NABARD Research Study No. 43

NABARD

ICRIER

ZERO BUDGET NATURAL FARMING

Implications for Sustainability, Profitability, and Food Security

Sandip Das | Mahima Khurana | Ashok Gulati

NABARD

ICRIER

NABARD Research Study No. 43

Zero Budget Natural Farming

Implications for Sustainability, Profitability, and Food Security

SANDIP DAS

MAHIMA KHURANA

ASHOK GULATI

Zero Budget Natural Farming

Implications for Sustainability, Profitability, and Food Security

SANDIP DAS (sandipdas2005@gmail.com)
MAHIMA KHURANA (mahimakhurana11@gmail.com)
ASHOK GULATI (agulati115@gmail.com)

Report designed by Rahul Arora, ICRIER

ISBN No.: **978–81–954132–4–9**

Table of Contents

List of Tables

List of Figures

Abbreviations Used

AI-NPOF	All India Network Programme on Organic Farming
AP	Andhra Pradesh
APCNF	Andhra Pradesh Community Managed Natural Farming
BPKP	Bhartiya Prakritik Krishi Padhati
CCE	Crop Cutting Experiment
CIFA	Consortium of Indian Farmers Associations
CM	Chief Minister
CMSA	Community Managed Sustainable Agriculture
CRZBNF	Climate Resilient Zero Budget Natural Farming
CWC	Central Water Commission
DAP	Di-ammonium Phosphate
DBT	Direct Benefit Transfer
DEAR	Department of Economic Analysis and Research
DES	Department of Economics and Statistics
FAI	Fertilizer Association of India
FAO	Food and Agriculture Organisation
FPO	Farmers Producer Organization
FY	Financial Year
GCA	Gross Cropped Area
GDP	Gross Domestic Product
GHG	Green House Gas
GM	Genetically Modified
GMO	Genetically Modified seeds
HP	Himachal Pradesh
ICAR	Indian Council of Agricultural Research
ICM	Integrated Crop Management
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IDSAP	Institute for Development Studies Andhra Pradesh
IFPRI	International Food Policy Research Institute
IIFSR	Indian Institute of Farming Systems Research
MH	Million Hectares
MMT	Million Metric Tonnes

MoAFW	Ministry of Agriculture and Farmers Welfare
MOVCDNER	Mission Organic Value Chain Development for North Eastern Region
MP	Madhya Pradesh
MT	Million Tonnes
NAAS	National Academy of Agricultural Sciences
NF	Natural Farming
NMNF	Natural Mission on Natural Farming
NPOP	National Programme for Organic Production
PGS	Participatory Guarantee System
PIB	Press Information Bureau
PKVY	Paramparagat Krishi Vikas Yojana
PM	Prime Minister
PNPI	Plant Nutrients and Protection Inputs
PTI	Press Trust of India
RKVY	Rashtriya Krishi Vikas Yojana
RySS	Rythu Sadhikaran Samstha
SPMU	State Programme Management Unit
SPNF	Subhash Palekar Natural Farming
TOI	Times of India
UN	United Nations
UNCCD	UN Convention to Combat Desertification
UP	Uttar Pradesh
US	United States

Abstract

With increasing use of fertilizer and pesticides in the Indian farming system, and at many places in a very imbalanced manner, environment has been harmed. Soils are getting acidic with low carbon content, ground water is getting polluted with high nitrate content, and air is accumulating more nitrous oxide. In order to ensure sustainability of Indian agriculture, the government has been trying to promote Zero Budget Natural Farming (ZBNF), renamed as Bhartiya Prakritik Krishi Padhati (BPKP)[1]. It was mentioned in the 2019-20, 2020-21 and 2022-23 Budget Speeches of the Hon'ble Finance Minister, Smt. Nirmala Sitharaman, at 14th UN Convention to Combat Desertification (UNCCD) by PM Narendra Modi, NITI Aayog and Economic Survey. However, the research questions for us are: what implication will be scaling up of ZBNF at a national level have on the sustainability of the environment, the productivity of major crops, the profitability of the farming community, and above all the national food security? In this study, we attempt to answer these questions with robust empirical analysis as well as field visits and focused group discussions with farmers.

Subhash Palekar, the man behind this formulation of ZBNF in India, specifies four essential elements of ZBNF- *Beejamrit, Jeevamrit, Acchadana, and Waaphasa,* which essentially focus on the rejuvenation of soil health. It claims that it can reduce the cost of cultivation, improve yields, and thus make agriculture more efficient and sustainable while augmenting farmers' incomes. Many political leaders and policy makers tend to agree to this viewpoint, as is clear from their speeches in various fora. However, several reputed agri-scientists and farmer organizations question these claims for their efficacy, and ask for proper scientific validation. In fact, they give a counter viewpoint saying ZBNF does not augment farmers' incomes significantly, would adversely impact the yield of agricultural commodities, thereby harming the country's food security system. Moreover, Sri Lanka's agrarian crisis emanating from a complete ban on import and usage of agrochemicals forewarns caution in adopting a nation-wide organic farming practice. Hence, there is a dire need to evaluate the farming practice of ZBNF before propagating it at a country level.

Andhra Pradesh has adopted ZBNF extensively, covering 7.5 lakh farmers and farm workers on roughly 100,000 hectares of land; its vision is to convert the entire 80 lakh hectares of land in Andhra Pradesh into natural farming by 2027. Other states like Himachal Pradesh are also following a similar model. Most studies on ZBNF capture the experiences of the farmers across Karnataka, Andhra Pradesh, and Maharashtra. Centre for Economic and Social Studies (CESS), and Institute for Development Studies Andhra Pradesh (IDSAP), Hyderabad-based research institutes, have conducted the assessment of ZBNF, analyzing the crop-cutting experiments for yield and surveying farmers for qualitative parameters to judge the efficacy of farming practices of ZBNF in Andhra Pradesh. Moreover, Indian Council of Agricultural Research (ICAR) has recently completed its three-year-long experiment on different ZBNF treatments at four locations across the country. Together, these two studies provide insights into the implications of ZBNF on profitability, productivity, food security, and sustainability; and the precise agenda of this paper is to uncover that.

[1] The study uses the term ZBNF, as used by most other research studies

The paper finds that the results of the CESS assessment for Andhra Pradesh are in complete disagreement with ICAR-IIFSR's trials. While CESS finds that in case of variety of crops, lower cost of biological inputs suggested under ZBNF, yields of crops and farmers' incomes have improved, and so has the food and nutritional security of the farmers practicing ZBNF. But the findings of ICAR-IIFSR agro-scientists, which is a government institute, suggest a 59 percent decline in the wheat yields and a 32 percent decline in the basmati rice yield compared to integrated crop management, adversely impacting the food supply. Further, ICAR-IIFSR also show that the sustainability of the soil could also be at risk due to insufficient nitrogen supply by the biological inputs prescribed under ZBNF. These contrary findings by CESS vis-à-vis ICAR-IIFSR suggest the need for rigorous assessment of ZBNF farming practices before being promoted as the preferred farming method at a national level. In addition, we also recommend a direct benefit transfer in place of fertilizer subsidy being given in the form of highly subsidised prices of fertilizers (especially urea, which carries almost 90 percent subsidy), irrespective of the crop grown or the farming practice adopted. This is likely to lead to more balanced use of fertilizers (N, P and K), as well as more optimal doses of fertilizers. Together, that will promote more sustainable agriculture.

Acknowledgements

This study is conducted as part of the larger agriculture project that ICRIER is doing with a vision towards 2030. The study is financially supported by the National Bank for Agriculture and Rural Development (NABARD). We are thankful to NABARD for their support and encouragement. We also express our deep appreciation and gratitude to Subhash Palekar, the real force behind ZBNF, for sharing his thoughts, technology, and complexities involved in the practicing of ZBNF. We are also thankful to him for facilitating our field visits to Gurukul (Kurukshetra), Saurashtra (Gujarat) and Vidarbha (Maharashtra) where farmers are adopting this ZBNF under his overall guidance and encouragement. We also met many other farmer leaders from Nagpur including Vijay Javandiya, Virendra Barbate and Sanjay Srikhande, who are sceptical about this farming method. We are grateful to them for sharing their frank opinions based on their own experiences or of other farmers in that area about ZBNF.

We are grateful to senior scientists especially Dr. N. Ravishankar, Principal Scientist (Agronomy), ICAR-Indian Institute of Farming Systems Research (ICAR-IIFSR), Modipuram, Meerut, Uttar Pradesh, and Dr. Trilochan Mohapatra, former Director General, ICAR, Scientists from National Academy of Agricultural Sciences (NAAS), Dr. Vilas Bahale, Vice Chancellor, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra for providing critical scientific inputs as well as data related to its trials. Without their support it would not have been possible to say much about its economic viability as well as its implications on food security. We also thank a senior Marathi journalist from Maharashtra – Sandip Bhujabal, who provided support in organizing farmers' group discussions in the field. Senior members of Shetkari Sanghathana, Maharashtra – Dr. Nilesh Patil & Lalit Bhale also extended great support for the study, and we remain grateful to them. We also benefitted from discussions with Anil Ghanvat of Shetkari Sanghathana on this subject. We are also immensely grateful for Dr. C.P. Nagi Reddy, Senior Consultant, SPMU – Rythu Sadhikara Samstha, Department of Agriculture, Govt. of Andhra Pradesh, for sharing the latest assessments conducted by Institute for Development Studies Andhra Pradesh (IDSAP). And, we also express our appreciation to Mr. Chengal Reddy, Chief Advisor of Consortium of Indian Farmers Associations (CIFA), for sharing his views on ZBNF practice in Andhra Pradesh.

We would like to express our profound gratitude to Shri Shaji KV, Chairman, NABARD, and Dr. Ajay K. Sood, Deputy Managing Director, NABARD for their support. We sincerely thank Dr. K.C. Badatya (Chief General Manager, DEAR) and his colleagues at NABARD, including Dr. Vinod Vidyarthi (General Manager), Dr. Sohan Premi (Deputy General Manager) and Ms. Anshumala (Assistant Manager) for providing us with valuable insights for enriching our paper, and their suggestions as the project evolved. We also express our profound gratitude to Dr. G.R. Chintala, and Dr. Harsh Kumar Bhanwala, former Chairman, NABARD, Mr. P. V. S. Suryakumar, former Deputy Managing Director, NABARD, and Dr. K. J. S. Satyasai, former Chief General Manager, DEAR, NABARD, for their support and productive interaction from the very conception of the project.

Needless to say, the final responsibility for facts, figures, analysis, and views expressed in this paper rests with the authors.

Foreword

In the dynamic landscape of Indian agriculture, the pursuit of sustainability and enhanced farmer well-being has become imperative. This comprehensive report delves into the promising yet contentious realm of Natural Farming, particularly focusing on the Zero Budget Natural Farming (ZBNF) approach, now known as Bhartiya Prakritik Krishi Padhati (BPKP). With a backdrop of concerns surrounding excessive fertilizer usage, environmental impact, and fiscal challenges, the Government of India has championed organic farming initiatives, prominently featuring ZBNF as a beacon of sustainable agriculture.

The report critically assesses ZBNF on four crucial parameters: its ability to promote sustainable agriculture, impact on farmers' net incomes, influence on crop productivity, and the potential implications on national food security if scaled up by 2030. The study draws from two substantial sources: field trials conducted by the Indian Institute of Farming Systems Research (IIFSR) and a comprehensive field survey spanning all 13 districts of Andhra Pradesh conducted by the Centre of Economic and Social Studies (CESS) and Institute for Development Studies Andhra Pradesh (IDSAP).

As the report unfolds, it navigates through contrasting findings from these studies, revealing divergent perspectives on ZBNF. While Andhra Pradesh emerges as a forerunner in adopting ZBNF with encouraging results, the IIFSR study raises concerns about the sustainability and yield potential of this farming method. The discrepancy in outcomes underscores the need for a comprehensive and independent evaluation before considering widespread adoption.

In light of these findings, the report recommends caution and calls for a large-scale assessment of ZBNF before advocating its broader implementation. Acknowledging the importance of long-term evaluations, the report proposes an independent review in Andhra Pradesh by experts of repute. Furthermore, it emphasizes the need for voluntary participation and suggests refraining from state-funded initiatives until the efficacy of ZBNF is established through rigorous testing.

The report also addresses the broader issue of fertilizer usage, advocating for a crop-neutral and agriculture-practice-neutral approach to fertilizer subsidies. The proposed direct benefit transfer to farmers' bank accounts, coupled with market-driven fertilizer pricing, aims to foster judicious fertilizer use while empowering farmers to choose practices aligning with their preferences and the well-being of the environment. As we navigate the intricate terrain of sustainable agriculture, this report serves as a timely contribution, urging stakeholders to tread carefully, prioritize evidence-based decision-making, and foster a balanced approach that ensures the resilience of Indian agriculture in the face of evolving challenges.

Deepak Mishra
Director & Chief Executive
ICRIER

Executive Summary

While India has become broadly self-sufficient in production of basic staples after the green revolution, several fault lines have also emerged over the years. The fertilizer consumption jumped from 4.3 million metric tonnes (MMT) in 1977-78 to 29.04 MMT in 2019-20; per hectare consumption has also increased from 24.9 kg to 144.9 kg over the same period. In states like Punjab, Haryana, and Rajasthan, Nitrogen-Phosphorus-Potash (N-P-K) application ratio is far from the recommended ratios. This excessive and imbalanced application of fertilizers has adversely affected soil fertility, polluted ground water, and emitted large amounts of nitrous oxide into the environment, raising overall greenhouse gas (GHG) emissions. On top of this, the fertiliser subsidy bill to the Central government has crossed Rs 2 lakh crores. So, environmentally or fiscally, this is not a very healthy and sustainable situation to be in.

