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

A comprehensive Approach using Crop Cutting Experiments

S. Galab
P. Prudhvikar Reddy
D. Sree Rama Raju
C. Ravi
A. Rajani

Centre for Economic and Social Studies
Nizamiah Observatory Campus
Begumpet, Hyderabad- 500 016
Telangana, India
Tel:040-23402789, Fax: 040-23406808
E-mail: postmaster@cess.ac.in, Website: www.cess.ac.in
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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 agriculture. The ZBNF is a paradigm shift in agricultural development. The main objective of the ZBNF is to make agriculture economically viable, agrarian livelihoods profitable and climate-resilient. ZBNF aims to reduce cost of cultivation, enhance yields, increase incomes, reduce risks, and protect from uncertainties of climate change by promoting the adoption of an agro-ecology framework. In this context, the Government of Andhra Pradesh through Rytu Sadhikara Samasta (RySS) has proposed a study to assess the impact of ZBNF on farming and farming community.

In this backdrop, the present study is undertaken to examine the impact of agro ecological practices such as biological inputs of ZBNF in growing crops on the production conditions of farmers; and assess the contribution of the agro ecological practices like intensive use of land and diversification of crops in terms of raising mixed crops, intercrops, 5-Layer models, boarder crops and bund crops with biological inputs, mulching and Waaphasa of ZBNF, in improving soil fertility and thereby to improve yield of crops, resilience of crops, quality of crop outputs and health of farming community.

2. The Approach

The study has adopted quantitative as well as qualitative approaches to assess the impact of ZBNF on farming and farming community. The integration of these approaches enables to capture comprehensively the impact of ZBNF. Listing Survey, household survey and village survey have been conducted to collect quantitative data. Case Studies of ZBNF farmers, Focussed Group Discussions with the farmers of ZBNF and Non-ZBNF, and Strategic interviews with the District Project Managers (DPMs) who implement ZBNF have been utilised to collect qualitative data.

Listing survey instrument has been administered for all the households in the sample villages to collect information on the adoption/non-adoption of ZBNF practices, crops grown under ZBNF and Non-ZBNF, size of landholding and source of irrigation to generate universe of ZBNF and Non-ZBNF farmers for drawing sample of ZBNF and Non-ZBNF farmers for assessing the impact of ZBNF. The study has adopted **"*With and Without* Approach"** to assess the impact of ZBNF. The approach makes a comparison between the ZBNF farmers (farmers who have adopted all the ZBNF practices-seed 2seed farmers) and Non-ZBNF

farmers (farmers who have not adopted ZBNF practices at all) in regard to all the impact domains to capture the contribution of ZBNF. Household schedule has been administered across the sample farmers of both ZBNF and Non-ZBNF to collect information on land use pattern, cropping pattern, patter of input use, cost of inputs, yields of crops and net incomes to farmers from crops to formulate impact indicators.

The ZBNF farmers have used Beejaamrutham, Ghanajeevamrutham, Dravajeevamrutham to activate microbes to enable the soil to utilise the nutrients available (bio available) in the soil itself for the healthy growth of crops and Kashayams/Asthrams to protect crops from pest and insects. These are biological-inputs. The Non-ZBNF farmers, in contrast, use chemical fertiliser to provide nutrients for the soil to contribute to the growth of crops and chemical pesticides/insecticides to control pests and insects. These are all chemical inputs. The biological inputs have been prepared from the ingredients available in the villages like leaves, uncontaminated soil, dung, urine of local cows and dairy products in the villages which are very cheap compared to chemical inputs those are obtained from external markets at higher costs. Hence, there may be remarkable reductions in the cost of growing crops under ZBNF in relation to those under Non-ZBNF. These biological inputs are expected to improve yields. Reduction in the cost of growing crops, even with the yields under ZBNF on par with those under Non-ZBNF can increase net incomes of farmers from crops considerably.

In this backdrop, the cost of biological inputs in relation to the chemical inputs per hectare, the share of biological inputs corresponding to the chemical inputs in the paid out costs per hectare for growing crops, the paid out costs per hectare of crops under ZBNF relative to that under Non-ZBNF, yields of crops under ZBNF proportionate to those under Non-ZBNF, and net incomes of crops under ZBNF in relation to those under Non-ZBNF are the five indicators formulated to assess the impact of agro ecological practices like biological inputs under ZBNF on the production conditions of farmers. The use of biological inputs may reduce the dependency of farmers on external inputs. The reduction in the cost of cultivation, due to ZBNF, may lead to reduction in the requirement of working capital for the farmers in growing crops. This in turn may reduce dependency of farmers on credit markets. The rise in the incomes enables farmers to free from debt trap.

The reduction in the cost of growing crops may enable farmers to withstand against the falling prices of crop outputs, since the falling prices cannot push the farmers in to debt trap under ZBNF against the situation of falling prices with raising costs for growing crops under Non-ZBNF. Thus ZBNF may improve the relative autonomy of farmers from external input

markets, credit markets, output market risks and debt trap. The qualitative data has been complemented to the quantitative data collected from farmer households in conducting this analysis.

Along with these, there are other agro-ecological practices like diversification and intensification activities in growing crops to improve soil fertility. Diversification of crops and intensive use of land in terms of raising mixed crops, intercrops, 5-Layer models, border crops and bund crops with biological inputs, mulching and Waaphasa of ZBNF improve water holding capacity of soils, enhance efficient utilisation of water and increase soil fertility. The soil fertility ultimately may result in improvement in the yields, quality of crop output and resilience against weather variability. Against this backdrop, information has been collected from the farmers through household schedule on these dimensions of impact of ZBNF.

A narrative on the agro-ecological practices adopted by the ZBNF farmers using quantitative data collected from the farmer households and through the qualitative data collected from the Focussed Group Discussions with farmers, Case Studies of Farmers and Strategic Interviews with the DPMs. This analysis is conducted using the prevalence of these practices such as biological input use, crop growing methods like mixed cropping, bund cropping, and border cropping, five-layer models and other models of growing crops among farmers. The soil fertility has been captured through the farmers' perceptions.

Farmers' have provided indication of increase in soil fertility through three indicators such as softening of soils, presence of earthworms in the field and increased green cover. These are all proxies for assessing soil fertility. There is a need to assess this through scientific studies.

The impact of soil fertility has been assessed through improvements in the yields of crops, resilience of crops in withstanding against weather variability, quality of crop outputs, and human health. All these factors together reflect the contribution of agro-ecological practices of ZBNF in providing ecological services for sustainable agriculture. The farmers have considered three dimensions to reflect on the quality of output. They include weight of the grains, strength of stems and taste.

The impact of ZBNF practices on the health of the farming community in production and consumption of ZBNF crops has been captured. All these indicators have been formulated on the basis of soft data. It should be noted that the reduction in expenditure on health improves disposable income of farmers. The income from mixed crops, border crops and bund crops,

and 5-layer models ensures continuous flow of incomes throughout the agricultural year to farmers.

The study has been conducted in two agricultural seasons - Kharif and Rabi of the agricultural year of 2018-19. The sample villages selected for conducting study in Kharif season are totally different from those villages in which the study conducted in Rabi season. This has been planned to capture adequate sample of farmers in Rabi season. The study has been conducted in all the 13 districts of the state in Kharif as well as in Rabi Seasons to capture different agro-climatic conditions across the states. In Kharif, a sample of 10 villages have been selected randomly from the villages that have grown at least one principal crop out of three of the district and also have at least 10 ZBNF seed to seed (S2S) farmers. A listing survey of all the households in the sample villages has been conducted to generate population of ZBNF farmers and Non-ZBNF farmers to draw the sample. A sample of 10 ZBNF and 10 Non-ZBNF farmers has been selected randomly from the respective groups of farmers. Thus a sample of 100 ZBNF and 100 Non-ZBNF farmers are selected randomly from each of the district. In total, a sample of 1300 ZBNF farmers and another sample of 1300 Non-ZBNF have been selected randomly from the state. This is the sample design formulated to conduct survey in Kharif season.

The same scheme of sample design has been followed for the Rabi Study. But the Rabi Study confined to half of the sample size of Kharif Season. Thus a sample of 650 ZBNF farmers and a sample of 650 Non-ZBNF in total 1300 farmers were considered. This is due to the fact that the crops in Rabi season are grown by limited number of farmers. Qualitative data has been collected from 65 Focussed Group Discussions and 65 Case Studies at the rate of 5 from each district and 13 strategic interviews at the rate of one from each district.

It should be noted here that the input use, cost of growing crops, and reported yields of the crops by the farmers were used to assess the impact of ZBNF on cost and returns of crops and crop incomes accrued to the farmers. Crop cutting experiments (CCEs) were used to assess and compare the yields of crops grown under ZBNF and Non-ZBNF. The number of CCEs was less in Kharif season due to the late start of Kharif survey. However, the required number of CCEs was covered in Rabi survey. Comparison of different impact parameters was made between ZBNF and Non-ZBNF farmers in regard to the same crop for the crop analysis. Randomisation has been followed at every stage of the selection of sample units. This helps to provide reliable estimates of the impact parameters.

The estimates of the parameters are provided only at the state level. It should be noted that the sample of farmers has contained three categories of farmers, viz., ZBNF farmers (farmers who have adopted all the ZBNF practices - pure ZBNF); Non-ZBNF farmers (Farmers who have adopted none of the ZBNF practices - pure Non-ZBNF); and farmers who have raised the same crops under ZBNF as well as Non-ZBNF, adopting some of the ZBNF practices on the Non-ZBNF crops. Hence, the third category of farmers has experienced contamination. It was decided to take out this category of farmers from the analysis and as a result the sample size was shrunk for the analysis. It is also thought over to assess the ZBNF positive externalities effect on the impact of ZBNF. But appropriate counterfactual of Non-ZBNF crops were not available to net out the impact of ZBNF on the contaminated Non-ZBNF crop of the third category of farmers. Hence, the analysis has been carried out with Pure ZBNF and Pure Non-ZBNF farmers for assessing the impact of ZBNF.

3. The Findings

The major findings of the study are grouped into three broad categories. They include: impact of agro-biological practices like use of biological inputs on production conditions of farmers; impact of agro-ecological practices like diversification of crops and intensive land use practices combined with biological input, mulching and Waaphasa on soil fertility; impact of soil fertility on yields of crops, quality of crop outputs, resilience of crops to weather variability; and health of farming community. The details of the findings are in order.

3.1 Impact of use of Biological Inputs of ZBNF on the Production Conditions of Farmers (see Table 1)

3.1.1Biological Inputs and Dependency on External Input Market

- The cost of biological inputs (Beejaamrutham, Ghanajeevamrutham, Dravajeevamrutham and Kashayams/ Asthrams) of ZBNF per hectare is lower than that of chemical inputs (fertiliser plus pesticides) of non-ZBNF across all the crops grown in Kharif as well as in Rabi seasons. It is remarkably lower than that of chemical inputs in the Rabi crops over the Kharif crops.

- The extent of reduction (in terms of percentage) in the cost of biological inputs in relation to that of chemical inputs has varied across crops.

- It has ranged from 24 per cent for maize to 70 per cent for tomato in Kharif season, while it has varied between 15 per cent for sugarcane to 89 per cent for maize in Rabi Season.

- The crops grown under different irrigation and unirrigated conditions have experienced considerable reduction in input costs due to the use of biological inputs of ZBNF in both the seasons.
- The impact of cost of biological inputs on the cost structure of the crops has been examined to assess its contribution to the reduction in the paid out cost in growing crops.
- The share of cost of biological inputs in the paid out cost of ZBNF crops is found to be invariably lower than that of chemical inputs in the paid out cost of Non-ZBNF. This is evident in the case of all the crops grown in Kharif as well as in Rabi.
- The reduction in the cost of inputs per hectare and the share in the paid out costs per hectare of crops due to the use of biological inputs of ZBNF imply that the dependency of farmers on external inputs has declined. The discussions with the farmers through Focussed Group Discussions and Case Studies of farmers have also reinforced this.

