg per acre. After 50-60 days, these crops should be wrapped and plowed, preparing the soil for turmeric cultivation.

Seed Selection:
To ensure a successful turmeric harvest, source 800 kg of high-quality turmeric seed.

Plant Land Preparation:
Initiate land preparation by plowing with a 5-cluster plow, followed by two rounds of plowing with a 9-cluster plow and rotavator plowing for two rounds. During the second plowing, incorporate one ton of ganajeevamirtham per acre. Create a trench that is 1.5 feet high for planting.

Seed Treatment:
Soak the turmeric seeds in beejamirtham for seed treatment, enhancing their germination and vitality.

Plantation:
Plant the turmeric seeds in rows with a 1.5-foot distance between rows and a 0.5-foot spacing between plant-to-plant placements.

Water Management:

Provide water once in the first week after planting. If there is sufficient moisture, additional watering might not be necessary.

Weed Management:
Perform the first weeding on the 20th day after planting. To suppress weed growth, sow 8 kg of moth beans per acre during weeding. Depending on weed growth, conduct two or three rounds of hand weeding. Alternatively, prevent weed growth by applying sugarcane mulch, around 1-foot high, over the acre.

Cutting Leaves:
Approximately 15 days before harvest, trim the turmeric leaves. This practice promotes healthier growth and eases harvesting.

Inputs:

Irrigation Water:
Irrigate consistently since planting, applying 200 liters per acre twice a month. For the first four months, add 3 liters of fish amino acid to 200 liters of water monthly. Post the first weeding, soak 15 kg of groundnut cake, castor cake, and neem cake in 200 liters of water for two days before using for irrigation.

Spraying:
Apply Panchagavya at a rate of 300 ml per 10 liters of water once a month from planting. Alternatively, mix one liter of Jeevamirtham with 10 liters of water for spraying.

Pest Management:
On the 30th day after planting, spray insect repellent to control pests. Only use insect repellants if there is a noticeable pest presence in the field.

Harvest:
Turmeric can be harvested within 10 months. After harvesting, boil and dry the turmeric before polishing. This process yields around 2500 kg of dry turmeric per acre.

Natural Farming Practices for Groundnut Cultivation

Introduction:
Natural farming is an environmentally conscious and sustainable approach to agriculture that emphasizes working in harmony with nature's processes. Groundnut cultivation, following these principles, entails a holistic and integrated approach to achieve healthy crop growth, high yields, and ecological balance.

Seed Management:

To establish a strong foundation for a successful groundnut crop, begin with selecting high-quality seeds. A seed rate of 70 kg per acre is recommended for optimal plant density.

It's crucial to choose seeds from mature pods, ensuring genetic viability. Further enhancing seed quality, a 30-day hibernation period for seed pods before sowing promotes better germination rates. Immediate removal of pod shells just before planting aids in reducing transplant shock and accelerating establishment.

Green Manuring and Incorporation:

Soil health is paramount in natural farming. Initiating the cultivation process with a 9-tip (Tyne) plow and subsequent rotavator plowing contributes to soil aeration and minimizes soil compaction. Incorporating green manure adds organic matter and enhances soil fertility. Sow a diverse mix of 25 kg seeds from various categories, including cereals, pulses, oilseeds, green manure, spices, and herbal seeds. The 45 to 60-day growth period culminates in incorporating the green manure using a rotavator, ensuring its integration into the soil for nutrient enrichment.

Land Preparation:

Effective land preparation is essential to create an optimal growing environment. Begin with a single plowing using a 5-tip (Tyne) plow, followed by two rounds of plowing with a 9-tip (Tyne) plow. Subsequently, employ the rotavator to ensure thorough soil preparation. The final step involves creating a raised bed measuring 4 feet in width, which improves drainage and root penetration.

Seed Sowing:

Precision in seed sowing guarantees uniform growth and proper utilization of resources. Plant seeds at a depth of around 1 inch on dry surfaces. Optimal spacing facilitates healthy plant development. Organize seeds into four rows with equal 25 cm widths, maintaining a one-foot spacing between seeds along each row. Adequate spacing reduces competition for resources and sunlight.

Irrigation:

Water management is critical for groundnut cultivation. After sowing, provide the initial watering promptly. Subsequently, follow a consistent irrigation schedule, irrigating once every 7 days, regardless of the chosen irrigation method—drip or flood. Proper moisture management ensures steady growth and reduces stress-induced vulnerabilities.

Crop Management:

Cultivating groundnuts exclusively on raised beds enhances drainage, a fundamental aspect of natural farming. Adequate drainage prevents waterlogging, which can lead to root decay and hinder overall plant health. Pay attention to maintaining optimal drainage to create a conducive environment for plant growth.

Weed Management:

Weed management is crucial for resource optimization and reducing competition. Initiate the first weeding within 20 days of planting and the second weeding within 40 days. Following the second weeding, apply a basal application of 500 kg of Farmyard Manure (FYM), 50 kg of Neem cake, 50 kg of Groundnut cake, and 50 kg of a special nitrogen substance per acre. This enhances soil fertility and supports crop growth.

Growth Promoters:

Applying growth promoters contributes to robust plant growth. Jivamirtham, administered at a rate of 200 liters through water every 10 days, provides essential nutrients and enhances soil microbial activity. Alternatively, every 15 days, choose between spraying 100 ml of fish acid (fish hydrolysate) or 200 ml of Panchagavya mixed with 10 liters of water per tank, considering the requirement of 15 tanks per acre. These substances foster plant vigor and overall health.

Insect Management:

Pest control is a vital component of natural farming. Utilize a neem solution of 500 ml 3G mixed with 10 liters of water per tank for spraying on the 7th and 15th days after sowing. To manage leaf and stem-eating worms, apply 350 ml of Agni Astra mixed with 10 liters of water per tank on the 21st and 28th days. Although natural farming minimizes insect-related challenges, a preventive measure like Agni Astra provides added protection.

Disease Management:

To counter viral issues such as yellow patch disease, deploy disease management techniques. Prepare a solution consisting of 1 liter of buttermilk, 10 gm of turmeric powder, and 5 gm of asafoetida powder mixed with 10 liters of water per tank. Apply this solution at the rate of 15 tanks per acre, effectively mitigating disease risks.

Trap Crops around Border:

Promote ecological balance through trap crops around the border of the field. These attract beneficial insects, aiding in the control of harmful pest populations. Implement a strategy of planting maize seeds in three rows, with half-foot spacing between rows and two feet between plants. The outer fourth row should be dedicated to cowpea seeds, spaced 3 feet apart plant-to-plant. Interplant yellow-flowering plants like mustard or marigold between the cowpea rows, fostering a diverse ecosystem.

Light Traps and Sticky Traps:

Implement light traps and sticky traps to manage pests effectively. Install solar light traps 7 days after sowing, positioning one per acre at a height of approximately 4 feet in the field's center. Incorporate 10 yellow sticky traps and 3 purple sticky traps per acre, each tied to a

2-foot wooden stick. These traps serve as attractants and contribute to pest population control.

Harvest and Yield:

The culmination of a well-executed natural farming process is a rewarding harvest. Groundnuts can be harvested in approximately 120 days, yielding around 1300 kg of pods or 830 kg of seeds per acre. A successful harvest signifies the harmony achieved between sustainable practices and productive outcomes.

Natural Farming Practices For Banana Cultivation

Introduction:
Banana, a versatile and popular fruit, can be cultivated using natural farming practices that ensure a healthy crop while minimizing environmental impact. This detailed guide provides an in-depth exploration of banana cultivation, from selecting the right species to harvesting, while emphasizing the significance of eco-conscious methods.

Varieties and Seasons:
In Tamil Nadu, banana cultivation includes varieties with export potential such as Nendran, Kathali, and Grand 9, as well as domestic consumption varieties like Karpuravalli, Poovan, Red Plantain, Mondhan, and Rasthali. To optimize yield and price, strategic planting is recommended to align with festive seasons when banana demand peaks.

Preparation of Field:
A well-drained land is optimal for banana cultivation. Enhance soil fertility by planting 25 kg of multi-grains per acre, followed by plowing on the 50th day. Apply 100 kg of Ghana Jeevamrutham and 100 kg of neem cake to enrich the soil and combat nematode and fungal issues.

Rhizome Selection:
Choosing healthy rhizomes is essential for successful banana cultivation. Select disease-free rhizomes from robust mother trees. Optimal suckers are around three months old with a height of 2-3 feet, emerging from rhizomes near the mother tree. Rhizomes should weigh 1-2 kg and be free from nematodes and rhizome palm weevil attack.

Seed Treatment:
To prevent soil-borne diseases, treat rhizomes with beejamirtham before planting. This treatment also improves germination rates.

Cultivation Methods:
Planting distances vary based on the selected variety. For Nendran and Kathali, plant in a 6x6 feet pattern, accommodating 1200 suckers per acre. For Red Plantain, Mondhan, Poovan, and Rasthali, opt for a 7x7 feet pattern, allowing for 1000 suckers per acre.

Plantation and Water Management:
Plant rhizomes ensure they are well-covered with soil to prevent wind-related damage. Water immediately after planting and provide regular irrigation, adjusting the frequency based on the growth stage and weather conditions.

Intercrops and Maintenance:
Intercropping short-term vegetables before banana growth provides supplementary income. Crops like onion, tomato, radish, and more can be grown before bananas provide shade. Proper maintenance is essential to ensure healthy banana growth and yield.

Weed Management and Nearby Suckers:
Plant cowpea as an intercrop before banana to control weeds. Remove nearby suckers monthly to prevent nutrient competition and ensure the growth of primary plants.

Earthing Up and Cutting Dry Leaves:
Earthing up during the 4-5th month supports root growth and stability. Regularly cutting and mulching dried leaves prevents palm weevil infestations and promotes overall plant health.

Flower and Bunch Management:
Pluck male flowers after fruiting to divert nutrients to the bunch, enhancing bunch size and quality. Support banana trees during windy seasons with propping and timely removal of male flowers.

Ratoon Crop and Growth Regulators:
Allow red plantain, Mondhan, and Poovan varieties to undergo ratoon cropping for continuous cultivation. Use growth regulators like jeevamrutham, fish amino acids, and groundnut cake to promote healthy growth and development.

Activators and Pest Management:
Utilize graperas or panchagavya to enhance fruit appearance and weight. Implement measures to combat pests and diseases like rhizome palm weevil, nematodes, and leaf blight using neem cake, intercropping, and natural solutions.

