NATURAL FARMING

Report of a Dipstick Study

September 2019

PRAXIS

ate CHANDRA FOUNDATION

Table of Contents

Foreword

The issue of agri-stress among the farmers has increasingly dominated national discourse in recent years and has been deeply disconcerting to the team at A.T.E. Chandra Foundation. To put the national relevance of this issue in perspective, the share of agriculture in the Gross Value Added (GVA) is just 14.6 per cent in 2019-20, but it impacts an enormous 48.3 per cent[1] of households. Importantly, a large percentage of our farmers are marginal and do not have access to irrigation. Unfortunately, most of them have only been finding their economic condition worsening over time.

With this backdrop, agriculturalists, planners, and policymakers have all been looking at working closely with the Agriculture sector to re-examine the major building blocks of the farming value chain and address each component so that farmers can sustainably benefit from the change in practices and policies in a scalable manner. The team at A.T.E. Chandra Foundation has been focusing on some aspects of these complex issues. For a long period, our focus was on water security for farmers in drought-prone districts. However, during our visits to drought-prone regions, we started learning from farmers about sustainable agriculture practices such as Shivansh Khad and other natural farming techniques that materially improve net income of marginal farmers while having other collateral benefits for the ecosystem.

One such visit to Latur, Maharashtra, exposed us to a women's collective which was working with women farmers on natural farming and other income boosting initiatives. Enthused by their drive and initial findings, we supported them to scale this initiative to 1,000+ farmers with the desire and to further understand the impact of natural farming. The collective's experience helped us realize that farmers were reporting high savings on input costs within a year of adopting these techniques, thereby significantly improving their net income.

Around the same time, the stellar efforts of Community Managed Natural Farming (CMNF), an initiative by Govt. of Andhra Pradesh and backed by Azim Premji Philanthropic Initiatives (APPI), also gained our attention. CMNF aims to scale natural farming to over 6 million farmers by 2027 and has made significant progress in Andhra Pradesh. We were also encouraged by the clarion call made by the Honourable Prime Minister Narendra Modi to farmers from the rampart of the Red Fort to consider adopting this technique, followed up by the Honourable Finance Minister Nirmala Sitharaman in her budget speech in 2019.

Encouraged by all this, the team wanted to further understand:

a) Whether farmers from different parts of the country are also reporting similar benefit to what we were seeing in Latur?
b) What is the perception of natural farming among the practitioners more widely?
c) How have farmers in different states adopted natural farming?

Towards this end, we commissioned an independent multi-state dipstick study by the credible Praxis Institute for Participatory Practices to:

1) Help us better define what is natural farming? Understand how is it different from alternative forms of agriculture production systems?
2) What are the economics of natural farmers (yield, income, etc.)?
3) What are the pros and cons of natural farming methods?
4) What are the enablers and disablers to scale?

To prepare their analysis and report, Praxis reached out to a wide sample of 100+ farmers across five states - Maharashtra, Andhra Pradesh, Karnataka, Kerala, and Himachal Pradesh.

[1] Reserve Bank of India, Annual Report 2019-20

They sought answers to the above questions through understanding each farmer's journey from conventional farming to natural farming.

At the outset, it is important to note that the study is not a randomised control trial (RCT). The objective of this study was an interim bridge between the increasing body of purely anecdotal evidence in favour of natural farming and a proper RCT study. Being an independent foundation with solely societal interests and a focus on sustainable rural development allowed us the mandate of requesting Praxis to study farmers who had worked with these practices and compile data without any biases. We encouraged Praxis to report back both successes and failures and be completely objective with their findings.

Praxis' analysis and report to us indicate that natural farming methods have shown promising results across most crops and geographies:

1) 86% of farmers reporting positive experiences about natural farming
2) The main benefit to farmers is on account of 82% of the farmers reporting a reduction in input costs. 40% of all the small and marginal farmers surveyed reported a saving of upto Rs. 10,000 per annum
3) A good test of the above is that about 50% of farmers surveyed were found practising natural farming for over three years and some as long as ten years despite no subsidies or price premium. The above data indicates a belief in the technique of natural farming and more importantly, ecological and financial sustainability for the farmers.

The emerging data from the study validates the anecdotal claims of natural farming leading to higher profitability, largely on account of input cost reduction, for many types of crops. Findings from other crop cutting experiments cross India during 2018-19 further validate these claims. An impact assessment[2] of over 400 natural paddy farmers in Andhra Pradesh showed on an average 10% improvement in net income and a 68% reduction in input costs.

There are other important benefits of Natural Farming which the study has not focused on but are critically important. The Government of India spends over Rs. 70,000 Cr[3] in fertilizer subsidies annually, a huge burden in times of fiscal stress. Based on a report[4] published in January 2020 the state of Andhra Pradesh alone can save Rs. 1,000 Cr annually, if just 33% of farmers transition to natural farming. Additionally, because these farms tend to consume less water, it would help reduce the electricity subsidy burden in some states, owing to lesser pumping. Another study[5] done in Andhra Pradesh estimates that Natural Farming processes require 50-60% less water. Over and above this, the produce from these farms, being natural, would be wholesome for the consumers.

Considering the above, it is, therefore, not surprising to see the Government of India as well as State Government's like AP and HP actively promoting natural and agro-ecological methods through Paramparagat Krishi Vikas Yojana[6] under the National Mission for Sustainable Agriculture. NITI Aayog has also been at the forefront of promoting natural farming and in May 2020[7] hosted a convention on natural and agroecology farming.

---

[2] Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh –Kharif 2018-19, *Centre for Economic and Social Studies, Hyderabad*

[3] https://pib.gov.in/Pressreleaseshare.aspx?PRID=1579455

[4] Can Zero Budget Natural Farming Save Input Costs and Fertiliser Subsidies? Evidence from Andhra Pradesh, *Council for Energy, Environment, and Water, Niti Gupta, Saurabh Tripathi, Hem Himanshu Dholakia*

[5] Life cycle assessment of ZBNF and non-ZBNF, *Center for Study of Science, Technology and Policy*

[6] https://pgsindia-ncof.gov.in/pkvy/Introduction.aspx

[7] https://pib.gov.in/PressReleasePage.aspx?PRID=1628285

These are all welcome steps in the right directions, but given that agriculture is a state subject, each state government must consider what more it can do to encourage this movement, as a way to both improve the condition of its most marginal farmers, but also the health of its balance sheet.

I thank the team at PRAXIS for their efforts in designing and carrying out this study. As the government aims to double farmer incomes within a few years, we believe that the road to sustainability will require many initiatives. We believe that exploring and supporting natural farming amongst marginal farmers, wherever feasible could be desirable for all stakeholders and should be considered far more seriously than is being done at present. We hope that the findings from this report will help all stakeholders involved to arrive at a more informed view on this subject.

Amit Chandra
Founder, A.T.E. Chandra Foundation and
Chairman, Bain Capital India

Acknowledgements

Praxis Institute for Participatory Practices conducted a dipstick study on Zero Budget Natural Farming across five states – Maharashtra, Karnataka, Kerala, Andhra Pradesh and Himachal Pradesh between December 2018 and March 2019. The study team engaged in conversation with men and women farmers from Latur, Beed and Wardha in Maharashtra; Belgaum, Bidar, Bijapur and Raichurin Karnataka; Palakkad and Thrissur in Kerala; Ananthpur, West Godavari and Visakhapatnam in Andhra Pradesh and Mandi in Himachal Pradesh.

An eleven member team – Anil Jha, Anthony Mary, Dheeraj, Kavitha Srinivasan, Kolla Ramalingeswara Rao, Madhavi Ganapathi, Mary George, Nirmita Roychowdhury, Poorvi Kulkarni, Sreelesh Nambiar and Yogendra Ghorpade supported the study. Tarini Shipurkar and Sowmyaa Bharadwaj supported with the finalisation of the report.

The study team acknowledges the relentless support provided by the A.T.E. Chandra Foundation team along with partner organisation APPI and field coordinators. The team would like to especially thank Deepti Kommera and Shantanu Gharpure for working round the clock and overtime with our team to coordinate the visits. We also acknowledge the support of the Administration and Finance wings of Praxis as well as of A.T.E. Chandra Foundation for providing all the support, which made these visits possible and successful.

Finally, the team would like to thank with immense gratitude the farmers who shared their valuable thoughts and insights with the team to make the study possible.


INTRODUCTION

1. Introduction

The 'Green Revolution' of the 1960s resulted in far-reaching changes in the agricultural development of India. While it was intended as a strategy to rebuild the agricultural productivity of the newly independent India, it replaced "an indigenous low-input, organic-based strategy with an exogenous, high external input chemical-intensive one" (Banerjee 2016)[8]. The push for increased productivity led to the introduction of modern inputs like fertilizers, credit, marketing facilities, as well as a need for 'improved' crop varieties since the native crop varieties did not respond as well to these modern inputs. This led to the germination of a new breed of 'High Yielding Varieties' (HYVs) by scientists. These HYV seeds matured in a shorter time required water throughout the year and also required much more fertilizer compared to the traditional variety of seeds. Given the requirement of water, the revolution remained largely limited to a few states such as Punjab, Haryana and Uttar Pradesh and was principally focused on wheat and other cereal crops.

While this rapid change in the agricultural practices benefitted many and increased the productivity of some crops in India, there were many challenges faced in the 'post-revolution' phase. The benefits were largely restricted to those farmers that were growing cereals and had proper irrigation facilities – these were invariably wealthier farmers. There has also been a rapid decline in the agricultural diversity of Indian seeds – only a handful of the High Yielding Varieties (HYVs) were grown across 70% of the paddy land and 90% of the wheat land of India (Kothari 1994)[9]. Intensive mono-cropping promoted during the green revolution also ended up making production more susceptible to environmental stresses and shocks. One consequence of the green revolution was also the dependence of the farmers on the market – for inputs (seeds, fertilizers, pesticides, weedicides, machines, etc.) as well as for selling their produce. "Industrial inputs of fertilizers and pesticides were seen as enablers that would break Indian agriculture out of the shackles of the past" (Banerjee 2016).

These changes brought with them a variety of problems which include the increased utilisation of harmful chemicals and fertilizers which have extensive negative impacts on the environment as well as human and plant health. Over time, the overuse of fertilizers, high yielding seeds and pesticides has resulted in adverse effects on the soil and weakened the overall plant resistance. Large numbers of farmers complain of dry and hard soil which is unable to retain water, and crops that are nutrient-deficient.

Global movements in the 1970s and 80s created a demand for a shift back to a more sustainable and nature-friendly way of farming. Appeals were made for an equally 'revolutionary' shift to a different type of farming that focused on reducing/removing these modern inputs that had taken over agriculture – these varied from organic farming, natural farming, permaculture, agroecology, and so on. One such type was Natural farming, made popular by Masanobu Fukuoka of Japan. The key of natural farming accordingly is that farmers do not use any farm resources from external sources.

1.1 Natural Farming

As described by Fukuoka, natural farming is a 'do-nothing' agricultural method.

