Can Zero Budget Natural Farming Save Input Costs and Fertiliser Subsidies?

Evidence from Andhra Pradesh

Niti Gupta, Saurabh Tripathi, and Hem H. Dholakia

Report | January 2020

CEEW's Niti Gupta talking to farmers near Guntur district, Andhra Pradesh, to understand their natural farming practices for designing this study.

Images: Saurabh Tripathi/CEEW

Can Zero Budget Natural Farming Save Input Costs and Fertiliser Subsidies?

Evidence from Andhra Pradesh

Niti Gupta, Saurabh Tripathi, and Hem H. Dholakia

Report
January 2020
ceew.in

Suggested citation: Gupta, Niti, Saurabh Tripathi, and Hem Himanshu Dholakia. 2020. *Can Zero Budget Natural Farming Save Input Costs and Fertiliser Subsidies? Evidence from Andhra Pradesh*. New Delhi: Council on Energy, Environment and Water.

Cover image: Niti Gupta, CEEW

Peer reviewers: Prof. Ravindra Dholakia, IIM Ahmedabad; Prof. Varsha Khandker, IIM Nagpur; Abhishek Jain, Senior Programme Lead, CEEW; and Vaibhav Chaturvedi, Research Fellow, CEEW.

Publication team: Alina Sen (CEEW), Mihir Shah (CEEW), The Clean Copy, Aspire Design, and Friends Digital.

Organisations: The **Council on Energy, Environment and Water** is one of South Asia's leading not-for-profit policy research institutions. The Council uses data, integrated analysis, and strategic outreach to explain and change the use, reuse, and misuse of resources. It prides itself on the independence of its high-quality research, develops partnerships with public and private institutions and engages with the wider public. In 2019, CEEW has once again been featured across nine categories in the *2018 Global Go To Think Tank Index Report*. It has also been consistently ranked among the world's top climate change think tanks. Follow us on Twitter @CEEWIndia for the latest updates.

Vijayavahini Charitable Foundation - Supported by Tata Trusts is a Sec-8 Company, established in May 2017. It is a non-profit, non-political and secular organization, working for the development of the poor, especially the deprived and marginalized sections, irrespective of religion, race, caste or creed. The focus areas of VCF include education, skill development, rural-upliftment, capacity building, relief of the poor, medical relief, yoga, preservation of the environment (including watersheds, forests and wildlife), preservation of monuments or places or objects of artistic or historic interest. Currently, VCF is undertaking multi-thematic interventions across the states Andhra Pradesh & Telangana.

The **Sustainable India Finance Facility (SIFF)** is a path-breaking initiative to enable and generate space for key stakeholders from the government, private sector, development partners and research institutions to foster an environment where innovative sustainable finance can be a tool for the country to meet its development and climate targets. The SIFF leverages 'private finance for public good' through long-term loans and/or grants directed at sustainable rural development, poverty alleviation, renewable energy access and inclusive growth. SIFF activities are impact focused ensuring there is improvement in well-being of marginalized communities, including women and vulnerable populations, resulting in large-scale positive change in India.

Council on Energy, Environment and Water
Sanskrit Bhawan, A-10 Qutab Institutional Area,
Aruna Asaf Ali Marg, New Delhi - 110067, India

About CEEW

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

In 2019, CEEW once again featured extensively across nine categories in the *2018 Global Go To Think Tank Index Report*, including being ranked as South Asia's top think tank (15th globally) with an annual operating budget of less than USD 5 million for the sixth year in a row. CEEW has also been ranked as South Asia's top energy and resource policy think tank in these rankings. In 2016, CEEW was ranked 2nd in India, 4th outside Europe and North America, and 20th globally out of 240 think tanks as per the ICCG Climate Think Tank's standardised rankings.

In nine years of operations, The Council has engaged in over 230 research projects, published over 160 peer-reviewed books, policy reports and papers, advised governments around the world nearly 530 times, engaged with industry to encourage investments in clean technologies and improve efficiency in resource use, promoted bilateral and multilateral initiatives between governments on 80 occasions, helped state governments with water and irrigation reforms, and organised nearly 300 seminars and conferences.

The Council's major projects on energy policy include India's largest multidimensional energy access survey (ACCESS); the first independent assessment of India's solar mission; the Clean Energy Access Network (CLEAN) of hundreds of decentralised clean energy firms; the CEEW Centre for Energy Finance; India's green industrial policy; the USD 125 million India-U.S. Joint Clean Energy R&D Centers; developing the strategy for and supporting activities related to the International Solar Alliance; designing the Common Risk Mitigation Mechanism (CRMM); modelling long-term energy scenarios; energy subsidies reform; energy storage technologies; India's 2030 Renewable Energy Roadmap; energy efficiency measures for MSMEs; clean energy subsidies (for the Rio+20 Summit); *Energy Horizons*; clean energy innovations for rural economies; community energy; scaling up rooftop solar; and renewable energy jobs, finance and skills.

The Council's major projects on climate, environment and resource security include advising and contributing to climate negotiations in Paris (COP-21), especially on the formulating guidelines of the Paris Agreement rule-book; pathways for achieving Nationally Determined Contributions (NDCs) and mid-century strategies for decarbonisation; assessing global climate risks; heat-health action plans for Indian cities; assessing India's adaptation gap; low-carbon rural development; environmental clearances; modelling HFC emissions; the business case for phasing down HFCs; assessing India's critical minerals; geoengineering governance; climate finance; nuclear power and low-carbon pathways; electric rail transport; monitoring air quality; the business case for energy efficiency and emissions reductions; India's first report on global governance, submitted to the National Security Adviser; foreign policy implications for resource security; India's power sector reforms; zero budget natural farming; resource nexus, and strategic industries and technologies; and the Maharashtra-Guangdong partnership on sustainability.

The Council's major projects on water governance and security include the 584-page *National Water Resources Framework Study* for India's 12th Five Year Plan; irrigation reform for Bihar; *Swachh Bharat*; supporting India's *National Water Mission*; collective action for water security; mapping India's traditional water bodies; modelling water-energy nexus; circular economy of water; participatory irrigation management in South Asia; domestic water conflicts; modelling decision making at the basin-level; rainwater harvesting; and multi-stakeholder initiatives for urban water management.

Acknowledgments

First and foremost, we would like to thank Vijayavahini Charitable Foundation – Supported by Tata Trusts for their financial support and valuable comments on the report. Sincere thanks to T. Vijay Kumar, Satya Tripathi, Naveen Chand, G. Murlidhar, Kaavya Varma, and Todd Rosenstock for their valuable inputs that helped strengthen the report. We would also like to thank Chakali Manohar and Gopi Chand from Rythu Sadhikara Samstha (RySS) for their constant support throughout the project. Our thanks to Rajyalakshmi as well for helping us conduct the enumerators' training. We also express our gratitude to Sai Nellore Kishore from Sustainable India Finance Facility for his support in conducting the focus group discussions. We thank the peer reviewers of this document for their critical feedback and comments that have helped in improving the report.

The authors extend immense gratitude to Abhishek Jain for his constant guidance throughout the study and his critical feedback on the content and structure of the report, Sunil Mani for his support in data cleaning and analysis, and Arnab Laha for sharing his expertise in designing and improving the research methodology.

We are grateful to all the stakeholders from the fertiliser and pesticide industry who participated in the interviews and shared their thoughts on natural farming practices. We also thank Srinivasan Rao, of the Fertiliser Wing, Department of Agriculture, Government of Andhra Pradesh, for providing us with the data on fertilisers and sharing his valuable insights, which helped us understand the fertiliser subsidy mechanism.

The authors

Niti Gupta
niti.gupta@ceew.in

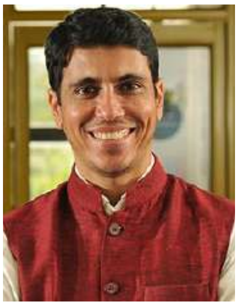
Niti is a Research Analyst who works on sustainable agriculture. Her work at The Council centres on the assessment and scaling up of sustainable agricultural practices, tackling crop-residue burning in Punjab by promoting conservation agriculture for stubble management. Niti holds a master's degree in Development Studies, with a major in Economics of Development from the International Institute of Social Sciences (ISS), Erasmus University.

"Indian agriculture needs a paradigm shift to address farm distress and climate change through sustainable agricultural practices. The large-scale ZBNF experiment in Andhra Pradesh is a promising alternative that could alter the landscape of chemical-intensive agriculture and the fiscal burden that comes with it. This study is an attempt to look at the budgetary savings that come from alternative agricultural practices that could be directed to promote more sustainable agriculture practices."

Saurabh Tripathi
saurabhtripathi.in@gmail.com

Saurabh Tripathi was a Programme Associate at The Council, where he worked on households' access to electricity and clean cooking energy. Saurabh has four years of experience in sustainability and policy research and holds an MSc in Economic Development and Policy Analysis and a BA (Hons) in Economics, both from the University of Nottingham.

"It is encouraging to see the phenomenal extension of ZBNF in Andhra Pradesh being driven by the state government as well as local communities in recent years. My hope for this study is for it to facilitate a constructive dialogue on the need for agricultural reform in India, and for farmers' well-being and soil health to be placed front-and-centre in the conversation."



Hem Himanshu Dholakia
dr.dholakia@gmail.com

Hem Dholakia is a health professional turned policy researcher. He formerly led the Risks and Adaptation portfolio at The Council. His research addresses the linkages between energy, environment, human health, and public policy in India. Hem holds a doctorate from the Indian Institute of Management (Ahmedabad); a master's in Exercise Science from the University of Brighton (UK); and a bachelor's in physiotherapy from Seth G.S. Medical College, Mumbai.

"This, first-of-its-kind, independent evaluation of zero budget natural farming shows the multiple benefits of shifting away from chemical farming practices. At scale, ZBNF can have a transformational impact on fertiliser subsidies, farmer livelihoods, food security as well as climate change in India."

Contents

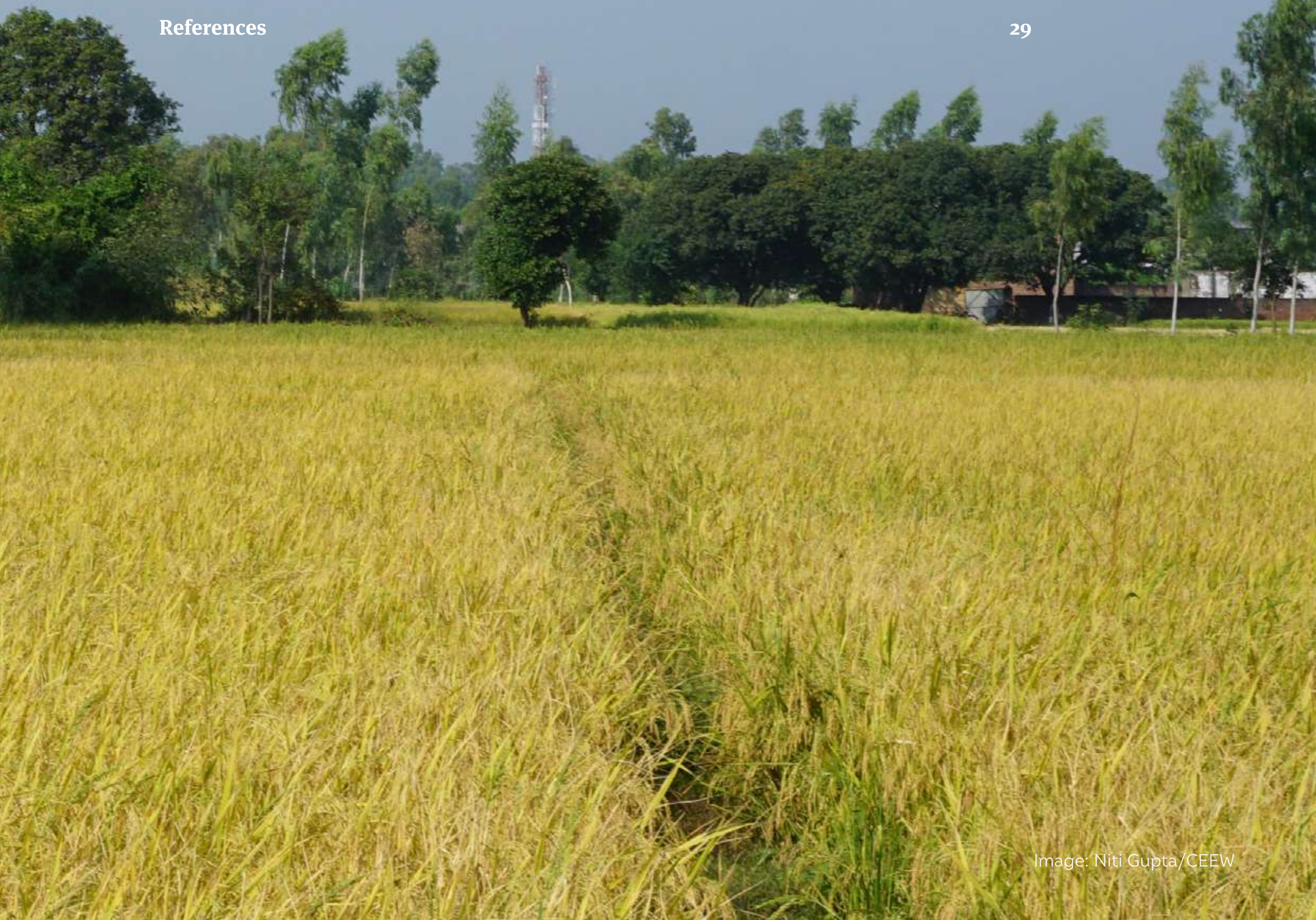


Image: Niti Gupta/CEEW

List of figures

List of tables

Abbreviations

DAP	diammonium phosphate
DBT	Direct Benefit Transfer scheme
ECA	Essential Commodity Act
FAI	Fertiliser Association of India
FGDs	focus group discussions
FYM	farmyard manure
GHG	greenhouse gas
iFMS	Integrated Fertiliser Management System
JPC	Joint Parliamentary Committee
K	potassium
MMT	million metric tonnes
MOP	muriate of potash
MRP	maximum retail price
N	nitrogen
NPS	New Pricing Scheme
NBS	nutrient-based subsidy
OBC	Other Backward Classes
P	phosphorous
RPS	Retention Price Scheme
RySS	Rythu Sadhikara Samstha
SSP	single superphosphate
ZBNF	zero budget natural farming

ZBNF farmers showing different variety of seeds used while preparing their kitchen garden.

