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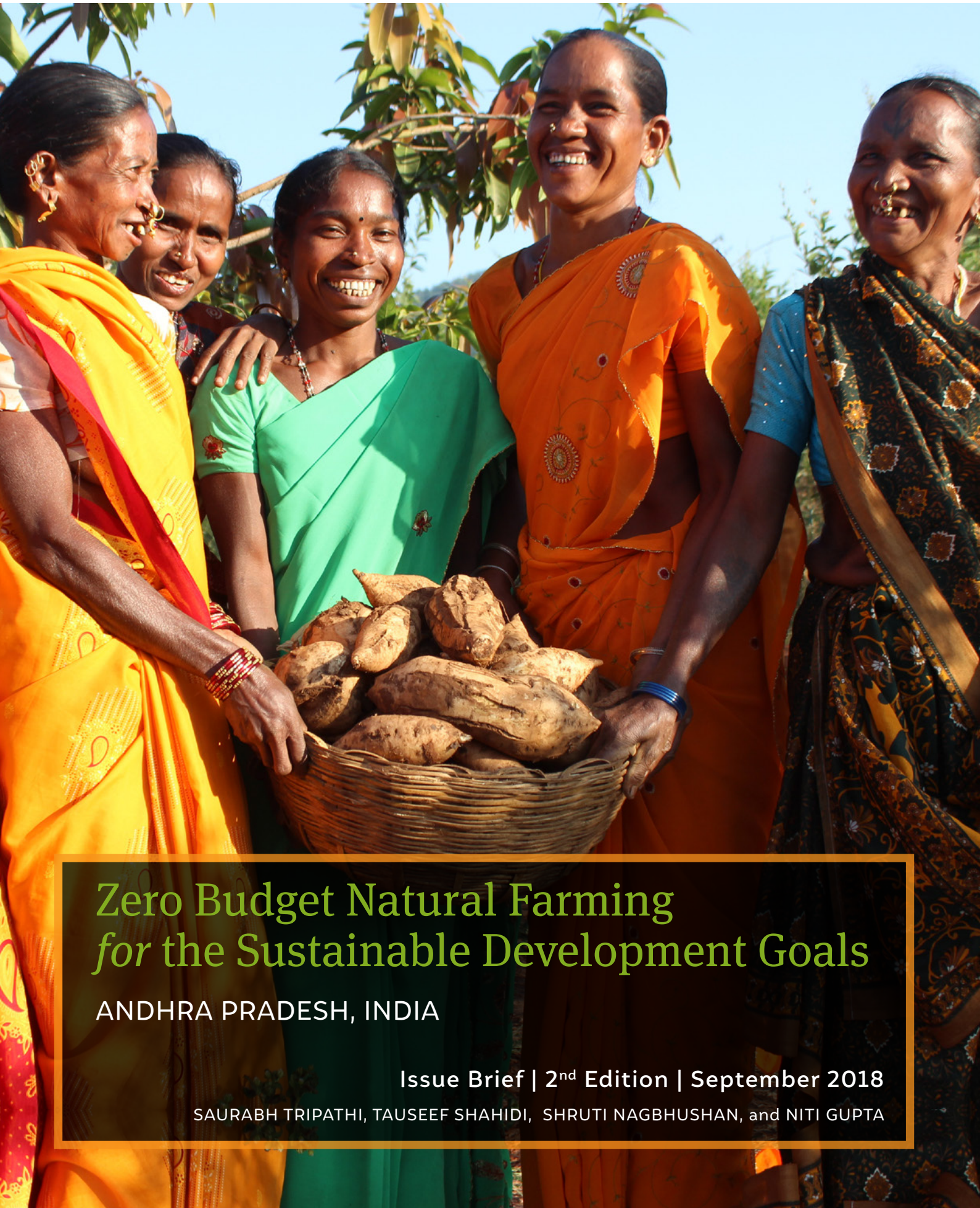

Zero Budget Natural Farming *for* the Sustainable Development Goals

ANDHRA PRADESH, INDIA

Issue Brief | 2nd Edition | September 2018

SAURABH TRIPATHI, TAUSEEF SHAHIDI, SHRUTI NAGBHUSHAN, and NITI GUPTA

Image:
RySS

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Issue Brief on 'Zero Budget Natural Farming for the Sustainable Development Goals, Andhra Pradesh, India'.

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Organisations:

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The Council on Energy, Environment and Water (CEEW) is one of South Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain – and change – the use, reuse, and misuse of resources. The Council addresses pressing global challenges through an integrated and internationally focused approach. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions, and engages with wider public.

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Abbreviations

AP	Andhra Pradesh
APPI	Azim Premji Philanthropic Initiatives
ANGRAU	Acharya NG Ranga Agricultural University
CCEs	crop cutting experiments
CEEW	Council on Energy, Environment and Water
CRP	community resource person
CO_2	carbon dioxide
DGF	Digital Green Foundation
DDT	dichlorodiphenyltrichloroethane
GHG	greenhouse gas
GoAP	Government of Andhra Pradesh
GVA	gross value added
ICT	information and communication technology
INR	Indian Rupee
Jr CRP	junior community resource person
NFFs	natural farming fellows
PCB	polychlorinated biphenyl
PDS	public distribution system
RCTs	randomised controlled trials
R&D	research and development
RySS	Rythu Sadhikara Samstha
SCs	scheduled castes
SDGs	Sustainable Development Goals
SIFF	Sustainable India Finance Facility
SHG	self-help groups
Sr CRP	senior community resource person
STs	scheduled tribes
UN	United Nations
USD	United States Dollars
WASH	water, sanitation and hygiene
WSHGs	women's self-help groups
ZBNF	Zero Budget Natural Farming

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Image:
RySS

1. Introduction

Agriculture has been the mainstay of the Indian economy for centuries. Over half the country's population today depends on agriculture and allied services for their livelihoods. Agriculture constitutes 17.4 per cent of the gross value added (GVA) to the national economy[1]. Agriculture in India has transitioned from subsistence to commercial farming in order to reduce the country's import-dependence on food grains. It has also evolved to meet the diverse nutritional requirements of a rapidly growing populace.

However, due to systemic inefficiencies and high resource-dependencies, the dominant form of agriculture today imposes significant negative externalities and presents critical challenges for a range of stakeholders – from farmers to consumers, as well as natural ecosystems and biodiversity. Out of the nine planetary boundaries identified as "safe operating spaces for humanity"[2,3], two have been completely transgressed – biosphere integrity and biogeochemical flows – with agriculture being an important driver of both[4].