Harvest and Yield:
Banana varieties yield different weights and sizes. In organic farming, Nendran yields approximately 15-20 tons per acre, while Kathali produces 12-15 kg per bunch. The duration of the crop varies by variety and maintenance.

Yield Details:

With conventional methods, the esteemed country variety, Nendran, typically yields around 15 kg per bunch. However, when it comes to natural Nendran banana cultivation, farmers can anticipate an impressive yield ranging from 15 to 20 tons per acre. Another noteworthy cultivar, the Kathali variety, boasts a weight of 12 to 15 kg per bunch.

Varieties with Good Yield:

Several banana varieties are known for their exceptional yield potential:

- Grand 9 – A notable yielder, producing bunches weighing around 30 kg.
- Red Plantain – Demonstrating its productivity, the Red Plantain variety yields approximately 30 kg per bunch.
- Monthan – With a yield range of 20 to 25 kg, the Monthan variety stands as a reliable producer.
- Rasthali – A consistent performer, Rasthali yields bunches weighing 15 to 18 kg.
- Karpuravalli – Known for its generous yield, the Karpuravalli variety produces bunches weighing between 25 and 30 kg.
- Poovan – This variety is known for its dependable yield, with bunches weighing around 20 to 25 kg.

Period/Duration of the Crop:

The duration of banana crops varies based on the chosen variety and the care provided:

- Nendran: A tenacious cultivar, Nendran bananas require a duration of 10 to 11 months to reach maturity.
- Monthan: The Monthan variety follows a slightly extended growth period, maturing over the course of 12 months.
- Poovan: Poovan bananas take approximately 11 to 14 months to develop fully.
- Kathali: The Kathali variety, known for its versatility, achieves maturity within 10 to 12 months.
- Red Plantain: Red Plantain bananas exhibit a longer growth period, needing around 18 months to reach their peak.
- Karpuravalli: Karpuravalli bananas require 12 to 14 months to achieve their full potential.
- Rasthali: Similar to Karpuravalli, Rasthali bananas also require 12 to 14 months to mature.

Annexure 11: Isha Outreach Rajasthan Experience

The Director of Agriculture of Rajasthan, in 2017, invited Isha Outreach to provide policy recommendations to make Rajasthan an Organic State. A 3 member team from Isha Outreach visited the state and conducted various stakeholder meetings. The team primarily visited the arid regions of the state to conduct Focus Group Discussions with farmers, field level officers, senior officers and created this document. They also observed the agro climatic conditions and other relevant factors. Later the visit outcomes were presented to the state's agriculture department. The headquarter officials, district joint directors and agro climatic zone incharges were present in the meeting. In a detailed discussion with the Director of Agriculture, suggestions as to how Rajasthan can become an Organic State were given.

The suggestions made in this report came from this first hand experience of the 15-day visit. It encompasses the stories of farmers who have successfully done sustainable agriculture in their farms.

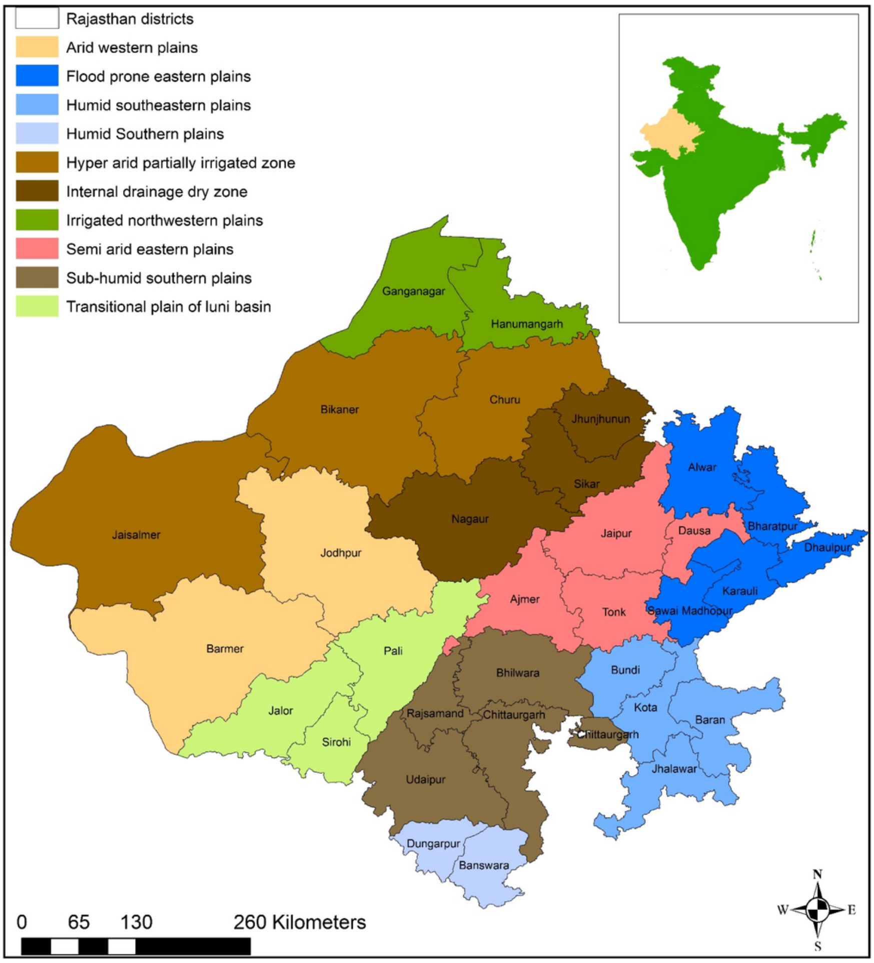
Field Visit Report of Meeting Stakeholders To Consult On Natural Farming In Rajasthan, 2017

Abstract

A 10-day field visit was conducted by a team of three people across four agro-climatic zones. This was to assess the status of farmers' wellbeing and to understand the circumstances in which they live. During this visit, we held discussions with farmers, agriculture supervisors, different officials from agriculture and horticulture departments across the zones we visited. We also visited a private goshala and also gathered information on livestock from all the people with whom we interacted. This is a report presenting the findings from the visit.

Visit Overview

This visit was to understand the farming patterns, circumstances of the farmers cultivating in most of the rainfed regions of the state.



Places Visited During The Visit

Table 1: Places visited during the field visit			
Dates	Agro Climatic Zones	Places Visited	Activity
16-Dec-2017	Internal drainage dry zones	Sikar village, Sikar Block, Nagaur District	FGD (Focus Group Discussion) with Jaivik Krushak (organic farmers)
		Ladnun Atal Kendra, Ladnun Block, Nagaur District	Interaction with 22 Agriculture supervisors from Ladnun block area
17-Dec-2017	Internal drainage Zone	Jorawarpura Village, Khimsar Block, Nagaur District	FDG with chemical farmers cultivating in the Surpanch's house without irrigation (Random visit)
18-Dec-2017	Arid western plains	Michoda village, Sindhuri Block, Barmer District	Interaction with the farmers cultivating with fertilizers without irrigation
	Transitional plain of Luni basin	Sayala village, Sayala Block, Jalore District	Interaction with farmers with irrigation facilities
		Pavapuri Jain temple, Krishnaganj village, Sirohi District	Visit to goshala facility of the temple, and interaction with the manager of the facility
20-Dec-2017	Humid southern plains	Manava, Dungarpur block, Dungarpur District	- One on one interaction with C1 farmers of the village. - Visit to chemical farmer (Random visit)
		Dungarpur city, Dungarpur District	Seminar with 200 agriculture-supervisors and department staff

The visits and discussions were primarily necessary for us to understand the following aspects of Rajasthan's state agriculture from different stakeholders as mentioned below:

1. Farmers:
    - Trends in cultivation pattern
    - Experiences of the farmers in using different kind of inputs and produce outcomes
    - Migration trends and reasons
    - Income generated by the type of farming any farmer does
    - Water situation
    - Health situation
    - Land and soil situation

- Climate situation

2. Agriculture supervisors
    - Their outreach mechanism
    - Their observation on farmers' wellbeing
    - Their thoughts on how to approach wellbeing of farmers

3. Higher level department officials
    - The big picture of their block and district agriculture produce and productivity
    - Input use
    - Water status

Interaction with Farmers

The purpose of interaction with farmers for the team was to understand their farming experience, challenges in their specific agro-climatic zones. Across all the agro-climatic zones, the irrigation facility is not available to the majority number of farmers. The farmers we visited 5 of small land holding and 2 of medium landholding have installed tube wells. All of them except the Sayala farmers are irrigating using micro-irrigation technology. At a cursory level an attempt was made to compare the production, income perception of the farmers when they moved between chemical to organic and vis-à-vis.

Interaction with Sikar Farmers

A group of 13 farmers from Sikar were present to interact with us. All of them have taken training from Subhash Palekar in natural farming. Sheer Singh has been farming for 8 years and has a land holding of 2 Ha.

Timeline	BEFORE	NOW
Income	70 of 100 earned from agriculture was spent on farm	30% of what is earned from agriculture is spent on farms.
Wheat Produce	7.5 Quintal / bhiga	12.5 Quintal / bhiga

Image 1: Sheer Singh, we had a group discussion in his farm

The farmers shared that there was a drop in their production in the initial 3 years during the transition. But if they are given a second chance they may do what they did in transition differently and will take them around 1.5 years only to equal the same chemical farming yields. Later it only increases.

The farmers have learnt from each other a lot more than the training provided, in addressing certain practical issues in the field. Formations of farmer groups have been very useful to transfer learnings and knowledge among farmers. Most of the farmers in Sikar use drip irrigation and have a tube well to themselves.

When asked if it is useful to know the "principles and reasons" to do natural farming alone, they felt it would be a lot easier to transition and reduce risk if there were a "package of practices" available for organic farming just like chemical farming.

"It will be useful to have package of practices in organic farming just like in chemical farming for farmers to easily transition and reduce risks.

Farmer groups make the innovation among farmers possible"

Image 2 Sher Singh's low-cost cold storage innovated & improved by the farmer himself.