Image: Niti Gupta/CEEW

Executive summary

Since the Green Revolution of the 1960s, agriculture in India has relied heavily on chemical fertilisers and pesticides. Over the years, their excessive use has resulted in their diminishing marginal utility leading to declining net incomes and growing debt for farmers. Their excessive application also poses a threat to soil health, groundwater purity, local biodiversity, and human health. The inherent unsustainability of chemical-based agriculture and its contribution to the ecological and agrarian crises had resulted in a growing demand for alternative agroecological farming practices that promise a host of ecological and social benefits.

Zero Budget Natural Farming could potentially reinvigorate rural economies and reduce credit risks for farmers caused by high-input resource-intensive chemical farming

Zero budget natural farming (ZBNF) – a sustainable agricultural system – is one such alternative to chemical fertiliser based agriculture and high input cost agriculture. It exemplifies agroecological principles where the emphasis is on "enhanced soil conditions by managing organic matter and soil biological activity; diversification of genetic resources; enhanced biomass recycling; and enhanced biological interactions" (Khadse, et al. 2018). The practice advocates 100 per cent elimination of synthetic chemical inputs (fertiliser and pesticides) and encourages the application of natural mixtures made using cow dung, cow urine, jaggery, pulse flour etc., mulching practices, and symbiotic intercropping. The practice could potentially reinvigorate rural economies and reduce credit risks for farmers caused by high-input resource-intensive chemical farming. It will also help agricultural families retain greater resources to spend on their well-being for needs such as education, health, and financial security (Tripathi, et al. 2018). At the same time, the practice holds promise for improving biological soil health and local biodiversity, enhancing the climate resilience for crops, contributing towards the Sustainable Development Goals, and supporting the achievement of the Global Nutrition Targets 2025 of access to affordable and safe food.

In 2015, the Government of Andhra Pradesh mandated Rythu Sadhikara Samstha (RySS), a state-owned, non-profit organisation to scale-up ZBNF practices to cover all six million farmers and eight million hectares of agricultural land in the state by 2024. In the face of agrarian distress, the programme aims to promote climate-resilient, chemical-free, ecological agriculture and provide small and marginal farmers with profitable livelihoods from agriculture. The programme was launched in 2015–16 and its implementation in the field started in 2016–17. As of July 2019, more than 500,000 farmers have enrolled in the programme across all 13 districts in Andhra Pradesh, covering an area of around 204,000 acres. The implementation of this project at scale could help India make significant progress towards almost a quarter of 169 SDG targets as outlined by Tripathi et al. (2018).

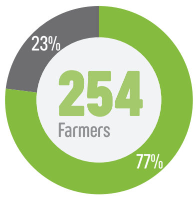
The Government of India allocates a sizeable portion of its budget to agricultural subsidies – with fertiliser subsidies being the most dominant, amounting to close to INR 70,000 crore (USD 9,758 million) in 2018–19. The projection for 2019–20 is a 14 per cent increase to INR 79,960 crore (USD 11,110 million). The urea subsidy alone corners more than 60 per cent of the allocation, amounting to INR 53,629 crores (USD 7,472 million), and the rest is nutrient-based subsidies (Economic Times 2019). We estimate the total outlay on fertiliser subsidies in 2017–18 in Andhra Pradesh alone to be INR 3,485 crore (close to USD 490 million). During this time, the consumption of urea in Andhra Pradesh was reported to be 14,00,000 tonnes and that of diammonium phosphate (DAP) was a little over 326,000 tonnes. In addition, the sales of a range of complexes was reported to be close to a million tonnes (Fertiliser Association of India [FAI] 2018).

If ZBNF was scaled up across Andhra Pradesh, it would considerably alter the landscape of chemical inputs in agriculture, particularly fertilisers. The avoided fertiliser subsidies from scaling ZBNF would lead to significant budgetary savings, which could be redirected towards more sustainable uses, including funding ZBNF scaling up efforts. This CEEW study was carried out to improve the current understanding of ZBNF and aims to highlight the differences between ZBNF cohorts and those practising chemicals-based agriculture in terms of fertiliser consumption. It also provides an estimate for the savings in fertiliser subsidies resulting from reduced fertiliser consumption due to ZBNF adoption.

Sampling and data

We surveyed 639 farmers across six agro-climatic zones of Andhra Pradesh to estimate reductions in self-reported fertiliser use attributable to ZBNF adoption. We adopted a stratified random sampling approach to select the districts, *mandals* (sub-districts), villages, and farmers. The districts sampled were Srikakulam, Vizianagaram, West Godavari, Krishna, Kadapa, and Anantapuram. The survey instrument captured information on the socioeconomic characteristics of the farmers and data on their landholding size, crops cultivated, input costs, and chemical and natural fertiliser consumption. We also conducted focus group discussions (FGDs) with farmers and semi-structured interviews with retailers and officials from the state Fertiliser Wing to qualify our findings.

Prior to data analysis, the data was tested for outliers and erroneous values using information from the Directorate of Economics and Statistics (2018) and Agriculture Census (2015–16) and 58 observations were dropped from the sample. Thus, the working sample for this study is 581 farmers across six districts of which 254 farmers (44 per cent) are practising ZBNF and 327 (56 per cent) are practising conventional farming using chemical fertilisers.



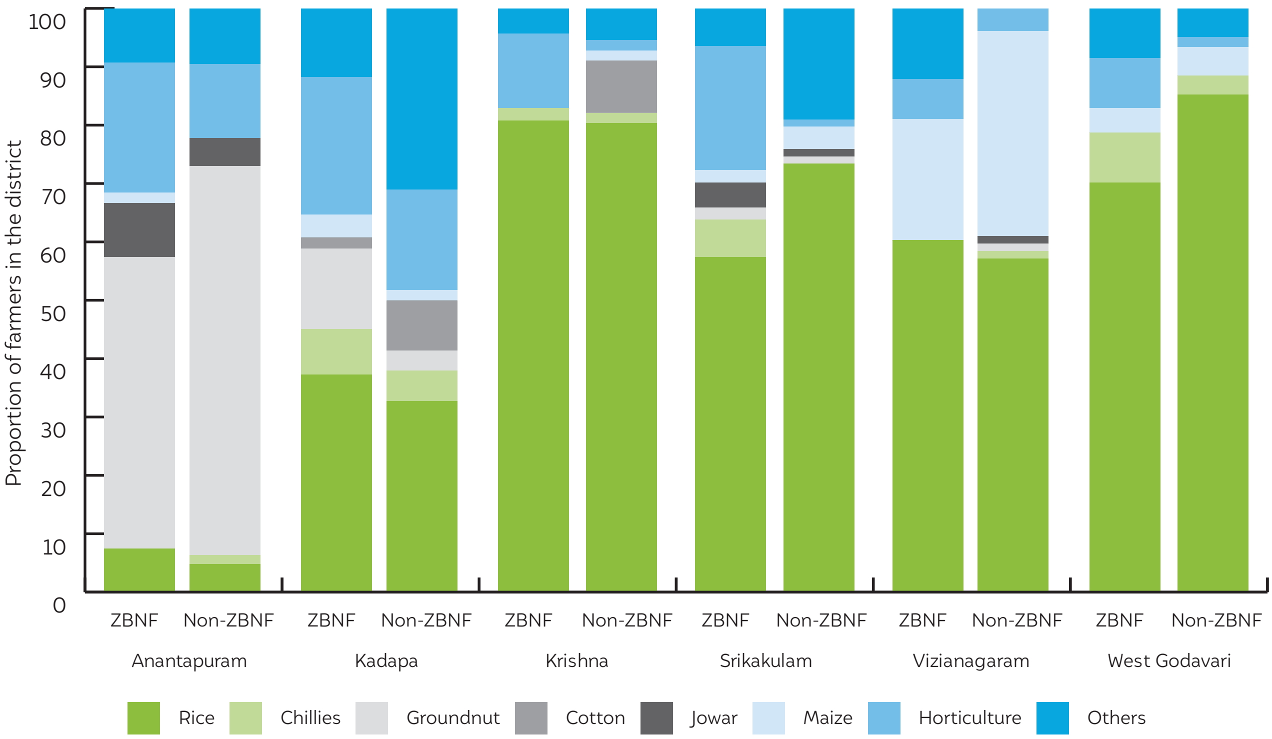
From our discussions with farmers, we learnt that the transition from chemical-based practices to natural farming is an incremental and iterative process. Farmers could start natural farming by adopting a few of the practices and principles initially and testing them in a small portion of their land. A vertical transition phase will include shifting from a few natural practices to using all-natural inputs and complete elimination of synthetic fertilisers and pesticides. Until then, they are referred to as chemical partial farmers. A horizontal transition happens when the complete landholding of a farmer is brought under natural farming.

In our sample, out of the 254 ZBNF farmers, 77 per cent use all-natural inputs and the remaining 23 per cent are partial ZBNF farmers

In our sample, out of the 254 ZBNF farmers, 77 per cent use all-natural inputs and the remaining 23 per cent are partial ZBNF farmers, which means that they use a few critical natural farming practices, but are also using some amount of chemical inputs on their ZBNF land. For convenience, we refer to them as complete and partial ZBNF farmers in this study. We also observed that 36 per cent of ZBNF farmers are practising it in 100 per cent of their landholdings and using only all-natural inputs, while the remaining 64 per cent are currently practising it in some portion of their total landholding. In this study, we have collected information on various inputs from ZBNF farmers only for the cultivated land in which the farmers were practising ZBNF, as opposed to the farmer's total land. In our analysis, we include all 254 farmers as part of the ZBNF cohort, including the partial ZBNF farmers as well.

The sample in this study is broadly representative of the major crops grown in Andhra Pradesh – a parameter that we expect drives fertiliser consumption. In our sample, 63 per cent of farmers cultivated rice as the principle crop in the kharif season, 13 per cent cultivated groundnut, and 6 per cent maize. We limit the crop-level analyses in this study to rice, groundnut, and maize, for which we have a sufficient number of observations to derive inferences.

ES1: ZBNF farmers were growing more fruits and vegetables as their kharif crop compared to non-ZBNF farmers



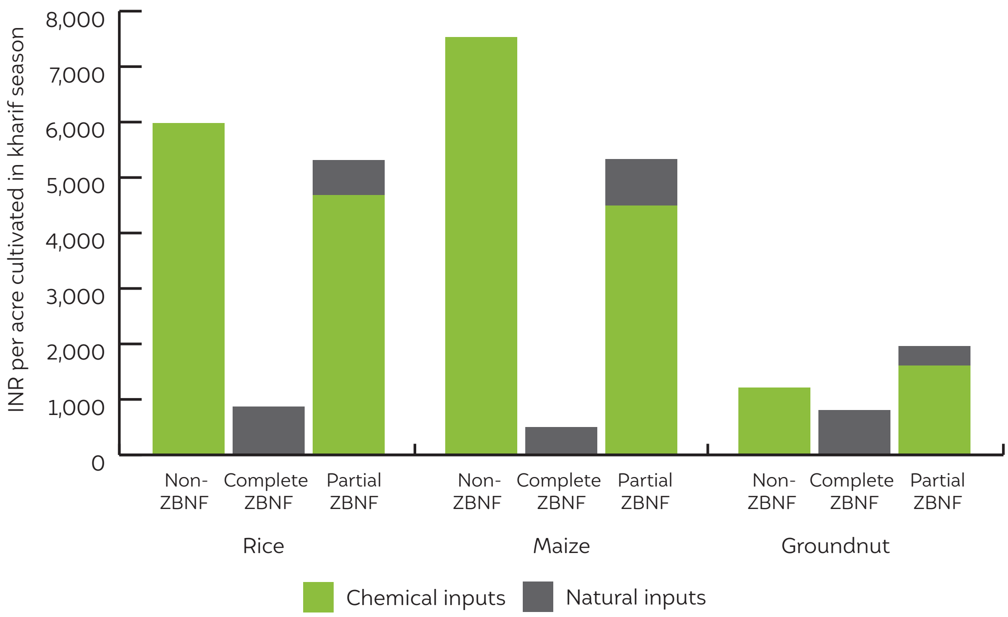
Source: Authors' analysis

We also found that almost twelve per cent of ZBNF farmers were growing fruits and vegetables as their main kharif crop as compared to three per cent of non-ZBNF farmers. Such a shift in cropping pattern could be the result of multi-cropping and inter-cropping – both of which are strongly encouraged under ZBNF – and could critically alter the relative production of various food crops in the state. The change could likely contribute towards a balanced diet for agricultural households and consumers at large, with a potentially higher and more resilient income for agricultural households.

Fertiliser and pesticides cost is significantly lower under ZBNF than in chemicals-based farming

The cost of chemical fertiliser and pesticide are zero in case of a complete ZBNF farmer and it is lower in a partial ZBNF farmer vis-à-vis a chemical farmer. We found a difference of almost 90 per cent in the expenditure on fertilisers and pesticides between the two cohorts for rice cultivators. On an average, chemical farmers cultivating rice spent INR 5,961 (SD: INR 4,496) on chemical inputs while a complete ZBNF farmer incurred an expenditure of INR 846 per acre (SD: INR 785) on natural inputs. Partial ZBNF farmers, who used some amount of both, natural and chemical fertilisers, reported an average expenditure of INR 4,664 per acre (SD: INR 3,176) on chemical inputs and INR 652 (SD: INR 823) on natural inputs, which is still marginally lower than using all chemical inputs.

