Zero Budget Natural Farming for the Sustainable Development Goals

Andhra Pradesh, India

SAURABH TRIPATHI,
SHRUTI NAGBHUSHAN,
AND TAUSEEF SHAHIDI

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Image: RySS

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Contents

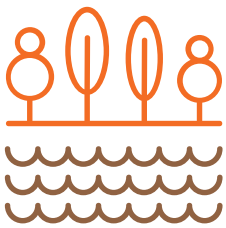
1. Introduction

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 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.

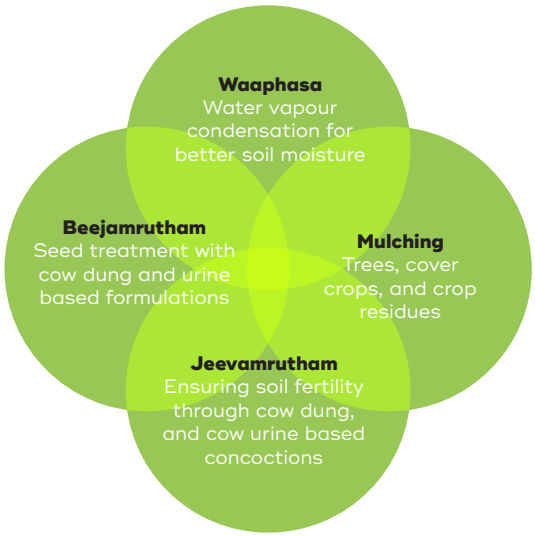


Agriculture, today, accounts for almost 70 per cent of the world's freshwater consumption

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 concoction 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 (4) *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 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.

FIGURE 2: Jeevamrutham

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). In addition to funds assigned by GoAP, support from Azim Premji Philanthropic Initiatives (APPI) has been crucial to the roll-out of ZBNF to 138,000 farmers across all districts of AP. In just two years, almost 150,000 acres of agricultural land has been brought under the ZBNF model of agriculture. 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 'master farmers' to institute a unique community-based dissemination of ZBNF.

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.

ZBNF could help AP and India make significant progress towards almost a quarter of the 169 SDG targets

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 mobilization 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 from 2016 and 2017 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 and can raise their disposable incomes. Farmers vulnerable to economic shocks have an important safety net against short-term shocks.

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

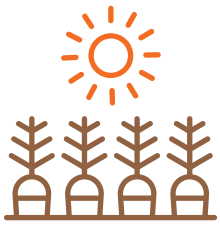
CASE IN FOCUS

Improved incomes for farmers

Farmer 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 16,600 (USD 262) per acre, and under ZBNF was INR 7,956 (USD 126) per acre. Kandimalla's yield under ZBNF was 9 tonnes per acre, almost 4 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 224,200 (USD 3,520) under ZBNF, against INR 95,400 (USD 1,498) 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.

farmers are in this category. They are introduced to specific crop and livestock models to enhance their incomes and food security, and receive a one-time financial support of 50 per cent of the cost of transition to ZBNF.



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

Poor and vulnerable farmers, who do not own large tracts of land and therefore cannot benefit from economies of scale, depend on the price premiums for chemical-free produce to boost net incomes. 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.

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

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 late 2017 show that **ZBNF groundnut farmers had on average a 23 per cent higher yield** than their non-ZBNF counterparts. **ZBNF paddy farmers have had on average a 6 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.

ZBNF groundnut farmers had 23 per cent higher yield than non-ZBNF counterparts

ZBNF is 'zero-budget' because the costs of the main crop are offset by income from intercrops

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

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

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

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 diseases such as acute and chronic neurotoxicity, 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].

Improved incomes might help farmers cope better with stress and bring down instances of farmer suicide

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.**

Once implemented across all farmlands of AP, ZBNF can have considerable health benefits for over 50 million consumers in the state, who would be able to avoid exposure to inorganic chemicals present in crops. **Pesticides contain endocrine disrupting chemicals (EDCs)**, which enter humans through diet and can have negative health impacts such as breast cancer, reproductive disorders, and poorer intellectual development of children[15,16,17]. Moreover, discontinuing chemical pesticides and fertilisers in fields will also prevent run-off into water sources, further reducing communities' exposure to such chemicals.