3.1.2 Biological Inputs and Dependency on Credit Markets

- The patterns of input use of the crops analysed above should reflect in the cost of production of crops. The paid cost of cultivation per hectare found to be lower across all the crops under ZBNF compared to the same crops and other crops specific to Kharif and Rabi Seasons under Non-ZBNF, though the quantum and percentage of reduction varied across crops.
- The reduction in the cost of growing crops has implication for the mobilisation of working capital for raising crops. The working capital required for raising crops under ZBNF in relation to that required under Non-ZBNF has come down substantially. This means that the dependency of farmers on credit markets has come down to that extent. Thus the farmers have gained relative autonomy from credit markets.

3.1.3 Cost of Biological inputs, Crop Incomes and Indebtedness of Farmers

- The reduction in the cost of cultivation per hectare under ZBNF over non-ZBNF should results in the raise in net income of the ZBNF across all crops. It is evident from the data that the net income per hectare to farmers is higher from ZBNF over Non-ZBNF for all the crops in Kharif as well as Rabi seasons.

- It is noticeable that the increase in net incomes is higher in Rabi over Kharif across all the crops. The increase in net incomes is substantial among the crops grown under dry and irrigated dry conditions (like pulses and high value crops) than those grown under flood irrigation (like Paddy and Sugarcane).

- 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, the more number of ZBNF farmers adopted mixed cropping; border cropping and bund cropping compared to non-ZBNF and earned more income from these crops compared to non-ZBNF farmers.

- The case studies of farmers have revealed that the farmers could have derived more income under ZBNF, had there been proper marketing support in place. These case studies clearly provide evidence that the farmers can increase their incomes further if proper marketing support is provided by the RySS.

- The increased incomes of the farmers enabled them to depend more on their savings accumulated through the cultivation of ZBNF in the previous years for meeting the working capital required to grow crops in the agricultural reference year in Kharif season. Similarly in Rabi, 78.4 per cent of farmers have practiced ZBNF method have managed their working capital through their savings as against 60 percent of the non-ZBNF farmers. Farmers are also free from indebtedness.

3.2 Impact of Agro-ecological Practices of ZBNF on Soil Fertility (see Table2)

- It is clear from the Case Studies of Farmers and the Strategic Interviews with the District project Managers that the farmers have cultivated land intensively (changes in land use pattern) and changes in cropping pattern through adopting different crop growing models of diversified cropping patterns like mixed cropping, inter cropping, border cropping, and bund cropping, 5-Layer Model and 36*36 Models. These agro-ecological practices combined with other practices like biological inputs, mulching and whapsa have enabled the soils to utilise the nutrition available in the soil (bio available).This has ultimately resulted in the improvement of soil fertility.

- The farmers have provided evidence through three parameters - softening of soils, presence of earthworms, and increased green cover in the fields. Some other farmers

reported that the gestation period required to start yielding of orange garden has declined considerably under ZBNF compared to the gardens grown under Non-ZBNF practices. It is also reported by farmers that the shelf life of vegetable crops has gone due to ZBNF agro-ecological practices.

3.3 Impact of Increased Soil Fertility (see Tables 3 and 4)

- The farmers have reported that the improvement in soil fertility has contributed to increase in yields of crops, enhancement in quality of crop outputs, increased resilience of crops against weather variability and improvements in human health.
- The test of significance between the yields of the crops grown under ZBNF and Non-ZBNF indicates that there is no significant difference in the yields obtained through CCEs between ZBNF and Non-ZBNF.
- As a matter of fact, the yields of crops such as maize, Sesamum, Sugarcane and Sunflower under ZBNF are significantly higher than those under non-ZBNF. But, the yield of Paddy crop is higher under non-ZBNF over ZBNF. This is due to lower yields of paddy of ZBNF under flood irrigation conditions in delta districts.
- The farmers have reported in Kharif as well as in Rabi seasons that the quality of crop output has improved due to ZBNF. The 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 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 and the weight of grains has increased
- As to the resilience of crops in withstanding to dry spells and wind is concerned, the farmers reported that the crops grown under ZBNF have more resilience to withstand against dry spells and wind.
- It has been reported by farmers in the FGDs that the incidence of occurrence of seasonal pests to the crops also declined due to ZBNF. The farmers are saved from the exorbitant costs of chemical pesticides and are also protected from the health hazards caused due to the use of chemical pesticides. They reported ‘reduced health costs of the family members’ as they are saved by not inhaling the powerful chemical pesticides stored in the

houses or when sprayed in the fields. This has improved the disposable income of households.

3.4 Adoption of ZBNF Practices (see Figures 0.1 and 0.2)

- The above findings have provided the multiple benefits accrued to farming and farming community due to ZBNF. These benefits should encourage farmers to adopt ZBNF practices. This should reflect in the adoption of ZBNF practices.

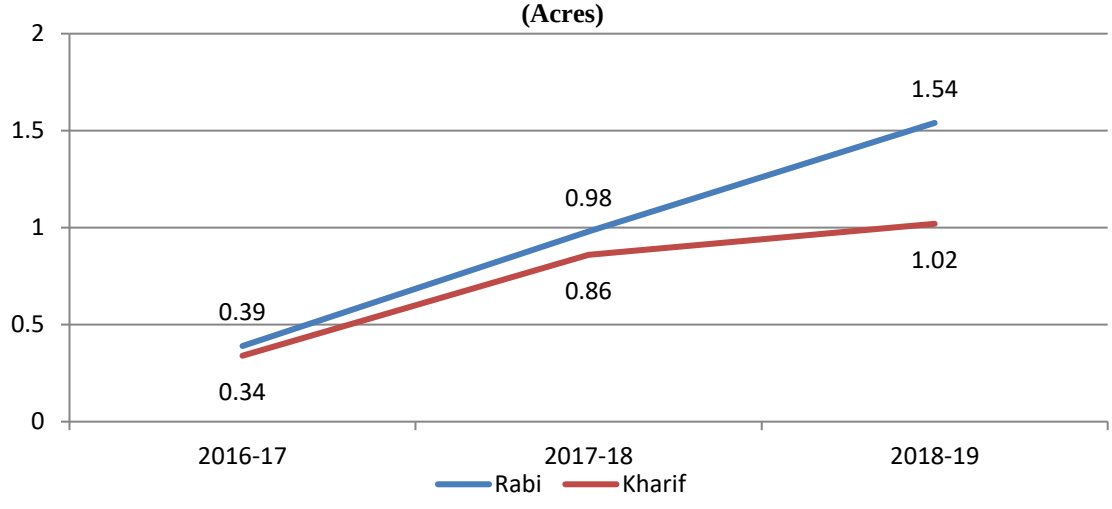
- The adoption of ZBNF can be measured through two indicators - percentage of farmers adopted ZBNF among the farmers over years; and percentage of area brought under ZBNF practices over years. The second parameter has been considered to assess the adoption of ZBNF.

- The cropped area under ZBNF per farmer has increased in Kharif as well as Rabi Season between agricultural years of 2016-17 and 2018-19. Similarly the percentage of area under ZBNF in the total cropped area of the farmers has also increased.

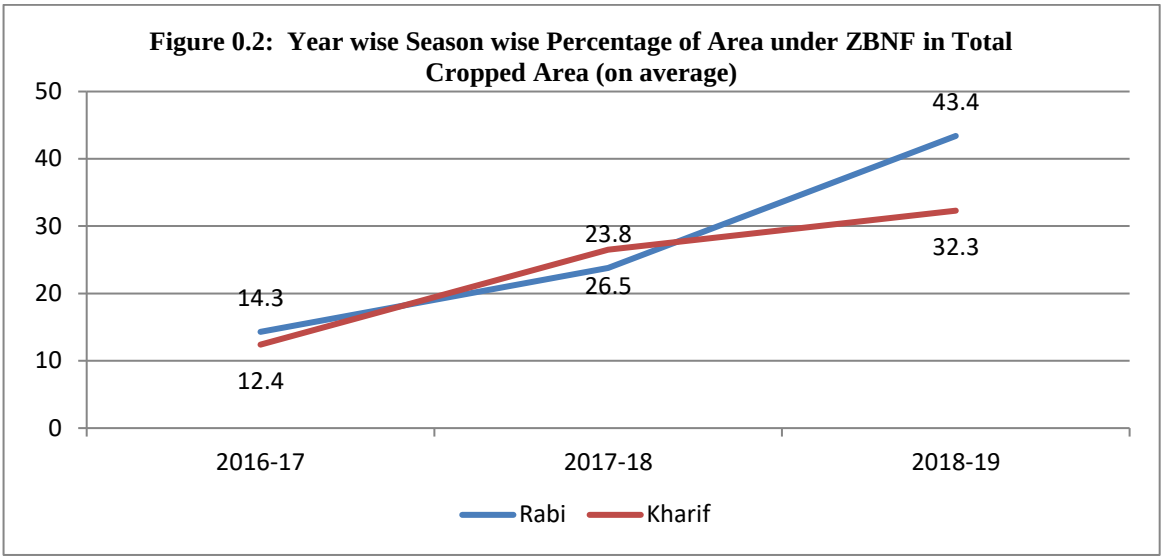
- This provides substantial evidence to the fact that farmers have responded to adopt ZBNF looking at the multiple benefits flowing from it. This has happened in Kharif and Rabi Seasons. But the response is higher in Rabi over Kharif.

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

Figure 0.1: Year-wise Season-wise Per Farmer Average Area under ZBNF (Acres)



Source: Field Survey



Source: Field Survey

3.5 Major Highlights of the Study

- Unlocking of nutrients available in the soil through agroecological practices of ZBNF contributed to the growth of crops/plants on par with that of crops/plants of non-ZBNF that supplied nutrients to soil through external chemical inputs.
- The intensive use of crop land with diversified cropping practices under ZBNF along with the other agroecological practices like application of biological inputs, mulching and whapassa has contributed to the improvements in fertility of soils.
- The increased soil fertility due to agroecological practices under ZBNF has contributed to ecological services like improvements in quality of crop outputs and resilience of crops to weather variability
- The pattern of changes in input use, due to ZBNF, in terms of complete reduction of the use of chemical pesticides to control pests is signal to the ecological services like reduction in the environmental pollution; and complete replacement of chemical inputs by biological inputs led to conversion of saline land in to fertile land, and thereby arresting the depletion of natural resources like land; and reduction in the incidence of health problems for the farming community from the use and store of chemical inputs; and increased use of bullock services for tilling the crop lands under ZBNF is indication to the improvements in soil fertility.
- The agroecological practices of ZBNF have reduced the risks of the farmers who generally encounter in the production process of crops. The risks are related to input markets, credit markets, output markets (in terms of falling crop output prices), yields

of crops, and indebtedness. Thus, the ZBNF farmers have become resilient to these risks. This has ultimately improved relative autonomy of farmers from these risks due to ZBNF.

- ZBNF ensures food and nutritional security even for the small and the marginal farmers in the context of declining per capita availability of land.
- Irrigated, irrigated dry and dry land crops have benefitted from ZBNF practices. But, flood irrigated paddy crop in delta districts has derived yield benefits from ZBNF with a time lag of two or three years.
- Reduced cost of growing crops has improved incomes of farmers in the case of all crops grown under ZBNF. But reduction of costs as well as improvements in yields have contributed to the rise in incomes of farmers in the case of a few crops like maize, sesamum, sunflower and sugarcane due to ZBNF.
- The ZBNF farmers have explored the new marketing channels that connect them directly to consumers without the involvement of middlemen for marketing some of their ZBNF crop outputs. This means that ZBNF farmers opted for retail marketing channels. This enabled farmers to derive higher prices for their ZBNF crop outputs over those under non-ZBNF.
- The adoption of ZBNF practices by the farmers is on the increase over time. Consumption of tasty and chemical free ZBNF crop outputs by the friends and relatives of ZBNF farmers has contributed to the conversion of these farmers in to ZBNF. The transparency in the Crop Cutting Experiments regarding yield assessment among the farmers has also promoted confidence among farmers about ZBNF. These are some of the non-traditional factors, among others, contributed for encouraging farmers in adopting ZBNF.