We found a significant difference of 93 per cent in fertiliser expenses between the two cohorts for maize as well. Complete ZBNF farmers spent INR 503 (SD: INR 414) on natural inputs, whereas chemical farmers, on an average, spent INR 7,509 per acre (SD: INR 4,382) on chemical fertilisers inputs. For groundnut, a chemical farmer spent INR 1,187 per acre as against INR 780 per acre by a complete ZBNF farmer. A partial ZBNF farmer, however, reported an even higher amount of INR 1,936 per acre, on both natural and chemical inputs.



ES2:
Average input cost on fertilisers and pesticides drops significantly for ZBNF rice and maize farmers

Source: Authors' analysis

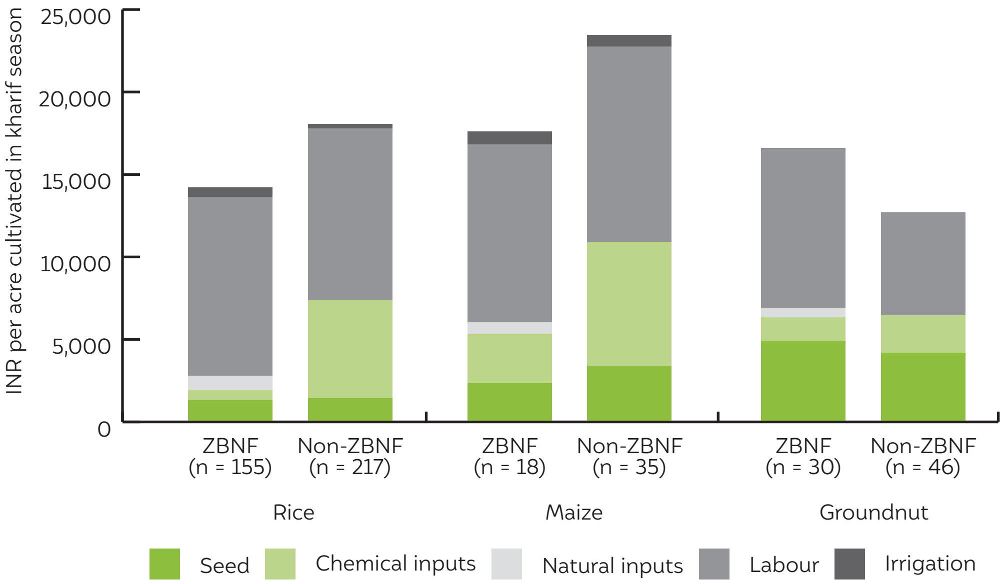
Number of Observations:

Rice: N-ZBNF (217), C-ZBNF (133), P-ZBNF (22); Maize: N-ZBNF (35), C-ZBNF (6), P-ZBNF (12); Groundnut: N-ZBNF (46), C-ZBNF (21), P-ZBNF (14)

It is important to note that several components of chemical inputs such as urea are heavily subsidised by the central government. If we add back the subsidised amount in this calculation, there would be an even higher difference in the fertiliser cost between the two cohorts.

Average input cost drops significantly for ZBNF rice and maize farmers

ZBNF farmers cultivating rice and maize in the Kharif season reported lower input costs per acre as compared to their non-ZBNF peers. Most of the savings were driven by dissimilarities in the expenditure on fertilisers and pesticides. ZBNF cohort growing rice reported the median cost per acre at INR 12,200 (mean: INR 13,918) whereas that for the non-ZBNF cohort was INR 14,700 (mean: INR 15,580). For maize cultivators, the median expenditure per acre for ZBNF farmers was INR 15,660 (mean: INR 15,925), while that for non-ZBNF farmers was INR 17,425 (mean: INR 19,812). The per acre input cost of ZBNF farmers cultivating groundnut was however higher than that of non-ZBNF farmers, in contrast to rice and maize. The median cost of groundnut cultivation per acre for the ZBNF cohort was INR 12,483 (mean: INR 15,964) as compared to the median of INR 9,996 (mean: INR 11,952) for the non-ZBNF group.



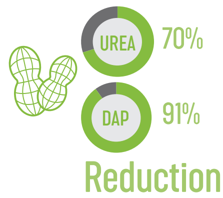
ES3:
Average input cost drops significantly for ZBNF rice and maize farmers mainly because of savings from avoided use of chemical fertiliser and pesticides

Source: Authors' analysis

Avoided fertiliser subsidies from the scale-up of ZBNF

Using econometric analysis, we estimate the potential savings in the consumption of fertiliser subsidies if ZBNF were to be scaled up in Andhra Pradesh. We found that on average, non-ZBNF farmers used three times more urea and DAP per acre than ZBNF farmers. We also found considerable variations in the use of fertiliser across crops. While rice and maize farmers used more urea per acre than those growing other crops, groundnut farmers applied much less of each fertiliser.

To calculate the difference in expected fertiliser, use between the ZBNF and non-ZBNF cohorts, we used the crop-specific binary variables and crop–ZBNF interaction variables in the model. For instance, the expected urea use for ZBNF rice farmers is 0.59 kilograms per acre (kg/acre) and for non-ZBNF farmers is 74.46 kg/acre, resulting in 73.87 kg/acre of avoided urea consumption. The avoided fertiliser consumption due to ZBNF varied from 83–99 per cent for various fertilisers in rice. For groundnut, we found a reduction of almost 70 per cent in urea and 91 per cent in DAP, due to ZBNF.



For groundnut, we found a reduction of almost 70 per cent in the use of urea and 91 per cent in DAP, due to ZBNF

Fertiliser	Unit	Rice	Groundnut	Maize
Urea	kg/acre	74.4	12.7	71.4
	%	99.2	69.4	84.8
DAP	kg/acre	46.7	16.1	41.6
	%	98.4	90.9	78.4
SSP	kg/acre	2.4	0.7	10.9
	per cent	82.8	58.3	79.7
MOP	kg/acre	2.3	0.7	1.0
	%	99.8	47.6	24.6
Complexes	kg/acre	3.2	2.2	6.2
	%	90.3	44.3	67.3

Source: Authors' analysis

ES4:
Fertiliser consumption of non-ZBNF farmers (in kg/acre) and avoided fertiliser consumption due to ZBNF (percentage)

We estimated the savings in fertiliser subsidies in Andhra Pradesh in three policy scenarios: (1) a low -policy-effort scenario where 25 per cent of the total cropped area in Andhra Pradesh shifts to ZBNF; (2) a medium-policy-effort scenario, where 75 per cent of the total cropped area in Andhra Pradesh shifts to ZBNF; and (3) a high-policy-effort scenario, where the government's effort is able to implement ZBNF in 100 per cent of the cropped area in Andhra Pradesh.

Based on the actual reported consumption of fertilisers in our survey, if no one in Andhra would have been practising ZBNF, the annual subsidy outlay would have been about 2,154 crores (USD 300 million). Against this counterfactual, we estimate fertiliser subsidy savings worth INR 517 crore (USD 72 million) annually on account of ZBNF penetration in a low-policy scenario and INR 1,553 crore (USD 218 million) annually in a medium policy scenario, with the bulk of the savings resulting from the avoidance of the subsidy on urea. In a high policy effort scenario, we expect subsidy savings worth INR 2,071 crores (USD 290 million) annually. which is almost 96 per cent of the subsidy outlay under the counterfactual scenario (zero penetration of ZBNF). This estimation reflects the current ground realities where some of ZBNF farmers are still using some level of chemical inputs.

We also estimated the potential savings in fertiliser subsidies considering the same three scenarios but assuming a complete transition of the adopters. We find that in a low policy effort scenario, fertiliser subsidy savings worth INR 539 crore (USD 76 million) annually could be expected. In a high policy scenario, we expect subsidy savings worth INR 2,154 crore annually (USD 300 million) – a 100 per cent savings against the counterfactual scenario.

It is worth noting that our estimated fertiliser subsidy outlay in the counterfactual scenario, i.e. INR 2,154 crores is only about 60 per cent of the actual subsidy outlay for Andhra Pradesh for the years 2017-18. The difference in subsidies based on actual consumption and the sales records of manufacturers could likely be because of the leakages in the current subsidised fertilisers' administration mechanism. The nearly 40 per cent difference between the two figures is slightly lower than the 65 per cent of leakage in fertiliser subsidies estimated by the Government of India (2017).

While this study establishes the fertiliser savings potential with the scaling-up of ZBNF, we need further rigorous evidence to understand ZBNF's impact on improving crops' climate resilience, the soil health, local biodiversity, and water-use in agriculture. When scaled up, ZBNF could significantly reduce fertiliser requirement and consequently the fiscal allocation for fertiliser subsidies, while potentially ensuring chemical-free food to billions of Indians across the country.

Annual subsidy savings

₹ 2,071 crores
$ 290 million

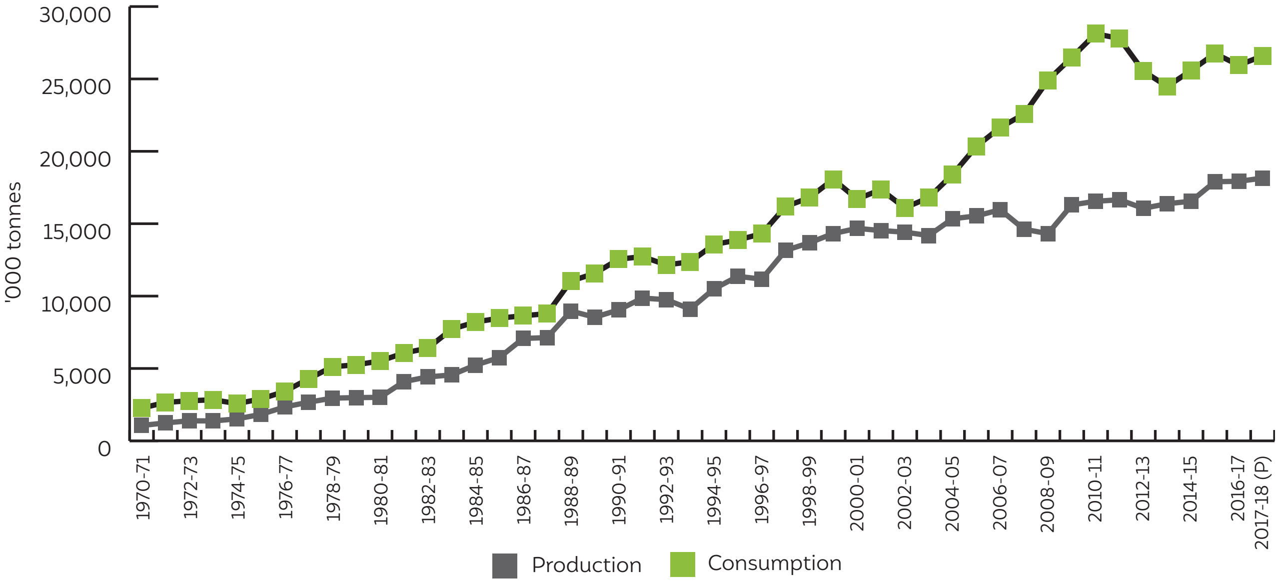
In a high-policy-effort scenario, we expect subsidy savings worth INR 2,071 crores (USD 290 million) annually, which is almost 96 per cent of the subsidy outlay under the counterfactual scenario (zero penetration of ZBNF)

1. Introduction

Ever since the Green Revolution of the 1960s, agriculture in India has been heavily reliant on external chemical inputs such as fertilisers and pesticides. A growing demand for food and a crushing dependence on food imports were instrumental in generating political support will for government subsidies for several agricultural inputs, principally fertilisers.

Food grain production in India increased from 80.6 million metric tonnes (MMT) in 1963–64 to 285 MMT in 2017–18 (Fertiliser Association of India [FAI] 2018), of which about 50 per cent of the gains were grown using fertilisers (Sharma and Thaker 2011). The consumption of fertilisers increased ten-fold from 13.61 kilograms per hectare (kg/ha) in 1970–71 to 134.07 kg/ha in 2017–18 (FAI 2018). Although the domestic production of fertilisers had historically kept up with consumption, the flattening production since the turn of the century meant that the increasing demand has been met primarily through higher imports (see Figure 1).

Figure 1: A decline in domestic production of fertilisers along with an increasing demand has resulted in higher import dependency



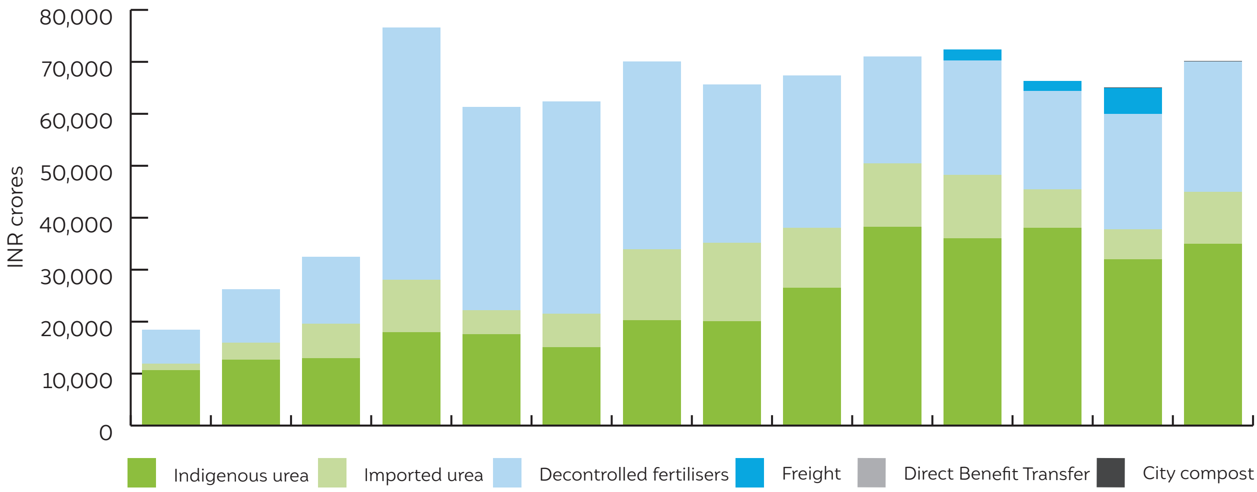
Source: Fertiliser Association of India. 2018. Annual Report 2017–18. Government of India, Ministry of Chemicals & Fertilisers.

