Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh
A comprehensive Approach using Crop Cutting Experiments
Report for the Agricultural Year 2018-19

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Acronyms

ATMA	:	Agriculture Technology Management Agency
AWC	:	Anganwadi Centre
CA	:	Cluster Assistant
CCE	:	Crop Cutting Experiment
CESS	:	Centre for Economic and Social Studies
CRP	:	Community Resource Person
CS	:	Case Studies
CSPro	:	Census and Survey Processing System
DES	:	Directorate of Economics and Statistics
DPM	:	District Project Manager
DWAMA	:	District Water Management Authority
FDG	:	FGDs
FPO	:	Farmers Producers Organization
GCC	:	Girijan Co-operative Corporation
IASRI	:	Indian Agricultural Statistical Research Institute
ICRP	:	Internal Community Resource Person
ICT	:	Information and Communication Technology
MGNREGS	:	Mahatma Gandhi National Rural Employment Guarantee Scheme
NGO	:	Non-Government Organization
NPN	:	Non-Pesticide Management
NSSO	:	National Sample Survey Organization
NZBNF	:	Non-Zero Budget Natural Farming
PDS	:	Public Distribution System
RySS	:	Rythu Sadhikara Samstha
S2S	:	Seed to Seed
SDES	:	State Directorate of Economics and Statistics
SHG	:	Self Help Group
SI	:	Strategic Interview
ToT	:	Training of Trainers
TV	:	Television
ZBNF	:	Zero Budget Natural Farming

Executive Summary

I. Context

1. The Government of Andhra Pradesh through Rythu Sadhikara Samstha(RySS), Department of Agriculture has introduced Zero Budget Natural Farming (ZBNF) in 2016 as an alternative to chemical based agriculture. ZBNF is a paradigm shift in agricultural development. The main objective of ZBNF is to make agriculture economically viable, agrarian livelihoods profitable and climate-resilient. ZBNF aims to reduce cost of cultivation, enhance yields, increase incomes, reduce risks and protect agriculture sector from uncertainties of climate change by promoting the adoption of an agroecology framework. The present study is undertaken to examine the impact of agro ecological practices such as biological inputs, intense use of land, diversification of crops - intercrops, border crops, bund crops and different models of ZBNF - on the production conditions of farmers including improved soil fertility, improved yield, improved quality of output, improved health of farming community and resilience of crops to droughts, floods and cyclones (Paras 1.4 to 1.9).

II. The Approach

2. The study has adopted quantitative and qualitative approaches to assess the impact of ZBNF. As part of quantitative tools, listing Survey, household survey and village survey schedules were canvassed. As part of qualitative tools, Case Studies (CSs) of ZBNF farmers, Focussed Group Discussion (FGDs) with ZBNF and Non-ZBNF farmers and Strategic Interviews (SIs) with the District Project Managers (DPMs) who implement ZBNF at district level have been utilised. The study has adopted **"*With and Without* Approach"** to assess the impact of ZBNF. The approach makes a comparison between the ZBNF farmers and Non-ZBNF farmers to capture the contribution of ZBNF (Para 1.1).

3. The village-wise list of ZBNF farmers (Seed to Seed farmers or S2S farmers) was considered as the overall sample universe for the study. From this list of villages with S2S farmers, all the villages with more than 10 S2S farmers were short listed and further shortlisted the villages which grow at least one principal crop of the district for selection of 10 villages randomly from each district. Listing survey was administered for all the households in the sample villages to collect information on

the adoption/non-adoption of ZBNF practices, crops grown under ZBNF and Non-ZBNF, size of landholding and source of irrigation to generate universe of ZBNF and Non-ZBNF farmers for drawing sample of ZBNF and Non-ZBNF farmers. Based on listing survey, the required number of ZBNF and non-ZBNF farmers was randomly selected for household survey. Household schedule has been administered across the sample farmers of both ZBNF and Non-ZBNF to collect information on land use pattern, cropping pattern, patter of input use, cost of inputs, yields of crops and net incomes to farmers from crops to formulate impact indicators (Paras 1.13 to 1.18) .

4. The ZBNF farmers have used Beejamrutham, Ghanajeevamrutham, Dravajeevamrutham to activate microbes to enable the soil to utilise the nutrients bio available in the soil itself for the healthy growth of crops. Kashayams/ Asthrams have been used to protect crops from pest and insects. These are biological inputs. The biological inputs have been prepared from the ingredients available in the villages like leaves, uncontaminated soil, dung, urine of local cows and dairy products in the villages which are very cheap compared to chemical inputs that are obtained from external markets at higher costs. The Non-ZBNF farmers, in contrast, use chemical fertiliser to provide nutrients for the soil to contribute to the growth of crops and chemical pesticides/insecticides to control pests and insects.

5. The study has been conducted in two agricultural seasons - Kharif and Rabi of the agricultural year 2018-19. The sample villages selected for conducting study in Kharif season are totally different from those villages selected for Rabi season. The study has been conducted in all the 13 districts of the state in Kharif as well as in Rabi Seasons to capture different agro-climatic conditions across the state. Based on listing information, top 3 crops in each of the districts have been short listed. Given this, in Kharif, a sample of 10 villages per district have been selected randomly from the villages that have grown at least one principal crop out of three of the district crops and also have at least 10 S2S farmers. A listing survey of all the households in the sample villages has been conducted to generate population of ZBNF farmers and Non-ZBNF farmers to draw the sample. A sample of 10 ZBNF and 10 Non-ZBNF farmers has been selected randomly from the respective groups of farmers. Thus, a sample of 100 ZBNF and 100 Non-ZBNF farmers are selected randomly from each district for Kharif 2018. In total, a sample of 1300 ZBNF farmers and another

sample of 1300 Non-ZBNF have been selected randomly from the state making it a total of 2600 farmers. The same scheme of sample design has been followed for the Rabi Study. But the Rabi Study is confined to a sample of 650 ZBNF farmers and 650 Non-ZBNF farmers making a total of 1300 farmers. This is due to the fact that the crops in Rabi season are grown by limited number of farmers (Paras 1.12 to 1.14).

6. Qualitative data have been collected from 65 FGDs and 65 CSs at the rate of 5 from each district and 13 strategic interviews at the rate of one from each district were conducted. All the DPMs were interviewed as part of Strategic Interviews (SIs).

7. Crop Cutting Experiments (CCEs) were used to assess and compare the yields of crops grown under ZBNF and Non-ZBNF. However, the number of CCEs was lower than expected in Kharif season due to the late start of Kharif survey. But, the required number of CCEs was covered in Rabi survey. Randomisation has been followed at every stage of the selection of sample units to derive reliable estimates of the impact parameters.

8. The estimates of the parameters are provided only at the state level. The sample of farmers contained three categories of farmers, viz., S2S farmers (pure ZBNF farmers), pure Non-ZBNF farmers and farmers who have raised the same crops under ZBNF as well as Non-ZBNF adopting some of the ZBNF practices on the Non-ZBNF crops. The third category of farmers has experienced contamination. It was decided to take out this category of farmers from the analysis and, as a result, the sample size was shrunk for the analysis. The analysis has been carried out with Pure ZBNF and Pure Non-ZBNF farmers for assessing the impact of ZBNF.

III. The Findings

Impact of Biological Inputs on Costs, Credit Markets and Incomes

9. Biological inputs in ZBNF cultivation (Beejamrutham, Ghanajeevamrutham, Dravajeevamrutham and Kashayams/ Asthrams) and chemical inputs in non-ZBNF cultivation (chemical fertilizers and pesticides) occupy a prominent proportion of cost of cultivation (measured in terms of paid out costs in our study). The per hectare cost of biological inputs of ZBNF is lower than that of chemical inputs of non-ZBNF across all the crops grown in Kharif as well as in Rabi seasons. It is

remarkably lower than that of chemical inputs in the Rabi. The reduction in biological input costs of ZBNF ranged from 30 per cent in Tomato to 76 per cent in Maize of chemical input costs of non-ZBNF in Kharif season, while it varied between 11 per cent in Maize to 85 per cent in maize in Rabi Season (Table 2.1 and Table 2.2).

10. The crops grown under both irrigated and un-irrigated conditions have experienced considerable reduction in input costs due to the use of biological inputs of ZBNF in both the seasons.As a result of reduced biological input costs under ZBNF, the share of cost of biological inputs in the paid out cost of ZBNF is found to be invariably lower than the share of chemical inputs in the paid out cost of Non-ZBNF. This is evident in the case of all the crops grown in Kharif as well as in Rabi (Table 2.3).

11. This reduction in paid out costs due to the use of biological inputs of ZBNF imply that the dependency of farmers on external inputs has declined. The discussions with the farmers through FGDs and Case Studies of farmers have also reinforced this aspect. The patterns of input use of the crops analysed above should reflect in the cost of cultivation. Per hectare paid out cost of cultivation is found to be lower across all the crops under ZBNF compared to the same crops under Non-ZBNF, though the quantum and percentage of reduction varied across crops (Table 2.5).

12. The reduction in the cost of cultivation has implications for the mobilisation of working capital for raising crops. The working capital required for raising crops under ZBNF in relation to that required under Non-ZBNF has come down substantially. This means that the dependency of farmers on credit markets has come down to that extent. Thus, the farmers have gained relative autonomy from credit markets. Most of the ZBNF farmers are also free from indebtedness.

13. The reduced cost of cultivation and, thus, the increased incomes of the farmers enabled them to depend more on their savings for meeting the working capital required to grow crops. In Rabi, 72 per cent of ZBNF farmers managed their working capital through their savings as against 60 per cent of the non-ZBNF farmers (Figure 2.3).

14. As a result of the reduction in per hectare cost of cultivation under ZBNF per hectare net income to ZBNF farmers is higher over Non-ZBNF farmers for all the crops in

Kharif as well as Rabi seasons. The increase in net incomes is substantial among the crops grown under dry and irrigated dry conditions (pulses and high value crops) than those grown under flood irrigation (Paddy and Sugarcane). For example, the study showed that per hectare net income to ZBNF farmers is higher than the per hectare net income to non-ZBNF farmers by 111 per cent in Maize and 9 per cent in Paddy in Kharif 2018 (Table 2.6).

15. The study also captured the net income from mixed crops, bund crops and border crops as the main motto of ZBNF is to encourage multiple crops in a piece of land to achieve more returns in a given piece of land. In Kharif season, more number of ZBNF farmers adopted mixed cropping, border crops and bund crops compared to non-ZBNF and earned more income from these crops compared to non-ZBNF farmers (Table 2.8).

Impact of Agro-ecological Practices of ZBNF on Soil Fertility (Tables 3.1&3.2)

16. It is clear from the CSs and SIs that the farmers have cultivated land intensively through adoption of diversified cropping patterns like mixed cropping, inter cropping, border cropping, bund cropping, 5-Layer Model and 36*36 Models. These agro-ecological practices combined with other practices like biological inputs, mulching and Whaapsa have enabled the soils to utilise the nutrition available in the soil (bio available).This has ultimately resulted in the improvement of soil fertility (Para 3.36).

- The farmers have provided evidence on improvement to soil quality in terms of softening of soils, presence of earthworms, and increased green cover in the fields. Some other farmers reported that the gestation period required to start yielding of orange garden has declined considerably under ZBNF compared to the gardens grown under Non-ZBNF practices. It is also reported, by farmers, that the shelf life of vegetable crops has gone up due to ZBNF agro-ecological practices (Table 3.3).

17. The farmers have reported that improved soil fertility contributed to increase in yields of crops, enhancement in quality of crop outputs, increased resilience of crops against adverse weather conditions such as cyclones, floods, droughts and dry spells (Figure 3.3, Tables 3.6 and 3.7).

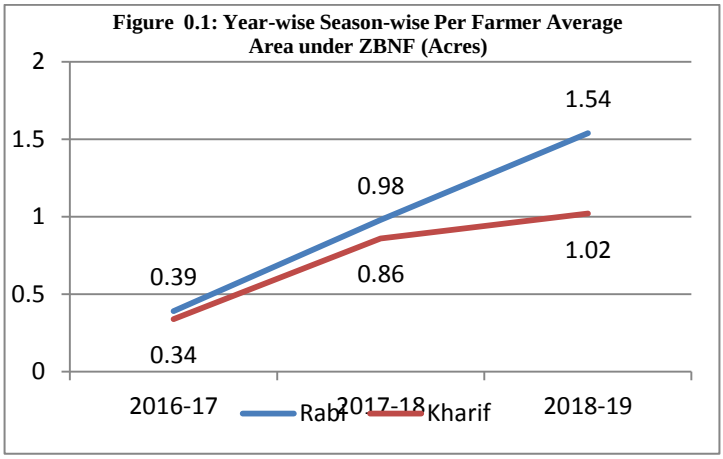
18. The yields of crops such as maize, Sesame, Sugarcane and Sunflower under ZBNF are significantly higher than those under non-ZBNF. But, overall, the yields of Paddy crop are higher under non-ZBNF over ZBNF. This is due to lower yields of paddy of ZBNF under flood irrigation conditions in delta districts Table 3.5).

19. It has been reported by farmers in the FGDs that the incidence of occurrence of seasonal pests to the crops also declined due to ZBNF. They reported 'reduced health costs of the family members' as they are saved by not inhaling the powerful chemical pesticides stored in the houses or when sprayed in the fields. There is reduction in the incidence of health problems for the farming community due to non-use and non-storage of chemical inputs. ZBNF ensures food and nutritional security even for the small and the marginal farmers in the context of declining per capita availability of land. Increased use of bullock services for tilling the crop lands under ZBNF is indication to the improvements in soil fertility (Table 3.2).

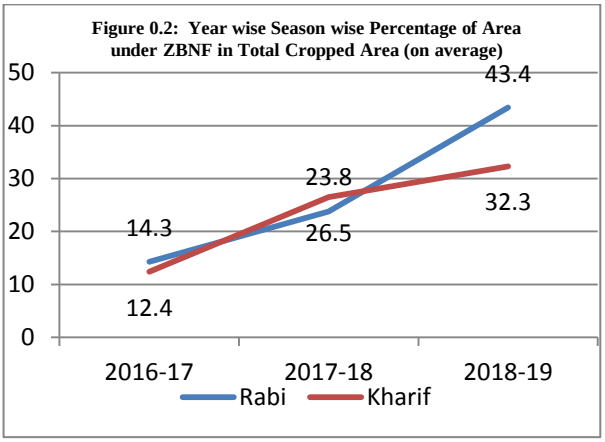
Adoption of ZBNF Practices (see Figures 0.1 and 0.2)

20. The above findings of multiple benefits to ZBNF farmers should encourage farmers to adopt ZBNF a period of time. The adoption of ZBNF can be measured through two indicators –per farmer average area under ZBNF and the percentage of area brought under ZBNF practices over the years. Per farmer cropped area under ZBNF has increased in Kharif as well as Rabi Season between agricultural years of 2016-17 and 2018-19. Similarly the percentage of area under ZBNF in the total cropped area of the farmers has also increased.

21. The expansion of larger cropped area under ZBNF in Rabi over Kharif season probably indicates that farmers have expanded cropped area under ZBNF in Rabi season after convincing themselves through their experience in Kharif season with ZBNF (Figures 0.1 and 0.2).



i. ***Source:***Field Survey



1. ***Source:***Field Survey

22. The pattern of changes in input use, due to ZBNF, in terms of reduction of the use of chemical pesticides to control pests is signal to the ecological services like reduction in the environmental pollution. The ZBNF farmers have explored new marketing channels that connect them directly to consumers without the involvement of middlemen for marketing some of their ZBNF crop outputs. ZBNF farmers opted for retail marketing channels to derive higher prices for their ZBNF crop outputs over those under non-ZBNF.

IV. Policy Implications

23. It is evident from the analysis that the major constraint for the adoption of ZBNF relates to the inadequate exposure of farmers to the method of natural farming. Moreover, some of the farmers reported that they do not have adequate knowledge

for the preparation of *Kashayams* and *Asthrams*. The extension services should be strengthened to advise and guide the farmers in preparing and applying Kashayams/ Asthrams to the fields during the pest attack. The expansion of extension services by way of increasing CRPs at the village level may address this issue.

24. There is a need to address the issue of overcoming labour shortage and ensuring the availability of readymade biological inputs of ZBNF for farmers. The supply of inputs through NPM shops in villages reduces the cost of labour in preparing inputs due to economies of production experienced by the NPM shop owners in preparing inputs. Thus, there is every need to strengthen NPM shops. Moreover involvement of women and men collectives as producers and suppliers of biological inputs also facilitates for overcoming these problems.

25. Household survey has clearly revealed that farmers complained about lack of proper marketing support for realising higher prices for crop outputs of ZBNF. Very few ZBNF farmers have explored new channels in which direct contact between farmers and consumers is established without the involvement of middlemen. Farming community can be supported through promotion of Farmer Producers Organisations (FPOs) for improving the bargaining power of farmers by avoiding middlemen and for negotiating with the consumers directly to obtain higher price for ZBNF produce. Higher prices for ZBNF produce would induce farmers to adopt and expand area under ZBNF.

26. The diversified and intensive use of land through different models of growing crops should be promoted among farmers for improving the soil fertility. More importantly, policy support is also needed for meeting investment requirements of farmers adopting ZBNF. For instance, the adoption of 5-layer model of growing crops requires considerable upfront investments to ensure continuous flow of incomes and full green cover in the fields. These investment requirements can be met by on-going government programs being implemented by different departments of agriculture, rural development and other related departments.

27. In short, the following measures should be undertaken for effective implementation of ZBNF:
    - Strengthening Extension Services,
    - Providing Market Support,

- Promoting farmers collectives,
- Integrating the ZBNF with all relevant government programs to enable farmers for adopting innovative models of growing crops for enabling farmers to realize related benefits of ZBNF.

