Impact Assessment of Zero Budget Natural Farming in Andhra Pradesh – Kharif 2018-19

A comprehensive Approach using Crop Cutting Experiments

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EXECUTIVE SUMMARY

1. Context

The Government of Andhra Pradesh has introduced Zero Budget Natural Farming (ZBNF) in 2016 as an alternative to chemical-based and capital intensive agriculture, through its implementing agency Rythu Sadhikara Samstha (RySS).The main objective of the ZBNF is to make agriculture economically viable, agrarian livelihoods profitable thereby reduce agrarian distress through cost reduction and sustainable agricultural practices that are climate-resilient. ZBNF aims to reduce cost of cultivation, enhance soil fertility, enhance yields, reduce risks, and protect from uncertainties of climate change by promoting the adoption of an agro-ecology framework. Extension support is led by farmers (including women) through a process of farmer-to-farmer learning. The programme aims to reach all farmers in the state – 6million farmers, including tenants - and stay engaged with them to achieve a 100% chemical-free agriculture by 2024. ZBNF also aims to create the human and social capital necessary for vibrant and inclusive agricultural production. The ZBNF is a paradigm shift in agricultural development and it has passed through three agricultural years of implementation since its inception. RySS thought it is the time to assess the impact of the ZBNF on farming and farming community. Hence the present study is sponsored to assess the impact and to suggest policy inputs to bring improvements in the ZBNF, if any, required.

2. Research Questions

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

1. What is the impact of ZBNF on the levels and composition of input use for crops grown?
2. How far the input use of ZBNF has contributed to the cost of production of crops?
3. How far the ZBNF inputs have impacted yield of crops?
4. What is the impact of ZBNF on incomes of farmers?
5. How far the ZBNF practices like intercropping, rising of border and bund crops have contributed to farmers' incomes?
6. What are the benefits accrued to farming and farmers beyond costs and returns?
7. What are the policy implications emerging from the analysis for realising the potential benefits from ZBNF?

3. The Methodology

The detailed narration of methodology for assessing the impact of ZBNF is in order.

3.1 The Basic Approach

In order to assess the impact of ZBNF, a comparison has been made between ZBNF farmers and non-ZBNFfarmers in regard to input use, cost of cultivation and yield of crops, and net income to farmers and other impact domains. This evaluation methodology is based on what is known as **"with and without" approach**. The study has deployed both quantitative and qualitative methods. Listing Survey and Household Survey have been conducted to collect quantitative data from the households. Focussed group discussions and case studies with farmers, and strategic interviews with District Project Managers have been conducted to obtain qualitative data as well.

3.2 Parameters considered for assessing impact of ZBNF

ZBNF is expected to have a major impact on farming system and farming community, thanks to its potential in promoting sustainable agricultural livelihoods without degrading natural resources and environment. The inputs of ZBNF like *Beejammurtham, Ghanajeevmrutham, Dravajeevamrutham,* different*Kashayams and Asthrams* prepared with locally available resources can reduce the costs of production of crops as well as improve the health status of soil and crops grown. This is the strategy for improving farm income by stabilizing and increasing crop yields and reducing cost of cultivation and out-of-pocket expenses. Besides, this is likely to enhance farm income by using land continuously but sustainably throughout the agricultural year, raising crops on farm bunds and border areas of cropped area both for protecting main crops from pest attacks as well as for generating a continuous flow of income throughout the agricultural year.

In this backdrop, the parameters considered for assessing the impact of ZBNF include: cost of inputs per hectare (biological inputs in case of ZBNF and chemical inputs for Non-ZBNF), percentage of cost of inputs in the total cost of production per hectare, cost of production per hectare, yield in quintals per hectare, net income per hectare accrued to farmers, income to farmers from intercropping, border and bund crops. The data on yields of crops were collected from farmers as well as through Crop Cutting Experiments (CCEs)

The other parameter considered for assessing the impact of ZBNF on farming include: health status of land, quality of crop output, resilience of crops to weather variability, financial empowerment of farmers and respectability towards agriculture. Softening of soils, presence of earthworms and green cover in the fields are considered to measure soil health. Weight of the grains, strength of stems and taste are considered to measure quality of output. Resilience of crops withstanding to dry spells and wind is considered to assess the resilience of crops to

weather variability. The prominent contribution of ZBNF is to financial empowerment of the farmers. This is measured through dependency for working capital required to grow crops in the agricultural reference year, more on their savings accumulated through the cultivation of ZBNF in the previous years. Respectability towards agricultural occupation is assessed in terms of liking agricultural occupation due to ZBNF.

3.3 Sample Design

The study has covered all the districts of Andhra Pradesh. It is conducted in the villages where there are at least 10 farmers those have adopted all the practices i.e., seed to seed farmers of ZBNF and where the farmers have grown at least one major crop of the district. Ten villages from each district are randomly selected. Thus 130 villages in total are selected from the state. A Listing Survey has been conducted to cover all the households in the village to generate a sample framework for selecting the farmers for household survey. Stratified random sampling method is adopted to select the farmers belonging to pure tenant farmers, marginal farmers, small farmers and other farmers from the sample frame generated from the Listing Survey conducted in all the sample villages. Ten ZBNF farmers are randomly selected from each category of farm size. Similarly, ten non-ZBNFfarmers from each village are selected randomly. Thus 1300 ZBNF farmers and 1300 non-ZBNFfarmers, in total 2600 farmers, are selected for Kharif season.

3.4 Data Base

A detailed household questionnaire has been administered across all the sample farmer households to collect the data on the impact parameters mentioned above. Qualitative data has been collected through case studies of farmers, focussed group discussions with farmers and strategic interviews with the District Project Managers (DPMs). This data enabled to examine the research questions like interventions made under ZBNF to ensure continuous flow of income throughout agricultural year to the farming community, market channels opted by the farmers to get higher prices for ZBNF crop outputs, constraints encountered by farmers in using ZBNF inputs for crops, and other benefits, if any, accrued to farmers beyond costs and returns of crops.

4. Major Findings

The major findings of the analysis are presented in three sections. Section-1 deals with the major findings on the costs and returns of Paddy crop and other crops like Maize, Groundnut, Cotton, Tomato and Bengal gram. The findings related to the analysis on the issues like methods of growing crops to ensure flow of incomes to farmers throughout the agricultural year, and the

constraints encountered by the farmers in preparing/accessing ZBNF inputs are presented in section-2. The impact of ZBNF on the domains other than costs and returns like heath of soils, quality of output, and resilience of crops to withstand against weather variability, financial empowerment of farmers and respectability towards agricultural occupation are presented in section-3. The major findings of the study are in order.

Section 1: Costs and Returns of Crops

Paddy crop

- A comparison of the cost of biological inputs with that of chemical inputs has revealed that the cost of ZBNF inputs (biological inputs) per hectare is found to be only Rs.4216 per hectare and that of non-ZBNFinputs (chemical inputs) has turned out to be Rs.13248 per hectare for Paddy crop. Thus, there is a decline in the cost of these inputs by Rs.9032 per hectare due to ZBNF practices. It means that there is a reduction in the cost under ZBNF by 68 per cent over those non-ZBNFi.e. chemical inputs per hectare. The percentage of reduction in this cost has ranged from 27 per cent in Srikakulam district to 90 per cent in Nellore district.
- The cost of biological inputs has formed 11.7 per cent of total cost per hectare under ZBNF, while the cost of chemical inputs constitute 31.7 per cent under non-ZBNFPaddy. This clearly means that the cost of biological inputs have formed considerably lower proportion in the total cost of production under ZBNF compared to those under non-ZBNF.
- The paid out cost for the cultivation of Paddy crop per hectare under non-ZBNFis Rs.41737, on average, at the state level. But it is found to be Rs.36009 under ZBNF. Thus, the paid out cost per hectare has been reduced by Rs.5728 due to the adoption of ZBNF practices leading to a decline by 14 per cent in the cost of cultivation. But the cost of biological inputs declined by 68 per cent due to ZBNF.
- The relationship between increase in the ZBNF input use and the cost of production per hectare is influenced by the percentage of increase in the use of ZBNF inputs in relation to the level of non-ZBNFinputs and labour market conditions. This is the reason why the percentage of increase in the use of ZBNF inputs does not ensure the same percentage of reduction in the cost of production per hectare due to ZBNF.
- There is no significant difference in yield of Paddy crop between ZBNF and non-ZBNFand the yield is hovering between45 and 48 quintals for hectare at the state level.

- There is no significant difference in yields of Paddy crop between the reported yield by farmers and that arrived at by CCEs.
- The farmers' incomes has been improved by 8 per cent only. The higher improvements in the levels of income is recorded in non-delta district.

Other crops

- A comparison of biological input cost of ZBNF and chemical input cost of non-ZBNFper hectare has revealed that the cost of ZBNF inputs is lower than that of non-ZBNFacross the crops like Maize, Groundnut, Cotton, Tomato, and Bengal gram. Per hectare cost of biological and chemical inputs respectively are: Rs.4611 and Rs. 6029 for Maize; Rs.2759 and Rs. 3732 for Groundnut; Rs.2863 and Rs. 9041 for Cotton; Rs.5085 and Rs. 16705 for Tomato; Rs.4535 and Rs. 8191 for Bengal gram. The extent of decline in absolute and relative terms is pronounced in case of high value crop like Cotton and vegetable crop like Tomato compared to other crops considered for the analysis.
- The share of cost of biological inputs in the paid out cost ranges from 6.7 per cent for Tomato to 16.0 per cent for Bengal gram under ZBNF, while the share of cost of chemical inputs ranges from 12.5 percent for Groundnut to 27.5 per cent for Cotton. The absolute costs as well as share in the paid out cost of production of non-chemical inputs per hectare are found to be considerably lower for the crops grown under ZBNF compared to the chemical inputs for the same crops under non-ZBNF. The reduction of costs is pronounced among the high value crops like Tomato, Cotton and Bengal gram due to the use of ZBNF inputs.
- The cost of production of crops per hectare is found to be the lowest i.e. Rs.27164 in case of Cotton and the highest of Rs. 75951 in case of Tomato grown under ZBNF.The same is found to be the lowest i.e. Rs.29957 for Groundnut and the highest of Rs.93151 for Tomato grown under non-ZBNF. Moreover, the cost of cultivation per hectare found to be lower across all the crops grown under ZBNF compared to the same crops grown under Non-ZBNF. 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 like Tomato compared to those under other crops
- The use of biological as well as chemical inputs has reflected in the yield of crops**.** The yield of the crops grown under ZBNF are found to be on par with those grown under non-ZBNF. This true across crops like Groundnut, Cotton, Bengal gram and Tomato. Moreover, the yield of Maize under ZBNF is significantly higher than that under non-ZBNF.This provides compelling evidence that the yield response to biological inputs is much higher than that of

chemical inputs. This is more so because of higher yield for Maize crop of ZBNF over non-ZBNFand yield on par with those of other crops despite the lower levels of use of ZBNF inputs, compared to the levels of use of chemical inputs.

- The net income per hectare to the farmers is higher from ZBNF for all the five crops considered for the analysis. It is the highest for Tomato under ZBNF i.e. Rs. 323409 per hectare as against Rs. 229926 in case of Tomato under non-ZBNF. Similarly for Bengal gram, the net returns per hectare under ZBNF are Rs.54559 as against Rs.46498, followed by Maize (Rs. 45375 as against Rs. 21458), Groundnut (Rs. 35819 and Rs.25409) and Cotton (Rs.28585 and Rs.19662).The highest increase in net income of farmers due to ZBNF is from Maize (111 percent) followed by Cotton (45 per cent), Groundnut and Tomato (41 per cent each) and 17 percent in case of Bengal gram

Section2: Regularity in income flows, higher prices for crop outputs and Constrains in preparing /Accessing ZBNF inputs

- Keeping in mind the agro climatic conditions of the region, the principle of 5-Layercropping pattern with a different combination of suitable crops for each layer is recommended for cultivation under ZBNF.
- Case studies clearly depict evidence that the farmers can increase their incomes further if proper marketing support is provided by the RySS.
- Apart from scarcity of local cows and scarcity of human labour, other constraints reported by the farmers include: the knowledge required to prepare *Kashayams* and *Astrams* to control pest is not imparted to many of the farmers; leaves required to prepare these inputs are not available in some villages and hence farmers are not able to prepare these inputs themselves; readymade ZBNF inputs are not available in the markets; and NPM shops are not providing these inputs because they are not available in all the villages and or they are not functioning even though they are in existence in some of the villages.

Section3: Soil Health, Crop Health, Resilience of Crops, Financial Empowerment, and Respectability of Agricultural Occupation

- A large proportion of ZBNF practicing farmers have reported that the soil fertility has gone up due to ZBNF.This is true by and large across all the districts.
- Farmers have provided evidence through three parameters namely softening of soils, presence of earthworms, and increased green cover in the fields. It is also clear that the green cover is not as widely present as the other two dimensions of soil fertility.

- Farmers have considered three dimensions to reflect on the quality of output. They include weight of the grains, strength of stems and taste. Among these dimensions, larger proportions of farmers across the villages of the districts have reported that the crop output of ZBNF is very tasty. Between the other two dimensions, higher proportion of farmers have reported that the plants of the crops have stronger stems.
- 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.
- The prominent contribution of ZBNF is financial empowerment of the farmers. This is evident from the fact that farmers have depended for working capital required to grow crops in the agricultural reference year, more on their savings accumulated through the cultivation of ZBNFin the previous years.
- The most significant contribution of ZBNF is that most of the farmers like the agricultural profession. Thus the occupation status of agriculture has gone up due the ZBNF in the rural areas of the State of Andhra Pradesh.

5. Policy suggestions

It is evident from the analysis that the major constraint for the adoption of ZBNF relates to the inadequate exposure to this method of natural farming. Moreover, some of the farmers reported that they do not have adequate knowledge for the preparation of *Kashayams* and *Asthrams*. Lack of awareness has also constrained them from realising the full potential benefits of ZBNF. The expansion of extension services by way of increasing CRPs at the village level may help the farmers in acquiring skills, addressing the market related issues and achieving the full potential of ZBNF.