The unavailability of raw materials critical to the production of certain fertilisers has led to rising import dependency. For instance, potassic fertilisers such as diammonium phosphate (DAP) are imported owing to the limited availability of sulphur and rock phosphates. The import of DAP and muriate of potash (MOP) was 4.22 and 4.74 million tonnes in 2017–18 (Fertiliser Association of India 2018).

1.1 Reliance on fertilisers: an economic and environmental burden

The Government of India allocates a sizeable portion of its budget towards fertiliser subsidies, with the outlay on urea forming the bulk of this expense (see Figure 2). In 2019–20, the expenditure on fertiliser subsidies is projected to increase to INR 799,960 million (approximately, USD 11,000 million) from the revised estimate of INR 700,857 million (USD 9,725 million) in 2018–19. Over the past decade, while the subsidies on decontrolled fertilisers (DAP and MOP) and single superphosphates (SSP) have been declining, there has been an emphasis on subsidising indigenous urea.

Figure 2: Annual subsidy on fertilisers in India with urea forming the bulk of this expense (2005-06 to 2018-19)



Source: Fertiliser Association of India. 2018. Annual Report 2017–18. Government of India, Ministry of Chemicals & Fertilisers

The government's policy on fertilisers has gone through four major phases:

1. **1950s and 1960s**: This was a period of limited government control, when although straight fertilisers (nitrogen (N), phosphorous (P), and potassium (K)) were under price control, their distribution was not regulated.
2. **1970s and 1980s**: Controls on fertiliser prices and distribution were introduced in 1973, and the movement of fertilisers was brought under the *Essential Commodities Act* (ECA). In 1977, the *Retention Price Scheme* (RPS) was introduced for urea due to the volatile global prices of gas and urea; this was later extended to other complex fertilisers in 1979. Under RPS, the retail price of fertilisers was fixed by the government, and the subsidy was calculated as the difference between the RPS and the sale price for each unit individually (Gulati and Banerjee, 2016).
3. **1990s and 2000s**: In the early 90s, the increased cost of imported fertilisers and the devaluation of the rupee added to the subsidy burden, resulting in a high fiscal deficit. In 1992, the government decontrolled the import of all phosphatic and potassic fertilisers, excluding urea. In 2003, *New Pricing Policy* (NPS) was introduced to increase energy efficiency and reduce the cost of production. Much of the increase in the fertiliser

subsidy bill – even after decontrolling phosphatic and potassic fertilisers – was on account of import dependence. The *Nutrient-based Subsidy* (NBS) policy was introduced in 2010, wherein the government fixed the subsidies based on the nutrient content (per kg) of fertilisers. The scheme aimed to ensure the balanced use of fertilisers and improve agricultural productivity.

4. **2010s**: Urea was made available in the market only after a neem coat was applied in order to reduce diversion of the commodity for non-agricultural purposes. The Integrated Fertiliser Management System (iFMS) was instituted to electronically track the movement of fertilisers from manufacturers to input dealers. In 2016, the *Direct Benefit Transfer* scheme (DBT) for fertilisers was introduced through small pilots to enable better monitoring of transactions related to subsidised fertilisers. Under DBT, the subsidy is released to fertiliser companies on the basis of actual sales made by retailers to farmers, thereby improving transparency in the process.

Timeline of the fertiliser subsidy regime

1977
The *Retention Price Scheme* (RPS) was introduced for urea.

1979
RPS was extended to phosphatic and other complex fertilisers.

1982
RPS was extended to single superphosphates.

1991
An increase in subsidies led to high fiscal deficits, and coupled with a foreign exchange crisis, this led to a 40% increase in fertiliser prices. The price of urea was rolled back by 10% due to political protests.

1992
The Joint Parliamentary Committee (JPC) on fertiliser policy recommended decontrol of fertilisers. Following the recommendations, all phosphatic and potassic fertilisers under RPS were decontrolled. Urea continued to be under RPS.

1997
Uniform maximum retail prices (MRP) for fertilisers like DAP, MOP, complex NPK, etc. were introduced.

2003
The *New Pricing Scheme* (NPS) was introduced for urea units replacing the RPS.

2004
Stage II of NPS was introduced from 1 April 2004 to 30 September 2006.

2006
Stage III of NPS was introduced from 1 October 2006 onwards.

2010
The *Nutrient-based Subsidy* (NBS) policy was introduced for decontrolled fertilisers.

2015
The *New Urea Policy* was launched.

2016
The pilot run of Direct Benefit Transfer (DBT) began in a few districts. The DBT scheme was rolled out in 2018.

Source: Ministry of Chemicals and Fertilisers(n.d.)

In spite of these reforms, the subsidy regime remains highly criticised, primarily due to the heavy regulation of the urea sector, which incentivises production inefficiencies and under-pricing. This results in the overuse of fertilisers, which in turn has many negative environmental consequences and social consequences. Excessive use of fertilisers is known to cause groundwater contamination, soil erosion, salinisation, and the loss of biodiversity and natural habitats. The dependence on external inputs—coupled with plummeting market prices for agricultural produce—has also resulted in an exponential increase in the cost of cultivation and the scale of agricultural debt. Farmers increasingly find themselves trapped in a vicious cycle of debt due to high cultivation costs, high credit rates, the rising cost of fossil fuel-based inputs, and fluctuating market prices (Khadse, et al. 2018; Mohanty 2011). Exposure to harmful chemicals and pesticides has also caused serious human health problems; studies reveal its correlation with neuronal disorders and degenerative diseases ranging from congenital anomalies to cancer (Sharma and Singhvi 2017).

The dependence on external inputs – coupled with plummeting market prices for agricultural produce – has also resulted in an exponential increase in the cost of cultivation and the scale of agricultural debt

1.2 ZBNF – an alternative agricultural practice

There is a growing call to promote alternative agricultural practices that are sustainable yet fiscally sound. One such farming practice—zero budget natural farming (ZBNF)—which advocates the use of natural fertilisers and pesticides in lieu of external synthetic chemical inputs has been gaining momentum in certain regions, and in Andhra Pradesh in particular.

ZBNF prescribes the 100 per cent elimination of synthetic chemical inputs (fertilisers and pesticides) and encourages the use of locally sourced inputs, such as natural concoctions and inoculums prepared with cow dung, cow urine, jaggery, green chillies, neem paste, etc. Tripathi et al. (2018) list various natural fertilisers and pesticides encouraged under ZBNF, and the potential for ZBNF to address the social, economic, and environmental challenges faced by Indian agriculture today. Based on crop-cutting experiment data, the 2018 report maps the possible impact of the ZBNF programme in meeting the sustainable development goal targets and concludes that ZBNF could help India make significant progress towards almost a quarter of the 169 SDG targets, including strengthening resilience against climate-related hazards such as drought risks; minimising and reducing marine pollution and the impacts of ocean acidification by eliminating the use of chemical fertilisers and biocides; promoting tree-based agroforestry models to improve the productivity of the land; and also ensuring landscape restoration and prevention of biodiversity loss. In addition, the report discussed that ZBNF holds the potential to reinvigorate rural economies, reduce credit risks for farmers, and help agricultural families allocate greater amounts of resources towards education, health, and financial security (Tripathi, et al. 2018). These ZBNF findings, collectively, could potentially contribute to meeting the 2030 Agenda goals along with supporting the achievement of the Global Nutrition Target 2025 of access to affordable and safe food.

As of July 2019, more than **500,000** farmers have enrolled in the programme across all 13 districts in Andhra Pradesh covering an area of around 204,000 acres

In 2015, the Government of Andhra Pradesh mandated Rythu Sadhikara Samstha (RySS) to extend ZBNF to farmers across the state. In June 2018, it expressed an ambition to scale ZBNF to all six million farmers and eight million hectares of agricultural land in the state by 2024–25 (The Hindu 2018). As of July 2019, more than 500,000 farmers have enrolled in the programme across all 13 districts in Andhra Pradesh covering an area of around 204,000 acres. As a result of this wide-scale 'experiment' with ZBNF in Andhra Pradesh, the practice has gathered much attention nationally. In her Union Budget 2019 speech, the finance minister highlighted zero budget farming and its potential to double farmers' income, a stated objective of the current government (India Today 2019). While addressing the 14th Conference of Parties (COP14) to the United Nations Convention to Combat Desertification (UNCCD), current Prime Minister Narendra Modi also mentioned India's focus on zero budget natural farming (Yashee 2019).

As ZBNF is scaled up across Andhra Pradesh, it will considerably alter the landscape of chemical inputs in agriculture, especially fertilisers. In 2017–18, the consumption of urea in the state was reported to be 1.4 million tonnes and that of DAP was a little over 326,000 tonnes (FAI 2018). We estimate the total subsidy outlay on fertilisers in Andhra Pradesh in 2017–18 to be INR 3,485 crores (approximately, USD 490 million). As such, the savings in subsidies from taking ZBNF to scale would by significant, which could be redirected towards more sustainable uses, including to fund ZBNF scaling efforts.

1.3 About the report

The study aims to address some important gaps in our current understanding of ZBNF. The specific research questions are as follows:

1. Do ZBNF adopters use significantly less synthetic chemical fertilisers per acre of cultivable land than non-ZBNF farmers? Is the self-reported paid-out cost on fertilisers and pesticides significantly different for ZBNF farmers and those practising chemicals-based agriculture?
2. What is the potential for savings in fertiliser subsidies due to ZBNF penetration in Andhra Pradesh?

The report is structured as follows: Chapter 2 outlines the methodology of data collection and analysis; Chapter 3 details the results of the farmer survey, and specifically examines impact of ZBNF on farmers paid-out cost on fertiliser and pesticide; Chapter 4 offers a perspective on the potential savings in fertiliser subsidies if ZBNF were scaled up in all of Andhra Pradesh; Chapter 5 concludes the report.

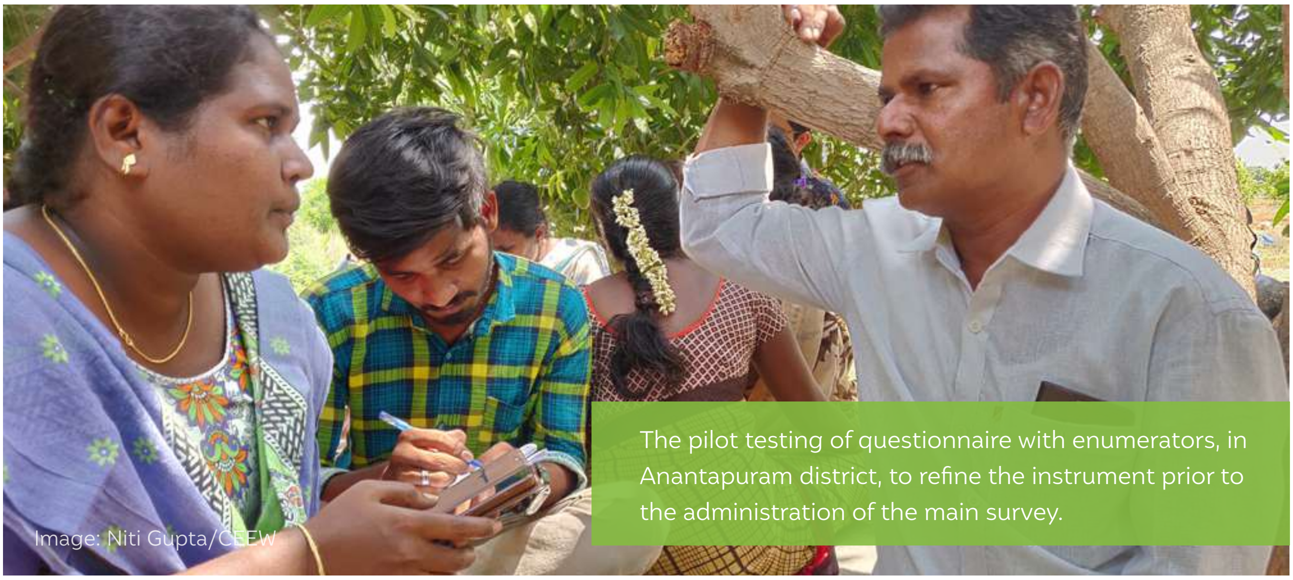
A participatory rural appraisal exercise in progress to map the landless, tenant farmers and farmer landholdings. ZBNF recognises landless and tenant farmers, and farmers with less than 2.5 acres of dry land or 1.25 acres of wet-land, as the "poorest of the poor" and introduces kitchen-gardening to enhance their food security.

Image: Saurabh Tripathi/CEEW

2. Methodology

We employed a mixed-methods approach for this study. First, we surveyed 639 farmers across six agro-climatic zones in Andhra Pradesh, and then, we complemented the survey with focus group discussions (FGDs) as well as semi-structured interviews with different stakeholder groups. These groups included private-sector fertiliser retailers and company officials, and officials from the state Fertiliser Wing. To calculate savings in fertiliser subsidies, we employed a regression analysis, using the survey data to determine the difference in expected fertiliser consumption between ZBNF and non-ZBNF farmers.

2.1 Survey of farmers



The pilot testing of questionnaire with enumerators, in Anantapuram district, to refine the instrument prior to the administration of the main survey.

We surveyed 639 farmers across 60 villages in six districts of Andhra Pradesh in May 2019. We tested the data for outliers and erroneous values before data analysis. Using information from the Directorate of Economics and Statistics (2018) and Agriculture Census (2015–16), we winsorised[1] outliers, dropping 58 observations from the sample. Thus, the working sample for this study is 581 farmers across six districts, of whom 254 farmers (44 per cent) are practising ZBNF and 327 (56 per cent) are practising conventional farming using synthetic chemical fertilisers (Table 1).