4. Policy Implications

- It is evident from the analysis that the major constraint for the adoption of ZBNF relates to the inadequate exposure of farmers to the method of natural farming. Moreover, some of the farmers reported that they do not have adequate knowledge for the preparation of *Kashayams* and *Asthrams*. The extension services should be strengthened to advise and guide farmers in preparing and applying especially Kashayams/ Asthrams to the fields during the pest attack. The expansion of extension services by way of increasing CRPs

at the village level may address this. The farmers may exit from ZBNF practices if they are not properly supported in this issue.

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

- Household survey has clearly revealed that farmers complained about lack of proper marketing support. Marketing support is particularly important for realising the higher prices for crop outputs of ZBNF. The ZBNF farmers have explored new channels in which direct contact between farmers and consumers is established without the involvement of middlemen. Farming community can be supported to promote farmers producers organisations (FPOs) for improving the bargaining power of farmers for avoiding middlemen and for negotiating with the consumers directly as far as possible to obtain higher price for their crop outputs over Non-ZBNF crop outputs. The market support for ZBNF crop outputs enhances further net incomes of farmers. The market support also induces farmers to adopt and expand area under ZBNF.

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

In short, the following measures should be undertaken for effective implementation of ZBNF:

(1) Strengthening Extension Services,
(2) Providing Market Support,
(3) Promoting farmers collectives,

(4) Integrating the ZBNF with all relevant government programmes to enable farmers for adopting innovative models of growing crops for enabling farmers to realize related benefits of ZBNF.

Table 1: Cost of Inputs, Cost of Production and Net Incomes for ZBNF and Non-ZBNF Farmers across Crops in Kharif and Rabi Seasons of 2018-2019

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

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

Table 2: Impact of Agro ecological Practices on Soil Fertilizers in Kharif and Rabi Seasons of 2018-19, as reported by farmers

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

Source: Field Survey

Table 3: Impact of Improved Soil Fertility due to ZBNF on Crop Yields - Kharif and Rabi Seasons of 2018-19

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

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

Table 4: Impact of increased Soil Fertility due to ZBNF on Quality of Output in Kharif and Rabi Seasons of 2018-19,as reported by farmers

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

Source: Field Survey

CHAPTER 1

Context, Objectives and Methodology

1.0 Context

Farming and farming community in Andhra Pradesh, as elsewhere in the country, have been facing many challenges under chemical-based agriculture. The Focused Group Discussions (FGDs) recently held with the farmers in the villages across all the districts of Andhra Pradesh have highlighted the challenges and the consequences of chemical-based agriculture. The outcomes of the discussions are in order.

To begin with, 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. This demands mobilization of larger volume of working capital. As a result, farmers have depended on informal credit institutions that provide credit at relatively higher interest rates with extreme payment conditions. This has often pushed farmers into debt trap. This is more so in the 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 the use of heavy doses of chemical fertilizers every year. This has resulted in the reduction of the marginal productivity of land with respect to fertilizer inputs. The use of heavy doses of fertilizers has also given rise to the growth of different types of pests at the different phases of growth of crops. The use of heavy doses of pesticides to control the pests attacked has, in turn, led to rising cost of cultivation as well as severe damage to health of soil and quality of output. The withstanding capacity of crops to weather variability like deficit or excess in rainfall has also declined over time. This is due to the damage of soil health, especially its water-holding capacity, under chemical-based agriculture. Mixed, border, and bund crops, which are necessary not only to increase crop income but also to rejuvenate the soils, are conspicuously absent under chemical-based agriculture. The absence of 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 for a continuous flow of incomes to farmers. The crops those are produced under chemical-based agriculture have been chemicalised. This has led to higher incidence of health problems both to farmers and consumers. In this context, agro-ecology is gaining momentum as a sustainable farming approach to address the concerns emerged from the FGDs. There is growing evidence of its multiple benefits, from farm productivity to climate resilience. However, its promotion in public agricultural policies,

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

1.1 Research Questions

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

1. What is the impact of agroecological practices such as biological inputs of ZBNF in growing crops on the production conditions of farmers?
2. How far have the agroecological practices like intensive use of land with diversified cropping patterns in terms of raising mixed crops, intercrops, 5-Layer models, border crops and bund crops with biological inputs, mulching and Waaphasa of ZBNF contributed to change in soil fertility?

3 How far have the changes in soil fertility contributed to yields of crops, resilience of crops to weather variability, quality of crop outputs and heath related to chemical inputs?

4. What are the suggestions that flow from the analysis to bring improvements in the implementation of ZBNF for enabling farmers to adopt ZBNF and reap benefits from it?

1.2 The Methodology

The detailed narrative of methodology adopted for the study is in order. It includes the conceptual framework of ZBNF, basic approach, sample design, data gathering and data management.

1.2.1 Conceptual Framework of ZBNF

ZBNF is an agroecological farming approach. Agroecology regards biodiversity and ecological process as central to agro-ecosystem functioning through providing ecosystem services. It refers to farming practices that depend on ecosystem rather than on external inputs. Hence, ZBNF believes that the soil already has all the nutrients necessary for plant growth. There is no need for adding any external inputs to supply nutrients. Instead, the existing nutrients have to be released and made bio available. Agroecological practices of ZBNF facilitate this process. Thus, ZBNF is contrary to the conventional chemical-based agriculture. Beejaamrutham, Jeevamrutham, Acchadana (mulching), and Waaphasa are the four wheels those are at the heart of ZBNF farming practices.

Beejaamrutham is a microbial coating of seed/seedlings is based on cow dung, cow urine and lime. It protects young roots from fungus and seed-borne or soil-borne diseases. Jeevamrutham is a fermented microbial culture derived primarily from cow dung and urine, jaggery, pulse flour and uncontaminated soil. This stimulates microbial activity to make nutrients plant-available; protect against pathogens; and increase soil carbon. Acchadana (mulching) is the process of covering the top soil with cover crops and crop residues. This produces "humus", conserves topsoil, increases water retention, encourages soil fauna, supplies the soil with essential nutrients, and control weeds. Whapassa is soil aeration, a result of Jeevamrutham and Acchadana, and represents the changes in water management brought about by improved soil structure and humus content.

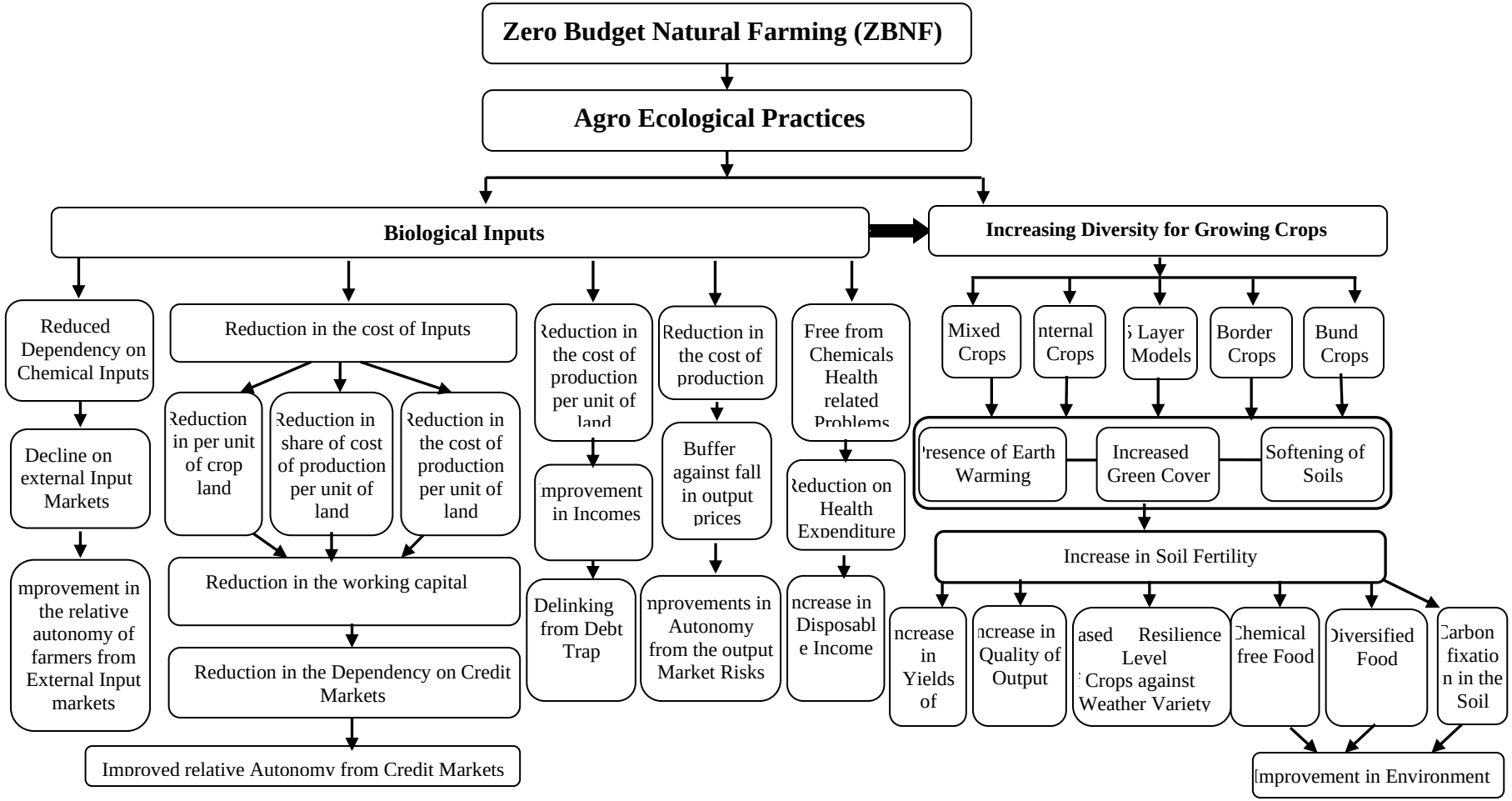
In order to protect crops from pests and insecticides, ZBNF prescribes a number of natural fungicides and pesticides made from locally available ingredients like neem leaves, chillies, garlic, tobacco, sour buttermilk. Thus, ZBNF has two major dimensions, viz., agronomic and structural.

Diversification is the key to agroecological transitions to ensure food security and nutrition while conserving, protecting and enhancing natural resources. Biological inputs combined with crop diversification and agroecological practices like mixed cropping, internal cropping, 5-Layer models of growing crops, border cropping and bund cropping, mulching and whapassa contributes to the reduction in cost of growing crops and improvement in net incomes of farmers from crop production. These practices also provide ecological services like soil fertility, resilience of crops to weather variability, quality of crop outputs and health of farming community, fixation of carbon in the soil without emitting in to environment, on the one hand, and on the other, enhancement in production of chemical free and diversified agricultural outputs that ensure increased availability of nutrients for human health, apart from productivity.

The preparation and use of biological inputs in the place of chemical inputs in crop production has a lot of implications for structural changes in production conditions of farmers. Increased use of biological inputs in place of chemical inputs leads to reduction in dependency on external input markets. This ensures improvement in relative autonomy of farmers from the external input markets. Reduction in cost of production of crops per unit of land due to ZBNF inputs reduces dependency of farmers on credit markets. This also enables farmers in gaining relative autonomy from credit markets. Further, reduction in cost of production of crops, given the yields of crops, improves crop incomes of farmers, thereby enabling them to delink from indebtedness. Furthermore, reduction in cost of production of crops facilitates farmers to withstand against output market risk such as falling output prices. This is possible because

higher prices of crop outputs, given the reduction in cost of production of crops, leave more profit margins. Further, falling prices of outputs leaves less margin but does not push farmers into heavy losses, provided that fall of prices may not be so heavy. Farmers and their families suffer from health problems through inhaling the pungent smell that comes from pesticides stored at home before applying on fields. Similarly, agricultural labourers have been affected through inhaling of chemical inputs especially pesticides during application on fields. The biological inputs enable farming community to be free from health problems related to storing and using of chemical inputs . This reduction in the expenditure on chemical-related health problems increases the disposal income of farming community (See Figure 1.1).