Household survey has clearly revealed that farmers complained about lack proper marketing support. Marketing support is particularly important for realising the full potential benefits of ZBNF. Besides, there is also a need to address the issue for overcoming labour shortage, and ensure the availability of readymade inputs. The promotion of farmers' collectives both for male and female farmers may address these issues. More importantly, policy support is also needed for meeting the financial and investment requirements of farmers adopting ZBNF. For instance, the adoption of 5-layer model of growing crops requires considerable investments upfront to ensure continuous flow of incomes and full green cover in the fields. These investment requirements can be met by ongoing government programmes being implemented by different departments of agriculture, rural development and other related departments. Thus the key

findings recorded above led to the following suggestions to bring improvements in the implementation of ZBNF:

(1) Strengthening Extension Services,

(2) Providing Market Support,

(3) Promoting farmers collectives, and

(4) Integrating the ZBNF with all relevant government programmes to enable farmers for realising the vision of making the entire state of Andhra Pradesh as a natural farming state.

CHAPTER 1

Context, Objectives and Methodology

1.0 Context

The farming system and the farming community in Andhra Pradesh, as well as in the entire country, have been facing many challenges under chemical-based agriculture. Recent focused group discussions held with the farmers in villages across all districts of Andhra Pradesh by a research team from the Centre for Economic and Social Studies (CESS), Hyderabad has highlighted most of the challenges and negative consequences of chemical-based agriculture. These challenges and consequences might have provided the rationale and justification for introduction and promotion of Zero Budget Natural Farming (ZBNF) both within and beyond Andhra Pradesh. To begin with, the cost of cultivation of crops is very high under chemical-based agriculture. This is due to a heavy dependency on costly chemical inputs, which are purchased from markets external to the villages. The chemical-based agriculture is also highly capital-intensive requiring the mobilization of larger volume of working capital from private groups and institutions, including informal credit institutions that provide credit at relatively higher interest and extreme payment conditions. This has often led the farmers into debt trap and vicious circle of poverty, which is more so in case of farmers, who have not obtained remunerative prices for their crop outputs.

From an ecological and resource perspective, the soil fertility has declined over time due to 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 different phases of crop growth. The use of heavy doses of pesticides to control the pests attacked has, in turn, led to rising cost of cultivation as well as severe damage to human health and quality of output. The extensive use of chemical inputs has also affected soil fertility and land productivity. The withstanding capacity of crops to weather variability like deficit or excess in rainfall has also become very low. This is due to the damage of soil health, especially its water-holding capacity, under chemical-based agriculture. Mixed, border, and bund crops, which are necessary not only to increase farm income but also to rejuvenate the soils, are conspicuously absent under chemical-based agriculture. The absence of mixed crops has resulted in the reduction of risk-coping capacities of crops to weather variability. The absence of border and bund crops has eliminated the scope of arresting pests to the main crop and a continuous flow of incomes to the farmers. The crop outputs produced under chemical-based agriculture have been

chemicalised.This has led to higher incidence of health problems both to farmers and to consumers.Farmers expressed that they have suffered from several health problems like irritation of eyes, skin, nose, throat, and lungs.As a result, many farmers have kept their land follow and /or leased it out because they realized that farming is not economically viable and want to be free from various forms of economic and health-related risks and uncertainties.

It is in this emerging context, the Government of Andhra Pradesh has introduced Zero-Budget Natural Farming (ZBNF) in 2016 as an alternative to chemical-based and capital intensive agriculture.The main objective of the ZBNF is to make agriculture economically viable, agrarian livelihoods profitable and reduce agrarian distress and risk through cost reduction and sustainable agricultural practices that are climate-resilient. ZBNF aims to reduce cost of cultivation, enhance soil fertility, enhance yields, reduce risks, and protect from uncertainties of climate change by promoting the adoption of an agro-ecology framework. Extension support is led by farmers (including women) through a process of farmer-to-farmer learning. The programme aims to reach all farmers in the state - 6million farmers, including tenants - and stay engaged with them to achieve a 100% chemical-free agriculture by 2024. It will support each farm family, at least, for a 5-year period or till it attains sustainable and viable livelihoods under ZBNF. ZBNF also aims to create the human and social capital necessary for vibrant and inclusive agricultural production.

1.1 Research Questions

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

1. What is the impact of ZBNF on the levels and composition of input use for growing crops?
2. How far the input use of ZBNF has contributed to the cost of production of crops?
3. How far the ZBNF inputs have impacted yield of crops?
4. What is the impact of ZBNF on incomes of farmers?
5. How far the ZBNF practices like intercropping, rising of border and bund crops have contributed to farmers' incomes?
6. What are the benefits accrued to farming and farmers beyond costs and returns?
7. What are the policy implications emerging from the analysis for realising the potential benefits from ZBNF?

1.2 The Scope of the Study

ZBNF is expected to have a major impact on farming system and farming community, thanks to its potential in promoting sustainable agricultural livelihoods without degrading natural resources and environment. The inputs of ZBNF like Beejammurtham, Ghanajeevmrutham,

Dravajeevamrutham, different *Kashayams* and *Astrams* prepared with locally available resources can reduce the costs of production of crops as well as improve the health status of soil and crops grown. This is the strategy for improving farm income by stabilizing and increasing crop yields and reducing costs of cultivation and out-of-pocket expenses. Changing land use pattern and cropping pattern is one of the dominant impact expected from ZBNF. This is likely to enhance farm income by using land continuously but sustainably throughout the agricultural year, raising crops on farm bunds and border areas of cropped area both for protecting main crops from pest attacks as well as for generating a continuous flow of income throughout the agricultural year. Thus, the ZBN practices impact soil fertility, quality of crop output, resilience of crops to withstand against weather variability, financial empowerment and respectability towards agricultural occupation in addition to cost of cultivation and yield of crops, and incomes to farmers. These issues formed the scope of the study.

1.3 The Methodology

The detail narration of methodology adopted for the study is in order. It includes basic approach, sample design, data gathering and data management.

1.3.1 The Basic Approach

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 farmers cultivating the same crop using chemical farming. In doing so the comparability of the two groups are ensured in two ways. In first method is perfect control, where comparability is ensured by selecting a farmer cultivating the same crop in two conditions and in the second method sample from two farming group cultivating the same crop in same village and in same land size class are selected for comparison. The study has deployed both quantitative and qualitative methods. Listing Survey and Household Survey have been conducted to collect quantitative data from the households. Focussed group discussions and case studies with farmers, and strategic interviews with District Project Managers have been conducted to obtain qualitative data as well. Crop cutting experiments (CCEs) are conducted to assess the yield apart from collecting farmer reported yields. Though we are expected to conduct one CCE for every sample farmer, the study could not do for all because of delay in the initiation of the study i.e. in the midst of November 2018 and by that time, many farmers have harvested their Kharif crops.

1.3.2 The Sample Design

The sample design of the survey was prepared keeping in view of the methodology followed for evaluating the efficacy of ZBNF.As per the 2017-18 data supplied by RySS, there are 17491 ZBNF farmers spread over 1000 villages across all the 13 districts of the state. They are growing about 72 different crops. Since conducting Crop Cutting Experiments (CCE) and cost estimation for all these crops is not feasible, the proposed sample design would focus only on three major crops identified in each of the 13 districts and considered only those villages where, at least, one of these major crops were grown during the year 2017-18 (Table 1). The identified set of major crops includes horticultural crops also. Further, in order to ensure availability of 10 ZBNF farmers in each village, only those villages with, at least, 10 ZBNF farmers reported growing the major crops in the recent year have been included in sample frame. Finally, a total of 492 villages are considered in the sampling frame (Table 1). Information provided by the RySS on ZBNF spreadform the basis for sample design.

Table 1. Three Major Crops grown by ZBNF farmers 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
Kadapa	Paddy	Banana	Groundnut	18
Kurnool	Paddy	Cotton	Groundnut	32
Ananthapuramu	Paddy	Maize(Corn)	Groundnut	38
Chittoor	Paddy	Groundnut	Tomato	18
Andhra Pradesh				492

A stratified multi-stage sample design is adopted for the survey. First, 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. In second stage, a sample of 10 ZBNF and 10 non-ZBNFfarmers are selected from each sample village using stratified random sampling method. For this purpose, in each village, all the ZBNF and non-ZBNFcultivators were listed and stratified into four strata based on land owned: 1) Landless, 2) Owning 0 Less than 2.5

acres, 3) Owning 2.51 to 5 acres,4) other large farmers. This list of farmers is used as the sample frame for each village, from which the samples of farmers are drawn. The detailed methodology followed at each stage is described below.

For each district, a list of villages with presence of a minimum of 10 ZBNF farmers growing at least, one of the identified crops is prepared first to serve as a sample frame. From this list, a sample of 10 farmers was selected randomly. One limitation of the present sample design is that it is based on data pertaining to the previous year i.e. 2017-18. Although the three 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. Therefore, after a village is selected, if the investigator finds that there are no farmers growing major crops, it has be dropped and substituted with another village. In this way, a basket of 15 sample villages is prepared for each district.

The sample of 10 ZBNF was selected from the sample frame of each village. The sample of 10 farmers 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.

While selecting the ZBNF farmers, priority is given to farmers who are cultivating the identified major crop in non-ZBNFconditions also. As mentioned above, these farmers constitute perfect controls. Thus, a total of 10 ZBNF farmers are selected from each village, some of them also serve as non-ZBNFsamples i.e. self-control. A sample of 10 non-ZBNFfarmers were selected from each village for the purpose of control. Within each selected village, the non-ZBNFfarmers were listed and stratified into four strata based on land owned. The required 10 sample farmers were selected from four strata following the same principle as in case of ZBNF samples. However, since some of the ZBNF sample farmers also served as controls (perfect matches), the total non-ZBNFsamples to be drawn from non-ZBNFlist is reduced by the number of perfect matches found in ZBNF sample.

After selecting the farmer, the parcel of land, where the farmer is growing the major crop, was identified. From this parcel of land, a plot of *size as required by the procedure* will be selected at random for estimating yield through crop cutting experiments (CCEs). It is to be noted that

the study adopted standard methodology of IASRI (followed by Directorate of Economics and Statistics of A P) for conducting CCE.

For this study, 10 villages from each district are selected randomly and from each selected village, 10 ZBNF i.e. Seed-to-Seed farmers are similarly selected. Equal number of control farmers (non-ZBNF) is selected from the same village. Thus, a total of 2600 sample farmers (1300 ZBNF farmers and 1300 non-ZBNFfarmers) are selected for Kharif 2018.

CCEs are used to assess the changes in yield ofcrops. As changes in farm practices and processes are part of the impacts, they are captured by visiting the sample farmers three to four times in the season to minimise the memory lapses in recall by farmers. 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. CCEs are done following the methodology suggested by NSSO and adopted by the State Directorate of Economics and Statistics. The expertise of the personnel associated with these institutions has been utilised well for finalising the methodology. The entire data is captured on mobile so that there is no need for manual entry of data other than qualitative information. The system is supported by videos for all important activities.

1.3.3 The Data Gathering

The objective of the study is to assess the impact of ZNBF on farming system and farming community. It is hypothesised that the ZBNF bring changes in the status of farming system and farming community. The data required in this regard have been collected from the sample households through structured schedule. Data on land use pattern and cropping pattern, input use, cost of production and yield of crops, health status of land and crops to assess the impact on farming, mobilisation of working capital by farmers, income accrued to farmers, and respect towards agricultural profession to assess the impact on farming community, are also collected.

The assessment of the impact of ZBNF on farming system and farming community cannot be captured in totality and only through the quantitative data collected from the above described structured schedule. This is because the impact of ZBNF may be in an event form but it has a time lag for its impact to manifest in a perceptible way. The survey method helps to capture only a phenomena but not an event. Hence, the case studies of events used are able to capture these dimensions of the impact ofZBNF.Further, the ZBNF practices may give opportunity for the farmers to combine their indigenous knowledge with the proposed practices of ZBNF and come out with innovative practices well-matched with the ZBNF practices. Sometimes, the existing structures of land relations like tenancy contracts and social structure of villages in terms of

homogeneity/ heterogeneity with their relation to size of population may become barriers/drivers for the adoption of ZBNF.The case studies of farmers, who have managed the manifestation of these structures, and became successful farmers in adopting ZBNF, can also provide additional insights on the role factors both internal and external to farmers. As it happened in the case of green revolution technology with a dramatic increase in returns, medium and large farmers residing in/outside villages may resort to leasing in land to expand their operational holding if they convince themselves with higher returns of ZBNF. The case study of such farmer enable to capture the event of reverse tenancy (i.e., vacating tenant) under ZBNF.The impact of models of crop cultivation being promoted under ZBNF as well as the process adopted in deriving benefits from these models under different agro-climatic conditions can be captured well through case study method. Hence, case studies of this nature have been developed to capture the impact of ZBNF in its complete form.

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.Focussed group discussions (FGDs) of farmers, which have been organised in five villages from each district, leading to a total of 65FGDs in the state, can shed more lights on the key challenges to be addressed for realizing potential benefits of ZBNF. Valuable data have been generated and recoded from these FGDs. The study also conducted strategic interviews with District Project managers (DPMs) of ZBNF to record their version to supplement the analysis wherever necessary.

Thus, the quantitative data (from listing survey of households and the sample survey of households) has been integrated with the qualitative data collected from case studies and FGDs not only to capture the impact of ZBNF on the farming system and farming community in totality but also to identify the key challenges to be addressed for realising the potential benefits of ZBNF.CCEs have been organised for estimating and comparing the yields of crops grown under ZBNF and non-ZBNF.This is in addition to the data on yields reported by farmers in the household survey.

1.3.4The Data Management

ZBNF core team is having rich experience in data management including huge longitudinal studies such as Young Lives, AP Rural Poverty Reduction Project, AP District Poverty initiatives Project, Rural Indebtedness project and Mission Bhageeratha. Apart from this, two of the core team members worked in cost of cultivation scheme, AP Agricultural University for about two and half decades. Besides team leader and other core team members chosen agricultural costs and returns for their doctoral degrees. Apart from all these, the team has

continuous guidance of an eminent Economist who headed a Committee on Agricultural Sustainable development in A P. Given this rich exposure on the subject, the team identified the possible common errors/lapses that may arise and strengthened the in-house data management unit by placing trained personnel in appropriate places. In brief, the quality ensuring steps and key management aspects are given below.