During our discussions with ZBNF farmers, we learnt that farmers may take a few years after first implementing the practices to completely move away from synthetic fertilisers

1 Winsorisation is the transformation of statistics by limiting extreme values in the statistical data to reduce the effect of possibly spurious outliers.

to all-natural practices and principles. This shift happens in an incremental and iterative manner and includes both vertical and horizontal transitions to the practice. Farmers may start natural farming by adopting a few practices in the initial years and by testing them in a small portion of their land. Gradually, they undertake a vertical transition when they shift to all-natural practices and completely eliminate the use of any synthetic fertilisers and pesticides. Until they stop using synthetic fertilisers completely, they are referred as partial ZBNF farmers. Horizontal transition is when the complete landholding of a farmer is brought under natural farming. We recognise that this could possibly be due to behavioural inertia arising having used such inputs for decades or an unwillingness to entirely discard them immediately.

In our sample, out of the 254 ZBNF farmers, 77 per cent use all-natural inputs and the remaining 23 per cent are partial ZBNF farmers in the vertical phase of transitioning, where they are using a few natural farming practices along with some amount of chemical inputs on their ZBNF land. We observed that 36 per cent of ZBNF farmers are practising it in 100 per cent of their landholding and using only all-natural inputs and the remaining 64 per cent are currently practising it in some portion of their total landholding. In this study, we have taken information on various inputs from ZBNF farmers only for the cultivated land in which they are practising ZBNF, as opposed to the total land with the farmer. In our analysis, we include all 254 farmers, including the partial ZBNF farmers, to derive insights.

Table 1: **Sample distribution across the different agro-climatic zones**

Agro-climatic zone	District	No. of farmers	Total ZBNF farmers	Complete ZBNF farmers	Non-ZBNF farmers
Scarce rainfall zone	Anantapuram	88	40	26	48
Southern zone	Kadapa	91	44	27	47
Krishna zone	Krishna	94	43	43	51
High altitude and tribal area	Srikakulam	100	40	37	60
North coastal zone	Vizianagaram	104	42	19	62
Godavari zone	West Godavari	104	45	44	59

Source: Authors' analysis

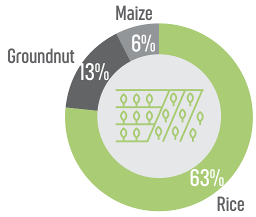
Sampling

We adopted a stratified random sampling approach in this study. The state of Andhra Pradesh is divided into 13 districts and six agro-climatic zones based on crops grown, soil type, irrigation, and rainfall. From each zone, we selected one district at random. The six districts sampled were Srikakulam, Vizianagaram, West Godavari, Krishna, Kadapa, and Anantapuram.

For each district, we listed the mandals based on 2011 Census data. From these, we selected ten mandals across each district at random. In all, 60 mandals were selected for the study. In each mandal, we listed all the villages practising ZBNF, based on data from RySS. From the list of ZBNF-practising villages from each mandal, we randomly selected one village. Finally, from each village, we selected ten farmers (five practising ZBNF and five practising chemical farming) at random.

For the selection of farmers, our enumerators selected every fifth household. In a few cases, where enumerators were not able to find five ZBNF farmers in a particular village, the remaining farmers from the control group were selected. We only included those respondents for whom agriculture was the primary source of income and who were the primary decision-makers of farming-related decisions in the household.

Even though the sampling framework was not designed to reflect the cropping pattern, we found, in retrospect, that with the exception of Bengal gram, the principle crops captured in our survey broadly align with the major crops grown in Andhra Pradesh as per the Directorate of Economics and Statistics (2018). In our survey, 63 per cent of farmers were cultivating rice, 13 per cent groundnut, and 6 per cent maize, as the principle crop in the kharif season. We found small groups of farmers growing cotton and chillies, and even smaller groups growing oilseeds, pulses, fruits, and vegetables as the primary kharif crop.



In our survey, 63 per cent of farmers were cultivating rice, 13 per cent groundnut, and 6 per cent maize, as the principle crop in the kharif season

Survey instrument design

The survey instrument primarily focused on understanding the difference in fertiliser consumption of farmers practising conventional farming and those practising ZBNF. Following an internal review of the instrument, we administered the questionnaire to over 10 farmers to test its efficacy. Based on the feedback received from a pilot test in Anantapuram district, the instrument was refined prior to the administration of the main survey. The final questionnaire consisted of 59 questions and covered socioeconomic characteristics; landholding size; crop details for both the kharif and rabi season; input costs; chemical and natural fertiliser consumption details; and awareness about fertiliser subsidies along with satisfaction with ZBNF.

The instrument was designed in English and subsequently translated to Telugu. Independent bilingual experts helped in fine-tuning the translated questionnaire.

Data collection and monitoring

We conducted in-person training sessions for each enumerator selected to facilitate data collection. All enumerators were from Andhra Pradesh and were familiar with the local geography and local agricultural terminology. We trained them in the use of the survey tool to ensure data reliability. The survey was conducted on the mobile application, SurveyCTO. Real-time acquisition was made possible by using the mobile application to collect responses, which enabled us to monitor any oddities during the survey.

2.2 Qualitative assessments

The CEEW team conducted focus group discussions in Vizianagaram district, Andhra Pradesh.

Image: Saurabh Tripathi/CEEW

We conducted focus group discussions and semi-structured interviews with different sets of stakeholders to substantiate the findings; the details follow.

Focus group discussions

We conducted six FGDs, one in each of the sampled districts. The aim of the FGDs was to solicit farmers' perspectives on three overarching themes: (1) the process of procuring fertilisers and the timely availability of fertilisers; (2) their experiences with fertiliser retailers and wholesalers and their fertiliser subsidy awareness; and (3) their views on future plans to scale-up ZBNF. One village from each of the sampled districts was randomly selected to participate in the FGDs. Each group comprised of both ZBNF and non-ZBNF farmers. The group size ranged from 15–25 farmers and each discussion lasted for about one hour on average. We audio-recorded all the discussions. All FGD audio recordings were transcribed from Telugu to English for the purpose of analysis. Notes were made in addition to the audio recordings. The information gathered at these discussions was used to substantiate, validate, and complement the quantitative analysis of the survey.

Semi-structured interviews

In addition to the FGDs with farmers, we also conducted two sets of semi-structured interviews for this study. In the first set, six interviews were conducted separately with fertiliser dealers and retailers. One retailer or dealer was randomly selected from the village where an FGD was conducted. Their views were solicited on scaling ZBNF and the challenges faced by them in the current fertiliser distribution scenario. In the second set, two semi-structured interviews were conducted in Guntur district with key industry stakeholders and state government officials from the Fertiliser Wing. The objective of these interviews was to help us understand the fertiliser subsidy mechanism and distribution in the state and to solicit stakeholders' views on scaling up ZBNF.

Image: Field partner

2.3 Calculation of savings in fertiliser subsidies

The CEEW team conducted semi-structured interviews with key industry stakeholders and state government officials in Vijayawada, Andhra Pradesh.

Image: Field partner

We attempt to study the fiscal implication of ZBNF scale-up in terms of savings in fertiliser subsidies. This section explains the approach taken for the calculations.

Avoided fertiliser consumption and subsidies

We hypothesise that there is a significant difference in the average consumption of fertilisers by farmers who practice ZBNF and those who do not. To test our hypothesis, we used a simple linear regression approach. For each type of fertiliser (urea, SSP, MOP, etc.), we ran an independent analysis.

We used a linear regression equation with the natural log of the fertilisers used per acre in the kharif season as the dependent variable. Some farmers did not report any consumption of fertilisers, which made the natural log calculations impossible. Therefore, before converting the values into their logarithmic form, they were increased by one.

Summary statistics of all the covariates used in the linear regression model is given in Table 2. The following explanatory variables are employed in the regression.

ZBNF farmer is a dummy variable and represents whether the respondent is a ZBNF farmer or a non-ZBNF farmer. We asked farmers how much of their landholding is under ZBNF cultivation out of their total agricultural land. We coded the response into a binary variable where "1" is assigned to farmers who reported area under ZBNF as greater than zero and "0" where the area under ZBNF was reported as zero. All the results pertaining to ZBNF farmers in this study refers to only ZBNF land and not the total agricultural land.

We include **age of the farmer** as a proxy for his experience in farming. The effect of age on fertiliser use is not straightforward in the literature. Older farmers may have more experience in farming, which may affect how much fertilisers to use. Farmers with more years of farming experience are better positioned to make rational choices and decide between alternative farm inputs. On the other hand, older farmers tend to be more averse to risk and prudent than younger farmers and have a higher likelihood of applying greater amounts of fertiliser (Zhou, et al. 2010).

We include **the number of household members engaged in agriculture** as a proxy for readily available farm labour. Having more household members engaged in agriculture could imply more availability of farm labour, especially for field application and transportation of fertilisers (Minot, Kherallah and Berry 2000). Alternatively, having more household members engaged in agriculture could also mean an easier transition to ZBNF, which is much more labour intensive than conventional farming.

We include a binary variable for **whether the farm household also has a non-farm income** as a proxy for its ability to make out-of-pocket expenditures. A consistent off-farm income could also ensure cash availability for agricultural input purchases (Zhou, et al. 2010).

Cultivated area is the total cultivated land (owned as well as leased) for a given season as reported by farmers and measured in acres.

We include a binary variable for **whether the farmer irrigates** for the main kharif crop to control for farmers' access to irrigation, which could affect fertiliser use. The percentage of area under irrigation and the quality and quantity of the irrigation are determinants of fertiliser consumption (Malik and Sekhar 2007). We expect that access to irrigation could facilitate higher fertiliser use.

We include dummy variables for three crops—**rice farmer, maize farmer, and groundnut farmer**—to capture the crop-specific effect on fertiliser consumption. Each crop has different nutrient requirements, and its N, P, and K consumption varies. Cereals like paddy or maize require more N fertilisers when compared to crops such as oil palm and sugarcane, which require greater K use (Heffer, Gruère and Roberts 2017). We selected these three crops as there were a significant number of observations for these three crops in our data-set. Each of the variables takes the value of "1" if the farmer is cultivating that specific crop and "0" otherwise. We also included three interaction terms in our equation – ZBNF rice farmer, ZBNF groundnut farmer, and ZBNF maize farmer – in order to capture the effect of ZBNF on these crops.

The **price of fertiliser** is the median price of a particular fertiliser that farmers reported in a particular village. The median value was calculated using the values given by farmers who reported a non-zero price. If all farmers reported a zero price for any fertiliser, the district median price of that fertiliser was applied. This covariate required changes similar to those in the fertiliser consumption variable.

The **level of education** of the farmer is often used as a measure of better access to technical information about fertilisers and knowledge on how much fertilisers to use, which could reduce the probability of excess consumption (Waithaka, et al. 2007). We use four dummy categories for education keeping no formal schooling as the base category; (a) up to fifth standard; (b) up to tenth standard; (c) twelfth standard or diploma; and (d) graduate and above.

Table 2: Expected association with fertiliser use and summary statistics of all covariates used in the linear regression model (n = 581 farmers)

Dependent variable: fertiliser used per acre [ln(y+1)]	Expected association with fertiliser use	Mean	Standard deviation	Minimum	Maximum
Farmer practices ZBNF (binary variable)	-	0.437	0.496	0	1
Age of the farmer (years)*	+/-	48.224	12	19	82
Age of the farmer [ln(y+1)]	+/-	3.865	0.257	2.996	4.419
Number of household members involved in agriculture [ln(y+1)]	+	1.127	0.329	0.693	2.398
Household has non-agricultural source of income (binary variable)	+	0.530	0.5	0	1
Total cultivated area (acres)*	-	3.274	5.141	0.1	70
Total cultivated area [ln(y+1)]	-	1.209	0.605	0.095	4.263
Farmer irrigates land for main kharif crop (binary variable)	+	0.914	0.281	0	1
Farmer grows rice (binary variable)	+	0.652	0.477	0	1
Farmer grows rice and practices ZBNF (binary variable)	-	0.272	0.445	0	1
Farmer grows groundnut (binary variable)	-	0.139	0.347	0	1
Farmer grows groundnut and practices ZBNF (binary variable)	-	0.06	0.238	0	1
Farmer grows maize (binary variable)	+	0.091	0.288	0	1
Farmer grows maize and practices ZBNF (binary variable)	+/-	0.031	0.173	0	1
Price of urea in the village (per kilogram)*	-	6.646	1.087	5.4	14
Price of urea in the village [ln(y+1)]	-	2.027	0.111	1.856	2.708
Price of DAP in the village (per kilogram)*	-	24.931	3.023	13	30
Price of DAP in the village [ln(y+1)]	-	3.247	0.133	2.639	3.434
Price of SSP in the village (per kilogram)*	-	20.853	5.570	6	32
Price of SSP in the village [ln(y+1)]	-	3.0443	0.303	1.946	3.497
Price of MOP in the village (per kilogram)*	-	22.252	34.944	11.1	300
Price of MOP in the village [ln(y+1)]	-	2.975	0.361	2.493	5.707
Price of complexes in the village (per kilogram)*	-	58.861	234.484	12.354	1808
Price of complex in the village [ln(y+1)]	-	3.306	0.668	2.592	7.501
Education of the farmer (categorical; base category is no education)					
Up to 5th standard	-	0.284	0.451	0	1
Up to 10th standard	-	0.250	0.433	0	1
Up to 12th standard	-	0.071	0.256	0	1
Graduate and above	-	0.074	0.262	0	1

* *Although summary statistics of the variable are presented to lend context, only the [ln(y+1)] transformation of the variable was used in the regression analyses.*

Source: Authors' analysis

According to our survey, non-ZBNF farmers used three times more urea and DAP per acre than ZBNF farmers did.

Image: Niti Gupta/CEEW

3. Results of the survey

In this chapter, we describe some key predictors for a farmer adopting ZBNF practices and assess the degree to which ZBNF affects the use of, and expenditure on, various agricultural inputs, and primarily fertilisers.

ZBNF farmers mulching a field with groundnut shells.

3.1 Sample characteristics of ZBNF and non-ZBNF cohorts

About 44 per cent of the farmers in our sample were practising ZBNF. Education levels differed between the two cohorts – a much higher proportion of ZBNF farmers had been educated beyond fifth standard (grade) schooling than non-ZBNF farmers. This was a trend found in all districts surveyed, notwithstanding systematic differences in farmers' education levels across districts (see Table 3).