It is against this backdrop; the Government of India has been encouraging organic farming and other chemical-free approaches to agriculture via schemes like Rashtriya Krishi Vikas Yojana (RKVY) and Paramparagat Krishi Vikas Yojana (PKVY). Zero Budget Natural Farming (ZBNF), renamed Bhartiya Prakritik Krishi Padhati (BPKP), is a sub-scheme of PKVY since 2020-21 that claims to raise the returns and yields of farmers without using chemicals and pesticides. BPKP offers Rs. 12,200 per hectare as a financial support for forming clusters, certification of products, residue analysis and handholding by training personnel for three years.

ZBNF has received attention from various politicians and policy makers. The Hon'ble Prime Minister, Shri Narendra Modi, himself talked about this while addressing National Conclave on Natural Farming 2021 and UN Convention to Combat Desertification (UNCCD). Nirmala Sitharaman mentioned this in her budget speeches, and NITI Aayog, and Economic Survey, have also expressed their interest in expanding the outreach of this farming method as an instrument of achieving the objective of doubling farmers' incomes by 2022-23 and simultaneously promoting sustainable agriculture. Budget 2022-23 proposed a 5 km wide natural farming corridor around the Ganga River banks. Madhya Pradesh government is giving monetary support for rearing indigenous cows and NITI Aayog is designing an action plan to fully harness the potential of cows and improve the economic viability of gaushalas. While India stresses promoting ZBNF at a national level, countries like Sri Lanka have faced negative economic consequences of announcing organic agriculture as a national farming strategy.

Against this backdrop, this paper assesses the farming method on four parameters: (a) does it promote sustainable agriculture as it claims? (b) does it raise farmers' net incomes on a per hectare basis? (c) does it improve the productivity of crops? and finally, (d) if scaled up at an all-India level, say by 2030, what implications it may have on national food security? The study does not conduct a full-fledged survey but analyses and juxtaposes the two comprehensive studies conducted on ZBNF. One is field trials conducted by the scientists of the Indian Institute of Farming Systems Research (IIFSR) – an institute affiliated with the Indian Council of Agricultural Research (ICAR), apex scientific body of Government of India on agriculture. The other is a field survey covering all 13 districts of Andhra Pradesh – the frontrunner in implementing ZBNF among all states – by two reputed research institutes of Andhra Pradesh -

Centre of Economic and Social Studies (CESS) and Institute for Development Studies Andhra Pradesh (IDSAP). ICAR-IIFSR tested the ZBNF concoctions in a controlled environment and compared the outcomes with Integrated Crop Management (ICM). ICM is a close proxy of conventional agriculture practices in a controlled environment. CESS-IDSAP analyzed crop cutting experiments for yields and conducted household surveys to compare returns and sustainability of ZBNF and non-ZBNF practices. Besides, the study also incorporates the insights gathered from field visits, interaction with key stakeholders like farmers, scientists, and government officials associated with the propagation of ZBNF.

Natural Farming, as the name suggests, is farming with nature without the use of modern tools and technology (like machinery, genetically modified seeds, soil testing). It works on the principle that soil has all the nutrients essential for plant growth. According to this technique, plants obtain 98-98.5 percent of nutrition from air, water, and sun, and the remaining 1.5 percent from the soil. The system, therefore, can sustain and flourish even without nutrient supplementation, just like a forest ecosystem. Some essential elements of natural farming are maintaining live crop cover throughout the year, growing 15-20 diverse crops, intercropping, 5-layered cropping, indigenous seeds, and minimal intervention. The transformation is slow, but bio-stimulants catalyze the transition. These bio-stimulants or Palekar's four wheels of ZBNF (Beejamrita (seed- microbial coating), Jeewamrita (soil-microbial coating), Waaphasa (soil aeration), and Acchadana (mulching)) are formulations prepared from naturally available inputs like cow dung, cow urine from indigenous cows, jaggery, and gram flour. In addition, formulations to prevent pest and weed attacks (Agniastra, Brahmastra, and Neemstra) are prepared with some extra inputs like chillies, garlic, neem, and tobacco.

Several states are adopting variants of ZBNF; the study uses the common term ZBNF for these natural farming methods. Andhra Pradesh is a forerunner in adopting ZBNF. The state had been attempting sustainable agriculture practices for a long time. In 2004, it started a programme called Community Managed Sustainable Agriculture (CMSA), also a zero-chemical approach, but ultimately switched to ZBNF (known as Community Managed Natural Farming in the state) in 2016. As of 2021, 100,000 hectares of land are under natural farming; the number of farmers has significantly increased from 40 thousand farmers in 2016-17 to 7.5 lakh farm workers and farmers in 2020-21; the state has targeted to bring the entire agricultural land under natural farming by 2027. Himachal Pradesh, following the footsteps of Andhra Pradesh, started a natural farming programme in 2018. Karnataka has initiated the implementation of ZBNF in 10 Agro-climatic zones. Haryana has taken up ZBNF in 80 acres of land at Gurukul in Kurukshetra, while Kerala plans to experiment with ZBNF. However, being an unproven method, many scientists and farmer group leaders are showing their reservation. They claim that it lacks scientific rigor. Apprehensions are that the nationwide implementation of ZBNF, without rigorous tests by reputed scientific organisations for its credibility can pose a yield-driven risk to national food security.

Rythu Sadhikaran Samstha (RySS), the implementing agency of ZBNF in Andhra Pradesh, has assigned two research institutes – CESS and IDSAP – to make regular independent assessments of the status of natural farming. CESS conducted the assessment for two seasons (Kharif and Rabi 2018-19); IDSAP continued it for the next two seasons (Kharif and Rabi 2019-20). The findings for six main crops of the state (paddy, groundnut, cotton, Bengal gram, black gram,

and maize) suggested low expenditure on biological inputs and lower paid-out costs for the ZBNF farmers in comparison to non-ZBNF farmers. The expenditure on inputs for ZBNF practitioners was 3.54 percent to 74.63 percent lower than the non-ZBNF practitioners, and the paid-out costs were 9.08 percent to 35.97 percent lower than non-ZBNF, for a majority of ZBNF crops, indicating the scope of higher savings in the ZBNF method. Interestingly, the yield was also higher in most ZBNF crops than the non-ZBNF crops, ranging between 0.94 to 23.4 percent. The cost-saving due to biological inputs was so much that the ultimate returns were positive for all ZBNF farmers even when the yields were not as high as non-ZBNF farmers.

The findings of ICAR-IIFSR are in complete contrast with the CESS-IDSAP results. ICAR-IIFSR tested ZBNF concoctions over basmati rice-wheat cropping system at four locations - Pantnagar (Uttarakhand), Ludhiana (Punjab), Kurukshetra (Haryana), and Modipuram (Uttar Pradesh) for three years (Rabi 2017 to Kharif 2020). The study revealed that despite the low input cost, returns for ZBNF farmers could not improve due to low yields under the ZBNF system. The rice had 22.6 percent and wheat had 18.2 percent lower cost of cultivation in ZBNF than ICM; the returns fetched were also 58 percent lower in ZBNF. The yield outcomes for Basmati were 37 percent and for wheat were 53.9 percent lower than ICM after the second year. The study also predicted a 32 percent decline in Basmati rice yields and a 59 percent decline in wheat yields from the current levels if ZBNF is adopted at a large scale.

To analyze the possible impact on future food security if ZBNF expands at various scales, we have taken the ICAR-IIFSR as a base. This is because ICAR-IIFSR is a government institute under the aegis of ICAR. From the estimates of yield reduction of 59 percent for wheat and 32 percent for Basmati rice as stated by ICAR-IIFSR, we have estimated an impact on production from ZBNF based probable scale of adoption at 30 percent, 50 percent, and 100 percent of the grossed cropped areas and compared the decline in production with the output conventional farming method. The simulation suggests that the wheat production decline with ZBNF methods, compared to the conventional method, can be 17.7 percent if 30 percent of the net sown area is covered under ZBNF, 29.5 percent in the case of 50 percent area, and 59 percent in case of complete conversion to ZBNF. In case of basmati rice, the reduction in production is relatively lower– 9.7 percent, 16.1 percent, and 32.2 percent in 30 percent, 50 percent, and 100 percent ZBNF scenarios, respectively. This sharp fall in output because of ZBNF inputs should be a cause of concern for the government as the country tries to meet the rising demand for food by 2030.

The findings related to the sustainability question in the two studies are also conflicting. IDSAP, for its 2019-20 study, interviewed a panel of 260 farmers that were taken in the 2018-19 study to gather inputs on their crop experience. It found that most farmers indicated an improvement in crop weights, resilience to weather changes, and improvement in soil quality. On the other hand, the ICAR-IIFSR findings from the field trials suggested that the soil carbon content of the ZBNF field was lower than the ICM and was just as good as the control field (control field is the one where no inputs are added). Moreover, the ZBNF concoctions could meet only 39.51 percent of nitrogen requirements of the plant, and this could reach close to only 70 percent with an addition of inputs like farm-yard manure and Azolla, added by most ZBNF farmers. The scientists indicate that this nitrogen content is insufficient for healthy plant growth and thus poses a challenge to the sustainability of the environment.

In conclusion, as the outcomes of two quite reliable sources indicate wide divergence, we recommend a large-scale assessment of the farming method prior to recommending it for wider adoption in the country. We also suggest an independent evaluation in Andhra Pradesh to verify their claims by a team of independent experts of repute. Further, we recommend the need for long term assessments before concluding about the impact of natural farming. ICAR-IIFSR has already initiated a programme to test the complete package suggested in ZBNF from Kharif 2020. Moreover, we believe that the practice is admissible as long as it is voluntary and not state-funded. In addition, to avoid excessive and disproportionate application of fertilizers, the study recommends making fertilizer subsidy crop-neutral and agriculture-practice neutral. We find that based on the current budgetary allocation of the government, a direct benefit transfer of Rs. 5000 to Rs 10,000 per hectare to their bank accounts, and setting fertilizers free to be determined by market forces, will ensure judicious use of fertilizers by the farmers, and give them the freedom to choose any agriculture practice s/he deems beneficial.

1

Introduction

India has achieved self-sufficiency in essential agricultural commodities, especially staples, in the last couple of decades. This success is primarily because of green (cereals), white (milk), and blue (fisheries) revolutions, initiated through successive government-supported interventions. The production of foodgrains has increased significantly in the last few decades, especially since the launch of the green revolution in the 1960s; the use of chemical fertilizers (containing nitrogen, phosphorus, and potassium) has also increased correspondingly. From a total fertilizer consumption of 4.3 million metric tonnes (MMT) and per hectare usage of 24.9 kg in 1977 (Gulati & Banerjee, Rejuvenating Indian Fertilizer Sector, 2019), the consumption was 29.04 MMT; per hectare usage stood at 144.9 kg by 2019-20 (FAI, 2020). Further, the usage of fertilizers (N, P, and K), too, has been highly unbalanced with much higher doses of N compared to recommendations for optimal combinations of N, P, and K, adversely impacting soil fertility.

The country faces several challenges on agri-front: it has to feed 18 percent of the global population and 15 percent of the global livestock with just 2.5 percent of the global geographical area (Bhattacharya, et al., 2015); 30 percent of the land is degraded and about half the cultivated area is rain-fed (Venkateswarlu & Prasad, 2012) (Gulati and Juneja, 2021)For long, the country's agricultural strategy remained production and food security oriented; the need of raising farmers' income was not explicitly recognized (Jadhav, 2021). However, looking at small holding size of most of the farmers (86 percent are below 2 ha) and their low levels of income, government took many initiatives with a view to double farmers' income by 2022-23.

The government is encouraging various farming systems that entail less and judicious use of chemical fertilizer and pesticides and at the same time, help achieving the objective of doubling farmers' income. Many farmers worldwide have blamed contemporary scientific agriculture relying on external chemical inputs for environmental degradation, climate change, and biodiversity loss. Several small groups across the globe are experimenting with alternative farming methods and have also started looking at ancient farming practices for guidance. The ZBNF is one such farming method that has gained significant attention. First practiced by a Japanese farmer and philosopher, Masanobu Fukuoka, on his family farm on the island of Shikoku, it is being promoted by an agriculturist in Maharashtra - Subhash Palekar for last many years. However, the practice makes several untested claims for which it is highly debated amongst policymakers, scientists, and other stakeholders for its efficacy and scientific validation.

PM Modi in his address to National Conclave on Natural Farming 2021, said, "We need to take agriculture out of the chemical lab and connect it with nature's lab" (TOI, 2021). There is an emphasis on switching from chemical-farming practices to natural farming methods. Despite the lack of information and scientific assessment of ZBNF, the Economic Survey (2021-22, 2018-19), Nirmala Sitharaman in three out of four budget speeches (Jain, 2022) and NITI Aayog have shown keen interest in expanding the footprint of ZBNF across the country. The Budget 2022-23 indicated the promotion of a five-kilometer-wide natural farming corridors, accounting for an estimated area of 1.5 million hectares (Sharma B. R., 2022), on the banks of river Ganges. As India has the largest bovine population globally, NITI Aayog is eyeing the overhaul of the gaushala economy to be more remunerative, economically viable and less detrimental for farmers (PTI, 2022). The idea is to generate revenue from cattle by-products other than milk;

for instance, cattle urine and dung find uses in the preparation of organic fertilizers, herbal products, and pharma, and to take stray cattle off the roads (Sharma Y. S., 2022). A Niti Aayog task force in its report titled 'production and promotion of organic and bio-fertilizers with special focus on improving economic viability of Gaushalas' (released on March 10, 2023) has recommended exploring possibility of integrating chemical fertilizers with cow dung and cow urine based organic fertilizers. Considering the importance of indigenous cattle in natural farming, the government of Madhya Pradesh has set up cattle shelters and cattle sanctuaries for the cattle population. It is primarily incentivizing desi-cattle rearing by giving Rs. 900 per month and thus, Rs. 10,800 per year to the farmer rearing at least one desi-cattle (India.com Business Desk, 2022). Various states governments are also promoting ZBNF or its variants like Community Managed Natural Farming in Andhra Pradesh, as a means of rejuvenating Indian agriculture and raising farmer incomes.