Interaction with Jorawarpura farmers

Image 3 Interaction with farmers in Sarpanch Ananda Ram's house

Jorawarpura is a village, composed of chemical farmers, some of whom have tube wells for irrigation. This village is seated in a typical Thar Desert scenario where there is only one well in between three villages. The traditionally sound rain water harvesting structures of Rajasthan are still found here. Ananda Ram has a tank in his house of approximately 1.4 lakh liter capacity, which had been built by his grandfather and has been maintained till date. This traditional system harvests the rainwater falling in its immediate vicinity and is used for a whole year to sustain them by meeting the drinking water needs of the family and livestock.

The interaction of the farmers and the elders of the village gave us a purview into the forms of crops they were cultivating to what they do now. While most of the production in the past was about subsistence requirements (*bajra, moong, moat and gawar*), now it has increased to a larger range of varieties - *bajra, jowar, moong, moat, gawar, til, cotton, jeera, mustard, fennel, dill (Sindhi sua)*. The population of cattle has gone down due to the ban on Nagori breed of bulls.

Timeline	BEFORE	NOW
Cropping pattern	Only Kharif crops were grown to meet subsistence needs with rainwater	We grow crops in Kharif, Rabi and Jayat.
Cropping expenses	Livestock , no inputs, native seeds and therefore savings was 75%	We spend on tractor, input, electricity bill, hybrid seeds. Save around 25%
Cash crops	None	Cotton, as there is tube well now.
Cropping practice	Leave half the land untilled and lay all dung on it	Till entire piece of land

> *"We see that there are lot of cases of cancer in the areas with canal irrigation. The canals seem to carry concoction of chemicals that people consume and contract cancer."*

"Farmers in this village still grow produce for personal consumption organically. The bajra that they consume at home is only grown with rainwater as it tastes better than the one grown in tube well water."

Image 4: Jeta Ram, elder of the village, age 75

A short reasoning exercise and workshop with them illustrated that the farmers are aware of increased expenses and issues around chemical farming. Although they use chemicals, due to lack of irrigation their use is limited. Their comment on cancer issues in Ganganagar district was telling of their understanding of the health effects of unbridled use of chemicals on their land. They still use herbal homemade concoction for their small illnesses.

This set of farmers were of the opinion that good yields are possible only with use of chemicals. When the case of Sikar farmers was shared they were eager to visit them and know more about it. By the end of our interaction they were asking eager questions on how to prepare Jeevamrutham. It was suggested that rather than a piecemeal learning, it would be more productive for them to visit and establish a relationship with the farmers at Sikar practicing Zero Budget Natural Farming. However, a small demonstration activity on mulching was undertaken, wherein all the farmers present got involved.

Interaction with Michoda Farmers

We interacted with a set of 20 farmers in this village. Most of them were practicing chemical farming. They used tube well water sourced using a micro-sprinkler for irrigation. There has been a large uptake of pomegranate in this region.

Image 5: Pomegranate (eaten by parrots) and dates orchard in Poora Ram's farm

Timeline	BEFORE	AFTER
Income	When we used to not use chemicals, we earned less, but we saved 70% from what we earned.	We earn 12 lakhs, but we spend 10 lakhs on the farm
Produce	Bajra, moong, moat, gawar, til	Bajra, moong, moat, til, gawar, chili, papaya, isabgol, pomegranate
Input use	Farm Yard manure	DAP, Urea, Sulphur powder, farm yard manure fertilizer, pesticide
Climate	Temperatures max 45oC, and it rains once in 4 years.	Temperatures max 52oC, and it rains once in 5 years.

This village deep into the Barmer district gets rain once every 4 years. The land holdings in the region is around 10-15 Ha. Their tube wells are 300-450 feet deep. They do consume a varied variety of wild fruits like khejri, kaire, kumutia, chimdi, a variety of watermelon.

> *"One of the farmers in the region consistently produced pomegranates using organic inputs for three years. But he found that he did not realize any more price than the others. He lapsed back to chemical."*

Ethirajalu, along with Lakshmanan, had a two-hour long interaction with the farmers, and discussed with them what is good for the soil and what improves the health of the soil. People then, asked about the methods and ways to learn about organic farming, they were asked if they want to learn from farmers or from experts. They expressed interest in learning from farmers, and they were directed to the Sikar farmers. One of them shared that their father practiced organic for three years and quit.

Interaction with farmers from Sayala

The landholdings as we moved towards irrigated patches reduced to a band of 1 – 5 Ha. There is water from Narmada in this district. The problems these farmers face are of different sorts. They have access to water and therefore they have been using fertilizers, pesticides in good quantities and for a long period of time. Interacting with the oldest man in the village we found that years ago, although we did not have irrigation and could farm only on a small portion of the land, the yield from just this portion of land with only rain for irrigation would provide adequate sustenance. However, today even though they farm all of the land using irrigation, they are still only able to make ends meet.

Timeline	BEFORE	AFTER
Irrigation	Rainfed and well water	Narmada water and tube well using drip
Produce	Bajra, moong, moat, jowar	Bajra, moong, moat, mustard, castor, pomegranate, chilly , cumin, isabgol,
Crop diseases	Earlier manageable with little pesticides	Now newer forms of pesticide resistant pests, complicated diseases are observed. chilies never had diseases, even they have diseases now.
Climate	Winters and summer were clear	We have hot winds in winter and cold winds in summer. This was observed in the kind of insects found in the fields and in the air.
Water	Rainwater and surface water	Tube wells and fluoride in the water

Interaction with Manava farmers

We visited a village in Dungarpur block. Here, we conducted two, one-on-one interviews with two C1 farmers. These people were doing only rainfed farming before. It has been eight years since the tube well was installed in their farms. Most of the production by these farmers is for personal consumption. In the past also, they have been using chemicals quite meagrely. They use urea on wheat fields when there is excess rain to provide strength to that crop and help make it stand.

The practices they have been taught include vermicomposting (for which they have been provided with vermicomposting pits), and Jeevamrut. In order to facilitate collection of urine for Jeevamrut they have made an arrangement for penning the livestock inside their home, and have made a pit in the floor for allowing the urine to flow into it.

It has been a year since both the farmers have started to do organic farming. Both Shankar and Kariala moved to organic farming as they fell sick and had diarrhea. In this first year of the transition they have seen a reduction of 25% in their produce. This year's organic Kharif crop of maize was lost to stray / wild animals – wild boar, Nilgai, and stray cattle. When quizzed about their awareness of PMFBY to compensate for this loss, only one of them was aware of it, but seemed hesitant to take the effort needed to apply for it. The group of farmers we met later were also not aware of it.

Lakshmi, who is doing organic vegetable cultivation, is selling her produce in the Dungarpur market. There is no special market pricing available for organic vegetables, in spite of which Lakshmi earns around ₹ 300-400 every alternate day she goes to the market. Earlier, she used to earn ₹ 100/ day under MGNREGS.

We randomly walked into the farm of Bapulal, another farmer in the same area. He has a small piece of land of 3 bigha. He uses urea because he thinks that it makes the wheat crop mature fast and uses weedicide because he thinks the weeds do not allow the crop to mature at all. Kitchen gardens and fruiting trees are grown by all the farms we visited. All of them were growing the vegetables in the kitchen garden and also fruit trees for their family and children. In his house, he also bred poultry and goats for eggs and meat as part of their diet. Tribals drink home-brewed alcohol of Mahua by the end of their work days.

Interaction with Agri-supervisors

The agriculture supervisors are the face of the agriculture department to the farmers. The meeting and discussions held with the agriculture supervisors has been insightful and encouraging. During the first discussion with the supervisors from Ladnun, we found that they are quite open to thinking on questions of welfare of farmers. Therefore, we tried a group discussion exercise on the go. Since the response to this exercise was very encouraging, we restructured it and repeated it at Ladnun with the help of one agriculture supervisor and also at Dungarpur in the one-day long workshop with all agriculture supervisors of the district present, along with their higher-ups.

The questions given were quite open ended and there was very little tutoring. The way the questions were addressed reflected a clear understanding of issues on the ground, no fear of higher-ups, little inhibition and free flow of thoughts to answer the questions asked.

The outcomes from the discussion with Ladnun agriculture-supervisors (22) and with the larger group in Dungarpur (approximately 190) are summarized in the table at Appendix A.

The questions asked were:

1. How will you increase the net income of farmers? What are your ideas and options?
2. How will you improve the health of the farmer?
3. What are your ideas to eliminate chemical fertilizers and pesticides?
4. If you are given an opportunity to do the above what support will you need?
5. What is your plan of action for converting your entire block to organic (chemical-free) farming? How long will it take?
6. Would you like to experiment and experience the actual organic farming activity along with the farmers? If YES, then what support will you require?

Observation on agriculture supervisors: No fear of officials and very little inhibition. Their ideas were rooted from their experience with farmers.

The following was the procedure followed for conduct of these exercises:

In Ladnun four groups of minimum five members each and at Dungarpur, seven groups of 25 members each were created. At Dungarpur, one entire group was composed only of women. One group leader was selected in each group who would moderate the discussions and summarize the result of discussion at the end of the session.
After the discussion session was over each group leader presented (read out and explained) the summary prepared by him / her to everyone present.

The collated results are presented in the Table at Appendix A.

Visit to Pavapuri Goshala, Sirohi

We visited the goshala maintained by the Pavapuri Jain temple, who take care of 6000 cows. Around 1200 calves are born every year, and they take in orphan cows that roam around in the area of 30 km of the goshala. There is a clear process of giving away healthy cows older than 2.5 years to poor farmers. This involves a verification letter from their Sarpanch and references from two Jains that the person taking the cow for bona-fide agricultural or dairy use. The death rate of the goshala is 40 cows in a month, which is claimed to be the lowest in the country. The facility has a capacity of 10000 cows.

They produce and utilize biogas for their campus kitchen using part of the dung generated. The balance of dung is left in heaps to decompose and is given to farmers in need of FYM. Now, they have an intention of using this same surplus dung for production of value added bio-inputs such as Jeevamrut, Ghanajeevamrit, etc.

The cows are well taken care of, with access to allopathic medicine and telemedicine facility to consult veterinary doctors in Ahmedabad or Jaipur.

We observed a few goshalas on the way during this trip and came to know of the existence of many more like this, which needs a closer attention. This visit to the goshala was a precursor to that.