Characteristics	ZBNF cohort	Non-ZBNF cohort
Age (years; median values)	46	49
Gender		
Male	93%	96%
Female	7%	4%
Education		
No formal schooling	20%	42%
Up to 5th standard	30%	27%
Up to 10th standard	30%	21%
12th standard or diploma	9%	5%
Graduate and above	11%	5%
Caste		
Scheduled Caste	9%	8%
General	38%	48%
Other Backward Class	44%	37%
Scheduled Tribe	3%	3%
Others	6%	4%
Has non-farm income source	58%	49%

Table 3: Socioeconomic characteristics of the ZBNF and non-ZBNF cohorts

Source: Authors' analysis

We also found that three-quarters of the ZBNF respondents were marginal farmers, whereas half of the non-ZBNF farmers were in this operational land holdings category (Figure 3). Further, within ZBNF-practising farmers, those with large operational landholdings use ZBNF practices in only 48 per cent of their land as compared to 77 per cent of land among small farmers and 61 per cent of land among marginal farmers.

When asked in the FGDs, small and large farmers clarified that since the preparation of ZBNF inputs is time and labour intensive, and since there are not enough shops selling natural fertilisers right now, they would like to test the process and assess the yield in smaller plots of land before applying it to their entire cultivable land.

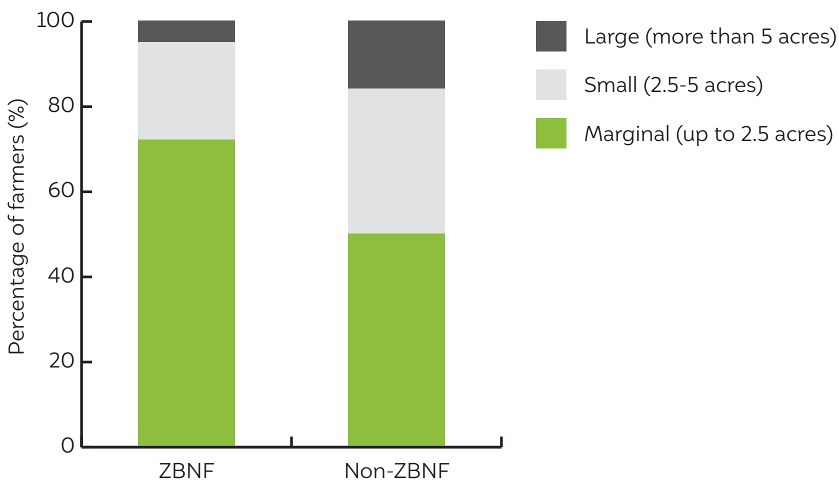
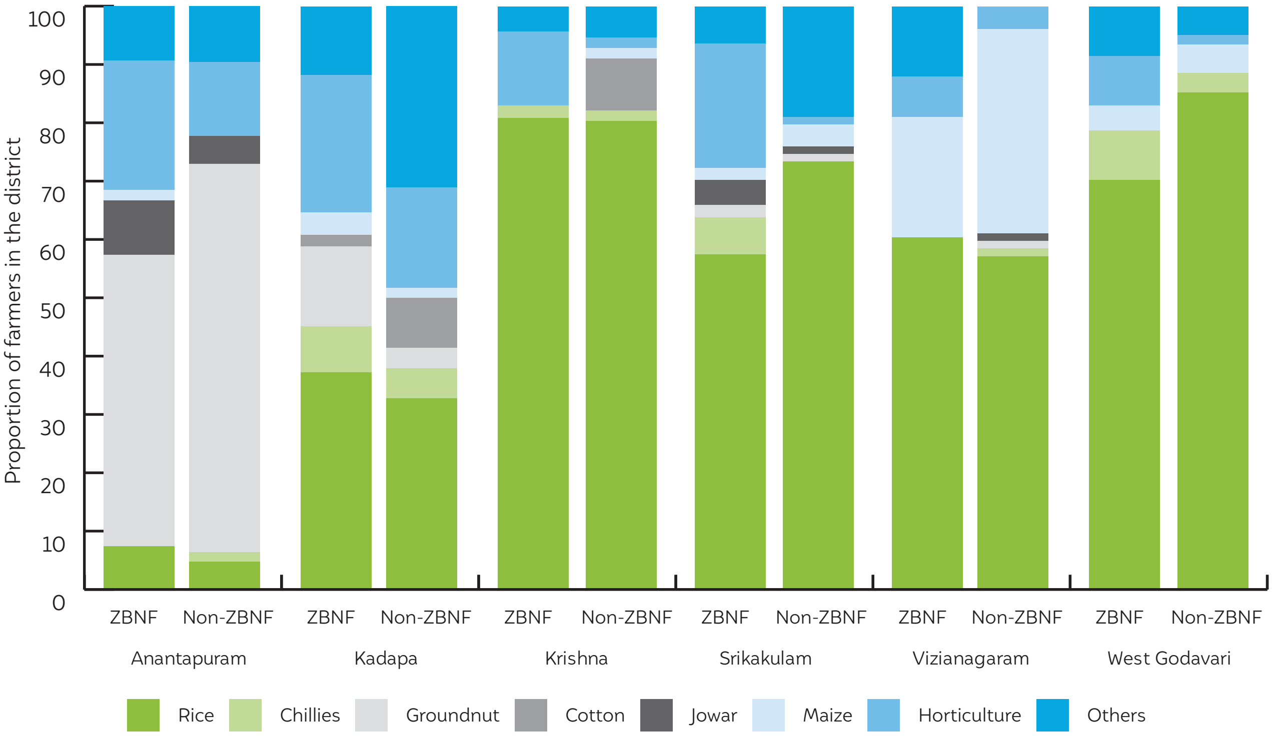


Figure 3: Almost 70 per cent of the ZBNF respondents were marginal farmers as compared to 50 per cent of non-ZBNF farmers with operational land holdings of less than 2.5 acres

Source: Authors' analysis

In all districts—barring Kadapa—ZBNF farmers were cultivating a far wider set of crops as their primary kharif crop, indicating potential for a shift in Andhra Pradesh's cropping pattern (see Figure 4). In Kadapa, where farmers were generally cultivating less of conventional crops in lieu of bananas, sunflower, sesame, and sorghum, a higher proportion of ZBNF farmers were growing chillies and groundnut than non-ZBNF farmers.

Figure 4: ZBNF farmers were growing more fruits and vegetables as their kharif crop compared to non-ZBNF farmers



Source: Authors' analysis

Rice and maize were the most cultivated crops across both cohorts in all the districts except Anantapuram, where groundnut remained the most cultivated crop. We found that almost 12 per cent of ZBNF farmers were growing fruits and vegetables as their main kharif crop as compared to three per cent of non-ZBNF farmers. Such a shift in the cropping pattern could be the result of multi-cropping and inter-cropping – both of which are strongly encouraged under ZBNF – and could critically alter the relative production of various food crops in the state.

All crop-level analyses to follow in this study are limited to rice, groundnut, and maize, on which we have enough observations to derive inferences. We have a reasonable number of observations for rice in five districts, except for in Anantapuram, where we found that most farmers were cultivating groundnut. Only in Vizianagaram did we find a sizeable proportion of maize farmers. For the district-level crop-wise analysis, only these district–crop combinations were considered, mainly owing to the limited number of observations with other district–crop permutations.

3.2 Is ZBNF less cost intensive than chemicals-based farming?

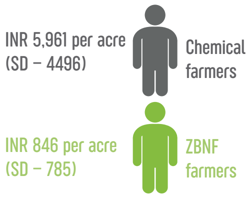
Image: Niti Gupta/CEEW

The central proposition of ZBNF is the lower costs on fertiliser inputs compared to chemicals-based agriculture. We compare the fertiliser input costs by crop for complete ZBNF, partial ZBNF and conventional farmers to test this (Figure 5).

The cost of chemical fertiliser and pesticide are zero in case of a complete ZBNF farmer and it is lower in a partial ZBNF farmer vis-à-vis a chemical farmer. We found that on an average, chemical farmers cultivating rice spent INR 5,961 per acre (SD – INR 4,496) on chemical inputs, while a complete ZBNF farmer incurred an expenditure of INR 846 per acre (SD – INR 785) on natural inputs, a difference of almost 90 per cent in the expenditure on fertiliser and pesticide inputs (Figure 6). The partial ZBNF farmers in the transition phase, who used some amount of both natural and chemical fertilisers, reported spending an average of INR 4,664 per acre (SD – INR 3,176) on chemical inputs and INR 652 per acre (SD – INR 823) on natural inputs, which is still marginally lower than using all chemical inputs. Several components of chemical inputs such as urea are heavily subsidised by the central government. If we add back the subsidised amount in this calculation, an even higher difference in fertiliser costs between the two cohorts is likely.

We found a significant difference (93 per cent) in fertilisers expenses between the two cohorts for maize as well. ZBNF farmers spent INR 503 per acre (SD – INR 414) on natural inputs whereas chemical farmers, on an average, spent INR 7,509 per acre (SD – INR 4,382) on chemical fertilisers inputs (Figure 5). For groundnut, a chemical farmer spent INR 1,187 per acre as against INR 780 per acre by a complete ZBNF farmer. A partial ZBNF farmer, however, reported an even higher expenditure of INR 1,936 per acre on both natural and chemical inputs.

Several components of chemical inputs such as urea are heavily subsidised by the central government. If we add back the subsidised amount in this calculation, we could expect an even higher difference in the fertiliser cost between the two cohorts.



On an average, chemical farmers cultivating rice spent INR 5,961 per acre on chemical inputs, while a complete ZBNF farmer incurred INR 846 per acre on natural inputs

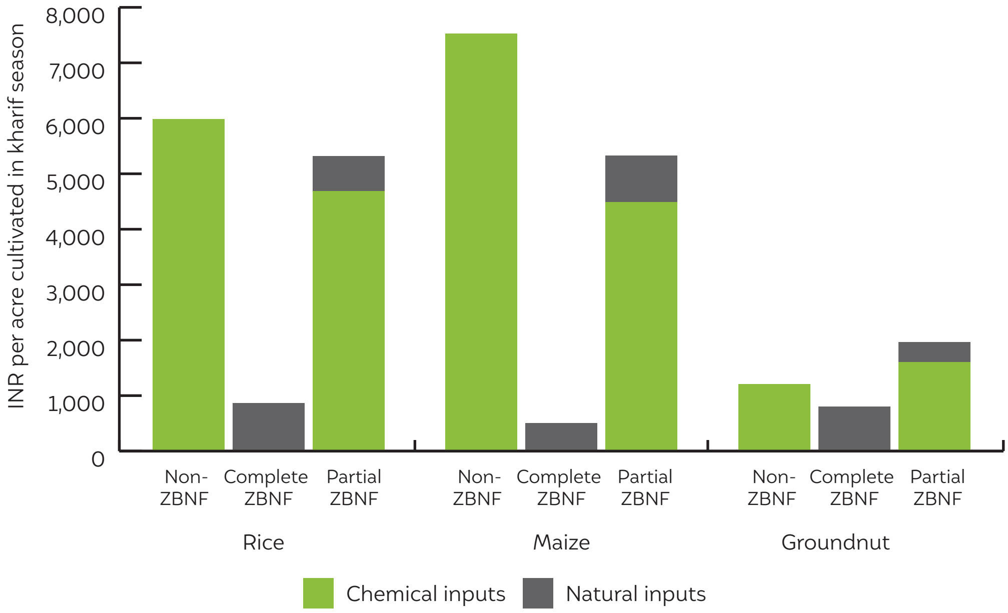


Figure 5: Average input cost on fertilisers and pesticides drops significantly for ZBNF rice and maize farmers

Source: Authors' analysis

Number of Observations: Rice: N-ZBNF (217), C-ZBNF (133), P-ZBNF (22); Maize: N-ZBNF (35), C-ZBNF (6), P-ZBNF (12); Groundnut: N-ZBNF (46), C-ZBNF (21), P-ZBNF (14)

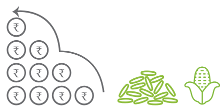
It is also important to note that fertiliser consumption in Andhra Pradesh varies by agro-climatic zone. While per-acre urea and SSP consumption was highest in Vizianagaram, DAP use was highest in Kadapa, and MOP highest in Krishna. These differences could be a function of the crops cultivated, soil type, and prevailing local agricultural norms.

ZBNF inputs like *jeevamrutham*, *beejamrutham*, *kashayam*, and other natural preparations could have a major impact on cost of cultivation due to reduced expenditure on chemical fertilisers and pesticides. In our FGDs, we observed that labour cost is an important component that could impact the net income of natural farmers. *Beejamrutham* proves to be the most labour intensive, as it requires coating the seeds in the prepared treatment and mixing them by hand. Most activities under ZBNF requires manual effort. Concerns around the labour intensity of the process and the low availability of input shops were raised primarily by farmers with larger landholdings.

We compare input costs by crop for ZBNF and conventional farmers (Figure 6). Our calculation of farm input cost is the sum of the self-reported expenditure on seeds, fertilisers (chemical and natural), pesticides (chemical and natural), weedicides, irrigation, and labour (for land preparation, sowing, irrigation, chemical fertiliser application, harvesting, threshing, transport and pest and weed control). It does not include the cost of agricultural implements and livestock.

ZBNF farmers cultivating rice and maize in the kharif season bore considerably lower input costs per acre as compared to their non-ZBNF peers. The median cost per acre of cultivated land for the ZBNF cohort growing rice stood at INR 12,200 (mean: INR 13,918), whereas that for the non-ZBNF cohort was INR 14,700 (mean: INR 15,580). For the cultivation of maize too, the median expenditure per acre for ZBNF farmers was INR 15,660 (mean: INR 15,925), while that for non-ZBNF farmers was INR 17,425 (mean: INR 19,812). The per acre input cost of ZBNF farmers cultivating groundnut was however higher than that of non-ZBNF farmers, in contrast to rice and maize. The median cost of groundnut cultivation per acre for the ZBNF cohort was INR 12,483 (mean: INR 15,964) as compared to the median of INR 9,996 (mean: INR 11,952) for the non-ZBNF group.