On the other edge of the spectrum are the countries which have suffered the consequences of attempting organic farming in the entire nation. Sri Lanka is a case in point, undergoing a severe economic crisis after a bold move to turn completely organic. It is well known that organic farming yields are 19 to 25 percent lower than chemical farming (Nulkar, 2021), and feeding a large population relying solely on organic farming is challenging. Yet, the country banned the import of all the pesticides and chemical fertilizers on 29th April 2021 (Pandey, 2021) and coerced all the 2 million farmers (Nordhaus & Shah, 2022) to turn organic, putting the food security of the nation at risk. The result was soaring inflating, falling Sri Lankan currency and mass public unrest. In this context, the study attempts to analyze the impact and implications of this natural farming method on Indian agriculture. The objective is to examine the viability of ZBNF from the farmers,' the country's environmental sustainability, and food security perspective by analyzing the possible consequences of adopting such farming methods on India's agricultural production system.

The study has objectively looked at ZBNF from two perspectives – first, the form practiced in Andhra Pradesh, where the government has allocated huge resources to extend support to farmers to smoothly transition into the practice and second, the scientific experiments conducted by Indian Council of Agricultural Research (ICAR) affiliated Indian Institute of Farming Systems Research (IIFSR) in Modipuram, Uttar Pradesh. Centre for Economic and Social Studies (CESS) and Institute for Development Studies Andhra Pradesh (IDSAP) have been the evaluators of the practice since its inception; assessing it for the last five agricultural seasons (Vijaykumar, 2021). Meanwhile, IIFSR was also carrying out an assessment of ZBNF in a scientifically controlled environment for the last three years (2017-2020), at four locations, on Basmati Rice-Wheat cropping system.

1.1 Methodology

The report combined the inputs from field visits, discussions with stakeholders like farmers, scientists, farmer group leaders, key government officials associated with the propagation of ZBNF, and secondary literature. Further, it has also utilized relevant government documents from Lok Sabha, Press Information Bureau, letters exchanged between T. Vijay Kumar and the Andhra Pradesh Government from the website, and documents of communication between from National Academy of Agricultural Sciences and Prime Minister Narendra Modi.

Following secondary data sources from both government and international databases have been used:

- Online open sources of data from international organizations like the Food and Agriculture Organisation (FAO) and the International Centre for Research in Semi-Arid Tropics (ICRISAT)
- Open-source data from the National Academy of Agricultural Sciences (NAAS), Economic Survey (2018-19), and the union budget speech of Sitharaman.
- Ministry of Agriculture and Farmers Welfare
- Data informally shared by the ICAR-IIFSR, Modipuram, an institute affiliated to Indian Council for Agricultural Research (ICAR)
- CESS and IDSAP assessments of Andhra Pradesh Community Managed Natural Farming.

Table 1.1: List of field visits conducted

State	Place	Purpose
Uttar Pradesh	ICAR-IIFSR, Modipuram	Interactions with scientist who are conducting field trials on ZBNF and visit to field for seeing the standing crops
Gujarat	Fields in Somnath, Gir, Amreli districts	Interactions and field visits to farmers who have adopted ZBNF methods
Maharashtra	Fields in Nagpur, Amaravathi, and Akola districts	Visits to farms which follow ZBNF, research field of Panjabrao Deshmukh Krishi Vidyapeeth, Akola and interactions with farmers, groups such as Shetkari Sanghathana as well as the scientists and Vice Chancellor of the Vidyapeeth

The study is organized into six broad sections. After looking at the backdrop of the study and methodology in the Section 1, Section 2 gives a broad overview of ZBNF in the country. It delves into the details of ZBNF, its evolution in India, its purpose, and the key elements of the farming method. The section also provides a background of government's efforts towards promoting chemical-free methods of farming. Section 3 discusses the status of ZBNF implementation across different states. Section 4 presents the outlook of different stakeholders, including the farmers, farmers groups, and the scientific community, on this natural farming method. It also discusses the farmer experiences gathered from the state visits. Section 5 examines ZBNF as an agricultural system, from the point of view of environmental sustainability, profitability for farmers, the productivity of crops, and national food security by juxtaposing the methodologies and findings of two critical studies on ZBNF, one by the CESS and IDSAP, and the other by ICAR-IIFSR. Section 6 presents conclusions and policy recommendations based on the research and from the field visits, and interactions with key stakeholders.

2

Overview of Zero Budget Natural Farming

2.1 Evolution of ZBNF in India

India's foodgrains production rose by more than six times (from 50.8 million tonnes (MT) in 1950-51 to 323.55.65 MT in 2022-23 (DES, 2021) but, the share of agriculture sector in national income has fallen from 18.2 percent in 2014-15 to 16.5 percent in 2019-20 (GoI, 2020); the issues associated with malnutrition, poverty and hunger continue to remain an area of concern. Around 78 percent of groundwater extracted is used for irrigation as per CWC, and as per FAO, this figure stands at 89 percent, and crops such as paddy and sugarcane consume more than 60 percent of irrigation water. Despite an expansion in the irrigation facility, a substantial area (almost half) that is cultivated still depends on the monsoon rains for growing their crops. As a result, climate change resulting in extreme weather, heat, and rainfall, all pose enormous challenges for the Indian agriculture and allied sector. The risks are likely to accentuate at multiple levels, including crop or livestock, farm or cropping system, and food system due to the climatic variations and extreme weather events.

Since 86 percent of holdings are small (less than 2 ha), income of most farmers remains low, especially those growing staples for subsistence. To tackle the climate and the livelihood challenge in agriculture, a natural farming technique, ZBNF is being promoted to improve soil quality, water use efficiency, and soil fertility. The 'zero budget' farming is being considered as a way to reduce reliance on loans for modern inputs and drastically cut production costs. This may help reduce the debt burden, but the ZBNF is extremely labour demanding. The Economic Survey refers to 'zero budget' as no use of credit and external inputs and 'natural farming' as farming with nature without applying chemical fertilizers (GoI, 2019). However, it is debatable, since economically speaking, it is impossible to produce without inputs; even freely available inputs like rainwater and deployed family labour also have an opportunity cost (Das, 2019). The actual practitioners in several states as well as the propagator Palekar opine that 'Zero budget' is not about external costs but the compensation of the expense on the main crop through ancillary income obtained through farm diversifying activities like intercropping, instead of business-as-usual monoculture. (Khadse & Rosset, Zero Budget Natural Farming in India - from Inception to Institutionalisation, 2019). This school of thought puts the blame on modern chemical-based agriculture not only for adverse environmental impact but also for farmers' debt burden and thereby their suicides. We do not get into this issue of suicides as that is much more complex issue and needs a separate paper. There is ample evidence to prove that as percentage of population engaged in farming, farmer suicides are not out of line with suicides occurring in urban areas, including student groups, etc. So, putting the entire blame of farmer's suicides on modern agriculture, in our view, is a misplaced notion.

Andhra Pradesh has about 6 million farmers in agriculture, which contributes about 34 percent of the state GDP. It has one of the highest fertilizer and electricity consumption on a per capita basis and most of the farmers take credit for agriculture and other operations. At any point of time, 90 percent of agricultural households would show outstanding loans (debt) against them (Veluguri, et al., 2021). In 2004, the state started an organic farming programme called Community Managed Sustainable Agriculture (CMSA) but switched to state-funded ZBNF as an ecologically sound alternative to the previous heavy-input conventional agriculture in 2016 (Saldhana, 2018); states like Himachal Pradesh emulated the shift in 2018. Despite its numerous names such as Climate Resilient Natural Farming, Climate Resilient Zero Budget Natural

Farming, and Community Managed Natural Farming, it is not very different from the ZBNF propagated by Subhash Palekar. The prime point of differentiation is additional innovations in the latter that are against the principles suggested by Subhash Palekar, such as the use of NADEP compost, pre-monsoon dry sowing, vermicomposting (Veluguri, et al., 2021), farmyard manure, and machinery (CESS, 2019).

Nonetheless, both practices entail giving up chemical fertilizers, pesticides, and other foreign inputs (Saldhana, 2018). This paper uses the term ZBNF for both these natural farming variants, as done in most studies.

The concept of ZBNF got a boost, for the first time from Rajiv Kumar, former Vice Chairman, NITI Aayog. According to him, the ZBNF practices enrich the soil with humus which in turn fuels the soil with microorganisms, enhancing the crop productivity, carbon sequestration, water availability, and the biodiversity of the region. He also believes that this method can help in the diversification of farmers' risks, contribute in cost reduction while enhancing the food security of the farmers and the nutrient security of all citizens (Kumar R. , 2019). Later, the practice has been promoted by several government officials, on various occasions. While referring to the concept (ZBNF), Sitharaman in her Union Budget (2019-20) speech (MoF, July 5, 2019) said,

> *"We shall go back to basics on one count: Zero Budget Farming. We need to replicate this innovative model through which in a few States farmers are already being trained in this practice. Steps such as this can help in doubling our farmers' income in time for our 75th year of independence,"*

In her 2022-23 budget speech, she put forward the idea of natural farming corridors along the banks of the river Ganges in Uttar Pradesh (GoI, 2022). 2020-21 budget speech, she referred to inclusion of ZBNF as part of promoting integrated farming systems in rain fed areas (MoF, Feb 1, 2020). The Economic Survey of 2018-19 also explained its positive ecological impact by enhancing soil fertility, and reducing water usage. (Govt. should stop promoting zero budget natural farming pending proof: scientists, 2019). Moreover, PM Modi has also been advancing ZBNF as India's strategy on various international platforms like the UNCCD (ibid, (The Wire Staff, 2019)). These references have been triggering a debate about the scientific and economic viability and sustainability of ZBNF.

Given the emphasis on natural farming and only the need for a suggested package for providing an appropriate environment to the soil for microbial activity, we now look at what drives such a method of farming propagated by Subhash Palekar.

2.2 Key elements of ZBNF

There are some universal principles to natural farming, other than no use of synthetic inputs - 15-20 diverse crops natural farming involves maintaining a crop cover with living root all-round the year; minimal intervention; use of indigenous seeds; integration of animals via their dung or urine; encouraging diversity of organic residues; pest management only through good agronomic practices and no use of pesticides or herbicides (Vijaykumar, 2021). Other than that, India is endowed with naturally available inputs that can be used to prepare bio-stimulants to expedite the pace of transition to natural farming (ibid).

According to the natural farming proponents, the method needs no inputs (farmyard manure, organic or chemical) (Raghuram). Air, water, and sun provide 98-98.5 percent of plant nutrients, and the remaining 1.5 percent from the soil are available free of cost (DoA, H.P., n.d.). Several naturally-prepared concoctions can be added to provide the soil with the environment for activating the soil biota for its independent sustenance.

Palekar calls these concoctions, the "four wheels of ZBNF": Beejamrit, Jeevamrit, Mulching and Waaphasa. Beejamrit is the microbial coating of seeds with formulations of cow urine and cow dung. Jeevamrit is the enhancement of soil microbes using an inoculum of cow dung, cow urine, and jaggery. Mulching is the covering of soil with crops or crop residues. Waaphasa is the building up of soil humus to increase soil aeration. In addition, ZBNF includes three methods of insect and pest management: Agniastra, Brahmastra and Neemastra (all different preparations using cow urine, cow dung, tobacco, fruits, green chilli, garlic, and neem).

Stage I: *Beejamrit*: prepared using cow dung liquids comprising of local cow dung, local cow urine, lime, and undisturbed chemical free soil. Seed is soaked in this solution before sowing. Required quantity: Wheat (100 kg per hectare) & Basmati rice (15-20 kg per hectare)
Stage II: *Jeevamrit*: water (200 lit), fresh cow dung (10 kg), cow urine (5-10 lit), Jaggery (2 kg), pulse flour/ besan (2 kg) & soil from same farm (100-150 kg). These materials are mixed in a plastic drum and it is ready on the 8th day. It is applied @500 litres/ hectare twice in a month through irrigation water.
Stage III: *Ghanjeevamrit* is a soil nutrient (100 kg desi dried cow dung, 2 kg jaggery, 2 kg besan (pulse flour), 5 litres desi cow urine, and 250 g forest soil) @250 kg/hectare.
Stage IV: *Agniastra* & *Brahmastra* (insecticide management made from desi cow urine, neem leaves, chilli, tobacco)
Stage V: *Acchadana* (soil, straw, and live mulch) & *Waaphasa* (encouraging both air and water molecules present in the soil through reducing irrigation, irrigating only at noon and in alternate furrows)

In Andhra Pradesh, in addition to Beejamrit (microbial seed coating) and Ghanajeevamrit (soil microbial enhancer), Dravajeevamrit (liquid soil microbial enhancer) is used as per the crop requirements and the location (Vijaykumar, 2021). Pest management involves good agronomical practices and bio-inoculants called Kashayams, also prepared from locally available ingredients (ibid).

Other critical elements of ZBNF include:

- **Intercropping** – The practice of growing monocot and dicot crops on the same field compensates for the cost incurred on the main crop (Mishra, 2018), ensuring a regular flow of income for the farmers. States also follow ZBNF recommended practices like 5-layered farming to replicate forest-like ecosystems.
- **Contours and bunds** – To preserve rainwater, Palekar recommends the construction of the contours and bunds.
- **Local species of earthworms** – Palekar opposes the use of vermicompost. ZBNF supports the revival of local deep soil earthworms through increased organic matter.
- **Cow dung** - ZBNF revolves around Desi cow; dung from the Bos-indicus (humped cow/ desi) is considered most beneficial and has the highest concentrations of micro-organisms as compared to European breed of cows such as Holstein.

Palekar equates farming with forest ecosystem; he emphasizes the need to reinvigorate the soil ecosystem that chemical-based farming has annihilated. Therefore, the ZBNF package designed strictly opposes previous practices like organic farming, the use of Genetically Modified seeds (GMOs) to enhance the nutrient value of the crop (Climate Resilient Zero Budget Natural Farming (CRZBNF) Is this 'Exclusivity' & Nomenclature justified in a Government Scheme, 2018) and soil testing.