Agriculture in its prevailing form requires farmers to rely heavily on inorganic external chemical inputs such as fertilisers and pesticides. These contaminate groundwater and other water-dependent ecosystems, reduce soil fertility over time, and contribute to biodiversity loss in farmlands[5,6]. The use of such inputs exposes smallholder farmers to a high degree of credit risk, and traps them in a perpetual cycle of debt. An agricultural system with such exposure to risk favours large farming, and adversely impacts the 2.5 billion people who are involved in full- or part-time smallholder farming worldwide. Small holdings are a critical source of livelihoods, and smallholders in developing countries produce about 80 per cent of the food consumed[7]. They are also integral to addressing the global food security challenge, which will compound multi-fold by 2050.

Prevailing agricultural practices such as mono-cropping decrease soil moisture content, causing tremendous stress on water resources. Agriculture, today, accounts for almost 70 per cent of the world's freshwater consumption[8]. The use of external inputs by adoption of uniform, hybridised, and genetically modified crop varieties erodes genetic diversity of seeds, and reduces their capacity to adapt to changing climatic conditions[9,10]. These practices, coupled with widespread farmland degradation, make agriculture a major contributor to global greenhouse gas (GHG) emissions, and climate change.

Alternative low-input farming practices have emerged in pockets across the world promising reduced input costs and higher yields for farmers, chemical-free food for consumers and improved soil fertility. Zero Budget Natural Farming (ZBNF) is one such low-input, climate-resilient type of farming that encourages farmers to use low-cost locally-sourced inputs, eliminating the use of artificial fertilisers, and industrial pesticides. Natural farming was first popularised by the Japanese scientist and philosopher, Masanobu Fukuoka, who practised it on his family farm in the island of Shikoku. In India, noted agriculturist Subhash Palekar has helped popularise ZBNF practices across the country. He has identified four aspects that are integral to ZBNF (1) *beejamrutham*, or microbial coating of seeds using cow dung and urine based formulations; (2) *jeevamrutham*, or the application of a bio-inoculum made with cow dung, cow urine, jaggery, pulse flour, water and soil to multiply soil microbes; (3) mulching, or applying a layer of organic material to the soil surface in order to prevent water evaporation, and to contribute to soil humus formation; and (d) *waaphasa*, or soil aeration through a favourable microclimate in the soil. For insect and pest management, ZBNF encourages the use of various *kashayams* (decoctions) made with cow dung, cow urine, lilac and green chillies.

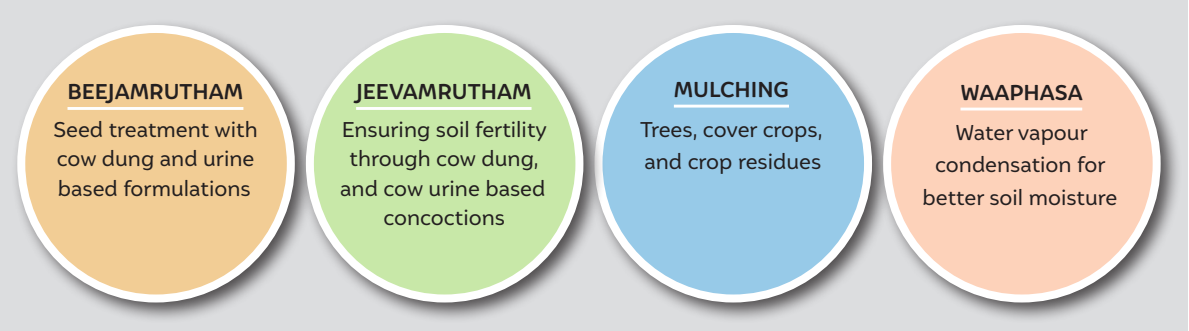

FIGURE 1:
The four-wheels of zero budget natural farming.

The cow dung and urine used in the preparation of natural inputs are only from indigenous cows. These practices have been shown to have a positive effect on the quality of the soil, improving its fertility and water retention capacity. This is likely to reduce the reliance on resources such as water and electricity for irrigation. Substituting chemical fertilisers and pesticides with natural inputs might reduce input costs and farmers' exposure to credit risks; the increase in net income will improve the cash flow of poor and vulnerable farmers, and may enhance their ability to deal with economic shocks; and the reduced resource-dependence and improved soil quality might then help farmers adapt better to extreme climate events.

In 2015, the Government of Andhra Pradesh (GoAP) instituted the Rythu Sadhikara Samstha (RySS), a state-owned, non-profit organisation to introduce ZBNF practices to all farmers in the Indian state of Andhra Pradesh (AP). The

FIGURE 2:
Preparation of *Jeevamrutham* using jaggery, pulse flour, cow dung, cow urine and soil.

Images
NITI GUPTA/CEEW

implementation of the project in the field was started in 2016-17 and in 2017-18, around 1,63,000 farmers in 972 villages across all 13 districts of the state have adopted ZBNF practices. An action plan has been prepared for 2018-19 to cover 500,000 farmers in 3,015 villages under natural farming by end of 2018-19 season. As on Sept, 2018, the number of farmers enrolled in ZBNF is 354,000. The Andhra Pradesh Government plans to cover 6 million farmers in 12,924 Gram Panchayats by year 2024 and cover the entire cultivable area of 8 million hectares by 2026.

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In addition to funds assigned by GoAP, support from Azim Premji Philanthropic Initiatives (APPI) has been crucial to the rollout of ZBNF to 163,000 farmers across all districts of AP. To ensure that the programme reaches every farmer in the state, the GoAP and RySS have used a decentralised cluster model to identify, mobilise, and train forthcoming and early-adopting farmers to institute a unique community-based dissemination methodology for ZBNF. The programme, in its expansion phase, also aims to leverage the social capital of the state by engaging women's self-help groups for the promotion of natural farming principles and practices.

The implementation of this project at scale will impact a multitude of stakeholders, and also help India progress towards achieving the Sustainable Development Goals (SDGs) set by the United Nations (UN) to facilitate the post-2015 development agenda. The SDGs provide a global development framework, an enabling environment for collaboration between relevant stakeholders, and targets and indicators to evaluate institutional and public programmes.