CHAPTER 1

Context, Objectives and Methodology

I. Context

1.1 Farming and farming community in Andhra Pradesh, as elsewhere in the country, have been facing many challenges under chemical-based agriculture. To begin with, the cost of cultivation of crops is very high under chemical-based agriculture due to a heavy dependence on costly chemical inputs purchased from markets external to the villages. From an ecological and resource perspective, the soil fertility has declined over time due to the use of heavy doses of chemical fertilizers every year. This has resulted in the reduction of the marginal productivity of land with respect to fertilizer inputs. The use of heavy doses of fertilizers has also given rise to the growth of different types of pests at the different phases of growth of crops. The use of heavy doses of pesticides to control pests has, in turn, led to rising cost of cultivation as well as severe damage to health of soil and quality of output. The withstanding capacity of crops to weather variability like deficit or excess in rainfall has also declined over time. This is due to the damage to soil health, especially its water-holding capacity under chemical-based agriculture. The chemical-based agriculture is also highly capital-intensive and demands mobilization of larger volume of working capital. As a result, farmers have depended on informal credit institutions that provide credit at relatively higher interest rates with adverse payment conditions. This has often pushed farmers into debt trap.

1.2 Agro-ecological practices such as mixed, border, and bund crops, which are necessary not only to increase crop income but also to rejuvenate the soils, are conspicuously absent under chemical-based agriculture. The absence of these practices has resulted in the reduction of risk-coping capacities of crops to weather variability and eliminated the scope for a continuous flow of incomes to the farmers. The crops produced under chemical-based agriculture have also led to higher incidence of health problems both to farmers and consumers. In this context, agro-ecology is gaining momentum as a sustainable farming approach to address the concerns emerged. There is growing evidence of multiple benefits of agro0ecology from farm productivity to climate resilience. However, its promotion in public agricultural policies, research and extension is still limited.

1.3 The Government of Andhra Pradesh has introduced Zero Budget Natural Farming (ZBNF) with agro-ecology framework in 2016 as an alternative to chemical-based agriculture. The main objective of the ZBNF is to make agriculture economically viable and climate resilient and agrarian livelihoods profitable. ZBNF aims to reduce the cost of cultivation, enhance yields, increase incomes, reduce risks and protect from adverse impacts of climate change. Extension support under ZBNF is led by farmers (including women) through a process of farmer-to-farmer learning. ZBNF also aims to create human and social capital necessary for vibrant and inclusive agricultural production.

II. *Conceptual Framework of ZBNF*

1.4 ZBNF is an agroecological farming approach and refers to farming practices that depend on ecosystem rather than on external inputs. Dorin defines *agro-ecology* as "*Context-specific agroecosystem that boosts biological synergies below and above ground, amongst numerous plant and animal species (from soil fungi to trees, from soil bacteria or worms to cattle, etc)*" (for detail see Dorin *et al.*, 2013, Dorin, 2017)

1.5 ZBNF believes that the soil already has all the nutrients necessary for plant growth and there is no need for adding any external inputs to supply nutrients. Instead, the existing nutrients have to be released and made bio available to the plants/ crops. The practices of ZBNF facilitate this process. Beejamrutham, Jeevamrutham, Acchadana (mulching) and Whaapsa are the four wheels at the heart of ZBNF farming practices.

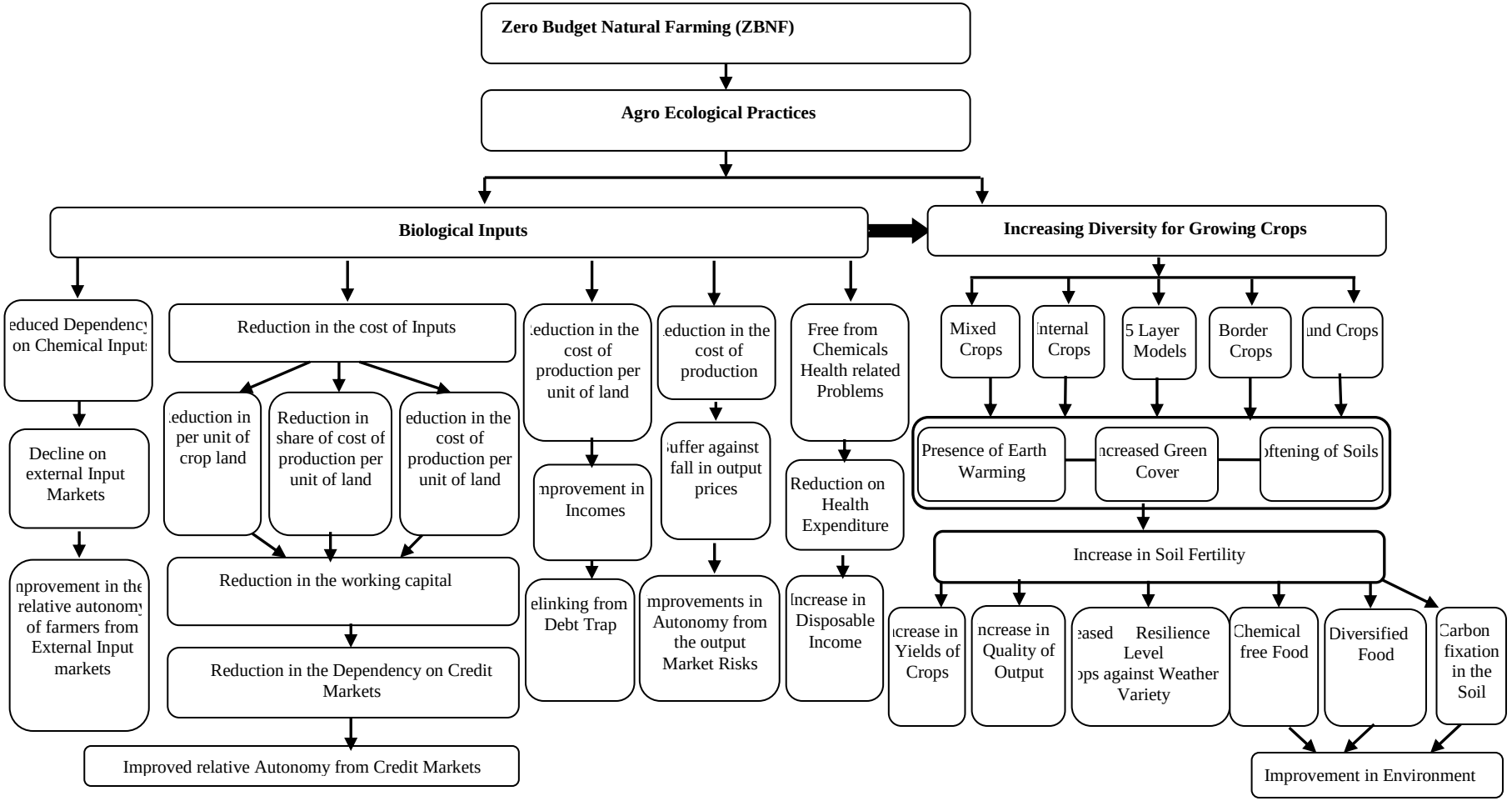
1.6 Beejamrutham is a microbial coating of seed/seedlings based on cow dung, cow urine and lime. It protects young roots from fungus and seed-borne or soil-borne diseases. Jeevamrutham stimulates microbial activity to make nutrients plant-available, protects against pathogens and increases soil carbon. Acchadana (mulching) is the process of covering the top soil with cover crops and crop residues. This produces "humus", conserves topsoil, increases water retention, encourages soil fauna, supplies the soil with essential nutrients, and controls weeds. Whaapsa is soil aeration, a result of Jeevamrutham and Acchadana, and represents the changes in water management brought about by improved soil structure and humus content. In order to protect crops from pests and insecticides, ZBNF prescribes a number of natural fungicides and pesticides made from locally available ingredients like neem leaves, chillies, garlic, tobacco, sour buttermilk. Thus, ZBNF has two major dimensions, viz., agronomic and structural.

1.7 Biological inputs combined with crop diversification and agro-ecological practices like mixed crops, internal crops, 5-Layer and 36*36 models, border crops and bund crops, mulching and Whaapsa contribute to the reduction in cost of cultivation and improvement in net incomes of farmers. These practices also provide ecological services like soil fertility, resilience of crops to weather variability, improved quality of crop outputs, health of farming community, fixation of carbon in the soil without emitting it into environment (for details of ZBNF refer http//apzbnf.in/) and http://apzbnf.in/wp-content/uploads/2019/11170919-Brochure-final updated Million-Final-for-print.pdf)

1.8 The preparation and use of biological inputs in the place of chemical inputs in crop production has implications for structural changes in production conditions of farmers. Increased use of biological inputs in place of chemical inputs leads to reduction in dependency on external input markets. Reduction in cost of production of crops per unit of land due to ZBNF inputs reduces dependency of farmers on credit markets. This also enables farmers in gaining relative autonomy from credit markets. Further, reduction in cost of production of crops, given the yields of crops, improves crop incomes of farmers, thereby enabling them to delink from indebtedness. Furthermore, reduction in cost of production of crops facilitates farmers to withstand against output market risk such as falling output prices. This is because reduction in cost of cultivation leaves more profit margins. Further, lower costs of cultivation provide some cushion to the farmers in case the output prices fall.

1.9 Farmers and their families suffer from health problems through inhaling the pungent smell that comes from pesticides stored at home before applying on fields. Similarly, agricultural labourers have been affected through inhaling of chemical inputs especially pesticides during application on fields. The biological inputs enable farming community to be free from health problems related to storing and using of chemical pesticides.This reduction in the expenditure on chemical-related health problems increases the disposal income of farming community (See Figure 1.1).

Figure 1.1: Conceptual Framework for Assessing the Impact of Zero Budget Natural Farming on Farming and Farming community



Source: Authors' Formulation

III. Research Questions

1.10 In the aforementioned backdrop, the study addresses itself to the following research questions:

- What is the impact of agro-ecological practices such as biological inputs of ZBNF in growing crops on the production conditions of farmers?
- How far have the agro-ecological practices like intensive use of land with diversified cropping patterns in terms of raising mixed crops, intercrops, 5-Layer models, border crops and bund crops with biological inputs, mulching and Whaapsa of ZBNF contributed to change in soil fertility?
- How far have the changes in soil fertility contributed to yields of crops, resilience of crops to weather variability, quality of crop outputs and heath related to chemical inputs?
- What are the suggestions that flow from the analysis to bring improvements in the implementation of ZBNF for enabling farmers to adopt ZBNF and reap benefits from it?

IV. Methodology and Sampling Design

1.11 The evaluation methodology is based on what is known as "with and without" approach wherein outcomes of a random sample of ZBNF farmers cultivating a particular crop are compared with the outcomes of a random sample of non-ZBNF farmers cultivating the same crop using chemical farming. In doing so, the comparability of the two groups is ensured in two ways. In the first method, there is perfect control, where comparability is ensured by selecting a farmer cultivating the same crop under ZBNF and non-ZBNF conditions. In the second method, sample farmers from ZBNF and non-ZBNF cultivating the same crop in same village and in same land size class are selected for comparison.

1.12 The study has deployed both quantitative and qualitative methods. Listing Survey, Household Survey and village survey have been conducted to collect quantitative data from the households and villages from ZBNF perspective. Focussed Group Discussions (FGDs) with farmers, Case Studies (CSs) of farmers, and Strategic Interviews (SIs) with District Project Managers (DPMs) have been conducted to obtain qualitative data. Crop Cutting Experiments (CCEs) are conducted to assess the yield apart from collecting farmer reported yields. CCEs are used to assess yield of

crops. The impacts of ZBNF are captured by visiting the sample farmers three to four times in the season to minimise the memory lapses in recall by farmers. CCEs are conducted following the methodology suggested by NSSO and adopted by the State Directorate of Economics and Statistics (SDES). The services of personnel associated with these institutions have been utilised for finalising the methodology. The system is supported by videos for all important activities. Costs and returns are estimated adopting the tools of farm management studies, i.e., cost of cultivation scheme under the Ministry of Agriculture and Cooperation, Government of India.

1.13 The study to assess the impact of ZBNF is conducted in all the 13 districts of the State. There are 17,491 ZBNF farmers spread over 1000 villages across all the 13 districts of the state as per the 2017-18 data of RySS. They are growing about 72 different crops. Conducting CCEs and estimation of cost production for all these crops is not feasible. Hence, it is focussed only on three major crops identified in each of the 13 districts. The villages where at least one of the major crops is grown during the year 2017-18 are considered. Among these villages, the villages, where at least 10 ZBNF farmers grew the major crops in the said year, have been segregated. Finally, 492 villages that constitute the sample frame of the study are selected.

1.14 All the ZBNF farmers are divided into 13 strata where each stratum is co-terminus with each district. In the first stage, a random sample of 10 villages was selected from each stratum. One limitation of this sample design is that it is based on data pertaining to the previous year, i.e., 2017-18. Although the major crops identified in each district may not vary in the current year, some farmers in few villages are likely to shift to different crops in the current year-2018-19, the reference year of the study. The sample villages, where there are no farmers growing major crops in the reference year of the study are dropped and substituted with another village. In this way, a basket of 15 sample villages is prepared for each district.

1.15 In these sample villages, listing survey has been conducted to identify the universe of ZBNF farmers in terms of Seed to Seed (S2S) farmers and Non-ZBNF farmers. Then, two samples, one with 10 ZBNF farmers and another with 10 non-ZBNF farmers, are selected from each sample village using stratified random sampling method. For this purpose, in each village, all the ZBNF and non-ZBNF cultivators were listed separately and stratified into the two (ZBNF and non-ZBNF)

categories of farmers. Each of the categories is divided into four strata based on land owned: 1) Landless, 2) Owning less than 2.5 acres, 3) Owning 2.51 to 5 acres,4) other large farmers. Then, each sample of 10 farmers (of ZBNF and Non-ZBNF) was distributed across the strata as: 2 from stratum 1, 3 from stratum 2, 3 from stratum 3 and 2 from stratum 4. In actual practice, however, adequate number of farmers may not be available in each stratum. In such cases, any shortfall of sample in a stratum is compensated by taking farmers from the immediate next stratum. If there is shortfall in the next stratum also, the compensation can be from the next and so on. However, since some of the ZBNF sample farmers also served as controls (perfect matches), the total non-ZBNF samples to be drawn from non-ZBNF list is reduced by the number of perfect matches found in ZBNF sample. Thus, 2600 farmers in total consisting of 1,300 ZBNF and 1,300 ZBNF farmers are randomly selected for the Kharif survey.

1.16 For each of the selected farmers, the parcel of the land of farmers, where the farmer is growing the major crop, was identified. From this parcel of land, a plot of *size as required by the procedure* has been selected at random for estimating yield through CCEs. It is to be noted that the study adopted standard methodology of Indian Agricultural Statistical Research Institute (IASRI) followed by NSSO and Directorate of Economics and Statistics (DES) of Andhra Pradesh for conducting CCE. Costs and returns are estimated adopting the tools of farm management studies, i.e., cost of cultivation scheme under the Ministry of Agriculture and Cooperation, Government of India. The system is supported by videos for all important activities.

1.17 The Rabi 2018-2019 villages selected on the basis of crops grown in Rabi are different from those villages selected for Kharif study. The same scheme of sample design followed for the Kharif Study was also followed for Rabi. But the Study confined to half of the sample size of Kharif season. Thus, a sample of 650 ZBNF farmers and 650 Non-ZBNF farmers were considered, covering totally 1300 farmers. This is because that the crops in Rabi season are grown by limited number of farmers (for details see Appendix Tables A 1.1 to A 1.6)

1.18 The quantitative data from the household questionnaire has been collected to assess the impact of ZBNF on input use pattern, cost of inputs, cost of cultivation for growing each of the crops and net incomes obtained by the farmers from each of the crops considered for the analysis. This data enables to assess the impact of agro-

ecological practices such as application of biological inputs for growing crops under ZBNF on the production conditions of farmers.

1.19 The impact of ZBNF in making agriculture sustainable has been measured at two levels - improvements in soil fertility and yields and improvements in ecology. The proxy indicators considered for measuring improvements in soil fertility include loosening of soil, presence of earthworms in the soil and increase in greenery in the fields. Improvement in the growth of the stems of crops, improved taste in crop outputs, resilience of crops in withstanding against weather variability and health problems related to chemical input use are considered to measure the ecological impacts of ZBNF. It may be mentioned that the improvements in yields were assessed through CCEs.

1.20 The analysis of household survey alone may not be adequate enough to identify all the key challenges involved in realising the potential benefits from ZBNF. FGDs of farmers have been organised in the sample villages, at the rate of five villages from each district leading to a total of 65 FGDs in the state. These can shed more light on the key challenges to be addressed for realizing potential benefits of ZBNF. Similarly, 65 Case Studies (CSs) of the farmers have developed to assess the impact of ZBNF on land use pattern, cropping pattern, costs and returns of crops, marketing channels, soil fertility, and yields of crops. In addition, Strategic Interviews (Sis) were conducted with the DPMs of all 13 districts.

V. The Data Collection and Management

1.21 The prepared instruments for all field-based evaluations have in-built checks with appropriate skip patterns over and above the supportive manual with instructions and clarification for all questionnaires. A pilot was conducted for testing all instruments used for field-based evaluation within-house research associates/ research assistants to check the consistency and flow of questions; and the feedback session was organized for the team members to help refining the questionnaire.