2.3 National efforts towards Chemical-free agriculture

The government of India has been encouraging organic farming in the country through dedicated schemes like Paramparagat Krishi Vikas Yojana (PKVY) and Mission Organic Value Chain Development for North Eastern Region (MOVCDNER) since 2015-16. Under PKVY, states are given flexibility to adopt any model of organic farming. Natural farming was added to PKVY in 2018 (PIB, 2018). ZBNF has been renamed as Bhartiya Prakritik Krishi Padhati (BPKP)[2], a sub scheme of PKVY since 2020-21. These schemes aim to promote cluster or Farmers Producer Organization (FPO) based chemical-free low input cost sustainable organic farming and support farmers from organic inputs production, procurement to market linkages. Steps have been initiated promoting organic inputs - bio-fertilizers, bio-pesticides, vermicompost, botanical extracts etc. through assistance and incentives.

Under PKVY, an assistance of Rs.50,000 per hectare for three years is provided, out of which Rs. 31,000 (61 percent) is given as Direct Benefit Transfer (DBT for inputs (like bio-fertilizers, bio-pesticides, vermicompost, botanical extracts etc.), production/ procurement, and post-harvest infrastructure. Since 2020-21, Under MOVCDNER, the farmers are assisted with Rs 7,500 per hectare for three years for on-farm and off-farm organic inputs, production, and procurement. From 2020-21 onwards, ZBNF is being implemented as a sub-scheme of PKVY to promote the traditional farming techniques among the small and marginal farmers (MoAFW, 2021). Under this, a financial assistance of Rs. 12,200 per hectare is given for three years as a means of building capacity, training, residue analysis, and providing certification and promoting cluster formation (ibid).

[2] This paper follows a common terminology ZBNF instead of BPKP, in line with the current literature on natural farming.

The National Programme for Organic Production (NPOP) - a joint initiative by the commerce and agriculture ministries, has developed an organic certification concept through optimum use of inputs and ensures versatile crop rotation with legumes and appropriate coverage of the soil during the year of production with diverse plant species. NPOP recommends that fertilization management should minimize nutrient losses. Weeds, pests, and diseases should be controlled by a number of preventive cultural techniques which limit their development, e.g., suitable rotations, green manures, a balanced fertilizing programme, early and pre-drilling seedbed preparations, mulching, mechanical control, and the disturbance of pest development cycles. The natural enemies of pests and diseases should be protected and encouraged through proper habitat management of hedges, nesting sites, etc.

As a result of these efforts, total area under organic farming across the country is now around 2.78 million hectares (MH). Madhya Pradesh has 0.76 MH areas under organic cultivation, which is over 27 percent of India's total organic cultivation. Madhya Pradesh along with Rajasthan and Maharashtra, account for about half area under organic cultivation (Khurana & Kumar, 2020). Natural farming is also steadily spreading across the country. A recent estimate for the area covered under natural farming suggests that the farming practice is being carried out on 4.09 lakh hectare of area, and an amount of Rs. 4,980.99 lakh has been released by the states in total (MoAFW, 2021). The state-wise details of the area covered under ZBNF and the funding released for the same suggest that Andhra Pradesh is a front runner in ZBNF implementation and has brought about greatest area under ZBNF while releasing lesser funding as compared to many other states (**Table 2.1**).

Table 2.1: State-wise details of the spread of ZBNF

States	Agricultural land/ cultivable land (2016-17) (thousand hectares)	Area under ZBNF (in '000 ha) as on 7.12.2021*	% age of agricultural area under ZBNF	Amount released under ZBNF (Rs. crore) *	Total amount released PKVY+RKVY since inception (in crores) #	% share of ZBNF in assistance under PKVY & RKVY
Andhra Pradesh	9047	100	1.11	7.50	1562.4	0.48
Chhattisgarh	5558	85	1.53	13.53	1102.4	1.23
Kerala	2584	84	3.25	13.37	666.0	2.01
HP	813	12	1.48	2.86	256.9	1.11
Jharkhand	4367	3.4	0.08	0.54	394.2	0.14
Odisha	6690	24	0.36	3.82	1683.0	0.23
Madhya Pradesh	17231	99	0.57	7.88	1810.8	0.43
Tamil Nadu	8110	2	0.02	0.32	1395.0	0.02

*Source: *Economic Survey 2021-22, Standing committee on agriculture, #17th Lok Sabha, Demand for Grants (2020-21), 9th report Ministry of Agriculture*

As Table 2 shows, ZBNF is spreading across states, with the area under the natural farming varying between 100 thousand ha in AP and 2 thousand ha in Tamil Nadu. However, the share

of ZBNF in a total agricultural area is minuscule; Chhattisgarh has the largest share of cultivable land under ZBNF (1.53 percent), and Tamil Nadu has the least (0.02 percent). Moreover, the percentage of ZBNF in the total amount released under the income support schemes like PKVY and RKVY is also minute. A probable explanation could be that it is still in its initial phases and is one of many options available to states to move to adopt chemical-free agriculture. Another cause could be the skepticism in the scientific and farming community concerning the scientific validity and outcomes of ZBNF, as will be discussed in Section 4.

3

State-wise progress on ZBNF

There has not been any official data on state-wise number of farmers following ZBNF so far. Andhra Pradesh government has been promoting ZBNF through its implementing agency - Rythu Sadhikaran Samstha (RySS). Several states have initiated measures on ZBNF under Rashtriya Krishi Vikas Yojana (RKVY) & PKVY (MoAFW, 2019). Karnataka has started a pilot implementation of ZBNF in an area of 2000 hectares through the efforts of state agricultural and horticultural universities in each of its 10 Agro–climatic zones (PIB, 2019). The institutions are conducting scientific field trials and demonstrations on an Operational Research Project mode (MoAFW, 2019). Himachal Pradesh took up ZBNF in their State through scheme '*Prakritik Kheti Khushal Kisan*' in the May of 2018 (ibid). The number of farmers and area has increased significantly from 2,669 farmers in 357 hectares in 2018-19 to 19,936 farmers in 1,155-hectare area in 2019-20 and 11,670 farmers in 6377 farming in hectare of land as of March 2021 (Gupta, Pradhan, Jain, & Patel, 2021). Haryana has taken ZBNF on 80 acres land at Gurukul, District Kurukshetra and Kerala is under the planning stage of taking up ZBNF, currently focusing on attracting farmer interest through various workshops, training, awareness programmes (MoAFW, 2019). Now the study takes a close look at the progress of ZBNF across different states.

Andhra Pradesh:

The state government introduced ZBNF under the name Climate-Resilient Zero-Budget Natural Farming (CRZBNF) in Kharif 2016 as an alternative to chemical-based and capital-intensive agriculture, through RySS. The main objective of the ZBNF was to make agriculture economically viable, agrarian livelihoods profitable, and thereby reduce agrarian distress through cost reduction and sustainable agricultural practices that are climate-resilient.

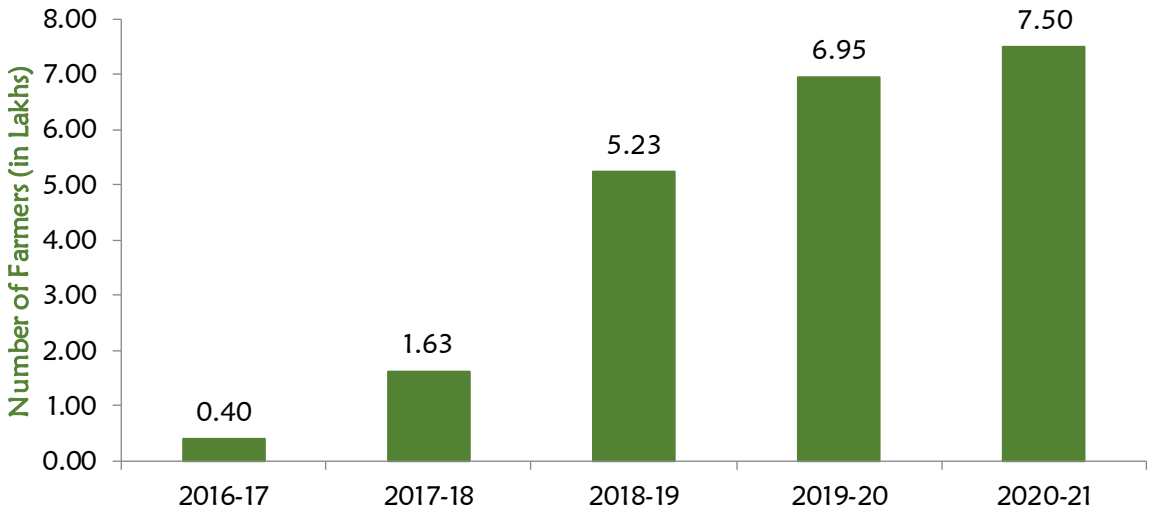
With the agenda of reducing the cost of cultivation, enhancing soil fertility, yields, reducing risks, and protecting farmers from uncertainties of climate change, the Andhra Pradesh government rolled out a plan to become the country's first state to practice 100 percent natural farming by 2024, bringing 60 lakhs farmers and covering the entire agricultural area under the farming practice. The state is now targeting the conversion of the entire 80 lakh hectares of land to natural farming by 2027.

The number of farmers practicing natural farming has increased from merely 40,656 farmers in 2016-17 to 7.5 lakh farmers and farm workers (Vijaykumar, 2021) covering 100,000 hectares of land, in 2020-21 (MoAFW, 2021) (**Figure 3.1**). By 2020-21, 28 percent of all villages and 10 percent of all farmers were enrolled under the programme rising from 22 percent villages and 9 percent of farmers in 2019-20 (Vijaykumar, 2021); the government's target for 2021-22 is coverage of 1.1 million farmers and farm workers.

T. Vijaykumar, the man behind several agro-ecology programs in Andhra Pradesh, including ZBNF, provides an estimate of Rs. 15,000 per farmer for eight years to cover the entire state by 2027, of which 77 percent (Rs. 11,600) of the amount is for capacity-building support, and the remaining is for establishing community institutions, quality assurance and PGS certification, monitoring, and tracking, apart from some technical support, and overall programme management at the different levels of the state (Vijaykumar, 2021) US$ 250 million had been

raised for funding till 2024, of which 90 million euros was a loan from the German KfW bank; Azim Premji Foundation also earmarked a grant of US$ 16 million upto 2021 (ibid).

Figure 3.1: Trend of number of farmers under Natural Farming Programme in Andhra Pradesh



Source: (Vijaykumar, 2021)

The earlier government led by Chief Minister Chandrababu Naidu, envisaged the expansion of ZBNF on a larger scale. Since the new Chief Minister Y. S. Jaganmohan Reddy took over, the outreach programme for ZBNF has slowed down. The state government's allocation towards CRZBNF has not been significant, keeping in mind the need for expansion (Refer **Table 3.1** below).

Table 3.1: Andhra Pradesh government's allocation towards CRZBNF / ZBNF

Year	Allocation
2016-17	Rs. 5 crores
2017-18	Rs. 20 crores
2018-19	Rs. 100 crores
2019-20 (Revised estimate)	Rs. 90 crores
2020-21 (Budget estimate)	Rs. 90 crores

Source: AP budget documents, www.apfinance.gov.in

In January 2020, Andhra Pradesh signed a memorandum of understanding (MoU) with German state-owned development bank KfW to encourage ZBNF in the state (Staff Reporter, 2020). In the next five years, the state government has earmarked Rs 1,015 crore for popularizing ZBNF in 600 villages (ibid). For the fiscal year 2020-21, Rs 90 crore was earmarked for the ZBNF programme.

Himachal Pradesh:

The state government had announced 'Prakritik Kheti Khushhal Kisan Yojna' in March 2018 after senior officials from the state government had made a 'on-farm' visit to Kurukshetra to study ZBNF concept in Gurukul farm, a private farm which has adopted the farm practice since last many years. The focus of the programme was to enhance farm income in harmony with nature by adopting low-cost climate resilient Subhash Palekar Natural Farming System. In 2017, around 20 percent samples of various fruits and vegetables in the state found as 'toxic' with pesticides residue of more than prescribed limits; this excessive pesticide addition was one of the forces that encouraged the government to shift to ZBNF. According to state government officials, around 50,000 farmers have adopted ZBNF and the focus would be to ensure that around 3.6 lakh farmers adopt ZBNF by 2022-23. As of March 2021, 1.16 lakh farmers are already practicing natural farming on a land area of 6377 hectares (Gupta, Pradhan, Jain, & Patel, 2021). And the latest data (Table 2) suggests 12,000 hectares of land is under Natural Farming cultivation in Himachal Pradesh.

The state has been preparing for its phased transformation to 100 percent ZBNF since 2018, following the footsteps of Andhra Pradesh. The plan includes mass awareness programmes and scientist-farmers interactions called 'Kisan Goshtis' (ICAR, 2021) to increase the know-how of ZBNF farmers; increasing the production of native cattle germplasm by the Animal Husbandry department of the state to cover for the need of inputs from a desi cow in the programme; assistance of 75 percent for pest management considering the slow progress towards soil enrichment in the ZBNF; 80 percent assistance for setting up linings for cattle sheds and cow urine collection systems; and Rs. 50,000 monetary supports spread across three years for the Prakritik Kheti Sansadhan Bhandar – the scheme for incentivising farmers owning native cattle to set up shops selling the essential inputs at an affordable price (Government of Himachal Pradesh, 2018).

Even though, agricultural scientists have stated that ZBNF can work in a limited way in case of fruits and vegetables as these crops do not require huge amount of external chemical inputs, the field experiments in the state show that the soil quality has improved in one agricultural season itself and the attack of Invasive leaf miner too, has reduced as compared to the previous agricultural methods.