In this brief, we map the possible social, economic and environmental impacts of the GoAP-led ZBNF programme vis-à-vis specific targets under each SDG. Once it is rolled out across the state, **ZBNF could help AP and India make significant progress towards almost a quarter of the 169 SDG targets**. This mapping exercise makes use of data from crop cutting experiments (CCEs) conducted in all 13 districts of the state, and information on programme-level policies and interventions provided by RySS.

Image:
NITI GUPTA/CEEW

2. Understanding the impacts of ZBNF

SDG 1
End poverty in all its forms everywhere

GOAL 1: TARGETS IMPACTED BY ZBNF	
1.1	Eradicate extreme poverty, currently measured as people living on less than USD 1.25 a day (~INR 80 a day)
1.3	Implement nationally appropriate social protection systems, measures, and floors
1.4	Ensure that everyone has equal rights to economic resources, basic services, ownership, and control over land and property
1.5	Reduce exposure of the poor and vulnerable to climate-related extreme events and other shocks and disasters
1.a	Ensure mobilisation of resources to help developing countries implement programmes and policies to end poverty
1.b	Create pro-poor and gender-sensitive policy frameworks to support investment in poverty eradication

Crop cutting experiments of both commercial and food crops indicate that ZBNF farmers in AP have witnessed a **sharp decline in input costs and an improvement in yields**. As a result, they earn better net incomes.

ZBNF farmers in AP have witnessed a sharp decline in input costs and an improvement in yields.

Results from RySS-led crop cutting experiments in 2017 show that farmers growing paddy through natural practices have had a 51 per cent increase in their net income as compared to their non-ZBNF counterparts. For commercial crops, such as rainfed groundnuts and cotton, the increase in net income was 135 per cent and 87 per cent, respectively. Farmers who are traditionally vulnerable to economic shocks now have an important safety net against short-term shocks with this increase in net income.

The project recognises landless and tenant farmers, farmers with less than 2.5 acres of dry-land or 1.25 acres of wet-land, and single women farmers as "poorest of the poor" farmers. About 20 per cent of all farmers are in this category. They are introduced to specific crop and livestock models to enhance their incomes and food security. In addition, special credit facilities

and handholding support are also provided to these farmers. The programme aims to assure food security to them and to generate a net income of INR 100,000 (USD 1380) per annum for each family through reduced input costs, increased productivity, and diversified livelihoods.

Poor and vulnerable farmers who do not own large tracts of land and, therefore, cannot benefit from economies of scale, can depend on the price premiums typically associated with chemical-free produce to boost their net income. In contrast to farmers using prevailing practices, **ZBNF farmers can earn a premium in domestic and international markets** as their produce is primed to earn Fairtrade or other organic certifications.

Case in Focus: Improved incomes for farmers

Name
Kandimalla Kondala Rao

District
Prakasam

Land size
4.5 acres (owned) and 8.5 (leased); total land: 13 acres

In 2016/17, Kandimalla grew papaya using both prevailing farming practices and ZBNF, on 6 acres and 4.5 acres, respectively. His input cost on non-ZBNF land was INR 70,450 (USD 992) per acre, and under ZBNF was INR 46,450 (USD 654) per acre. Kandimalla's yield under ZBNF was 56 tonnes per acre, almost 16 tonnes per acre more than the produce with prevailing practices, despite using a smaller area for ZBNF cultivation. His net income per acre was INR 448,000 (USD 6,310) under ZBNF, against INR 320,000 (USD 4,507) under conventional agriculture. Kandimalla also reported receiving a premium for his produce due to the improved quality and taste of the fruits. Crop longevity and storage value also improved.

SDG 2
End hunger, achieve food security and improved nutrition and promote sustainable agriculture

GOAL 2: TARGETS IMPACTED BY ZBNF	
2.1	End hunger and ensure access by all people, in particular the poor and vulnerable to safe, nutritious and sufficient food
2.3	Double the agricultural productivity and incomes of all small-scale food producers, through secure and equal access to land, productive resources and inputs, knowledge, financial services, opportunities for value addition and non-farm employment
2.4	Ensure sustainable food production systems and implement resilient practices that increase productivity, help maintain ecosystems, strengthen adaptation to climate change, and improve land and soil quality
2.5	Maintain genetic diversity of seeds, cultivated plants and farmed and domesticated animals, and promote access to and equitable sharing of benefits from the use of genetic resources
2.a	Increase investment in rural infrastructure, agricultural research and extension services, technology development and plant and livestock gene banks, to enhance productive capacity

ZBNF groundnut farmers had on average a 36 per cent higher yield than their non-ZBNF counterparts.

As a result of increased crop yields, **ZBNF farmers may be able to improve food and nutritional security for their families**. Results from RySS-led CCEs from 2017 show that **ZBNF groundnut farmers had on average a 36 per cent higher yield** than their non-ZBNF counterparts. **ZBNF paddy farmers have had on average a nine per cent higher yield**. Such increases are the result of sustainable farming practices, which also improve farmers' capacity to adapt to climate change.

In the drought-prone districts of the state, the programme has promoted and assisted in the making of farm ponds for water storage, and in making dead furrows to reduce the velocity of run-off.

FIGURE 3:
Farm pond in a drought-prone area of Andhra Pradesh.

Image:
RySS

Due to the improvements in yield, **smallholders can earn more while simultaneously increasing the amount of food available for their families.** The practice of intercropping – growing multiple crops in proximity to each other – is encouraged under ZBNF as it ensures **vulnerable communities access to a suite of nutritional sources and income-generating crops throughout the year**. ZBNF is considered 'zero budget' because the costs of the main crop are offset by the income that farmers earn from intercrops during the agricultural season.

In the long-run, due to the use of local inputs, **the project is likely to contribute to maintaining the genetic diversity of seeds and crops**. Globally, as few as 30 crops constitute 90 per cent of the calorie intake of people[11]. ZBNF may improve the potential of crops to adapt to and be produced for evolving climatic conditions.