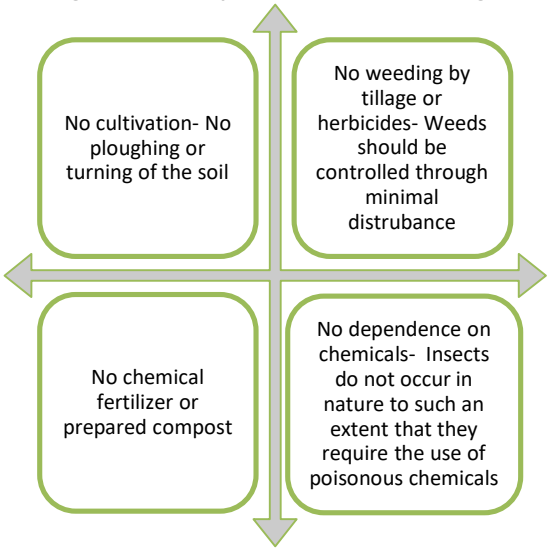
> "Farming as simply as possible within the natural environment, rather than the modern approach of applying increasingly complex techniques to remake nature entirely for the benefit of human beings." (Fukuoka, 1978)

[8] Banerjee Soumik, 2016 *Handbook of Sustainable Agriculture*, Pradan, New Delhi
[9] Kothari Ashish, 1994 "Reviving Diversity in India's Agriculture", *Seeding – October 1994.*

According to him, modern techniques seemed necessary to farmers because the natural balance of nature had been upset by the overuse of chemicals and pesticides. The green revolution, in this sense, set up a footing for the dependence on chemicals for good yields – making the farmer dependent on external forces. Fukuoka clarifies in his book, 'One Straw Revolution', that while many interpreted natural farming as a reaction against such reckless development of science, his main aim was to show that "humanity knows nothing". He states that human beings emphasize specialisation and therefore, while they think they can understand nature, they cannot truly grasp the varied relations within nature.

To maintain a balanced field ecosystem, Natural farming has the following four principles as seen in Figure 1 alongside[10].

Figure 1: Principles of Natural Farming



Schools of Natural Farming

According to Fukuoka, organic farming is a 'system which emphasized the fundamental importance of compost and of recycling human and animal waste'. It is intensive and includes various practices such as crop rotation, companion planting, etc. Harvesting schedules are precise and agriculture was mainly concerned with organic matter and composting techniques.

Broad natural farming: This type of natural farming exists when there is complete unity between human and nature. The belief is that if the human temporarily abandons their own will and allow them to be guided by nature, nature will respond by providing them with everything. Pure natural farming, according to Fukuoka, is striving to 'do nothing'.

Narrow natural farming: The narrow view of natural farming involves the self-conscious 'attempt', by 'organic' or other methods to *pursue* the way of nature. Although sincere in its love for nature, such a way of natural farming is used to achieve a given objective. While Fukuoka states that it is fine to apply organic material to the field and raise animals, by this way alone, "the spirit of true natural farming cannot be kept alive".

1.2 Contextualising Indian Natural Farming

Inspired by Fukuoka, Subhash Palekar of Vidharbha, Maharashtra, put together a four-step technique of natural farming.[11] This technique has been widely promoted across different states as 'Zero Budget Natural Farming'[12].

[10] Fukuoka, 1978 "The One-Straw Revolution: An Introduction to Natural Farming", Rodale Press
[11] JishuLatha, 2018 "The zero budget farming discord", Down to Earth
https://www.downtoearth.org.in/blog/agriculture/the-zero-budget-farming-discord-62003
[12] This name has now been changed to Subhash Palekar Spiritual Farming (SPSF)

Figure 2: Key Practices Adopted by Natural Farmers in India

Jeevamrutha: Fermented microbial culture derived primarily from cow dung and urine from desi/ Indian breeds only, jaggery, pulse flour and uncontaminated soil

Beejamrutha: Microbial coating of seed/seedlings, is based on cow dung, urine from desi/ Indian breeds only and lime

Mulching: The process of covering the top soil with cover crops and crop residues

Waaphasa: Soil aeration, a result of jeevamrutha and acchadana - represents the changes in water management brought by improved soil structure and humus content

Source: http://apzbnf.in/faq/

The Andhra Pradesh and Himachal Pradesh government have already stepped in for extensive adoption of the natural farming method by the farmers. With the 'back-to-nature' approach[13], Andhra has become the first state to adopt it with an agenda of converting the state as a natural farming state by 2026-2027. Himachal Pradesh and Kerala also adopted Natural Farming to make farmers self-reliant and climate-resilient

1.3 Setting the Backdrop

A dipstick study was commissioned by A.T.E Chandra Foundation to study Natural Farming techniques and its movement across the states. The scope of the study involved documentation of personal journeys of 100 farmers across 5 states. The key objectives of the study are as follows:

- Unravelling the Natural Farming techniques including its production mechanisms and multifaceted use
- Understanding farmer experiences and unfolding the positive and negative impact of the Natural Farming methods on yield, soil health, environment and farm economics of 100 farmers and highlight the challenges across various geographies and agro-ecological contexts
- Understanding the adoption of Natural Farming by various stakeholders (State Governments, Individuals, NGOs) techniques and identifying the possibilities of scaling up

1.4 Methodology of the Study

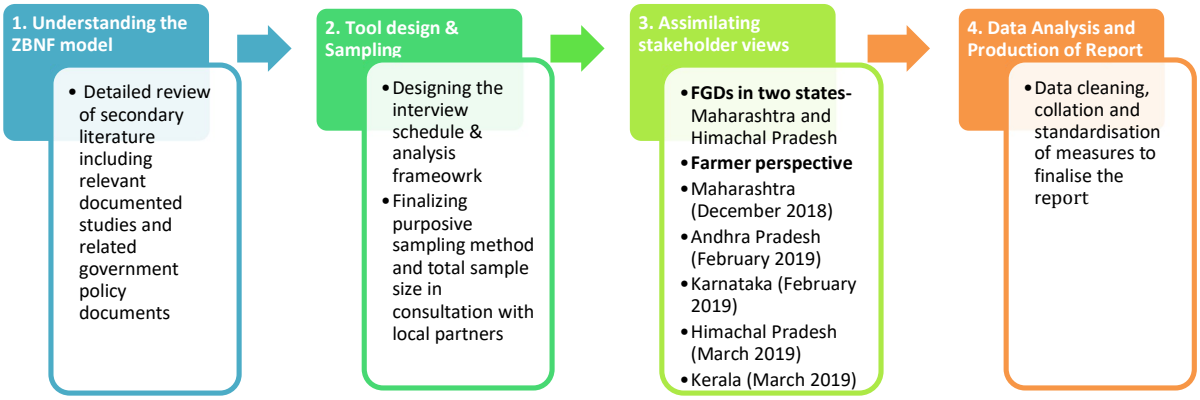
The study has been undertaken across thirteen districts of five states –Latur, Beed and Wardha in Maharashtra; Belgaum, Bidar, Bijapur and Raichur in Karnataka; Palakkad and Thrissur in Kerala; Ananthpur, West Godavari and Visakhapatnam in Andhra Pradesh, and Mandi in Himachal Pradesh. The fundamental objective of the study was to capture the journeys of 100 farmers as well as to reflect upon their experiences of using ZBNF techniques. The total sample of 100 farmers has been taken through selective or purposive sampling method based on shared characteristics of the farmers and the objectives of the study. Data has been collected based on the following criteria:

- Gender
- Landholding size
- Means of irrigation
- Age
- Season-wise cropping pattern
- Ownership of livestock

[13]https://www.indiatoday.in/magazine/states/story/20171113-andhra-pradesh-natural-farming-agriculture-ministry-to-present-best-practice-in-climate-change-resilience-1077175-2017-11-03

- Duration and extent of adoption of Natural Farming techniques
- Experiences of using various ZBNF techniques
- Crops that are grown under Natural Farming

Figure 3: Steps of Dipstick Study



To interact with the selected sample, an interview schedule template for the case study collection was created in collaboration with the A.T.E. Chandra Foundation team and finalised before the study was initiated. Similarly, a series of tools for the Focused Group Discussions were also finalised for the group interactions that have been undertaken in two locations of two states.

Figure 4: State-wise sample design

Chart 1: Farmer Gender

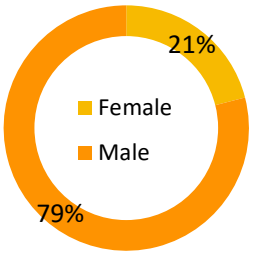


Chart 2: Years of NF adoption

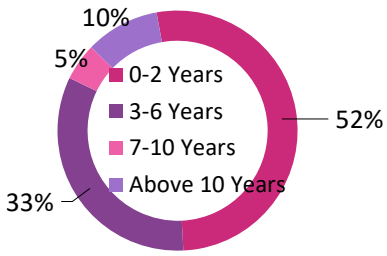


Chart 3: Cropping pattern in Natural Farming

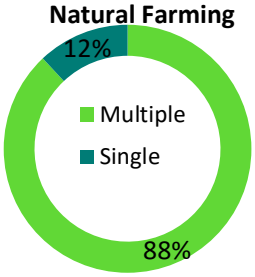
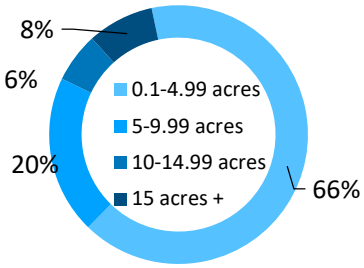


Chart 4: Land Ownership Patterns*
(based on share of landholding)



Source: Fieldwork, December 2018 – March 2019
**Note: 13 farmers within the total sample of 100 own lands in joint families, the total land hasn't yet been divided. The category of land ownership pattern considered the rest 87 who have their own landholding.*

1.5 Geographical and Ecological Context

The farmer stories were collected from thirteen different districts spread over five states –Andhra Pradesh, Himachal Pradesh, Karnataka, Kerala and Maharashtra. They are located across different

geographies and as a result, are in varied Agro-Climatic Zones and Agro-Ecological Zones (AEZ) of India. AEZ is a region having uniformity in terms of physiography, climate, and length of growing period and soil type for macro-level land-use planning and effective transfer of technology. [The sample districts have been mapped across AEZ, along with some basic tenets in Annexure 1.]

1.6 Landholding under ZBNF Adoption

The following table depicts the distribution of landholding at farmers' level across five states. It takes into account average operational landholding and operational landholding under ZBNF method.

Table 1: State-wise landholding pattern of the farmers

States	Andhra Pradesh	Himachal Pradesh	Karnataka	Kerala	Maharashtra
Total no. of farmers	41	16	11	14	18
Average operational landholding (in acre)	8.09	1.36	15.14	5.46	5.9
Median operational landholding (in acre)	4.8	0.99	9.5	5.5	2.25
Average area under ZBNF method (in acre)	5	0.8	14.41	4.74	3.15
Median land under ZBNF (in acre)	4.07	0.58	8	3.9	1.75

Source: Fieldwork, December 2018 – March 2019
Note: Lease land has also been included in operational landholding, of those farmers who neither have nor own land in joint families. Total no. of farmers practicing ZBNF in lease land is 3.

Average operational landholding and land under ZBNF usage are the lowest in Himachal (1.36 acre) and highest in Karnataka (15.14 acre).

1.7 Limitations of the Study

- In most of the states except in Andhra Pradesh, Natural Farming was being adopted in a scattered manner. This hampered the pace of the study as well as threw challenges in terms of selection of sample farmers. In states such as Kerala and Karnataka, the team had to travel in a range of 15 to 40 kilometres to interview individual farmers.
- Farmers found it difficult to recall the economics of their natural farms. In many cases, it was found that farmers were happy to talk about their experiences rather than discussing economic returns. This made it difficult to estimate monetary returns from crops under Natural Farming.
- While selecting sample one of the key criteria was to interview only those farmers who identify themselves as Natural farmers (ZBNF). The study has only covered farmers who explicitly stated that they are adopting Natural Farming methods. In Andhra Pradesh sample was largely chosen based on the suggestions made by the implementing partner. The study in its scope is limited to the experiences of farmers in the context of Natural Farming and has not comprehensively captured other strands within sustainable farming.
- The mentioned criteria were quite challenging to collate before field visit, a few of them evolved during the conversations with the farmers. But samples were selected based on some fundamental criteria like gender, the status of landholding (small, medium and large), use of ZBNF method in single and multiple crops and span of using Natural Farming techniques in cultivation.
- The study does not include farmers who have chosen not to practice Natural Farming.