Madhya Pradesh[3]:

MP has proposed setting up Madhya Pradesh Natural Agriculture Development Board to promote natural farming along the Narmada River banks. In the initial stage, scaling natural farming in the entire state involves encouraging special activities and workshops to incline farmers in 100 villages in each of the 52 districts and commencing the programme in all 5,200 districts in the Kharif-2022. The state is also giving Rs. 900 per month or Rs. 10,800 per annum to all the farmers rearing desi-cow, considering the significance of dung from indigenous cattle in the natural farming processes. Moreover, natural farming master trainers (Kisan Mitra and

[3] Heavily drawn from (Staff Reporter, 2022)

Kisan Didi) in each village and five full-time workers in each block are proposed to be deployed to guide and handhold the farmers (Staff Reporter, 2022).

Uttar Pradesh[4]:

Uttar Pradesh is also coming forward in implementing ZBNF on a wide scale. The CM of UP – Yogi Adityanath, indicated the progress of ZBNF in the state during his speech at a one-day National Workshop at "Azadi the Amrit Mahotsav" in 2022. The improvement includes 82.83 crore funding from the central government for encouraging the practice across 35 districts of the state on an area of 38,670 hectares for a three-year programme starting in Kharif 2022. Bundelkhand, a traditional natural farming region in the state, is proposed to get support in 500 to 1000 hectares clusters in all the districts, financed entirely by the state. The most significant initiative on natural farming is the proposed building of 5 km broad natural farming corridors on both sides of the river Ganga.

Other States:

According to agriculture ministry officials, the farmers are not following ZBNF in coastal districts and key rice growing areas in Odisha. Instead, farmers actively practice rice and vegetables based organic farming systems involving fishery as an integral component to support their food and nutritional security. Information on the expansion of ZBNF in states such as Karnataka and Kerala is not available officially. Although, there are several instances of farmers opting for organic farming instead of farming based on chemical fertilizer. The Kerala government has allocated Rs. 15 lakhs towards promoting ZBNF in 2019-20 (Government of Kerala). Karnataka was among the first few states which adopted ZBNF for reducing the cost of production of farmers and increase their income last year. Officials in the agriculture ministry stated that the expansion of ZBNF in Karnataka has slowed down because of lack of support from the government.

Currently, the agriculture ministry and NITI Aayog are still working out modalities for expanding ZBNF across the country. The Government has formulated Natural Mission on Natural Farming (NMNF) by up-scaling the BPKP to promote natural farming on higher scale across the country. The Department of Agriculture and Farmer Welfare is undertaking large scale training of master trainers, and practicing farmers on techniques of ZBNF through National Institute of Agricultural Extension Management and National Center of Organic and Natural Farming. The absence of any scientific protocol for ZBNF is a crucial factor. The opposition by farmers groups and agricultural scientists has also resulted in the government taking a more cautious route in expansion as it involves enormous food security implications.

[4] Drawn heavily from (IANS, 2022)

4

Viewpoints of different stakeholders

Even though, the ZBNF practice is catching up in some states, most notably in Andhra Pradesh, various farmers groups as well as agricultural scientists have opposed ZBNF as it lacks scientific rigor. Dr. Vilas M Bhale, Vice Chancellor, Dr Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra has following points to oppose ZBNF:[5]

- There are experiments with various methods of farm practices using optimum chemical as well as organic inputs.
- Jeevamrit does have some relevance and impact. However, the method recommended by Subhash Palekar would not control the pest completely thus exposing crops to pest attacks
- Palekar has claimed that if the farmers start reusing Genetically Modified (GM) cotton seeds every year, on the sixth year, it would turn into a 'desi' or indigenous seed, which is strongly contested by scientists. It is not scientifically possible as the GM crops cannot be multiplied. On the 'straight' variety seeds can be multiplied not hybrid.

The farmers' organisation in Maharashtra like Shetakari Sanghathana has objected to ZBNF as it lacks scientific validation. They say,

> *"It is scientifically, technically, and economically, objectionable to say it is the only way to farm judiciously and that the farmers are under heavy distress because they don't know art of curtailing costs of cultivations"[6].*

A leading farmers' leader Chengal Reddy, who is associated as the Chief Advisor with the Consortium of Indian Farmers Associations (CIFA) and Federation of Farmers Associations, indicated ambiguity in the outreach of ZBNF in Andhra Pradesh. He stated that it is not possible to arrange adequate labour to produce Jeevamrit of the required quantity. According to Reddy, a large number of farmers in Andhra Pradesh are not aware about the programme – being implemented in Andhra Pradesh.

Scientists raise objections about whether or not one should practice Subhash Palekar way for farming. In SPNF, the hypothesis is that one indigenous or desi cow gives around 10 kgs dung per day, which is a critical ingredient in the preparation of Jeevamrit. Thus 30 acres of land can be applied Jeevamrit over 30 days. Scientists indicate that the quantity of dung and urine suggested by Palekar is not sufficient for producing the suggested amount of Jeevamrit. Moreover, since most farmers do not possess a local cow, the expansion of ZBNF is a challenge. For instance, Dr. Peter Carberry, Director General, International Centre for Research in Semi-Arid Tropics (ICRISAT) states that the recommendation of 10kg/acre/month of manure roughly equating to 10 kg nitrogen/ per hectare is insufficient for crop production. Palekar's belief that only the dung and urine from the native variety of cattle has the ability to replenish the soil with necessary microorganisms is also been challenged by the scientific community. Agricultural scientists KV Prabhu, chairperson protection of plant varieties and farmers rights authorities

[5] Based on personal interaction
[6] Lalit Patil Bahale, Spokesperson, Shetakari Sanghatana's statement

considers it laughable to believe cows fed same stuff as per body mass ratio can have different microbial composition.[7]

Insights from the state visits

For assessing the economic viability of ZBNF from states, focussed groups discussions with farmers at the field was organised in Saurashtra (Gujarat) as well as Vidarbha (Maharashtra). A critical constraint in identifying farmers following ZBNF in these states was that there was no official information on the number of farmers following such a method of farming. The extensive interactions with farmers in these two states indicate that the spread and adaptability of ZBNF have been patchy and uneven.

A farmer who practices ZBNF & sells his produce: Nagpur, Maharashtra

Sudhakar Kubdey, from Selu village, Nagpur district grows brinjal, tomato, cowpea, banana, cauliflower and other fruits and vegetables and takes up arhar (pulse), turmeric and metis as intercrops in his seven acres of land. He uses groundwater for irrigation. Since 2008, he has been following ZBNF or SPNF after came in contact with an associate of Subhash Palekar.

He claims that he does not use any chemical or external inputs. He uses Jeevamrit every forth-night. Only external inputs he needs for preparing Jeevamrit is 600 kg of jiggery which he purchases at Rs 35 a kg. Annually it costs about Rs 21,000 to Kubdey. He has two desi cows and all the fodder is sourced from the field. He uses temporary labour for weeding and inter-cultural operations and has one labour engaged full time for which he has to pay Rs 80,000 a year. "SPNF farmers are independent compared to those who do chemical farming," he said.

Although he does not keep a break-up of the cost of the production in a scenario where multiple crops are grown, he said that annual earning after taking into consideration cost of production is in the range of Rs 4.5 lakh to Rs 5 lakh. He claims that all the seeds for growing fruits and vegetables are saved from his own field thus saving cost of buying hybrid seeds.

For selling his produce, he has devised a unique marketing system. Weekly twice, he takes his produce (fruits and vegetables) to a locality in Nagpur (about 30 km away from his farm) and sells fruits and vegetables at Rs 40 a kg irrespective of prevailing market price. "I have developed a clientele for my produce, which is grown using natural inputs," he said. As pointed out earlier in this paper, the marketing of produce grown using ZBNF remains an area of concern as most of the farmers belong to small and marginal category thus cannot devote so much of resources for marketing as done by Kubdey. Although in a scenario where a farmer grows multi-crops, calculating yield for each of the crop remains a challenge. Replicating such marketing model would have huge impact on the country's production of fruits and vegetables which have been rising steadily especially in the last two decades. At best, ZBNF farmers could cater to a niche market.

[7] Reviewer of the paper Dr. K.V. Prabhu's opinion in his individual capacity

The study profiles select farmers who have adopted ZBNF for the last few years. As stated earlier, the farmers practising ZBNF are few in numbers. Many of them follow a mixed farming pattern only using ingredients recommended under ZBNF (SPNF) as additional inputs for soil rejuvenation.

Farmers such as Kubdey (referred to in the box above) have been marketing their products independently. He has created his consumer base for his agricultural produce. Farmers in India who mostly have medium and smallholdings have no marketing channels to sell their produce directly to consumers. Thus, ZBNF farmers face real hurdles in marketing which hits their income.

As part of the study, extensive interactions were undertaken with the farmers in Gujarat and Maharashtra to ascertain critical aspects of ZBNF. On the marketing aspect, 'Nagpur Natural,' a first-of-its-kind outlet, sold agricultural produce grown using ZBNF. Nagpur Natural has an outlet in Nagpur city where around 400 farmers supply their produce. These farmers mainly sourced from nearby districts such as Gondia, Chandrapur, and Amaravati. One of the co-promoters of Nagpur Natural – Virendra Barbate, has around 16 acres of land at Chacher village of Nagpur district. He uses growing varieties of crops such as paddy, pulses turmeric, fruits, and vegetables. He said that he gets yield of 8 quintals of rice per acre, which is comparable to rice grown using chemical fertilizer. However, the study could not independently verify his claim of rice yield. He supports ZBNF as its increases crop diversity; thus, soil is enriched. All the farmers practicing ZBNF do not use any urea or DAP. All the member farmers donated Rs 1000 each as initial capital for Nagpur Natural. However, awareness about agricultural produce grown using ZBNF is still not there, thus depriving farmers of higher prices. Marketing remains an area of concern.

Subhash Palekar's village – Belora, Amaravati district, Maharashtra has not adopted ZBNF!

At the first glance Belora looks like any other village of Vidarbha region, where agriculture is the main occupation for around 600 people where Subhash Palekar lived initial years of his life. A focus group discussion was organized with farmers from the village to assess their views on ZBNF and the reasons for not taking up such method of farming. All the farmers who participated in the group discussion were of the opinion that crop yield declines sharply by adoption of ZBNF. Farmers grow soyabean, tur (*arhar*), cotton and wheat. Farmers say buying seeds each year gives better yield while in ZBNF yield drops sharply. The ZBNF protocols are not even followed in around 11 acres of land, Palekar owns in the village. The care taker of the Palekar's land did not elaborate on the reasons behind not adopting farm practices which he himself is promoting.

Palekar has been promoting the concept of ZBNF through extensive field workshops where farmers from across the country are invited to join for few days, and they are taken to those select fields where farmers have adopted ZBNF. When Palekar visited Saurashtra in early October (2019), around 200 farmers mostly from northern and western regions joined the field visits come workshop. All the three districts – Somnath, Amreli and Bhavnagar, officials from the agriculture department of Gujarat did not join such workshop. Palekar and his team mostly

managed these field visits. The whole focus of the field visits by the farmers was to show crops grown using ZBNF methods while ignoring the aspects that a large number of farmers in the same village (where farmers were taken) have not adopted such farm practices.

The key aspect farmers stressed was that the yield sharply declines in ZBNF methods for getting higher yield quality seeds in case of sugarcane, cotton, and groundnut in Saurashtra have to be purchased from the market. Farmers do acknowledge that through mulching, inter-cropping, and use of Jeevamrit, the soil gets some essential nutrients. However, it is not adequate along with Palekar's insistence on desi or indigenous seeds results in a sharp fall in yield.

5

Implications for Sustainability, Profitability, Productivity, and Food Security

Existing literature on the efficacy of ZBNF is based primarily on the authors' surveys of farmers in the implementing states showing improvement in yields and income (Khadse A. , Rosset, Morales, & Ferguson, 2017) (Mishra, 2018). However, no study has looked at a comparative evaluation of the ZBNF practiced on the ground and the exact ZBNF practice prescribed by Subhash Palekar, analyzed through scientific experiments. The only extensive economic research has been conducted by CESS for Kharif 2018-19 and Rabi 2018-19, and later continued by Institute of Development Studies Andhra Pradesh (IDSAP) for Kharif 2019-20 and Rabi 2019-20, both covering all the 13 districts of Andhra Pradesh, assessing the viability of the ZBNF in the state. As for scientific trials, as mentioned previously, only IIFSR has conducted a large-scale experiment at four locations to evaluate the efficacy of ZBNF concoctions.

The present section analyzes the methodologies and results of these two research studies operating on entirely different research approaches wherein one has tested ZBNF concoctions in a controlled environment, and the other analyzed the ZBNF 'actually' practiced by the farmers in Andhra Pradesh. The objective is to compare the two studies on four parameters: environmental sustainability, profitability for the farmers, productivity, and food security.

5.1 CESS and IDSAP consolidated study for 2018-19 and 2019-20[8] (IDSAP, 2021) (IDSAP, 2020)

The government of Andhra Pradesh implemented ZBNF in 2016, as a low-input, livelihood-securing alternative to the prevailing chemical-based, low-profit agriculture in the state (Veluguri, et al., 2021). RySS - the implementing body of the natural farming programme, entrusted CESS and IDSAP to evaluate the success of the programme on quantitative as well as qualitative parameters. The institutions compared the experiences of the ZBNF farmers with non-ZBNF farmers by analyzing the crop cutting experiments, conducting household surveys, focused group discussions, case studies, and interviews. The institutions gathered evidence on quantitative parameters like yields, paid-out costs, cost incurred on inputs, gross and net revenues, and qualitative parameters like soil quality, food quality, health issues of farmers after adoption. While CESS assessment was for the year 2018-19, IDSAP validated it for 2019-20.