SDG 3
Ensure healthy lives and promote well-being for all at all ages

GOAL 3: TARGETS IMPACTED BY ZBNF	
3.4	Reduce by a third premature mortality from non-communicable diseases and promote mental health and well-being
3.9	Reduce the number of deaths and illnesses from hazardous chemicals and air, water and soil pollution and contamination

Direct and indirect exposure to fertilisers and pesticides have been shown to have adverse impacts on farmers as well as consumers. Farmers are exposed to contaminants when applying chemical inputs to their crops. By replacing such external inputs with locally made natural concoctions, inoculums, and decoctions, the **project could help in reducing the incidence of non-communicable**

Since August 2018, the programme has rolled out integrated village health and nutrition plans in eight districts across Andhra Pradesh, covering a total of 35 villages.

diseases such as reproductive disorders, acute and chronic neurotoxicity, micro-nutrient deficiencies, respiratory diseases and even cancer, which are associated with the use and application of inorganic chemicals in agriculture. The International Agency for Research on Cancer concluded that exposure to pesticide compounds such as polychlorinated biphenyl (PCB), gamma-hexachlorocyclohexane (lindane) and dichlorodiphenyltrichloroethane (DDT) can be "probably carcinogenic to humans"[12,13].

Many farmers experience mental distress and depression from the stress of low incomes, and difficult credit repayment cycles. As ZBNF eliminates the need for external chemical inputs, it reduces the need for credit for cultivation while enabling farmers to produce similar, if not better yields, with reduced input cost. As indebtedness and bankruptcy lead to nearly 40 per cent of farmer suicides in India[14], improved incomes might help farmers cope better with stress and bring down instances of farmer suicide.

Since August 2018, the programme has rolled out integrated village health and nutrition plans in eight districts across Andhra Pradesh, covering a total of 35 villages. The programme aims to work on three major themes with agricultural families: anaemia, dietary diversification, and non-communicable diseases. **Many interventions have been designed under this plan, such as the promotion of nutri-gardens; promotion of homestead food production; enhancement of the quality of school feeding programmes; ensuring water, sanitation and hygiene (WASH) behaviour; and crop planning to promote the cultivation of millets.**

Once implemented across all farmlands in AP, the health and nutrition plan aim to achieve chemical-free, diversified, and sufficient food consumption across the state population; better hygiene behaviours among people; and eventually a decrease in health-related morbidity and expenditure.

SDG 4
Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

GOAL 4: TARGETS IMPACTED BY ZBNF	
4.4	Increase the number of youth and adults with relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.
4.7	Ensure that all learners acquire the knowledge and skills needed to promote sustainable development

Agriculture is central to the country's transition towards sustainable development. Yet, there has been little emphasis on educating and equipping farmers with the necessary tools to carry out sustainable agriculture. Under the GoAP ZBNF programme, farmers are being educated about health and soil fertility impacts of conventional produce and are being trained to implement ZBNF efficiently. To help farmers acquire the skills to promote sustainable development, the programme is

Farmers are being educated about health and soil-fertility impacts of conventional produce.

creating farmer-friendly video content on ZBNF processes, in partnership with the Digital Green Foundation (DGF). So far, over 300 videos covering various topics related to ZBNF programmes have been made by local youth trained in film-making. In addition, a comprehensive ZBNF workbook and many ZBNF primers have also been published by the state's Agricultural Department and Agricultural University, which explain the concepts in an easy and pictorial manner. Crop cards, with information on practises and timelines for cultivation activities, have been made accessible to all farmers in the vernacular language.

Such videos are screened at farmer field schools, which are an important avenue for farmer-to-farmer knowledge dissemination and the demonstration of ZBNF farming practices by master farmers. **Under the programme, half a million farmer groups and 25,000 village level federations – village and farmer level capacity building and knowledge sharing institutions – will be formed by 2026.** These will help in disseminating traditional agricultural knowledge and skills as well.

In January 2018, the GoAP and RySS organised a nine-day training programme for over 7,000 participants, most of whom were farmers interested in learning ZBNF techniques. Subhash Palekar was the main trainer who explained in detail the nature of the farming ecosystem. Understanding the impact of prevailing agricultural practices on human health, soil quality, and in the long-run, on agricultural yield was also part of the training. Conducting such workshops across the state will help ZBNF reach out to tens of thousands of farmers through word-of-mouth.

The programme uses a strong community-based model for effective adoption and expansion of ZBNF. Community resource persons (CRPs) have been selected and appointed to train the other farmers in the villages. **CRPs are farmers who have demonstrated expertise in natural farming practices. Their role is to convince farmers to adopt ZBNF through intensive persuasion, hands-on training, farmer field schools, video dissemination, etc.** CRPs also identify other promising farmers in the village and groom them to become future CRPs. **As of September 2018, the programme has 4,568 CRPs covering 3015 villages. In November 2018, another 3,500 CRPs from 1,000 villages will be inducted into the programme.**

Since 2017, the ZBNF project has also started a three-year fellowship course. Natural farming fellows (NFFs) are young graduates and postgraduates from agriculture and allied streams who are required to stay in a village and practise ZBNF. There is one NFF per five villages (1 per 2,000 farmers). NFFs' training primarily focuses on capacity building in various capacities—as farmers, trainers, managers, scientists, and team leaders. After completing a six-month induction, NFFs are allotted a cluster, wherein they lease their own land and practise natural farming (with other farmers) and become part of a cluster team of CRPs. NFFs are encouraged to experiment with farming techniques and design various innovative farming models. So far, 230 NFFs have been recruited and are being trained. Another 300 NFFs are likely to be registered in 2018.

Case in Focus: Story of a natural farming fellow

Name
Vimala

District
Chittoor

Vimala pursued a graduate programme in agricultural science at S.V. Agricultural College, Tirupati, (from ANGRAU University), where Subhash Palekar's training on ZBNF piqued and strengthened her interest in natural farming. During her studies, she attended a rural agricultural work experience programme in Anantapur.

After graduating, she pursued the fellowship opportunity in ZBNF, was selected for induction, and was assigned to Bommanacheruvu cluster in Chittoor district. During her nine-month induction, she learned about many aspects of ZBNF, and has had to undergo the difficult process of unlearning some of the things she had learned about chemical farming. NFF gave her an opportunity to become a trainer at the district and state level.

Vimala has decided to implement a five-layer model in an existing orchard, and will try to implement rainfed agriculture, since she is located in a dryland area.

Vimala has been a constant support to the farmers by providing information, guiding, and motivating them to pursue ZBNF.