1.22 Thirteen experienced supervisors were identified. Qualified investigators were selected from the pool suggested by RySS, who have qualification, motivation and sufficient agricultural background. During a four-day intensive training conducted at CESS the core team members explained the entire questionnaire along with manual of

instructions on FGDs, Case Studies (CSs) and the internal checks to be followed. Senior statisticians in the team explained on the sample design and on the selection of farm households. The actual field survey was commenced on 22nd November 2018 in Kharif study and on 1st January 2019 in Rabi study. FGDs were conducted by the field supervisors. Senior core team members conducted strategic interviews with DPMs using a common check list. A separate mobile-based app was developed/ generated to enter the CCE information and training was given to all the supervisors duly installing the app in their mobiles. Core team members visited the field and cross-checked the information filled. The data entry program was written in CSPro software While generating the result tables, the identified outliers were cross-checked with original schedule and with the concerned supervisors and final result tables were generated only after ensuring data quality.

VI. Structure of the Report

1.23 The context, objectives and methodology of the study have been presented in Chapter 1. Chapter 2 deals with the impact of biological input use on the production conditions of farmers. The analysis relating to the impact of agro ecological practices such as use of biological inputs, diversification of crops, mulching on soil fertility and in turn impact of soil fertility on the yields of crops and ecological services is presented in Chapter 3. Chapter 4 deals with the conclusions and policy suggestions flown from the analysis for improving the implementation of ZBNF. The executive Summary of the study is also presented.

CHAPTER 2

Impact of Biological Inputs of ZBNF on Crop Production Conditions

I. Introduction

2.1 This chapter is an attempt to assess the impact of the use of biological inputs (one of the agro-ecological practices) in growing crops under ZBNF. The implication of these practices is that the input structure for raising crops undergoes a radical transformation from chemical inputs to biological inputs. This is expected to produce cascading effects on costs and incomes to farmers in terms reduction in the costs of crop production and a substantial enhancement in crop incomes. These changes may ultimately bring considerable modifications in the dependency on external inputs and on credit markets. Besides these, the reduction in the cost of production of crops may enable farmers to withstand against the falling crop output prices (output market risks) without landing into debt trap and to reduce expenditure on chemical inputs related health problems and thereby enabling improvement in disposable incomes of farmers. In this backdrop, this chapter addresses the following research questions:

- What is the impact of use of biological inputs of ZBNF on the production conditions of crops in terms of cost of cultivation and incomes to farmers?
- How far have the changes in production conditions enabled farmers to improve their relative autonomy from external input markets, credit markets and output market risks?

2.2 Three dimensions of cost of inputs of crops and four dimensions of crop net incomes that accrue to farmers have been considered to examine the impact of use of biological inputs on production conditions. Three dimensions of cost of inputs of crops –per hectare biological inputs, per hectare share of biological inputs in the cost of production of crops and per hectare paid out costs.Net incomes from main crops, mixed crops, bund crops and border crops accrued to farmers are the three dimensions of income to the farmers[1]. Farmers' capacity utilising own savings for meeting working capital requirements have been considered to assess the possibility of farmers

[1] There are some caveats in the present methodology adopted and analysis carried out They are: quality differences in the ZBNF inputs across the farmers is not considered; family labour use in costs and returns analysis of crops is not considered though the data on family labour is available; the time spent by non-ZBNF farmers in the procurement of fertilizer and pesticides not included in valuing labour spent by the farmers to compare with ZBNF farmers; the fertilizers and pesticides are not valued at market price in making comparison with ZBNF inputs; the difference benefits between early adopters and late adopters has been examined.

in overcoming indebtedness. The implication of these parameters is examined in terms of reducing the dependency of farmers on external input markets and credit markets and enabling farmers for overcoming indebtedness that ultimately contributes to the improvements in relative autonomy of farmers. The FGDs (FGDs) and Case studies (CSs) of farmers have been utilised to complement the hard data collected from Households.

II. The Analysis

The Analysis *Biological Inputs and Dependency on External Input Markets*

2.3 A comparison of the per hectare cost of biological inputs of ZBNF and that of chemical inputs of Non-ZBNF has revealed that the cost of ZBNF inputs is lower than that of non-ZBNF across all the crops grown in Kharif as well as in Rabi seasons. The cost of biological inputs is strikingly lower than that of chemical inputs in the Rabi crops over Kharif crops. This is further reinforced from the comparison of the same crops, such as paddy, maize, groundnut and Bengal gram, in both the seasons (Table 2.1 and 2.2).

Table 2.1: Per Hectare Cost of Biological Inputs under ZBNF and Chemical Inputs under Non-ZBNF: Kharif of 2018-19

Description of Crops	Biological Input Costs) under ZBNF (Rs)	Chemical Input Costs under non-ZBNF(Rs)	Difference over chemical input cost (Rs)	% of the cost of Biological inputs to the cost of chemical inputs	% of decline in the cost of ZBNF input over the non-ZBNF input
1	2	3	4	5	6
Paddy	4215	13248	9033	31.8	-68.2
Maize	4611	6029	1418	76.5	-23.5
Groundnut	2759	3732	973	73.9	-26.1
Cotton	2863	9041	6178	31.7	-68.3
Tomato	5085	16705	11620	30.4	-69.6
Bengalgram	4535	8191	3656	55.4	-44.6

i. ***Source:*** Field Survey

Table 2.2: Per Hectare Cost of Biological Inputs under ZBNF and Chemical inputs under Non-ZBNF: Rabi 2018-19

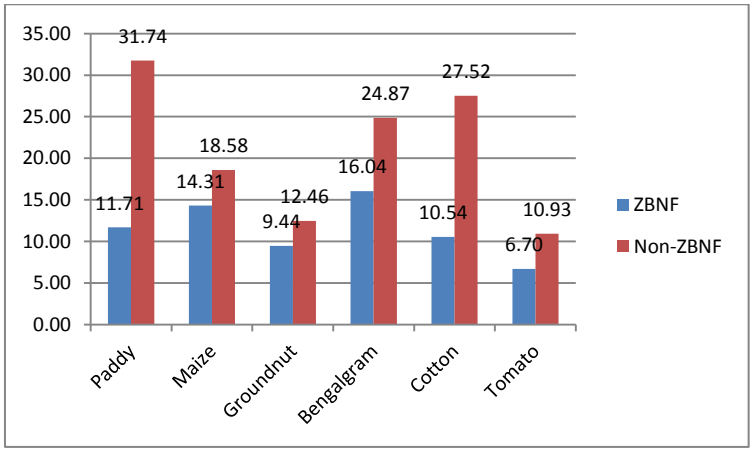
Description of Crops	Biological Input Costs) under ZBNF (Rs)	Chemical Input Costs under non-ZBNF(Rs)	Difference over chemical input cost (Rs)	% of the cost of Biological inputs to the cost of chemical inputs	% of decline in the cost of ZBNF input over the non-ZBNF input
Paddy	2510	19040	16530	13.2	-86.8
Maize	2567	23301	-20734	11.0	-89.0
Groundnut	1587	8846	-7259	17.9	-82.1
Bengalgram	3071	12401	-9330	24.8	-75.2
Jowar	1686	12072	-10386	14.0	-86.0
Black gram	724	5459	-4735	13.3	-86.7
Green gram	622	1839	-1217	33.8	-66.2
Sesame	828	1826	-998	45.3	-54.7
Banana	7555	20353	-12798	37.1	-62.9
Sugarcane	2763	3258	-495	84.8	-15.2

Source: Field Survey

2.4 The percentage of reduction in the cost of biological inputs in relation to that of chemical inputs has varied across crops. It has ranged from 24 per cent in case of maize to 70 per cent in case of tomato in Kharif season, while it has varied between 15 per cent in case of sugarcane to 89 per cent in case of maize in Rabi. Thus, the crops grown under different irrigated and un-irrigated conditions have experienced considerable reduction in input costs due to the use of biological inputs under ZBNF.

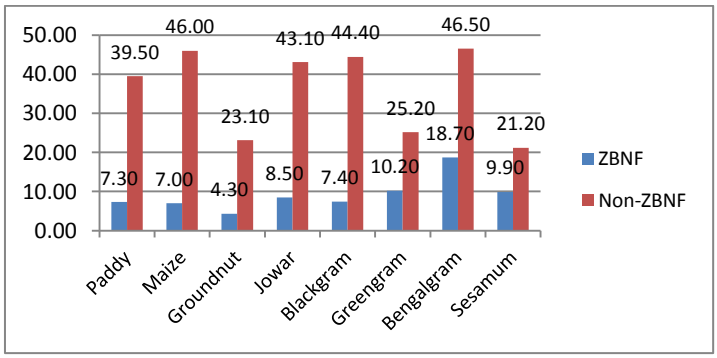
2.5 The impact of cost of biological inputs on the cost structure of the crops has been examined to assess its contribution to the reduction in the paid out cost in growing crops. The share of cost of biological inputs in the paid out cost of ZBNF crops is found to be invariably lower than that of chemical inputs in the paid out cost of Non-ZBNF. This is noticeable in the case of all crops grown in Kharif as well as in Rabi (Figures 2.1 to 2.2 and Table 2.2)

Figure 2.1: Share of Biological and Chemical inputs Costs in Paid Out Cost of Production per hectare under ZBNF and non-ZBNF: Kharif 2018-19 (in percentage)



i. ***Source:*** Field Survey

Figure 2.2: Share of Biological and Chemical Inputs Costs in Paid Out Costs of Production per hectare under ZBNF and non-ZBNF: Rabi 2018-19 (in Percentage)



Source: Survey data

Table 2.3: Per Hectare Share of Biological (ZBNF) / Chemical (Non-ZBNF) Costs in Total PaidOut Costs (%)				
Crop	Kharif		Rabi	
	ZBNF	Non- ZBNF	ZBNF	Non- ZBNF
Paddy	11.71	31.74	7.30	39.50
Maize	14.31	18.58	7.00	46.00
Groundnut	9.44	12.46	4.30	23.10
Jowar			8.50	43.10
Sugarcane			3.20	3.70
Black gram			7.40	44.40
Green gram			10.20	25.20
Bengalgram	16.04	24.87	18.70	46.50
Sesame			9.90	21.20
Banana			8.20	22.00
Cotton	10.54	27.52		
Tomato	6.70	17.93		

Source: Field Survey

2.6 Apart from the reduction in the share of biological inputs of ZBNF in relation to the chemical inputs of Non-ZBNF in the total cost of production of crops, there are two inputs - hired human labour and bullock labour - that have strikingly appeared in the cost structure of crops in Kharif as well as Rabi seasons. The shares of both of these inputs are considerably higher for ZBNF over Non-ZBNF in the case of all crops in Kharif and Rabi Seasons (Tables A 2.3 to A 2.5). The rise in share of cost of hired human labour may be compensated by the rise in the average labour productivity of output across crops under ZBNF over Non-ZBNF. On the other hand, the rise of share of bullock labour charges in the total cost in case of ZBNF over Non-ZBNF indicates increase in tilling by bullocks. The tillage by bullocks increases soil biota activity and improves soil fertility. This is one of the ecological services provided by ZBNF. It is also an indication of strengthening agriculture and livestock linkages.

2.7 The reduction in the cost of inputs per hectare and the share in the paid out costs per hectare of crops due to the use of biological inputs of ZBNF imply that the dependency of farmers on external inputs has declined. Thus, the farmers have gained relative autonomy from external input markets. This is further evident from the Case Studies of Farmers and the FGDs with the farmers (See Appendices 1 and 2).

2.8 In the interaction with the ZBNF farmers in developing the case studies, farmers have reported that the use of chemical fertilisers and pesticides in farming has come down to zero level in growing crops. The use of Beejamrutham, Ghanajeevamrutham, Dravajeevamrutham, Kashayams and Asthrams has entered the input basket of crop growing practices under ZBNF. The ingredients required for preparing the above

inputs are drawn from the locally available resources like dung, urine, dairy products from local cows; leaves and other locally available material. This ensures low cost inputs to farmers for growing crops. The inputs of ZBNF are at lower cost because they are locally prepared by the farmers using the locally available ingredients. Further, the incidence of occurrence of seasonal pests to the crops also declined due to ZBNF. The farmers are saved from the exorbitant costs of chemical fertilizers and pesticides. Thus, dependency on the external input markets has come down drastically (for details see Appendix 2).

2.9 The farmers in FGDs reported that dung, urine and dairy waste products of local cows as ingredients in the preparation of inputs constitute the central component of ZBNF. Hence, the availability of local cows is fundamental for organising agriculture under ZBNF. The scarcity of local cows as a constraint has been reported in all the villages across the districts. However, farmers have adopted ZBNF despite the scarcity of local (variety) cows to reduce cost of inputs for growing crops, this is by procurement of local cows by some of the farmers and some others have obtained these ingredients from other farmers. Further, some others have obtained these ingredients especially dung and urine from nearby "gosalas" maintained by temple authorities. A few farmers have procured local cows which were ready to be deported to slaughterhouses. The north coastal districts and both Godavari districts have tribal areas and they have become the supply source for cow dung and cow urine to farmers in other non-tribal parts of the districts. Thus, farmers are motivated to prepare biological inputs from locally available ingredients to reduce the cost of cultivation of crops. Farmers have also reported that the biological inputs enabled them to reduce their dependency on external inputs (for details see Appendix 1).

Biological Inputs and Dependency on Credit Markets

2.10 The patterns of input use of the crops analysed above should reflect in the cost of production cost of crops. The paid cost of cultivation per hectare is found to be lower across all the crops under ZBNF compared to the same crops under Non-ZBNF in both Kharif and Rabi seasons, though the quantum and percentage of reduction varied across crops (Tables 2.4 and 2.5). The reduction in the cost of production of crops per hectare is found to be the highest by 19 per cent for cotton and tomato compared to around one per cent for the other crops like maize, groundnut and

Bengalgram in Kharif Season. However, both the percentage of reduction of inputs per hectare and the cost of cultivation per hectare are higher in case of high value crops like cotton and vegetables compared to those under other crops in Kharif. The percentage of reduction in the paid out costs per hectare for growing crops has varied between -0.4 for Banana and -38.3 for Bengal gram in Rabi. Among all the crops, paddy, maize, jowar and pulses have experienced higher rate of decline in costs due to ZBNF (Tables 2.4 and 2.5). It is abundantly clear that the ZBNF has brought down substantial reduction in the cost of production across all the crops. This has implication for the mobilisation of capital for raising crops. The reduction in the working capital required for raising crops under ZBNF in relation to that required under Non-ZBNF has come down substantially. This is evident from the extent of reduction in the paid out costs due to ZBNF. This means that the dependency of farmers on credit markets has come down. Thus the farmers have gained relative autonomy from credit markets.

Table 2.4: Per Hectare Paid Out Cost of Production of Crops under ZBNF and non-ZBNF: Kharif 208-19

Crop	Per Hectare Paid Out Cost (Rs.)		
	ZBNF	Non ZBNF	%Change over non-ZBNF
Paddy	36009	41737	13.70
Maize	32214	32458	-0.01
Groundnut	29219	29957	-0.03
Cotton	27164	32854	-17.31
Tomato	75952	93149	-18.46
Bengalgram	28279	32939	-1.41

Source: Field Survey

Note: In case of Groundnut which is dominant in Ananthapuramu is grown under rain-fed condition. Normally farmers are not using any fertilizers with the fear of uncertainty of rains. Even if used farmers apply not more than one bag per acre. Incidentally majority of the villages are dry and the crop is grown under rained with very less application of chemical fertilizers. This is why the difference in paid-out cost under ZBNF and Non-ZBNF is meager

Table 2.5: Per hectare Paid-out Cost under ZBNF and Non-ZBNF : Rabi 2018-19

Crop	Paid Out Cost (Rs.)		%change over Non-ZBNF
	ZBNF	Non-ZBNF	
Paddy	34346	48209	-28.8
Maize	36493	50630	-27.9
Groundnut	36956	38288	-3.5
Jowar	19779	28036	-29.5
Sugarcane	86757	88093	-1.5
Black gram	9781	12294	-20.4
Green gram	6081	7304	-16.7
Bengal gram	16464	26693	-38.3
Sesame	8354	8632	-3.2
Banana	92287	92637	-0.4

Source: Field Survey

Biological inputs, Crop Incomes and Indebtedness of Farmers

2.11 The reduction in the cost of cultivation per hectare under ZBNF over non-ZBNF should result in the net income of the ZBNF across all crops. It is evident from the data that the net income per hectare to farmers is higher from ZBNF over Non-ZBNF for all the crops considered for the analysis in Kharif as well as Rabi seasons. It is noticeable that the increase in net incomes is higher in Rabi over Kharif across all the crops (Tables 2.5 and 2.6). For instance, the highest increase in net crop incomes due to ZBNF is experienced by farmers from maize (111 per cent) followed by cotton (45 per cent), groundnut and tomato (41 per cent each) and 17 per cent in case of Bengal gram in Kharif. Similarly, increase in net income has varied between 10 per cent in case of sugarcane and 133 per cent in the case of Bengal gram in Rabi season (Tables 2.6 and 2.7). This indicates that the increase in net incomes is substantial among the crops grown under dry and irrigated dry conditions (like pulses and high value crops).