For Kharif 2018-19, initially, a study sample of 1,300 ZBNF and 1,300 non-ZBNF farmers were taken that included the same farmers practicing both ZBNF and non-ZBNF farming on different fields, known as self-control farmers in the study. However, only 661 pure ZBNF and 704 pure non-ZBNF farmers were ultimately taken for the analysis to avoid cases where there is possibility of the cross-application of biological and chemical practices. Following a similar methodology, the Rabi 2018-19 study analyzed 190 pure ZBNF and 196 pure non-ZBNF farmers and 1,789 Crop Cutting Experiments in total. The IDSAP assessment for Kharif 2019-20 collected the data for 1,422 ZBNF and 628 non-ZBNF farmers and surveyed 902 ZBNF and 601 non-ZBNF farmers during Rabi 2019-20 (**Table 5.1**). The study that has collectively examined the Impact Assessment Reports of Kharif and Rabi 2019-20 and extended the assessments carried out in 2018-19 is the Consolidated Impact Assessment by CESS-IDSAP for 2019-20. It has covered 13 crops in all for both Rabi and Kharif seasons; in this paper, to narrow down the review, we

[8] Sourced from RySS officials

have examined the outcomes of six major crops of the state based on the gross cropped area (GCA). Paddy occupies the largest area of the state (30 percent of GCA) followed by groundnut (11.96 percent of GCA), cotton (8.59 percent of GCA), bengal gram (6 percent of GCA), black gram (5 percent of GCA), and maize (4 percent of GCA).

Table 5.1: Number of farmers and crop cutting experiments in Kharif and Rabi reports of CESS and IDSAP

		Kharif		Rabi	
	Year of the Report	ZBNF	Non-ZBNF	ZBNF	Non-ZBNF
Number of farmers surveyed	2018-19	661	704	190	196
	2019-20	1422	628	902	601
Number of CCEs collected	2019-20	1231	531	263	101

Source: CESS and IDSAP reports

Findings:

Farming can be made a profitable occupation either through costs reduction or through yield accession. The study reveals that biological inputs have saved farmer expenditures on inputs. The range of difference in expenditure between ZBNF and non-ZBNF farmers varied from 74.63 percent in Kharif Cotton to 3.54 percent in Rabi Black Gram (**Table 5.2**); the difference could widen with the use of relatively inexpensive own or local seeds, which have not been opted for as common practice as of now. The report stated that there is no significant variation in the kind of seeds used by both categories of farmers. Further, the paid-out costs too are lower for all the major crops except Black gram cultivated in the Rabi Season, in which case it is 21 percent higher for the ZBNF farmers, underscoring savings in the cost of cultivation.

Table 5.2: Difference between ZBNF and non-ZBNF farmers: Percentage change

Crop	Season	Expenditure on PNPIs	Paid-out costs	Yields	Net revenue
Paddy	Kharif	-64.86	-19.22	5.85	65.73
	Rabi	-40.31	-15.48	-7.02	14.6
Groundnut	Kharif	-12.59	-9.08	0.94	23.81
	Rabi	-53.32	-16.19	4.76	21.67
Cotton	Kharif	-74.63	-35.97	-2.93	165.65
Bengal gram	Kharif	-62.39	-33.45	1.69	181.9
	Rabi	-55.54	-27.45	-9.47	116.07
Black gram	Kharif	-48.08	-20.51	23.21	67.08
	Rabi	-3.54	21.12	2.45	-1.92
Maize	Kharif	-56.72	-18.47	-4.73	-5.26
	Rabi	-70.25	-17.41	8.94	21.31

Source: Impact Assessment of APCNF Consolidated 2019-20 report

The yield of crops analyzed by the CESS for 2018-19 also showed a reassuring picture, with eleven out of nineteen crops exhibiting higher yields in ZBNF than non-ZBNF methods during the Rabi season and all six crops but paddy exhibiting higher yield outcomes during the Kharif season (CESS, 2019). In 2019-20, the IDSAP study found that a majority of the ZBNF crops

witnessed higher yields in both Rabi and Kharif seasons. Among the six major crops taken in this study, the Kharif season yields improved for four of them, and the difference between ZBNF and non-ZBNF crop productivity ranged from 0.94 percent in groundnut to 23.21 percent in black gram. Out of the five critical crops cultivated in the Rabi season, three showed higher yields with ZBNF methods (Table 5.2).

The net income of the ZBNF farmers exceeded that of the non-ZBNF practitioners in most crops, so much so that despite yields and prices not being as heartening, losses, if any, got covered from the savings. The net returns were positive with ZBNF methods owing to the sharp decline in the spending on agrochemicals applied in the conventional farming methods (Table 5.2).

Besides the above quantitative findings, the study also interviewed, in 2019-20, a panel of 260 farmers picked randomly from twenty villages, from all the districts in 2018-19. The results, after one year of assessment, indicated an increment in yields as well as net returns. Though only four crops were common among the farmers – paddy, Bengal gram, groundnut, and red gram – the impressive growth rates of yields - 25 percent for Bengal gram and 43 percent for groundnut – suggested an improvement at least after a year of adoption. Furthermore, the farmers also pointed to lesser reliance on external credit, improvement in weight of crop, thereby quality, and resistance to weather uncertainties. Despite higher labour days in ZBNF methods (15 extra days of labour in ZBNF compared to conventional methods), the savings estimated in the study depicts a positive picture.

The study finds that ZBNF farmers spent Rs. 164.98 crores on biological inputs, and non-ZBNF farmers spent Rs. 469.3 crores on chemical inputs; therefore, it estimates that Rs. 300 crores are saved on nutrient inputs by the ZBNF farmers. Furthermore, they also evaluate a saving of Rs. 360 crores on paid-out costs and Rs. 593 crores higher returns for the ZBNF farmers as a result of a cut on agro-chemicals in the ZBNF programme. Extended at a state level, if the entire gross cropped area is brought into ZBNF, the study estimates a saving of Rs. 12,396.37 crore worth of agrochemicals. Besides, farmer saving is expected to be Rs. 8,038.5 crore in nutrient inputs and Rs. 9,504.27 crore in paid-out costs, which comes to 64.85 percent and 21.47 percent respectively as compared to the expenditure in the non-ZBNF approach.

5.2 Indian Council of Agricultural Research (ICAR)

ICAR-IIFSR, coordinated field research on "Evaluation of concoctions of Natural Farming in basmati rice-wheat system" over the last three years for evaluation and development of a protocol for ZBNF under the 'All India Network Programme on Organic Farming.' It conducted the field trial for rice (Basmati) and Wheat cropping system at four locations – Kurukshetra (Haryana), Ludhiana (Punjab), Pant Nagar (Uttarakhand), and Modipuram (UP) from Rabi 2017 to Kharif 2020. In Modipuram, Pantnagar, and Ludhiana, Basmati Rice-Wheat system was tested, whereas in Kurukshetra Coarse Rice-Wheat system was analyzed. They looked at the impact of different concoctions used in ZBNF – Beejamrita, Jeevamrutha, and Ghanjeevamrit on yield and cost of cultivation working on six treatments. The results were assessed on several parameters of which we collected information from IIFSR on three main parameters – yield, cost of cultivation and soil organic carbon at the end of two-year rice-wheat cycle.

ICAR has also established a committee under the chairmanship of V. Praveen Rao, Vice-Chancellor of Professor Jayashankar Telangana State Agricultural University to undertake a long-term experiment named 'Evaluation of Natural Farming Experiments in different Agro-ecology,' starting from Kharif-2020. The agenda is to study the viability of a completely characterized ZBNF package incorporating all the ZBNF practices recommended by Subhash Palekar's package, conducting ZBNF field trials at twenty locations (representing all the agricultural zones) across sixteen states and eight cropping systems. They are experimenting using nine treatments (**Table 5.3**) and assessing them on parameters like economics, growth and yield, carbon sequestration and Greenhouse gas emissions, shelf life of produce, soil microbial activity, fungal bacterial ratio, ecosystem services, energy analysis, physic-chemical, biological properties of soil including soil aggregate stability after each crop season.

Table 5.3: Treatments in the two ICAR programmes

Evaluation of concoctions of Natural Farming in basmati rice-wheat system	Evaluation of Natural Farming (NF) Experiments in different Agro-ecology
Control (No input addition except labour)	Control (No input addition except labour for weeding)
Gurukul package supplied by Gurukul (a privately owned farm on which IIFSR has been conducting experiments in Kurukshetra.	Complete NF (1. Beejamrit, Ghanjeevamrit, Jeevamrit 2. Crop residue mulching 3. Intercropping 4. Waaphasa)
All-India Network Programme for Organic Farming	NF without 1. (Beejamrit, Jeevamrit, Ghanjeevamrit)
Integrated Crop Management (50 percent of nutrient application through organic inputs and 50 percent nutrient application through chemical inputs)	NF without 2. (Crop residue mulching)
Locally Prepared Gurukul Products	NF without 3. (intercropping)
Location specific improved Gurukul products	NF without 4. (Waaphasa, irrigating in alternate rows during noon)
	All India-Network Programme for Organic farming
	ICM (+ some other inputs from IIFSR)
	ICM (50 percent nutrient application through organic manures, 50 percent through inorganic sources+ need based pesticides)

Source: Inputs from ICAR-IIFSR

The aforementioned methodologies of CESS and ICAR bring out the stark contrast in the approach used to analyse ZBNF adopted by the two institutions; while CESS is a field sample survey of ZBNF and non-ZBNF farmers growing major crops across the different districts of Andhra Pradesh, ICAR studies are field trials in a controlled environment to test the efficacy of

ZBNF inputs in exact proportion prescribed by Palekar. Now we analyze the findings of ICAR-IIFSR to understand the implications of ZBNF adoption from its perspective.

Findings

Empirical analysis on ZBNF package (including concoctions, intercropping, and mulching of crop residues) could provide only 39.51 percent of the nitrogen requirements of the plant; this value increased by 31.58 percent with addition of Azolla and farm yard manure – common practices adopted by some ZBNF farmers – still insufficient for the plant. Since doubling of inputs like urea doubled the yields during green revolution, ICAR makes an estimate that a nitrogen deficit of close to 50 percent would nearly reduce the yields to half of its current level, in India. Another important parameter of soil health is the organic carbon content, a system that improves the organic carbon content of the soil fares better in terms of environment sustainability. IIFSR study found that at the end of two-year rice-wheat cropping cycle, on an average organic carbon (in percent) of AI-NPOF Package (0.68) and Integrated Crop Management (ICM) (0.64) fared better than that using the treatment of Natural Farming Concoctions (NF Concoctions) (0.60). Moreover, organic carbon content of NF concoctions was no better than the Control treatment (0.60) (**Table 5.4**).

Table 5.4: Average organic carbon content (percent) at the end of 2 years (Rice-Wheat cropping cycle)

Treatment	Average organic carbon content in four locations* (in percent)
Control	0.60
NF Concoction	0.60
AI-NPOF	0.68
ICM	0.64
*4 locations are Modipuram, Pantnagar, Ludhiana, Kurukshetra	

Source: ICAR-IIFSR

Soil organic carbon is classified in to three categories namely low (<0.50 percent), Medium (0.50 to 0.75 percent) and High (>0.75 percent) and even a small improvement of 0.1 percent, in soil organic carbon takes years[9].

ICAR-IIFSR study has looked at the ZBNF from the sustainability angle which is possible only with scientific testing, and hence was missing from the economic research conducted by CESS. However, to compare the two studies, yield and profitability outcomes can be checked.

Farmers use Integrated Crop Management, a practice of meeting partial (50 percent) nutrient requirement of the plant through chemical inputs and the remaining (50 percent) through organic inputs. Hence, any comparison with ICM can serve as a comparison with conventional practices as it can be considered a close proxy of conventional practice in controlled environment. For the first year, IIFSR found the average yield for the four locations in case of

[9] Inputs from ICAR-IIFSR

ZBNF system to be 19.9 percent lesser than ICM for basmati and coarse rice and 46.3 percent lesser than ICM for wheat; this difference expanded further in the second year by 37 percent in case of rice and 53.9 percent for wheat (**Table 5.5**).

Table 5.5: Average yield per hectare in case of ZBNF and ICM system for rice and wheat

	2018-19 (for Rice) and 2017-18 (for wheat)			2019-20 (for Rice) and 2018-19 (for wheat)		
	NF concoctions	ICM	Percent change in Yield in NF compared to ICM	NF concoctions	ICM	Percent Change in Yield in NF compared to ICM
Basmati Rice and Coarse Rice	3429	4279	-19.9	2138	3391	-37.0
Wheat	2469	4602	-46.3	2026	4393	-53.9

Source: ICAR – IIFSR

Moreover, for a country wide expansion according to the findings of the three-year experiment, ICAR-IIFSR estimated a decline of production by 59 percent in the case of wheat and 32 percent in case of Basmati rice/coarse rice in ZBNF in comparison to Integrated Crop Management if ZBNF is adopted at a large scale (**Table 5.6**).

Table 5.6: Expected impact following large-scale adoption of ZBNF on production of basmati rice and wheat in India

Crop	Area (MH)	Production (MT)	Yield (kg/ha)	Yield (ZBNF)	Expected production with ZBNF(MT)	Change (percent)
Basmati	1.51	5.31	3507	2377	3.6	-32
Wheat	30.60	98.38	3216	1313	40.18	-59

Source: ICAR-IIFSR

Total cost of cultivation in natural farming concoction treatment was 22.6 percent lower than ICM for basmati rice and 18.2 percent lower than the ICM in case of Wheat (**Error! Reference source not found.**).