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



Source: Authors' Formulation

1.2.2 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 the first method, there 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, and village survey to collect information at village level from ZBNF perspective. Focussed Group Discussions (FGDs) with farmers, Case Studies (CSs) of farmers, and strategic interviews (SIs) with District Project Managers (DPMs) have been conducted to obtain qualitative data as well. Crop cutting experiments (CCEs) are conducted to assess the yield apart from collecting farmer reported yields. CCEs are used to assess yield of crops. 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. CCEs are conducted following the methodology suggested by NSSO and adopted by the State Directorate of Economics and Statistics (SDES). 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. Costs and returns are estimated adopting the tools of farm management studies, i.e., cost of cultivation scheme under the Ministry of Agriculture and Cooperation, Government of India.

1.2.3 The Sample Design

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

All the ZBNF farmers are divided into 13 strata, where each stratum is co-terminus with each district. In the first stage, a random sample of 10 villages was selected from each stratum. One limitation of this sample design is that it is based on data pertaining to the previous year, i.e., 2017-18. Although the 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-2018-19, the reference year of the study. The sample villages, where there are no farmers growing major crops in the reference year of the study, are dropped and substituted with another village. In this way, a basket of 15 sample villages is prepared for each district.

In these sample villages, listing survey has been conducted to identify the universe of ZBNF farmers (Seed to Seed–S2S farmers) and Non-ZBNF farmers. Then, two samples, one with 10 ZBNF farmers and another with 10 non-ZBNF farmers, are selected from each sample village using stratified random sampling method. For this purpose, in each village, all the ZBNF and non-ZBNF cultivators were listed separately and stratified into the two categories of farmers. Each of the categories is divided 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. Then, each sample of 10 farmers (of ZBNF and Non-ZBNF) was distributed across the strata as: 2 from stratum 1, 3 from stratum 2, 3 from stratum 3 and 2 from stratum 4. The sample of 10 ZBNF was selected from the sample frame of each village. In actual practice, however, adequate number of farmers may not be available in each stratum. In such cases, any shortfall of sample in a stratum is compensated by taking farmers from the immediate next stratum. If there is shortfall in the next stratum also, the compensation can be from the next and so on. However, since some of the ZBNF sample farmers also served as controls (perfect matches), the total non-ZBNF samples to be drawn from non-ZBNF list is reduced by the number of perfect matches found in ZBNF sample. Thus 2600 farmers in total consisting of 1,300 ZBNF and 1,300 ZBNF farmers are randomly selected for the Kharif survey. Thus, stratified multi-stage sample design is adopted for the survey.

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

associated with these institutions has been utilised 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.

In the case of Rabi Study of 2018-19, the villages where the crops grown in Rabi season are considered for the study. These villages are different from those villages selected for Kharif study. The same scheme of sample design followed for the Kharif Study. But the Study confined to half of the sample size of Kharif season. Thus a sample of 650 ZBNF farmers and a sample of 650 Non-ZBNF farmers were considered, covering totally 1300 farmers. This is due to the fact that the crops in Rabi season are grown by limited number of farmers (for details see Appendix Tables A 1.1 to A 1.6)

1.2.4 The Data Base

As mentioned earlier, the study has deployed both quantitative and qualitative methods. Listing Survey and Household Survey have been conducted to collect quantitative data from the households. Village Survey has been conducted at village level. Focussed Group Discussions (FGDs) with farmers of ZBNF as well as Non-ZBNF, Case Studies (CSs) of farmers, and strategic interviews (SIs) with District Project Managers (DPMs) have been conducted to obtain qualitative data as well.

The quantitative data collected from listing survey of farmers in the 130 sample villages of Kharif study and in the 65 villages of Rabi study in regard to adoption of ZBNF practices, crops grown and size of landholding have been utilised for formulating sample frame of farmers of ZBNF as well as Non-ZBNF for selecting the farmers.

The quantitative data from the household questionnaire has been collected to assess the impact ZBNF on input use pattern, cost of inputs, cost of cultivation for growing each of the crops and net incomes obtained by the farmers from each of the crops considered for the analysis. This data enables to assess the impact of agroecological practices such as application of biological inputs for growing crops under ZBNF on the production conditions of farmers.

The quantitative data from the households have been collected to examine the impact of agroecological practices such as biological inputs, crop diversification, mulching on making the agriculture sustainable. ZBNF making agriculture sustainable has been measured at two levels - improvements in soil fertility; and impact of improvements on yields of crops. The proxy indicators considered for measuring improvements in soil fertility include loosening of soil, presence of earthworms in the soil, and increase in greenery in the fields. Improvement in

the growth of the stems of crops, improved taste in crop outputs, resilience of crops in withstanding against weather variability and health problems related to chemical input use are considered to measure the ecological services of ZBNF. The data on all these indicators are collected from farmers' perceptions, captured through household questionnaire. The improved soil fertility should reflect on the yields of the crops grown. The yields of the crops have been assessed through Crop Cutting Experiments (CCEs) to assess the impact of improvement in soil fertility on yields of crops.

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 have been organised in the sample villages, at the rate of five villages from each district leading to a total of 65 FGDs in the state. These can shed more light on the key challenges to be addressed for realizing potential benefits of ZBNF. Similarly, 65 case studies (CSs) of the farmers have developed to assess the impact of ZBNF on land use pattern, cropping pattern, costs and returns of crops, marketing channels, soil fertility, and yields of crops.

1.2.5 The Data Collection and the Management Process

The prepared instruments for all field-based evaluations have in-built checks with appropriate skip patterns over and above the supportive manual with instructions and clarification for all questionnaires. Before finalizing these instruments, a daylong brain-storming session was convened with personnel experienced in field surveys and the suggestions emerged therein were incorporated. Similarly, the study convened a daylong session with the senior researchers, who are entrusted with the task of conducting the case studies in all thirteen districts to familiarize them with concepts and objectives of the project as well as check list for administering case studies. A pilot was also conducted for testing all instruments used for field-based evaluation with in-house research associates/ research assistants to check the consistency and flow of questions; and the feedback session was organized for the team members to help refining the questionnaire.

In-house field supervisors are also involved in the preparation of questionnaire along with core team members. A two-day Training of Trainers (ToT) was conducted at CESS headquarters. Given the workload, the study identified eight experienced personnel to work as supervisor of a district, apart from the five in-house supervisors. Thus, one supervisor was deployed for each of the 13 districts. Qualified investigators were selected from the pool suggested by RySS, who have motivation and sufficient agricultural background. A four-day intensive training was conducted at CESS headquarters during 16-19th November 2018 with one-day on-field training.

In the training, the services of senior personnel from RySS were obtained to explain the background of the research study, and experienced personnel from NSSO and DES were deputed to explain the procedure for CCEs. The core team members have also explained the entire questionnaire along with manual of instructions on FGDs, case studies (CSs) and the internal checks to be followed. Senior statisticians in the team explained on the sample design and on the selection of farm households. During all the four days of training, senior experts selected for case studies and personnel selected to lead 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 full command over the questionnaire, the actual field survey was commenced on 22nd November 2018 in Kharif study and on 1st January 2019 in Rabi study. All the supervisors are instructed to send the filled-in schedules after the completion of all the schedules for each village. Two senior research associates were involved in getting English translation of the FGDs conducted by the field supervisors. Senior core team members conducted strategic interviews with District Project Managers using a common check list. A separate mobile-based app was developed/ generated to enter the CCE information and training was given to all the supervisors duly installing the app in their mobiles. Core team members visited the field and cross-checked the information filled.

The study entrusted a senior research associate with the task to monitor the receipt of filled-in schedules and to look after the entry work done by four entry operators. The entry programme was written in CSPro software by one of the core team members with in-built 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 data entry operators. Any discrepancies noticed in the data entry, the research associate/ data manager will cross-check with concerned field supervisors and the correctness of the information will be passed on to the entry operators to proceed accordingly. While generating the result tables, the outliers identified were cross-checked with original schedule and with the concerned supervisors and final result tables were generated only after ensuring data quality.

1.3 Structure of the Report

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

and policy suggestions flown from the analysis for improving the implementation of ZBNF. The executive Summary of the study is also presented.

CHAPTER 2

Impact of Biological Inputs of ZBNF on Crop Production Conditions of Farmers

2.0 Introduction

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

2.1 Research Questions

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

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

2.2 Methodology

Three dimensions of cost of inputs of crops and four dimensions of crop net incomes accrued to farmers have been considered to examine the impact of use of biological inputs on production conditions. Two dimensions of cost of inputs of crops include biological inputs per hectare, share of biological inputs in the cost of production of crops per hectare are used to assess the extent of dependency of farmers on external input markets. Paid out costs per hectare for growing crops under ZBNF in relation to the same parameter of chemical inputs for raising crops under Non-ZBNF have been considered to assess the dependency on credit markets. Net crop incomes, mixed crop net incomes, bund crops net incomes and border crops net incomes accrued to farmers; and farmers' utilising own savings for meeting working capital requirements have been considered to assess the possibility of farmers in overcoming

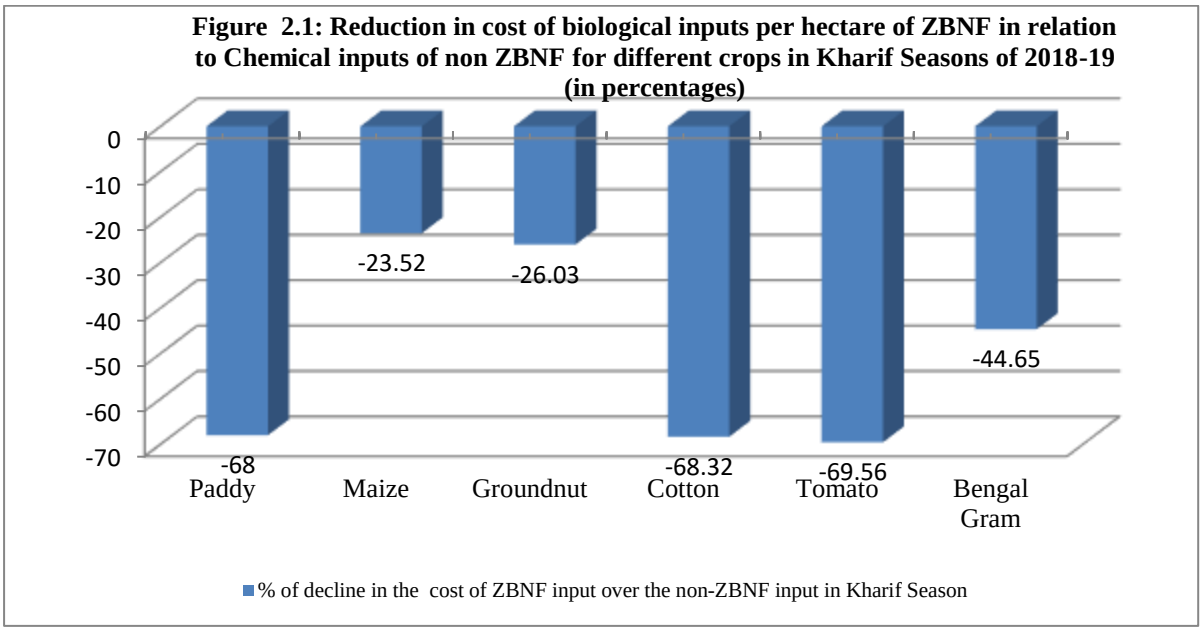
indebtedness. The implication of these parameters is examined in terms of reducing dependency of farmers on external input markets and credit markets; and enabling farmers for overcoming indebtedness that ultimately contributes to the improvements in relative autonomy of farmers. The Focussed Group Discussions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