FINDINGS & ANALYSIS

2. Findings and Analysis

This chapter details the key findings that have emerged from the 100 case studies, the FGDs that were conducted as part of this study and interactions with the stakeholders

2.1 Natural Farming process, adoption of its techniques, experiences of the farmers and its impact on the farm economics

The following section shares an overview of Natural farming techniques adopted by the 100 farmers who were interviewed as part of the dipstick study, their experiences and the impact of their farm economics, soil health and environment.

2.1.1 Principle-wise use of Natural Farming techniques across states

There are certain techniques to be followed to be referred to as a 'complete' Natural Farmer, the practice of the techniques are contextual, place-specific and situational.

The fieldwork across diverse geographies unfolded Natural Farming (ZBNF) as an experiential method where the farmers exercise their choices in selecting which techniques to be followed within the purview of natural farming. The choice of techniques depends upon situational factors like climate, landscape, soil quality and availability of raw materials to mention a few. The method is also 'experiential' as 52% the farmers in our sample took up Natural Farming (ZBNF) in last 2 years and are still at a preliminary stage of adoption and want to see the outcome before scaling up the method across the entire farmland. Significantly, 10% of the sample farmers mentioned that they adopted Natural Farming more than 10 years ago.

Key Insight: *Jeevamrutha is most preferred techniques used by 74 out of 100 farmers in this study group.*

Table 2: State-wise usage of Natural Farming techniques

Order of importance	Technique used/State	Andhra Pradesh	Himachal Pradesh	Karnataka	Kerala	Maharashtra	Total
1	Jeevamrutha	19	14	11	13	17	74
2	Beejamrutha	9	6	9	3	13	40
3	Mulching	15	7	11	3	5	41
4	Agniastra	21	5	3	0	0	29
5	Brahmastra	22	5	3	0	0	30
6	Neemastra	24	3	6	0	0	33
7	Other methods	2	4	0	1	3	10
	Total no. of farmers	**41**	**16**	**11**	**14**	**18**	**100**

Source: Fieldwork, December 2018 – March 2019
Note: Though the total sample is 100, the cumulative number of farmers may exceed the total sample size because in many cases one farmer uses multiple techniques. Thereby, the cases are overlapping.
Other methods – Traditional natural farming techniques which are used by farmers

The category referred to as '*other methods*' reflects traditional farming techniques where the farmers do not strictly follow Natural Farming principles but use similar ingredients in their raw form. For example, Dayal Singh from Himachal Pradesh shared that he had a gobar gas plant and used to use cow urine even before Natural Farming (ZBNF), it has been traditionally used by him for wheat. Kamala Verma narrated that she collects dry leaves and arranges them as a bed in the cowshed, the cow urine makes the leaves wet; she then stores her crop seeds in this bed of wet leaves –which forms

an ideal condition for the germination of seeds. Narayanankutty from Kerala revealed that he is practicing natural farming since 2008 by using ingredients like jaggery, cow urine and cow dung whereas three farmers from Maharashtra practice need-based seed preservation techniques.

Key Insight: *While Jeevamrutha has emerged to be the most prominent technique used by the farmers in the sample, pest management techniques are adopted as and when needed.*

Pest management mixtures like *Dashparni ark*, *saptadhanyakur* (reported in Himachal Pradesh), *panchagavya* (reported in Andhra Pradesh and Kerala), *nimboli ark* (reported in Maharashtra) and manure like *ghanajeevamrutha* (reported in Himachal Pradesh and Maharashtra), which uses dry cow dung, are also commonly used in all the states. In short, as the farmers perceive it, such principles are not new to them, rather are fundamentals of natural farming which they have been familiar with for very long.

> "Jeevamrutha is prepared in a 200 litre drum with 200 litre water, 10 kg Indian breed cow dung and 10 litre cow urine, 1 kg jaggery, 1 kg gram flour or crushed pulses and 10 gram soil collected from the roots of any big tree. The mixture is first boiled and then cooled. It is kept for seven days and then opened in the sun. The mixture is shaken well before using in the farm. 200 litre is enough for 1 acre."
>
> - FGD participants, Himachal Pradesh

As mentioned above (refer to section 2.2.1) and the narratives reflect that although few farmers strictly adhere to all ZBNF principles, most of them selectively adopt these principles in their farm.

Farmers across the states mentioned that classical forms of farming have been an age-old practice. The new addition under the purview of Natural farming has been the preparation of 'specific' mixtures like beejamrutha, jeevamrutha, etc. that have proper methods of preparation that need to be followed. Therefore, since many farmers have been using natural techniques in varying degrees, Natural farming (ZBNF) is viewed by many of them as a shift to a different culture of natural farming. For instance, although Divya from Kerala has read and heard about Palekar's ZBNF model, she does not count herself as a strict follower of the same but integrates the philosophy of using desi cow urine and dung, mulching for germination of seeds, etc. She has not attended any training on Natural Farming but works on a trial and error basis. She started with cow urine and dung, biogas slurry, food waste, green waste from the garden and also uses kitchen waste. She lets these stay for a while and then applies them in the garden.

> "Over the years I have become very confident and also, I am exploring the usage of desi cow dung in various forms. Within jeevamurtha, ghanajeevamrutha and panchagavya that I prepare, I find panchagavya as one of the best ways. Panchagavya is made from the blend of five cow-derived products. It is made of cow milk, curd, cow urine, ghee and fresh cow dung and sugarcane juice or jaggery, tender coconut water and ripe banana. It has to be prepared in a wide mouth container made of mud, concrete or plastic. Fresh cow dung and ghee are mixed in the container and stirred twice a day for 3 days. On the fourth day, remaining ingredients are mixed in the container; the mixture is stirred twice a day for the next 15days. It can be sprayed once in 15 days, before and after and fruit bearing time."
>
> - P.P. Unnikrishnan, Kerala

Even before the Karnataka government launched an organic farming mission in 2004, it has been in practice. In the decades that K.M.Kumbal from Karnataka has practiced Natural farming, he has always been following natural farming techniques. "No chemical inputs have been used on the farm since my grandfather's time. We have followed farming and cow rearing under the larger farming philosophy of 'Low External Input Sustainable Agriculture'. Even though we say we have been doing organic farming, we have never used any organic inputs that are purchased from the market or brought from other environs. We have only used the materials available on our farm", shared Mr Kumbal.

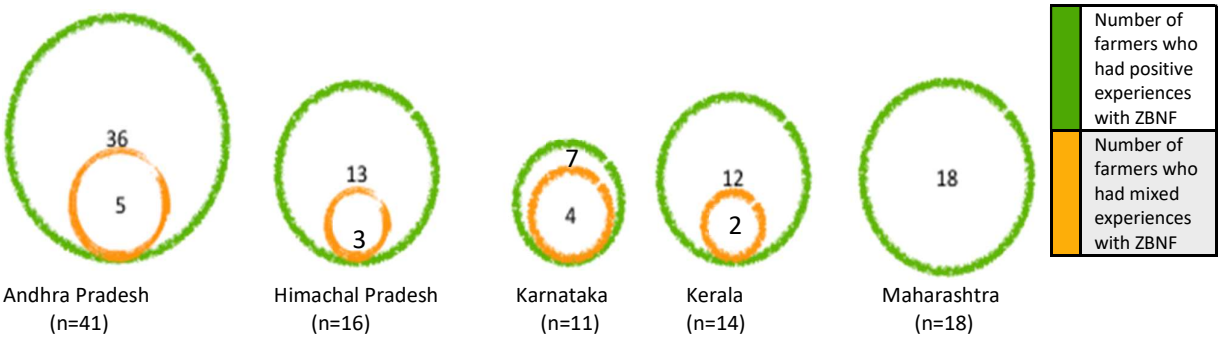
2.1.2 Mapping the Farmers' Experiences

"Achieving stability in Natural Farming won't happen overnight. We must prepare for glitches, be it in yield, volume or anything else. Farmers must be prepared to bear losses", says Venkatesh from Karnataka. The narrative leaves a distinct implication that soil which has been exposed to chemical fertilisers takes a stipulated time, at least 4-5 years to get adapted to natural ingredients. Differences in farmers' experiences of adopting Natural farming are based on multiple factors including how and which techniques they use, the distance of farmland from the source of raw materials, terrain and suitability of the climate to mention a few.

Key Insight: *86% of farmers claimed to have positive results in both single and multiple crops.*

Across stories, an analysis of farmers' experience depicts an overall positive scenario vis-à-vis the Natural Farming method. Within the total sample**,** at the farmers' level, the state-wise distribution of perceived positive responses is as follows:

Figure 5: Number of farmers experiencing positive and mixed results in Natural Farming method



Source: Fieldwork, December 2018 – March 2019

The key positive and negative factors related to Natural Farming have been mapped across the five states. Many farmers in Kerala identified healthier crops as a key positive factor. While few farmers highlighted negative factors, the main concern was regarding the pricing for natural produce.

Key Insight: *30 and 48 farmers identified the increase in yield and reduction in input costs as a positive factor of Natural Farming respectively.*

Table 3: Positive factors of Natural Farmers as identified by farmers across states

Order of importance	Positive Factors	Andhra Pradesh (n=41)	Himachal Pradesh (n=16)	Karnataka (n=11)	Kerala (n=14)	Maharashtra (n=18)
1	Reduction in input cost/ no input cost	20	8	6	3	11
2	Increased yield and income	21	1	1	0	7
3	Healthier crops and greenish farm	10	12	5	13	6
4	Minimal pest attack	9	5	2	1	12

Order of importance	Positive Factors	Andhra Pradesh (n=41)	Himachal Pradesh (n=16)	Karnataka (n=11)	Kerala (n=14)	Maharashtra (n=18)
5	Reduction in growth of weed	8	0	0	0	2
6	Mulching allows more seeds to germinate	5	1	0	0	2
7	Improved soil health	4	5	6	8	8
8	Increased moisture retention capacity of soil	0	4	3	1	6

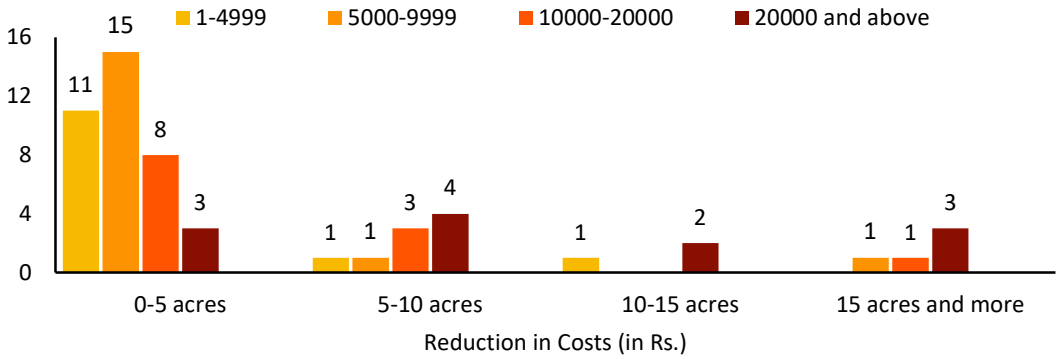
2.1.3 Benefits as Perceived: Through Quality, Yield and Income

An analysis of the narratives of the 86 farmers, who had 'all positive' results with ZBNF methods, helps us identify the predominant benefits and positive experiences that farmers had across the states. The key positive results have been listed below:

- ***Reduction in input cost**:* Besides all other soil environment and crop-related impacts, the economics of production is perhaps the most common issue that the farmers spoke about. Adoption of Natural Farming techniques has reduced the input cost to a great extent, for example by 68.6% for Ishrat from Maharashtra. Parvati and Champa Devi from Himachal, for instance, said, "We adopted Natural Farming because there is no input cost involved and chemicals are causing harm to our health". Rajendra Patil from Karnataka stated that along with chemical fertilizers, the use of chemical insecticides was also terminated in his farm since 2010. "Thus, with a major chunk of chemical inputs dropped, my cultivation costs also decreased to a great extent. My total expenditure on chemical fertilizers – Di-ammonium Phosphate (DAP) and urea – for the entire farm used to be Rs. 22,500 while that on chemical insecticides used to be Rs 25,000. All of these costs are now eliminated", said Rajendra. Murlidharan from Kerala reflects on how agriculture can be perceived as a viable means of livelihood, "Before ZBNF, I used to spend thousands of rupees on chemical fertilizers and the soil was getting damaged. But now I save on the cost of seeds, fertilizers and pesticides. The new system of farming has freed us from the debt trap and instilled a renewed sense of confidence to make farming an economically viable venture". 82 out of the 100 farmers interviewed were able to provide details of the extent of cost reduction in their input costs. These costs included a reduction due to the lack of expenses on chemicals like DAP and Urea, chemical insecticides and savings on seed costs.