While ZBNF gave Rs. 41,022 per hectare, ICM returns on an average were Rs. 96,526 per hectare (
). This difference resulted in the returns fetched by ZBNF crop on an average to be 58 percent lower than ICM in the basmati-rice wheat system[10]. The primary reason for such low returns is lower yield in ZBNF. Premium price is received only on certified organically farmed products; ZBNF are not certified. Even if they were certified, a 5-20 percent higher price received with

[10] Inputs from IIFSR study findings.

certification would be insufficient to compensate for the lower yields resulting in lower returns, especially in under irrigated areas.[11]

Table 5.7: Cost of cultivation (Rs/hectare)

Crop	Integrated Crop Management	ZBNF concoction	Change over ICM (percent, +/-)
Basmati rice	55,286	42,765	-22.6
Wheat	35,856	29,335	-18.2

Source: ICAR-IIFSR

*Data collected for three rabi and kharif seasons – 2017 / 2018 / 2019 (wheat and Basmati Rice)
**50 percent organic & 50 percent inorganic or synthetic fertilizer used

Table 5.8: Average net return (Rs. Per hectare) from NF concoctions and ICM

	NF concoctions	ICM
Net Return	41,022	96,526

Source: ICAR-IIFSR

Productivity is an important determinant of food security; however, the ICAR study depicts an unfavorable picture of crop productivity after the ZBNF adoption, raising concerns for the national food security. The Committee set up to evaluate the completely characterized ZBNF package in different agro-ecology systems, for Kharif 2020 onwards, gives a preliminary estimate of the impact of ZBNF on the food security. As doubling of nitrogenous inputs like urea, during the green revolution doubled the yields and food output, a nitrogen deficit close to 52 percent emanating from the ZBNF will translate into 50 percent decline in the food output besides mining of native soil nutrients, bearing a direct impact on the food security of the country. Following the three-year study, ICAR-IIFSR concludes that ZBNF will especially reduce the output of highly-productive systems as the practices like intercropping reduce the scope of mechanization.

The ICAR-IIFSR results, quite contrary to CESS-IDSAP consolidated study reveal a threat to the sustainability of soils, yield, profitability as well as food security. Irrespective of the results evident from the three-year testing of concoctions, IIFSR posits the need of long-term testing before concluding about the practice. It is also undertaking a long-term study at twenty locations covering sixteen states and eight cropping systems, with complete characterization of ZBNF inputs adopting every practice suggested by Subhash Palekar in his package to check its validity. However, with the current findings it suggests that the components of natural farming such as Beejamrit, Jeevamrit and Ghanjeevamrit can be promoted for improving the soil productivity and sustainability in agriculture, but not as a substitute to fertilizers; intercropping and mulching are scientifically proven practices for all types of farming such as chemical, organic, and natural farming, thus should not be restricted to natural farming. The information available in the public domain that one cow is enough for 30 acres under ZBNF is not practiced

[11] Inputs from IIFSR Scientists

by any of the farmers who follow ZBNF[12]. However, there is a need for a science-based evidences and validation using multi-location, multi commodity through a network programme for ZBNF.

Impact of adopting ZBNF/SPNF on a large scale[13]

Ensuring self-sufficiency in basic food staples has always been a vital objective of the agricultural policy makers. Rising population along with economic growth and expanding pace at which urbanisation is taking place, the demand for food grains has been rising steadily. According to a study by International Food Policy Research Institute (IFPRI), the food grains demand for human consumption to 2030 is projected to be in the range of 267-272 MT – 116 MT rice, 101-104 MT of wheat, 28 MT of coarse grains and 22-23 MT of pulses (Kumar & Joshi, 2016).

This surge in consumption requires an equivalent effort towards improving production as well nutrient value of the produce. NAAS in its communication to Prime Minister Narendra Modi on ZBNF, September 2019, has already put forward the concerns of ZBNF/SPNF not being able to meet the future needs by pointing out the following:

- If all the production zones of country were to adopt ZBNF with traditional varieties, there would be a significant drop in food grain production. Consequently, there will be significant food shortages. Further, traditional varieties under low nutrient inputs like ZBNF can result in per unit area productivity decline driven by low nutrient uptake-led.

- ZBNF bans the usage of high-yielding seeds, without considering that traditional seeds are low in productivity potential as well as in nutrient potential. For instance, traditional wheat seed variety yields less than two tonnes per hectare and less than 200-250 kg of proteins per hectare under ZBNF, which in the case of improved wheat varieties grown under recommended dose of fertilizers produces 450-700 kg per hectare proteins.

- Hence, NAAS suggests that to overcome hunger, starvation, stunting, and anaemia in Indian citizens especially women, the nutrient supply cannot be compromised. At the same time, it is not wise to invest resources in promoting ZBNF, which is technically infeasible and unscientific.

Using the ICAR-IIFSR estimate of 59 percent decline in yield for wheat and 32 percent reduction for Basmati rice, if ZBNF is adopted at a large scale; we have estimated a possible change in production of these crops critical for India's food security system, if ZBNF is adopted on 30 percent of area, 50 percent of area and 100 percent of area.

The Inter-ministerial Committee on Doubling Farmers' Income chaired by Ashok Dalwai, in its report, has projected an increase in output of cereals, pulses, oilseeds, and other crops (**Table 5.9**).

[12] Inputs from ICAR-IIFSR
[13] Author's own computation based on the yield results provided by IIFSR.

Table 5.9: Projected Demand of major food commodities in India (in million tonnes)

Commodities	2030	2050
Cereals	284	359
Pulses	26.6	46
Edible oil	21.3	39
Fruits	103	305
Vegetables	192	342

Source: Inter-minister Committee on Doubling Farmers' Income, 2018

The following two tables (**Table 5.10** & **Table 5.11**) indicate the average yield, production, and area under cultivation of the rice and wheat during 2015-16 to 2019-20 in the country. These would help us projecting a possible scenario where the farmers adopt SPNF in 30 percent, 50 percent, and 100 percent of the net sown area of basmati rice and wheat. Since basmati rice's area, production, and yield data are not available; we have used the 2018-19 data provided by IIFSR.

Table 5.10: Basmati Rice: Area (million hectare), Production (million tonne) & Yield (kg/hectare) (2018-19)

Area (MH)	Production (MT)	Yield (kg/ha)
1.51	5.31	3507

Source: Data shared by IIFSR

Table 5.11: Wheat: Area (million hectare), Production (million tonne) & Yield (kg/hectare)

Year	Area (Million hectare)	Production (million tonne)	Yield (kg/hectare)
2015-16	30.42	92.29	3034
2016-17	30.79	98.51	3200
2017-18	29.65	99.87	3368
2018-19	29.32	103.6	3533
2019-20	31.45	107.59	3421
Average	30.3	100.4	3311.2

Source: Agricultural Statistics at a glance, 2020

As evident from the tables (**Table 5.12** & **Table 5.13**), the possible impact on the foodgrains would be huge if all the net sown areas under wheat and rice adopt SPNF practices. Even 50 percent of the areas of basmati rice and wheat shift to SPNF, there would be decline of more than 16.16 percent & 29.5 percent respectively if we consider average output during FY16-FY20 (**Table 5.11**). This would impact India's self-sufficiency in foodgrains achieved through sustained efforts by government, scientists, and farmers.

Table 5.12: Possible implications on the Basmati Rice production (if ZBNF is adopted in large scale)

Possible scenario	Likely overall production (Million tonne)	Likely decline in production comparison to conventional chemical-based faming (percent)
S-1 30 percent of cropped area under ZBNF, rest under the conventional chemical-based farming	107.31	9.7
S-2: 50 percent of cropped area under ZBNF, rest under the conventional chemical -based farming	99.66	16.1
S-3: 100 percent of cropped area under ZBNF, rest under the conventional chemical-based farming	80.52	32.2

Yield & production is arrived taking into account average output/yield between (FY16-FY20)

Table 5.13: Possible implications on the Wheat production (if ZBNF is adopted in large scale)

Possible scenarios	Likely overall production (Million tonne)	Likely decline in comparison to conventional chemical-based faming (percent)
S-1: 30 percent of cropped area under ZBNF, rest under the conventional chemical-based farming	82.61	17.7
S-2: 50 percent of cropped area under ZBNF, rest under the conventional chemical-based farming	70.77	29.5
S-3: 100 percent of cropped area under ZBNF, rest under the conventional chemical-based farming	41.17	59.0

Yield & production is arrived taking into account average output/yield between (FY16-FY20)

6

Conclusions and Policy Recommendations

The sheer disparity in the outcomes of the two experiments conducted by CESS-IDSAP and ICAR-IIFSR suggests the importance of long-term experimentation before declaring this as a nationwide agriculture practice. If the yield and production plummet, as the ICAR-IIFSR findings advocate, the implications for food security can be severe. Naturally obtained inputs like cow dung, cow urine, leaves, etc. are without any reservation sustainable alternatives to the chemical inputs which have destroyed nature's inherent ability to rejuvenate the soil. If the yields improve as they seem to have in Andhra Pradesh, then a shift to natural farming can turn out to be a revolutionary change.

Genetically modified seeds have become prominent in crop like cotton. They have reduced pesticides and herbicides use to these disease resistant varieties. In crops like wheat and rice, high yielding varieties dominate. But ZBNF discards genetically modified as well as high yielding variety seed technology and insists on going back to the basics and using indigenous seeds. The question that warrants attention before declaring ZBNF as a national practice is whether the old technology can sustain the higher yields? Or will the yields plummet to intolerable pre-green revolution era levels? The policy decision also stands on the question - whether traditional seeds can satiate the nutrition requirements of the country struggling with food insecurity? Or rather, they will improve the yields, instead?

Labour is not available free of cost; even family labour bears an opportunity cost. Thus, we also need more information on the use of family labour; it is unclear whether the Andhra Pradesh CESS-IDSAP studies incorporate family labour in the imputation. Interviews of farmers suggested that many farmers left the practice. Hence a close monitoring and protocol system is needed to address the questions raised on the efficacy of the ZBNF practice and the possible negative implications which might arise if IIFSR results turn out to be true. It requires more data analysis and a third-party commentary on the success or failure of the practice.

So long as the practice is voluntary and not state-funded, it is acceptable. If the government funds without appropriate testing and the outcomes turn unfavourable, it will imperil the nation's well-being and stability and fiscal health. So far, chemical fertilizers, especially urea, have been hugely subsidized as they helped give higher yields and feed the nation. What we would suggest is to create crop neutral incentive structures. What this means is that farmers be given support directly into their bank accounts on per hectare basis (direct income/investment support). And let the prices of chemical fertilizers be determined by free play of markets. And let farmers choose the crops and farming practices that suit them most. That way, those who want to practice ZBNF will not be discriminated against. In fact, this DBT should also apply to power subsidy at the state level, or any other subsidies that Centre or states want to give to farming community. Right now, chemical fertilizers are excessively subsidized leading to their imbalanced use, and therefore adverse impact on environment. Much of this can be reduced/eliminated by creating crop-neutral incentive structures.

Thus, we recommend the subsidy system to be a Direct Benefit Transfer on a per hectare basis instead. The soaring fertilizer prices indicate that the fertilizer subsidy had already crossed Rs. 100 thousand crores and may cross even Rs 200,000 crores in 2023-24. As India has a gross cropped area of roughly 200 million hectares, a simple calculation suggests that direct benefit

transfer could be minimum of Rs. 5000/ha and maximum of Rs 10,000/ha. Giving all farmers an amount irrespective of the farming practice can give them leverage on results, as this way, they could choose the most beneficial practice for them.

We do not discard the potential of ZBNF or BPKP in the longer run, especially when favorable outcomes are evident in Andhra Pradesh. Since scientists are apprehensive of the impact ZBNF concoctions can pose on the environment and output sustainability, we need long-term research and third-party surveillance on the methodology adopted in Andhra Pradesh before amplifying the Andhra Pradesh experiment across all the states. Moreover, the Sri Lankan crisis acts as a lesson for the entire world to take preparatory actions like educating the farmers and consumers about the likely impact of the switch: creating adequate infrastructure such as availability of inputs for the new farming method and maintenance of supply chains before banning the utilization of inorganic fertilizers; and spreading awareness among the populace about the potential benefits (Nulkar, 2021).

Based on the study's findings, we make the following policy suggestions before the government mandates ZBNF as a national farming practice.

1. Need for a long-term experimentation before suggesting ZBNF as a national level agriculture practice

The fact that the two studies present diverging outcomes regarding ZBNF is sufficient to highlight that we need long-term testing (for a decade at least) to evaluate the efficacy and validity of the practice. The agriculture ministry affiliated National Centre of Organic Farming could play a vital role in developing a scientifically valid protocol for ZBNF. ICAR-IIFSR has begun testing the complete characterization of ZBNF inputs in twenty locations, sixteen states, and eight cropping systems from Kharif 2020 onwards. A rigorous assessment and ICAR-approved protocol are essential before announcing ZBNF as a nationwide agricultural practice, as its consequences remain ambiguous as of now.

2. Need for a database and monitoring of the practitioners

At present, there is no official database on the state-wise number of ZBNF or BPKP practitioners. There is no close monitoring of the farmers to analyze their long-term response to natural farming - no record of the farmers discussing whether they increased the area devoted to natural farming, reduced it, or gave up the practice due to some reason. According to some farmer leaders in Andhra Pradesh, the entire movement is a farce; few farmers who opted for it significantly reduced the land size devoted to it, and primarily grew crops using natural farming for subsistence needs. In the absence of official data or regular monitoring by a third party, analyzing the actual impact and assessing the outreach of ZBNF becomes a cumbersome task.

3. Making subsidy crop neutral and farming practice neutral

Every year government transfers a large share of its budgetary allocation to the pockets of fertilizer companies in the form of fertilizer subsidies. Heavy fertilizer subsidy that is too skewed

towards urea has resulted in increased nitrogen concentration in the soils. At the same time, it has brought about other nutrient deficiencies as the absence of any nutrient does not allow other nutrients to express themselves. Thus, controlling environmental degradation necessitates rationalizing the usage of fertilizers and thereby the rationalization of the fertilizer subsidy regime. The study estimates an amount of Rs. 5000 to Rs 10,000 per hectare of direct benefit transfer to the farmer considering the anticipated increase in the allocation for fertilizer subsidy due to the expected rise in the prices of urea. The transfer of subsidy directly into the bank accounts of farmers will allow the farmers to have freedom of choosing a farming practice and thereby making subsidy farming-practice neutral and crop-neutral. As prescribed by (Gulati & Banerjee, Fertilizer Pricing and Subsidy in India, 2018) the amount should be revised frequently to adjust it according to the current and forecasted fertilizer prices.

4. Strengthening the input supply chain

While organic farming and related practices like natural farming are successful in niche markets where a premium price can compensate for the returns from lower yields, a complete switch to organic approaches can hamper national food production. Resilient supply chain networks for the farm inputs required in natural farming are a prerequisite to transitioning towards natural farming.