Table 2.6:Per Hectare Net Incomes under ZBNF and Non-ZBNF: Kharif 2018-19

Crop	**Per Hectare Net Income (Rs.)**		**Change over non-ZBNF(in percentages)**
	ZBNF	**Non ZBNF**	
Paddy	45262	41708	8.52
Maize	45375	21458	111.46
Groundnut	35819	25409	40.97
Cotton	28585	19662	45.38
Bengalgram	54559	46498	17.34
Tomato	323409	229926	40.66

Source: Field Survey

Table 2.7 Per Hectare Net Incomes under ZBNF and Non-ZBNF: Rabi 2018-19

Crop	Per Hectare Net Incomes (Rs,)		**% Difference over non-ZBNF (percentage)**
	ZBNF	Non- BNF	
Paddy	49645	33637	47.6
Maize	89577	79120	13.2
Groundnut	47489	35695	33.0
Bengal gram	35627	15277	1332
Jowar	14915	8288	80.0
Black gram	14706	8005	83.7
Green gram	12606	9360	34.7
Sesame	28707	23403	22.7
Banana	173381	96546	79.6
Sugarcane	110981	100928	10.0

Source: Field Survey 2018-19

2.12 The study also captured the net income from mixed crops, bund crops and border crops as the main motto of ZBNF is to encourage multiple crops in a piece of

land to achieve more returns in a given piece of land. In Kharif season, 154 ZBNF sample farmers have grown 28 different mixed crops ranging from 2 to 4 crops in a plot. On the other hand, 68 non-ZBNF sample farmers have also grown 11 different mixtures. On an average, ZBNF farmers earned a net income of Rs. 46042 per hectare from mixed crops as against Rs. 35548 by non-ZBNF farmers. Similarly, 39 sample ZBNF farmers who have grown bund crops in Kharif as against 20 non-ZBNF farmers derived an average net income of Rs. 4229 compared to Rs. 3922 by a non-ZBNF farmer. Further, 24 ZBNF farmers have grown border crops and earned a an average net income of Rs. 4019 compared 12 non-ZBNF farmers earned an average income of Rs. Rs. 3695 per farmer (Table 2.8). Thus, more number of ZBNF farmers adopted mixed cropping, border cropping and bund cropping compared to non-ZBNF; and earned more income from these crops compared to non-ZBNF farmers.

Table 2.8: Net Income from Mixed Crops, Border Crops and Bund Crops under ZBNF and Non-ZBNF(in rupees)

Type of Crop	ZBNF	Non-ZBNF
Mixed crop income per hectare	46042	35548
Bund crop income per farmer	10450	9691
Border crop income per farmer	9931	9130

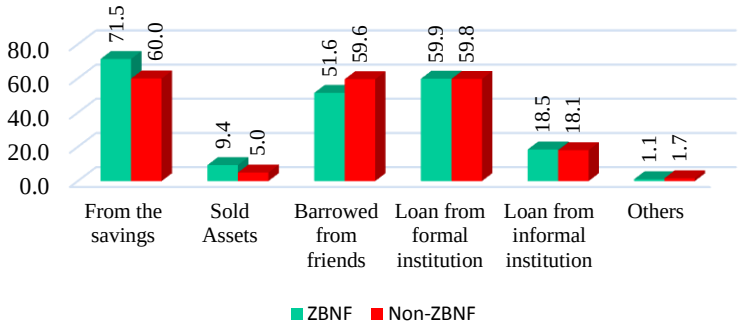
Source: Field Survey

2.13 The case studies of farmers have revealed that the farmers could have derived more income under ZBNF, had there been proper marketing support in place. Farmers have adopted different channels to market their produce as some farmers have sold through their collectives while a few sold their produce through linking with Government Department like Anganwadi Centres (AWC) and Government Market Yards. One farmer is found to be utilising Information Technology and Market Melas to develop market linkages with the far off customers. Another farmer has explored his market through social networks. One farmer even tried to link with private companies but was not successful. Farmers maintained links with local and external markets in Telangana and Andhra Pradesh to sell their produce. It is reported that supplying to the external markets fetched them better prices compared to selling in local markets. For example, one farmer reported that *donda* vegetable fetched him Rs.20/- per kg in the local market but he could sell the same in Hyderabad at Rs.40-50 per kg. The farmers faced a number of problems in marketing including difficulty in establishing the differentiation of ZBNF products from Non-ZBNF products because of which they could not claim a higher price for the ZBNF output. One farmer has suggested that certification of ZBNF farm produce is essential for informing the

consumers that the produce of ZBNF is chemical free. This will be helpful for the farmers in obtaining premium price for ZBNF produce. He has also suggested that the ZBNF farmers to be given ZBNF Identity Cards for selling ZBNF produce in the Rythu Bazaars. Thus, these case studies clearly provide evidence that the farmers can increase their incomes further if proper marketing support is provided by the RySS.

2.14 The increased incomes of the farmers enabled them to depend more on their savings accumulated through the cultivation of ZBNF in the previous years for meeting the working capital required to grow crops in the agricultural reference year in Kharif season. Similarly in Rabi, 72 per cent of ZBNF farmers have managed their working capital through their savings as against 60 per cent of the non-ZBNF farmers. This provides ample evidence for the increase in incomes of farmers from crops grown (Figure 2.3).

Figure 2.3: Distribution of Farmers Reported according to Sources of Working Capital for the Agriculture Operations of ZBNF and Non-ZBNF: Rabi 2018- 2019 (in percentages)



i. ***Source:*** Field Survey

Conclusions

2.15 The agro-ecological practices of ZBNF have reduced the risks of the farmers who generally encounter in the production process of crops. The risks are related to input markets, credit markets, output markets (in terms of falling crop output prices), yields of crops and indebtedness. Thus, the ZBNF farmers have become resilient to these risks. This has improved relative autonomy of farmers from these risks due to ZBNF.

CHAPTER 3
Agro-ecological Practices of ZBNF and Soil Fertility

I. Introduction

3.1 This chapter is an attempt to analyse the agro-ecological practices such as biological input use, intensive use of, crop diversification activities like mixed cropping, bund cropping, border cropping and five-layer models and he impact of these models on ecology. These practices, through improvement in soil fertility have an impact on the yields of crops, quality of output, resilience of crops against weather variability and human health. These are the dimensions considered for assessing the provision of ecological services of ZBNF. In this backdrop, this chapter addresses the following research questions:

i. What are the agro-ecological practices adopted by the ZBNF farmers in growing crops?
ii. Are these practices associated with the changes in soil fertility of the farmers?
ii. How far has the changes in soil fertility provided ecological services such as quality of crop outputs, resilience against the weather variability and human health, apart from changes in the yield of crops?

3.2 The soil fertility has been captured through perceptions of farmers in terms of presence of earthworms in the field, increased green cover and improved yields. Soil quality has also been assessed through improvements in the resilience of crops in withstanding against weather variability and quality of crop outputs.. All these factors together reflect the contribution of agro-ecological practices under ZBNF to the ecological services. This is qualitative assessment. However, there is a need to assess soil fertility through scientific studies.

II. Case Studies Perspectives

Case Studies Perspectives on Agroecological Practices

3.3 Farmers have used biological inputs and adopted mixed cropping, inter cropping, border cropping and bund cropping in addition to 5-layer and 36*36 models to ensure steady and regular incomes. The tallest contribution of ZBNF is changing the cropping pattern from mono to poly cropping. The case studies have brought out

various issues from farmers' perspective. Major issues encountered during the interactions with the farmers as part of case studies are:

A detailed discussion of the case studies is in order.

Models Including 5 Layer Model and 36*36 Models

3.4 The experience of farmers with regard to drivers and barriers which they have encountered in their journey through ZBNF and the suggestions offered by them to overcome these barriers is also documented through these case studies. The case studies of farmers spread across the districts of Andhra Pradesh clearly reflect the successful strategies adopted by the RySS in bringing about changes in land use pattern and cropping patterns. It is evident from the case studies that the farmers have adopted mixed cropping, inter cropping, border cropping and bund cropping methods of growing. They have also adopted the 5-layer model and 36*36 models in cultivating different varieties of crops to ensure steady and regular incomes. The tallest contribution of ZBNF is changing the cropping pattern from mono to poly Cropping.

Box -1: Models and Regular Income

G. Srinu, Bendupudi Village, Thondangi Mandal, East Godavari (EG.)District cultivates Banana with vegetables and flowers as intercrops.

Mani Rambabu, Velicheru village, Atreyapuram Mandal, E.G. District cultivates ZNF with banana, ginger, tomato and Bengalgram with chrysanthemum as border crop to repel pests.

Munuswami Reddy is a young, innovative and early adopter of ZBNF in paddy. He has a 36*36 model with 25 types of horticulture species, 25 types of Vegetables and leafy vegetables to keep the land covered with greenery throughout the year.

Venkatappa, Ananthapuramu District Venkatappa, Ananthapuramu District has a 5 layer model using drip. Along with oranges, he cultivates caster, cowpea, velvet and jabbeans. He receives income from all the crops and received an income of Rs. 12500/- from Velvet crop only. This is in addition to the income from his main crop orange. He practices all ZBNF PoPs.

G. Yesu, Mundlamuru Cluster, Prakasam District is a B.Tech., graduate cultivates ZBNF in 7 acres of land (4.5 acres own la.d and 2.5 leased in land). In his 36*36 model, Yesu grows 8 types of different crops (Vegetable, leafy vegetables, drumstick, castor, different fruits and also flower.

K. Nanaji, Karkaputtu village, Paderu Mandal, Visakhapatnam District. Nanaji has 7 acres of coffee plantation with paddy, Guli Ragi, millets, pulses and pepper. Kovel foundation helped him with 5 layer model wherein dragon fruit, mango, orange, lemon, jackfruit, tamarind, banana, drumstick, cardamom, cloves, cherries, neem and Neredu are grown.

KV Homendra, Balapanuru village, Panyam Mandal, Kurnool District is an NFF, practicing 5 layer model - Mango, Sweet Lemon or FIGs, Papaya or Drumsticks or Guava or perennial red gram, Vegetables and Leafy vegetables. He follows all ZBNF PoP religiously and gets better price for his produce as they are locally known as natural Products. He claimed that the self- life of his vegetables is also high.

3.5 As part of an innovation under ZBNF, the existing coffee plantations in the hilly areas have been transformed into the 5-layer model. This experimentation of RySS has ensured continuous flow of income to the tribal farmers. Apart from rotation of crops, the border and bund crops

raised by these farmers has ensured considerable income to meet the investment for raising the main crops in their fields. This has resulted in intensive use of land throughout the year. The farmers have also reported that the gestation period required to start yielding of orange garden has declined considerably under ZBNF compared to the gardens grown under Non-ZBNF practices. Keeping in mind the agro climatic conditions of the region, the principle of 5-layer cropping pattern with combination of suitable crops in each layer is recommended for cultivation under ZBNF in this region.

Local Variety Seeds

3.6 Local varieties of seeds have been used for raising crops under ZBNF by many farmers.

Small Farmer Focus

3.7 The existing small pieces of land have been put to effective use by the farmers under different models of growing crops under ZBNF which also ensured food security and balanced diet even to small farmer households.

Marketing Support

3.8 The case studies indicate that the farmers could have derived more income under ZBNF, had there been proper marketing support in place for them. It is observed that farmers adopted different channels to market their produce. Some farmers have sold through their collectives while a few sold their produce through linking with Government Department like Anganwadi Centre (AWC) and government market yards. One farmer is found to be utilising information technology and market melas to develop market linkages with the far off customers. Another farmer has explored his market through social networks. One farmer even tried to link with private companies but was not successful.

Farmers maintained links with local and external markets in Telangana and Andhra Pradesh to sell their produce. It is observed that supplying to the external markets fetched them better prices compared to selling in local markets. For example, one farmer reported that donda vegetable fetched him Rs.20/- per kg in the local market but he could sell the same in Hyderabad at Rs.40-50 per kg. The farmers faced a number of problems in marketing including difficulty in establishing the differentiation of ZBNF products from non-ZBNF products because of which they could not claim a higher price for the ZBNF output.

Box - 2: Marketing

G. Srinu, Bendupudi Village, Thondangi Mandal, EG. District Srinu.He self-markets his ZBNF produce but complained of no premium prices. RySS staff promised better prices for ZBNF produce through Reliance Fresh but this did not materialize. There is a ZBNF stall at Prattipadu but this is of little help to the ZBNF farmers who are small and marginal farmers.

Mani Rambabu, Velicheru village, Atreyapuram Mandal, E.G. District.Sells his produce to wholesalers in Hyderabad, Vijayawada and Rajahmundryfor a better price. He has created his own channel for Banana in Hyderabad and supplies to them directly. He is so interested in Natural Farming that he buys cow urine from SurabhiGoshala in Kateru near Rajahmundry.

Jyothibabu, Singarajupalem village, Nallajerla Mandal, West Godavari District.JyothibabuCultivates paddy, vegetables and lemon in 5 acres of land. Markets rice at a premium price but vegetables are sold at normal prices.

G. Yesu, Mundlamuru Cluster, Prakasam Districthas tied up with Anganwadi Centre in the village. Hence, he need not travel to the neighboring villages, as far away as 15 kms, to sell his vegetables like earlier. The villagers like the quality of his vegetables and fruits and, hence, pay higher prices.

L Ganga Raju, Bandaluppi village, Parvathipuram Mandal, Vizianagaram District promoted collectivization of ZBNF produce in this village and Ganga Rajua is the leader of the group that promoted this collectivization group which exports ZBNF produce to Visakhapatnam, Vijayawada and Hyderabad. All the net proceeds after expenses of these exports are shared by the farmers.

Extension Services Support

3.9 Paddy cultivation under flood irrigation conditions, especially under public canal irrigation in delta regions has shown mixed results in the enhancement of yields. The case studies in this regard have attributed this to two reasons: The first being insufficient quantity of inputs used under ZBNF and the second reason cited is wrong proportion and wrong combination of ingredients used to prepare the inputs. Due to lack of continuous and effective monitoring by the extension agencies, the farmers often made mistakes in preparation of the inputs which is more so in the preparation of Kashayams and Asthrams at the village level. It is not out of place to recall the focussed group discussion held in one of the villages of Kadapa District where the farmers reported that the Asthrams prepared and used by the farmers under ZBNF could not control the pests on the chilly crop. This provides substantial evidence that the right mix of ingredients in preparation of Asthrams and Kashayams does matter in getting good yield.

Box - 3: Extension Services

G. Srinu, Bendupudi village, Thondangi has an NPM shop with assistance from RySS but this underutilized due to lack of demand for ZBN inputs.

G. Srinu, Bendupudi village, Thondangi Mandal, East Godavari District says that RySS staff promised better prices for ZBNF produce through Reliance Fresh but this did not materialize. There is a ZBNF stall at Prattipadu but this is of little help to the ZBNF farmers who are small and marginal farmers.

S. Munuswamy Reddy, Sripurandapuram village, Buchireddypalem Mandal, Nellore District suggested that ZBNF farmers shall be issued identity cards to enable them to get better prices for their produce at Rythu bazaars.

K. Nanaji, Karkaputtu village, Paderu Mandal, Visakhapatnam District mentioned that ZBNF helped him in increasing the output of coffee and pepper and, thus, incomes.

Mani Rambabu, Velicheru village, Atreyapuram Mandal, East Godavari Districtis a champion farmer and encourages fellow farmers to undertake ZBNF. He wished better cooperation from ZBNF staff in marketing ZBNF produce.

K Chandra Rao, Ibrahimbad, Etherla Mandal, Srikakulam Districtsells his vegetables in nearby markets but wished that a separate wholesale shop for ZBNF products in the area

L Ganga Raju, Bandaluppi village, Parvathipuram Mandal, Vizianagaram District mentioned that ZBNF has played a crucial in

3.10 One farmer has suggested that certification of ZBNF farm produce is essential for informing the consumers that the produce of ZBNF is chemical free. This will be helpful for the farmers in obtaining premium price for ZBNF produce. He has also suggested that the ZBNF farmers have to be given ZBNF identity cards for selling ZBNF produce in the Rythu Bazaars. Thus these case studies clearly provide evidence that the farmers can increase their incomes further if proper marketing support is provided by the RySS.

III. Analysis of Strategic interviews

Strategic Interviews Perspective on Agroecological Practices

3.11 The strategic interviews with the DPMs also have revealed that there are some other innovations in ZBNF. Some of these innovations include Farmer friendly content and Package of practices; Location specific methods for growing crops; New ways of arresting pests; New crops (millets) New crop combinations; Encouragement of local seeds; Pre-Monsoon Dry Sowing; Integrated farming – Paddy, fish, border and bund crops; SRI paddy cultivation; Guli Ragi cultivation; Mulching; Ready availability of ZBNF inputs; and A comprehensive ICT support. For illustration purpose, some of the Agroecological Models are presented below:

3.12 The DPMs of Ananthapuramu and Guntur districts mentioned that PMDS is very successful in their districts. A picture of PMDS in Ananthapuramu district is given below:

Picture – 3.1: PMDS of Navadhanyas in Ananthapuramu District in May 2018.

This picture was taken in January 2019.

3.13 The integrated model paddy with fish and border and border crops as shown in the following picture is very successful in East Godavari district and is yielding higher incomes to the farmers.

Picture – 3.2: Integrated Model of Paddy and Fish in East Godavari District

3.14 Experimentation with large number of local paddy seeds is another innovation under ZBNF. Farmers in Krishna District experimented with 53 varieties of local paddy seeds as shown by the following picture:

Picture – 3.3: 53 Varieties of local Paddy Seeds in One Plot

Guli Ragi cultivation has increased Ragi yield by more than 3 times compared to cultivation of Ragi through normal practices. The following picture in this regard is in order:

Picture – 3. 4: Guli Ragi Vizianagaram District

Suggestions for Universal Spread of ZBNF through Strategic Interviews

3.15 Constraints for the spread of ZBNF vary from district to district. For instance, in Chittoor and other districts in Rayalaseema, there is a hesitation among farmers to implement ZBNF because of their single-season cultivation that requires them to wait for a year, if their current crop fails or has low yield. Other major hurdles for the expansion of ZBNF as perceived by some of the DPMs are: lack of resources such as local cows, NPM shops, pulverisers, required leaves in delta areas and power weeders. It is, therefore, better to supply these items on 100 per cent subsidy to the farmers to encourage the spread of natural farming, the DPM opined. ZBNF inputs need to be prepared by family members by themselves which some farmers feel a time consuming task and not inclined to do such practices. Also noticed is the fact that nuclear families are increasing over time and, hence, there is a dearth of family members. Besides, lack of labour supply and locally available inputs are some of the other reasons for the slow growth of area expansion under ZBNF. One of the DPMs observed that at present, ZBNF is practiced mostly for self-consumption and changes in the attitudes of the farmers take time. Further, tenants are not coming forward because they are not sure of tenancy continuation as they believed that the investments in ZBNF will yield results only after two years or so.