Key Insight: *56 out of 82 farmers (68 per cent) had a reduction in cost to the tune of Rs. 10,000.*

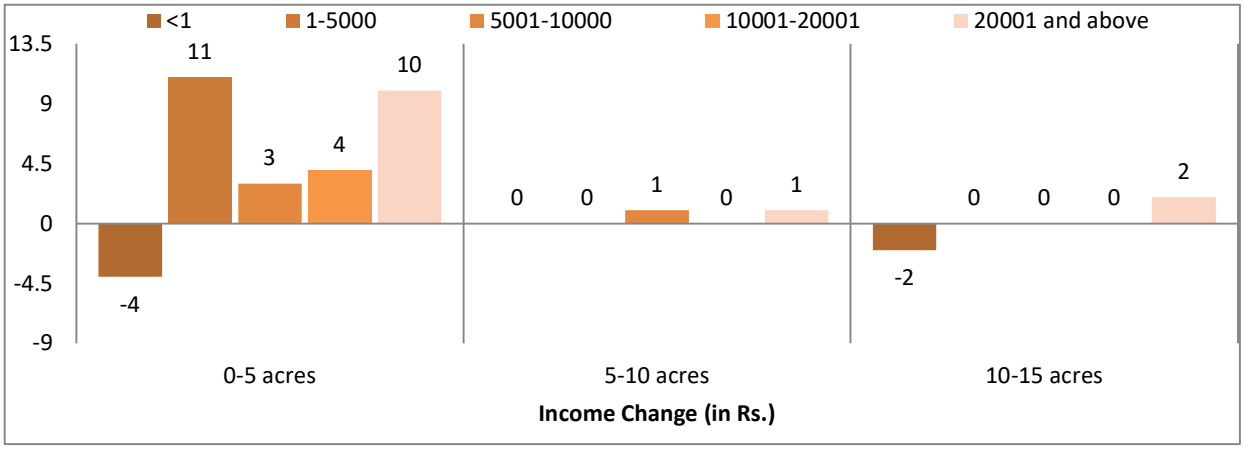
Figure 6: Reduction in costs of farmers



- ***Increase in yield***: With the reduction in input cost, the added advantage has been an increase in yield, though Somkrishan, an organic farmer from Himachal said that the yield is low in ZBNF method compared to organic farming. Though few pointed out that the yield is low in initial years, many claimed to have more yield in ZBNF after this initial low yield. Kantabai from Maharashtra said that her usage of ZBNF mixtures has been consistent since she first adopted this in Kharif 2017. "The quantity of my black gram and green gram produce increased two-fold from around 10 kgs with chemical methods to 20 to 26 kgs with ZBNF", she said.
- ***Increase in income with a better sale price*:** Increase in yield is linked to an increase in income, as farmers perceived. "Now there is a special market price for the Natural farm produce. We can sell products in the weekly market or go to the nearest town. I get regular orders from an institute that ensures a better price. I am happy about the kind of work I am doing", shared Vantala Gopala Rao from Andhra Pradesh. Shalubai Bhalake from Maharashtra also shared, "Using chemical fertilizers, I used to produce 10kg urad, 15kg mung, and 5-6 quintal of soybean. Every year per acre expenditure was more than Rs.12000 to 15000/- towards purchasing seeds, fertilizers, pesticides and weedicides along with labour charges. After using Natural farming techniques now I produce 32kg urad, 35 kg mung and more than 9 quintals of soybeans from the same area of land. The price offered for crops and grains is 20% to 25% more than earlier".

Key Insight: *19/38 farmers interviewed shared that their incomes have enhanced in the range of 20,000 by adoption Natural Farming techniques*

Figure 7: Income change of farmers



- ***Healthier crops**:* Majority of the farmers across states remarked that their crops were healthier, bigger in size and thicker compared to those grown with chemicals. Antika Jadhav from Maharashtra gave some of the black and green grams to her other neighbours - "Their positive feedback was assuring. They said these grams were more luscious and cooked faster", she said. M. Subadra from Andhra Pradesh stated, "The plants look different in quality, the size is bigger and they tasted better".
- ***Minimal pest attack:*** Another contribution of the ZBNF method for a few farmers had been the reduction in pest attacks. "Ever since I adopted ZBNF technique, I did not encounter any pest attack in mung and urad. Otherwise, I used to spray chemical pesticides 2-3 times during each crop season. Currently, I'm growing bengal gram in Rabi season, which is also free of pests, while other farmers have

"I made pendamruthra, hingwadravamum, beejamrutha, and narushudhi (root treatment). I also prepared brahmasthra, pullatimajjiga (sour milk) and neemastra for pest control. Since pests are less it is not made often."

-M.Subadra, Andhra Pradesh

been struggling with recurrent pest attacks", said Ashok from Maharashtra. Another farmer, Korra from Andhra Pradesh shared, "Despite spending nearly Rs. 2000 every season on buying chemical insecticides to control pests, I used to struggle with recurrent diseases and pest attack. After I shifted to ZBNF, I have been able to see the change in the first season itself". Though pest attack is minimal as shared by the majority of the respondents, Santhosh from Kerala reflects on the advantageous use of biological pesticides instead of chemicals, "Since Natural Farming involves using of biological pesticides; it doesn't have any harmful effect on soil unlike chemical pesticides".

- **Reduction in the growth of weed:** Ten farmers highlighted that since they had started practicing ZBNF, they had a reduction in the growth of weed. Vishwanath from Latur, Maharashtra mentioned that Jeevamrutha had resulted in less proportion of weeds during Kharif as well as Rabi seasons. "Unwanted and disproportionate growth of weeds was occurring regularly. However, after adopting ZBNF techniques, there were very few weeds this year", said Vishwanath. The reduction of weed was also a cost-saving method for some farmers, as Mucherla Anjappa from Ananthapur, Andhra Pradesh remarked that he now had to reduce the number and rounds of labourers required to remove the weed.
- ***Improved soil health**:* Chemical-borne soil used to be hard, rough and tight while natural ingredients have brought in significant changes in the soil quality. The soil has become loose, smooth and fertile with microbes and an increased number of earthworms. The major impact that Rajshekhar from Karnataka observed on his farm after he adopted ZBNF was the notable improvement in the soil quality. "The soil under the mulch never gets hardened or forms lumps. The soil has been strengthened to a great extent", Rajshekhar attributes this change primarily to mulching. The humus content has also increased in the soil. Girishan from Kerala also had similar kind of experience, "The quality of soil improved, it turned out to be softer and the colour has changed from red to dark black, water always remains on the topsoil due to which the irrigation process has become easier".
- ***Increased moisture retention capacity of soil***: Waaphasa, the microclimate in the soil allows the micro-organisms and roots to grow properly in an air-moisture balance. With waaphasa, the technique of mulching helps to retain moisture in the soil. Raksha Sharma from Himachal said that "Our soil used to get hard with continued use of chemicals. Jeevamrutha has brought in significant changes in the soil, it now has moisture and therefore it is soft even when there is no water". "Soil has smoothened. There are no lumps and hardness. The humus content has also improved. Besides, the soil's water retention capacity has also increased," stated Amol from Karnataka. He said that "even when it rained excessively, neither did our farm get waterlogged nor did the water get drained." While water scarcity is a pressing issue in Himachal Pradesh and most of the farmers depend on rain-fed irrigation, many farmers revealed that adopting Natural Farming, especially the use of jeevamrutha in crops, does not allow the crops to get dry. Champa Devi from Himachal shared, "The crops are healthy even with the minimal usage of water". Rajshekhar from Karnataka shared, "the number of irrigation rounds was also reduced after adopting waaphasa, a technique that does not emphasize on more irrigation".
- ***Increased germination of the seeds**: "*Germination percentage has increased from 70% in chemical farming to 85% in using Natural Farming", shared Heerala Shekar from Andhra Pradesh. Adopting Natural Farming has resulted in more numbers of germinated seeds while in chemical fertilizers – seed death has been a common problem. More number of germinated seeds was also linked to an increase in production. Due to drought and low rainfall in Maharashtra, farmers used to always grapple with poor germination of seeds every season. "Many times, therefore, we have had to sow twice." But, this year,

> "We have been trained in seed conservation and now save seeds from the harvest for sowing in the next season. Cow dung has to be burnt, dried and turned into ash. Mixture of this ash and ground lemon leaves is thenapplied to the seeds and stored for eight months till the next sowing season."
>
> -FGD participants, Maharashtra

her experience with the seeds given to her by Adarsh Mahila Griha Udyog (which were procured from a ZBNF farm) was different. “All the seeds germinated. None failed,” she added. Thereby, the farm-saved seed has been a successful venture in Maharashtra. Asharam from Himachal has also spoken positively about the germination of the seed, “Merely 50%-60% seed used to get germinated. After the adoption of ZBNF, 90% of seeds are germinated”.

2.1.4 Challenges in the adoption of Natural Farming and Scaling up

Though farmers across the states have identified several positive impacts of Natural farming, a few farmers within the total sample reported it to be a mixed experience. The causal factors about such experiences attribute to excessive time and effort, physically more demanding work, lesser yield in the initial years compared to the yield under chemical fertilizers, limited knowledge of direct market linkage and marketing strategy of the natural produces.

20 out of 41 farmers from Andhra mentioned that the method is laborious, gives lesser yield and is not suitable for commercial farming as there is no difference in price. “Though the input cost of ZBNF is less, crops in organic farming and natural farming are the same but the latter requires more labour. If I include the cost of labour that my family provides and then compare with the cost of organic farming, then ZBNF does not seem very profitable. As I grow exotic vegetable it costs more. Natural farming has the potential, provided the people are aware of its proper use”, shared Somkrishan. He said that income is not even equal to the input cost incurred; thereby he is not happy with Natural farming whereas he has been practicing organic farming for 16 years which brings him more income. He says that crops in organic and ZBNF are the same and the input cost in ZBNF is less, but it requires more labour. He said if you include the cost of labour that the whole family puts in free of cost and then compare the cost with organic farming, then ZBNF does not seem very profitable though he has a firm belief in the practice. Amol from Karnataka finds the method much more demanding in comparison to chemicals and shared that, “It does take more effort than the chemical method. Besides, the extensive use of cow dung also repels most farmers from adopting Natural Farming”.