Interaction with Field Level Officers from Department

In this whole trip we interacted with the Additional Director, Deputy Directors, Joint Directors, Assistant directors across the department who gave us a bigger picture perspective on the following:

1. Type of produce found in the region
2. Quantum of produce found in the region
3. Fertilizer Input used in the region
4. Type of livestock

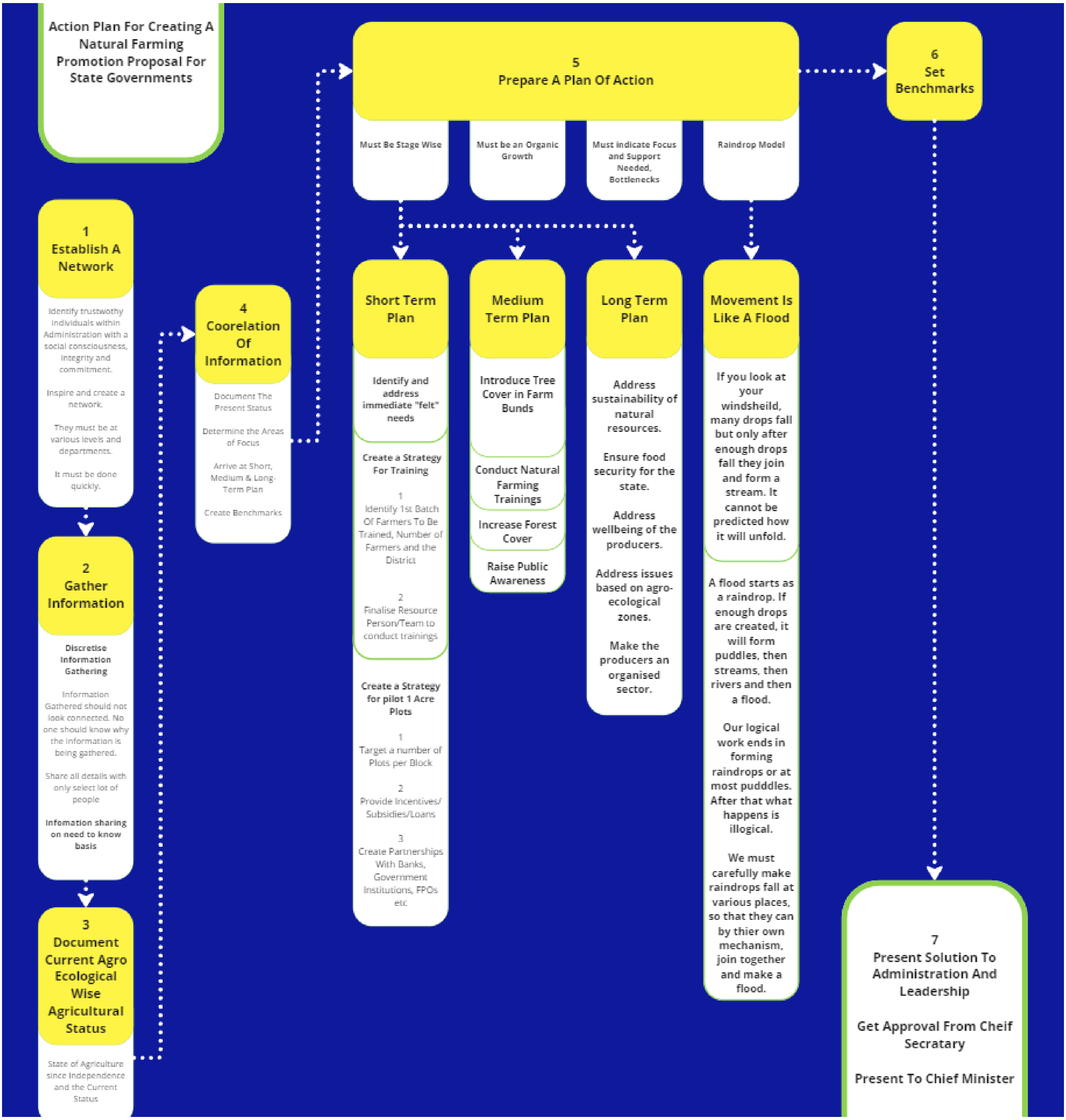
Conclusion and Way Ahead

This trip was primarily planned for getting first-hand ground-level experience of the status of agriculture, farms, water, health, climate and other aspects of farmers' life specific to the rain-fed agro-climatic zones. To that end the purpose of this visit has given adequate insight on a macro level.

The following way ahead is suggested:

- A similar study of other agro-climatic zones in a more structured way to be taken up.
- The questionnaire seeking data / information circulated to all districts (Appendix B) may be collected by 31 Dec 2016, and collated into one MS Excel Workbook.
- Specific to the vision of "Organic Dungarpur" necessary directions for the following may be issued on priority:
    - Questionnaire specific to Dungarpur (Appendix C) may be filled up and submitted
    - Structure for preparation of a micro-plan to be finalized.

Annexure 1: Mind Map of Action Plan To Create Natural Farming A Mainstream Phenomena In The State



Appendix A

COLLATION OF RESULTS OF FOCUS GROUP DISCUSSION (FGD)

Sn	Question	Ladnun Response	Dungarpur Response
1	How will you increase the net income of farmers? What are your ideas and options?	1. Grow crops suitable to climate 2. Grow crops with reduced water requirement 3. Promote livestock rearing & horticulture (fruits & vegetables) 4. Use improved varieties. 5. Use vermicompost 6. Go for plantation of medicinal plants 7. Ostrich farming 8. Vermicompost unit establishment 9. Pisciculture, Apiculture 10. Food processing Units (such as papad making using Moat (90% produced in Nagore), pickle making, etc. 11. Dairy, rearing goat & sheep	1. AgroForestry 2. Treatment of seeds for better yield and timely sowing 3. Cropping techniques, crop rotation, mixed cropping 4. Access to irrigation 5. Promotion of livestock - sheep and goat 6. Access to cow 7. Reduce input cost to save money 8. Reduce produce price fluctuation 9. Disincentivize mechanization 10. Promoting practice of organic farming to reduce input cost
2	How will you improve the health of the farmer?	Inspire farmers to consume organic crops, fruits & vegetables that are seasonal and high in vitamins & nutrients.	1. Awareness of health and non-chemical food 2. Agroforestry to make him consume good quality food (fruits etc.) 3. Access to safe drinking water to address problems like fluoride contamination 4. Balanced diet -with fruits and vegetables 5. Reduce use of toxic chemical to prevent falling sick
3	What are your ideas to eliminate chemical fertilizers and pesticides?	Elimination of fertilizers like urea. DAP to be compensated by (a) Use & popularization of FYM, compost & green manure (b) Prepare compost using NADEP system By reducing use of pesticides and fertilizers, requirement of irrigation is reduced and cost of cultivation will also come down Use bone meal, poultry manure, oil cakes Farmer may undertake trials in a small patch and then expand based on his success	1. Improve organic carbon in soil by natural means to replace chemical use for productivity. 2. Non-renewal of licenses to chemical fertilizers/ pesticides 3. Ban chemicals (in 30 days) 4. Incentivize female farmers, uptake in family is ensured if a women takes to the practice 5. Listen to farmers to solve issues first so that a proper organic solution is given so that it replaces the chemical need definitely
4	If you are given an opportunity to do the above what support will you need?	1. Work plan for organic & traditional farming appropriate for rural areas and agro-climatic conditions to be made 2. Provide proper guidelines / Package of Practices prepared by experts 3. Provide financial assistance 4. The problem is mindset and not the practice.	1. Smart phones with WhatsApp to communicate to farmers on new finds by supervisors and also within farmer groups 2. Communicate about organic both benefits and losses in “easy to understand” fashion 3. Train and educate politicians so that they support 4. Need more experts to be accessible on the matters of organic. Experts need not be BSc and MSc alone; can be practicing farmers. 5. Trained agriculture department staff

5	What is your plan of action for converting your entire block to organic (chemical-free) farming? How long will it take?	(a) Use modern techniques for promotion (प्रचार) and broadcasting (प्रसार) to promote it among farmers (b) Provide information about organic products (c) Promote centers for sales of organic products (d) Tell more & more farmers about organic farming and reduced input cost of it (e) Organic farming awareness camps (f) Awareness of disadvantages of chemicals (g) Use video clips and charts that show comparison of organic & inorganic products & areas (h) Farmers will want to see other farmers who have done it as they will take advice from farmers. One in every 100 farmers should be successful to have the rest of the population to change. Therefore, per agri-supervisor, 40 farmers need to be converted initially. So, in one year we will be able to convert.	1. 3-5 year timeline. 2. Constant conversations, workshops, sharing and exchange of information 3. Reduce the PMKVY limit to 0.2 Ha, as most of the farmers in Dungarpur have that size of holding. This will help in risk taking 4. Incentivize organic farming, felicitate agri-supervisors, and organic farmers 5. Continuous communication on organic farming through radio, TV, social media means for 3 to 5 years
6	Would you like to experiment and experience the actual organic farming activity along with the farmers? If YES, then what support will you require?	Build awareness about organic & traditional farming, and ill-effects of chemical inputs. Provide financial assistance to promote organic farming Need a role model and financial support	1. Changing mindset, behavior and then habits takes time. Listen to farmer carefully to facilitate change 2. Marketing and direct link to customers 3. Make a badge for all organic farmers to sport with pride. Have a dress code in a week so that people ask and discuss this 4. Public awareness on organic to improve its reception and readiness to pay more for the produce increases 5. Government should give native breed of cows. 6. Tie MGNREGA scheme to other farmer schemes so that he builds necessary infrastructure for organic with that support

Appendix C

MACRO LEVEL DOCUMENTATION

Status of Agriculture - Rajasthan

1. Guidelines for Documentation
   - (a) Data to be gathered Agro-climatic Zone wise
   - (b) Within each agro climatic zone, it will be good if data is available block-wise, otherwise at least district-wise
   - (c) Data to be gathered for as long a duration as possible and from independent sources if possible.
2. MAP
3. SOIL FERTILITY
   - (a) Soil Classification
   - (b) Organic Carbon
   - (c) Erosion
     - (i) Soil Erosion
     - (ii) Nutrients Erosion
   - (d) Salinisation of Land
     - (i) Extent & Increase over the years
     - (ii) Any correlation to introduction of Irrigation
4. WATER
   - (a) RAIN
     - (i) Rainfall Pattern
       - (aa) For past 100 years (or as many years as available)
       - (ab) Specific data on change of rainy days
       - (ac) History of drought
       - (ad) History of floods
   - (b) RIVERS
   - (c) GROUND WATER
     - (i) Status of extraction
   - (d) WATER QUALITY
     - (i) TDS
     - (ii) Pollutants in Water
       - (aa) Heavy Metals Arsenic, Mercury, Chromium, etc.
       - (ab) Other pollutants Fluoride, Nitrates, etc.
       - (ac) Sewage
5. CLIMATE
   - (a) Meteorological Data
     - (i) Data & changes in... Temperature, Relative Humidity, Wind pattern
     - (ii) Data and history of Khamsin (Dry, hot, sandy, local wind)
   - (b) Green cover in non-forest lands
   - (c) Desertification – Status & Increase over the years

6. Agriculture & Horticulture (Economical & Statistical Data)

(a) Land

(i) Net sown area

(aa) Rain fed

(ab) Irrigated (Canal / River/Tanks)

(ac) Borewell

- Fallow land
- River Bed Cultivation land (Land belonging to Government)

(ad) Micro-irrigation

(ii) Under forest cover

(iii) Under cultivation

(aa) Land Holding Pattern (Small, Medium, Large... As per standard definition across India)

(b) Crops

(i) Crop Profile

(ii) Area under cultivation

(iii) Cropping Patterns *(Season-wise)*

(iv) Typical Yield and Profile *Productivity of crops)*

(v) Total yield

(vi) Agriculture Methodologies (Use of draught animals, machinery, etc.)