3.16 Farmers are habituated to readymade inputs and not able to spend time for the preparation of inputs required in advance. In ZBNF, family members must cooperate for timely preparation of inputs. One of the officers observed that it is now a testing period and these experiments will take time to spread to other farmers. Further, farmers have a strong belief that yields in the initial years of ZBNF are not attractive and are afraid of loss of income and, as a result, they are not expecting immediate positive impact of ZBNF.

3.17 In delta areas, farmers do not have options for promoting ZBNF essentially due to the dominance of canal irrigation with fixed water supply schedule and reliance on flood irrigation method. But, the district units and farmers are making efforts to find the ways for spreading ZBNF. However, majority of the DPMs interviewed admitted that their unit is under-staffed to meet the demand for managing various activities on hand in time. Field staff in the district units needs to be strengthened

immediately for taking more activities in spreading the program. DPMs are burdened with administrative works or deskwork and finding it difficult to monitor field activities. Proper monitoring of fieldwork is essential, especially in the new and innovative programs like ZBNF. But due to lack of appropriate staff, there are lacunae in the monitoring activities of CRP/ICRPs/CAs and farmers. Print material and other related books are supplied at the state level but not at the district level. DPM of the Srikakulam district observed that wherever the traditional cows are available, the spread of ZBNF cultivation became easy. Farmers in delta area are more entrepreneurial and confident in earning much more income on the time spent for the preparation of ZBNF inputs. Further, in delta area, dearth of local cows and other natural ingredients required for preparing ZBNF inputs is a barrier in the spread of program.

3.18 Another major hurdle in the spread of ZBNF is marketing. Those practicing ZBNF are expecting higher price for their output as the output is chemical-free and healthy. RySS is aware of this aspect and efforts are being made to strengthen the marketing. However, individual farmers are successful in getting a good price for their output due to tie up with traders in Bangalore and Hyderabad cities. Best example is a farmer from Siddotam mandal, Kadapa district practicing ZBNF for the last three years growing Guava crop in his 7 acre land. He had a tie up with traders in Bangalore and they are approaching him directly and buying the output from farm at a good price (see photo). District official observed that on an average each Guava fruit weigh around 600 grams and there are many visitors to his field interacting with him on the market arrangement.

3.19 Majority of the officials interviewed opined that the government must create confidence among farmers through:

- Increased number of demonstration plots;
- Increased number of exposure visits;
- Assurance of better output price;
- Creation of local market awareness with a separate stall in Rythu bazaars, private super bazaars and in every mandal headquarters.

3.20 There is a need for convergence of different departments in the district headquarters and ZBNF staff needs to be involved in all the departmental meetings. In other words, personnel from top to grassroots levels such as Joint Director, mandal

level officers and village officials need to be involved and they should own ZBNF program to create confidence among the farmers for achieving universal spread. Agriculture and allied departments such as horticulture, animal husbandry, DWAMA, medical department, marketing department, etc., must work together in spreading the ZBNF. At present, ZBNF is treated as a separate wing within the Agriculture Department, but convergence of related departments is very important. Government must establish certification agency to test the produce and such certification will fetch farmers a premium price for their produce. ZBNF fields also need to be demarcated and a code number has to be given for wide publicity.

3.21 Government should initiate steps to buy the ZBNF products for PDS, student hostels, AWCs, temples, etc. SHGs and NPM shops need to be encouraged to supply ZBNF inputs on subsidised prices in every village. Government should also support in marketing aspects by creating awareness about ZBNF to the consumers and separate processing units and facilities in the market yards. FPOs have to be encouraged and DPMs have to be supported with sufficient number of staff to universalise the ZBNF.

3.22 Some of the NGOs are supplying ZBNF inputs free of costs to the farmers for the spread of ZBNF and, such initiatives by others need to be encouraged for universal spread of ZBNF. Subsidies to ZBNF inputs and on the purchase of local cows have to be extended with full-fledged leak proof system for speedy expansion of ZBNF. Scientists have to be invited and they should be encouraged to conduct experiments on ZBNF to convince themselves on its economic, environmental and health benefits so that the same can be spread widely, not only among the farming community but also among the intellectual community. Convergence between scientists, all the agriculture and allied departments and RySS is the need of the hour. One of the DPMs observed that there is need to stop providing subsidies to chemical fertilizers and pesticides to safeguard human and soil health. `Goshalas' are to be promoted and encouraged; and also ZBNF inputs have to be inter-linked with a scheme to promote ZBNF method of cultivation.

3.23 A separate platform in the market yards for ZBNF outputs with government certification has to be provided to create confidence among the consumers so that ZBNF farmers will also get better output price. It is also suggested to arrange on-farm testing for the chemical residue to get the consumer confidence. There is also a need

for separate rice mills for ZBNF rice as there are complaints that ZBNF and non-ZBNF rice are being hulled in the same rice mills, because both varieties are likely to get mixed; and as a result, a suspicion on the ZBNF quality among farmers and consumers is generated. In such a case, farmers have to compromise with low prices being paid by consumers. It is also suggested that exclusive seed multiplication centres for ZBNF are to be established. Similarly separate market stalls, separate MSP for ZBNF products and linking MGNREGS works with ZBNF activities may go long way in spreading ZBNF.

3.24 In addition to regular motivation of staff and farmers, extension activities, periodic training to CRPs/ICRPs, involvement of social activists, regular media briefings and publication of district-specific literature are also needed to expand the spread of ZBNF. Notably, a separate helpline for ZBNF may go a long way for receiving suggestions for improvement including marketing related aspects. From a long-term perspective, there is also a need to explore how digital technology can be used to achieve better coordination; and it is also important to include ZBNF as part of the curriculum of all agricultural courses.

IV. Focussed Group Discussions Perspective on Agroecological Practices

3.25 In all, 65 FGDs have been held in the state. The discussions have been centred broadly on three issues, viz., the constraints faced by farmers in realizing benefits from ZBNF; the association between the constraints encountered by the farmers and the overall performance of ZBNF in the villages and the suggestions offered by the farmers for addressing the constraints to attain the potential benefits from ZBNF. Based on the discussions of these FGDs, the villages have been classified into four categories, viz., average performance villages (with a score of 1-3); moderate performance villages (with a score of 4-6); high performance villages (with a sore of 7-9) and very high performance villages (with a score of 10). The analysis conducted in this regard is in order.

3.26 Constrains identified from the FGDs are broadly grouped into four categories. They are:

- Awareness about ZBNF among the farmers;
- Availability of the resources required to prepare the inputs required for ZBNF:
    - Percentage of villages reported scarcity of cows;

- Percentage of villages reported inadequacy of human resources;
- Percentage of villages reported time consuming process of ZBNF inputs preparation;
- Percentage of villages reported scarcity of inputs;
- Percentage of villages reported absence and/or non- functioning of NPM shops;

- Mobility of crop land among farmers to adopt ZBNF
  - Tenancy conditions and
- Marketing issues

A summary analysis of the correlates of performance of ZBNF in villages as revealed by Focussed Group Discussions is provided below:

Table 3.1: Correlates of Performance of ZBNF in the Villages of Andhra Pradesh

Sl. No	Description of the correlates	Indicator	Distribution of villages by performance levels				
			Average performance(1-3)	Moderate performance 4-6)	High (Performance)(7-9)	Very High Performance(10)	AllVillages
1	Awareness	% of farmers aware of ZBNF	40.0	53.5	55.6	69.2	54.6
2	Required Resources	% of villages reported scarcity of local cows	50	61.1	63.3	28.6	50.8
		% of villages reported inadequacy of human labour	30.0	38.9	23.3	14.3	26.6
		% of villages reported time consuming process for the preparation of ZBNF inputs	40	33.3	43.3	28.6	36.2
3	Scarcity of inputs	% of villages reported	30	61.1	60.0	28.6	45
4	NPM Shops	% of of villages reported absence and / are not functioning	30	11.1	20	14.3	18.8
5	Tenancy	% of villages reported non-suitability of existing tenancy contracts to ZBNF)	10	16.7	30	28.6	21.3
6	Marketing	% of villages reported lack of Marketing support for ZBNF products	40	61.1	63.3	71.4	59.0

***Source*:** Field Survey

Awareness:

3.27 The results from the FGDs have revealed that the awareness levels in terms of percentage of farmers aware of ZBNF have varied across villages and districts. Moreover, it has also varied among the villages in a district also. The very pertinent issue that has emerged from the data is that the variations across the villages within the districts are larger than the same across districts. This suggests that adequate staff should be provided at the village level to reach out each and every farmer in the village. Further, it is evident that the awareness levels are at lower level among the marginalised groups like Scheduled Castes. Hence, focus should be on these communities also.

3.28 Results show that the percentage of farmers aware of ZBNF is found to be the highest (69 per cent) in very high performance villages and lowest (40 per cent) in average performance villages. Further, it is increasing with the increased performance of the villages. Thus, awareness has turned out to be one of the dominant factors that have determined the performance of the villages.

Scarcity of Local Cows:

3.29 The availability of local cows is fundamental for organising agriculture under ZBNF. In view of this scarcity of cows reported from many villages, some farmers have obtained cow dung and urine from nearby villages and Goshalas maintained by temple authorities. Some districts like north coastal districts and Godavari districts have tribal areas that have become the supply source for cow dung and cow urine to farmers in other parts of the districts. The farmers located in the Guntur delta villages of low lying areas and areas near to the sea found it difficult to maintain cows because they are far away from nearby towns to sell cow milk.

3.30 The non-availability of desi cows, which is crucial for ZBNF, is found to be the lowest in the very high performance villages. But, interestingly, this constraint is felt more by the farmers among high performance villages than the moderate and average performance villages. The development of markets for cow urine, dung and other dairy products in and around nearby villages including nearby *Goshalas* have enabled the farmers in these villages to overcome the scarcity of local cows.

Scarcity of Human Resources:

3.31 The scarcity of labour for the preparation of inputs is found to be lower in very high performance villages as compared to all the other categories of villages reflecting the dominant factor in determining the performance of villages. Similarly, in contrast to other categories of villages, the opportunity cost of labour is found to be lower in the very high performance villages. The disaggregated data has shown that the districts with high intensity of cropping and/or availability of opportunities for off-farm and non-farm employment have encountered the labour scarcity and thereby exhibited lower performance. The farm households who depend more on non-agricultural activities for their livelihoods look for hired labour for providing services in the preparation of ZBNF inputs because these households get more wages for their labour in the non-agricultural activities. Thus, the high performance villages have not experienced the scarcity of labour as compared to the average and moderate

performance villages. This means that the farmers in these villages are largely dependent on family labour for adopting ZBNF.

Scarcity of ZBNF Inputs:

3.32 The farmers have reported the following four reasons for scarcity of ZBNF inputs:

- Sufficient knowledge required to prepare Kashayams and Asthrams to control pest is not provided to many of the farmers,
- The leaves required to prepare these inputs are not available in some villages,
- The same are not available in readymade form in the markets and
- NPM shops are not providing these inputs.

3.33 The non-availability of ingredients like leaves and other related materials to prepare inputs of ZBNF is less pronounced in very high performance villages and average performance villages. Thus, the scarcity of raw materials required to prepare inputs of ZBNF has determined the performance of villages. The district level data shows that dry land and rainfed districts have experienced scarcity of the ingredient for the preparation of ZBNF inputs.

Tenancy Considerations:

3.34 The existing short term nature of tenancy contracts is not suitable to for ZBNF as the tenants perceive that crop yields are lower during the first three years under ZBNF and yield improvements can be realised only after the third year. This means that tenants are more likely to adopt ZBNF if the tenancy period is at least five years. Hence, there is need to address the tenancy issue under ZBNF as the tenancy is wide spread in the State of Andhra Pradesh. The tenancy issue is reported prominently by the tenant farmers in high performance and very high performance villages. These farmers are most probably owner-cum-tenant farmers of small landholders in high performance villages.

NPM Shops:

3.35 Many farmers reported that adequate number of NPM shops is not available and the existing NPM shops are not able to supply the required inputs because many of the existing NPM shops are not functioning effectively. The high performance villages have experienced the problem of non-availability and/or not functioning NPM shops.

Marketing Issues:

3.36 Marketing is one of the constraints prominently reported by the farmers in the FGDs in all the villages across all the districts. Farmers have utilised the telephonic communication, Rythu bazaars, Wholesale and retail marketing and Marketing melas to reach out to consumers in the big towns and cities. But the farmers are demanding that ZBNF farmers should be linked with the government departments, particularly, the public distribution systems. The corporate sector shall also be approached and encouraged to purchase ZBNF commercial crops like cotton and Chillies. Lack of market support has become a major constraint both among the high and very high performance villages as compared to the other categories of villages. This undermines the need for vibrant marketing support system in the high and very high performance villages.

Agroecological Practices and Improvements in Soil Fertility

3.37 A large proportion of ZBNF practicing farmers in Kharif season have reported that the soil fertility has gone up due to ZBNF. The farmers have provided evidence through three parameters - softening of soils, presence of earthworms and increased green cover in the fields. It is also clear from the reporting of farmers that the green cover is not as widely present as the other two parameters of soil fertility. It is reported by one of the farmers that his saline land has been turned into fertile land, thanks to the rejuvenating role of ZBNF..

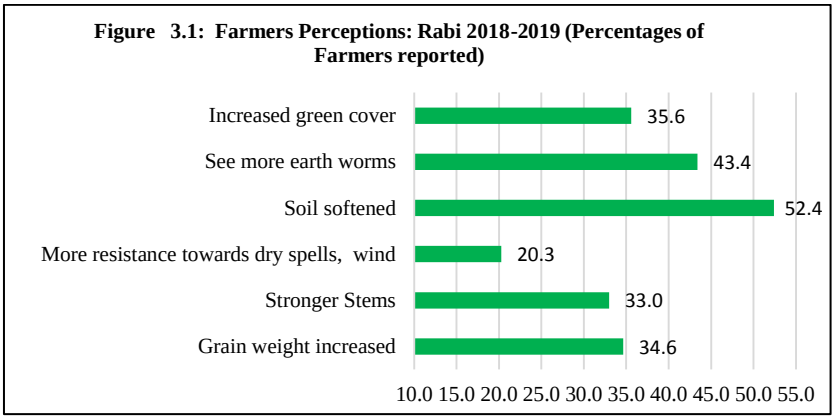
Table 3.2: Percentage ZBNF Farmers Reported Improvement to Soil due to ZBNF: Kharif 2018-2019

Percentage of Farmers reporting on Soil Qualities	
Indicator	(%) of Farmers Reported
Enhanced quality	83.00
Soil softened	83.38
Now see more earth warms	81.83
Increased green cover	56.49

Source: Field Survey

Similarly, as high as 52 per cent of farmers reported that their soil softened due to practice of ZBNF in Rabi. Further, 43 per cent of farmers have observed that they are now seeing earth worms in their fields and around one third of the farmers have reported that there is increase in the green cover in the fields (Table 3.1 and 3.2 & Figure 3.1)

Figure 3.1: Farmers Perceptions: Rabi 2018-2019 (Percentages of Farmers reported)

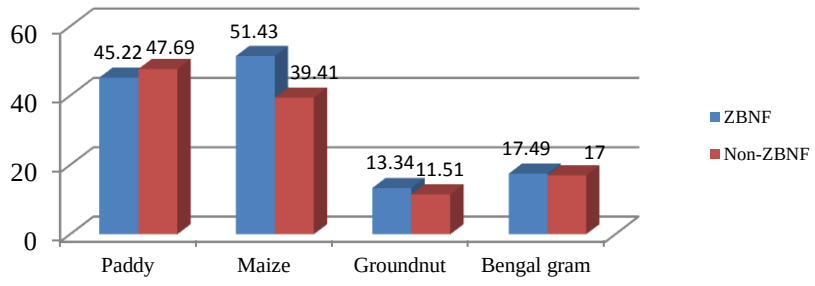


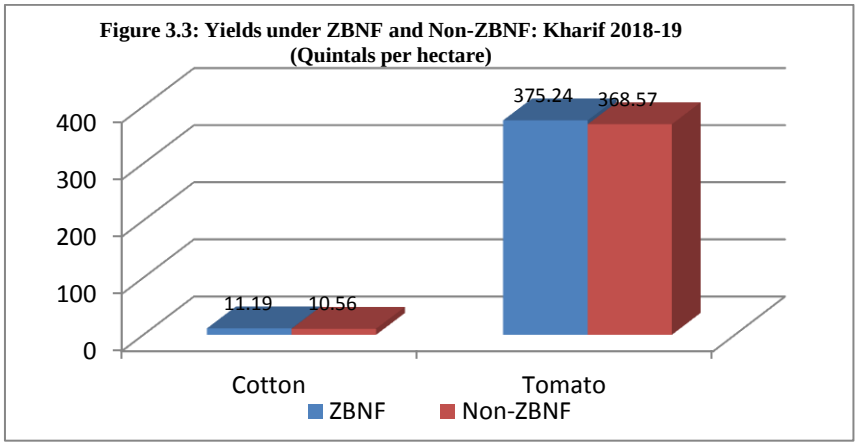
iii. ***Source:*** Field Survey

Improved Soil Fertility and Yields of Crops(Estimated through Crop Cutting Experiments)

3.38 One of the major activities of this study is to collect yield data from CCEs. As the survey for Kharif season commenced in the 3rd and 4th week of November 2018, the study could not do CCEs of all the crops, as by that time many of the crops have been harvested. The test of significance between the yields of the crops grown under ZBNF and non-ZBNF indicates that there is no significant difference in the yields obtained through CCEs between ZBNF and non-ZBNF in Kharif season (Figures 3.2 to 3.3 & Table 3.3).