References

- Bharucha, Z. P., Sol, B. M., & Pretty, J. (2020). Towards redesign at scale through zero budget natural farming in Andhra Pradesh. *International Journal of Agricultural Sustainability* .
- Bhattacharya, R., Ghosh, B. N., Mishra, K. P., Mandal, B., Rao, C. S., Sarkar, D., et al. (2015). Soil Degradation in India: Challenges and Potential Solutions. *Sustainability* , 3528-3570.
- Carberry, P. (2019). Can India's Success in agriculture Benefit Africa? *NAAS Foundation Day Lecture* .
- CESS. (2019). *Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh - Kharif 2018-19.* Begumpet: Centre for Economic and Social Studies.
- CESS. (2019). *Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh - Rabi 2018-19.* Begumpet: Centre for Economic and Social Studies.
- CLEAR Center. (2020, June 26). *Using Global Emission Statistics is Distracting Us From Climate Change Solutions*. Retrieved from UC Davis. Clarity and Leadership for Environmental Awareness and Research at UC Davis: https://clear.ucdavis.edu/explainers/using-global-emission-statistics-distracting-us-climate-change-solutions
- Climate Resilient Zero Budget Natural Farming (CRZBNF) Is this 'Exclusivity' & Nomenclature justified in a Government Scheme. (2018, September 24). *CRZBNF: Issues, Concerns and Questions, Letter to RySS* . Andhra Pradesh, India.
- Das, V. K. (2019, July 6). How Seriously Should We Take Sitharaman's Idea of Zero Budget Farming? *The Wire* .
- DES. (2017-18). Estimates of cost of production/ cultivation and related data. New Delhi: Department of Economics and Statistics, Government of India.
- DoA, H.P. (n.d.). *Four Wheels of SPNF*. Retrieved August 20, 2021, from Subhash Palekar Natural Farming, Prakritik Kheti Khushal Yojana, State Project Implementation Unit: https://spnfhp.nic.in/SPNF/en-IN/input_preparations.aspx
- FAI. (2019-20). *65th Annual Report 2019-20.* New Delhi: The Fertilizer Association of India.
- FAI. (2020). *Executive Summary.* New Delhi: Fertilizer Association of India.
- FAO. *52 Profiles on Agroecology: Zero Budget Natural Farming in India.* Food and Agriculture Organisation.
- GoI. (2018). *Economic Survey 2017-18.* New Delhi: Department of Economic Affairs, Ministry of Finance, Government of India.
- GoI. (2019). *Economic Survey 2018-19.* New Delhi: Department of Economic Affairs, Ministry of Finance, Government of India.
- GoI. (2020). *Economic Survey 2019-20.* Ministry of Finance, Government of India.
- GoI. (2022). *Speech of Nirmala Sitharaman - Minister of Finance.* Government of India.
- Department of Economic Affairs, Ministry of Finance, Government of India.
- Government of Himachal Pradesh. (2018, May). Guidelines for Implementation of "Prakritik Khel Khushhal Kissan Scheme" in Himachal Pradesh. Shimla, Himachal Pradesh, India: Department of Agriculture.

- Govt. should stop promoting zero budget natural farming pending proof: scientists. (2019, September 11). *The Hindu* .
- Gulati, A., & Banerjee, P. (2018). Fertiliser Pricing and Subsidy in India. In A. Gulati, M. Ferroni, & Y. Zhou, *Supporting Indian Farmers the Smart Way* (pp. 91-147). Academic Foundation.
- Gulati, A., & Banerjee, P. (n.d.). Fertilizer Sector in India. *Unpublished* .
- Gulati, A., & Banerjee, P. (2019). Rejuvenating Indian Fertilizer Sector. *Preprints of Seminar Papers - 2019* .
- Gupta, N., Pradhan, S., Jain, A., & Patel, N. (2021). *Sustainable Agriculture in India 2021: What we know and How to Scale up.* New Delhi: Council of Energy, Environment and Water.
- Gupta, N., Tripathi, S., & Dholakia, H. H. (2020). *Can Zero Budget Natural Farming Save Input Costs and Fertilizer Subsidies?* New Delhi: Council on Energy, Environment and Water.
- IANS. (2022, April 25). UP to promote natural farming in a big way. *The Statesman*. Retrieved from https://www.thestatesman.com/uttar-pradesh/promote-natural-farming-big-way-1503064403.html
- ICAR. (2021, July 26). *Kisan Gosthi*. Retrieved from ICAR - Central Institute for Subtropical Horticulture: http://cish.res.in/kisan.php
- IDSAP. (2020). *Impact Assessment of APCNF - Kharif 2019-20 Report.* Visakhapatnam: Institute for Development Studies, AP.
- IDSAP. (2021). *Impact Assessment of APCNF Consolidated 2019-20 Report.* Visakhapatnam: Institute for Development Studies AP.
- IDSAP. (2020). *Impact Assessment of APCNF-Rabi 2019-20 Report.* Visakhapatnam: Institute for Development Studies Andhra Pradesh.
- India.com Business Desk. (2022, April 26). Farmers To Get Rs 900 Per Month In Madhya Pradesh | Complete Details Here. *india.com*. Retrieved from https://www.india.com/business/farmers-to-get-rs-900-per-month-in-madhya-pradesh-chief-minister-shivraj-singh-chouhan-complete-details-here-5358697/
- Jadhav, R. (2021, May 10). Doubling farmers' income: It's still a long road ahead. *The Hindu Business Line* .
- Jain, A. (2022, February 24). PM Modi in his address to National Conclave on Natural Farming 2021 (TOI, 2021), said,. *Indian Express*. Retrieved from https://indianexpress.com/article/opinion/columns/roadmap-for-india-natural-farming-ambitions-nirmala-fm-budget-7788054/
- Khadse, A., & Rosset, P. M. (2019). Zero Budget Natural Farming in India - from Inception to Institutionalisation. *Agroecology and Sustainable Food Systems* , 848-871.
- Khadse, A., Rosset, P. M., Morales, H., & Ferguson, B. G. (2017). Taking Agroecology to Scale: the Zero Budget Natural Farming peasant movement in Karnataka. *Journal of Peasant Studies* .
- Khurana, A., & Kumar, V. (2020). *State of Organic and Natural Farming in India: Challenges and Possibilities.* New Delhi: Centre for Science and Environment.
- Kumar, P., & Joshi, P. K. (2016). Food demand and supply projections to 2030: India. In *International trade and food security: The future of Indian agriculture* (pp. Chapter 4, 29-63). CABI.
- Kumar, R. (2019, April 25). Opportunity waits for no one. *Business Standard* .

- Kumar, R., Kumar, S., Yashvanth, B., Meena, P., Indoria, A., Kundu, S., et al. (2020). *Adoption of Natural Farming and its Effect on Crop Yield and Farmers' Livelihood in India.* Hyderabad: ICAR-National Academy of Agricultural Research Management.
- Kumar, T. V. (n.d.). A.P– a plan for sustained well being and prosperity of all farmers in the state. Andhra Pradesh, India: Agriculture Government of Andhra Pradesh.
- Kumar, T. V. (2018, November 26). Letter responding to specific points.
- Mishra, S. (2018). Zero Budget Natural Farming: Are this and the similar practices the answers? *Working Paper No.70* .
- MoA&FW. (2019). *Agricultural Statistics at a Glance.* New Delhi: Directorate of Economic Statistics, Department of Agriculture Cooperation & Farmers Welfare, Ministry of Agriculture and Farmers Welfare.
- MoA&FW. (2020). *Agricultural Statistics at a Glance.* New Delhi: Directorate of Economic Statistics, Department of Agriculture Cooperation & Farmers Welfare, Ministry of Agriculture and Farmers Welfare.
- MoAFW. (2021). *Lok Sabha Unstarred Question No. 3645 - Zero Budget Natural Farming.* Lok Sabha. New Delhi: Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation And Farmers Welfare, Government of India.
- MoAFW. (2019). *Lok Sabha Unstarred Question No. 5011 - Zero Budget Natural Farming.* New Delhi: Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Government of India.
- MoC&F. (2021-22). Notes on Demand for Grants, 2021-2022. *Demand no.6* . India: Department of Fertilizers, Ministry of Chemicals and fertilizers. Retrieved August 6, 2021, from https://www.indiabudget.gov.in/doc/eb/sbe6.pdf
- MoF. (July 5, 2019). *Budget 2019-20: Speech of Nirmala Sitharaman.* New Delhi: Ministry of Finance, Government of India.
- MoF. (Feb 1, 2020). *Budget 2020-21.* New Delhi: Ministry of Finance, Government of India.
- Munster, D. (2018). Performing alternative agriculture: critique and recuperation in Zero Budget Natural Farming, South India. *Journal of Political Ecology , 25*, 749-764.
- NAAS. (2019, September). Communication to Prime Minister on ZBNF. *[Letter]* . India: National Academy of Agricultural Sciences.
- NAAS. (2019). *Zero Budget Natural Farming- A Myth or Reality? Policy Paper No. 90.* New Delhi: National Academy of Agricultural Sciences.
- Narayanamoorthy, A. (2019, September13). Is zero budget natural farming working? *The Hindu business line* .
- Nordhaus, T., & Shah, S. (2022, March 5). In Sri Lanka, Organic Farming Went Catastrophically Wrong. *FP*. Retrieved from https://foreignpolicy.com/2022/03/05/sri-lanka-organic-farming-crisis/?msclkid=3ed941c8cf8811ec95528ef6db9347c8
- Nulkar, G. (2021, September 22). Sri Lanka's organic farming crisis: Learning from failures. *Down to Earth*. Retrieved from https://www.downtoearth.org.in/blog/agriculture/sri-lanka-s-organic-farming-crisis-learning-from-failures-79138?msclkid=b18fa831cf8611ec9c5430b150ec7336
- Pandey, S. (2021, September 5). How Sri Lanka's overnight flip to total organic farming has led to an economic disaster. *The Print*. Retrieved from https://theprint.in/world/how-sri-lankas-overnight-flip-to-total-organic-farming-has-led-to-an-economic-disaster/728414/?msclkid=e27c8113cf8c11ec94bf69c41b1c7328

- PIB. (2018, August 10). Promotion of Zero Budget Natural Farming. New Delhi, India: Ministry of Agriculture & Farmers Welfare, Government of India. Press Information Bureau. Retrieved from https://pib.gov.in/PressReleasePage.aspx?PRID=1542615
- PIB. (2019, July 23). Zero Budget Farming. New Delhi, India: Ministry of Agriculture and Farmers Welfare, Government of India. Press Information Bureau. Retrieved from https://pib.gov.in/Pressreleaseshare.aspx?PRID=1579906
- PIB. (2019, November 22). Zero Budget Natural Farming. New Delhi, India: Ministry of Agriculture and Farmers Welfare, Government of India. Press Information Bureau. Retrieved from https://pib.gov.in/PressReleseDetailm.aspx?PRID=1593123
- PTI. (2022, April 14). Niti Aayog working on road map to develop Gaushala economy. *The Print*. Retrieved from https://theprint.in/economy/niti-working-on-gaushala-economy-to-address-stray-cattle-issue-says-its-member/916367/?msclkid=dffa0ea7d03011ecb53da0fcdfea6d76
- Raghuram, N. Zeroing in on farm budgets or zero budget natural farming? *Perspectives. UN environment programme* (37).
- Rao, L. (2019, August 21). Workshop on ZBNF. National Academy of Agricultural Sciences.
- Saldhana, L. F. (2018). *A Review of Andhra Pradesh's Climate Resilient Zero Budget Natural Farming Programme.* Bangalore: Environment Support Group.
- Sharma, Y. S. (2022, Jan 27). Niti Aayog working on road map to develop Gaushala economy. *The Economic Times*. Retrieved from https://economictimes.indiatimes.com/news/economy/policy/niti-aayog-working-on-road-map-to-develop-gaushala-economy/articleshow/89145535.cms?msclkid=8ac942f7d03211ec9794db7ceb84473d
- Staff Reporter. (2020, January 9). Govt. inks pact with KfW on Zero Budget Natural Farming. *The Hindu* .
- Staff Reporter. (2022, April 26). MP Natural Agriculture Devp Board constituted. *the pioneer*. Retrieved from https://www.dailypioneer.com/2022/state-editions/mp-natural-agriculture-devp-board-constituted.html?msclkid=e3b22f96cd1c11ec92b7666de8b53445
- The Wire Staff. (2019, September 10). Narendra Modi Announces in India's Land Restoration Target at UN Conference. *The Wire* .
- The World Bank. (2014, March 19). Promote Environmentally Sustainable Agriculture. Retrieved July 8, 2021, from https://www.worldbank.org/en/topic/agriculture/brief/promote-environmentally-sustainable-agriculture
- TOI. (2021, December 16). Time to act now before farming issues become severe: PM Modi. *The Times of India*. Retrieved from https://timesofindia.indiatimes.com/india/time-to-act-now-before-farming-issues-become-severe-pm-modi/articleshow/88316117.cms
- Veluguri, D., Bump, J. B., Venkateshmurthy, N. S., Mohan, S., Pulugurtha, K. T., & Jaacks, L. M. (2021). *Agroecology and Sustainable Food Systems , 45* (6), 907-930.
- Venkateswarlu, B., & Prasad, J. (2012). Carrying capacity of Indian agriculture: issues related to rainfed agriculture. *Current Science , 102* (6), 882-888.
- Vijaykumar, T. (2021, August 18). Watch | How Andhra wants to convert to 100% natural farming by 2027. (T. Vivek, Interviewer) The Hindu Business Line.

NATIONAL BANK FOR AGRICULTURE AND RURAL DEVELOPMENT
Plot No. C-24, 'G' Block, Bandra Kurla Complex Rd, Bandra East, Mumbai, Maharashtra 400051

INDIAN COUNCIL FOR RESEARCH ON INTERNATIONAL ECONOMIC RELATIONS
Core 6A, 4th Floor, India Habitat Center, Lodhi Road, New Delhi 110003