Table 4: Negative factors of Natural Farming as identified by farmers across states

Order of importance	Negative Factors	Andhra Pradesh (n=41)	Himachal Pradesh (n=16)	Karnataka (n=11)	Kerala (n=14)	Maharashtra (n=18)
1	No different price and market for natural produces	12	0	0	7	0
2	Lesser or no yield in the initial years	5	0	2	0	0
3	Physically more demanding	3	0	2	0	0
4	Limited knowledge of direct market linkage	0	4	0	0	0
4	Excessive time	0	4	0	0	0

Though hardly any farmers (less than 1%) across five states spoke about negative impacts, they identified some of the challenges in the adoption of the ZBNF method.

- ***No difference in price and market for natural produces:*** 19 farmers pointed out that as the selling price of crops grown with the use of chemicals and those grows by ZBNF methods is the same. "Nobody knows what chemically grown produce is and what is naturally grown produce. Somebody should certify and create a better market. Then only will it benefit farmers who are practicing ZBNF method," remarked Gadde Muneeswararao from West Godavari, Andhra Pradesh. The main challenge the farmers highlight is that those involved in natural farming do not get sufficient support from the government, or the right prices, nor sufficient subsidy. "The farmer gives his best product but it is not valued, or he gets the same price as chemical farmers," remarks Thaijudeen T.S from Pallakad, Kerala.
- ***Time-consuming and labour-intensive:*** Though Natural Farming is economical and beneficial, the process involves long hours. "Besides that, not all farmers have access to desi cow, neem leaves, cattle shed with the provision of collecting urine and dung separately, which is an extra task", added Subadra from Andhra Pradesh. Heerala feels that spraying jeevamrutha or any other extracts are a problem, "because the filtration time and process are too hard to deal with". A total of nine farmers (three from Andhra Pradesh, two from Karnataka and four from Himachal Pradesh) admitted that Natural farming required a lot of effort right from rearing cattle to collecting their urine and dung, preparing inputs and following a strict, timed farm schedule. Vidya from Maharashtra said that the input preparation time could not be quantified as such and that there was work to do round the clock.
- In addition to this, during the focus group discussion, farmers mentioned that the absence of desi cow and less availability of cow feed was another challenge. As not all the farmers own desi cows and the Natural farming technique require a lot of dung and urine – some farmers face difficulties in gathering these ingredients. Korra Sathyam, a farmer from Andhra shared that fodder is also not easily available. Farmers also stated the problem of availability of neem leaves. "Unavailability of neem trees is affecting the preparation of ZBNF natural extracts. Few farmers are taking neem leaves from somewhere else, but that is very expensive" stated Rammurthy from Andhra Pradesh. Cow urine and cow dung being the fundamental ingredients in the adoption of ZBNF method, ownership of desi cow is significant. The table below maps the state-wise distribution of farmers owning desi cows apart from other livestock.

> "On the quantity of cow dung and cow urine, I differ from Palekar's theory that Jeevamrutha for 30 acre can be prepared from just one cow. Cows also need a certain diet. To prepare Jeevamrutha in the quantity required for thirty acre from just one cow may not be possible. At least two cows are needed."
>
> -K.M. Kumbal, Karnataka

Key Insight: *79 farmers across five states within the sample own desi cows.*

Table 5: State-wise distribution of farmers owning desi cows

States	Andhra Pradesh	Himachal Pradesh	Karnataka	Kerala	Maharashtra	Total
No. of farmers	41	16	11	14	18	100
No. of farmers having desi cows	33	11	11	9	15	79

Source: Fieldwork, December 2018 – March 2019

- ***Ineffective methods to control excessive growth of weeds:*** Weedicide is one chemical input that farmers frequently use even after the adoption of Natural Farming because the method doesn't have any natural extract preparation to curb weeds in the plants. Rajendra from Karnataka shared that he continues to use this even after he shunned the others eight years ago. "Growth of weeds called *harli* or *durwa* takes place a lot and weeding have to be done. But, employing labourers

costs a lot. So, using weedicides is the only viable option," he shared. He stated that Natural Farming provided no remedy to control weeds. "If we use dry farm waste for mulching, then it leads to a lot of weeds which have to be either removed or destroyed." In such cases, it is important to note that as Natural farming techniques have not been followed as per the recommended methods, results may invariably not be as effective.

- ***Not all techniques work on all crops***: Rajendra identified that the application of jeevamruth is crop-specific. For example, he said that "It does not work for chickpea, as it takes away the sourness from the crop which is essential for growth".
- ***Fear of loss and need for immediate returns:*** Many being the first-time practitioner of Natural Farming fear the chances of facing economic loss from the yield, thereby continue to use chemicals. Asharam from Himachal reflects upon its harmful effects, "Yield is reducing in chemical farming and diseases will increase until the use of chemicals is completely stopped. Earthworms used to go deeper in soil upto 15 feet that naturally used to plough the farm. Urea has destroyed all the earthworms living in the soil and groundwater level has gone down. The government should immediately intervene to close down the fertilizer companies as it is a threat to the environment". Ghanshyam Chopade from Maharashtra feels that farmers are either unwilling or hesitant in trying out new methods that hinders its expansion across a larger set of farmers, "Most of the farmers are engaged in traditional ways of farming and just follow what is being offered by corporate companies and implemented by other farmers".

Many farmers could not afford to give their fields time to recover from the chemical onslaught. Even if they believed in the philosophy of not interfering in the natural processes of farming, many were bound by the necessity of repaying loans and debts. "It is the factor of initial monetary losses that dissuade farmers from adopting the method", Venkatesh, from Karnataka, added. "Because there is a financial liability on most farmers of repaying loans every season, they cannot afford to take up alternative forms," he further said. Bhuma Somi Reddy from Andhra Pradesh also reflects upon the challenges of getting good yield during the initial years of adopting this natural farming method, "We found the process difficult in initial days and the yield also decreased in the first year but later, the yield increased gradually". In such cases, getting a good yield was of utmost importance, which often forced farmers to use some form of chemicals to get higher yields, despite the quality of the crop is poor.

A Narrative of Transition from Chemical to Natural Farming

To experiment with other forms of farming, farmers used a small patch of land that was for their subsistence. Amol from Belgaum, Karnataka on his farm in separate farm plots execute both chemical farming and Natural farming. Chemical fertilisers and pesticides are used on 8 acres of the farmland on which sugarcane is cultivated as a single crop. Amol on the remaining 1.5 acres of the land, on the other hand, has attempted natural farming. Amol planned the switch from chemical to natural farming on his farm carefully and in phases. Instead of adopting ZBNF techniques directly on the major crop of sugarcane at the outset, he executed them on a different set of crops to gauge the feasibility and results. Therefore, while many of the farmers may be keen to adopt the philosophy of a natural form of farming, in many cases they are only able to adopt these changes in the small patch where they grow crops for themselves.

2.1.5 Cropping Patterns in Natural Farms

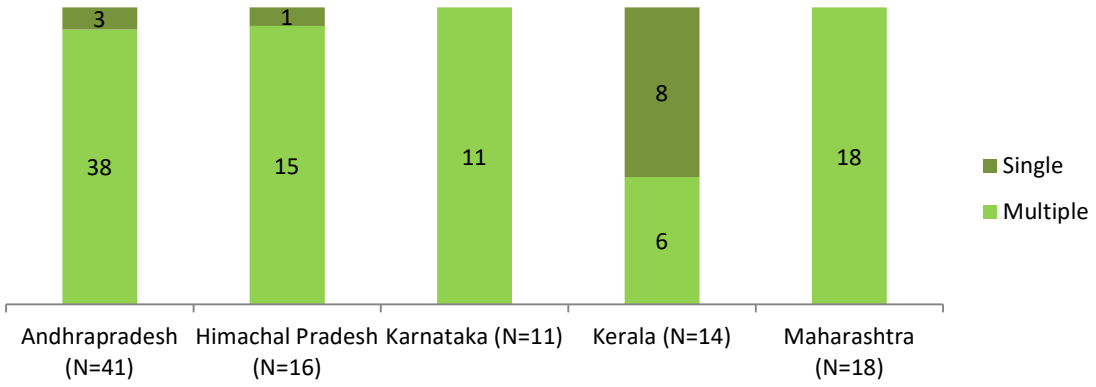
> Crop rotation is one of the important components of zero budget natural farming method. Multiple crops and of new types are cultivated simultaneously in the farm. This is good for soil as well as the crop because it improves soil fertility which ultimately results in increased farm produce every year".
>
> -Uttam Salame, Wardha, Maharashtra

According to the farmers' narrative, Natural Farming techniques have been applied in both single and multiple crops – 88% of the farmers of the total sample reported to have used Natural farming techniques in multiple crops whereas the rest 12% used Natural Farming techniques in single crops. It was noted that it was mainly the farmers who reported using ZBNF techniques in multiple crops that also practiced intercropping. Natural farming also boosted the variety of crops, i.e., crop diversification within the same landholding. For instance, Ishrat from Maharashtra shared that, "Until Kharif 2018, we had been cultivating three crops – pigeon pea intercropped among soybean in the Kharif season and chickpea in the Rabi season. This cropping pattern diversified in Kharif 2018 when I was introduced to Zero Budget Natural Farming – as many as 16 crops were added. In Kharif and Rabi 2018, therefore, a total of 19 crops – a cereal, an oilseed, four pulses, three fruits and ten vegetables – were cultivated by using my marginal 1.5-acre landholding."

Key Insight: *88% of the farmers interviewed have reported that they grow diversified crops in their farms after adopting Natural Farming techniques.*

The bar graph below displays that most farmers from Kerala used ZBNF practices in a single crop, while only a few farmers from Andhra Pradesh and Himachal Pradesh used it in a single crop. All farmers in Maharashtra and Karnataka used ZBNF techniques in multiple crops.

Figure 8: Distribution of farmers across single and multi crop usage



Source: Fieldwork, December 2018 – March 2019

Besides the boost in crop diversification, the farmers from Andhra Pradesh specifically mentioned having better results in some of the crops cultivated under Natural farming.

The table below provides details about which crop farmers had better results in and the frequency of those specific positive results:

Key Insights: *Most farmers reported good results (improved quality of seeds, reduced pests, increased yield) in Paddy (14/41 from Andhra Pradesh) and Groundnut (12/41 from Andhra Pradesh)*

Table 6: Results Among Farmers

Crops / Vegetables / Fruits	Andhra Pradesh	Himachal Pradesh	Karnataka	Kerala	Maharashtra
Paddy	14				
Sweet potato, Potato	2				1
Pepper	3				
Coffee	3				
Maize	1				
Groundnut	12				
Pulses	8				
Black gram					2
Green gram					2
Fruits (Banana, Pomegranate, Mango, Coconut, Papaya)	6				
Vegetables (Cauliflower, capsicum, sweet potato, potato, ginger, turmeric, tomato, bitter gourd, onion, spinach)	8	1			1
Total no. of farmers	**41**	**15**	**7**	**14**	**16**

Better were results observed mainly in paddy and groundnut. Better results indicate improved weight in paddy, coffee, pepper and good quality of seeds; no occurrence of pests in paddy while earlier pest attack was frequent in paddy; increased yield due to enhanced fertility of the land; vegetables remain fresh for longer.

2.1.6 Degree of adoption of Natural Farming method

The narratives related to a gradual shift in the area had been very subjective and varied from one farmer to another based on the availability of resources, risk-taking, adoption of technique, diversification etc. In terms of yield, most farmers spoke to about having a reduced yield in the first year of adoption, but a subsequent increase in the coming years. Even in diversification, instances were found where farmers added to diversification on the field with years of practice as they learnt while cultivating.