Figure 3.2: Yields under ZBNF and Non- ZBNF: Kharif 2018-19 (Quintals per hectare)





Source: Field Survey

Table 3.3: Differences in Crop Yields under ZBNF and Non- ZBNF: Kharif 2018-19(Quintals per hectare)

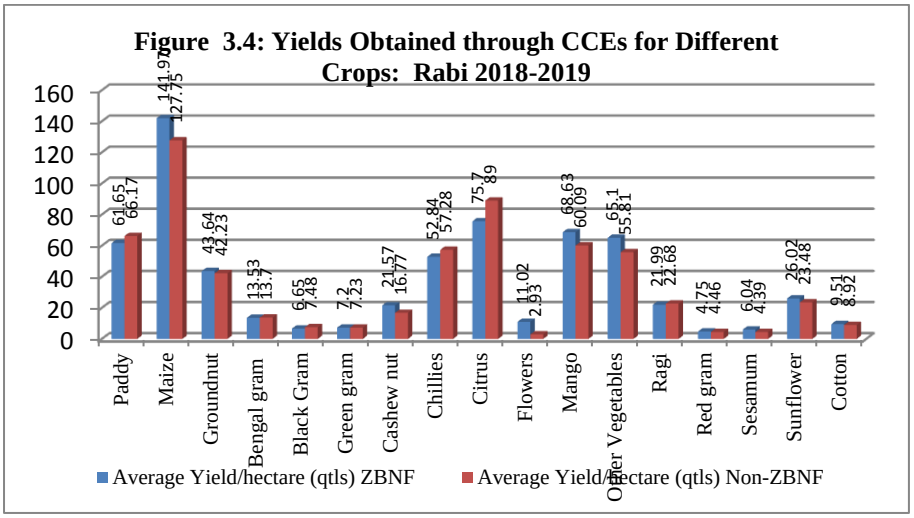
Crop	Yield of Crops Obtained through CCEs		Yield Significantly Differ between ZBNF and Non-ZBNF (Test of Significance)
	ZBNF	*Non-ZBNF*	
Paddy	45.22	47.69	Not Significant
Maize	51.43	39.41	*Significant
Groundnut	13.34	11.51	Not Significant
Cotton	11.19	10.56	Not Significant
Bengal gram	17.49	17.00	Not Significant
Tomato	375.24	368.57	Not Significant

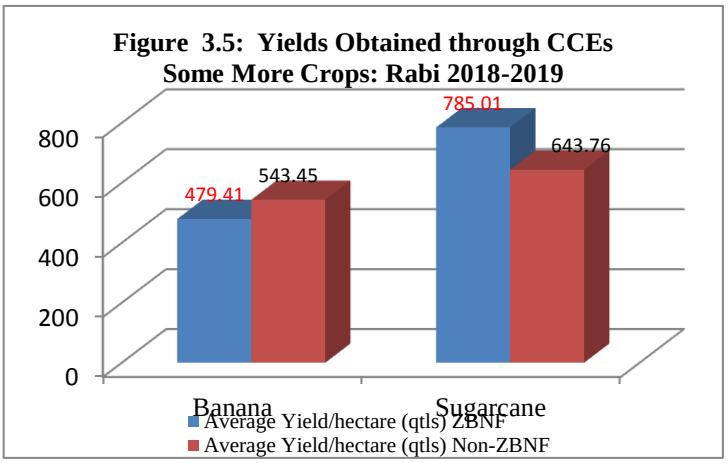
Source: Field Survey

Note 1: * Significant at 1 per cent level of significance

Note 2: CCE yields are at higher than those reported by farmers in case of each crop

3.39 A comparison of yields obtained through CCEs for different crops grown under ZBNF and non-ZBNF of Rabi crops has revealed that there is no statistically significant difference in yields between ZBNF and non-ZBNF in the case of majority of crops considered for the analysis. As a matter of fact, the yields of crops such as maize, sesame, sugarcane and sunflower under ZBNF are significantly higher than those under non-ZBNF. But, the yield of paddy crop is higher under non-ZBNF over ZBNF (Figures 3.4 and 3.5 & Table 3.4).





Source: Field Survey

Table 3.4: Differences in Yields Obtained through CCEs for Different Crops:Rabi 2018-2019

Description of Crop	Average Yield/hectare (qtls)			Number of CCEs	
	ZBNF	***Non-ZBNF***	***Difference in Yields***	***ZBNF***	***Non-ZBNF***
Banana	479.41	543.45	Not-Significant	12	7
Bengal gram	13.53	13.70	Not-Significant	33	33
Black Gram	6.65	7.48	Not-Significant	85	67
Cashew nut	21.57	16.77	Not-Significant	32	41
Chillies	52.84	57.28	Not-Significant	52	45
Citrus	75.70	89.00	Significant at 10% level	46	40
Cotton	9.51	8.92	Not-Significant	13	11
Flowers	11.02	2.93	Not-Significant	13	11
Green gram	7.20	7.23	Not-Significant	55	54
Groundnut	17.66	17.09	Not-Significant	106	91
Maize	57.45	51.70	Significant at 5% level	87	106
Mango	68.63	60.09	Not-Significant	22	24
Other Vegetables	65.10	55.81	Not-Significant	19	12
Paddy	61.65	66.17	Significant at 1% level	186	181
Ragi	21.99	22.68	Not-Significant	7	13
Red gram	4.75	4.46	Not-Significant	7	5
Sesame	6.04	4.39	Significant at 5% level	29	49
Sugarcane	785.01	643.76	Significant at 5% level	28	31
Sunflower	26.02	23.48	Significant at 10% level	14	24

Source: Field Survey

Note: CCE yields are at higher than those reported by farmers in case of each crop

3.40 The yields of the crops grown under ZBNF are found to be on par with those grown under non-ZBNF. This is true across all crops. This provides compelling evidence that the yield response to biological inputs is much higher than that of chemical inputs. This also means that the unlocking of nutrients available in the soil through agro-ecological practices of ZBNF has resulted in higher yields or yields on par with those of Non-ZBNF in short run. Hence, it is also an indication that the yields of crops under ZBNF can be higher than those under Non-ZBNF in years to come.

Impact of Agroecological Practices on Quality of Crop Output and Resilience of Crops and Human Heath

3.41 The farmers have reported in Kharif season that the quality of crop output has improved due to ZBNF. The farmers have considered three dimensions to reflect the quality of output. They include weight of the grains, strength of stems, and taste. Among these dimensions, larger proportions of farmers have reported the crop output of ZBNF is very tasty. Between the other two dimensions, higher proportion of farmers has reported stronger stems of plants and grain weight has also increased. As to the resilience of crops withstanding to dry spells and wind is concerned, 42 per cent of the farmers reported that the crops grown under ZBNF have more resilience to withstand against dry spells and wind. In Rabi season also, farmers also reported that the crops of ZBNF have strong stems compared to crops grown under non-ZBNF. The farmers found higher grain weight due to ZBNF. One-fifth of the respondents experienced that crops grown under ZBNF are more resilient towards weather abnormalities like dry spells and wind (Tables 3.5 & 3.6)

Table 3.5: Farmers Reported Quality of ZBNF Crops and Output : Kharif 2018-2019
(in percentages)

Quality of output	Grain weight increased	Stronger Stems	Resilience towards dry spells and wind
	53.4	60.44	42.17
Source: Field Survey			

Table 3.6: Farmers Reported Taste of Food under ZBNF Compared to non-ZBNF Crops: Kharif 2018-19 (in percentages)

Tests of Crop outputs	Not aware of any Difference	ZBNF product is more tasty	Non-ZBNF product is more tasty	Unable to judge the difference
	8.2	81.8	1.6	8.4

Source: Field Survey

3.42 It has been reported by farmers in the FGDs that the incidence of occurrence of seasonal pests to the crops also declined due to ZBNF. The farmers are saved from the exorbitant costs of chemical pesticides and are also protected from the health hazards caused due to the use of chemical pesticides. They reported reduced health costs of the family members as they are saved by not inhaling the powerful chemical pesticides stored in the houses or when sprayed in the fields. This improves the disposable income of the households.

Conclusions

3.43 The agro-ecological practice of ZBNF have provided ecological services such as improved soil fertility, enhanced quality of crop outputs, crop resilience to climate change and reduction in health problems related to chemical inputs. The case studies of farmers and input use of biological inputs also provided ecological services. Arresting depletion of natural resource like land is another ecological service provided by agro-ecological practices of ZBNF. This is evident from the case studies of ZBNF farmers. Soil fertility might have improved through increased dependency on bullocks for tilling land. This is another dimension of ecological services of ZBNF. The reduction in the use of chemical pesticides due to the use of biological inputs might have reduced environmental pollution. This is also ecological service provided by agro-ecological practices under ZBNF.

CHAPTER 4

Summary, Conclusions and Policy Implications

I. Summary

4.1 The basic premise of this study is to assess the impact of ZBNF on farming and farming community in Andhra Pradesh. Firstly, the study focuses on assessing the impact of agro-ecological practices of ZBNF on production conditions like cost of cultivation, value of output and net crop incomes to farmers and their implications for the relative autonomy of farmers. Secondly, it examines the impact of intensive use of land through agro-ecological practices like diversification of crops in terms of raising mixed crops, intercrops, border crops, bund crops, 5-layer and 36*36 models with ZBNF practices on fertility of soil. Thirdly, it also focuses on assessing the impact of soil fertility on yields of crops, quality of crop output, and resilience of crops to weather variability and health of the farming community.

4.2 Both quantitative and qualitative data are used for the study. The study has been conducted in all the 13 districts through a random sample of 130 villages, at the rate of 10 villages from each district, covering a random sample of 1300 ZBNF farmers and 1300 non-ZBNF farmers from the selected villages, at the rate of 10 ZBNF farmers and 10 non-ZBNF farmers per village, in Kharif season. For Rabi season different sample of villages had to be chosen. However, the same scheme of sample design has been followed as per the Kharif. In Rabi, the Study confined to 650 ZBNF farmers and a sample of 650 non-ZBNF farmers, covering totally 1300 farmers. The required quantitative data has been collected through Listing Survey, Farmers Household Survey and Village Survey in the sample villages. The qualitative data has been collected through (i) Focussed Group Discussion with farmers, (ii) Case Studies of farmers, and (iii) Strategic Interviews with District Project Managers (DPMs). The data on costs and returns of crops have been collected from farmers through 2 or 3 visits to the farmers at their residences during survey in Kharif as well as Rabi seasons. The data on yields of crops has been obtained through Crop Cutting Experiments (CCEs).The summary of findings emerged from the study are in order.

- The cost of biological inputs and the overall paid out costs of growing crops have come down remarkably due to biological inputs of ZBNF used in growing crops.

- The net crop incomes of farmers have gone up considerably due to biological inputs.
- The use of biological inputs from locally available ingredients under ZBNF has reduced dependency of farmers on external input markets.
- This reduction in the cost of growing crops implies reduction in working capital required for growing crops under ZBNF and this, in turn, implies that farmers have freed themselves from credit markets to that extent.
- The increase in the net crop incomes has unchained farmers from debt trap.
- The diversified and intensive use of land with mixed crops, internal crops, 5-layer models, border crops and bund crops with different crop mixes suitable to the agro-climatic conditions in line with other biological practices like biological input use, mulching and Whaapsa under ZBNF has led to improvement in the soil fertility.
- Increased soil fertility has resulted in the yields of crops of ZBNF to be on par with or higher than those of non-ZBNF crops both in Kharif and Rabi seasons.
- Increased soil fertility has contributed to ecological services like improvement in the quality of output and enhancement in the resilience of crops against the variability in weather.
- Non-use of chemicals has also saved the farming community from health hazards related with storage and use of chemicals.

II. Conclusions

The conclusions emerged from the synthesis of the findings of the analyses conducted in chapters 2 and 3 are in order.

Unlocking *of nutrients available in the soil:*

4.3 The basic tenet of ZBNF is that the nutrients required for the growth of crops/plants are available in the soil itself. Hence, there is no need to supplement nutrients to the soil from external inputs. ZBNF contemplates that facilitation of the release of the nutrients in the soil is enough for the growth of crops/plants. The applications of biological inputs that include facilitate the process of unlocking of nutrients in the soil. The analysis of the use of ZBNF biological inputs and non-ZBNF external chemical inputs for growing crops provides substantial evidence to the fact that the unlocking of nutrients in the soil through ZZBNF biological inputs has resulted in the yield of crops that are on par with the yield of the same crops grown with the external inputs. This is true for all the crops, by and large, grown in Kharif and Rabi seasons.

The cost incurred for unlocking nutrients available in the soil under ZBNF is far lower than the cost of external inputs used under non-ZBNF to supply nutrients for obtaining the same level of crop yields. Further, the biological inputs used under ZBNF donot damage the soil fertility, while external chemical inputs used under non-ZBNF cause the damage for which ample evidence is already available in the literature. The same levels of yields obtained through the use of costly chemical inputs have also been obtained through very cheap biological inputs prepared from the locally available ingredients without damaging the soil fertility. Thus, the analysis of the empirical data collected in Kharif and Rabi with scientific sample design on costs and yields of crops under ZBNF and non-ZBNF provides compelling evidence to the basic tenet that the unlocking of nutrients available in the soil itself under ZBNF is highly preferable to the use of external chemical inputs under non-ZBNF to provide nutrients for growing crops.

Diversified Copping Practices under ZBNF

4.4 The data collected from households of ZBNF as well as non-ZBNF farmers has revealed that the incidence of growing of mixed crops, border crops and bund crops is higher among ZBNF farmers than that among non-ZBNF farmers. The case studies of ZBNF farmers have brought out clearly that the farmers have grown mixed crops, internal crops, border crops, bund cops, 5-layer and 36*36 models. The strategic interviews with the DPMs have informed that there are different models of growing crops for intensive use of land with diversified cropping patterns. This has been practiced along with the application of biological inputs, mulching and Waaphasaby the farmers. The qualitative data collected from the households made it clear that the farmers have observed improvement in the fertility of their crop lands. The farmers have provided three indications in support of their claim. The farmers reported the three indications: (i) the soils in their lands are loosening, (ii) the presence of earthworms in their fields and (iii) the increased green cover in their fields has been observed. Apart from these, the achievements of yield of crops under ZBNF on par with those of crops under non-ZBNF provide robust evidence to the improvements in soil fertility due to agro-ecological practices of ZBNF.

The *increased soil fertility and quality of crop output*

4.5 The qualitative data collected from farmer households to capture the ecological services shows evidence of improvement in the soil fertility due to agro-ecological practices of ZBNF through conservation, protection and enhancement of the agro-

ecological system. The ZBNF farmers have reported that they have observed improvements in the quality of output of the crops they have grown under ZBNF. They have provided three indications, viz., improved grain weight of food crops, stronger stems of plants of crops and increased taste of crop output, in support of their perception that quality of output has increased. They asserted that there is improvement in all these dimensions of quality of output of ZBNF compared to that of non-ZBNF. They further report that the resilience of crops to the weather variability like scarcity of rain fall and winds has increased due to ZBNF practices.

Improvement in Agro-Ecological Conditions

4.6 The data collected from the farmer households on the input use pattern of ZBNF compared to that of non-ZBNF has given very interesting indications for ecological services of agro-biological practices of ZBNF. Firstly, the complete reduction in the use of chemical pesticides has taken place by ZBNF farmers because of the usage of biological inputs. Further, the occurrence of any type of pest has been controlled by the use of Kashayams and Asthrams. Thus, the use of zero level of chemical fertilizers and pesticides is an indication to the improvements in ecological services like reduction in environmental pollution. The zero level of use of chemical fertilizers and pesticides has reduced the incidence of health problems that would have occurred due to inhaling the pungent smell of pesticides not only when they are stored in the homes of farmers but also when applied in the fields of farmers. This has been reported by the farmers in the FGDs and in the case studies. One of the ZBNF farmers reported in course of development of his case study that his saline land has been converted to fertile land and the same has been put under plough now due to the use of biological inputs. On the other hand, the hard data collected from the farmer households on input use for growing crops has clearly brought out to the fore that the dependency of ZBNF farmers has increased on bullock services for tilling their crop lands, as this is evident from the share of costs of bullock services in the total paid out costs per hectare for ZBNF and non-ZBNF farmers across all the crops grown in Kharif as well as in Rabi season. This is clearly an indication for the improvement in soil fertility due to tilling by bullocks through its positive cascading effects on agro-ecological system that ultimately results in the improvement in soil fertility.

Reduced Dependence of farmers on External inputs

4.7 The biological inputs have replaced the chemical inputs due to ZBNF. This has reduced the dependency of farmers on external inputs. They have also reduced the cost of cultivation of crops and thereby reduced the working capital requirements for growing crops to that extent. This has led to the reduced dependency of farmers on credit markets. The reduced cost of cultivation of crops has led to increased incomes of farmers, given the yields of crops. The increased incomes have delinked the farmers from debt trap. The income from mixed crops, border crops bund crops, and 5-layer models ensured continuous income flows from agriculture and consequently the reduced variability in the income flows throughout the agricultural year.