ZBNF farmers



(Oct.-March)

ZBNF farmers cultivating rice and maize in the kharif season bore considerably lower input costs per acre as compared to their non-ZBNF peers

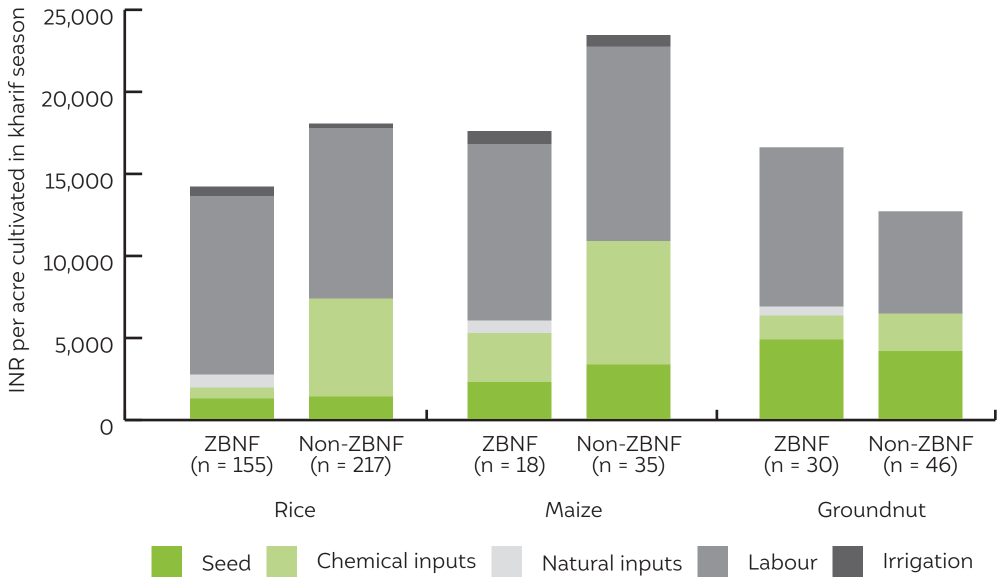


Figure 6:
Average input cost drops significantly for ZBNF rice and maize farmers mainly because of savings from avoided use of chemical fertiliser and pesticides

Source: Authors' analysis

Calculation of input costs per kg of output could also give interesting insights to this practice. We recognise that the actual yield captured on farm depends on several climatic and non-climatic factors including the water and nutrients absorbed by the crop, presence of weeds and pests, the crops' genetic potential, etc. A study of variations in yield requires scientific crop-cutting experiments. From the self-reported yield data from the farmers in our study, we could not find any conclusive results as to the impact of ZBNF on crop yield. Further examination and in-depth analysis of the data with scientific institutions would be valuable for further research.

4. The potential for savings in fertiliser subsidies

Due to systemic inefficiencies and high resource dependencies, the dominant form of agriculture today imposes critical challenges for a range of stakeholders – from farmers to consumers, as well as natural ecosystems and biodiversity.

In this chapter, we estimate the avoided fertiliser consumption in the event of full-scale ZBNF adoption in Andhra Pradesh. We then calculate the potential for savings in fertiliser subsidies and abated emissions.

4.1 How much will fertiliser consumption drop if ZBNF were adopted state-wide?

We use an ordinary least squares regression model to identify the extent to which ZBNF adoption could drive a reduction in fertiliser use, after accounting for other potential determinants of consumption. A model is specified for each of the fertilisers studied – urea, DAP, SSP, MOP, and complexes (see Table 4).

Table 4: Results of the linear regression model for each fertiliser studied

Dependent variable: fertiliser used per acre [ln(y+1)]	Urea	DAP	SSP	MOP	Complex
Farmer practises ZBNF (binary variable)	−2.998*** (0.331)	−3.039*** (0.364)	−1.187*** (0.313)	−0.842*** (0.210)	−1.285*** (0.393)
Age of the farmer [ln(y+1)]	−0.151 (0.261)	0.047 (0.280)	−0.073 (0.241)	−0.015 (0.184)	0.193 (0.269)
Number of household members involved in agriculture [ln(y+1)]	0.339* (0.205)	0.163 (0.230)	0.135 (0.205)	0.105 (0.142)	0.251 (0.240)

Table 4 continued...

Dependent variable: fertiliser used per acre [ln(y+1)]	Urea	DAP	SSP	MOP	Complex
Household has a non-agricultural source of income (binary variable)	0.15 (0.117)	0.124 (0.128)	0.054 (0.129)	0.256** (0.103)	0.222 (0.145)
Total cultivated area [ln(y+1)]	0.118 (0.082)	0.079 (0.070)	0.164** (0.080)	0.152** (0.062)	0.325*** (0.089)
Farmer irrigates land for the main kharif crop (binary variable)	0.253 (0.298)	-0.267 (0.308)	0.816*** (0.185)	0.194 (0.131)	0.204 (0.263)
Farmer grows rice (binary variable)	0.677** (0.268)	0.090 (0.293)	-0.157 (0.332)	0.223 (0.225)	−0.534 (0.355)
Farmer grows rice and practises ZBNF (binary variable)	−0.857* (0.343)	−0.293 (0.383)	0.299 (0.351)	−0.370 (0.227)	0.105 (0.402)
Farmer grows groundnut (binary variable)	−1.024** (0.471)	−0.932* (0.474)	−0.839* (0.463)	−0.411 (0.335)	−0.803 (0.528)
Farmer grows groundnut and practises ZBNF (binary variable)	1.965*** (0.540)	1.098* (0.562)	0.901** (0.419)	0.605** (0.288)	0.917* (0.494)
Farmer grows maize (binary variable)	0.636** (0.278)	−0.022 (0.357)	1.089** (0.458)	−0.274 (0.227)	−0.002 (0.380)
Farmer grows maize and practises ZBNF (binary variable)	1.186* (0.613)	1.588** (0.635)	−0.127 (0.632)	0.706*** (0.244)	0.415 (0.489)
Price of urea in the village [ln(y+1)]	−0.562 (0.948)				
Price of DAP in the village [ln(y+1)]		−0.380 (0.665)			
Price of SSP in the village [ln(y+1)]			−0.379 (0.242)		
Price of MOP in the village [ln(y+1)]				−0.089 (0.080)	
Price of complexes in the village [ln(y+1)]					0.042 (0.119)
Education of the farmer (categorical; base category is no education)					
Up to 5th standard	−0.157 (0.146)	0.035 (0.163)	−0.108 (0.164)	−0.191 (0.124)	−0.036 (0.185)
Up to 10th standard	−0.043 (0.162)	0.026 (0.176)	−0.130 (0.182)	0.071 (0.146)	−0.046 (0.193)
Up to 12th standard	−0.472 (0.315)	0.031 (0.325)	0.202 (0.289)	−0.032 (0.231)	−0.032 (0.298)
Graduate and above	−0.655 (0.252)	−0.431* (0.258)	−0.235 (0.236)	−0.269 (0.198)	−0.190 (0.277)
Number of observations	580	580	580	580	580
District fixed effects	Yes	Yes	Yes	Yes	Yes
F statistic	119.75	60.68	7.08	8.35	6.57
Prob>F	<0.001	<0.001	<0.001	<0.001	<0.001
R^2	0.6706	0.5540	0.2171	0.3382	0.2314

*Note: Standard errors are in parentheses below the coefficients. Standard errors reported are robust to heteroskedasticity of residuals. *** p<0.01, ** p<0.05, * p<0.10*

Source: Authors' analysis

As hypothesised, we find that farmers who have adopted ZBNF use less of each fertiliser than the non-ZBNF cohort, ceteris paribus. Non-ZBNF farmers used three times more urea and DAP per acre than ZBNF farmers did.

There were considerable variations in the use of fertilisers across crops. Rice and maize farmers used more urea per acre than those growing other crops, and groundnut farmers used far lesser of each fertiliser modelled than those cultivating other crops. Reliance on SSP was by far the highest among maize farmers, indicating the highly crop-specific application of fertilisers and the need for crop-segregated analysis.

We estimate the expected use of each fertiliser per acre, ceteris paribus, for the three major crops in our survey—rice, maize, and groundnut—and all other crops, by multiplying the coefficient and the arithmetic mean of the covariates in the regression analysis and summing them up. To calculate the difference in expected fertiliser use between ZBNF and non-ZBNF cohorts, we used the crop-specific binary variables and crop–ZBNF interaction variables in the model (see Table 5). For instance, the expected urea use for ZBNF rice farmers is 0.59 kilograms per acre (kg/acre) and for non-ZBNF farmers is 74.46 kg/acre, resulting in 73.87 kg/acre of avoided urea consumption. The avoided fertiliser consumption due to ZBNF varied from 83–99 per cent for various fertilisers in rice. For the groundnut crop, we found a reduction of almost 70 per cent in urea and 91 per cent in DAP, due to ZBNF (Table 5)

Fertiliser	Unit	Rice	Groundnut	Maize
Urea	kg/acre	74.5	12.8	71.4
	%	99.2	69.5	84.9
DAP	kg/acre	46.8	16.2	41.7
	%	98.5	90.9	78.4
SSP	kg/acre	2.5	0.7	11.0
	%	82.9	58.3	79.8
MOP	kg/acre	2.4	0.8	1.1
	%	99.8	47.7	24.6
Complexes	kg/acre	3.3	2.3	6.3
	%	90.4	44.4	67.4

Table 5: Fertiliser consumption of non-ZBNF farmers (kg/acre) and avoided fertiliser consumption due to ZBNF (per cent)

Source: Authors' analysis

The differences in avoided fertiliser use across crops are attributable to the binary variables included for each of the main crops. However, the avoided fertiliser consumption for each crop is attributable to two reinforcing effects: (a) the general effect of ZBNF practices stemming from the binary variable, indicating whether or not a farmer has adopted ZBNF; and (b) the specific effect that ZBNF has on each crop where it is practised, stemming from the crop–ZBNF interaction variables.

To determine the total fertiliser subsidy that will be avoided if ZBNF were scaled up state-wide, we first envision three policy scenarios:

1. **Low-policy-effort scenario**: The state government does not actively try to extend ZBNF to all farmers, and reduces its budgetary allocation for scaling up ZBNF. Given the current penetration of ZBNF, even without a concerted policy push, 25 per cent of the total cropped area in Andhra Pradesh will still shift to ZBNF, owing to word-of-mouth communication about the impacts of the practice in social networks.

2. **Medium-policy-effort scenario**: The state government tries to extend ZBNF to all farmers in the state. Not all are convinced to shift to ZBNF, and those who make the switch do not do so on all the land that they cultivate. In this case, 75 per cent of the total cropped area in Andhra Pradesh shifts to ZBNF.
3. **High-policy-effort scenario:** The state government actively tries to extend ZBNF to all farmers in sync with its vision to cover the entire 8 million hectares of agricultural land in Andhra Pradesh. In this case, 100 per cent of the total cropped area in Andhra Pradesh shifts to ZBNF.

Next, we calculate the state-wide reduction in fertiliser consumption (in metric tonnes) using the coefficients estimated in Table 4. We assume that the per acre avoided consumption holds true for all farmland in Andhra Pradesh. The state-wide consumption figures in the three policy scenarios are then used to estimate savings in fertiliser subsidies.

4.2 To what extent will fertiliser subsidies be avoided?

The Fertiliser Association of India (2018) reports the extent of the subsidy provided by the Government of India for each major fertiliser sold in 2017–18 (see Table 6). We use these figures to estimate the potential savings in the three policy scenarios. The per tonne subsidy on urea is derived from the total outlay subsidy on urea in 2017–18 (INR 46,980 crore/ USD 6600 million) as reported in Standing Committee report on Chemicals and Fertiliser 2017–18 and total urea sales during that year – approximately 3 crores tonnes (Fertiliser Association of India 2018). The subsidy on complexes is an average of the subsidies offered on 15 different types of complexes that were sold in 2017–18, since we do not know which specific complex our survey respondents had used.

	Low-policy-effort scenario	Medium-policy-effort scenario	High-policy-effort scenario
	Given the current penetration of ZBNF, even without a concerted policy push, ***25%*** of the total cropped area in Andhra Pradesh will still shift to ZBNF, owing to word-of-mouth communication about the impacts of the practice in social networks.	The state government tries to extend ZBNF to all farmers in the state. Not all are convinced to shift to ZBNF and in this case, ***75%*** of the total cropped area in Andhra Pradesh shifts to ZBNF.	The state government actively tries to extend ZBNF to all farmers in sync with its 2024 vision and in this case, ***100%*** of the total cropped area in Andhra Pradesh shifts to ZBNF.
Expected savings in fertiliser subsidy	**Current transition (includes partial ZBNF farmers)**		
	₹ 517 crores ($ 72 million) annually	**₹ 1,553 crores** ($ 218 million) annually	**₹ 2,071 crores** ($ 290 million) annually
	Future transition (assumes all adopters as complete ZBNF farmers)		
	₹ 539 crores ($ 76 million) annually	**₹ 1,615 crores** ($ 227 million) annually	**₹ 2,154 crores** ($ 300 million) annually

Source: Authors' analysis

Fertiliser	INR per tonne	USD per tonne
Urea	15,715	221
DAP	8,937	125
SSP	2,166	30
MOP	7,437	105
Complexes	7,362	104

Table 6: Subsidy provided by the Government of India per tonne of fertiliser sold in 2017–18

Source: Authors' analysis and Fertiliser Association of India. 2018. Annual Report 2017–18. Government of India, Ministry of Chemicals & Fertilisers

Based on the actual consumption of major fertilisers reported in our survey, we estimate that if zero per cent of the total cropped area in Andhra Pradesh were under ZBNF – a counterfactual, the total outlay on subsidies would be INR 2,154 crore (USD 300 million)

Against this counterfactual, in the low policy effort scenario, we estimate fertiliser subsidy savings worth INR 517 crore (USD 72 million) annually on account of ZBNF penetration, which is 24 per cent of the total outlay on subsidies under the counterfactual scenario. Bulk of this savings is resulting from the avoidance of the subsidy on urea. In the medium policy effort scenario, we estimate subsidy savings worth INR 1,553 crore (approximately, USD 218 million) annually and finally, in 100 per cent ZBNF scenario, we expect subsidy savings worth INR 2,071 crores (USD 290 million) annually, which is almost 96 per cent of the subsidy outlay under the counterfactual scenario (zero penetration of ZBNF).This calculation reflects current ground realities where some ZBNF farmers are still in the transition phase and are using some level of chemical inputs.