The field instruments prepared have inbuilt checks with appropriate skip patterns besides supportive manual of instructions for all the questionnaires. Before finalizing the field instruments, study has convened a daylong brain storming session with experienced personnel in the field and incorporated their suggestions. Similarly, the study convened a daylong session with the senior researchers who are entrusted to conduct the case studies in all the thirteen districts to familiarize the concepts and objectives of the project and the check list for administering the case studies. A pilot was conducted on all the field instruments within-house Research Associates/Research Assistants to check the consistency of the questions and flow of the questions and the feedback session with the team members helped in refining the questionnaire.

In-house field Supervisors are also involved in the preparation of questionnaire along with core team members. A two day ToT was conducted in the headquarters. Given the workload, the study identified 8 experienced personnel to work as Supervisor of a district apart from 5 in-house Supervisors. Thus the study deployed one Supervisor in each of the 13 districts. The study also selected qualified Investigators from the pool suggested by RySS who have sufficient agriculture background. A four day intensive training was conducted in CESS headquarters during 16-19th November 2018 with one day on-field training. In the training, the study has drawn the services of senior personnel from RySS to explain the background of the research study, experienced personnel from NSSO and DES to explain on the CCEs, apart from the core team members explaining the entire questionnaire along with manual of instructions, FGDs, case studies and the internal checks to be followed. Senior Statisticians in the team explained on the sample design and on the selection of farm households. In all the four days of training, senior experts drawn for case studies, and personnel selected to lead the CCEs have participated. On reaching the field, respective Supervisors have conducted on field training in the neighbouring villages and only after all the Investigators getting command on the questionnaire, actual field survey was commenced i.e. on 22nd November 2018. All the Supervisors are instructed to send the filled in schedules after completion of a village and after filling the schedule completely i.e. completion of harvesting and winnowing etc. Two senior research Associates are involved to translate the FGDs conducted by the field Supervisors in to English language. Senior core team

members conducted strategic interviews with District Project Managers with a common check list. A separate APP was generated to enter the CCE information and training was given to all the Supervisors duly installing APP in their mobiles. Core team members visited the field and cross checked the information filled.

The study entrusted a senior research Associate to monitor the receipt of filled-in schedules and to look after the entry work done by 4 entry operators. The entry programme was written in CSPro by one of the core team members with inbuilt checks and tested the package for four days by entering dummy data and the package was rectified and refined based on the feedback of the entry operators. Any discrepancies noticed in the data entry, Research Associate / Data Manager have cross checked with concerned field Supervisors and the correctness of the information had been passed on to the entry operators. While generating the result tables, the out-layers identified are cross checked with original schedule and with the concerned Supervisors and final result tables are generated only after following the data quality checks.

1.4 Structure of the Report

The report is organised in to four chapters. The context, objectives and methodology of the study have been presented in chapter1.Chapter 2 deals with the analysis of the impact of ZBNF on cost of cultivation and yield of crops and farmers' incomes. Chapter 3 analyses the same issues dealt in chapter 2 in detail through qualitative data collected from households, case studies, focussed group discussion with the farmers and strategic interviews with the District Project Managers (DPMs).Summary, conclusions and policy implications of the analysis are presented in Chapter 4.Executive summary of the analysis is also presented in chapter 0.

CHAPTER 2

Impact of Zero Budget Natural Farming on Input use, Costs, Yields of Crops and Returns to Farmers

2.0 Introduction

This chapter is an attempt to assess the impact of ZBNF on farming and farming community. In contrast to the chemical based agriculture, the ZBNF is expected to bring changes in the cropping pattern from mono to poly cropping. This change ensures food security, balanced diet to safeguard nutrition, risk coping ability against weather variability and continuous flow of income to farming community. The ZBNF encourages farmers to grow crops on bunds of main fields as well as boarder/protective crops for crops grown in the field. Income from bund and boarder crops ensures income to farmers more or less equal to investment made on crops grown in main fields. The ingredients required for preparing inputs like Beejammurtham; Ghanajeevmrutham; Dravajeevamrutham; *Kashayams* and Astrams to protect crops from pests and insecticides are drawn from the locally available resources like dung, urine, dairy products, and farm yard manure from local cows; leaves and other related material. This ensures low cost inputs to farmers for growing crops. These inputs also improve yields of crops. Thus, lower cost of cultivation and improved yield of crops result in increase of incomes of farmers.

2.1 Research Questions

In the above backdrop, this chapter addresses to the following research questions:

1. What is the impact of ZBNF on level and composition of input use of crops grown?
2. How far the changes in input use due to ZBNF has impacted costs, yields and returns to farmers?

2.2 The Approach

A comparison has been made in regard to input use, costs and returns of farmers between ZBNF and Non-ZBNFpractitioners to assess the impact of ZBNF particularly on costs and returns of crops. Though a sample of 1987 farmers are covered in the study, 661 pure ZBNF farmers grown only ZBNF crops, 704 Non-ZBNFfarmers grown only crops under Non-ZBNFpractices are considered for the report. In other words, 622 self-control farmers who have grown the same crop under ZBNF as well as under non-ZBNFpractices, have not been included in the main analysis as the study noticed contamination in the input applications. It was thought the self-control farmers can be a better internal control to control all the household specific, land specific and management specific factors effectively to obtain the robust assessment of the ZBNF impact but in reality, it was found that these farmers have adopted some of the practices of ZBNF like

application of *Kashayams*/Astrams to control pests and diseases on non-ZBNFcrops. Thus, the self-control methodology has not served the purpose. Hence, a comparison has been made between pure ZBNF and non-ZBNFfarmers to assess the impact of ZBNF on costs and returns of crops (for details see Table 2.1). The data collected from farmers on level and composition of input use, costs and yield of crop have been analysed in this regard. As far as yield of crops are concerned, the reported yield of crops and the yield obtained through crop cutting experiments (CCEs) have been compared. As explained in the first chapter, the study drew the services of retired personnel from NSSO who have vast experience in CCE to conduct 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. However, the study has sufficient numbers of CCE district wise for paddy. But the whole analysis of costs and returns of crops has been conducted on the basis of reported yield of crops by the farmers, but not based on the CCEs.

Table 2.1 Distribution of Sample Farmers across the Districts in Kharif Season during 2018-19

District	Total Sample farmers (ZBNF + non-ZBNF)	ZBNF Farmers		Non-ZBNF Farmers(Growing crops under non-ZBNF only)
		Self-control Farmers(Growing Crops under ZBNF as well as non-ZBNF)	ZBNF farmers(Growing Crops Under ZBNF only)	
Ananthapuramu	163	43	60	60
Chittoor	179	26	77	76
East Godavari	167	34	63	70
Guntur	163	30	67	66
Kadapa	183	19	80	84
Krishna	116	82	18	16
Kurnool	181	20	81	80
Nellore	129	79	20	30
Prakasam	119	50	35	34
Srikakulam	124	75	24	25
Visakhapatnam	192	31	69	92
Vizianagaram	154	45	53	56
West Godavari	117	88	14	15
Total	1987	622	661	704

2.3 The Analysis

The impact analysis for different crops is in order.

2.3.1 Input use and Cost of Cultivation of Paddy Crop

It is hypothesized that the cost of cultivation of crops grown under ZBNF practices should be lower compared to that of under non-ZBNF. This is simply because the cost of inputs like *Beejammurtham, Ghanajeevmrutham, Dravajeevamrutham, Kashayams and Asthrams* used under ZBNF as against the fertilisers and pesticides under non-ZBNF is lower. However, the farmers may spend part (whole) of their savings from the expenditure on ZBNF input on other supporting services of human labour, bullock labour due to labour intensive nature of ZBNF. Thus the quantum of reduction in cost due to application of biological inputs over chemical inputs may not necessarily result in the reduction in the total cost of production per hectare to that extent for crops grown under ZBNF.

Cost of Biological (ZBNF) and Chemical Inputs (non-ZBNF)

A comparison of the cost of biological inputs with that of chemical inputs has revealed that the cost of ZBNF inputs (biological inputs) is found to be only Rs.4216 per hectare and that of non-ZBNFinputs (chemical inputs) has turned out to be Rs.13248 per hectare for paddy crop. Thus, there is a decline in cost of inputs by Rs.9032 due to ZBNF practices (Figure 2.1).It means that there is a reduction in the cost under ZBNF by 68 per cent over those non-ZBNFi.e. chemical inputs per hectare. The percentage of reduction in this cost has ranged from 27 per cent in Srikakulam district to 90 per cent in Nellore district (Colum 3 of Table 2.2). The reduction levels are higher in south coastal and dry land areas of Rayalaseema compared to that of in the rainfed areas of North Coastal Andhra. The use of chemical inputs per hectare is at lower level compared to that of the state average for the three North Coastal Districts. In north coastal districts, it is age old practice i.e. lower use of fertilisers and higher use of farm yard manure and it is reaffirmed in our study. This is the reason why the level of use of chemical inputs is lower than the state average (Colum 3 of Table2.2).

The other interesting observation on the data is that the districts where there is more need to use biological inputs to reduce the consumption of chemical input, the farmers have used lower levels of biological inputs. East Godavari, West Godavari, Krishna, Guntur, Prakasam, Nellore, Kadapa, Kurnool, and Chittoor fall under this category. This indicates that the doses of biological inputs applied by the farmers are independent of the requirements across most of the districts (Colum 1 of Table 2.2). Had they used the required level of biological inputs, the cost

of reduction would have been further higher and the yield of crops under ZBNF might have been far higher than that of the crops grown under Non-ZBNF.

Figure 2.1 Cost of Biological Inputs of ZBNF and Chemical Inputs of Non-ZBNF per Hectare of Paddy across Districts (in Rupees)

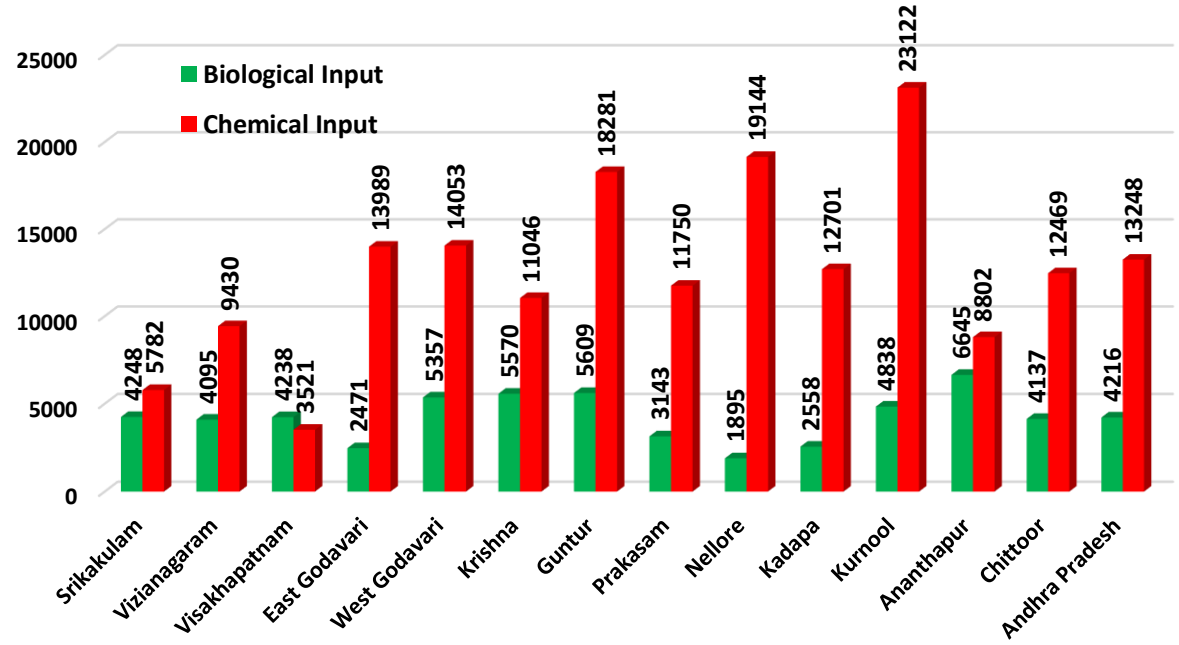


Table 2.2 Impact of Biological Inputs of ZBNF on Chemical Inputs of Non-ZBNFper hectare of Paddy across Districts

District	% of the cost of biological inputs to cost of chemical inputs	Reduction in chemical input cost due to use of Biological inputs (Rs)	% of decline in cost of ZBNF inputs over non-ZBNFinputs
Srikakulam	73.46	1534	27
Vizianagaram	43.42	5335	57
Visakhapatnam	120.35	-717	-20
East Godavari	17.66	11518	82
West Godavari	38.12	8696	62
Krishna	50.43	5476	50
Guntur	30.68	12672	69
Prakasam	26.75	8607	73
Nellore	9.90	17249	90
Kadapa	20.14	10143	80
Kurnool	20.92	18284	79
Ananthapuramu	75.49	2157	26
Chittoor	33.17	8332	67
Andhra Pradesh	20.07	9032	68

Note: Use of ZBNF puts is higher than that of non-ZBNFinputs in case of Visakhapatnam district.
Source: Field Survey

Cost of Biological (ZBNF) and Chemical Inputs (non-ZBNF) in total cost of Production per hectare of Paddy

Another parameter considered to assess the reduction in the cost of production of crops is percentage of cost of biological/chemical inputs in the total costs per hectare. Here, the paid-out costs for the cultivation of Paddy crop are considered for the analysis. The paid-out costs include the costs incurred on seeds, human labour, bullock labour, machine labour, biological inputs like Beejammurtham, Ghanajeevmrutham, Dravajeevamrutham,*Kashayams* and Astrams/chemical inputs like fertilisers and pesticides, and other expenditure like hiring implements. The cost of biological inputs has formed 11.7 per cent of total cost per hectare under ZBNF, while the cost of chemical inputs constitute 31.7 per cent under non-ZBNFpaddy (Table 2.3).This clearly means that the costs of biological inputs have formed considerably lower proportion in the total cost of production under ZBNF compared to those under Non-ZBNF.