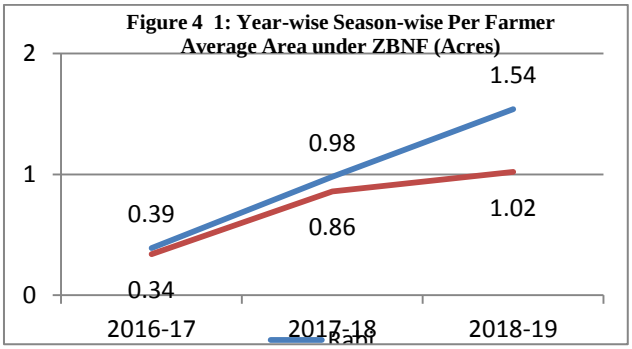
4.8 The unlocking of nutrients available in the soil through agro-ecological practices of ZBNF ensured crop yields to be on par with the yields of crops under non-ZBNF. Thus, ZBNF has reduced uncertainties in crop yields, and it is evident that the farmers are able to become resilient to the risks that the farmers generally encounter in the production process of crops due to ZBNF. This has ultimately enabled farmers to harness relative autonomy from all these risks related to different input and output markets.

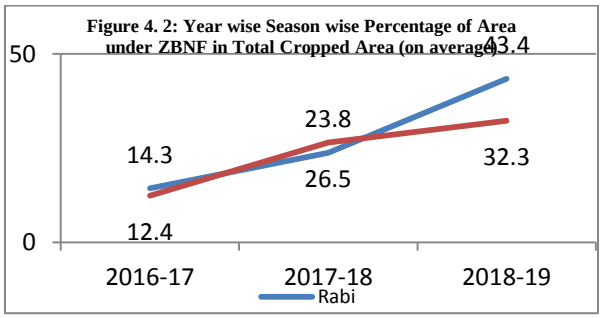
Food and Nutritional Security for Small and Marginal Farmers

4.9 The intensive use of land even on small landholdings with different diversified cropping models of growing crops result in in the chemical free agricultural outputs that encompass leafy vegetables, other vegetables, fruits, pulses, oil seeds and micro-nutritious rich cereals is the hallmark outcome of ZBNF practices. The case studies of farmers and strategic interviews with district project managers provide ample evidence to this. Thus, the ZBNF paradigm of agricultural development provides solution to the three challenges in the present agriculture in developing countries, viz., growth, inclusiveness and sustainability.

Multiple Benefits of ZBNF

4.10 The above findings have showed that the ZBNF has provided the multiple benefits to farming and farming community. These benefits should encourage farmers to adopt ZBNF practices. This should reflect in the adoption of ZBNF practices. The increase in the area under ZBNF over years both in Kharif and Rabi provides ample evidence to this (see Figures4. 1 and 4.2).





1. Source: Field Survey

III. Road Ahead

4.11 There are broadly four issues those need focus for the further expansion of ZBNF among farmers. They are related to development of biological input markets, provision of institutional support for the development of ZBNF output markets, crop growing methods and extension services. The narration of the details of these issues is in order.

Develop Biological Input Markets

4.12 The problem of preparation of biological inputs and/or lack of readymade availability of biological inputs is felt by ZBNF farmers and farmers willing to convert to ZBNF from non- ZBNF. This is because there are no markets developed for sale and purchase of dung and urine of local cows, which are crucial ingredients of biological inputs. Availability of local cows is almost absent in villages. Purchasing and Maintenance of local cows is difficult for farmers, especially for small and marginal farmers because this activity is not economical for single marginal as well as small farmers, given the present price of local cows and maintenance cost in relation to returns they get, apart from dung and urine. Individual entrepreneurships and/or collective entrepreneurships are required to develop markets for dung and urine of local cows. This is also true for the other readymade biological inputs of ZBNF. The

existing owners of NPM shop in the villages and/or Village organizations of women SHGs should be encouraged to take up this activity by providing required local cows per each village on subsidy basis under regular government programs. A demand schedule of cow dung and urine/readymade biological inputs should be discussed and decided in women village organization meetings before the commencement of the crop seasons and accordingly inputs should be delivered to individual farmers. Cluster level federations can be promoted wherever village organizations are not feasible from the demand for biological inputs perspective. The construction of cowsheds should also be provided under regular government programs. Some of the leaves required for the preparation of Kashayams and Asthrams are not available in the villages. Efforts should be made to grow the trees that provide leafs required .These should be grown on government lands with appropriate guidelines to village authorities from the State Government. Thus, these measures would contribute to the development of biological input markets in villages. Further, some of the farmers reported that they are not familiar with the right proportion of different ingredients to be used in the preparation of biological inputs especially the preparation of Asthrams and Kashayams to control pests. The farmers should be well capacitated in this regard. Some of the farmers reported that readymade biological inputs can solve the problem of labour scarcity for the preparation of biological inputs. All these result in the expansion of area under ZBNF.

Market Support for the sale of ZBNF crop Outputs

4.13 The farmers of ZBNF has reported their crop outputs are more tasty, chemical free and good for human health, compared to those of non- ZBNF. Hence, they all felt that their crop outputs should fetch them higher prices over those of non-ZBNF. Some Chilly growing farmers from Guntur have reported that they been accorded higher price by the private companies for having tolerable limits of chemical residue in their crop outputs. This method has yet to come up in case of other crop outputs. But in case of other crop outputs no differentiation is shown between these two types (ZBNF and non-ZBNF) of crops in established APMC market yard and Rythu Bazars. We have yet to see the link between ZBNF farmers with Supermarkets and Contract Farming Supply Chains. Some farmers failed to link with private company, but they have not succeeded. But consumers from middle class families from peri- urban and urban areas have picked up these products from farmers fields. Consumers are in the villages had paid higher prices. But one woman SHGs federations and one Farmers

producer organization, which we come across during our field work able to sell their crop output on their own even to long distance major markets for obtaining higher prices. Hence, promotion and nourishment of Farmers Producers organizations and/or Women self-help group federations seems to be better option to fetch higher prices for ZBNF products. Farmers have also demanded that they should be given a certificate by the government that their products are ZBNF products to maintain their brand image and distinguish themselves from non-ZBNF products.

Focus on Crop Growing Methods

4.14 Boarder Cropping, Bund Cropping and Mixed Cropping has to pick up. Mulching and Whaapsa practices need to be further stepped up. 5-Layer cropping methods should be expanded because this model can provide food and nutritional security and continuous flow of incomes even for very tiny farmers. This model should be different across geographies such as tribal, irrigated and un-irrigated. Indigenous variety seeds are used by some of the farmers for raising paddy. But the existing processing mills are not suitable to process this paddy variety because they need smaller mills to process. These issues may come up in some other paddy growing areas. It needs attention.

Adequate Extension Services

4.15 Farmers have reported inadequate extension services in some of the villages. Especially, it is felt during pest attacks to their crops. The farmers don't know what kind of Kashayams /Asthrams should be used and how it has to be prepared with right proportion of ingredients those have to be used for the preparation of Kashayams /Asthrams. These situations demand immediate attention and solution. Can this issue(s) be discussed in the executive committee of Village organization of women/men collectives with ICRP on the day itself when the incidence of pests is traced by the farmers? This demands an institutional mechanism to focus on these issues.

Appendix Tables of Executive Summary

Table 0.1: Cost of Inputs, Cost of Production and Net Incomes for ZBNF and Non-ZBNF Farmers across Crops in Kharif and Rabi Seasons of 2018-2019

Sl. No	Description of Crops	Reduction in the cost of Biological inputs over chemical inputs in Kharif season (percentages)	Reduction in the cost of Biological inputs over chemical inputs in Rabi season (percentages)	Share of Biological and Chemical inputs in the total cost of production in Kharif season (percentages)		Share of Biological and Chemical inputs in the total cost of production in Rabi season (percentages)		Reduction in the paid out costs per hectare under ZBNF over non-ZBNF in Kharif season (percentages)	Reduction in the paid out costs per hectare under ZBNF over non-ZBNF in Rabi season (percentages)	Increase in the Net Income per hectare under ZBNF over Non-ZBNF in Kharif Season (percentages)	Increase in the Net Income per hectare under ZBNF over Non-ZBNF in Rabi Season (percentages)
				ZBNF (Biological Inputs)	*Non ZBNF (Chemical Inputs)*	*ZBNF (Biological Inputs)*	*Non ZBNF (Chemical Inputs)*				
1	Paddy	-68.00	-86.80	11.71	31.74	7.30	39.50	-13.70	-28.80	8.52	47.60
2	Maize	-23.52	-89.00	14.31	18.58	7.00	46.00	-0.01	-27.90	111.46	13.20
3	Groundnut	-26.03	-82.10	9.44	12.46	4.30	23.10	-0.03	-3.50	40.97	33.00
4	Bengalgram	-44.65	-75.20	16.04	24.87	18.70	46.50	-1.41	-38.30	17.34	133.20
5	Cotton	-68.32		10.54	27.52			-17.31		45.38	
6	Tomato	-69.56		6.70	17.93			-18.46		40.66	
7	Jowar		-86.00			8.50	43.10		-29.50		80.00
8	Sugarcane		-15.20			3.20	3.70		-1.50		10.00
9	Black gram		-86.70			7.40	44.40		-20.40		83.70
10	Green gram		-62.20			10.20	25.20		-16.70		34.70
11	Sesame		-54.60			9.90	21.20		-3.20		22.70
12	Banana		-62.90			8.20	22.00		-0.40		79.00

Note: Farmer Reported yields of crops have been utilized in deriving gross value of output for estimating incomes of farmers

Source: Field Survey

Table 0.2: Impact of Agro ecological Practices on Soil Fertilizers in Kharif and Rabi Seasons of 2018-19, as reported by farmers

Sl. No	Description of Indicators	Percentages of Farmers Reported	
		Kharif Season	Rabi Season
1	Increased Green Cover	56.49	35.60
2	See more Earth Worms	81.83	43.40
3	Soil Softened	83.38	52.40

Source: Field Survey

Table 0.3: Impact of Improved Soil Fertility due to ZBNF on Crop Yields - Kharif and Rabi Seasons of 2018-19

Sl. No	Crops	Yield of Crops per Hectares in Kharif Seasons (in Qtls)			Yield of Crops per Hectares in Rabi Seasons (in Qtls)		
		ZBNF	Non-ZBNF	Significant/ Not Significant Differences	ZBNF	Non-ZBNF	Significant/ Not Significant Differences
1	Paddy	45.22	47.69	Not Significant	61.65	66.17	Significant at 1% level
2	Maize	51.43	39.41	*Significant	57.45	51.70	Significant at 5% level
3	Groundnut	13.34	11.51	Not Significant	17.66	17.09	Not-Significant
4	Cotton	11.19	10.56	Not Significant	9.51	8.92	Not-Significant
5	Bengal gram	17.49	17.00	Not Significant	13.53	13.70	Not-Significant
6	Tomato	375.24	368.57	Not Significant			
7	Banana				479.41	543.45	Not-Significant
8	Black Gram				6.65	7.48	Not-Significant
9	Cashew nut				21.57	16.77	Not-Significant
10	Chillies				52.84	57.28	Not-Significant
11	Citrus				75.70	89.00	Significant at 10% level
12	Flowers				11.02	2.93	Not-Significant
13	Green gram				7.20	7.23	Not-Significant
14	Mango				68.63	60.09	Not-Significant
15	Other Vegetables				65.10	55.81	Not-Significant
16	Ragi				21.99	22.68	Not-Significant
17	Red gram				4.75	4.46	Not-Significant
18	Sesame				6.04	4.39	Significant at 5% level
19	Sugarcane				785.01	643.76	Significant at 5% level
20	Sunflower				26.02	23.48	Significant at 10% level

Note: Yields assessed through Crop Cutting Experiments (CCEs) are utilised
Source: Field Survey

Table 0.4: Impact of increased Soil Fertility due to ZBNF on Quality of Output in Kharif and Rabi Seasons of 2018-19,as reported by farmers

Sl. No	Description of Indicators	Percentages of Farmers Reported	
		Kharif Season	Rabi Season
1	Grain Weight Increased	53.40	34.60
2	Stronger Stems	60.44	33.00
3	ZBNF product is more tasty	81.80	78.1

Source: Field Survey

APPENDIX TABLES OF CHAPTER 1

Table A 1.1 Three Major Crops grown by ZBNF farmers in the districts during 2017-18

District	Major crops			No.of villages with at least 10 ZBNF farmers growing major crops
	1	2	3	
Srikakulam	Paddy	Maize(Corn)	Black Gram	55
Vizianagaram	Paddy	Maize(Corn)	Black Gram	64
Visakhapatnam	Paddy	Green Gram	Tomato	57
East Godavari	Paddy	Cashew	Cotton	48
West Godavari	Paddy	Maize(Corn)	Palm oil	43
Krishna	Paddy	Maize(Corn)	Mango	52
Guntur	Paddy	Maize(Corn)	Cotton	35
Prakasam	Paddy	Bengal Gram	Chillies	13
Nellore	Paddy	Citrus	Chillies	19
YSR Kadapa	Paddy	Banana	Groundnut	18
Kurnool	Paddy	Cotton	Groundnut	32
Ananthapuramu	Paddy	Maize(Corn)	Groundnut	38
Chittoor	Paddy	Groundnut	Tomato	18
Andhra Pradesh				**492**

Source: Field Survey

Table A 1.2: Number of CCEs Conducted Across Districts in Rabi Season of 2018-19

District	No. of CCEs	District	No.of CCEs
Ananthapuramu	5	Ananthapuramu	111
Chittoor	4	Chittoor	127
East Godavari	10	East Godavari	142
Guntur	37	Guntur	120
Krishna	9	Krishna	123
Kurnool	27	Kurnool	112
Nellore	5	Nellore	175
Prakasam	10	Prakasam	146
Srikakulam	4	Srikakulam	149
Visakhapatnam	3	Visakhapatnam	159
Vizianagaram	3	Vizianagaram	146
West Godavari	1	West Godavari	141
YSR Kadapa	11	YSR Kadapa	138
Total	**129**	**All Districts**	**1789**

Source: Field Survey

Table A1.3: District wise Number of Listed Households in the Selected Villages: Kharif and Rabi2018-19

District	Kharif Sample		Rabi Sample	
	ZBNF	Non ZBNF	ZBNF	Non-ZBNF
Ananthapuramu	326	556	101	199
Chittoor	181	494	81	298
East Godavari	214	604	101	309
Guntur	217	547	77	300
YSR Kadapa	209	442	108	284
Krishna	199	491	122	304
Kurnool	249	563	87	301
Nellore	202	526	126	301
Prakasam	178	536	150	357
Srikakulam	339	558	102	328
Visakhapatnam	183	543	420	300
Vizianagaram	249	378	163	315
West Godavari	318	582	139	258
Total	**3,064**	**6,820**	**1777**	**3854**

Source: Field Survey

Table A1.4: District wise Number of Sample Farmers Covered: Kharif and Rabi_2018-19

Sl. No	District	District wise Sample farmers for Kharif 2018-19				District wise Number of Farmers Covered in Rabi Season			
		Total Sample farmers	ZBNF Self control	ZBNF Others	Non-ZBNF	Pure ZBNF	Pure Non-ZBNF	Matching	Total
1	Ananthpuramu	163	43	60	60	7	7	43	57
2	Chittoor	179	26	77	76	12	11	39	62
3	East Godavari	167	34	63	70	17	17	33	67
4	Guntur	163	30	67	66	20	20	30	70
5	YSR Kadapa	183	19	80	84	28	28	22	78
6	Krishna	116	82	18	16	1	2	50	53
7	Kurnool	181	20	81	80	42	45	8	95
8	Nellore	129	79	20	30	4	3	47	54
9	Prakasam	119	50	35	34	0	0	50	50
10	Srikakulam	124	75	24	25	6	6	44	56
11	Visakhapatnam	192	31	69	92	42	42	8	92
12	Vizianagaram	154	45	53	56	9	13	41	63
13	West Godavari	117	88	14	15	2	2	48	52
	Total	**1987**	**622**	**661**	**704**	**190**	**196**	**463**	**849**

Source: Field Survey

Table A1.5: District, Mandal and Villages Surveyed in Kharif of 2018-19

District	Mandal	Village
Ananthapuramu	Amadaguru	Gunduvaripalli
Anthapuramu	Bukkapatnam	Siddarampuram
Anthapuramu	Chilamattur	Tekulodu
Anthapuramu	Kuderu	Korrakodu
Anthapuramu	Madakasira	Melavoi
Anthapuramu	Raptadu	Marur
Anthapuramu	Rayadurgam	Mallapuram
Anthapuramu	Settur	Chintarlapalle
Anthapuramu	Somandepally	Chinnabaabayyapalli
Anthapuramu	Vajrakarur	Ragulapadu
Chittoor	Byreddypalli	Gounithimmepalli
Chittoor	Byreddypalli	Pathurnatham
Chittoor	Madanapally	Madanapalle (Rural)
Chittoor	Penumarru	Caharavaganipalli
Chittoor	Pulicherla	Venkatadasaripalli
Chittoor	Ramachandrapuram	Kuppambadur
Chittoor	Tottambedu	Peddakanaparthi
Chittoor	Gangadhara Nellore	Velkuru
Chittoor	Srikalahasthi	Melachur
Chittoor	Srikalahasthi	Kalavagunta
East Godavari	Devipatnam	Choppakonda
East Godavari	Gangavaram	B.Sivaramapatnam
East Godavari	Gangavaram	Molleru
East Godavari	Gokavaram	Gangampalem
East Godavari	Korukonda	Kotikesavaram
East Godavari	Pattipadu	Vommangi
East Godavari	Shankhavaram	Pedamallapuram
East Godavari	Y. Ramavaram	Dadalikavada
East Godavari	Y. Ramavaram	Singavaram
East Godavari	Yelleshwaram	Siripuram
East Godavari	Shankhavaram	Shankhavaram
East Godavari	Gangavaram	R D Puram
Guntur	Bellamkonda	Nandirajupalem
Guntur	Bollapalle	Gummanampadu
Guntur	Edlapadu	Kottapalem
Guntur	Kollipara	Bommavaripalem
Guntur	Kollipara	Chakrayapalem
Guntur	Kollipara	Davuluru
Guntur	Mangalagiri	Pedavadlapudi
Guntur	Pittalavanipalem	Alluru
Guntur	Bhattiprolu	Konetipuram
Guntur	Bollapalle	Vellatur
YSR Kadapa	Chakraipeta	Rajupalle
YSR Kadapa	Chinnamandem	Chinnarasupalle
YSR Kadapa	Chinnamandem	Paramatikona
YSR Kadapa	Kalasapadu	Pullareddypalle
YSR Kadapa	Lakkireddypalli	Lakkireddypalli
YSR Kadapa	Mydukuru	Mittamanipalle
YSR Kadapa	Pendlimarri	Nandimandalam
YSR Kadapa	Rayachoti	Gorlamudiveedu
YSR Kadapa	Vempalle	Vempalle