2.3 The Analysis

2.3.1 Biological Inputs and Dependency on External Input Markets

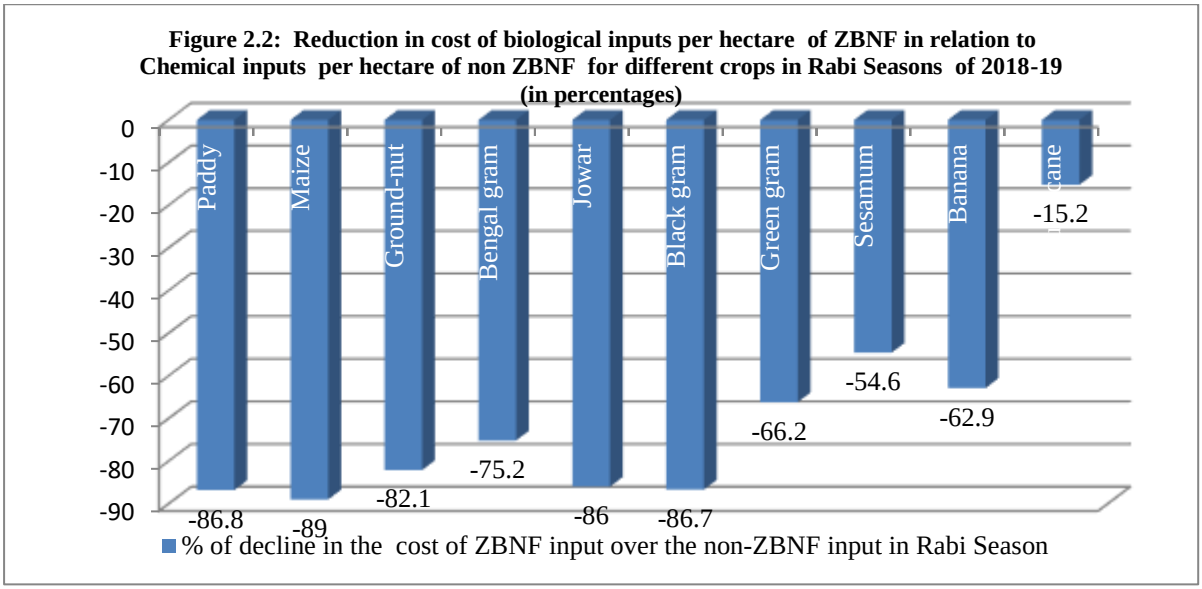
A comparison of the per hectare cost of biological inputs of ZBNF and that of chemical inputs of Non-ZBNF has revealed that the cost of ZBNF inputs is lower than that of non-ZBNF across all the crops grown in Kharif as well as in Rabi seasons. It is interesting to note that the cost of biological inputs is strikingly lower than that of chemical inputs in the Rabi crops over the Kharif crops. This is further reinforced from the comparison of the same crops, such as paddy, maize, groundnut and Bengal gram, in both the seasons (Table A 2.1 and A 2.2). But, the percentage of reduction in the cost of biological inputs in relation to that of chemical inputs has varied across crops. It has ranged from 24 per cent in case of maize to 70 per cent in case of tomato in Kharif season, while it has varied between 15 per cent in case of sugarcane to 89 per cent in case of maize (Figures 2.1 and 2.2& Table 2.1). Thus, the crops grown under different irrigation and unirrigated conditions have experienced considerable reduction in input costs due to the use of biological inputs of ZBNF.

Figure 2.1: Reduction in cost of biological inputs per hectare of ZBNF in relation to Chemical inputs of non ZBNF for different crops in Kharif Seasons of 2018-19 (in percentages)



Source: Field Survey

Figure 2.2: Reduction in cost of biological inputs per hectare of ZBNF in relation to Chemical inputs per hectare of non ZBNF for different crops in Rabi Seasons of 2018-19 (in percentages)



Source: Field Survey

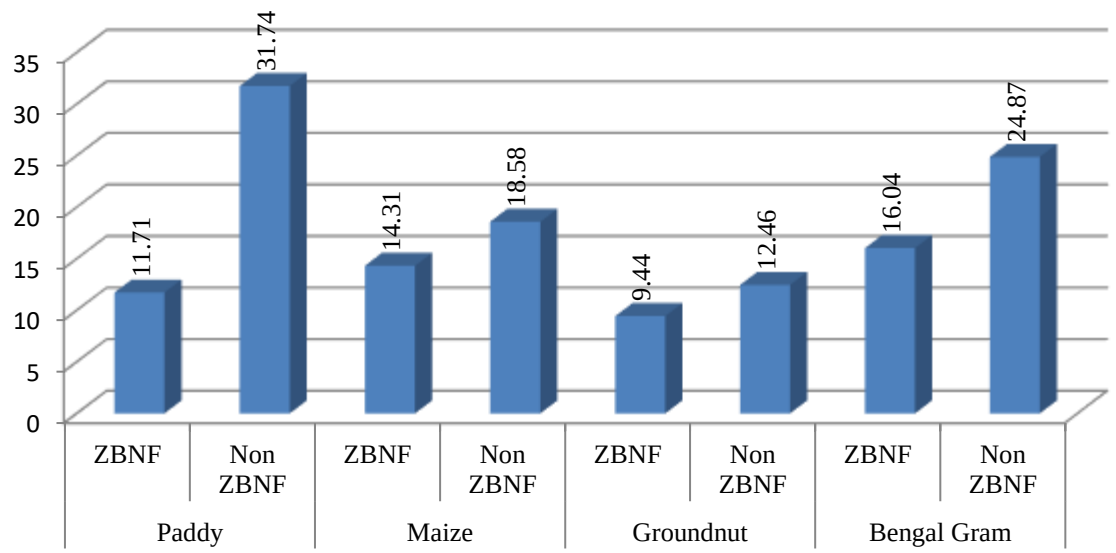
Table 2.1: Reduction in cost of biological inputs per hectare of ZBNF in relation to Chemical inputs per hectare of non ZBNF for different crops in Kharif and Rabi Seasons of 2018-19(in percentages)

Description of Crops	**Paddy**	**Maize**	**Groundnut**		**Cotton**		**Tomato**		**Bengal Gram**	
% of decline in the cost of ZBNF input over the non-ZBNF input in Kharif Season	--68.00	-23.52	-26.03		-68.32		-69.56		-44.65	
Description of Crops	**Paddy**	**Maize**	**Ground-nut**	**Bengal gram**	**Jowar**	**Black gram**	**Green gram**	**Sesa-mum**	**Banana**	**Sugar-cane**
% of decline in the cost of ZBNF input over the non-ZBNF input in Rabi Season	-86.8	-89	-82.1	-75.2	-86	-86.7	-66.2	-54.6	-62.9	-15.2

Source: Field Survey

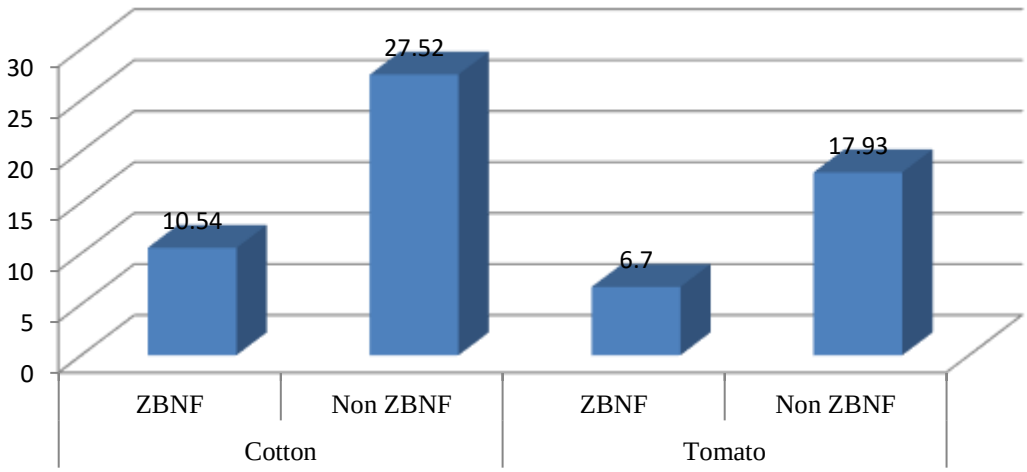
The impact of cost of biological inputs on the cost structure of the crops has been examined to assess its contribution to the reduction in the paid out cost in growing crops. In this regard, the share of biological inputs in the total cost per hectare of the production of crops grown under ZBNF has 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 of ZBNF crops is found to be invariably lower than that of chemical inputs in the paid out cost of Non-ZBNF. This is noticeable in the case of all crops grown in Kharif as well as in Rabi (Figures 2.3 to 2.6 and Table 2.2)

Figure 2.3: Share of Biological and Chemical inputs in paid out Cost of Production per hectare under ZBNF and non-ZBNF respectively for Paddy, Maize, Groundnut and Bengal Gram Crops in Kharif Season of 2018-19 (in percentage)



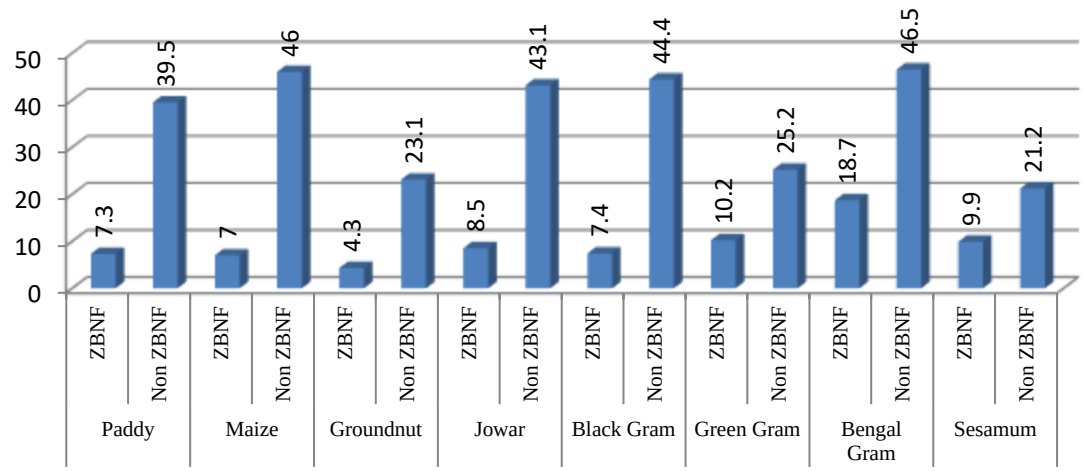
Source: Field Survey

Figure 2.4: Share of Biological and Chemical inputs in paid out Cost of Production per hectare under ZBNF and non-ZBNF respectively for Cotton and Tomato Crops in Kharif Season of 2018-19 (in Percentage)



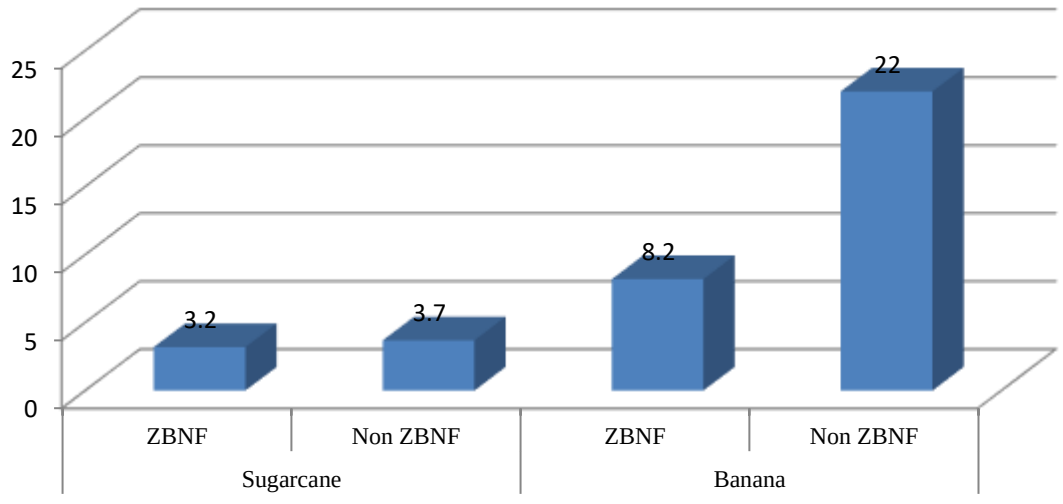
Source: Field Survey

Figure 2.5: Share of Biological and Chemical inputs in Cost of Production per hectare under ZBNF and non-ZBNF respectively for Paddy, Maize, Groundnut,Jowar,Black Gram, Green Gram, and Bengal Gram and Sesamum Crops in Rabi Season 2018-19 (in Percentage