SDG 4

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

Goal 4: Targets impacted by ZBNF

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 creating farmer-friendly video content on ZBNF processes using examples of master farmers, in partnership with the Digital Green Foundation (DGF). In two years, **DGF and RySS have trained close to 900 farmers to disseminate videos through group training sessions, and have trained 120 farmers to shoot and edit videos** on ZBNF across the 13 districts of AP.

Farmers are being educated about the impacts of conventional agriculture on health and soil fertility

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 2027.** 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 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, given the strong community-based dissemination model of the programme.

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 agricultural output in developing countries could increase by 2.5 - 4 per cent on average**[18]. Gender equality must, therefore, be stressed in agricultural policy and programme planning.

The programme will ensure gender equality at the cluster leadership level

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 become involved in agriculture full-time, and allow existing female farmers to improve their yield by reducing inequality in access to input resources.** 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.**

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, minimizing release of hazardous chemicals, reducing un-treated 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 improves the fertility and moisture retention capacity of the soil. ZBNF stresses 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[19]. 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.**

ZBNF can help prevent over-extraction of groundwater, enable aquifer recharge, and eventually contribute to increasing water table levels

Pesticide and fertiliser leaching is 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 concoctions 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

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 6 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.

The programme, at the scale of 6 million farm-lands, would help generate rural employment opportunities across the agricultural value chain

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, The Council 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

Inequality in India has risen to unsustainable levels. The top 10 per cent of the population account for 56 per cent of the income, and the top 1 per cent account for 22 per cent of the income[20]. 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 poor farmers are included in the programme, and provides financial incentives for the poorest farmers to adopt ZBNF.**

FIGURE 4: Intercropping between banana and pumpkin on a natural farm with drip irrigation

Image: Saurabh Tripathi / CEEW

RySS focuses on ensuring that poor farmers are included in the programme, and provides financial incentives for the poorest farmers to adopt ZBNF

The growth rate of India's per capita income was 9.7 per cent in 2016-17[21]. Data from RySS-led CCEs in 2016 and 2017 show that farmers practising ZBNF earn considerably more than the control group of conventional farmers. **Yields of five crops (paddy, groundnut, black gram, maize and chillies) have increased by 8-32 per cent for ZBNF farmers.** Transitioning to ZBNF can help farmers improve their incomes by about as much; assuming no information asymmetry, fair prices for ZBNF produce, and ideal market conditions. Intercropping also helps poor and vulnerable farmers maintain a steady cash flow throughout the year.

CASE IN FOCUS

Improved quality of life for marginal farmers

Farmer Name: Andra Narayanarao
District: Prakasam
Land Size: 2 acres

Andra is a marginal farmer in a drought-prone region of the state. Between 2005 and 2010, he cultivated paddy and red and black gram following prevailing farming methods. Due to extreme climate events, he incurred significant losses and became trapped in a debt-cycle. Soon after, having attended ZBNF training sessions by Subhash Palekar, Andra started using natural concoctions and inoculums in addition to botanical extracts. Since then, he reports that his soil structure has begun changing and that he has seen earthworms and other beneficial insects in his field. During the drought of 2015 and 2016, he was able to save most of his crop. Over the last five years, Andra's income has increased considerably, and he has been able to repay his debt.

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 farmlands may be able to withstand droughts, high-speed winds and flooding better than non-ZBNF plots

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. Based on such anecdotal evidence, it can be inferred 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, 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.