Table 2.3 Composition of Inputs in Total Cost per Hectare of Paddy cultivation under ZBNF and non-ZBNF

Inputs	Paddy			
	Cost under ZBNF (in rupees)	% in Total Cost	Cost under Non- ZBNF (in rupees)	% in Total Cost
Seed	2175	6.04	2125	5.09
Human Labour	14589	40.52	13527	32.41
Bullock Labour	1237	3.43	270	0.65
Machine Labour	10886	30.23	11066	26.51
Biological Inputs of ZBNF/ Chemical inputs (Fertilizers &Pests) of Non-ZBNF	4215	11.71	13248	31.74
Others	2908	8.07	1501	3.60
Total Cost	36009	100.00	41736	100.00

Source: Field Survey

Cost of Production of Paddy under ZBNF and Non-ZBNFPractices

The paid out cost for the cultivation of paddy crop per hectare under Non-ZBNFis Rs.41737, on average, at the state level. But it is found to be Rs.36009 under ZBNF. Thus, the paid out cost per hectare has been reduced by Rs.5728 due to the adoption of ZBNF practices leading to a decline by 14 per cent in the cost of cultivation (Table 2.4). But the cost of inputs declined by 68 per cent due to ZBNF. Then, the issue in question is why didn't this cost advantage of ZBNF inputs has not resulted in the decline of total cost of cultivation of paddy crop per hectare to that extent under ZBNF. The comparison of composition costs between ZBNF and Non-ZBNFpaddy may provide answer to this. It is evident that the expenditure on other services of human labour and bullock labour has gone up under ZBNF over that under non-ZBNF(Table 2.3). It is

understandable that preparation of ZBNF inputs require more human labour in comparison to chemical inputs which are readily available in the market. This is particularly true in case of nuclear families where there is scarcity of labour workforce within the household is observed. In addition, procurement and preparation of ZBNF inputs may not require entire day for a labour but forced to pay day wages. All this indicates that the farmers have incurred additional expenditure on wage payments of human labour, bullock labour, and implements. This shows that the changes in the practices of paddy cultivation under ZBNF have marginally increased the cost of other inputs for crop production. It also indicates that ZBNF practices created more employment opportunities even for family labour.

As observed at the state level, the rate of reduction in the cost of inputs due to use of biological inputs has not reflected in the total cost of production per hectare across all the districts (Table 2.4 and Figure 2.2).The grouping of the districts in to two categories, viz., delta and non-delta districts has brought out interesting insights in to this. The delta districts include East Godavari, West Godavari, Krishna and Guntur, while non-delta districts include all other districts. The percentage decline in the cost per hectare is found to be more or less the same around 12 in both the categories of districts. But, the paid cost under non-ZBNFis found to be higher in the delta districts compared to those in the non-delta districts. The reason for this could be as follows. As mentioned earlier, ZBNF practices are slightly labour intensive and increases the demand for labour. The increased labour demand on the wages of hired labour depends on the labour market conditions. It might have created pressure on the already existing scarcity of hired labour in the delta districts. This might have led to higher wages in the delta districts. On the other hand, this might not have created pressure on the existing labour markets in the non-delta districts where there is less scarcity of hired labour. Hence there may be lower increase in the wages of hired labour in the non-delta districts (predominantly of rain-fed and dry-land area). This is one of the dominant reasons for the lower cost of production in the non-delta districts. The higher percentage of reduction and lower cost per hectare in the rainfed areas compared to that of irrigated areas also provides substantial evidence to this. Further, the impact of increased demand for labour on the hired labour due to ZBNF practices may be more or less the same, as the labour market conditions could be more or less the same in both the irrigation practices (flow irrigation and other irrigation). Thus, the relationship between increase in the ZBNF input use and the cost of production per hectare is influenced by the percentage of increase in the use of ZBNF inputs in relation to the level of non-ZBNFinputs and labour market conditions. This is the reason why the percentage of increase in the use of ZBNF inputs does not ensure the same percentage of reduction in the cost of production per hectare due to ZBNF.

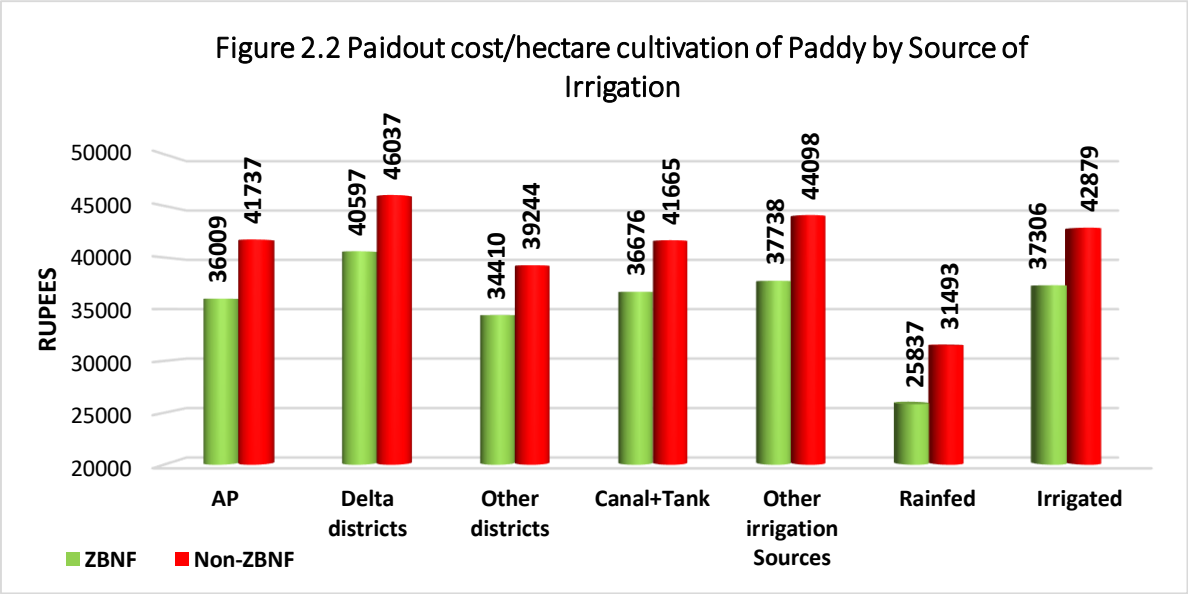


Table 2.4 Paid out Cost of Paddy crop under ZBNF and non-ZBNFacross Districts (in rupees per hectare)

Districts	Paid out cost perhectare		
	ZBNF	Non- ZBNF	% of Reduction in cost of ZBNF over non-ZBNF
Srikakulam	30455	28617	-6.4
Vizianagaram	33883	33961	0.2
Visakhapatnam	21918	23955	8.5
East Godavari	37089	40730	8.9
West Godavari	39011	45803	14.8
Krishna	44020	51769	15.0
Guntur	40897	50004	18.2
Prakasam	34141	47146	27.6
Nellore	40286	52680	23.5
Kadapa	41476	46434	10.7
Kurnool	38301	48467	21.0
Ananthapuramu	37536	39429	4.8
Chittoor	41537	44497	6.7
Andhra Pradesh	36009	41737	13.7
Delta districts	40597	46037	11.8
Other districts	34410	39244	12.3
Canal+Tank	36676	41665	12.0
Other Sources	37738	44098	14.4
Irrigated	37306	42879	13.0
Rainfed	25837	31493	18.0

Source: field Survey

2.3.2 Input use, Yield, and Income to Farmers

Yields as per CCEs

Before discussing the farmer reported yields and income to farmers, it is apt to examine the yield of Paddy through crop cutting experiments (CCEs).One of the major activities of this study is to collect yield data from crop cutting experiments (CCEs). As explained earlier in this report, the study has used the services of retired personnel from NSSO with vast experience in CCEs for guidance and conducting the 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. However, the study have sufficient numbers of CCE district wise for paddy crop and the results are presented in the Table 2.5.

As per the procedure, CCEs for paddy are conducted in 5*5 meters size of a selected plot and received an output of 13.85 Kgs wet weight at the state level. In terms of per hectare yield, the wet weight works out to 55.40 quintals as against the farmer reported yield of 48.68 quintals. However, it is to be noted that farmer reported yield is almost dry weight and there is need to convert wet weight into dry weight. The study arrived dry weight varies between 10 to 15% less of wet weight (differed from district to district) and the derived wet weight need to be deducted to arrive dry weight to compare with reported yield. If the study considers deduction of 12%, on an average, it works out to 48.75 quintals dry weight under ZBNF as against the farmer reported yield of 45.22 quintals. Thus the farmer reported yields are marginally lower compared to CCE derived yields. Similarly, CCE dry yield per hectare under non-ZBNFworks out to 53.18 quintals as against the farmer reported yield of 47.69 quintals. Yields under ZBNF are marginally low compared to the same under non-ZBNFirrespective of whether the yield data are collected from CCEs or household survey. There are inter-district variations in yield data obtained under both methods. But the test of significance indicates that there is no difference in the yields obtained through CCEs and farmer reported yields.

Table 2.5 Perhectare Yields of Paddy under ZBNF and Non-ZBNF Methods across Districts

District/ Yield	ZBNF				Non-ZBNF		
	Wet output for CCE plot (kgs)	Dry yield/ acre as per CCE (qtls)*	Reported yield per hectare (qtls)		Wet output for CCE plot (kgs)	Dry yield/ acre as per CCE (qtls)*	Reported yield per hectare (qtls)
Srikakulam	8.90	12.67	37.40		12.15	17.31	32.17
Vizianagaram	11.65	16.60	44.46		13.37	19.04	43.17
Visakhapatnam	10.95	15.61	26.23		13.68	19.48	28.14
East Godavari	16.81	23.94	41.12		11.45	16.31	43.78
West Godavari	16.22	23.10	50.52				48.54
Krishna	14.83	21.13	54.08		18.75	26.71	67.69
Guntur	16.64	23.71	49.59		18.63	26.54	57.83
Prakasam	15.59	22.21	48.97		16.07	22.90	52.20
Nellore	13.70	19.52	51.23		14.55	20.72	59.55
Kadapa	14.76	21.01	51.99		14.29	20.35	41.36
Kurnool	14.91	21.24	53.58		18.21	25.94	63.48
Ananthapuramu	12.86	18.31	49.16				35.67
Chittoor	12.21	17.39	48.84				55.08
Andhra Pradesh	13.85	19.73	45.22		15.11	21.52	47.70

Source: Field data

** Arrived based on the average dry weight from the field experiments i.e. around 12% less than wet weight*

Farmer reported yields and Incomes

The higher/lower level of cost per hectare reflects higher/lower level of input use per hectare. The cost of cultivation per hectare is lower for paddy under ZBNF over Non-ZBNFacross all the districts except Srikakulam. Hence the yield under ZBNF should be lower than that of under Non-ZBNF. But, the yield of ZBNF paddy is on par with that of Non-ZBNF, despite lower level of input use under ZBNF across all the districts except Krishna, Guntur and Kadapa (Table 2.6 and Figure 2.3).This indicates that the yield response to the ZBNF inputs is higher than that to the Non-ZBNFinputs. However, the yield is higher under Non-ZBNFthan that under ZBNF for Krishna and Guntur, the delta districts. This is due to higher use of chemical inputs than the biological inputs used under ZBNF. This indicates that the response to the biological input is not adequate enough to catch up with yield of Non-ZBNF. Had the farmers of ZBNF used some more doses of biological inputs, the yield response would have been higher. A comparison across the delta districts indicates that the response to the biological inputs is higher in non-delta districts over that in the delta districts. This is further substantiated by the evidence that the yield response to the biological inputs in Kadapa, a non-delta district, is higher than that in the Guntur, the delta district. The higher response of the yield to the biological inputs has reduced the cost

per quintal of production of paddy (Table 2.7 and Figure 2.3).Because of higher yields for paddy under ZBNF, the net income per hectare for the ZBNF farmers is higher than that under Non-ZBNFfarmers across most of the districts, especially Non-delta districts, non-flood among irrigation sources. But there is no difference in the net income to the farmers between ZBNF and non-ZBNFin rain fed conditions (Table 2.6 and Figures 2.4).