Source: Field Survey

Figure 2.6: Share of Biological and Chemical inputs in Cost of Production per hectare under ZBNF and non-ZBNF respectively for Sugarcane and Banana Crops in Rabi Season of 2018-19 (in Percentage)



Source: Field Survey

Table 2.2: Share of Biological and Chemical inputs in paid out Cost of Production per hectare under ZBNF and non-ZBNF respectively for Crops in Kharif and Rabi Seasons of 2018-19 (in Percentage)

Description of Crops	Paddy		Maize		Groundnut		Tomato		Bengal gram		Cotton	
Type of farming	ZBNF	Non ZBNF	ZBNF	Non ZBNF	ZBNF	Non ZBNF	ZBNF	Non ZBNF	ZBNF	Non ZBNF	ZBNF	Non-ZBNF
Share of Biological / Chemical in total paid out cost per hectare in Kharif	11.71	31.74	14.31	18.58	9.44	12.46	6.7	17.93	16.04	24.87	10.54	27.52

Description of Crops	Paddy		Maize		Groundnut		Jowar		Sugar-cane		Black gram		Green gram		Bengal gram		Sesamum		Banana	
Type of farming	ZBNF	NZBNF	ZBNF	NZBNF	ZBNF	NZBNF	ZBNF	NZBNF	ZBNF	NZBNF	ZBNF	NZBNF	ZBNF	NZBNF	ZBNF	NZBNF	ZBNF	NZBNF	ZBNF	NZBNF
Share of Biological / Chemical in total paid out cost per hectare in Rabi	7.3	39.5	7	46	4.3	23.1	8.5	43.1	3.2	3.7	7.4	44.4	10.2	25.2	18.7	46.5	9.9	21.2	8.2	22

Source: Field Survey

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

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

In the interaction with the ZBNF farmers in developing the case studies, farmers have reported that the use of chemical fertilisers and pesticides in farming has come down to zero level in growing crops. The use of Beejaamrutham, Ghanajeevamrutham, Dravajeevamrutham, kashayams and Astrams has entered the input basket of crop growing practices under ZBNF. The ingredients required for preparing inputs like Beejaamrutham, Ghanajeevamrutham, Dravajeevamrutham, *Kashayams* and Astrams are drawn from the locally available resources like dung, urine, dairy products from local cows; leaves and other related material. This ensures low cost inputs to farmers for growing crops. The inputs of ZBNF are at lower cost because they are locally prepared by the farmers using the locally available ingredients like cow dung, cow urine, leaves and other related material. Further, the incidence of occurrence of seasonal pests to the crops also declined due to ZBNF. The farmers are saved from the exorbitant costs of chemical pesticides. Thus dependency on the external input markets has come down drastically (for details see Appendix 2).

The farmers in FGDs reported that dung, urine and dairy waste products of local cows as ingredients in the preparation of inputs constitute the central component of ZBNF. Hence, the availability of local cows is fundamental for organising agriculture under ZBNF. The scarcity of local cows as a constraint has been reported in all the villages across the districts. However,

farmers have adopted ZBNF despite the scarcity of local (variety) cows to reduce cost of inputs for growing crops, this is by procurement of local cows by some of the farmers and some others have obtained these ingredients from other farmers. Further, some others have obtained these ingredients especially dung and urine from nearby gosalas maintained by temple authorities. Few farmers have procured local cows which are ready to be deported to slaughterhouses. The north coastal districts and both Godavari districts have tribal areas and they have become the supply source for cow dung and cow urine to farmers in other non-tribal parts of the districts. Thus farmers are motivated to prepare biological inputs from locally available ingredients to reduce the cost of cultivation of crops. Farmers have further reported that the biological inputs enabled them to reduce their dependency on external inputs (for details see Appendix 1).

2.3.2 Biological Inputs and Dependency on Credit Markets

The patterns of input use of the crops analysed above should reflect in the cost of production of crops. The paid cost of cultivation per hectare is found to be lower across all the crops under ZBNF compared to the same crops and other crops specific to Kharif and Rabi Seasons under Non-ZBNF, though the quantum and percentage of reduction varied across crops (Tables 2.3 and 2.4). The reduction in the cost of production of crops per hectare is found to be the highest by 19 percent for cotton and tomato compared to those (around one per cent for the other crops like maize, groundnut and Bengal gram in Kharif Season. However, both the percentage of reduction of inputs per hectare and the cost of cultivation per hectare are higher in case of high value crops like cotton and vegetables compared to those under other crops in Kharif. The percentage of reduction in the paid out costs per hectare for growing crops has varied between -0.4 for Banana and -38.3 for Bengal gram in Rabi. Among all the crops, paddy, maize, jowar and pulses have experienced higher rate of decline in costs due to ZBNF (Figure 2.7 and 2.8 and Tables 2.3 and 2.4). This is abundantly cleary that the ZBNF has brought down substantial reduction in the cost of production across all the crops. This has implication for the mobilisation capital for raising crops. The reduction in the working capital required for raising crops under ZBNF in relation to that required under Non-ZBNF has come down substantially. This is evident from the extent of reduction in the paid out costs due to ZBNF. This means that the dependency of farmers on credit markets has come down. Thus the farmers have gained relative autonomy from credit markets.

Table 2.3: Paid out Cost of Production of Crops per Hectare under ZBNF and non-ZBNF and Change in ZBNF over Non-ZBNF for different crops in Kharif Season of 2018-19
(Costs in rupees and Change in percentages)

	Method of Growing Crops

Description of Crops and Costs	ZBNF	Non ZBNF	%Change over non-ZBNF
Paddy			
Cost per hectare (Rs)	36009	41737	-13.7
Maize			
Cost per hectare (Rs)	32214	32458	-0.01
Groundnut			
Cost per hectare (Rs)	29219	29957	-0.03
Cotton			
Cost per hectare (Rs)	27164	32854	-17.31
Tomato			
Cost per hectare (Rs)	75952	93149	-18.46
Bengal gram			
Cost per hectare (Rs)	28279	32939	-1.41

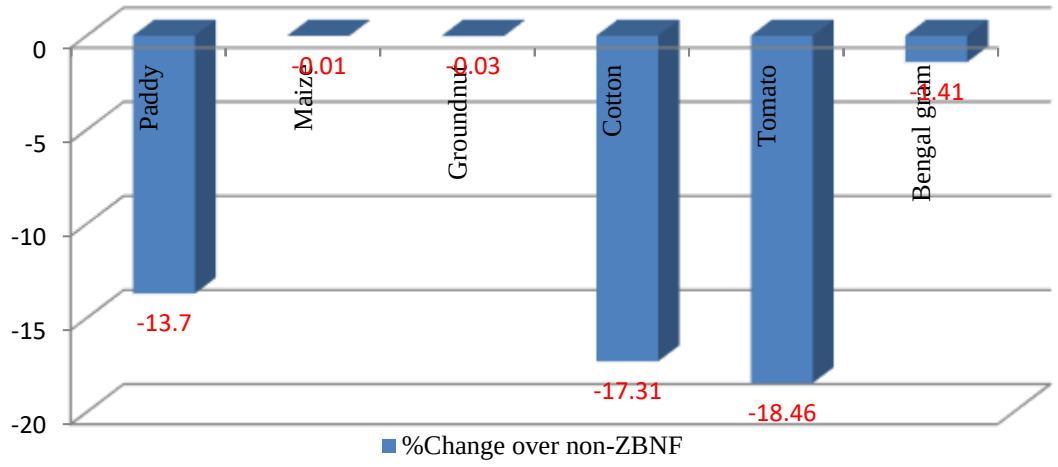
Source: Field Survey

Table 2.4: Paid-out Cost per Hectare under ZBNF and Non-ZBNF for different crops and Change in ZBNF over non-ZBNF across crops in Rabi Season of 2018-19
(Costs in rupees and Change in percentages)

Description of Crops	Paid out cost under ZBNF(in Rs)	Paid out cost under Non- ZBNF(in Rs)	%change over Non-ZBNF
Paddy	34346	48209	-28.8
Maize	36493	50630	-27.9
Groundnut	36956	38288	-3.5
Jowar	19779	28036	-29.5
Sugarcane	86757	88093	-1.5
Black gram	9781	12294	-20.4
Green gram	6081	7304	-16.7
Bengal gram	16464	26693	-38.3
Sesamum	8354	8632	-3.2
Banana	92287	92637	-0.4

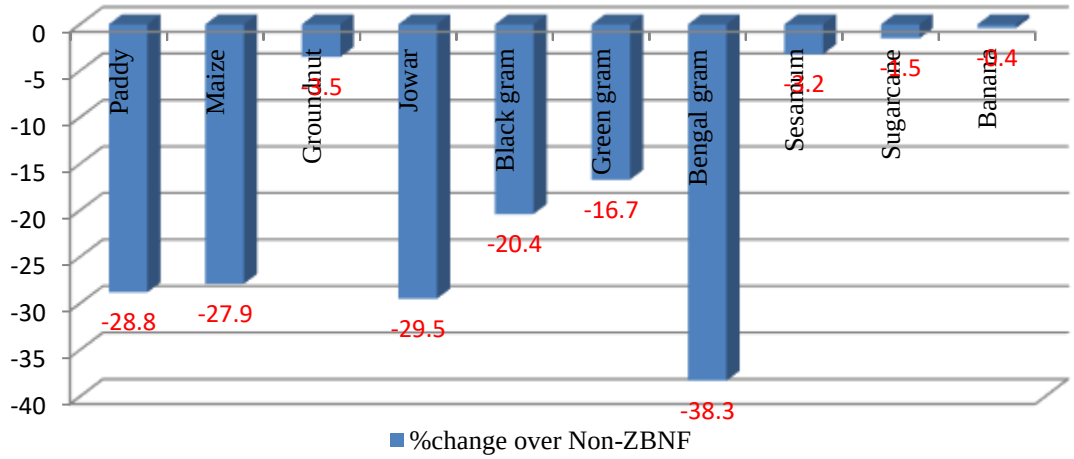
Source: Field Survey

Figure 2.7: Change in Cost of Production of different Crops per hectare under ZBNF over non-ZBNF in Kharif of 2018-19 *(in percentages)*



Source: Field Survey

Figure 2.8: Change in Paid-out Cost per Hectare of Crops of ZBNF over Non-ZBNF in Rabi Season of 2018-19 *(in percentage)*



Source: Field Survey

2.3.3 Biological inputs, Crop Incomes and Indebtedness of Farmers

The reduction in the cost of cultivation per hectare under ZBNF over non-ZBNF should result in the net income of the ZBNF across all crops. It is evident from the data that the net income per hectare to farmers is higher from ZBNF over Non-ZBNF for all the crops considered for the analysis in Kharif as well as Rabi seasons. It is noticeable that the increase in net incomes is higher in Rabi over Kharif across all the crops (Tables 2.5 and 2.6). For instance, the highest increase in net crop incomes due to ZBNF is experienced by farmers from maize (111 percent) followed by cotton (45 per cent), groundnut and tomato (41 per cent each) and 17 percent in case of Bengal gram in Kharif. Similarly, increase in net income has varied between 10 per cent in case of sugarcane and 133 per cent in the case of Bengal gram in Rabi season (Figures 2.9 to 2.16 & Tables 2.5 and 2.6). This indicates that the increase in net incomes is substantial among the crops grown under dry and irrigated dry conditions (like pulses and high value crops).