District	Mandal	Village
YSR Kadapa	C K Dhinne	Ippapenta
Krishna	Bapulapadu	A.Seetarampuram
Krishna	Bapulapadu	Bommaluru
Krishna	Chatrai	Arugolanupeta
Krishna	Machilipatnam	Kona
Krishna	Nagayalanka	T.Kothapalem (marripalem)
Krishna	Nuziveedu	Meerjapuram
Krishna	Nuziveedu	Mukkollupadu
Krishna	Pamarru	Nemmakuru
Krishna	Tiruvuru	Ramannapalem
Krishna	Unguturu	Atkuru
Kurnool	Atmakur	Kottalacheruvu (Kurukunda)
Kurnool	Chagalamarri	Muthyalapadu
Kurnool	Dhone	Kothakota (N V Pally)
Kurnool	Gudur	Budidapadu
Kurnool	Orvakal	Uyyalawada
Kurnool	Panyam	Alamur
Kurnool	Panyam	Bhupanapadu
Kurnool	Panyam	Gonavaram
Kurnool	Dhone	KothaBuruju
Kurnool	Peapally	N.Rangapuram
Nellore	Dagadarthi	Chennuru
Nellore	Ojili	Chillamanuchenu
Nellore	Ojili	PedaParia
Nellore	Sydapuram	Cheekavolu
Nellore	Udayagiri	Gandipalem
Nellore	Vidavaluru	Parlapalle
Nellore	Nellore Rural	Amancherla
Nellore	Naidupeta	Kuchiwada
Nellore	Vidavaluru	Mannadaraopeta
Nellore	Gudur	P R Kandriga
Prakasam	Kondepi	Peridepi
Prakasam	Mundlamur	Mundlamur
Prakasam	Naguluppalapadu	Naguluppalapadu
Prakasam	Naguluppalapadu	Pothavaram
Prakasam	Naguluppalapadu	Raparla
Prakasam	Marturu	Kolalapudi
Prakasam	Mundlamur	Pasupugallu
Prakasam	Ballikaruva	Nakkabokkalapadu
Prakasam	Mundlamur	Polavaram
Srikakulam	Etcherla	Bontalakoduru
Srikakulam	Etcherla	Kesavaraopeta (Shermahammadpuram)
Srikakulam	Kothuru	Sirusuvada
Srikakulam	Nandigam	Routhupuram
Srikakulam	Patapatnam	Baddumarri
Srikakulam	Patapatnam	Ganguvada
Srikakulam	Ranasthalam	Ranasthalam
Srikakulam	Ranasthalam	Ravada
Srikakulam	Seetampeta	Devanapuram

District	Mandal	Village
Srikakulam	Veeraghattam	Kambara
Visakhapatnam	Anantagiri	Pedakota
Visakhapatnam	Chintapalli	Chinnagedda
Visakhapatnam	GangarajuMadugula	Bharam
Visakhapatnam	Gudemkottaveedi	Lakkavarapupeta
Visakhapatnam	Hukumpeta	Kunturla
Visakhapatnam	Hukumpeta	Baluroda
Visakhapatnam	Kasimkota	G. Bheemavaram
Visakhapatnam	Makavarapalem	Mallavaram
Visakhapatnam	Munchingiputtu	Laxmipuram
Visakhapatnam	Chodavaram	Laxmipuram
Vizianagaram	Bobbili	Mettavalasa
Vizianagaram	Bondapalli	Gumadam (Kovadapeta)
Vizianagaram	Bondapalli	MaruvadaKothavalasa
Vizianagaram	Denkada	Golagam
Vizianagaram	Garugubilli	Santhoshapuram
Vizianagaram	Gummalaxmipuram	Gorada
Vizianagaram	Kurupam	Durubili
Vizianagaram	Kurupam	Manthinavalasa
Vizianagaram	Mentada	Mentada
Vizianagaram	Parvathipuram	Bandaluppi
Vizianagaram	Kurupam	Puthikavalasa
Vizianagaram	Gummalaxmipuram	Vallada
Vizianagaram	Parvathipuram	Gocheka
Vizianagaram	Denkada	Amakam
West Godavari	Chintalapudi (Upland)	Raghavapuram
West Godavari	Gopalapuram (Upland)	Chityala
West Godavari	Jeelugumilli (Tribal)	Swarnavarigudem
West Godavari	Jeelugumilli (Tribal)	Mulagalampalle
West Godavari	Kamavarapukota (Upland)	Kamavarapukota
West Godavari	Palakollu	Valamarru
West Godavari	Peravali (Delta)	Khandavalli
West Godavari	Peravali (Delta)	Mukkamala
West Godavari	Unguturu (Part of Delta)	Gollagudem
West Godavari	Pedavegi	Pinakadimi

Table A 1.6: District, Mandal and Villages Surveyed in Rabi of 2018-19

District	Mandal	Village
Anthapuramu	Vajrakaurur	Venkatampalli
Anthapuramu	Kuderu	Korrakodu
Anthapuramu	Amadaguru	Peravandlapalli
Anthapuramu	Vajrakaurur	J.r. Kottala
Anthapuramu	Kuderu	M.M.Halli B.C Colony
Chittoor	Bangarupalyam	Kallurupalli
Chittoor	Nagalapuram	Adavikandriga
Chittoor	GangadharaNellore	Velkur
Chittoor	Kuppam	Kothaindlu
Chittoor	Thamballapalli	Yeddulavaripalle
East Godavari	Tuni	Hamsavaram
East Godavari	Thondangi	PE Chinnayipalem
East Godavari	Yeleswaram	Ramanayyapeta
East Godavari	Gangavaram	Jaggampalem
East Godavari	Thondangi	A Kothapally
Guntur	Bhattiprolu	Vellaturu
Guntur	Kollipara	Attota
Guntur	Kollipara	Davuluripalem
Guntur	T.Sundur	T.Sundur
Guntur	Nakrikallu	Narasingapadu
YSR Kadapa	Chakrayapet	Gandikovvuru
YSR Kadapa	Vempalli	Kuppalapalli
YSR Kadapa	Vempalli	Musalreddygaripalli
YSR Kadapa	Badvel	Chinthalacheruvu
YSR Kadapa	Chakrayapet	K.Rajugaripalli
Krishna	Bapulapadu	A.Seetharampuram
Krishna	Nuzvid	East Digavalli
Krishna	Reddygudem	Naguluru
Krishna	Machilipatanam	Potlapalem
Krishna	Machilipatanam	Buddalapalem
Kurnool	Owk	Sunkesula
Kurnool	Nandavaram	Nagaladinne
Kurnool	Allagadda	Ahobilam
Kurnool	Kalluru	Bollavaram
Kurnool	Nandyala	Ayyaluru
Nellore	Rapur	Pangili
Nellore	Kavali	Kothapalli
Nellore	Dagadarthi	Tirivedipadu
Nellore	Muthukuru	Pidathapolur
Nellore	Sullurupeta	Mannarpoluru
Prakasam	Naguluppalapadu	Mattigunta
Prakasam	Sonthamaguluru	Kommalapadu
Prakasam	Korsipadu	Ravinuthala
Prakasam	Parchuru	BVG palem
Prakasam	Singarayakonda	Sanampudi

District	Mandal	Village
Srikakulam	Pollaki	Gollavalasa
Srikakulam	Gara	Poosarlapadu
Srikakulam	Vajrapukothuru	Synooru
Srikakulam	Narasannapeta	Sriramapuram
Srikakulam	Laveru	Kottakunkam
Visakhapatnam	V Madugula	Chintaluru
Visakhapatnam	Cheedikada	Cheedikada
Visakhapatnam	Chodavaram	Lakshmipuram
Visakhapatnam	Chodavaram	Rayapaurajupeta
Visakhapatnam	Elamanchili	Rukminipuram
Vizianagaram	Gajapathinagaram	Lingalavalasa
Vizianagaram	Vizianagaram	Gunkalam
Vizianagaram	Gajapathinagaram	Pidiseela
Vizianagaram	Parvathipuram	Chinabondapalli
Vizianagaram	Cheepurupalli	Karlam
West Godavari	Chintalapudi	Pothunur
West Godavari	Polavaram	Polavaram
West Godavari	Polavaram	Gutala
West Godavari	Buttaigudem	Kamayakunta
West Godavari	Buttaigudem	Rajanagaram

APPENDIX TABLES OF CHAPTER 2

Table A 2.1: Crop-wise Per hectare Cost on BiologicalIinputs under ZBNF and Chemical Inputs under Non-ZBNF_ Kharif of 2018-19

Description of Crops	Biological Inputs under ZBNF (Rs)	Chemical inputs under non-ZBNF(Rs)	% of the cost of Biological inputs to the cost of chemical inputs	Reduction in input cost due to use of Biological input use (Rs)	% of decline in the cost of ZBNF input over the non-ZBNF input
1	2	3	4=(2/3) *100	5= 3-2	6=(5/3)*100
Paddy	4215	13248	31.82	9033	68.18
Maize	4611	6029	76.48	1418	23.52
Groundnut	2759	3732	73.97	973	26.03
Cotton	2863	9041	31.68	6178	68.32
Tomato	5085	16705	30.44	11620	69.56
Bengal Gram	4535	8191	55.35	3656	44.65

Source: Field Survey

Table A 2.2: Cost incurred on Biological inputs per hectare under ZBNF and Non-ZBNF for the Crops Grown in Rabi of 2018-19

Crops	Cost of biological inputs (Rs)	Cost chemical inputs (Rs)	Difference over chemical input cost (Rs)	% reduction over chemical input cost
Paddy	2510	19040	-6689	-86.8
Maize	2567	23301	-8390	-89.0
Groundnut	1587	8846	-2938	-82.1
Bengal gram	3071	12401	-3776	-75.2
Jowar	1686	12072	-4203	-86.0
Black gram	724	5459	-1916	-86.7
Green gram	622	1839	-493	-66.2
Sesame	828	1826	-404	-54.6
Banana	7555	20353	-5179	-62.9
Sugarcane	2763	3258	-201	-15.2

Source: Field Survey

Table A 2.3: Cost of Different Inputs Per Hectare for different Crops under ZBNF and Non-ZBNF in Kharif of 2018-2019*(in rupees)*

Inputs/Crops		Seed	Human Labour	Bullock Labour	Machine Labour	Biological Inputs	Chemical inputs (Fertilisers and Pesticides)	Others	Total Cost
Paddy	ZBNF	2175	14589	1237	10886	4215	0	2908	36009
	% in Total Cost	6.04	40.52	3.43	30.23	11.71	0	8.07	100
	Non- ZBNF	2125	13527	270	11066	0	13248	1501	41736
	% in Total Cost	5.09	32.41	0.65	26.51	0	31.74	3.6	100
Maize	ZBNF	3263	12173	3242	7659	4611	0	1268	32214
	% share	10.13	37.79	10.06	23.77	14.31	0	3.94	100
	Non ZBNF	3449	11920	2285	7919	0	6029	855	32458
	% share	10.63	36.73	7.04	24.4	0	18.58	2.63	100
Groundnut	ZBNF	17038	3642	1583	2573	2759	0	1624	29219
	% share	58.31	12.47	5.42	8.8	9.44	0	5.56	100
	Non ZBNF	16934	3731	1486	2646	0	3732	1428	29957
	% share	56.53	12.45	4.96	8.83	0	12.46	4.77	100
Tomato	ZBNF	10479	47281	2151	6942	5085	0	4014	75952
	% share	13.8	62.25	2.83	9.14	6.7	0	5.28	100
	Non ZBNF	11110	49742	1641	8649	0	16705	5302	93149
	% share	11.93	53.4	1.76	9.28	0	17.93	5.69	100
Bengal gram	ZBNF	11321	3046	0	8287	4535	0	1090	28279
	% share	40.03	10.77	0	29.3	16.04	0	3.86	100
	Non ZBNF	11894	3412	0	8735	0	8191	707	32939
	% share	36.11	10.36	0	26.52	0	24.87	2.15	100

Source: Field Survey

Table A 2.4: Cost of Different Inputs Per Hectare for different Crops under ZBNF and Non-ZBNF in Rabi of 2018-2019*(in rupees)*

		Sample	Seed	Human Labour	Bullock Labour	Machine Labour	Implements	FYM	Non Chemicals / Fert& Pesticides	Others	Total Cost	Output (in quintals)	Gross Returns	Net Returns
Paddy	ZBNF	37	1538	20374	1012	7752	255	161	2510	742	34346	49.67	83990	49645
	NZBNF	26	1872	16442	730	8863	765	136	19040	361	48209	48.54	81846	33637
Maize	ZBNF	17	5684	17827	1248	4260	1076	2372	2567	1459	36493	63.15	126070	89577
	NZBNF	32	5235	13737	466	5837	601	312	23301	1142	50630	63.86	129750	79120
Groundnut	ZBNF	10	11400	14542	1908	6960	201	0	1587	358	36956	16.28	84445	47489
	NZBNF	11	10427	10444	864	6006	583	365	8846	753	38288	15.32	73983	35695
Black gram	ZBNF	33	1275	3668	1154	2563	196	0	724	201	9781	4.82	24487	14706
	NZBNF	24	1171	2477	424	2192	170	0	5459	399	12294	4.24	20298	8005
Green gram	ZBNF	24	578	3813	0	793	269	0	622	7	6081	3.77	18687	12606
	NZBNF	28	813	3291	0	1014	149	126	1839	73	7304	3.37	16663	9360
Bengal gram	ZBNF	10	2880	2046	1321	6084	316	0	3071	746	16464	11.86	52091	35627
	NZBNF	7	3314	1579	1120	7937	25	0	12401	317	26693	9.26	41970	15277
Banana	ZBNF	10	32053	32383	2577	6737	519	6552	7555	3910	92287	391.03	265668	173381
	NZBNF	8	30449	24844	1418	6188	503	5415	20353	3466	92637	282.65	189183	96546
Jowar	ZBNF	13	1578	6170	1154	6075	171	516	1686	2428	19779	16.11	34694	14915
	NZBNF	13	1716	5328	409	6520	46	153	12072	1791	28036	17.4	36324	8288
Sesame	ZBNF	17	322	2997	224	3136	104	266	828	477	8354	3.86	37061	28707
	NZBNF	20	152	2488	0	2515	45	814	1826	792	8632	3.35	32035	23403
Sugarcane	ZBNF	18	2875	56744	0	21120	70	2995	2763	190	86757	790.94	197737	110981
	NZBNF	16	2590	53353	229	22896	15	4286	3258	1466	88093	756.08	189021	100928

Source: Field Survey

Table A 2.5: Crop wise Input Cost Shares in Total Paid-out Cost in Rabi Season of 2018-2019(in percentages)

Cost component		Seed	Human Labour	Bullock Labour	Machine Labour	Implements	FYM	Biological/ Chemical inputs	Others	Total Cost
Paddy	ZBNF	4.5	59.3	2.9	22.6	0.7	0.5	7.3	2.2	100
	NZBNF	3.9	34.1	1.5	18.4	1.6	0.3	39.5	0.7	100
Maize	ZBNF	15.6	48.9	3.4	11.7	2.9	6.5	7.0	4.0	100
	NZBNF	10.3	27.1	0.9	11.5	1.2	0.6	46.0	2.3	100
Groundnut	ZBNF	30.8	39.3	5.2	18.8	0.5	0	4.3	1.0	100
	NZBNF	27.2	27.3	2.3	15.7	1.5	1.0	23.1	2.0	100
Jowar	ZBNF	8.0	31.2	5.8	30.7	0.9	2.6	8.5	12.3	100
	NZBNF	6.1	19.0	1.5	23.3	0.2	0.5	43.1	6.4	100
Sugarcane	ZBNF	3.3	65.4	0	24.3	0.1	3.5	3.2	0.2	100
	NZBNF	2.9	60.6	0.3	26.0	0	4.9	3.7	1.7	100
Black gram	ZBNF	13	37.5	11.8	26.2	2.0	0	7.4	2.1	100
	NZBNF	9.5	20.1	3.4	17.8	1.4	0	44.4	3.2	100
Green gram	ZBNF	9.5	62.7	0	13.0	4.4	0	10.2	0.1	100
	NZBNF	11.1	45.1	0	13.9	2.0	1.7	25.2	1.0	100
Bengalgram	ZBNF	17.5	12.4	8.0	37.0	1.9	0	18.7	4.5	100
	NZBNF	12.4	5.9	4.2	29.7	0.1	0	46.5	1.2	100
Sesame	ZBNF	3.9	35.9	2.7	37.5	1.2	3.2	9.9	5.7	100
	NZBNF	1.8	28.8	0	29.1	0.5	9.4	21.2	9.2	100
Banana	ZBNF	34.7	35.1	2.8	7.3	0.6	7.1	8.2	4.2	100
	NZBNF	32.9	26.8	1.5	6.7	0.5	5.8	22.0	3.7	100

Source: Field Survey

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