Figure 2.3 Yield / hectare of Paddy under ZBNF and Non-ZBNF

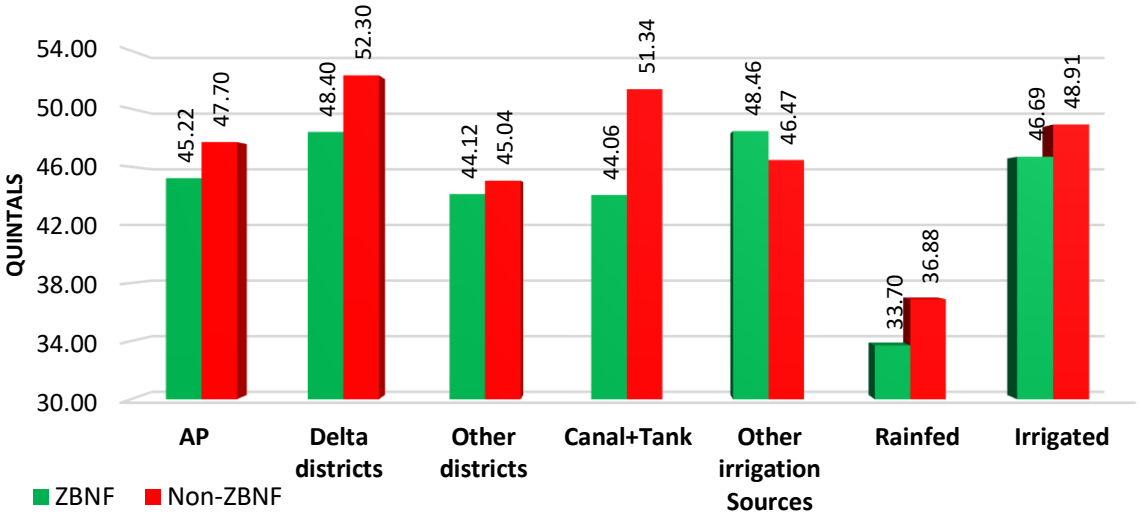


Table 2.6 District wise Yield of paddy under ZBNF and Non-ZBNF(Yield per hectare in Quintals)

District	Yield per hectare(in Quintals)		Whether Yield significantly differs between ZBNF and Non-ZBNF(Test of Significance)?
	ZBNF	Non ZBNF	
Srikakulam	37.41	32.17	Not Significant
Vizianagaram	44.46	43.17	Not Significant
Visakhapatnam	26.24	28.15	Not Significant
East Godavari	41.12	43.79	Not Significant
West Godavari	50.51	48.53	Not Significant
Krishna	54.09	67.68	**
Guntur	49.59	57.82	*
Prakasam	48.98	52.21	Not Significant
Nellore	51.23	59.55	Not Significant
Kadapa	51.99	41.37	**
Kurnool	53.57	63.48	Not Significant
Ananthapuramu	49.15	35.68	Not Significant
Chittoor	48.85	55.08	Not Significant
Andhra Pradesh	45.22	47.69	Not Significant
Delta districts	48.40	52.30	Not Significant
Other districts	44.12	45.04	Not Significant

District	Yield per hectare(in Quintals)		Whether Yield significantly differs between ZBNF and Non-ZBNF(Test of Significance)?
	ZBNF	Non ZBNF	
Canal+Tank	44.06	51.34	**
Other Sources	48.46	46.47	Not Significant
Rain-fed	33.70	36.88	Not Significant
Irrigated	46.69	48.91	Not Significant
Rain-fed	33.70	36.88	Not Significant

Source: Field Survey
** Indicates significance at 1 per cent level*
*** Indicates significance at 5 per cent level*

Figure 2.4 Net returns / hectare of Paddy crop for ZBNF and Non-ZBNF

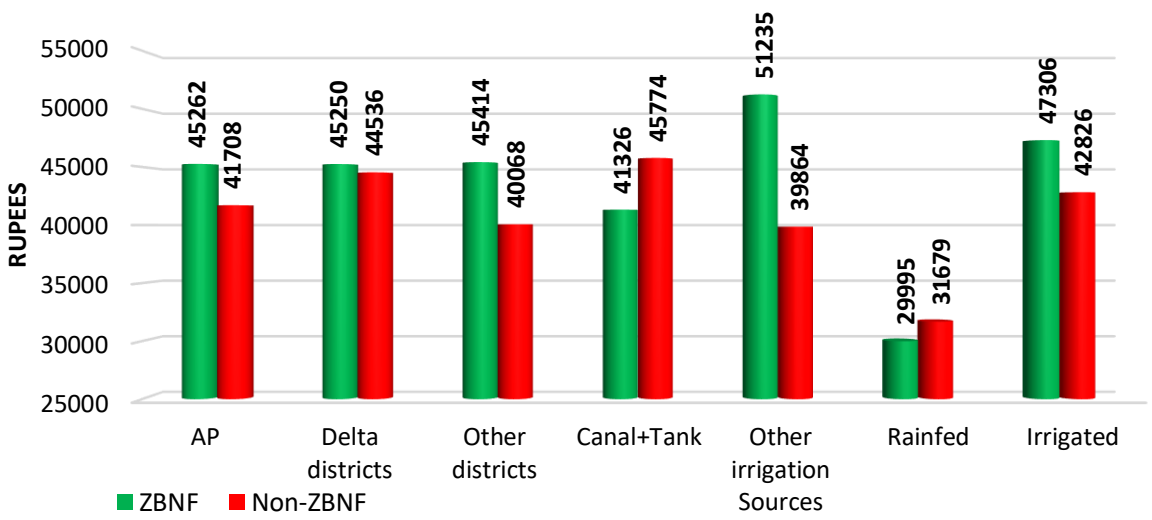


Table 2.7 District wise Cost per Quintal and Net Incomes per Hectare for Farmers of Paddy (In rupees)

District	Cost per Quintal and Net Income per Hectare	ZBNF	Non-ZBNF	% of Increase/Decrease under ZBNF over Non-ZBNF
Srikakulam	Cost per Qtl (Rs.)	814	889	8.5
	Net returns (Rs.)	26014	16913	-53.8
Vizianagaram	Cost per Qtl (Rs.)	762	787	3.1
	Net returns (Rs.)	48761	40539	-20.3
Visakhapatnam	Cost per Qtl (Rs.)	836	851	1.8
	Net returns (Rs.)	17843	19563	8.8
East Godavari	Cost per Qtl (Rs.)	902	930	3.1
	Net returns (Rs.)	38969	39589	1.6
West Godavari	Cost per Qtl (Rs.)	772	944	18.2
	Net returns (Rs.)	60998	37798	-61.4

District	Cost per Quintal and Net Income per Hectare	ZBNF	Non-ZBNF	% of Increase/Decrease under ZBNF over Non-ZBNF
Krishna	Cost per Qtl (Rs.)	814	765	-6.4
	Net returns (Rs.)	45447	68926	34.1
Guntur	Cost per Qtl (Rs.)	825	865	4.6
	Net returns (Rs.)	43607	44198	1.3
Prakasam	Cost per Qtl (Rs.)	697	903	22.8
	Net returns (Rs.)	69096	57653	-19.8
Nellore	Cost per Qtl (Rs.)	786	885	11.1
	Net returns (Rs.)	38522	40813	5.6
Kadapa	Cost per Qtl (Rs.)	798	1123	28.9
	Net returns (Rs.)	63184	34402	-83.7
Kurnool	Cost per Qtl (Rs.)	715	764	6.4
	Net returns (Rs.)	56523	62283	9.2
Ananthapuramu	Cost per Qtl (Rs.)	764	1105	30.9
	Net returns (Rs.)	52677	29724	-77.2
Chittoor	Cost per Qtl (Rs.)	850	808	-5.3
	Net returns (Rs.)	49528	57188	13.4
Andhra Pradesh	Cost per Qtl (Rs.)	796	875	9.0
	Net returns (Rs.)	45262	41708	-8.5
Delta districts	Cost per Qtl (Rs.)	839	880	4.7
	Net returns (Rs.)	45250	44536	-1.6
Other districts	Cost per Qtl (Rs.)	780	871	10.4
	Net returns (Rs.)	45414	40068	-13.3
Canal+Tank	Cost per Qtl (Rs.)	832	812	-2.6
	Net returns (Rs.)	41326	45774	9.7
Other sources	Cost per Qtl (Rs.)	779	949	21.8
	Net returns (Rs.)	51235	39864	-28.5
Irrigated	Cost per Qtl (Rs.)	799	877	8.9
	Net returns (Rs.)	47306	42826	-10.5
Rain fed	Cost per Qtl (Rs.)	767	854	10.2
	Net returns (Rs.)	29995	31679	5.3

2.4 Cost of Biological (ZBNF) and Chemical Inputs (Non-ZBNF) for Maize, Groundnut, Cotton, Tomato and Bengal Gram

The data relating to costs and returns have been collected for crops like Maize, Groundnut, Cotton, Tomato, Bengal Gram,Cashew,Citrus, Black gram and Palm Oil. However, the analysis is confined to the first five crops, as the sample is not representative for other crops to have meaningful averages. A comparison of biological input cost of ZBNF and chemical input cost of non-ZBNFper hectare has revealed that the cost of ZBNF inputs is lower than that of non-

ZBNFacross all the crops. Perhectare cost of biological and chemical inputs respectively are: Rs.4611 and Rs. 6029 for Maize; Rs.2759 and Rs. 3732 for Groundnut; Rs.2863 and Rs. 9041 for Cotton; Rs.5085 and Rs. 16705 for Tomato; Rs.4535 and Rs. 8191 for Bengal gram (columns 2 and 3 of Table 2.8). The extent of decline in absolute and relative terms is pronounced in case of high value crop like Cotton and vegetable crop like Tomato compared to other crops considered for the analysis (columns 5 and 6 of Table 2.8). The levels of biological input use might have been higher in case of Cotton and Tomato as the levels of chemical inputs is higher among these crops (columns 4, 2 and 3 of Table 2.8).

Table 2.8 Cost incurred on inputs per hectare under ZBNF and non-ZBNFfor Maize, Groundnut, Cotton, Tomato and Bengal Gram

District	Biological (Non Chemicals) under ZBNF (Rs)	Chemical(Fertilizers & Pesticides) inputs for 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-ZBNFinput
1	2	3	4=(2/3) *100	5= 3-2	6=(5/3)*100
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

2.4.1Cost of Biological (ZBNF) and Chemical Inputs (non-ZBNF) in paid-out cost of Production for Maize, Groundnut, Cotton, Tomato and Bengal Gramcrops

Another dimension of impact assessment of ZBNF is on cost structure of the crops. The share of biological inputs (non-chemicals) in the total cost per hectare of the production of crop grown under ZBNF has been compared with those of chemical inputs for crops grown under non-ZBNF.The share of cost of biological inputs in the paid out cost ranges from 6.7 per cent for Tomato to 16.0 per cent for Bengal gram under ZBNF, while the share of cost of chemical inputs ranges from 12.5 percent for Groundnut to 27.5 per cent for cotton. Thus, it is evident that the absolute costs as well as share in the paid out cost of production of non-chemical inputs per hectare are found to be considerably lower for the crops grown under ZBNF compared to the chemical inputs for the same crops under non-ZBNF. The reduction of costs is pronounced among the high value crops like tomato, cotton and Bengal gram due to the use of ZBNF inputs (Table 2.9).

Table 2.9 Percentage of Biological and Chemical inputs in Cost of Production under ZBNF and non-ZBNFfor Maize, Groundnut, Cotton, Tomato and Bengal Gram Crops

Inputs/Crops	Maize				Groundnut			
	ZBNF	% share	Non ZBNF	% share	ZBNF	% share	Non ZBNF	% share
Seed	3263	10.13	3449	10.63	17038	58.31	16934	56.53
Human Labour	12173	37.79	11920	36.73	3642	12.47	3731	12.45
Bullock Labour	3242	10.06	2285	7.04	1583	5.42	1486	4.96
Machine Labour	7659	23.77	7919	24.40	2573	8.80	2646	8.83
Non Chemical/ Fertilizers & Pesticides	4611	14.31	6029	18.58	2759	9.44	3732	12.46
Others	1268	3.94	855	2.63	1624	5.56	1428	4.77
Total Cost	32214	100.00	32458	100.00	29219	100.00	29957	100.00
	Tomato				Bengal gram			
Inputs/Crops	ZBNF	% share	Non ZBNF	% share	ZBNF	% share	Non ZBNF	% share
Seed	10479	13.80	11110	11.93	11321	40.03	11894	36.11
Human Labour	47281	62.25	49742	53.40	3046	10.77	3412	10.36
Bullock Labour	2151	2.83	1641	1.76	0	0.00	0	0.00
Machine Labour	6942	9.14	8649	9.28	8287	29.30	8735	26.52
Non Chemical/ Fertilizer, Pesticides	5085	6.70	16705	17.93	4535	16.04	8191	24.87
Others	4014	5.28	5302	5.69	1090	3.86	707	2.15
Total Cost	75952	100.00	93149	100.00	28279	100.00	32939	100.00

Inputs	Cotton			
	ZBNF	% of input in the total cost	Non-ZBNF	% of input in the total cost
Seed	5051	18.60	5042	15.35
Human Labour	9341	34.39	9675	29.45
Bullock Labour	4276	15.74	3535	10.76
Machine Labour	4182	15.40	4250	12.94
Non Chemical/ Fertilizers &Pesticides	2863	10.54	9041	27.52
Others	1451	5.34	1310	3.99
Total Cost	27164	100.00	32854	100.00

Source: Field survey

2.4.2 Cost of Production under ZBNF and non-ZBNFPractices for Maize, Groundnut, Cotton, Tomato and Bengal Gram

The patterns of input use of the crops analysed above should reflect in the cost of production of crops. The cost of production of crops per hectare is found to be the lowest i.e. Rs.27164 in case of cotton and the highest of Rs.75952 in case of tomato grown under ZBNF.The same is found to be the lowest of Rs.29957 for groundnut and the highest of Rs.93149 for tomato grown under

non-ZBNF. Moreover, the cost of cultivation per hectare found to be lower across all the crops grown under ZBNF compared to the same crops grown under Non-ZBNF. The reduction in the cost of production of crops per hectare is found to be the highest by 20 percent for cotton and tomato compared to those (around one per cent for the other crops like maize, groundnut and Bengal gram. Thus it is abundantly clearly that the ZBNF has brought down considerably the cost of production of crops per hectare across the crops. But the percentage of reduction in cost of production per hectare of crops is not in commensurate to that of percentage of reduction in input cost due to ZBNF. 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 like tomato compared to those under other crops (Table 2.10).