(c) Horticulture (Fruits, Vegetables, etc.)

(i) Horticultural Profile

(ii) Cropping Patterns *(Season-wise)*

(iii) Typical Yield and Profile (*Productivity of crops)*

(iv) Total yield

(v) Agriculture Methodologies (Use of draught animals, machinery, etc.)

(d) Supply chain Profile (crop-wise)

(i) Movement from Producer to Market to Consumer

(aa) From farmer to market

(ab) Status of Regulated Market

(ac) Status of Mandi

(ad) Status of Haat

(ii) Level of Organised Farmers

(aa) Individual Farmers

(ab) Farmer Collectives such as Small groups, Cooperative Societies, FPO, etc.

(ac) Corporate

(e) Agricultural Inputs

(i) Chemical

(aa) Fertilizers (consumption & supply-chain)

(ab) Pesticides

(ii) Organic
(aa) Farm Yard Manure (FYM)
(ab) Vermicompost
(ac) Other

(f) Seeds
(i) Data on seed requirement / crop
(ii) Sources of seeds
(aa) Purchased as packaged seeds
(ab) Farmer to farmer exchange
(iii) Native Germplasm
(aa) Status for various crops
(ab) Seed Banks
(iv) List of private seed companies supplying in Rajasthan (with type of seeds)

(g) Organic Certification
(i) Type of Certification
(ii) Area under certification

7. Crop Insurance:
(a) Current status of Crop Insurance

8. Livestock
(a) Population
(b) Varieties / Breeds
(c) Fodder sources & status
(d) Breeding Programs & Policy
(e) List of major / good Goshalas & Type of livestock being worked on

9. Demography
(a) Agriculture
(i) No. of farming families *(Actually involved with farming)*
(ii) Caste & Cultural divides
(iii) Landless laborers in agriculture
(iv) Migration patterns *(out of agriculture / villages)*
(v) Migrant labor *(from outside Rajasthan)*
(b) Food Consumption
(i) Food Consumption Patterns *(What is eaten & how much)*

10. Allied Sectors
(a) Food Processing (after crop is ready with farmer) / value addition
(b) Bee Keeping

11. Administrative Set-up:
(a) *Hierarchy within Department of Agriculture - from Chief Secretary to the lowest functionary), with approximate number of functionaries at each level*
(b) *Existing Infrastructure*
(c) *JZRAC - Package of Practices for Farming (including Organic)*

12. Financial Outlay & Flow of Finances
    - (a) Schemes
    - (b) Administration
    - (c) Research (Universities, etc.)
    - (d) Extension Work (Krishi Vigyan Kendra)
13. Krishi Vigyan Kendra
    - (a) Number & location of KVC
    - (b) Specialization of each KVK
14. Infrastructure
    - (a) Satellite Mapping
        - (i) Facilities
            - (aa) Available setup
            - (ab) Available capability
        - (ii) Utilization
            - (aa) Evaluation of net sown area, forests area, etc. (Data from other sources can be cross verified)
            - (ab) Mapping of crop area
            - (ac) Agriculture forecast
    - (b) Food & Safety Testing
        - (i) Facilities available for testing
        - (ii) Test for current status of chemical residues in food crops
        - (iii) Testing of pesticides / adulterants in milk
        - (iv) Existing standards for testing
15. NGO Network
    - (a) No. of NGOs
    - (b) List of NGOs
    - (c) Basic Profile
    - (d) No. of farmers in their coordination
    - (e) Genuineness and reputation
    - (f) Directly working with farmers
        - (i) Conventional & Organic Farming
        - (ii) Watershed Development
        - (iii) Cooperatives / FPO, etc.
        - (iv) Health Awareness & Food Adulteration
16. Festivals:
    - (a) List of festivals & purpose
    - (b) Dates
17. History of Natural Disasters
    - (a) Drought
    - (b) Flood
    - (c) Epidemic diseases in humans
    - (d) Epidemic diseases in livestock

18. Progressive Farmers

(a) Names and location

(b) Land

(i) Net sown area

(ii) Type of irrigation

(c) Crops

(i) Crop Profile
(ii) Area under cultivation
(iii) Cropping Patterns *(Season-wise)*
(iv) Typical Yield and Profile *Productivity of crops)*
(v) Total yield
(vi) Agriculture Methodologies (Use of draught animals, machinery, etc.)

Appendix C					
Village Data Collection Format					
1	Generic Village Information				
	Name of Village			Total Population	
	Name of Gram Panchayat			Men	
	Name of Block			Women	
	Name of District			Children	
	GPS Location			Ethnic Groups	
	Other Vital Information			Group Name	
				Group Name	
				Group Name	
				Group Name	

2	Classification of Farmers			
a	Farmers	Number	Area	Remarks
i	Men			
ii	Women			
b	By Land Holding			
i	Small and Marginal Farmers			
ii	Medium Farmers			
iii	Larger Farmers			
2	Village Area Details In Ha			

i	Total Village Area						
ii	Pasture Land						
iii	Residential Area						
iv	Agricultural Area						
v	Fallow Land Area						
vi	Other						
3	Agricultural Produce Details						
	Types of Crops Grown						
	Crop Name	Kharif		Rabi		Jayad	
		Area under Production in Ha	Quantity (in Kg)	Area under Production in Ha	Quantity (in Kg)	Area under Production in Ha	Quantity (in Kg)
i	Wheat						
ii	Bajra						
iii							
iv							
v							
4	Livestock Details						
	Livestock	Numbers	Uses of Animal Dung		Is Cow Dung sold	Yes	No
	Cow		Cooking fuel		If YES, where is animal dung is sold?		
	Buffalo		Manure for field		Village Haat		

	Goat		Others (please ask and fill details)			Village farmers			
	Camel					?			
	Chicken					Others			
	Others?								
5	Food Habits								
a	What is the regular food eaten? Please list things across seasons ?								
	Name of Produce	Season in which they consume it							
i									
ii									
iii									
b	Are any food from the forest / Wild harvested and eaten? (please list them, and do not restrict to the number of 5 only. You can add more in the row 5 if there are more to be recorded)								
	Name	Purpose Of Use							
i									
ii									
iii									
c	Are medicinal herbs / plants grown? (please list them, and do not restrict to the number of 5 only. You can add more in the row 5 if there are more to be recorded)								
	Name	Purpose of use							
i									
ii									
iii									

6	Market access and Trading Details							
a	List of Haats the Village Produce is sold at.				Produce Sold in the Haat			
	Haat Name	Frequency	Location of Haat (Panchayat/ Block/ District)	How many Villages participate	Wheat	Bajra	Vegetables	Fruits
i								
ii								
iii								
iv								

b	Road Network Connectivity			
	Road Names	Roads connecting to Block and District	Distance from the nearest State Highway	Road Condition
i				
ii				
iii				

c	List of Village Festival	Significance
i		
ii		
iii		

d	Health Status	Names of Diseases
i	Chronic Diseases	
ii	Acute Diseases	

Annexure 12: Highlights of Tamil Nadu Organic Farming Policy Paper 2023

Need For Organic Farming Policy

"The source of many health issues noticed world-wide is found to be the residues of agro chemicals used. It has been proven that the pesticide residues enter the food chain causing many health hazards to humans and animals. Providing healthy and chemical-free food is the new age mantra. The organic farming policy will help to ensure, upscale and support the chemical free organic agriculture in Tamil Nadu and to provide safe food for the people."

Objectives Of The Policy

The objectives of TNOF Policy[100] is to conserve agricultural soil, agroecology and biodiversity by creating awareness, promoting organic farming practices, facilitating organic certification and marketing.

Strategy

A. Encouraging Organic Practices And Resource Conservation
   - Sustainable agricultural practices such as integrated farming, multi-tier intercropping, agroforestry, crop rotation with pulses and cover cropping will be encouraged.
   - On-farm organic inputs as well as biofertilizers and biopesticides will be promoted. Quality testing of off-farm inputs will be strengthened.
   - Efficient management of soil and water, use of renewable energy and preserving local biodiversity will be encouraged.

B. Organic Certification
   - Participatory Guarantee Scheme and National Programme On Organic Production will be used to certify organic growers through a simple single window system.
   - Quality testing standards will be created and NABL is(National Accreditation Board for Testing and Calibration Laboratories) standard pesticide residue analysis labs will be encouraged.
   - Tamil Nadu Organic Certification Department (TNOCD) accreditation will also be extended for livestock and poultry products, apiculture, aqua culture, mushroom cultivation and poly greenhouse production.

[100] http://www.agritech.tnau.ac.in/pdf/66617733-Tamil-Nadu-Organic-Farming-Policy-2023_230315_093042.pdf

C. Preference To Cluster Approach
    - Various operations ranging from awareness creation, training, providing incentives, cultivation guidance, GIS based agri management systems, preprocessing, packing, transportation and marketing will be done within clusters of farmers/FPOs/FIGs/Villages.
    - Categorizing the clusters based on crops and integrating clusters into organic zones will be encouraged to support common property resources such as grain bank, fodder bank, compost production units etc.