CASE IN FOCUS
Building farmers' resilience to combat climate change

Farmer Name: Narayanappa
District: Anantapuramu
Land Size: 2.5 acres

Narayanappa cultivates 44 crops using natural farming, and feels that the usage of bio-fertilisers has improved soil health. Intercropping prevents soil erosion when it rains, because inter-crop creepers are strong, and prevent water from hitting the soil hard and washing it away. He says, "Since applying natural farming methods, the crop yields have improved. Mother Earth is happy as she feels she must return good food and high yield for the care the farmer has shown her." Narayanappa's groundnut crop withstood a dry spell of 25 days in July 2017, and on average his plants have 35-40 mature pods as against 8-12 in other fields. In late 2017, the GoAP felicitated him as a model farmer for leading the way for climate resilient natural farming.

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 minimize 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 on 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 chemical-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**

Poor households who purchase government procured produce through the public distribution system (PDS) will now be able to get access to chemical-free food at subsidised rates

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.

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 plans to invest in creating self-progressing institutions at the cluster and village level. Master 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.

FIGURE 5: Cyclone-damaged conventional paddy plot (a) adjacent to unaffected ZBNF paddy plot (b)

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[22], and can lead to eutrophication of aquatic bodies, and the modification of habitats. It can also affect local species of fish and crustacean species[23]. These are known to have unfavourable effects on the fecundity of certain aquatic species, and affect the growth of aquatic plants[24]. 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[25].

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	
15.3	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

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 ZBNF, farmers are encouraged to plant trees along with crops in 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.** Where farms are close to forest areas, 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.

FIGURE 6: Deep soil earthworms (ZBNF paddy field near Guntur, Andhra Pradesh)

The programme integrates rural economic development with soil ecosystem and biodiversity conservation 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.

In the agricultural model created by ZBNF, livelihood opportunities that provide conservation outcomes can be explored

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

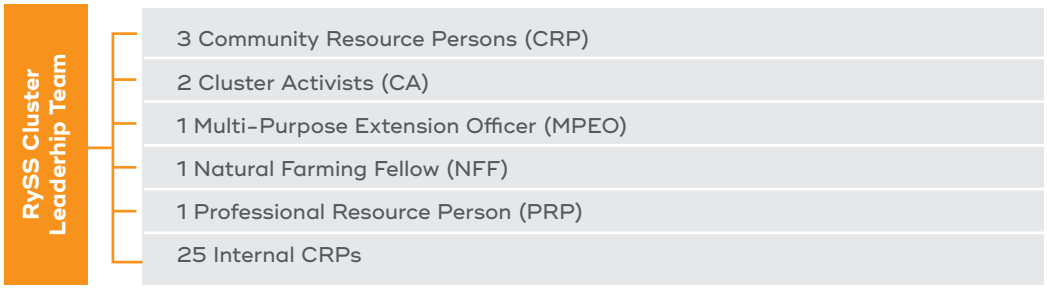
Goal 16: Targets impacted by ZBNF	
16.7	Ensure responsive, inclusive, participatory and representative decision-making at all levels

The ZBNF programme is administered by the GoAP, with a highly decentralised operational structure. The programme works with a basic unit, a cluster, which covers five *gram panchayats* (village councils); with over 2,500 clusters over the entire state. **In each cluster, three community resource persons (CRPs), also known as master farmers, lead the farmer-to-farmer training and extension for about 400 farming families.** The CRPs travel hundreds of kilometres to different areas of the state, stay with the community, showcase ZBNF methods in-person and identify and train other farmers to become internal CRPs, who in turn continue to increase the penetration of ZBNF in their respective clusters.

In each cluster, three community resource persons (CRPs) lead the farmer-to-farmer training and extension for about 400 farming families

Other aspects of ZBNF extension are decentralised too. In each cluster, for example, an individual trained in agricultural sciences is selected as a Natural Farming Fellow. This model allows farmers to adapt ZBNF practices based on specific issues within their cluster and build familiarity with their cluster leadership

FIGURE 7: Rythu Sadhikara Samstha Cluster Leadership Team



team. Through this leadership structure, the programme involves farmers in participatory decision-making processes and creates social capital across farming communities. This bottom-up capacity building process, beginning with CRPs and CAs, is important to strengthen the institutional mechanism of the programme at every level.

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 ZBNF programme meets the criteria for several climate adaptation and mitigation funds, because it helps reduce 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 governments, 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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