SDG 5
Achieve gender equality and empower all women and girls

GOAL 5: TARGETS IMPACTED BY ZBNF	
5.a	Reforms to give women equal rights to economic resources, access to land ownership and control, and natural resources
5.b	Enhance use of enabling technology to promote the empowerment of women

Historically, yield from female-led agricultural plots has been lower than that from male-led plots. But it is not well documented that this gap is primarily the result of unequal access to appropriate, and necessary agricultural inputs. The lower yield of female-headed plots is not a function of their efficiency or agricultural acumen. **If the gender gap in access to inputs were resolved, then the yield on land held by women would match that of land held by men.** This would raise agricultural output in developing countries by 2.5 - 4 per cent on average[15]. Gender equality must, therefore, be stressed in agricultural policy and programme planning.

An important objective for the programme is to ensure equal number of males and females at the cluster leadership level, which is the core unit of programme implementation. Ensuring that women are well represented at the leadership level, and are seen as decision makers is important for providing equitable access to basic inputs. **This could encourage many women to be involved in agriculture full time, and will allow existing female farmers to improve their yield by reducing inequality of access to input resources.**

ZBNF aims to utilise the existing institutional platform of women's self-help groups (WSHGs) for scaling, sustaining, and deepening the programme. **Simultaneously, it will encourage the direct participation of women and their institutions in**

ZBNF aims to utilise the existing institutional platform of women's self-help groups (WSHGs) for scaling, sustaining, and deepening the programme.

planning, implementing, and monitoring the programme. Under the action plan of 2018-19, around 86,000 women SHGs would be engaged in the ZBNF programme. SHGs are small, informal associations created for the purpose of enabling members to reap economic benefits through mutual help, solidarity, and joint responsibility. The benefits include mobilisation of savings and credit facilities and pursuit of group enterprise activities.[16]

The programme also encourages women to become entrepreneurs in the non-farm sector by giving them incentives to set up village-level shops to sell natural fertiliser and biocide mixtures to farmers. They are also trained to film and disseminate videos on ZBNF methods to induct other farmers into the programme. **These positions help women to be seen as guides and leaders in the local community, improving their social status.**

FIGURE 4: CEEW team interacting with a few members of a SHG in a village in West Godavari district.

Image: CEEW

SDG 6
Ensure availability and sustainable management of water and sanitation for all

GOAL 6: TARGETS IMPACTED BY ZBNF	
6.3	Improve water quality by reducing pollution, minimising release of hazardous chemicals, reducing untreated wastewater and increasing recycling and safe reuse
6.4	Increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater and reduce the number of people suffering from water scarcity
6.6	Protect and restore water-related ecosystems

The use of various mulching techniques by ZBNF farmers leads to the fast build-up of soil microbiota and soil aeration, which is critical for enhancing water percolation and the water retention capacity of the soil. ZBNF stresses

ZBNF practices lead to greater soil humus production and thereby, enhanced water vapour condensation on the soil surface, which contributes to meeting the water requirements of the plant.

on the moisture or water vapour requirements of the plant roots. The soil must contain a sufficient mix of water and air molecules. This has been shown to reduce water input requirement, improve water efficiency in agriculture, and also make crops drought resilient without affecting crop yields.

Groundwater irrigation has been expanding in India since the Green Revolution, and now accounts for over 60 per cent of the total irrigated area in India. Groundwater extraction is intensive in some parts of the country, leading to over-exploitation and falling water levels in aquifers, and salinity in fresh water aquifers in coastal areas[17]. ZBNF practices lead to greater soil humus production and thereby enhanced water vapour condensation on the soil surface, which contributes to meeting the water requirements of the plant. As it promotes economic use of water and reduces irrigation requirements of crops, **ZBNF can help prevent over-extraction of groundwater, enable aquifer recharge, and eventually contribute to increasing water table levels.**

Pesticide and fertiliser leaching are also a common cause of ground- and surface-water contamination. As groundwater is the most common source of drinking water in rural India, any contamination has direct health impacts. Nitrate contamination in groundwater causes the 'blue baby syndrome' that increases infant mortality. **Given that ZBNF eliminates the use of inorganic chemical inputs, it is likely to improve the quality of groundwater aquifers**, if natural fertilisers are used in moderation**.** Preventing the contamination of surface and groundwater would also enable protection and restoration of water-related ecosystems such as wetlands, forests, etc., depending on the agro-geological factors in the area.

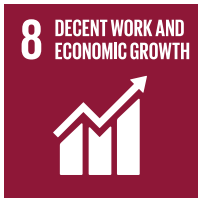
The high concentration of ammonium nitrate in fertilisers, and hazardous chemical pollutants from pesticides which run-off into rivers and oceans can severely impact aquatic life. Run-off can carry pesticides mixed in water as they are bound to eroding soil particles. **The use of natural bio-inoculants in ZBNF will help to reduce the contamination and degradation of rivers and oceans.**

SDG 7
Ensure access to affordable, reliable, sustainable and modern energy for all

GOAL 7: TARGETS IMPACTED BY ZBNF	
7.3	By 2030, double the global rate of improvement in energy efficiency

By eliminating the use of chemical fertilisers and pesticides, ZBNF will vastly reduce the need for, and use of energy along their value chain. Fertiliser production is an energy intensive process, requiring thermal and electrical energy. The gradual phaseout of fertilisers and pesticides would result in significant energy savings at the manufacturing and distribution stages. The ZBNF inputs replacing fertilisers and pesticides require much less energy at farmers' level for preparation. Given that Andhra Pradesh is one of the largest consumers of fertilisers in the country, **a possible consequence of the transition to ZBNF is the reduction**

in energy intensity per unit of gross domestic product. Further, due to the reduced water requirement under ZBNF, the pumping energy need also reduces. This would also **help the government reduce outlay on subsidies for electricity for agriculture**.



SDG 8
Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

GOAL 8: TARGETS IMPACTED BY ZBNF	
8.4	Improve resource efficiency in consumption and production and decouple growth from environmental degradation
8.5	Achieve full and productive employment and decent work for all women and men, including for young people

The programme, at the scale of six million farm-lands, would help generate rural employment opportunities across the agricultural value chain.

Zero budget natural farming is resource efficient as it minimises the use of financial and natural resources while increasing crop yield. **By restoring the quality of soil and water-related ecosystems, it decouples agricultural productivity and growth from ecosystem degradation and biodiversity loss.** This decoupling of growth and resource-use provides a sustainable livelihood to farmers and allied value chain actors.

The programme, at the scale of six million farm-lands, would help generate rural employment opportunities across the agricultural value chain, from the production, distribution, and retail of natural mixtures to market linkages for ZBNF produce. In villages that have adopted ZBNF, village-level entrepreneurs have set up enterprises to locally manufacture and sell ZBNF inputs to farmers, who are time-constrained to develop these inputs themselves.