D. Research, Development and Education
    - Documentation of indigenous technical knowledge and research on suitable crop varieties, their packages of practices and managing seed banks will be promoted in Agri Universities.
    - Farm schools, training programs, exposure visits by reputed institutions, KVKs and pioneer organizations will be encouraged.
    - Organic cultivation of vegetables will be encouraged in schools.
    - State Gene/Germplasm Bank for preserving seeds will be set up.

E. Promotion Of Organic Farming
    - Organic cells of the Agriculture, Horticulture and Organic Certification Department will be converged to improve efficiency. Convergence with Agricultural Technology Management Agency (ATMA) and PPPs will be promoted. Financial assistance will be given to organic input manufacturers, food processors and traders.
    - Creating and disseminating mass awareness materials through online and offline channels, organizing food festivals and popularizing urban farming will be done by involving organic activists and enthusiasts.
    - Baseline surveys will be conducted in all districts to identify potential areas. Progressive and leading farmers will be identified for experience sharing. Model organic farms will be developed at block level. Separate organic farming helpdesk to be instituted.
    - Stringent monitoring/regulation on organic produce will be initiated.

F. Focus On Potential Crops And Prospective Districts
    - Promotion of region wise predominant crops will be prioritized along with the promotion of related livelihood. Efforts will be made for maximizing potential yield. Default organic districts in rainfed areas will be identified.

G. Creating Market Linkages And Exports
    - Creation of supply chain for organic produce with backward and forward linkages, provide market intelligence to farmers and aggregators, provide

training on export policies and procedures, setting up organic outlets in cities, promoting e-business startups, organizing expos and promotional activities will be encouraged.
- Advanced block chain, AI and Internet Of Things will be developed along with project incubation centers in State Universities and Colleges.

Establishment Of Committees

- A high level committee will be formed under the Chief Secretary, members from the Government and Institutions to review the policy and status.

- Steering committee to be formed under Agriculture Production Commissioner and Secretary of Agriculture And Farmers Welfare Department to monitor implementation.

- District Level Committee to be formed under District Collector with members from various departments.

Financial Convergence

"Policy will be implemented through convergence of all related Central and State schemes of Departments like Agriculture, Horticulture, Agriculture Marketing, Agriculture Engineering, Animal Husbandry, Fisheries, Khadi and Textiles in an integrated approach."

Validity Of Policy

"The policy will come into effect from the date of issuance of the Government Order and will be reviewed after a period of five years."

Annexure 13: Dairy farming in India: A note for the future

Compiled by Prof. N. Punniamurthy[101]

(With inputs from Dr. Marimuthu Swaminathan and Dr. S. Satheshkumar)

Introduction

Indian agriculture is a finely tuned farming ecosystem consisting of a delicate mosaic of land, animals and farmers. The farm animals are not mere animals; indeed they are companions, livelihood assets, saving banks, insurance for the future, religious symbols, energy and nutrient suppliers for crop cultivation, family food security systems, source of employment and cash income. This is more pertinent with cattle and buffaloes. Some aspects of synergy between crop production and livestock have been weakened in the present agriculture production system, one of the prominent examples being the reduced dependency on animals for farm draft power. The rapid growth of the livestock sector, especially the cattle and buffalo production system, is towards dairying and factors like growing demand for milk. Income changes and urbanization favors this growth. The livestock sector is indispensable in sustaining rural economy and livelihood.

• As per the report of the working group on animal husbandry and dairying - 11th five year plan: 2007-12, the livestock sector employs eight percent of the country's labor force, including many small and marginal farmers, women and landless agricultural workers.

• Milk production alone involves more than 30 million small producers, each raising one or two cows or buffaloes.

• The organic fertilizer produced by the sector is an important input to crop production, and dung from livestock is widely used as fuel in rural areas.

• Livestock also serves as an insurance substitute, especially for poor rural households. They can easily be sold during times of distress (Islam et al., 2016).

1. Livestock Population

As per the 19th livestock census, 2012 (GOI, 2014) India's livestock sector is one of the largest in the world with a holding of 11.6% of the world livestock population, which consists of buffaloes (57.83%), cattle (15.06%), sheep (7.14%), goats (17.93%), camels (2.18%), horses (1.3%), pigs (1.2%), chickens (4.72%) and ducks (1.94%).

• India has a huge livestock population of 512 millions, which mainly includes cattle, buffalos, goats, sheeps and pigs. The total livestock population in India has decreased by 3.33% over the previous census.

• During the last intercensal period, there was a decrease in the population of cattle, sheep, goats and pigs by 4.1, 9.07, 3.82 and 7.54% respectively, while the population of buffalo and poultry increased by 3.19 and 19%, respectively.

[101]Professor and Head, Veterinary University Training and Research Centre, Ethnoveterinary Herbal Training and Research Centre, Thanjavur, Tamil Nadu

• The population of exotic and crossbred cattle registered a significant increase of 20.18% while the indigenous cattle decreased by 8.94%.

• The contribution of cattle, buffalo, sheep, goats, pigs and others in the total livestock population is 37.28, 21.23, 12.71, 26.4, 2.01 and 0.5%, respectively.

• The livestock population in India has increased substantially in Gujarat (15.36%), Uttar Pradesh (14.01%), Assam (10.77%), Punjab (9.57%), Bihar (8.56%), Sikkim (7.96%), Meghalaya (7.41%) and Chhattisgarh (4.34%).

• With an annual milk production of 146.3 million tons, India ranks first in the world and contributes about 16% to the world milk production (GOI, 2014).

• India's milk production continuously increased right from 1950-51, when the total milk production was 17 million tons.

• In India, Uttar Pradesh produces the maximum amount of milk followed by Rajasthan, Andhra Pradesh, Gujarat and Punjab.

• Tamil Nadu is the largest producer of exotic/crossbred cow milk in the country followed by Maharashtra.

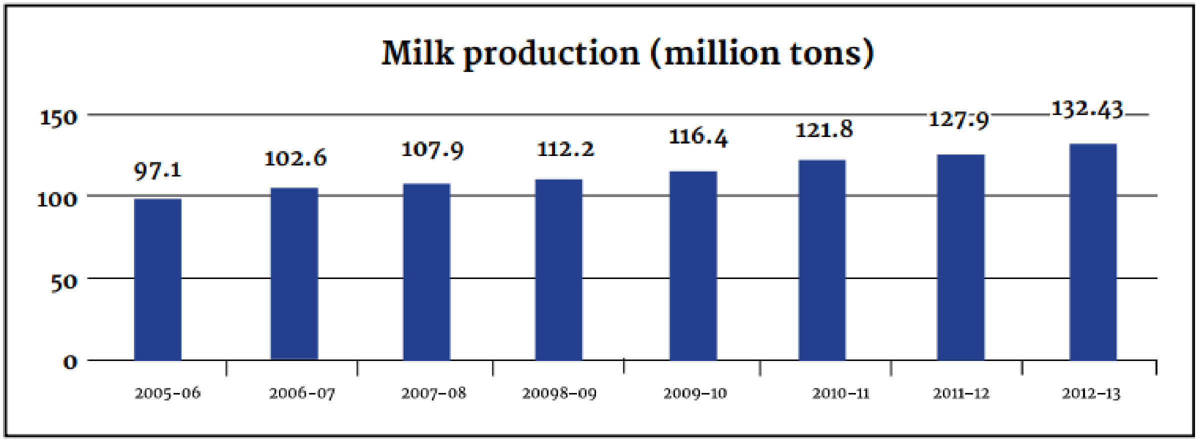
• The state of Uttar Pradesh is the largest producer of indigenous/non-descript cow milk followed by Rajasthan.

• Buffalo milk production predominates in the states of Uttar Pradesh, Andhra Pradesh, Rajasthan, Punjab, Haryana, Gujarat, Madhya Pradesh and Maharashtra with highest buffalo milk production by Uttar Pradesh.

• Uttar Pradesh also produced the maximum goat milk followed by Rajasthan. The share of milk production in 2012-13 was the highest from buffaloes, followed by exotic/crossbred cows, indigenous/non descript cows and goats with 51%, 24%, 21% and 4% of the total milk production, respectively.

2. Milk production in India and economic contribution of the livestock sector

Globally, India ranks first in terms of milk production and produces about 17% of the world's milk production. The milk production increased from 102.6 million tons at the end of the Tenth Plan (2006-07) to 127.9 million tonnes at the end of the Eleventh Plan (2011-12). The contribution of different species for the total milk production: crossbreds - 23%, indigenous – 20%, buffalos- 53% and goats – 4%. Milk production at the beginning of the Twelfth Plan (2012-13) is 132.43 million tons with an annual growth rate of 3.54%. The per capita availability of milk is around 296 grams per day in 2012-13. Growth in milk production from 2005-06 to 2012-13 is shown in the following chart (DAHD, 2014)



The contribution of livestock and fishery sectors to the national economy in terms of GDP at current prices are 4.1% and 0.8%, respectively during 2012-13. Agriculture and allied sectors alone contributed about 15.1% to the total GDP. Out of the total agricultural GDP, the livestock sector contributed about 27.25% during 2012-13. As per the report of the working group on animal husbandry & dairying - 12th five year plan: 2012-17, the livestock sector grew at an annual rate of 5.3% during the 1980s, 3.9% during the 1990s and 3.6% during the 2000s. Despite deceleration, growth in the livestock sector remained about 1.5 times higher than in the crop sector, which implies its critical role in cushioning agricultural growth. The value of output in 2012-13 from the livestock sector was Rs. 53,75,370 million at current prices. Livestock has been an important source of livelihood for small farmers and has contributed about 16% to their income (Planning Commission, 2012).

- The traditional milk sector has enormous size, spread, reach and impact potential.
- Traditional vendors are present in large proportions even in places where a number of players in the organized sector are present.
- With increasing urbanization, the proportion of milk handled by traditional vendors in the market is diminishing but still substantial quantities are handled and are expected to continue to do so for long.
- The traditional sector provides an important livelihood option for a large number of smallholder dairy farmers and milk vendors.
- In production points where there is no organized sector due to difficulty in access or unviable quantities for operation, vendors play an important role.

3. Per capita availability of milk in India

The per capita availability of milk in India has increased from 130g per day in 1950-51 to 299g per day in 2012-13, which is a little above the recommendation of ICMR i.e. 285g per day. Per capita per day availability of milk is maximum in Punjab (961g) followed by Haryana (767g), Rajasthan (555g), Tamil Nadu (541g) and Gujarat (476g).