We also calculated the potential savings in subsidies assuming a complete transition of the adopters. We find that in a low policy effort scenario, fertiliser subsidy savings worth INR 539 crore (USD 76 million) annually could be expected. In a medium INR 1,615 crore worth of savings could be expected (USD 227 million) and in the high policy scenario, we expect subsidy savings worth INR 2,154 crore annually (USD 300 million) – a 100 per cent savings against the counterfactual scenario.

These savings are crop-dependent, given the particular reliance of some crops on certain fertilisers and the crop-specific impact of ZBNF. For instance, the majority of savings in urea are concentrated in rice cultivation, given the high use of urea in rice, and the considerable area in the state allocated to rice cultivation. Most savings in SSP are concentrated in maize cultivation, in spite of the smaller area under cultivation, because of the high savings potential of avoidance of SSP in maize cultivation under ZBNF.

We find that our estimate of the subsidy requirement, based on actual use, is only about 60 per cent of the subsidy that is spent in the state, as based on sales figures reported by manufacturers, which is a little over INR 3,485 crore (USD 490 million). There are two possible explanations:

- We presume that the gulf between our subsidies estimate based on actual consumption and the actual figures based on the sales records of manufacturers can be explained by leakages in the subsidy mechanism. The nearly 40 per cent difference between the two figures is slightly lower than the 65 per cent of leakage in fertiliser subsidies estimated by the Government of India (2017). As the urea sector is highly regulated, it is highly probable that a black market exists. Since we did not directly capture leakage in the system, the presence of a black market might be a credible explanation.
- In our estimations, we asked farmers about their fertiliser use for their two main kharif and rabi crops. As a consequence, we were unable to include total fertiliser consumption by farmers who grow more than two crops each season. In our survey, only 24 per cent of all farmers had a second kharif crop to report on, so not many would have had a third or fourth crop.

In 100 per cent ZBNF scenario, we expect subsidy savings worth INR **2,071** crores (USD 290 million) annually, which is almost 96 per cent of the subsidy outlay under the counterfactual scenario (zero penetration of ZBNF)

With the introduction of the *Direct Benefit Transfer* (DBT) scheme in recent months, these leakages are expected to be plugged, and savings in fertiliser subsidies would then be attributable to both, ZBNF and the plugging of leakages through the direct transfer of subsidies.

Widespread adoption of ZBNF could have a direct impact on chemical fertiliser factories and retail shops, and most importantly, on jobs along the fertilisers value chain. During interviews, the responses of chemical retail shop owners ranged from complete ignorance to mild acceptance, when asked about the penetration of ZBNF practices in their local area. In the event of a ZBNF scale-up, such local shops could play an important role by stocking and retailing natural fertilisers. Most private retailers encountered during the course of this study showed a willingness to adapt to organic and natural fertilisers if the demand for those products was larger and sustained over a period of time. Many chemical retailers and dealers expressed concerns regarding the declining profitability of their shops, especially in rainfed districts such as Vizianagaram and Srikakulam, where they reported a decrease in fertiliser demand in recent years. Decreasing demand and profits are pushing existing private chemical fertiliser retailers to shut down. A surge in demand for ZBNF inputs could provide alternative livelihood opportunities for such local entrepreneurs.

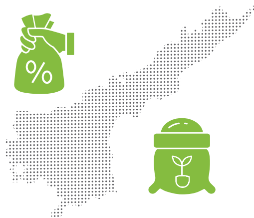
Most private retailers encountered during the study showed a willingness to adapt to organic and natural fertilisers if their demand was larger and sustained over a period of time

Indian farmers use about 55 million tonnes urea, DAP, MOP, and other complex fertilisers annually to increase productivity. In 2017–18, the per hectare consumption in 120 districts was more than 200 kgs, with the top five districts according to fertiliser consumption being Guntur and Kurnool in Andhra Pradesh, Jalgaon and Ahmedabad in Maharashtra, and West Godavari in Andhra Pradesh. As shown in the case of Andhra Pradesh, the savings in fertiliser consumption could help Indian government save a huge percentage in fertiliser subsidies, which is estimated at INR 79,996 crores (USD 11,110 million) for 2018–19.

5. Conclusion

Image: RySS

Agriculture is at the heart of the discourse on employment, economic growth, and food security in India. There is now increasing recognition that Indian agriculture needs to reduce its dependence on chemical fertilisers and adopt sustainable practices to take into account the full costs and impacts of existing production practices. In Andhra Pradesh, as part of a state government-led initiative, ZBNF practices have been extended to 500,000 farmers. The vision to extend ZBNF to all six million farmers and eight million hectares of cultivable land in the state by 2024 is ambitious but timely. Andhra Pradesh's leadership has had a decisive impact on the central government's strategy to promote sustainable agricultural practices across the country, with the prime minister having recommended the scaling up of ZBNF across the country while addressing the 14^{th} Conference of Parties (COP14) to the United Nations Convention to Combat Desertification (UNCCD). It is therefore critical that evidence of the process and the impacts of ZBNF be generated, not only in Andhra Pradesh, but in other regions and agro-climatic zones as well.



Andhra Pradesh with its vision to roll out ZBNF to the entire state could save ~ INR 2,100 crore/USD 295 million annually in fertiliser subsidies

Case studies on ZBNF have documented the experience of ZBNF farmers who transitioned from conventional practices. While some studies reported positive outcomes in terms of reduced input costs and improved yield and farm income, further data and research is needed to validate these outcomes (S.Galab, et al. 2019). This study contributes to a growing evidence base by gathering insights from a survey of about 600 farmers across all agro-climactic zones in Andhra Pradesh, and captures the potential for reduction in fertiliser consumption by ZBNF and non-ZBNF farmer cohorts.

We find that ZBNF farmers are growing more fruits and vegetables as their main kharif crop compared to their counterparts. Such a shift at scale could alter the relative production of various crops and at the same time could contribute towards more balanced diet of farmers and nutritional security for farmers and consumers. We find significantly lower fertiliser consumption (>95 per cent in most instances) in the ZBNF cohort than in the non-ZBNF cohort of farmers. The reduction in urea application in rice cultivation due to ZBNF practices is most notable, at 74 kg/acre. This could mean a dramatic reduction in the reliance on fertiliser subsidies if the practice were scaled up nationally. In the national context, if the transition to ZBNF happens at scale, we will have dramatic annual savings of thousands of crores of rupees (a 75 per cent transition to ZBNF in Andhra Pradesh alone is expected to reduce subsidy outflow by INR ~1,600 crore/USD 225 million). Andhra Pradesh with its vision to roll out ZBNF to the entire state could save ~ INR 2,100 crore/USD 295 million annually in fertiliser subsidies.

Indian agriculture is in the need of a 'shake-up', giving the surmounting agrarian crisis, growing water-stress, and stagnating yields despite growing chemical-inputs. Policies to promote ZBNF are yielding encouraging results for farmers in Andhra Pradesh. The sustained scale-up of ZBNF across the country may need state-level leadership in a manner similar to that in Andhra Pradesh. Changing cultivation practices to ZBNF could potentially eliminate the growing burden of fertiliser subsidies while extending chemical-free food to consumers.

References

Department of Agriculture, Co-operation & Farmers Welfare. 2018. *Agriculture Census 2015-16*. Ministry of Agriculture & Farmers Welfare Government of India.

Department of Fertilizers. n.d. *Fertilizer Policy.* Accessed September 14, 2019. http://fert.nic.in/page/fertilizer-policy.

Directorate of Economics and Statistics. 2018. *Statistical Abstract of Andhra Pradesh.* Vijayawada: Government of Andhra Pradesh.

2019. *Economic Times.* 05 July. Accessed November 18, 2019. https://economictimes.indiatimes.com/news/economy/policy/budget-2019-govts-subsidy-bill-13-32-up-at-rs-301694-cr-for-2019-20/articleshow/70091533.cms?from=mdr.

Fertiliser Association of India. 2018. *Annual Report 2017-18*. Government of India Ministry of Chemicals & Fertilizers Department of Fertilizers.

Gattingera, Andreas, Adrian Mullera, Matthias Haenia, Colin Skinner, Andreas Fliessbacha, Nina Buchmann, Paul Mädera, et al. 2012. “Enhanced top soil carbon stocks under organic farming.” *PNAS.*

Gulati, Ashok, and Pritha Banerjee. 2016. “Rationalising Fertiliser Subsidy in India: Key Issues and Policy Options.” *eSocialSciences.*

Gulati, Ashok, Marco Ferroni, and Yuan Zhou. 2018. “Supporting Indian Farms the Smart Way.” *Academic Foundation & ICRIER.*

Heffer, Patrick, Armelle Gruère, and Terry Roberts. 2017. *Assessment of Fertilizer Use by Crop at the Global Level*. International Fertilizer Association (IFA) and International Plant Nutrition Institute (IPNI).

India Today. 2019. *Budget 2019: What is zero budget farming that Nirmala Sitharaman referred to?* 05 July. Accessed September 14, 2019. https://www.indiatoday.in/budget-2019/agriculture/story/budget-2019-what-is-zero-budget-farming-that-nirmala-sitharaman-referred-to-1562554-2019-07-05.

Intergovernmental Panel on Climate Change. 2006. *Emission Factor Database*. Accessed September 14, 2019. https://www.ipcc-nggip.iges.or.jp/EFDB/main.php.

Khadse, Ashlesha, Peter Michael Rosset, Helda Morales, and Bruce G. Ferguson. 2018. “Taking agroecology to scale: the Zero Budget Natural Farming peasant movement in Karnataka, India.” *The Journal of Peasant Studies.*

Malik, R.P.S, and C.S.C Sekhar. 2007. *Factors Affecting Fertilizer Consumption in Haryana.* New Delhi: Agricultural Economics Research Centre.

Ministry of Chemicals and Fertiliser . 2017-18. “Standing Committee on Chemicals and Fertilisers.” Forty Third Report, New Delhi .

Minot, Nichloas William, Mylene Kherallah, and Phillippe Berry. 2000. *Fertilizer Market Reform and the Determinants of Fertilizer Use in Benin and Malawi*. MSSD Discussion Paper , Washington, D.C.: International Food Policy Research Institute.

Mohanty, BB. 2011. “We are Like the Living Dead’: Farmer Suicides in Maharashtra, Western India.” *The Journal of Peasant Studies* 243-276 .

S.Galab, P. Prudhvikar Reddy, D. Shree Rama Raju, C. Ravi, and A. Rajani. 2019. *Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh – Kharif 2018-19*. Hyderabad: Centre for Economic and Social Studies.

Sharma, Nayana, and Ritu Singhvi. 2017. “Effects of Chemical Fertilizers and Pesticides on Human Health and Environment: A Review.” *International Journal of Agriculture, Environment and Biotechnology*.

Sharma, Vijay Paul, and Hrima Thaker. 2011. “Demand for Fertiliser in India: Determinants and Outlook for 2020.”

The Hindu. 2018. *Naidu wants State to be a leader in natural farming*. 02 June. Accessed September 14, 2019. https://www.thehindu.com/news/national/andhra-pradesh/naidu-wants-state-to-be-a-leader-in-natural-farming/article24069375.ece.

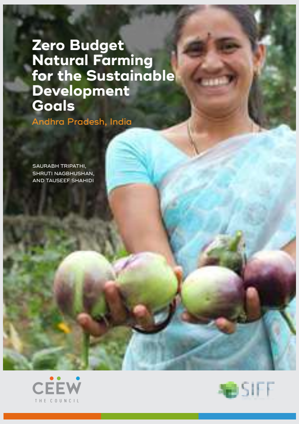
Tripathi, Saurabh, Tauseef Shahidi, Shruti Nagbhushan, and Niti Gupta. 2018. *Zero Budget Natural Farming for the Sustainable Development Goals*. CEEW.

Waithaka, Michael, Philip Thornton, Keith Shepherd, and Nicholas Ndiwa. 2007. “Factors affecting the use of fertilizers and manure by smallholders: The case of Vihiga, western Kenya.” *Nutrient Cycling in Agroecosystems* 78: 211-224.

Yashee. 2019. *Indian Express* . 10 September. Accessed November 14, 2019. https://indianexpress.com/article/explained/explained-the-idea-of-zero-budget-farming-and-why-scientists-are-sceptical-5983583/.

Zhou, Yuan, Hong Yang, Hans-Joachim Mosler, and Karim C. Abbaspour. 2010. “Factors Affecting Farmers Decisions on Fertilizer Use: A Case Study for the Chaobai Watershed in Northern China.” *Consilience* 80-102.

CEEW studies on Zero Budget Natural Farming in Andhra Pradesh



Zero Budget Natural Farming for Sustainable Development Goals (Andhra Pradesh, India)

Issue Brief | January 2018

Read the study here:
https://bit.ly/34zxZV9

Zero Budget Natural Farming for Sustainable Development Goals (Andhra Pradesh, India)

Issue Brief | 2nd Edition | September 2018

Read the study here:
https://bit.ly/34zoC4V

The issue briefs mapped the potential social, economic, and environmental impacts of the Government of Andhra Pradesh's (GoAP) Zero Budget Natural Farming (ZBNF) programme vis-à-vis the Sustainable Development Goals. Once rolled out across the state, ZBNF could help Andhra Pradesh and India make significant progress towards almost a quarter of the 169 SDG targets.

COUNCIL ON ENERGY, ENVIRONMENT AND WATER (CEEW)

Sanskrit Bhawan, A-10, Aruna Asaf Ali Marg
Qutab Institutional Area
New Delhi 110 067, India
T: +91 11 4073 3373

info@ceew.in | ceew.in | @CEEWIndia