SDG 9
Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

GOAL 9: TARGETS IMPACTED BY ZBNF	
9.4	Upgrade infrastructure and retrofit industries to make them sustainable, with increased resource efficiency and adoption of environmentally sound technologies and processes
9.5	Enhance scientific research and technological capabilities of industrial sectors, and increase spending in research and development (R&D) and R&D workers per 1 million people

Introducing ZBNF in AP will promote the efficient use of resources and help make agriculture sustainable. **By eliminating the use and corresponding production**

of fertilisers and other chemical inputs, ZBNF is likely to avoid CO_2 emissions at various stages of the agricultural value chain. This will help India progress towards SDG indicator 9.4.1 on reducing the CO_2 emissions per unit of value added in the sector.

The involvement of the World Agroforestry Centre, CEEW and other research partners will allow for more rigorous scientific research in the agriculture sector in AP for the scaling-up of ZBNF. **The programme will create a centralised research centre on ZBNF.** Other states and countries can benefit from it for agricultural extension practices, farmer training modules, M&E, etc.

SDG 10
Reduce inequality within and among countries

GOAL 10: TARGETS IMPACTED BY ZBNF	
10.1	Achieve and sustain income growth of the bottom 40 per cent of the population at a rate higher than the national average
10.2	Empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status

Inequality in India has risen to unsustainable levels. The top 10 per cent of the population account for 54 per cent of the income, and the top 1 per cent account for 22 per cent of the income[18]. To reduce inequality, those at the bottom of the income distribution must be provided with opportunities to rapidly improve their economic well-being. Many households in the bottom 40 per cent of the income distribution in India depend on agriculture for their livelihood. Adoption of ZBNF will improve their net income, reduce credit risk, let them allocate resources for education, health or other material assets and build financial security. **RySS focuses on ensuring that those who particularly gain from the programme include landless labourers, farmers from scheduled tribes (STs) and scheduled castes (SCs), tenant farmers, and single-woman farmers—who together comprise 20 per cent of the population.** Special models are being devised to accelerate incomes for such populations through alternate sources such as poly-cropping and raising backyard poultry and small ruminants. Special access to credit is being provided, and dedicated CRPs are being employed to handhold such groups of farmers during their initiation phase. For instance, landless labourers are first encouraged to start off with *kitchen gardening*. After having earned some disposable income, they are assisted to get leased land to start farm cultivation. Further growth would enable them to purchase their own land, eventually getting them out of the landlessness trap.

The substantial reduction in farming input costs due to independence from fertilisers—one of the major contributors to input costs—leads to an increase in net income for farmers.

A field study conducted by the RySS team of 533 farmers in nine districts across Andhra Pradesh showed that average input costs of INR 31,199 (USD 431), INR 36,124 (USD 499), and INR 19,781 (USD 273) led to net income generation of INR 46,102 (USD 637), INR 57,559 (USD 796) , and INR 45,948 (USD 635) among SC and ST farmers, tenant farmers, and single-woman farmers, respectively. The substantial reduction in farming input costs due to independence from fertilisers—one of the major contributors to input costs—leads to an increase in net income for farmers. This does not only allow farmers to avoid taking out fresh loans, but also allows them to redeem a significant portion of their outstanding debts.

Case in focus: Bringing happiness to the life of a tenant farmer

Name
T. Srinivas Rao

District
Guntur

Land Size
1 acre

Srinivas' father was an agricultural labourer. He took up farming as a profession to support his family after he finished his schooling. He practised chemical-based farming for five years, during which time his revenue used to almost match his input costs. In 2016, he started practising ZBNF on his one-acre farm with the help of his local community resource person (CRP). He sowed spices on half an acre and bananas on the other half, while intercropping with yams. He made a net income of INR 155,000 (USD 2143) which has relieved him of the burden of loans. ZBNF practices have revitalised microbial activity in his soil, increasing its fertility. He wishes to continue practising ZBNF, and inspire others in his neighbourhood to do the same. He aspires to build a house of his own for his wife and children.

FIGURE 5:
Intercropping between banana and yam plants on a ZBNF farm.

Image:
NITI GUPTA/CEEW

SDG 11
Make cities and human settlements inclusive, safe, resilient and sustainable

GOAL 11: TARGETS IMPACTED BY ZBNF	
11.5	Reduce the number of people affected and decrease the direct economic losses caused by disasters, including water-related disasters, with a focus on the poor and vulnerable

ZBNF might help farmers build resilience against extreme climate events by improving the fertility and strength of the soil. ZBNF farmers have shown that crop losses due to droughts, floods and other extreme events have been lower than in non-ZBNF farms. In Anantapur district, having a semi-arid and drought prone climate, few of natural farming fellows (NFFs) sowed *Navdhanya* (crop containing a combination of nine cereals and millets) pre-monsoon to harness water vapour in the air and accelerate percolation of rainwater. They employed *Jeevamrutham*, straw mulching, and seed treatment as per ZBNF recommendations. This resulted into restoration of soil bio-diversity and robust produce, when most of the other farmers in the district could not even sow their fields. Based on such anecdotal evidence, there are initial indications that in the event of a disaster, **ZBNF farmlands may be able to withstand droughts, high-speed winds and flooding better than non-ZBNF plots.** By improving soil fertility and strength, ZNBF helps vulnerable farming communities in drought-prone areas minimise economic loss,

FIGURE 6:
Pre-Monsoon sowing of *Navdhanya* (deep ploughing, mulching, seed treatment, broadcasting of seed).

Images:
RySS

and also reduce the number of people affected by disasters. **Some ZBNF farmers have reported a reduction in their yield loss during droughts,** and many of those who were in debt due to losses have reported that they have been able to repay most of their loans.

SDG 12
Ensure sustainable consumption and production patterns

GOAL 12: TARGETS IMPACTED BY ZBNF	
12.2	Achieve the sustainable management and efficient use of natural resources
12.4	Achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, and reduce their release to air, water and soil to minimise their adverse impacts
12.5	Reduce waste generation through prevention, reduction, recycling and reuse
12.7	Promote sustainable public procurement practices
12.8	Ensure that people have information and awareness to lead lifestyles in harmony with nature

At its core, ZBNF is about using resources efficiently to produce nutritious and sufficient food while minimising the environmental impact of agriculture. By reducing the need for irrigation and eliminating external chemical inputs, **ZBNF could reduce the material footprint per capita and material footprint per unit of value added in agriculture.** Wide-scale adoption of ZBNF would help reduce the release of harmful chemicals to the air, water and soil. It will minimise the adverse impacts on farmer and consumer health, and biodiversity. After adopting sustainable agricultural practices, several farmers have reported the return of certain bird and animal species to farmlands.