> In the first-year crop yield will go down. For coconut crop, ZBNF methods are not fully developed and there is a need to identify new methods for coconut. What is required is to build cattle sheds and increase NPM shops.
>
> Jujjavarla Satish, Andhra Pradesh

> The yield went down in the first year of ZBNF. I expect increased yield next year
>
> Killu Arjun, Andhra Pradesh

> In 2016 with the adoption of ZBNF, the yield of sugarcane fell by 55% from 40 tonnes per acre to 18 tonnes but by the third year it was recovered as the yield was similar to what was produced through chemical methods
>
> Venkatesh Mulimani, Karnataka

> Spices, flower and fruit were grown naturally in the first year as feasibility check whereas chickpea was the main crop in second year and sugarcane in the third year. Though the yield of both chickpea and sugarcane decreased in the base year, sugarcane yield has shown a marginal to a significant increase in the second and third year respectively. Even the naturally grown sugarcane matched the yield of chemically grown sugarcane in the third year.
>
> Amol Khurpe, Karnataka

2.1.7 Mapping the experiences of farmers across four principles of Natural Farming[14]

Fukuoka, in his book, states that 'returning-to-nature', although commendable, is not moving toward a solution, if it is carried out solely as a reaction to the overdevelopment of the present. As elaborated earlier, 'pure' natural farming according to Fukuoka implied that the farmer was in unity with nature and does not interfere in the natural processes. Therefore, making this transition to natural farming merely as a response to over-cultivation and the harmful repercussions of chemical farming, may not be enough, according to Fukuoka, it is also important for the farmer to imbibe the 'philosophy' of natural farming.

When the four principles of Natural Farming were mapped along with the narrative of 50 farmers (10 from each of the five states), it was found that many farmers undertook cultivation, weeding and prepared different solutions for Natural farming. A very low number of the farmers were dependent on chemicals, this was so because all the farmers interviewed were keen to shift to Natural farming, and all had given up the use of pesticides. Those who were troubled by pests switched to natural forms of pest reduction. "In making the transition to this kind of farming, some weeding, composting or pruning may be necessary at first, but these measures should be gradually reduced" specifies Fukuoka. Since many of the sample sizes had started practicing a non-chemical form of farming only since the last 0-2 years (53 farmers) or 3-6 years (33 farmers), many were still in the transition period.

Table 7: The Four principles of natural farming mapped along with farmer narratives

	Undertake Cultivation	Practice weeding (including Natural methods)	Use Chemical fertilizers	Prepare Bioinoculant
Maharashtra	5	4	0	10
Himachal Pradesh	9	3	2	9
Andhra Pradesh	8	2	0	10
Karnataka	3	0	1	10
Kerala	1	6	1	9
Total	**26**	**15**	**4**	**48**

Source: Fieldwork, December 2018 – March 2019

Cultivation

Cultivation alters the natural environment and has immeasurable repercussions on the soil, plants and weeds that grow. To cope with this, Fukuoka suggests abandoning all the unnatural practices – manmade chemicals and machinery.

Key Insight: *While many farmers did not mention anything about cultivation, 26 farmers specified that they plough the land. Some, like Kantabai from Maharashtra, pointed out that in the training she learnt that "ploughing in the daytime naturally destroys insects and their eggs which get killed and eaten by birds." She now ploughed the field in the daytime. While many farmers did not explicitly mention ploughing, the widespread practice could be inferred from the expenses that the farmers reported – the use of bulls to plough the land was mentioned in most.*

[14]The sample was not asked specifically about any of these four natural farming principles. A narrative analysis of the farmers' case stories was done to derive these inferences.

Vidya at her farm

Vidya, from Maharashtra, explained the evolution of the farming practices she had adopted over the past twenty years after chemical farming was abandoned. "In the beginning, we used vermicompost," said Vidya, indicating how she did not completely rely on ZBNF in the beginning. "Earthworms and microbes in our soil certainly increased with vermicompost." Therefore, between 1998 and 2008, she prepared and used four organic inputs on her farm viz. vermicompost, Jeevamrutha, cow urine-based seed treatment and cow urine-based insecticide. Thereafter from 2008 till date, Vidya reduced these to just two inputs –cow urine-based seed treatment and cow urine-based insecticide. Apart from this, she also practices natural mulching for her mango trees. "Her farms now have progressed to the 'do-nothing' stage," said Mahadev (her father). "Least application of inputs are now required. Nature ensures plant growth."

In the case of Vidya, since her father had the experience of natural farming and influenced her to shift to natural forms of farming, the 'philosophy' of natural farming has been one of the main reasons for her to shift to this form. In a similar case, Gangadhar from Karnataka stated that "The belief in Natural farming method is rather spiritual and one can see the change both inwards and outward in the field is something amazing. Even if there are some pests, which eat away plants or seeds, or something like, we allow it to take its natural course. Instead of applying tonics and allowing nature to take the different unknown path, we let it be." He has been practising Natural farming for the last 14 years and has worked towards convincing other farmers in this area to change their 'mindset' and to shift to a natural form of farming.

While this was the case for a very small portion of the sample, most farmers practised what Fukuoka would call 'narrow natural farming'. For most farmers, financial repercussions and the losses that they suffered because of chemical farming were the primary reasons behind their decision to explore other options of farming. In some cases, the farmers shifted to an alternate form of farming to reduce their expenses, as they then saved on the cost of fertilisers and pesticides. For instance, Ashok, from Maharashtra, was easily convinced to undertake ZBNF because it involved no or very little investment. He said, "Poor farmers like me have no other choices other than adopting the Natural farming". Padmanabhan from Kerala pointed out that "the benefits of Natural farming are especially valuable to smallholding farmers who grow on their land and owe their livelihood to their produce. By using only local and freely available substances for fertiliser, the costs of farming are much lower. Privatised seeds and chemical fertilisers are one of the biggest expenses for a farmer, and this new method means that the profits will substantially increase".

Weeding

Discontinuing cultivation, covering the field with straw and sowing the seeds for the next season while the preceding crop is still ripening the field are a few strategies suggested by Fukuoka to reduce weeds in the field. While Fukuoka identifies weeds as a cause of concern, he highlights the fundamental principle that weeds should be controlled and not eliminated. While many of the farmers haven't mentioned anything about weeding, 15 farmers reported having practiced weeding. While many had shifted to different concoctions of leaves which helped reduce weeds, some mentioned that they were

still troubled by weeds. In one case, due to financial constraints, the farmer was forced to use weedicides.

For ten farmers, natural farming has resulted in a reduction of weeds. “Weed has also reduced in crops, hence the number and rounds of labourers required to remove the weed have been reduced. I purchased a weeder, which I used on 2 acres of land”, shared Mucherla Anjappa from Andhra Pradesh. Krishnakutty from Kerala also said, “Mulching with organic residues reduces tillage and consequently the labour requirements as the process suppresses weeds, promotes humus formation and enhances the water holding capacity of the soil”. Asharam from Himachal, for instance, shared, “I hire labour during maize and wheat season for weeding”. The narratives are evident in stating that either the process of mulching is performed for the removal of weeds or manual labours are hired for weeding.

“Since, no fertilizers, pesticides, or manures are needed and mulching keeps the weeds under control as well, the input costs dropped. And the yield was almost the same, with a marginal decrease. Mulching greatly reduced the amount of water used too”

- Raju Kodag, Karnataka

Chemical fertiliser and dependence on chemicals

The growth of weak plants, high prevalence of plant diseases and insect imbalance, according to Fukuoka, are a result of the unnatural practices such as ploughing and chemical fertilisers. Two farmers from Himachal and one from Kerala reported to still practicing chemical farming, either in a small patch of land or completely. It does not necessarily consider only chemical fertilizers, but also includes chemical pesticides and insecticides. Leeladhar from Himachal though heard about Natural farming method from a fellow farmer still uses chemical in his farm, "I have been practising farming using chemical fertilisers and pesticides from the beginning. I realised that natural farming helps us in avoiding the modern-day diseases like diabetes and high blood pressure when I encountered people like my sister Kamlesh who took training in Natural farming at Shimla. She told me about natural farming methods and their benefits. I believe that the crops produced in natural farming are free from chemicals and those who consume naturally grown produce is healthy”. Sisupalan from Kerala shared, “Though I adopted ZBNF since 2009, I had in between shifted to using chemicals on a trial basis. I do not have any experience other than organic farming. In 2016-17, I started using chemical fertilizers like urea, potash and phosphorous for the field since I was not getting proper yield from ZBNF. Now I am cultivating coconut and mango trees in 4 acres and on the remaining land, I still continue to practise natural farming. The yield is getting lesser and lesser due to effect of fertilizers across the field. The mango yield has been worst hit due to pest attacks. But I still want to continue organic farming alongside. Only if the other farmers also convert to natural farming, it will be possible to sustain this farming method’.

Rajendra from Karnataka shared a different view on the use of chemicals, “Completely abandoning chemical fertilisers is considered a big mistake in general by farmers in villages”. He then drew an analogy of pickle served with the meal. “How at least a little pickle should be served with every meal, similarly, it is said a few chemical fertilizers at least should be used”.

Preparing Bioinoculant

Some of the negatives of the natural farming techniques when focusing on bio inoculants, were the effort involved and time consumed in preparation. Though Fukuoka's principle talks about no use of prepared bioinoculant and no hard work in its making process, 48 farmers within the sample reported having prepared jeevamrutha, ghanjeevamrutha in natural farming and vermicompost in organic farming. Some mentioned that making the preparations was quite laborious and time-consuming. Heerala from Andhra Pradesh shared, "Earlier, supplementary to chemical inputs, we used to just sprinkle cow dung on the field. Now, we know to prepare a proper mixture of cow dung with other natural things". Some farmers, like Amol from Karnataka, mentioned that "It does take more effort than the chemical method. Besides, the extensive use of cow dung also repels most farmers from adopting Natural farming. Many of the farmers said that preparation of these microbial cultures is an added strain to them because they do not own desi cows or do not have access to neem leaves.

Some positive aspects, as pointed out by farmers, were improvement in soil quality, reduction in weeds as well as a reduced impact on health. Leena from Himachal shares, "The soil has become softer and fertile because of the earthworms that grew in the soil in huge quantity after the application of jeevamrutha. Earthworms are the friends of the soil - they keep the oxygen-nitrogen balance in the soil. Neither pesticide nor weedicide has been applied in the farm after I started practicing Natural farming". Sangram from Maharashtra feels that preparing composts in Natural farming method is way better than applying chemicals in the field, "I was disappointed with the conventional way of farming as it wasn't beneficial in terms of production and thereby income. My investment incurred was more as compared to the returns in the conventional farming method, hence I shifted to the natural farming method. While using the conventional method of farming I had to spend more money on the purchase of fertilizers, pesticides and weedicides and had to pay for the labour hired. The use of chemical fertilizers led to increased weeds, which subsequently required spraying weedicides, and to hire labourers for removing unwanted weeds. After spraying chemical pesticides and weedicides the crop plants used to remain lusterless for 3-4 days. The spraying of chemical pesticides impacted my health and labourers. It used to cause irritation in eyes, nausea, burning of sole and skin. All these problems did not occur when I shifted to natural farming techniques".