Table 2.10 Cost of Production of Crops under ZBNF and non-ZBNF(Costs in Rupees)

Description of Crops and Costs	Method of Growing Crops		
	ZBNF	Non ZBNF	%Change over non-ZBNF
Maize			
Number of Farmers	17	18	
Cost per hectare (Rs)	32214	32458	-0.01
Cost per Quintal (Rs)	626	824	-24.03
Groundnut			
Number of Farmers	47	73	
Cost per hectare (Rs)	29219	29957	-0.03
Cost per Quintal (Rs)	2189	2602	-15.88
Cotton			
Number of Farmers	53	77	
Cost per hectare (Rs)	27164	32854	-17.31
Cost per Quintal (Rs)	2428	3111	-21.95
Tomato			
Number of Farmers	9	6	
Cost per hectare (Rs)	75952	93149	-18.46
Cost per Quintal (Rs)	202	253	-20.16
Bengal gram			
Number of Farmers	15	12	
Cost per hectare (Rs)	28279	32939	-1.41
Cost per Quintal (Rs)	1617	1937	-16.52

Source: Field survey

2.4.3 Input use, Yields and Income of Farmers

The use of biological as well as chemical inputs has reflected in the yield of crops. The yield of the crops grown under ZBNF are found to be on par with those grown under Non-ZBNF. This is true across crops like groundnut, cotton, Bengal gram and Tomato. Moreover, the yield of Maize under ZBNF is significantly higher than that under Non-ZBNF. This provides compelling evidence that the yield response to biological inputs is much higher than that of chemical inputs. This is more so because of higher yield for maize crop of ZBNF over non-ZBNFand yield on par with those of other crops despite the lower levels of use of ZBNF inputs, compared to the levels of use of chemical inputs (Table 2.11, Figures 2.5, 2.6 and 2.7)

Table 2.11 Crop wise Yields under ZBNF and ZBNF (Quintals per hectare)

Crop	Yield of Crops		Yield Significantly Differ between ZBNF and Non-ZBNF(Test of Significance)
	ZBNF	Non-ZBNF	
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; * Significant at 1 per cent level of significance*

The cost per quintal of output has declined by 24 per cent for maize followed 22 per cent for cotton crop, 20 percent for tomato, and around 16 per cent each for groundnut and Bengal gram due to ZBNF practices. Thus, it is very striking to note that the cost of production per quintal of output has reduced considerably compared to the cost of production per hectare under non-ZBNFacross all crops. This means that the yield response to the biological inputs is higher compared to that of chemical inputs across all the crops (Table 2.10). The reduction in the cost of cultivation per hectare and the cost per quintal under ZBNF over non-ZBNFshould result in the net income of the ZBNF across all crops. The net income per hectare to the farmers is higher from ZBNF for all the five crops considered for the analysis. It is the highest for Tomato under ZBNF i.e. Rs. 323409 per hectare as against Rs. 229926 in case of Tomato under non-ZBNF(Table 2.12). Similarly for Bengal gram, the net returns per hectare under ZBNF are Rs.54559 as against Rs.46498, followed by Maize (Rs. 45375 as against Rs. 21458), Groundnut (Rs. 35819 and Rs.25409) and Cotton (Rs.28585 and Rs.19662).The highest increase in net income of farmers due to ZBNF is from maize (111 percent) followed by cotton (45 per cent), groundnut and Tomato (41 per cent each) and 17 percent in case of Bengal gram (Table2.13).

Table 2.12: Net Income per hectare of Crop cultivation in Andhra Pradesh (Rs)

Crop/Method	ZBNF	Non ZBNF
Maize	45375	21458
Groundnut	35819	25409
Cotton	28585	19662
Bengal gram	54559	46498
Tomato	323409	229926

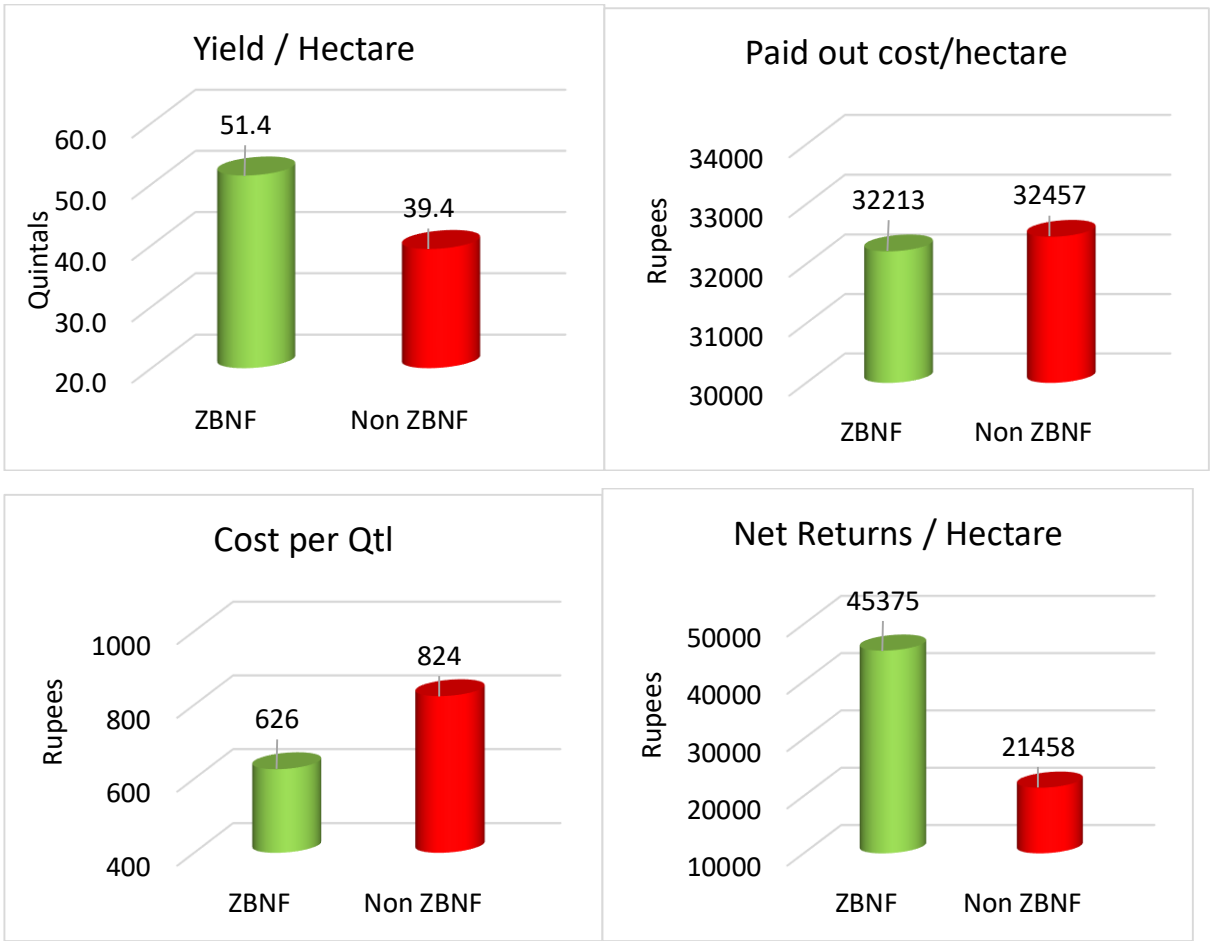
Source: Field Survey

Table 2.13 Crop wise Increase in the Net Incomes to farmers per hectare due to ZBNF

Description of Crops and Net Income	Increase in Net Income per hectare over non-ZBNF(Rs.)	% of increase in income to farmers from ZBNF over non-ZBNF
Maize	23917	111
Groundnut	10410	41
Cotton	8923	45
Tomato	93483	41
Bengal gram	8061	17

Source: Field Survey

Figure 2.5 Costs, Returns per hectare of Maize Cultivation – Kharif 2018-19 in A P



Source: Field Survey

Figure 2.6 Costs, Returns per hectare of Groundnut Cultivation – Kharif 2018-19 in A P

Source: Field Survey

Figure 2.7 Costs, Returns per hectare of Cotton Cultivation – Kharif 2018-19 in A P

Source: Field Survey

2.5 Per Farmer Net Income from Mixed crops, Border and Bund Crops

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 including bund crops to achieve more returns in a given piece of land. In Kharif season, 154 ZBNF sample farmers have grown 28 different mixed crops ranged from 2 to 4 crops in a plot. On the other hand, 68 non-ZBNFsample 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-ZBNFfarmers (Table 2.14).

Table 2.14: Net Income from Mixed Crops, Border Crops and Bund Crops (Rs)

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

Similarly 39 sample ZBNF farmers have grown bund crops in their main field in Kharif as against 20 non-ZBNFfarmers and derived a net income of Rs. 4229 by each farmer under ZBNF method compared to Rs. 3922 by a non-ZBNFfarmer. Further, 24 ZBNF farmers have grown border crops and each farmer earned net income of Rs. 4019; while 12 non-ZBNFfarmers who have grown border crops earned net income of Rs. 3695 per farmer. Thus, more number of ZBNF farmers adopted mixed cropping, border cropping and bund cropping compared to non-ZBNFand earned more income from these crops compared to their counterparts i.e. non-ZBNFfarmers.

CHAPTER 3

Impact of ZBNF on Farming and Farming Community Beyond Costs and Returns

3.0 Introduction

This chapter is an attempt to supplement the analysis conducted in the previous chapter on cost of cultivation, yields and incomes accrued to farmers. The incomes from crops, inter crops, boarder and bund crops are analysed. But the contribution of ZBNF to the continuous flow of incomes throughout agricultural year has not been touched upon; market channels that fetch farmers higher prices for their ZBNF crop outputs to achieve higher incomes ; constrains farmers have encountered in using ZBNF inputs to replace chemical inputs ; and other benefits accrued to farming and farming community from ZBNF like soil health, quality of crop outputs, resilience of crops to weather variability, health status of consumers of ZBNF crop outputs and respectability for agriculture occupation have not been dealt with in the previous chapter. This analysis presents a larger picture of ZBNF impact on farming and farming community. This chapter is a modest attempt to conduct analysis in this direction.

3.1 Research Questions

In the above backdrop, this chapter addresses to the following research questions:

i. What are the interventions made under ZBNF to ensure continuous flow of income throughout agricultural year to the farming community?

ii. How far the ZBNF farmers were able to obtain higher prices for their ZBNF crop outputs?

iii. What are the constraints encountered by farmers in using ZBNF inputs for crops?

iv. What are the other benefits, if any, accrued to farmers beyond costs and returns of crops?

3.2 The approach

Changes in land use pattern and cropping pattern have been analysed to address the issues relating to continuous flow of incomes to farmers throughout the agricultural year. Analysis of market channels through which ZBNF farmers have obtain higher prices for their ZBNF crop outputs has been utilised to address the second research question. The experiences farmers in using ZBNF inputs to cut down the use of chemical inputs to zero level has been analysed to capture the constraints farmers have faced in preparation, and procurement of ZBNF inputs. The benefits accrued to farmers in regard to soil fertility, quality of crop output, resilience of crops to weather variability, health status of consumers of ZBNF crop outputs, status of agricultural occupation are also considered for the analysis. All these dimensions of the analysis are captured through household survey of farmers, case studies of farmers, focussed group

discussion with the farmers and the interaction with the District Project Managers (DPMs) of RySS.

3.3 The Analysis

The detailed narrative of the analysis in regard to the each impact parameter of ZBNFis in order.

3.3.1 ZBNF practices to ensure regular income to Farmers

The case studies of farmers spread in the villages across the districts 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 techniques. They have also adopted the 5-layer model and 36*36 Models in growing crops in cultivating different varieties of crops to ensure steady and regular incomes. The farm households could generate additional income from the bund and border crops. The models of crops grown under ZBNF include: i)18 varieties of leafy vegetables and other vegetables through 5-layer model of cropping in mango orchard as intercrops. ii) Banana withinter-crops like chillies /benda/ vegetables /brinjal/ flowers/ colocasia (chama)/turmeric/ginger. iii)multi-season-based horticultural species with different types of leafy vegetables, curry leaves, along with different types of gourds in 36*36 models with 5-layer model, iv) Coffee plantation with dragon fruit, neem trees, orange, munaga, banana, spices, cherry, Jackfruit tress (*panasa*),tamarind trees, mango, and blue and black berry trees, (neredu) under the 5-layer model. v) 5-layer model of oranges with poly crops; 36*36 model with roots, tubers (radish and onion),*TeegaJathulu/*gourds varieties (cucumber, bitter gourd, country beans, ridge gourd, bottle gourd and snake gourd), curry leaves (sorrel leaves, spinach, sorrel leaves, fenugreek leave andamaranthus), leafy vegetables (brinjal, green chilli, tomato, ladies fingers, Indian beans(*chikkudukaya*) and cluster beans), red-gram and castor, drumstick and curry leaves (curry leaves),fruit bearing crops (guava, mango, papaya, pomegranate, clustered apple, coconut, sweet lime andcitrus) trap crops and flowers.

The existing coffee plantations in the hilly areas have been transformed into 5-layer model of growing crops. This experimentation of RySS has ensured continuous flow of income to the tribal farmers. Apart from rotation of crops, border and bund crops have also been raised by these farmers. This practice has ensured considerable income to meet the expense of raising main crops. This has resulted in intensive use of land throughout the year. The case studies clearly show that 5-layer model of growing crops which included fruits and vegetables has ensured continuous flow of income to the farmers. The existing small pieces of land has been put to use effectively by the farmers under different models of growing crops under ZBNF

which also ensured food security and balanced diet for everyone in the village. It is reported that there is increased vegetation in the village due toZBNF. Keeping in mind the agro-climatic conditions of the region the principle of 5-Layercropping pattern with a different combination of suitable crops for each layer isrecommended for cultivation under ZBNF.

3.3.3 Market channels of farmers to obtain higher prices for ZBNF crop outputs

Marketing is one of the constraints prominently reported by the farmers in the focussed group discussions in all the villages across all the districts. There are some farmers growing crops under ZBNF to meet family consumption. Some other farmers have also shared the ZBNF outputs to friends and relatives, apart from meeting their family consumption requirements. Some other farmers extended their consumers network beyond relatives and friends. Some of the employees of RySS and other consumers from nearby urban areas have procured these products from the fields of the farmers. Farmers have utilised the telephonic communication to book the orders from the consumers. Modern technologies have been utilised by educated farmers to establish market linkages. Rythu bazaars have been used by the farmers to sell their vegetables. Wholesale and retail marketing channels have been utilised by the farmers through their collective institutions. Marketing Melas have been used to reach out consumers in the big towns and cities. Relatives and friends of some of the farmers settled in abroad have been utilised to establish market linkages. But the farmers demanding to link with the Departments of Government These channels are fine to establish market linkages for the food grains. Interestingly the farmers have sold the processed crop outputs rather than the unprocessed outputs. This is due to the realisation that the farmers should also participate in post-production process to get larger share in the value chain. But these channels may not be useful for the commercial crops like cotton and chillies. The corporate sectors are in operation in Guntur to procure these chemical free products grown under ZBNF through local middlemen.