Farmers are encouraged to make use of agricultural waste instead of discarding or burning it. Crop residue, which can be reused for mulching, is useful for improving the nutritional content of the soil. **As the crops are now cultivated without chemicals, farmers also feel safe in using crop residue as feedstock for cattle.** This ultimately creates a cyclical system dependent on cattle - where the soil receives inputs from cattle waste, the crop receives inputs from soil, and the crop waste ultimately becomes feedstock for cattle.

The government could procure high quality produce from ZBNF farmers and catalyse the transition to sustainable agriculture. **Poor households who purchase government-procured produce through the public distribution system (PDS) can now get access to chemicals-free food at subsidised rates.** The programme would make consumers in rural and urban areas aware about the differences between conventional and ZBNF produce. **Targeted awareness campaigns based on evidence from the field on the benefits for health and ecosystems could enable consumers to make better choices about the types of food they buy.**

SDG 13
Take urgent action to combat climate change and its impacts

GOAL 13: TARGETS IMPACTED BY ZBNF	
13.1	Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries
13.3	Improve education, and human and institutional capacity on climate change mitigation, adaptation and impact reduction

Zero budget natural farming techniques have shown initial evidence of improving resilience of farmlands and crops against extreme weather events. During a bout of cyclonic winds in Vishakhapatnam in 2017, anecdotal records of farmers show, that **ZBNF paddy withstood the winds and water logging much better than adjacent non-ZBNF paddy fields**. This is likely due to the roots going deeper, stems being thicker and soil being more porous under ZBNF.

FIGURE 7:
Cyclone-damaged conventional paddy plot adjacent to unaffected ZBNF paddy plot.

Images:
RySS

The programme focuses on disseminating knowledge about ZBNF techniques through practical demonstrations as adverse impacts of agricultural practices on climate change and in turn on yield are not well understood. Educating farmers about the impacts of soil degradation, soil nitrogen contamination, and crop burning on climate change, helps contribute to climate change mitigation while building their capacity to tackle such issues. **RySS is engaged and invested in creating self-progressing institutions at the cluster and village level. Community resource persons (CRPs) are best performing farmers who are then employed by RySS to take these practices to farmers in other villages.** Lead farmers in each village transfer their knowledge of ZBNF practices to other farmers in neighbouring areas and help them transition from conventional agriculture.

The programme has a video dissemination component to accelerate the knowledge sharing and awareness-raising process. A ZBNF workbook has been published by the Agriculture Department and Agricultural University in the state to communicate ZBNF practices to farmers in local language. Crop cards mentioning practices and timelines for cultivation activities pertaining to each crop have

Crop cards mentioning practices and timelines for cultivation activities pertaining to each crop have been issued to each farmer.

been issued to each farmer. A comprehensive information and communication technology (ICT) support is under development to develop farmer database, perform e-tracking of adoption of ZBNF practices across the state, ensure monitoring of functionaries, do geo-mapping of fields and disseminate climate information.

RySS is partnering with the education department of the GoAP to develop content on natural farming which will be included in schools' curricula. Government schools are also being encouraged to start practising *kitchen gardening* in their backyards. Teachers and students are being trained on sowing, weeding, hoeing, and other farming activities to orient the coming generations towards natural farming.

Case in focus: Building farmers' resilience to combat drought risk

Name
Sivanna

District
Anantapur

Land Size
3 acres

Sivanna is entirely dependent on rainfall for irrigation. The usual practice among farmers in the area is to apply more fertiliser to compensate for poor rainfall. Sivanna had also been practising chemical-based farming for many years. After visiting a few ZBNF farms, he became convinced of its effectiveness, and switched to the practice under the close guidance of his local CRP. He has two indigenous cows whose dung is used to prepare ZBNF inputs. He uses crop residue as a green carpet (mulching) for his field, which is a labour-intensive process to improve the moisture-retention capacity of soil—a method which is not followed by all ZBNF farmers. With input costs of INR 12,500 (USD 173) he managed to earn a net income—in a year with limited rainfall—of INR 27,490 (USD 380), when other farmers suffered from crop damage and losses. Given this encouraging outcome, he is determined to pursue ZBNF in future as well.

SDG 14
Conserve and sustainably use the oceans, seas and marine resources for sustainable development

GOAL 14: TARGETS IMPACTED BY ZBNF	
14.1	Prevent and reduce marine pollution, particularly from land-based activities like marine debris and nutrient pollution
14.3	Minimise and address the impacts of ocean acidification

Chemical fertilisers and biocides are major constituents of marine pollution and ocean acidification. Agricultural pollution increases the concentration of nitrogen and phosphorus, which are scarce elements in natural water sources[19], and can lead to eutrophication of aquatic bodies, and the modification of habitats. It can also affect local species of fish and crustacean species[20]. These are known to have unfavourable effects on the fecundity of certain aquatic species, and affect the growth of aquatic plants[21]. Change in the reproductive systems of certain species, and nutrient enrichment for others that thrive on nitrates, can modify the food web of marine life. **Marine pollution is not the only impact of prevailing agricultural practices on ecological systems; ocean acidification is also a consequence of the unregulated application of fertilisers.** Ammonia, an important ingredient of urea-based fertilisers, is a well-known cause for acidification of water owing to its volatilisation[22].

Zero budget natural farming eliminates chemical fertilisers and pesticides, and would help reduce ocean acidification and marine pollution from land-based activities. It might help to reduce the leaching of nitrogen and phosphorous from the soil into groundwater or surface water, and eventually into rivers and oceans. Mulching techniques used by ZBNF farmers improve the water retention capacity of the soil, reduce crop irrigation requirements and control the concentration of groundwater contaminants.