2.2 Inferences from various stakeholders (State Governments, Individuals, NGOs) on the adoption of Natural farming techniques and potential possibilities of scaling up

2.2.1 State models and scalability

Andhra Pradesh

The Government of Andhra Pradesh (GoAP), Department of Agriculture (DoA) is implementing Natural farming programme, through the Rythu Sadhikara Samstha (RYSS) – a not-for-profit entity set up by GoAP with a mandate to promote farmers' welfare and empowerment. Rythu Sadhikara Samstha has been established as a not-for-profit company under Section 8 of the Companies Act 2013 to create an integrated institutional mechanism for all programmes, schemes and activities intended for farmer's empowerment, encompassing welfare, development, capacity enhancement, credit flow, financial support and allied empowerment activities.[15]AP Natural farming programme called APCRZBNF (Andhra Pradesh Climate Resilient Zero Budget Natural Farming) is planning to cover 6 million farm-families by 2024 and 80 lakh hectares of agricultural land in Andhra Pradesh by 2026 and make it as a ZBNF state.[16]

[15]http://apzbnf.in/about-ryss/(accessed on June 10, 2019)
[16]ZBNF Brochure (accessed on June 10, 2019)

RYSS has a well-defined structure for its mode of operations as seen below:

The Cluster Resource Person (CRP), alternatively referred as Project Resource Person (PRP) looks after the respective clusters under the intervention area whereas the Internal Community Resource Person (ICRP), who is local to respective villages is responsible to be in direct contact with the ZBNF farmers. Besides promoting ZBNF method of farming at the village level, the ICRPs individually visit the farmers to explain/help with the process and respond to their queries. At the field sites under this study, the model had not yet matured to the stage of Farmer Producer Organisations, but there was an initiation of group formation (SHGs) which had begun.

It is to be noted that while the RYSS has been made the implementing agency, the RYSS itself is bound by government policies and decisions and is not autonomous. In close association with RYSS, Kovel Foundation has implemented the project in Visakhapatnam and also providing the monitoring support. The NGO is working in Vizag's Paderu for more than a decade. The Andhra model is inbuilt with its troubleshooting system where the farmers reach out to the ICRPs for the solution of crop and process-related problems.

While such close monitoring and dissemination of Natural farming(by CRPs, ICRPs, etc.) has helped in faster outreach, if not supervised, it could have the potential to turn into a prescriptive, top-down extension methodology. As Khadse and Rosset (2019) point out, in cases where it is a top-down approach, there is the fear of the knowledge getting concentrated in the hands of a few farmers. They state that it could lead to a "dilution of learning processes and turn into a mere transmission of ZBNF practices, thus emulating a top-down approach".[17] To refrain from turning into a top-down model, there is a need to ensure that the farmers' knowledge and prior experience is kept at the centre of any extension methodology. Unlike a structured model in Andhra Pradesh, other states adopted natural farming largely on an independent basis without government and NGO interventions.

Maharashtra

Though Maharashtra does not have a structured format of adoption or government implementation, Latur district has an NGO which promotes natural farming and supports the farmers in buying cows. Besides promoting the farming technique, they have helped in forming SHGs in villages, and thus a network of SHGs. Having a close association with the NGO, the NGO representatives support the farmers in Latur with immediate solutions. The field coordinators individually visit the farmers for troubleshooting. Subhash Palekar's workshops across different locations in Maharashtra inspired many farmers to participate in the training and adopt the technique thereafter. Though most marginal farmers were happy with the adoption of Natural farming, farmers with larger landholdings did not find it as profitable because of the financial loss during the initial years of adoption.

Karnataka

In the locations under this study, it was found that the adoption of Natural farming in Karnataka was scattered in nature. The farmers were all self-motivated and had gone to different locations to attend Palekar's training, following which they trained others in their villages. The farmers support each other

[17]AshleshaKhadse& Peter M. Rosset (2019): Zero Budget Natural Farming in India – from inception to institutionalization, Agroecology and Sustainable Food Systems

at an individual level in cases of troubleshooting. As the initial use of ZBNF techniques produces low yield, most farmers preferred adopting the method in a small section of the land, to begin with, and then gradually increase the adoption. Majority of the farmers have been unable to market their produce, while a few of them sold the naturally grown produce through personal contacts.

Himachal Pradesh

Though Governor of Himachal Pradesh launched Natural farming project in 2018 with a hope that farmers will adopt organic/natural farming[18], the adoption of Natural farming has been scattered in the state. Natural farming activists and local NGOs have mostly promoted the method at an individual level. With the notion of performing *jahar-mukt-kheti* (poison-free farming) one village level organization called 'Paryavaranebam Gram Vikas Sangathan' led by Nekram Sharma is supporting the farmers with natural farming and millet cultivation. Either the farmers reach out to Mr Nekram Sharma or support each other for troubleshooting. While few of them attended Subhash Palekar's training, those who have directly been part of the training trained the rest. The Natural farming trained farmers to organise training within smaller groups at a village level whereas various demonstration sessions are conducted through *Mahila Mandals* (women associations).

Kerala

The adoption of Natural farming in Kerala is also scattered in nature. Peer learning among the farmers has been the extension strategy so far for those who are practicing the method. Farmers often visit the government Agriculture department (Krishi office) for receiving information regarding pesticides, fertilizers and similar queries, but the department does yet not impart information about natural farming. Organic farming has largely been the traditional practice for many of the farmers in Kerala, while some are now also adopting Palekar's model. Kudumbashree conducts awareness programs and training for farmers about natural farming. Farmers having expertise in natural farming techniques visit agricultural colleges to provide training and a few of them also organize training workshops in villages to promote its adoption. Market linkage has been identified as one of the major challenges as the local NGOs were not involved in marketing the products. Very few farmers have been able to sell their products either directly going the market or through agent/vendors or via own contacts.

2.2.2. Natural Farming adoption and understanding of trends in the transition of farmers

Scalability

Linkages with the market remain a problem for all farmers across states, aside from a few buyers that the farmers have been able to arrange at an individual level, there are no initiatives that farmers mentioned they had access to via the NGO or government.

19 farmers feel that there is no specific market for Natural farming products primarily for two reasons - absence of separate marketing system and the certification of Natural farming produces as 'natural products'. Along with the shortage of mixing vessels and equipment, the inadequacy of cows at the farmers' level, irrespective of small or large landholders has been identified as one the major hindrances in scaling up the method. On the other hand, farmers who own cows find it difficult to maintain them because fodder is hard to access in the drought-prone regions like Ananthpur, making it expensive to own a cow. In the context of Kerala in particular, the importance of the native cow poses a hurdle, as the introduction of high-yielding hybrid cows has meant that the availability of

[18] https://www.indiatoday.in/education-today/gk-current-affairs/story/to-promote-organic-farming-hp-governor-launches-zero-budget-natural-farming-1159421-2018-02-01 (accessed on June 11, 2019)

native cows has reduced greatly. The price of native cows has risen from Rs. 5000 in 2008 to Rs. 20,000 in recent years.[19] This expense is a barrier for farmers to readily switch to Natural farming.

The adoption by farmers is better if the initial practices are simple and require less effort or resources to implement.[13]The sample shows that Jeevamrutha was most frequently adopted technique by farmers. In terms of scaling up, across states it was found that it was mainly the simple practices that were adopted by most farmers and it was the small landholders that were very happy with their experience of Natural farming. Most farmers had reported healthier plants, lesser need for irrigation and labour and better soil health. Natural farming was best practiced in places where water sources are not scarce, and fodder is easily available. AP farmers, especially the smallholders stated the need to establish more Non-Pesticide Management (NPM) shops for creating livelihood opportunities.

As the transition to a new method of farming entails many potential risks, most farmers chose to undertake ZBNF on a small patch of their land in the first year, which they then gradually increased over time.

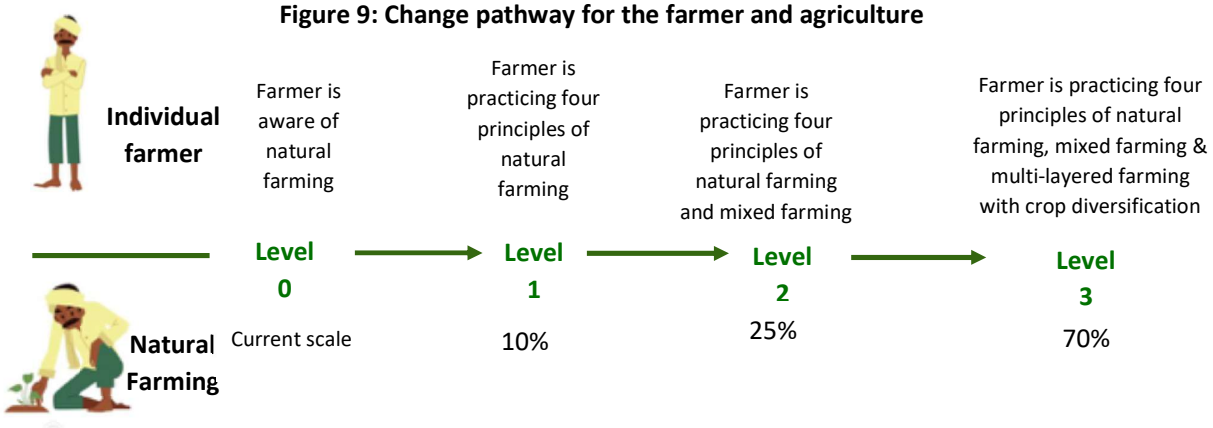
While a few farmers experienced a reduction in yield during their transition phase, many highlighted that this reduction in yield was offset by various other factors such as crop health, soil quality and input costs. For instance, Vidya from Maharashtra remarked "Sugarcane yields reduced in the initial years in comparison to the yield of 25 tonnes per acre that was obtained from chemical inputs in the previous years. But, since no input costs were incurred every season, losses from low yield were offset" (Land area: 15 acres). Similarly, many farmers stated that earlier they had a large expenditure on seeds and despite that, often, many seeds did not germinate. Now, they use farm-saved seeds and with the use of different ZBNF techniques, a very large percentage of these seeds germinate on time. All these changes have also led to a reduced dependence of farmers on external inputs.

- The yield stabilised for most farmers in the second or third year of ZBNF usage.
- Other issues applicable to the larger agrarian sector such as linkages with the market continue to plague natural farming as well. Here too, aside from a few buyers arranged at an individual level, there were no initiatives that farmers mentioned they had access to via the NGO or government.

2.2.3 Natural Farming Proposed Theory of Change from Stakeholder and Farmer Interactions

For any potential engagement on the issue of natural farming, the ideal change pathways are seen across two levels: that of the individual farmer and the practice of natural farming.

Figure 9: Change pathway for the farmer and agriculture



[19]Münster, D. 2016. Agro-Ecological double movements? Zero budget natural farming and alternative agricultures after the neoliberal crisis in Kerala. In Critical perspectives on agrarian transition: India in the global debate, ed. B. B. Mohanty, 222–44. India: Routledge.

The above changes will take place with simultaneous changes in three different domains of policy, practice and narrative (which is knowledge creation and dissemination) as seen in table 7 below:

Table 8: Indicative changes at each level across three domains

	POLICY - Policies and schemes to promote Natural Farming	**PRACTICE - More farmers practice natural farming and facilitate developing a market ecosystem around it**	**NARRATIVE - Diverse stakeholders start discussing, writing about the importance of Natural Farming- academics, policymakers, business experts, religious stakeholders**
Level 0	Model building support	Onus on farmers to make natural farming work	Margins, stakeholders write/ speak about it at a philosophical level
Level 1	Awareness of mass practice of natural farming	Onus shared by the Government	Evidence-based analysis of challenges, barriers and how and when it works
Level 2	Dis-incentivises non-natural farming and mainstreaming of natural farming	Onus starts shifting to the Market - natural seeds, natural manures, other inputs	Mainstreamed voices about the inevitability of natural farming. The narrative is spoken at business associations, chambers of commerce and even in the art and culture domain
Level 3	All non-agriculture policies such as industrial, trade, social sector, climate change policies build incentives for natural farming	An integrated policy-market-farmers system exists	Natural farming mainstreamed as the farming practice in terms of acceptance and practice narratives - any resistance to it is in the margins.