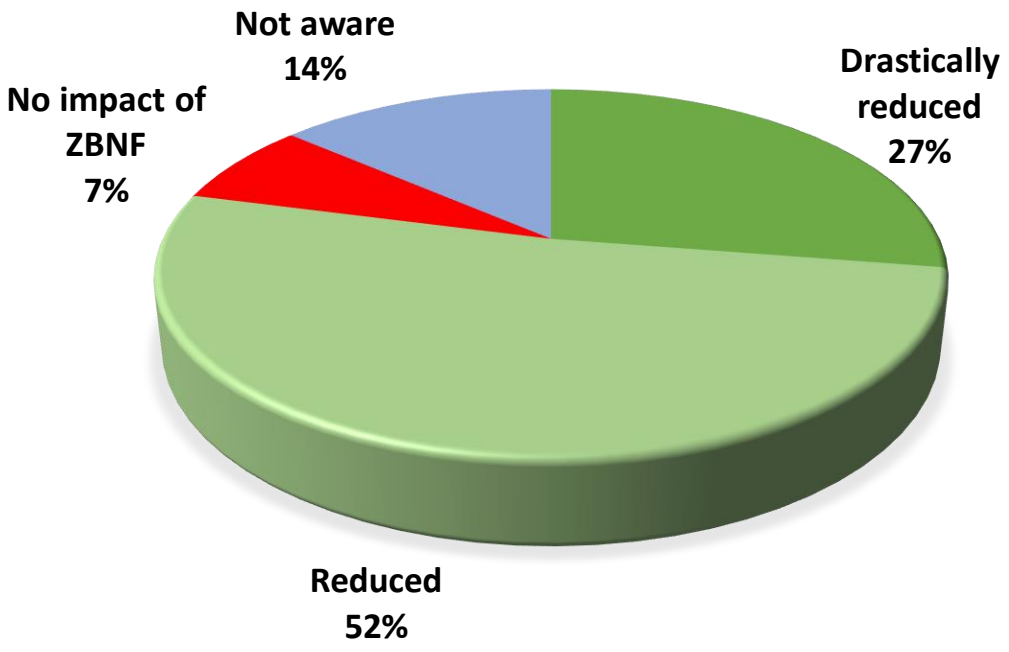
Farmers maintained links with local and external markets in Telangana and Andhra Pradesh to sell their produce. It is observed that supplying to external markets fetched them better prices compared to selling in local markets. For example, one farmer reported that *donda* vegetable fetched him Rs.20/- per kg in the local market but he could sell the same in Hyderabad at Rs.40-50per kg. The farmers faced a number of problems in marketing, including the difficulty in establishing the differentiation of ZBNF products from non-ZBNFproducts, which ultimately prevents them from claiming a higher price for ZBNF output. One farmer has suggested that certification of ZBNF farm produce is essential for informing the consumers that the produce ofZBNF is chemical-free. This will be helpful for the farmers in obtaining premium price for

ZBNFproduce. He has also suggested that the ZBNF farmers to be given ZBNF identity cards for sellingZBNF 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.

3.3.2 Constraints for spreading the use of ZBNF inputs

The case studies of farmers clearly show that the use of chemical fertilisers and pesticides infarming has come down to zero level. This is also evident from the household responses on the use of fertilizers in their villages indicating considerable reduction in the fertilizer use though vary from district to district (Figure 3.1 and Table 3.1).If we consider options of "reduced" and "Drastically reduced", 79% of the farmers perceived that the fertilizer consumption in their village reduced due to ZBNF. The use of Beejammurtham, Ghanajeevmrutham,Dravajeevamrutham, various *Kashayams* and Astrams has entered the input combinations of crop growing practices under ZBNF.The inputs of ZBNF are low cost and can be prepared locally by the farmers using the locally available ingredients like local cow dung, cow urine, leaves and other related material. Thus, dependency on the external markets for inputs has come down drastically as the farmers used locally available ingredients for preparing the inputs.

Fig 3.1. Farmers Perception on the Consumption of Fertilizer in their Village due to ZBNF



The focussed group discussions have revealed the following on the input preparation/accessing ZBNF inputs.

The dung, urine and dairy products of local cows as ingredients in the preparation of inputs of ZBNF are central to the ZBNF.Hence, availability of local cows is fundamental for 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 cows. This is due to procurement of local cows by some of the farmers and some others have obtained these ingredients from others. Further, some others have obtained these ingredients especially dung and urine from nearby *goshalas* maintained by Temple Authorities. Few farmers have procured local cows which are ready to be deported to slaughterhouses. Some of the districts like north coastal districts and both Godavari districts have tribal areas that have become suppliers of cow dung and cow urine to the farmers in other parts of the district. 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 the milk of cows for deriving income it is also reported by the farmers from the villages of dry land districts like Ananthapuramu that they sell away their cows due to lack of fodder. Hence these type of regions have faced in preparing ZBNF inputs.

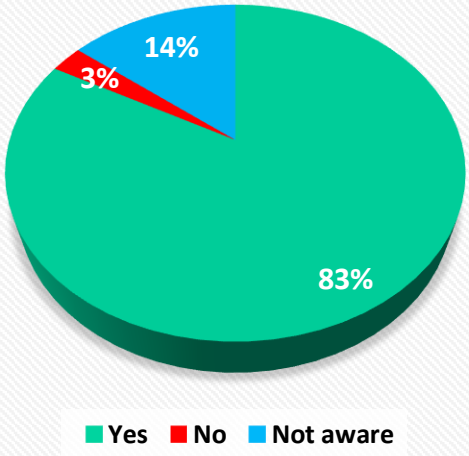
It is evident that the family labour use in the growing of crops under ZBNF has increased. This is due to investing more time on the preparation of inputs as well as other operations. Moreover preparation of inputs of ZBNF is time consuming process. It is also further clear that that the farmers have reported they have not adopted ZBNF due to lack family labour as well as hired labour. It is also revealed that hiring human labour for preparation of ZBNF inputs becomes costly because the input preparation may not require day long services and on the other hand they have to pay wages for the day. The farmer households who depend more on non-agricultural activities for their livelihoods look for labour for providing services in the preparation of ZBNF inputs because they get more wages for their labour in the non-agricultural activities and hence they don't want to spend their time on this. On the other hand, the medium and large farmers also look for labour to prepare ZBNF inputs. The implementation of MGNREGS has drawn the labour from the labour market. Hence there is scarcity of labour to prepare the ZBNF inputs. Moreover due to foul smell of ingredients of ZBNF inputs labourers have shown disinterest to offer their services for the preparation of ZBNF inputs. Hence farmers demanding readymade ZBNF inputs to overcome labour scarcity. They are also demanding that MGNREGS should be linked to ZBNF for facilitating the availability of labour.

The other constraints reported by the farmers include: the knowledge required to prepare *Kashayams* and Astrams to control pest is not imparted to many of the farmers; leaves required to prepare these inputs are not available in some villages and hence farmers are not able to prepare these inputs themselves; readymade ZBNF inputs are available in the markets; and NPM shops are not providing these inputs because they are not available in all the villages and or they are not functioning even though they are in existence in some of the villages.

3.3.4 Other Benefits Accrued to Farming and Farming Community

Health status of land, quality of crop output, resilience of crops to weather variability, empowerment of farmers and respectability towards agriculture are the dimensions considered for assessing the impact of ZBNF on the sustainability of agriculture. The analysis of impact of ZBNF on these parameters is in order. A large proportion of ZBNF practicing farmers have reported that the soil fertility has gone up due to ZBNF.This is true by and large across all the districts (Figure 3.2 and Table3.2).

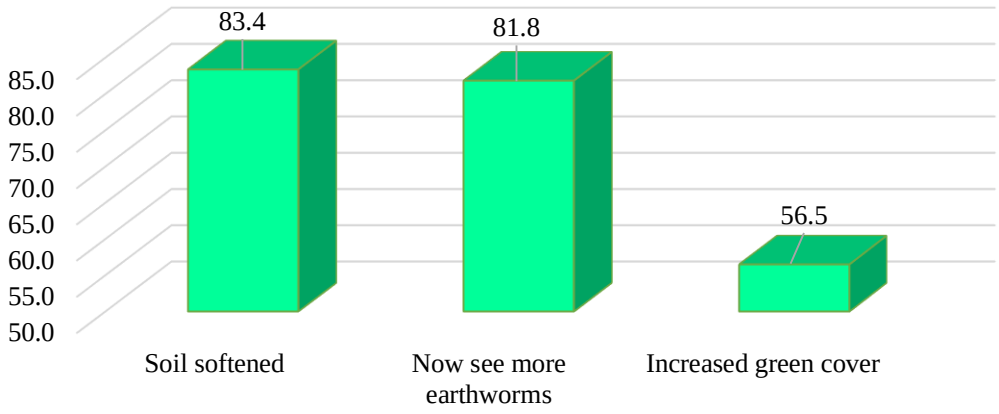
Figure 3.2 Farmers Reporting ZBNF practices enhanced quality of their land across Andhra Pradesh



The farmers have provided evidence through three parameters namely softening of soils, presence of earthworms, and increased green cover in the fields. It is also clear that the green cover is not as widely present as the other two dimensions of soil fertility. The districts of Rayalaseema region and two south coastal districts (Guntur and Prakasam) have lagged behind in regard to the presence of green cover in the fields of the farmers (Figure 3.3 and Table 3.3). 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. The quality of crop output has improved due to ZBNF (Table 3.4). 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 across the villages of the districts have reported the crop output of ZBNF is very tasty. Between the other two dimensions, higher proportion of farmers has reported that the plants of the crops have stronger stems. The three rainfed districts have performed better in regard to increase in grain weight as well as strength of stems. East Godavari and Prakasam were worse off in regard to both these parameters from South Coastal Andhra region. But in case of Rayalaseema districts, Ananthapuramu has turned out to better performing districts in regard to increase in grain weight as well strength of stems of the plants of the crops grown (Table 3.5).

Figure 3.3 % of Farmers reporting that ZBNF practices enhanced quality of land - Andhra Pradesh



As to the resilience of crops withstanding to dry spells and wind is concerned, 42 per cent of the farmers reported the crops grown under ZBNF have more resilience to withstand against dry spells and wind. The farmers from all the North Coastal Districts, two Rayalaseema Districts namely Ananthapuramu and Chittoor and only Krishna District from South Coastal Region(with reference to state average) have reported higher resilience of crops to weather variability (Table 3.6).

The prominent contribution ZBNF is to financial empowerment of the farmers. This is evident from the fact that farmers have depended for working capital required to grow crops, in the agricultural reference year, more on their savings accumulated through the cultivation of ZBNFin the previous years (Figure 3.4 and Table 3.7).The most significant contribution of ZBNF is making the people like agricultural profession. Thus the occupation status of agriculture has gone up due the ZBNF in the rural areas of the State of Andhra Pradesh (Table 3.8).

Figure 3.4 Distribution of Farmers According to Sources of Working Capital for the Agriculture Operations of ZBNF and Non-ZBNF

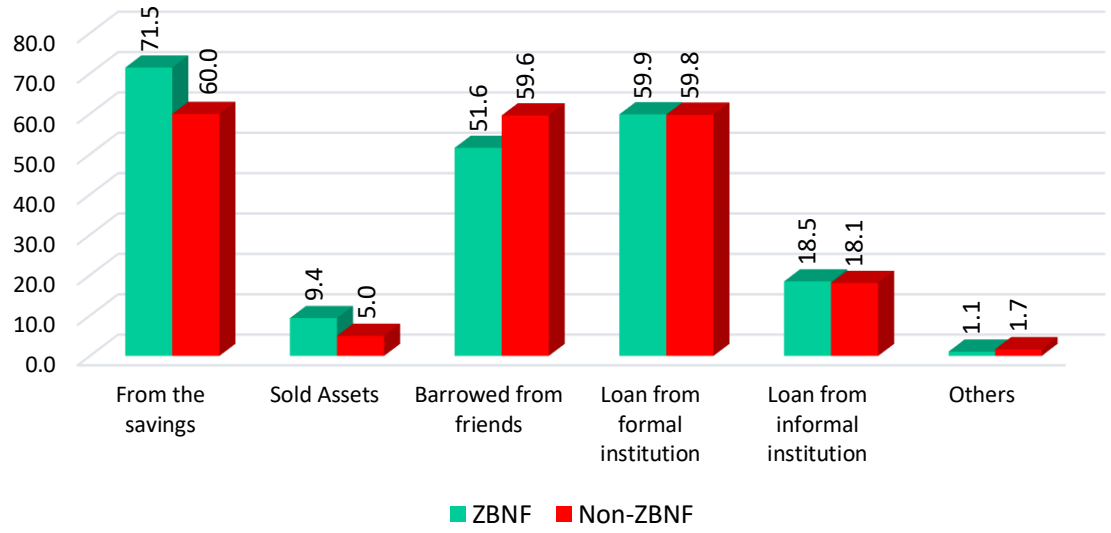


Table 3.1 Farmers Perception on the Consumption of Fertilizer in their Village due to ZBNF (%)

District	Drastically reduced	Reduced	No impact of ZBNF	Not aware
Srikakulam	72.0	20.0	0.0	8.0
Vizianagaram	23.7	38.1	11.3	26.8
Visakhapatnam	22.5	77.6	0.0	0.0
East Godavari	0.0	80.8	1.0	18.2
West Godavari	18.6	39.2	9.8	32.4
Krishna	0.0	94.0	0.0	6.0
Guntur	10.3	21.7	52.6	15.5
Prakasam	31.4	46.5	4.7	17.4
Nellore	1.0	81.0	2.0	16.0
Kadapa	25.3	69.7	5.1	0.0
Kurnool	89.0	1.0	1.0	9.0
Ananthapuramu	27.3	61.6	1.0	10.1
Chittoor	35.9	38.8	7.8	17.5
Andhra Pradesh	27.5	51.6	7.3	13.6

Source: Field survey

Table 3.2 ZBNF Farmers Reporting enhanced quality of their landdue to ZBNF (%)

District	Yes	No	Not aware
Srikakulam	85.9	1.0	13.1
Vizianagaram	85.6	10.3	4.1
Visakhapatnam	98.9	0.0	1.1
East Godavari	69.1	2.1	28.9
West Godavari	89.0	2.0	9.0
Krishna	83.3	1.0	15.6
Guntur	54.7	3.2	42.1
Prakasam	88.0	2.4	9.6
Nellore	73.2	2.1	24.7
Kadapa	94.6	0.0	5.4
Kurnool	87.0	2.0	11.0
Ananthapuramu	79.6	1.0	19.4
Chittoor	91.0	8.0	1.0
Andhra Pradesh	83.0	2.7	14.3