SDG 15
Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

GOAL 15: TARGETS IMPACTED BY ZBNF	
15.1	Ensure the conservation, restoration and sustainable use of terrestrial and inland freshwater ecosystems and their services, in particular forests, wetlands, mountains and drylands
15.3	Combat desertification, restore degraded land and soil, including land affected by desertification, drought and floods
15.5	Reduce the degradation of natural habitats, halt the loss of biodiversity and prevent the extinction of threatened species
15.9	Integrate ecosystem values into national and local planning, development and poverty reduction strategies and accounts

Under the ZBNF programme, RySS aims to encourage tree-based agroforestry models.

Erosion of topsoil strips the land of essential nutrients like moisture, nitrogen and phosphorus, requiring the fallowing of land to recharge some of those nutrients through natural processes. Initial reports from the farmers show that **conversion of agricultural lands to ZBNF helps restore degraded soil and improves the fertility of drought-prone land.** Although such results need to be further validated by scientifically assessing the change in soil quality after transition to ZBNF.

Under the ZBNF programme, RySS aims to encourage tree-based agroforestry models, restoring some of the terrestrial landscape which was traditionally under forests. The tribal farmers, who inhabit forest areas and drought prone areas are specially being encouraged to plant trees along with crops on the same plot of land. **Agroforestry not only improves the productivity of the land, but also plays a pivotal role in landscape restoration and prevention of biodiversity loss.** ZBNF could create a model for agriculture in which local communities can rehabilitate the fauna endemic to those areas by restoring their natural habitats. Integrating biodiversity conservation with ZBNF can create new opportunities to address the threats to life on land due to agriculture.

The programme integrates rural economic development with soil ecosystem and biodiversity preservation values. **In the agricultural model created by zero budget natural farming, livelihood opportunities that provide conservation outcomes can be explored.** For instance, ZBNF targets the revival of deep soil earthworms, which in turn improves soil quality and thus lowers input costs; also restoring the biological structure that is dependent on the earthworms.

FIGURE 8:
Deep soil earthworms.

Image:
Niti Gupta/ CEEW

SDG 16
Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

GOAL 16: TARGETS IMPACTED BY ZBNF	
16.7	Ensure responsive, inclusive, participatory and representative decision-making at all levels

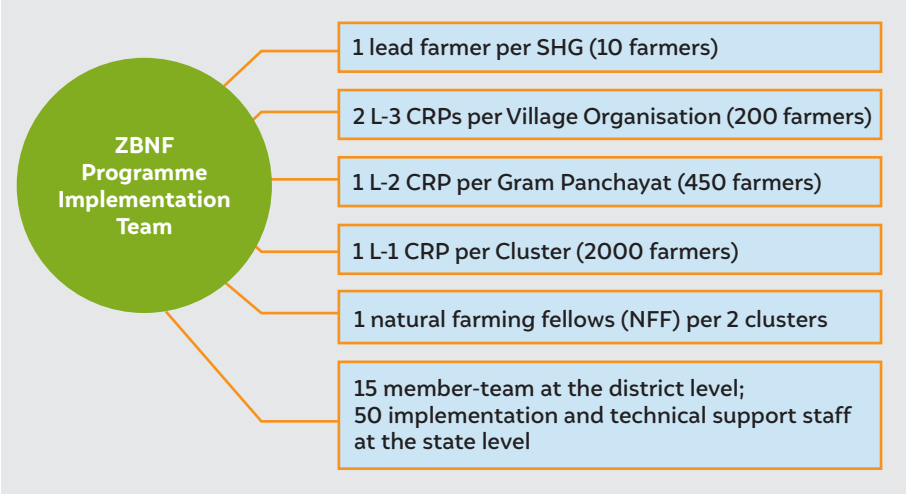
The ZBNF programme is administered by the GoAP, with a highly decentralised operational structure, and a strong focus on building and strengthening local-level institutions. The programme works at the village level with self-help groups, each comprising of 10-15 farmers. **ZBNF aims to rely on the existing network of 730,000 women SHG (WSHG) groups present in the state, covering 80 per cent of farming households, for propagating the program across the state.** SHG groups comprising only men from the same households are also being created to mirror women SHGs to ensure complete participation from every household. A lead farmer is selected by the group members, and is delegated the responsibility of promoting ZBNF practices in their village. One Level-3 CRP (Jr CRP) is selected per 50–100 farmers, covering the entire village. A Level-2 CRP (Sr CRP) is selected at the Gram Panchayat level—the lowest tier of local governing bodies in rural India. A cluster comprises four to five Gram Panchayats (about 2,000 farmers), and a Level-1 CRP is selected to administer the programme at this level. Experienced CRPs travel hundreds of kilometres to different areas of the state, stay with members of the community, personally demonstrate ZBNF methods, and identify and train other farmers to become internal CRPs, who in turn continue to increase the

FIGURE 9:
CRPs, NFF and support staff from RySS in West Godavari.

Image:
NITI GUPTA/CEEW

penetration of ZBNF methods in their respective clusters. As on September, 2018, the programme is operating in 3015 villages and 839 clusters with the support of 4568 CRPs.

FIGURE 10:
ZBNF programme implementation team: from village to state.



The programme has strategically leveraged the potential of young agriculture graduates from the state agricultural universities as national farming fellows (NFFs). There are 230 NFFs recruited for this 3-year fellowship. Within project villages, they lead innovations and experiments for the programme, which could be scaled in suitable areas across the state upon successful execution. The local implementation team is supported by a state level technical and administrative support team, who are professionals from agriculture and rural development sectors.

SDG 17
Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

GOAL 17: TARGETS IMPACTED BY ZBNF	
17.3	Mobilise additional financial resources for developing countries from multiple sources
17.16	Enhance global partnerships for sustainable development, by creating multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and other resources
17.17	Promote effective public, public-private and civil society partnerships

The programme meets the criteria for several climate adaptation and mitigation funds, because it helps reduces poverty, promotes food security and gender empowerment, creates models for climate resilient agriculture, builds skills for sustainable development and conserves biodiversity. **It could help India lead in promoting and implementing projects that are targeted at improving the lives of smallholders.**

The early-stage programme support provided by Azim Premji Philanthropic Initiatives provides an example of best-practice for the role that donors could play in large programmes of social and environmental significance. Similarly, each stakeholder is relevant and important at the various stages of programme implementation. **This programme brings together a range of actors** – international agencies, state and local government, banks, donors, research organisations and certification bodies – from across the public and private sectors and civil society. A diverse coalition helps mobilise and share knowledge from a variety of domains and create a comprehensive set of interventions that can be implemented practically.

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