4. Comparison of native livestock with imported in management

• In the past two decades the increase in demand was met mainly by expanding the livestock population.

• However, declining land areas per agricultural population forces India to intensify livestock production.

• The emphasis so far has been on disease management, labor efficiency, management practices and increasing yields.

• Today, we are faced with an extraordinary set of challenges of increasing food production of animal origin with all the other limitations like land, water, weather, etc and the question is how would we meet these demands.

• Most of the feed comes from grazing, although a small portion of concentrate feed containing various feed additives for enhancing milk production is being given to cattle.

• Most of the feed manufacturers in India make both poultry as well as cattle feed. The demand for usage of cattle feed will grow if the feed is economically viable.

• The challenge is to make a nutritionally competent feed using low-grade fibrous crop residues, which are mainly byproducts from other industries, along with feed additives.

• The cost of milk production is much higher with the crossbreeds. However, the crossbreeds are high-maintenance animals and are disease-prone.

• The feed requirements of native breeds are very minor. Their feed-to-milk conversion is good. Farmers in Kerala have endorsed their short breed, Vechur, saying they have the potential to produce highly-priced milk even with kitchen scraps and leftovers.

5. Need for Protection and Improvement of Native Livestock

Part of the productivity increase is due to the introduction of crossbreeding policies, which allowed farmers to favor certain traits in their livestock. But selective breeding is not without its drawbacks: over time, too much focus on productivity can lead to other genetic traits being phased out – including those that make traditional breeds uniquely adapted to their local environments. Traditional livestock are more adaptable to local conditions and environmental challenges. Hence scientists along with farmers are working against the clock to save traditional breeds before they disappear in favor of more productive crossbred cows.

The cost of inputs starting from the cost of the cow to the day-to-day expenditures of the crossbred cows is always high. Sustainability is the key issue. Longevity is another important issue favoring native breeds, despite their apparently low milk yield.

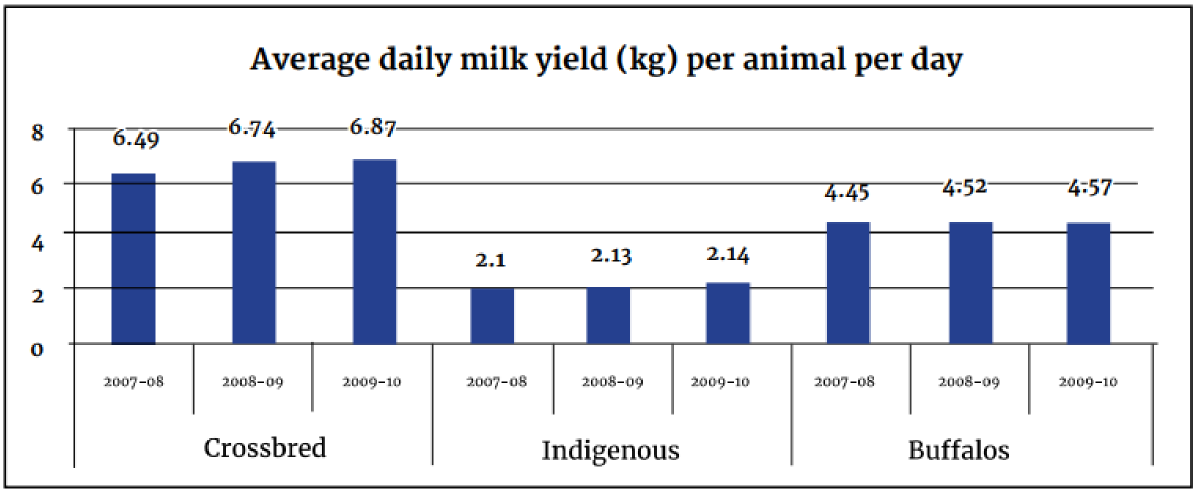
With the promise of short-term productivity, many rural farmers prefer crossbreeds, rather than locally adapted livestock. But the morbidity and mortality of non-native animals is high because they are poorly adapted to the local climate, and are vulnerable to local diseases. For example, Holstein Friesian crossbred cows threatened by Foot and Mouth disease cause wasting and death in up to a million livestock animals each year. Cows of the native breed carry genetic resistance to the disease.

A 2012 report by Kerala state Animal Husbandry Department stated that the State's new breeding policy limited exotic [that is, non-native] germplasm to 50 percent of cattle and encouraged propagating of native breeds by adopting artificial insemination programs with the semen of native bulls. It also stated that the milk of the Vechur breed has medicinal qualities recorded by Ayurveda ages ago. In more recent times, studies at the Kerala Agricultural University have also shown the percentage of fats and total solids of the Vechur cow to be higher than those found in crossbred cows. The smaller size of the fat globules in the Vechur's milk makes it more suitable for infants and the sick.

Hence, maintaining the genetic diversity of traditional livestock breeds is a more urgent problem in developing countries than it is in developed nations.

6. Policy Recommendations for Protecting and Improving Native Livestock

We need to develop emergency plans for endangered breeds in the case of epidemic outbreaks, and build up gene banks for native livestock. We need to encourage more breeders to take part in conservation programmes. Striking a balance between traditional genetic adaptations and modern productivity traits is essential for future livestock breeding programmes.Anoptimalbreedisonethatis well adapted to localconditions,able to feed mostly unavailable(fodder)resources,and able to produce quality products.



To conserve the genetic resources of native livestock:

(1) it is necessary to keep them in the form of live animals and/or

(2) in the form of sperm, oocytes, embryos, cells, chromosomes and genes that can be stored by applying cryogenic techniques.

Each method has some advantages and disadvantages. Cryogenic samples which are collected and frozen can be permanently preserved and, except for accidents within the storage system, they remain available under the same conditions as those at the time of sampling, any time in the future. Although it is expensive to initiate frozen collections, once they have become established, the cost associated with equipment maintenance, such as liquid nitrogen supply, is low.

Live animal conservation has a number of advantages over frozen cryo- preservation for the following reasons:

(I) cultural-historical reasons

(2) the opportunity to investigate topical or new traits in the population all the time.

(3) maintaining people's awareness of the existence of the breeds and interest in the frozen materials (Obata and Takeda, 1993).

• As a variety of native livestock have played important roles in the history and development of their respective area of origin, these breeds should be conserved.

Average daily milk yield (kg) per animal per day

• It is important to train people who are interested in native livestock.

• To reduce inbreeding in a small population, it may be desirable that individual farmers become organized in associations to control the breeding of the animals.

• Such associations which maintain the same purebred need to appeal to public opinion to obtain appropriate subsidies for production along with programs of conservation.

7. Ethnoveterinary Medicine for Livestock Health Care

Man has no power of altering the absolute conditions of life; he cannot change the climate of any country. He adds no new element to the soil but he can remove an animal or plant from one climate or soil to another, and give it food on which it did not subsist in its natural state. From a remote period, in all parts of the world, man has subjected many animals and plants to domestication or culture.

Domesticated livestock have been contributing to food and agriculture for more than ten millennia, providing meat, milk products, eggs, fiber, manure for crops, fuel and draught power. As of today it is estimated that, directly and indirectly, domestic animals supply one third of total human requirements for food and agriculture and also reduce farmers' exposure to risk and generate employment.

Globally, the resource-poor rural farmers rely on ancestral folk herbal knowledge to deal with the diseases of their livestock and poultry. Veterinarians show considerable interest in the medicinal plants employed in traditional systems. Qualified veterinary physicians around the world require orientation on the traditional folk veterinary medicine systems.

This emerging trend in favor of herbal medicine is partly due to the issues related to the antimicrobial drug resistance and drug residues in foods (milk/ meat/eggs) of animal origin. Farmers having either one or two cattle, goats, sheep or chicken need affordable access to primary veterinary healthcare at the earliest. These scattered livestock holdings provide subsistent income for landless laborers, especially farm women even in drought conditions. Commercialization of these components of animal husbandry could undermine this important income generation source of the rural poor.

There is an urgent need to promote use of Ethnoveterinary medicine (EVM) on a wider scale for sustainable livestock production. Popularising EVM on pragmatic lines will help conserve biological diversity. EVM is a cost effective and environmentally sound idea for sustainable livestock production in the villages.

The Indigenous Technical Knowledge (ITK) is regarded as the information gained over a period of time passed on from generation to generation. ITK is a community-based functional knowledge system, developed, preserved and refined by generations of people through continuous interaction, observation and experimentation with their surrounding environment. It is a dynamic system, adopting and adjusting to the local situations and has close links with the culture, civilization and religious practices of the communities. The communities have developed the indigenous knowledge system to conserve and utilize the biological diversity of their surroundings. It provides useful clues for planning projects for conservation of biological diversity, sustainable uses of natural resources, indigenous health practices, as well as World Bank and FAO-run programs focusing on indigenous knowledge.

Socially conscious groups support rural people to appreciate, test and improve their own indigenous traditional values and practices. About two thirds of the biologically active plant derived compounds currently used globally have been discovered through ethno-medical leads. In India, efforts for pharmacological and clinical validation of Ethnoveterinary herbal preparations have resulted in a number of publications on EVM, but have not been widely followed clinically.

The Tamil Nadu Veterinary and Animal Sciences University has taken a lead in this direction and has government-sponsored programs (Part II scheme of Government of Tamil Nadu and ICAR network programme) to train farmers and veterinarians in EVM for primary health care of livestock. Many of the EVM preparations are readily available and found to be location specific, as well as environment friendly - making the resource-poor livestock farmers self- reliant in primary healthcare of livestock. A decade long work by the Centre for Ethnoveterinary Herbal Training and Research at Tamil Nadu Veterinary and Animal Sciences University on the use of various fresh herbal recipes under field conditions proved to be successful clinically for a variety of ailments across a host of species of the livestock / poultry. Over 5000 farmers and 500 veterinarians have been shown to use EVM-based herbal preparations for the primary health care of livestock, in a standalone mode.

TANUVAS has been associated with the Trans-Disciplinary University (FRLHT), Bangalore, India in mainstreaming ethnoveterinary practices into modern veterinary curriculum and research and has launched a Post-Graduate diploma in Ethnoveterinary Practices (EVP) for veterinarians around the world through distance learning since 2011-2012. This effort will help traditional expertise in the long run to be more readily integrated with current medical knowledge in addressing local, regional and global healthcare issues of livestock and also help produce drug-residue free milk, meat and eggs for the food basket.