Table 2.5: Net Income per hectare from different crops under ZBNF and Non-ZBNF and Change in ZBNF over non-ZBNF in Kharif Season of 2018-19
(incomes in rupees and change in percentages)

Crop/Method of Farming	ZBNF	Non ZBNF	Change over non-ZBNF(in percentages)
Paddy	45262	41708	8.52
Maize	45375	21458	111.46
Groundnut	35819	25409	40.97
Cotton	28585	19662	45.38
Bengal gram	54559	46498	17.34
Tomato	323409	229926	40.66

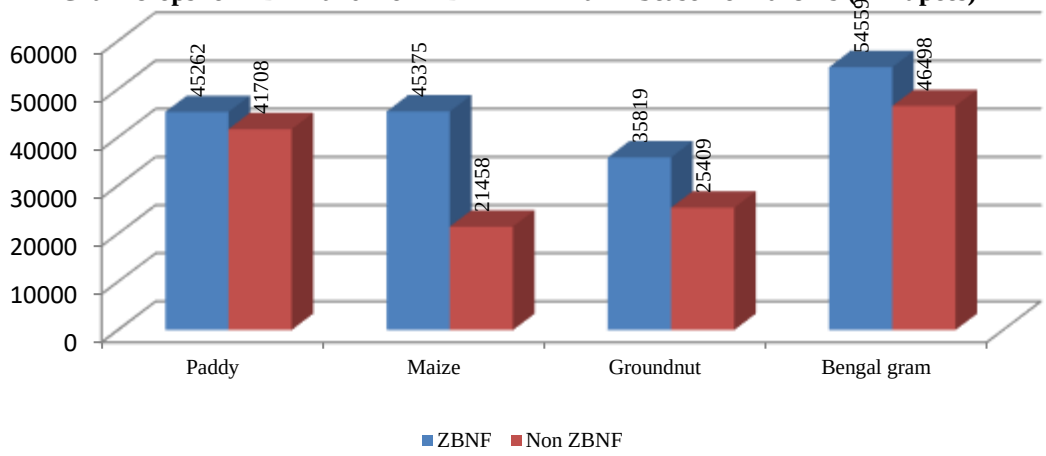
Source: Field Survey

Table 2.6 Net returns Per Hectare from different crops under ZBNF and Non-ZBNF and Percentage Change in ZBNF over non-ZBNF in Rabi Season of 2018-19
(incomes in rupees and change in percentages)

Description of Crops	Net returns of ZBNF(in Rs)	Net returns of non-ZBNF(in Rs)	% difference over non-ZBNF
Paddy	49645	33637	47.6
Maize	89577	79120	13.2
Groundnut	47489	35695	33.0
Bengal gram	35627	15277	133.2
Jowar	14915	8288	80.0
Black gram	14706	8005	83.7
Green gram	12606	9360	34.7
Sesamum	28707	23403	22.7
Banana	173381	96546	79.6
Sugarcane	110981	100928	10.0

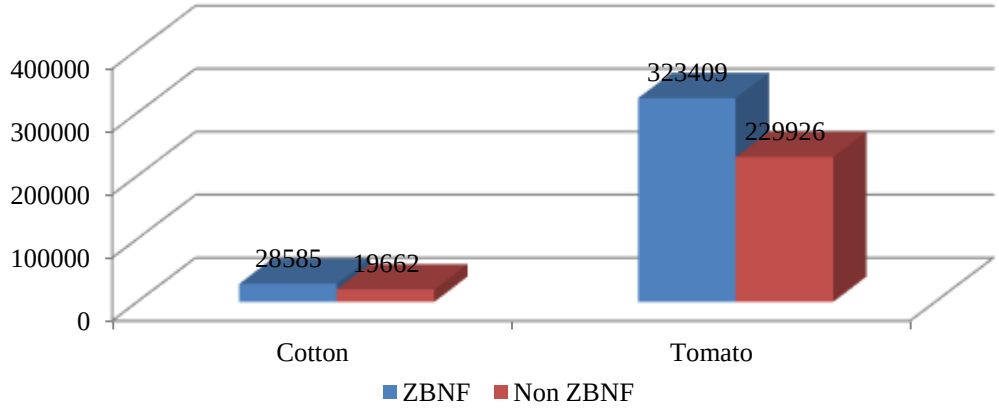
Source: Field Survey 2018-19

Figure 2.9: Net Income per hectare from Paddy, Maize, Groundnut and Bengal Gram crops for ZBNF and Non-ZBNF in Kharif Season of 2018-19 (in rupees)



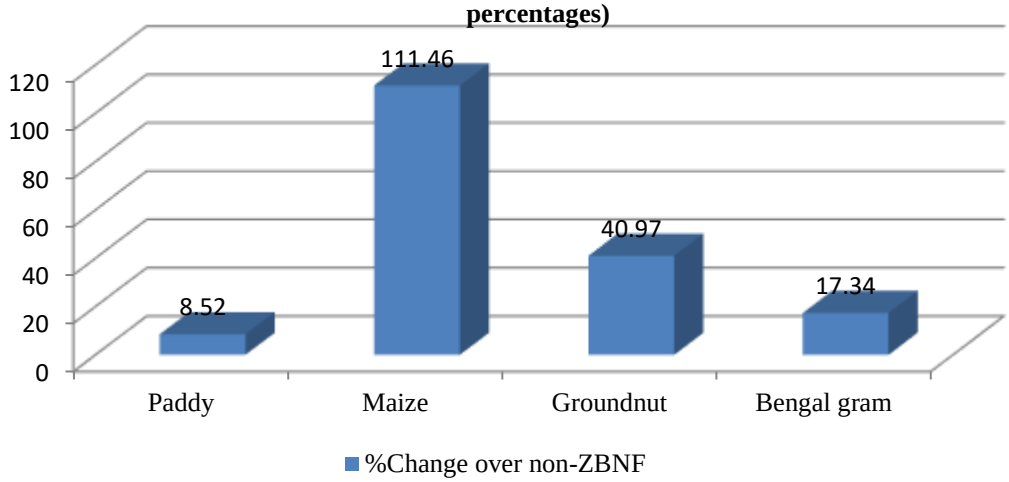
Source: Field Survey

Figure 2.10: Net Income per hectare from Cotton and Tomato Crops under ZBNF and Non-ZBNF in Kharif Season of 2018-19 (in rupees)



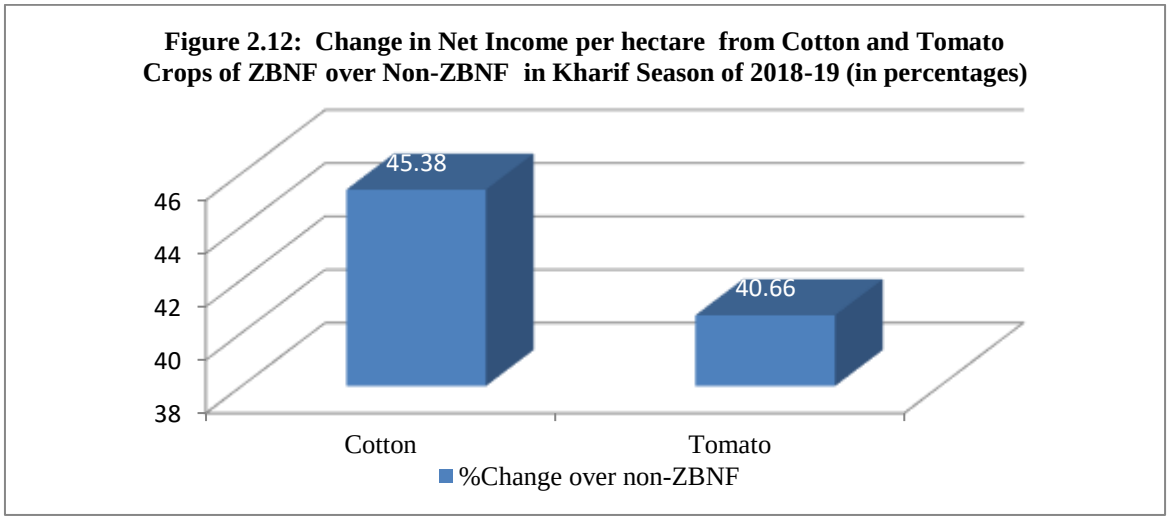
Source: Field Survey

Figure 2.11: Change in Net Income per hectare of Paddy, Maize, Groundnut and Bengal Gram Crops of ZBNF over Non-ZBNF in Kharif Season of 2018-19 (in percentages)



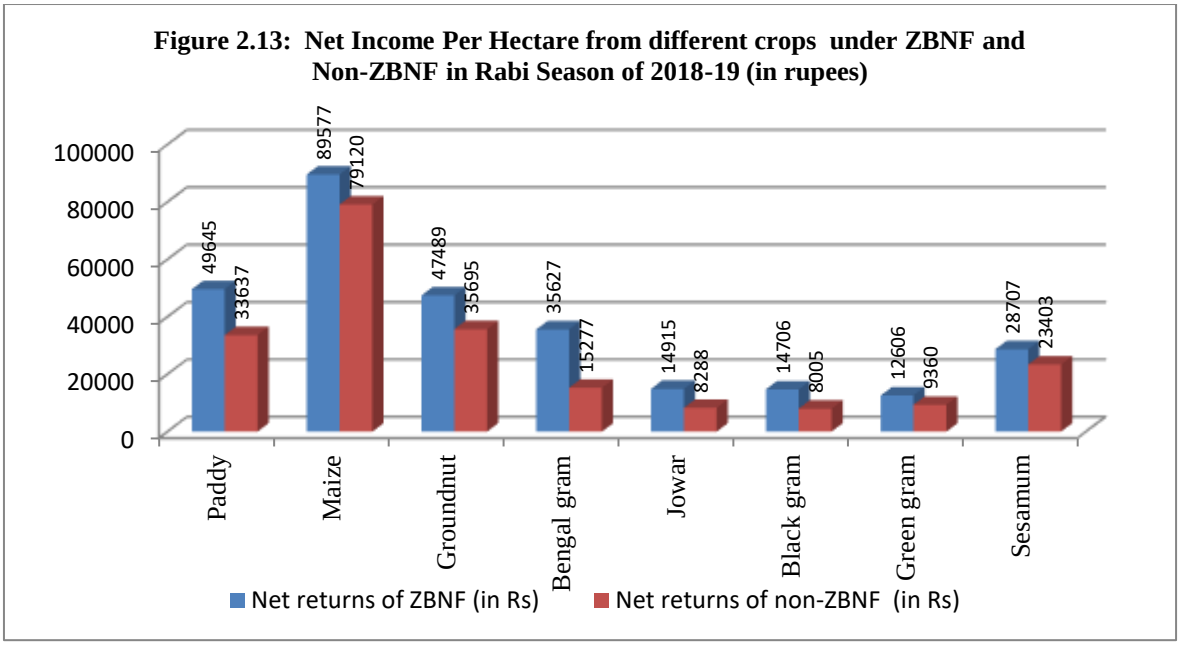
Source: Field Survey

Figure 2.12: Change in Net Income per hectare from Cotton and Tomato Crops of ZBNF over Non-ZBNF in Kharif Season of 2018-19 (in percentages)