To achieve the above, one must realise that all the three influences strengthen and often weaken each other given that any positive movements create equivalent frictions from the vested interests. These often do not have independent stakeholders. The table below details the levels at which some key influencing groups can guide a push to trigger higher levels of change.

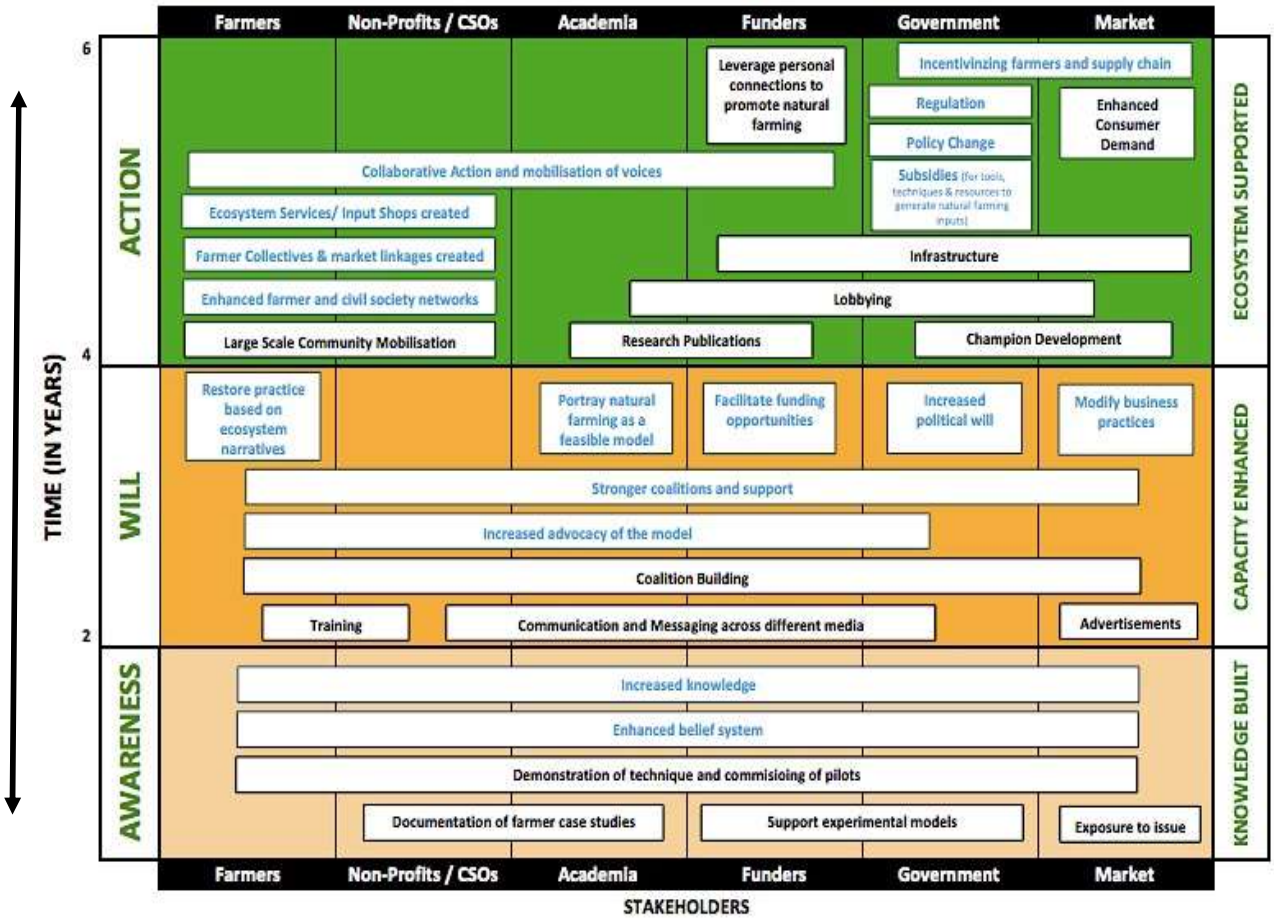
This forms the basis of the framework which provides direction to future interventions in the area of natural farming and is presented in the next section.

THE WAY FORWARD

3. Way forward

Based on the theory of change in the previous section and the above recommendations on way forward, a potential framework for future engagements it is presented in the figure below.

Figure 10: Framework for Future Engagement*



*Note: In the figure, the text in blue indicated outcomes and the text in black indicates actions

While activities and inputs in the initial phase could focus on a range of tasks to build on awareness to build knowledge on natural farming, engagement at a later stage could see a movement to increased willingness with capacities enhanced for the stakeholders. The culmination stage could then focus on actioning with a range of activities to build an ecosystem. The timeframe is subjective and may vary based on context.

Based on inputs from the farmers across study locations, this section below details three key ways forward for natural farming

1. Knowledge

- There is a need to create a platform or mechanism to ensure that the farmers' knowledge and prior experience is captured so that it can be kept at the centre of any extension methodology. It is important to pay heed to farmer level experiments with natural farming techniques and provide a mechanism to build such knowledge into a collective knowledge base.

2. Capacity Building

- Strengthening skills and capacity building of the farmers – especially in the case of small landholders where not all were aware of the different techniques.
- To scale up natural farming, there is a need to build an entrepreneurship capacity among the farmers through collectivisation of input purchase, bulk transport, market linkage and realisation of the best price following demand.

3. Infrastructure and Funding

- The government can develop a price regulating policy, as stated by the farmers. Farmers think, "Government should support (them) by providing seeds, drought compensation, water supply, and subsidised electricity charges".
- A Minimum Support Price (MSP) mandated by the government could ensure all farmers' income at market rate and reduce income inequality among them. A parallel subsidised price will ensure equitable access of food grains to the consumers.
- A provision can be made for the Government to provide a financial assistance programme for purchasing of desi cows and vessels to mix ingredients, especially to farmers with small landholdings.
- The government can focus on policies that encourage natural farming which can focus on reducing chemical pesticides, fertilisers as well as genetically modified or hybrid seeds. Similarly, hybrid varieties of cows should be disincentivised.
- There can be a promotion (by Government and others) on more Non-Pesticide Management (NPM) shops for timely availability of botanical extracts and all kinds of green inputs required for pest control.

Annexure 1: Sample districts mapped across Agro Economic Zones

	ANDHRA PRADESH			HIMACHAL PRADESH	KARNATAKA				KERALA		MAHARASHTRA		
District	Anantpur	Visakhapatnam	West Godavari	Mandi	Bijapur	Belgaum	Bidar	Raichur	Palakkad	Thrissur	Latur	Beed	Wardha
Agro-ecological region	Karnataka plateau	Eastern coastal plain, hot sub-humid to semi arid eco region	Eastern Coastal plain, hot sub-humid to semi arid eco region	Western Himalayas, Warm Sub humid	Deccan Plateau, Hot semi arid		Hot semi arid, North karnataka plateau	Deccan Plateau, Hot Semi arid	Western Ghats And Coastal Plain, Hot Humid region	Konkan, Karnataka and Kerala Coastal plain, Central and south Sahyadris	Deccan Plateau, Hot Semi-Arid		Central Highlands (Malwa And Bundelkhand), Hot Subhumid (Dry) Maharashtra plateau, hot dry subhumid
Agro-climatic zone	Southern Plateau and Hills Region	East coast plain and hill region	East Coast plain and hill region	West Himalayan Region	Southern Plateau & Hill Region	Southern Plateau and Hills Region	Southern plateau and Hills Region	Southern plateau and hill region	West Coast Plains AndGhat Region	West Coast Plains AndGhat Region	Western Plateau and Hills Region	Western Plateau and Hills Region	Western plateau and hills region
Geographical area ('000ha)	1913	1116.1	774.2	397.8	1053.5	1344.4	541.8 (lakh ha)	835.8	4.47 (lakh ha)	302.9	715.7	1068.6	629
Net sown area ('000ha)	1113	304	432.3	85.8	872.5	841.9	355.8	560.2	197.2	129.3	529	876	284
Net irrigated area	108.9	100.5	364.5	15.1	237.4	431.2	47.2	154.9	93	68.5	319	137.7	31.58
Annual average precipitation (mm)	560	1084	1153	1250.3	594.4	823.3	848	621	2472.1	2822.1	769.7	743.4	886.4
Major soil type	Shallow red soil, black soil and others	Red clay and sandy loam, coastal sandy, alluvial, clay loam	Alluvial, sandy and deltaic alluvial, coastal	Shallow to medium to deep loamy skeletal soil	Shallow, medium and deep black	Black, red, sandy and sandy loam	Deep black clayey (alluvial and	Deep black calcareous clayey,	Red, loamy, clayey	Laterite, sandy and sandy loam, clayey	Deep, medium deep and shallow	Deep, medium deep and shallow black soil	Deep, medium deep and shallow black soil

	ANDHRA PRADESH			HIMACHAL PRADESH	KARNATAKA				KERALA		MAHARASHTRA		
District	Anantpur	Visakhapatnam	West Godavari	Mandi	Bijapur	Belgaum	Bidar	Raichur	Palakkad	Thrissur	Latur	Beed	Wardha
			sandy loam, heavy clays, saline		soil, red sandy and loamy, red and black mixed soil		calcareous too), deep lateritic gravely clay, mixed clayey, red loamy	Medium deep red gravelly clay, Shallow red loamy and red gravely clayey			soil		
Major crops	Groundnut, bengalgram, sunflower, rice, redgram, sorghum, maize, cotton, ragi, horticulture fruits and vegetables	Paddy, sugarcane, ragi, maize, groundnut, horticulture fruits and vegetables	Maize, blackgram, tobacco, sugarcane, groundnut, sunflower, greengram, sesame, chilli, redgram, cotton, horticulture fruits and vegetables, spices and plantation crops	Maize, rice, black gram, soyabean, wheat, barley, pulses, rapeseed, mustard, linseed, horticulture fruits and vegetables	Sunflower, sorghum, pigeonpea, pearl millet, maize, chickpea,horticulture fruits and vegetables, spices and plantation crops, flowers	Maize, sugarcane, soybean, groundnut, sorghum, cotton, horticulture fruits and vegetables, spices and plantation crops	Sorghum, redgram, bengalgram, soybean, blackgramgreen gram, sugarcanesunflower, wheat, plantation crops, flowers, horticulture fruits and vegetables	Sunflower,sorghum, bengalgram, bajra, groundnut, cotton, redgram, horticulture fruits and vegetables, flowers	Rice, jowar, ragi, cereals/millets, pulses, horticulture fruits and vegetables, sugarcane, spices, groundnut, sesame, plantation crops	Paddy, tapioca, horticulture fruits and vegetables, spices and plantation crops	Soybean, sorghum, pigeonpeablack gramgreengram, sunflower, wheat, gram, sunflower, sugarcane, horticulture fruits and vegetables	Pearlmillet, sorghum, cotton, pigeonpea, soybean, wheat, gram, sunflower, sugarcane, horticulture fruits and vegetables	Soybean, cotton, pigeonpea, wheat, chickpea, groundnut, sugarcane, horticulture crops and vegetables, medicinal and plantation crops

Source:http://www.nicra-icar.in/nicrarevised/index.php/state-wise-plan (District-wise Agricultural Contingency Plans)