Source: Field survey

Table 3.3 District wise farmers reporting that ZBNF practices enhanced quality of land (%)

District	Soil softened	Now see more earthworms	Increased green cover
Srikakulam	98.85	97.70	89.66
Vizianagaram	100.00	97.87	94.68
Visakhapatnam	97.98	91.92	78.79
East Godavari	100.00	18.84	60.87
West Godavari	54.95	80.22	65.93
Krishna	84.71	97.65	75.29
Guntur	53.85	80.77	51.92
Prakasam	55.84	79.22	12.99
Nellore	94.87	67.95	56.41
Kadapa	87.37	89.47	16.84
Kurnool	59.55	93.26	56.18
Ananthapuramu	97.59	69.88	36.14
Chittoor	86.27	80.39	33.33
Andhra Pradesh	83.38	81.83	56.49

Source: Field survey

Table3.4 District wise farmers reporting the quality of ZBNF Cropsand Output compared to Non-ZBNFCrop (%)

District	Grain weight increased	Stronger Stems
Srikakulam	59.00	90.00
Vizianagaram	79.38	83.51
Visakhapatnam	62.89	61.86
East Godavari	29.17	21.88
West Godavari	54.90	73.53
Krishna	37.00	84.00
Guntur	10.71	42.86
Prakasam	9.30	12.79
Nellore	49.00	62.00
Kadapa	66.67	53.54
Kurnool	55.10	44.90
Ananthapuramu	88.24	85.29
Chittoor	78.64	58.25
Andhra Pradesh	53.40	60.44

Source: Field survey

Table 3.5 Farmers reporting their Experience on the Taste of Crop Output of food crops Produced under ZBNF compared to non-ZBNFcrops across the districts (%)

District	Not aware of any difference	ZBNF product is more tasty	Non-ZBNFproduct is more tasty	Unable to judge the difference
Srikakulam	6.0	90.0	1.0	3.0
Vizianagaram	13.4	70.1	7.2	9.3
Visakhapatnam	2.0	95.0	2.0	1.0
East Godavari	6.1	83.8	0.0	10.1
West Godavari	11.8	78.4	2.0	7.8
Krishna	2.0	95.0	0.0	3.0
Guntur	10.3	49.5	1.0	39.2
Prakasam	5.8	88.4	4.7	1.2
Nellore	11.0	77.0	1.0	11.0
Kadapa	6.1	88.9	1.0	4.0
Kurnool	4.0	77.8	0.0	18.2
Ananthapuramu	25.2	71.8	1.9	1.0
Chittoor	1.9	97.1	0.0	1.0
Andhra Pradesh	8.2	81.8	1.6	8.4

Source: Field survey

Table 3.6 District wise Distribution of Farmers Reporting Resilience of the Crops to Weather Variability with the ZBNF crops compared to non-ZBNFcrops (%)

District	More resistance towards dry spells and or wind
Srikakulam	61.00
Vizianagaram	79.38
Visakhapatnam	62.89
East Godavari	28.13
West Godavari	10.78
Krishna	54.00
Guntur	40.48
Prakasam	24.42
Nellore	16.00
Kadapa	40.40
Kurnool	14.29
Ananthapuramu	50.00
Chittoor	64.08
Andhra Pradesh	42.17

Source: Field survey

Table 3.7Distribution of Farmers According to Sources of Working Capital for the Agriculture Operations of ZBNF and Non-ZBNF(%)

Sources of Working Capital	ZBNF	Non-ZBNF
From the savings	71.45	59.96
Sold Assets	9.37	4.98
Barrowed from friends	51.56	59.59
Loan from formal institution	59.86	59.78
Loan from informal institution	18.47	18.08
Others	1.07	1.66

Source: Field survey

Table 3.8 Status of agriculture in the rural Areas

District	% of farmers like farming after adoption of ZBNF
Srikakulam	96.0
Vizianagaram	92.8
Visakhapatnam	100.0
East Godavari	99.0
West Godavari	99.0
Krishna	95.0
Guntur	72.2
Prakasam	100.0
Nellore	98.0
Kadapa	94.9
Kurnool	95.0
Ananthapuramu	98.1
Chittoor	74.8
Andhra Pradesh	93.4

Source: Field survey

CHAPTER 4

Summary, Conclusions and Policy Implications

4.1 Context

The Government of Andhra Pradesh has introduced ZeroBudget Natural Farming (ZBNF) in 2016 as an alternative to chemical-based and capital intensive agriculture, through its implementing agency Rythu Sadhikara Samstha (RySS).The ZBNF is a paradigm shift in agricultural development. The main objective of the ZBNF is to make agriculture economically viable, agrarian livelihoods profitable thereby reduce agrarian distress through cost reduction and sustainable agricultural practices that are climate-resilient. ZBNF aims to reduce cost of cultivation, enhance soil fertility, enhance yields, reduce risks, and protect from uncertainties of climate change by promoting the adoption of an agro-ecology framework. Extension support is led by farmers (including women) through a process of farmer-to-farmer learning. The programme aims to reach all farmers in the state – 6million farmers, including tenants - and stay engaged with them to achieve a 100% chemical-free agriculture by 2024. ZBNF also aims to create the human and social capital necessary for vibrant and inclusive agricultural production. It has passed through three agricultural years of implementation since its inception. RySS thought it is the time to assess the impact of the ZBNF on farming and farming community. Hence the present study is sponsored to assess the impact and to suggest policy inputs to bring improvements in the implementation of ZBNF, if any, required.

4.2. Research Questions

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

1. What is the impact of ZBNF on the levels and composition of input usefor crops grown?
2. How far the input use of ZBNF has contributed to the cost of production of crops?
3. How far the ZBNF inputs have impacted yield of crops?
4. What is the impact of ZBNF on incomes of farmers?
5. How far the ZBNF practices like intercropping, rising of border and bund crops have contributed to farmers' incomes?
6. What are the benefits accrued to farming and farmers beyond costs and returns?
7. What are the policy implications emerging from the analysis for realising the potential benefits of ZBNF?

4.3. The Methodology

The detailed narration of methodology for assessing the impact of ZBNF is in order.

4.3.1 The Basic Approach

In order to assess the impact of ZBNF, a comparison has been made between ZBNF farmers and non-ZBNFfarmers in regard to input use, cost of cultivation, yield of crops, net income to farmers and other impact domains. This evaluation methodology is based on what is known as "with and without" approach. The study has deployed both quantitative and qualitative methods. Listing Survey and Household Survey have been conducted to collect quantitative data from the households. Focussed group discussions and case studies with farmers, and strategic interviews with District Project Managers have been conducted to obtain qualitative data as well.

4.3.2 Parameters considered for assessing impact of ZBNF

ZBNF is expected to have a major impact on farming system and farming community, thanks to its potential in promoting sustainable agricultural livelihoods without degrading natural resources and environment. The inputs of ZBNF like *Beejammurtham, Ghanajeevmrutham, Dravajeevamrutham,* different*Kashayams* and *Asthrams* prepared with locally available resources can reduce the costs of production of crops as well as improve the health status of soil and crops grown. This is the strategy for improving farm income by stabilizing and increasing crop yields and reducing cost of cultivation and out-of-pocket expenses. Besides, this is likely to enhance farm income by using land continuously but sustainably throughout the agricultural year, raising crops on farm bunds and border areas of cropped area both for protecting main crops from pest attacks as well as for generating a continuous flow of income throughout the agricultural year.

In this backdrop, the parameters considered for assessing the impact of ZBNF include: cost of inputs per hectare (biological inputs in case of ZBNF and chemical inputs for non-ZBNF), percentage of cost of inputs in the total cost of production per hectare, cost of production per hectare, yield in quintals per hectare, net income per hectare accrued to farmers, income to farmers from intercropping, border and bund crops. The data on yield of crops were collected from farmers as well as through Crop Cutting Experiments (CCEs)

The other parameter considered for assessing the impact of ZBNF on farming include: health status of land, quality of crop output, resilience of crops to weather variability, financial empowerment of farmers and respectability towards agriculture. Softening of soils, presence of earthworms and green cover in the fields are considered to measure soil health. Weight of the

grains, strength of stems and taste are measured to characterise quality of output. Resilience of crops withstanding to dry spells and wind is used to assess the resilience of crops to weather variability. The prominent contribution ZBNF is to financial empowerment of the farmers. This is measured through dependency for working capital required to grow crops in the agricultural reference year, more on their savings accumulated through the cultivation of ZBNF in the previous years. Respectability towards agricultural occupation is assessed in terms of liking agricultural occupation due to ZBNF.

4.3.3 Sample Design

The study has covered all the districts of Andhra Pradesh. It is conducted in the villages where there are at least 10 seed to seed farmers of ZBNF and where the farmers have grown at least one major crop of the district. Ten villages from each district are randomly selected. Thus 130 villages in total are selected from the state. A Listing Survey has been conducted to cover all the households in the village to generate a sample framework for selecting the farmers for household survey. Stratified random sampling method is adopted to select the farmers belonging to pure tenant farmers, marginal farmers, and small farmers and other farmers (semi-medium, medium and large farmers) from the sample frame generated from the Listing Survey conducted in all the sample villages. Ten ZBNF farmers randomly selected from each category of farmers. Similarly, ten non-ZBNFfarmers from each village are selected randomly. Thus 1300 ZBNF farmers and 1300 non-ZBNFfarmers, in total 2600 farmers, are selected for Kharif season.

4.3.4 Data Base

A detailed household questionnaire has been administrated across all the sample farmer households to collect the data on the impact parameters mentioned above. Qualitative data has been collected through case studies of farmers, focussed group discussions with farmers and strategic interviews with the District Project Managers (DPMs). This data enabled to examine the research questions like interventions made under ZBNF to ensure continuous flow of income throughout agricultural year to the farming community, market channels opted by the farmers to get higher prices for ZBNF crop outputs, and constraints encountered by farmers in using ZBNF inputs for crops.

4.4. Major Finding

The major findings of the analysis are in order.

Costs and Returns of crops and ZBNF

The cost of biological inputs of ZBNF is lower than that of chemical inputs per hectare across all the crops, viz., Paddy, Maize, Groundnut, Cotton, Tomato and Bengal gram. The share of cost of

these inputs is lower than of chemical inputs in the total cost per hectare across all the crops. Moreover, the cost of cultivation per hectare is lower for ZBNF over non-ZBNFfor all the crops. It is striking to note that the yield response to biological inputs is higher than to the chemical inputs. The traditional argument against the alternative agricultural models to chemical based agriculture is that the yield of crops under the alternate models is lower than those under chemical. But the experience of ZBNF is contrary to this hypothesis. As a matter of fact there are no significant differences between the yields of ZBNF and non-ZBNFacross all the crops. Hence there would not be any threat of food insecurity from ZBNF to the society at large. The higher yields for lower levels of use of ZBNF inputs have brought down considerable reduction in the cost of production per quintal of output across all the crops. This has resulted in higher incomes to farmers from crops. Inter crops, border and bund crops have also contributed to the improvement in the incomes of ZBNF farmers. The shift to 5-layer models of growing crops under ZBNF has ensured continuous flow of incomes to farmers throughout the agricultural year. This model even on small piece of land holding has provided food security to households. However, there are variation in regard to the performance parameters of ZBNF across geographical regions and crops. The performance of paddy in delta district is not impressive over that in the non-delta districts. But the yields of paddy under ZBNF has increased overtime, this is evident from the data analysed. The high value crops grown like Cotton and Tomato under non-flood irrigation practices have performed extremely well. The analysis has shown that the farmers have used biological inputs independent of their required levels across the districts.

Beyond Costs and Returns of crops

There are benefits beyond costs and returns of crops those accrued to the farmers and farming community. They are in order. A large proportion of ZBNF practicing farmers have reported that the soil fertility has gone up due to ZBNF.This true by and large across all the districts. Farmers have provided evidence through three parameters namely softening of soils, presence of earthworms, and increased green cover in the fields. It is also clear that the green cover is not as widely present as the other two dimensions of soil fertility. Further, farmers have considered three dimensions to reflect the quality of output. They include weight of the grains, strength of stems and taste of output. Among these dimensions, larger proportions of farmers across the villages of the districts have reported that the crop output of ZBNF is very tasty. Between the other two dimensions, higher proportion of farmers have reported that the plants of the crops have stronger stems. As to the resilience of crops withstanding to dry spells and wind is concerned, 42 per cent of the farmers have reported that the crops grown under ZBNF have

more resilience to withstand against dry spells and wind. The prominent contribution ZBNF is to financial empowerment of the farmers. This is evident from the fact that farmers have depended for working capital required to grow crops, in the agricultural reference year, more on their savings accumulated through the cultivation of ZBNF in the previous years. The most significant contribution of ZBNF is making the people like agricultural profession. Thus the occupation status of agriculture has gone up due to the ZBNF in the rural areas of the State of Andhra Pradesh.

Policy Implications

Broadly there are three major challenges (3Cs) those need to be addressed .They are as below:

- Apart from scarcity of local cows and scarcity of human labour, the other constraints reported by the farmers in regard to ZBNF inputs include: the knowledge required to prepare *Kashayams* and *Asthrams* to control pest is not imparted to many of the farmers; leaves required to prepare these inputs are not available in some villages and hence farmers are not able to prepare these inputs themselves; readymade ZBNF inputs are not available in the markets; and NPM shops are not providing these inputs because they are not available in all the villages and or they are not functioning even though they are in existence in some of the villages. The spread of the use of ZBNF inputs is a greater challenge under these constraints.

- The case studies clearly reveal that the farmers can increase their incomes further if proper marketing support is provided by the RySS. Household survey has clearly show that farmers constrained mainly due to lack proper marketing support.

- The principle of 5-Layercropping pattern with a different combination of suitable crops for each layer is recommended for cultivation under ZBNFkeeping in mind the agro climatic conditions of the regions to ensure regular flow of income throughout the agricultural year. The replication of these models on wider scale wherever suitable across the farmers needs government support.

- The promotion of farmers' collectives of male and female can play a greater role in addressing the three challenges (3Cs) in more effective way to realise the potential benefits of ZBNF. This collectives can effectively negotiate with the staff of RySS at village, mandal and district levels as well as with the marketing channels to market their ZBNF products.