Understanding foraging as the dynamic quest to achieve homeostasis will lead to implementing management programs (wherever possible) where herbivores have access not only to diverse and nutritious foods but also to secondary metabolites of medicinal plants. Traditional production systems have viewed animals as partners in taming nature. Herbivores adapt to the external environment and to their changing internal needs not only by generating homeostatic physiological responses, but also by operating in the external environment. Most natural landscapes are diverse mixes of plant species that are literally nutrition centers and pharmacies with vast arrays of primary (nutrient) and secondary (pharmaceutical) compounds.

Following the ban on the use of antibiotics and other chemicals, fearing the risk caused to humans by chemical residues in food and by antibiotic resistance being passed on to human pathogens, scientists have intensified efforts in exploiting plants, plant extracts or natural plant compounds as potential natural alternatives for enhancing livestock productivity.

Natural products, such as primary and secondary metabolites of plants, plant- derived alkaloids, terpenes, sesquiterpene lactones and phenolics can benefit herbivores by, for instance, combating internal/external parasites, controlling populations of fungi and bacteria, and enhancing nutrition.

The simplification of agricultural systems to accommodate intensive livestock production, coupled with a view of secondary compounds as toxins, has resulted in a selection of biochemical balance in forages favoring primary (mainly energy) and nearly eliminating secondary compounds. Ecto-parasites (e.g., mites, lice, flies, and ticks) can distract livestock from grazing, damage hides, cause infections, and transmit diseases. Current parasite control methods rely on a combination of management methods and chemotherapeutics (insecticides and repellents).

Alternatives to the commonly used chemotherapeutics are needed for several reasons:

• The available treatments against parasites/microbes are becoming less effective. Parasites/microbes are becoming increasingly resistant to almost every chemical class of available compounds.

• Plant-derived alkaloids, terpenes, sesquiterpene lactones and phenolics can benefit herbivores by, for instance, combating internal/external parasites.

• There are environmental pollution and human health concerns with the available treatments. For example, ivermectin (endectocide) can potentially kill beneficial soil microorganisms and parasites develop resistance against it rapidly. Many of the chemicals for ecto-parasite treatments are organophosphates, which are cholinesterase inhibitors.

• There is a growing desire among the general population for more natural and environmentally friendly farming systems and they are looking for (organic) residue-free foods of animal origin.

• Use of fresh herbs empowers farmers (especially women) in times of need, wherever early intervention is crucial in livestock health care, especially rural areas.

Conclusion

The availability of alternative systems of medicines such as herbal medicines and ethno-veterinary practices together with the existence of significant levels of genetic variation in respect to disease resistance and susceptibility within the indigenous cattle and buffalo breeds provides an opportunity to control the use of antibiotics in dairy production. TANUVAS has perfected traditional veterinary practices to deal with various disorders and infections of livestock.

Therefore, integrating appropriate breeding strategies and genetic improvement programs using the cattle breeds which are genetically resistant to infections, with systematic application of traditional veterinary practices such as ethno- veterinary systems of animal treatment will definitely pave the way for developing a dairy production system which is free of synthetic drug residues and antibiotics.

In India, where dairy production is one of the important income sources for the farmers and the state, the combined approach of targeted breeding and traditional systems of veterinary medicine is a crucial factor to ensure a sustainable dairy production. In realization, the Government of India has established a program (Gokul Mission) for promotion, conservation and sustainable utilization of Indigenous Animal Genetic Resources with emphasis on cattle genetic resources.

References for Livestock Status in India

- Government of India (GOI). 2014. Basic Animal Husbandry Statistics. Ministry of Agriculture. Department of Animal Husbandry, Dairying and Fisheries. New Delhi.
- Planning Commission. 2012. Report of the Working Group on Animal Husbandry and Dairying for the Twelfth Five Year Plan 2012–2017. Government of India, New Delhi.
- Islam MM, Anjum S, Modi RJ1 and Wadhwani KN. (2016) Scenario of livestock and poultry in India and their contribution to the national economy. International Journal of Science, Environment and Technology, 5(3): 956 – 965
- Obata T and Takeda H (1993) Germplasm Conservation of Japanese native livestock breeds (Horses, Cattle and Goats). JARQ 27: 8-12
- Sainath, P. Cattle class: Native vs Exotic. The Hindu, JANUARY 06, 2012

References for EVM

- Azhahianambi, P., P.Hariharan, N.Punniamurthy and S.Gomathynayagam, 2004. Insecticidal property of leaves and seeds of sitaphal (Annona squamosa). Ind. J. Vet. Parasitol 18 (1) 55-57
- Mekala, P. N. Punniamurthy and P.Hariharan, 2006. Protective effects of Curcumin and Silymarin against aflatoxicosis in broiler chicken. Ind. Vet. J., 83 : (5) P 501-503.
- Mekala, P., P Hariharan and N Punniamurthy, 2007. Inhibition of aflatoxin induced liver damage in broilers by curcumin and silymarin. Toxicology International. 14 (2) 147 -151
- Mekala, P., P.Hariharan and N.Punniamurthy 2006. Hematological studies in Broilers fed Aflatoxin B1 and treated with Curcumin and Silymarin. Indian Vet. Journal. 83(9). Pp: 955-957.
- Nair MNB Punniamurthy N (Eds) (2010) Proceedings of the CEVP 2010 International Conference on Ethnoveterinary Practices, 4th to 6th January 2010, Thanjavur 310 pp, TANUVAS. I-AIM Bangalore.
- Ngeh J. Toyang, Jacob Wanyama, Mopoi Nuwanyakpa, and Sali Django (2007) Ethnoveterinary Medicine:a practical approach to the treatment of cattle diseases in sub-saharan Africa. Agromisa Foundation and CTA, Wageningen 90pp
- Punniamurthy, N. 2002 Ethno-Veterinary Medicine Practices for Primary Health Care Of Livestock: Issues And Strategies. Paper Presented In Siddha International Congress 2002, Gandeepam, Tamil Nadu, India.
- Punniamurthy, N. 2006. Ethno-Veterinary Medicine : A Traditional Approach to a Sustainable Farming System. Compendium of Lead papers and Research Abstracts presented in the Inter National Conference on “Advanced Veterinary Practice in Medicine and Surgery – Augmenting Health and Production”. Madras Veterinary College, Chennai.
- Punniamurthy, N. 2007. Complementary therapy in Carica papaya induced neuro-myotoxicity in guinea fowls - A field report” National Symposium on “Ethnopharmacology in Clinical Veterinary Practice and role of Nanotechnology in Drug Delivery systems” held from 28-30 November, 2007 at College of Veterinary and Animal Sciences, Kerala Agricultural University, Pookot, Kerala, India
- Punniamurthy, N. 2008. Combating a contagious viral disease of cloven footed livestock through Ethno-Veterinary Medicine in an organized farm in Tamil Nadu. India. International conference on “Emerging Infectious Diseases of Animals and Biotechnological Applications'' conducted from 28-07-2008 to 29-07-2008 at Madras Veterinary College, Chennai, India
- Punniamurthy, N. 2009. Ethno Veterinary Medicine (EVM) – Using fresh herbals for livestock health care at farmers’ level. World Conference on Medicinal and Aromatic plants at Capetown, South Africa. Proceedings of WOCMAP IV. November 2008
- Punniamurthy, N.V. Ranganathan and B. Muralimanohar, 2009. On field assessment of anthelmintic activity of cost effective (Herbal) functional remedies in goats for self reliance in livestock primary health care. 10th International Biennial conference of the society for tropical veterinary medicine in Lubeck, Germany. Proceedings STVM; June 29 to July 03, 2009.
- Punniamurthy, N., V.Ranganathan, C.Balachandran and B. Murali Manohar 2010.

SAVE SOIL

Hepatoprotective effect of Phyllanthus amarus on acetaminophen-induced liver damage in broiler chicks In Proceedings of the ICE P2010 International Conference on Ethnoveterinary Practices, 4th to 6th January 2010, Thanjavur 310 pp,TANUVAS. I-AIM Bangalore.

- Punniamurthy N. and K. Udayasurian 2010 EVM for veterinary primary health care. In Proceedings of the ICE P2010 International Conference on Ethnoveterinary Practices, 4th to 6th January 2010, Thanjavur 310 pp, TANUVAS. I-AIM Bangalore
- Punniamurthy N., Babu M. and Koteeswaran. A. 2006. Cissus Quadrangularis as a First aid in Musculoskeletal injuries in poultry and ratites. Lead papers and Research Abstracts presented in the International Conference on "Advanced Veterinary Practice in Medicine and Surgery – Augmenting Health and Production" (from 21.06.2006 to 25.06.2006), Chennai.
- Punniamurthy.N. 2005. Ethno-Veterinary Medicine : Use of fresh herbal extracts under field conditions for primary veterinary health care in India. Proceedings of the Fourth International Congress of Ethnobotany (ICEB 2005), 21-26, August 2005, Istanbul, Turkey , Pp 249-255.
- Punniamurthy N., Sujatha P. L., Preetha S. P. & N. Ramakrishnan, 2017. Analysis of the Mechanism of Action by Molecular Docking Studies of One Ethno Veterinary Herbal Preparation used in Bovine Mastitis. International Journal of Applied and Natural Sciences, 6-5 pp 23-30.
- Satheshkumar S. and N. Punniamurthy, 2005. Effect of Murraya koenigii (curry leaves) supplementation on oestrus induction and serum calcium and phosphorus concentrations of anoestrus heifers. National symposium on recent trends and innovations in animal reproduction, Jammu, India, 23-25 November 2005. pp: 100-101.
- Satheshkumar S., N. Punniamurthy and A. Palanisamy, 2008. Herbal approach for inducing multiple follicular development in crossbred cows. International Conference on Emerging infectious diseases of animals and biotechnological applications, Chennai, India, 28-29 July 2008. pp: 130.
- Satheshkumar S., N.Punniamurthy, P. Nedunchezhian and V. Sharavanan. 2009. Estrus induction by supplementation of Murraya koenigii in anoestrus heifers. Indian journal of Animal Reproduction. 30 (2)
- Wynn SG, Fougère BJ (Eds) (2007) VeterinaryHerbalMedicine. Mosby Elsevier, 736 pp.