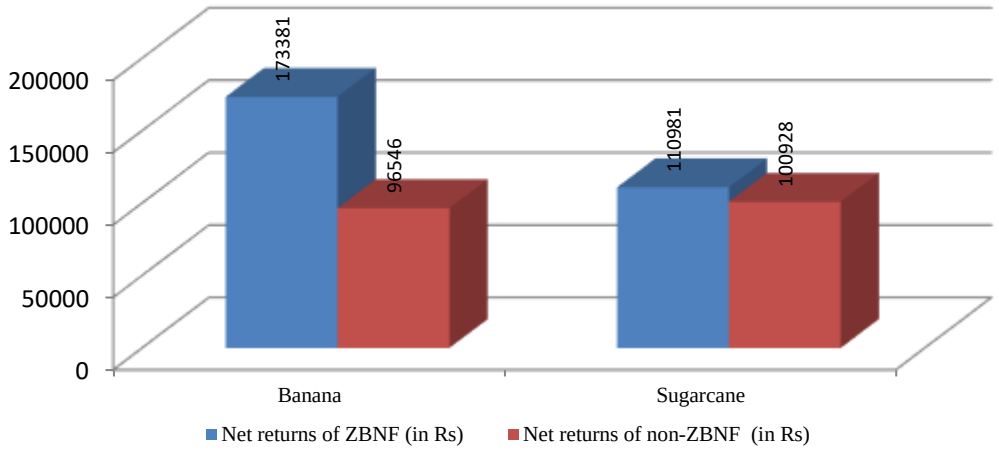
Source: Field Survey

Figure 2.13: Net Income Per Hectare from different crops under ZBNF and Non-ZBNF in Rabi Season of 2018-19 (in rupees)



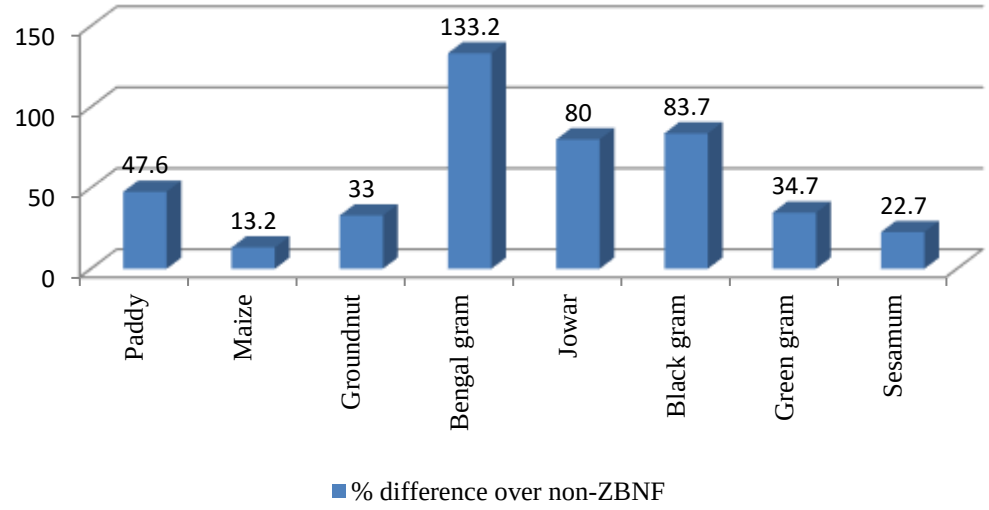
Source: Field Survey

Figure 2.14: Net Incomes Per Hectare from Banana and Sugarcane under ZBNF and Non-ZBNF in Rabi Season of 2018-19 (in rupees)



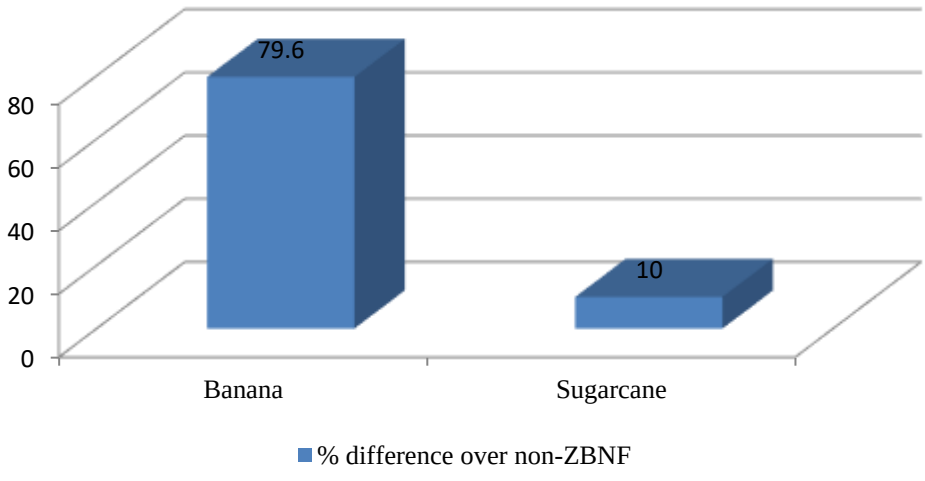
Source: Field Survey

Figure 2.15: Change in net income of ZBNF over non-ZBNF for Paddy, Maize, Groundnut, Bengal Gram, Jowar, Black Gram, Green Gram and Sesamum crops in Rabi Season of 2018-19



Source: Field Survey

Figure 2.16: Change in Net Incomes per hectare under ZBNF for Banana and Sugarcane crops over non-ZBNF in Rabi Season of 2018-19



Source: Field Survey

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-ZBNF sample farmers have also grown 11 different mixtures. On an average, ZBNF farmers earned a net income of Rs. 46042 per hectare from mixed crops as against Rs. 35548 by non-ZBNF farmers. Similarly 39 sample ZBNF farmers have grown bund crops in their main field in Kharif as against 20 non-ZBNF farmers and derived a net income of Rs. 4229 by each farmer under ZBNF method compared to Rs. 3922 by a non-ZBNF farmer. Further, 24 ZBNF farmers have grown border crops and each farmer earned net income of Rs. 4019; while 12 non-ZBNF farmers who have grown border crops earned net income of Rs. 3695 per farmer (Table 2.7). Thus, more number of ZBNF farmers adopted mixed cropping, border cropping and bund cropping compared to non-ZBNF; and earned more income from these crops compared to their counterparts, i.e., non-ZBNF farmers.

Table 2.7: Net Income from Mixed Crops, Border Crops and Bund Crops under ZBNF and Non-ZBNF (in rupees)

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

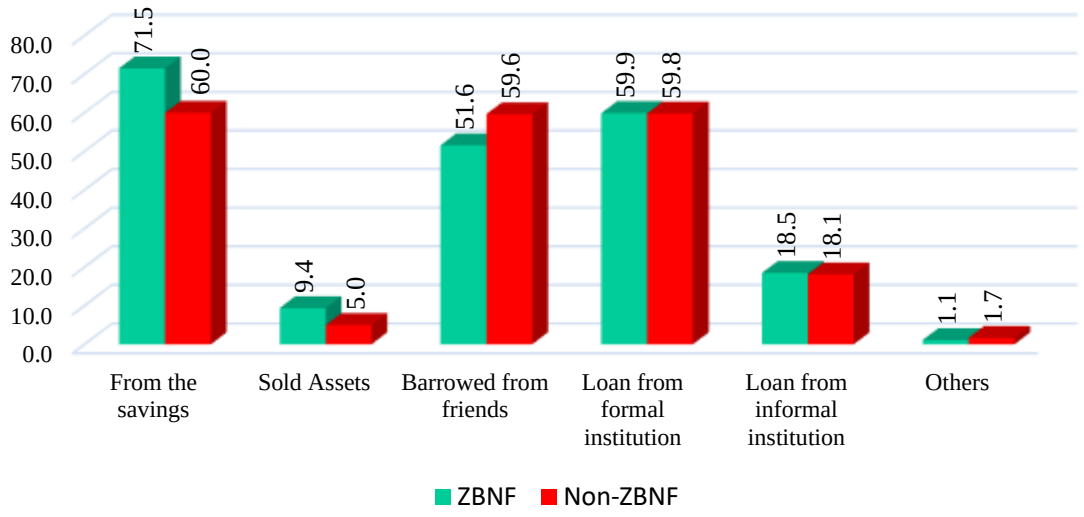
Source: Field Survey

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

of problems in marketing including difficulty in establishing the differentiation of ZBNF products from Non-ZBNF products because of which they could not claim a higher price for the ZBNF output. One farmer has suggested that certification of ZBNF farm produce is essential for informing the consumers that the produce of ZBNF is chemical free. This will be helpful for the farmers in obtaining premium price for ZBNF produce. He has also suggested that the ZBNF farmers to be given ZBNF Identity Cards for selling ZBNF produce in the Rythu Bazaars. Thus, these case studies clearly provide evidence that the farmers can increase their incomes further if proper marketing support is provided by the RySS.

The increased incomes of the farmers enabled them to depend more on their savings accumulated through the cultivation of ZBNF in the previous years for meeting the working capital required to grow crops in the agricultural reference year in Kharif season. Similarly in Rabi, 78.4 per cent of farmers who are practicing ZBNF method have managed their working capital through their savings as against 60 percent of the non-ZBNF farmers>This provides ample evidence for the increase in incomes farmers from crops grown (Figure 2.17).

Figure 2.17: Distribution of Farmers Reported according to Sources of Working Capital for the Agriculture Operations of ZBNF and Non-ZBNF (in percentages)



Source: Field Survey

Conclusions

The agroecological practices of ZBNF have reduced the risks of the farmers who generally encounter in the production process of crops. The risks are related to input markets, credit markets, output markets (in terms of falling crop output prices), yields of crops, and

indebtedness. Thus, the ZBNF farmers have become resilient to these risks. This has improved relative autonomy of farmers from these risks due to ZBNF.

CHAPTER 3

Agroecological Practices of ZBNF and Ecological Services

3.0 Introduction

This chapter is an attempt to analyse the agroecological practices such as biological input use, intensive use of land and crop diversification activities like mixed cropping, bund cropping and border cropping and five-layer models on ecological services. These practices through improvement in soil fertility impact on the yields of crops, quality of output, resilience of crops against weather variability, and human health. Health status of land, quality of crop output, and resilience of crops to weather variability are the dimensions considered for assessing the provision of ecological services of ZBNF.

3.1 Research Questions

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

i. What are the agroecological practices adopted by the ZBNF farmers in growing crops?

ii. Are these practices associated with the changes in soil fertility of the farmers?

iii. How far has the changes in soil fertility provided ecological services such as quality of crop outputs, resilience against the weather variability and human health, apart from changes in the yield of crops?

3.2 Methodology

A detailed narrative has been developed on the agroecological practices adopted by the ZBNF farmers using quantitative data collected from the farmer households and through supplementation of the Focussed Group Discussions (FGDs) with farmers and Case Studies (CSs) of Farmers and Strategic interviews (SIs). This analysis is conducted using the prevalence of these practices such as biological input use, crop growing methods like mixed cropping, bund cropping, and border cropping and five-layer models among farmers. The soil fertility has been captured through perceptions of farmers. Farmers have provided indication of increase in soil fertility through three indicators such as softening of soils, presence of earthworms in the field and increased green cover. These are all proxies for assessing about soil fertility. There is a need to assess this through scientific studies. The impact of soil fertility has been assessed through improvements in the yields of crops, resilience of crops in withstanding against weather variability, quality of crop outputs, and human health. All these factors together reflect the contribution of agroecological practices under ZBNF to the ecological services.

3.3 The Analysis

3.3.1 Diversified Cropping Patterns

It is evident from the analysis conducted in the preceding chapter that farmers have used biological inputs Beejaamrutham, Ghanajeevamrutham, Dravajeevamrutham, Kashayams and Astrams in growing crops. Further, farmers have raised mixed crops, border and bund crops also. This evidence has been supplemented by the case studies (CSs) of farmers along with strategic interviews (SIs) to obtain more narrative regarding the diversification activities in growing crops.

It is clear from the case studies that the farmers have adopted mixed cropping, inter cropping, border cropping, and bund cropping. 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 farmer households could generate additional income from the bund and border crops. The tallest contribution of ZBNF is changing the cropping pattern from mono to poly cropping.

The case studies have revealed that they have different models of raising crops under ZBNF. The models of crops grown under ZBNF include: i). leafy vegetables and other vegetables through 5-layer model of cropping in mango orchard as intercrops. ii). banana with intercrops like chillies /benda/ vegetables brinjal/ flowers/ colocasia (chema)/turmeric/ginger. iii).

horticultural species, leafy vegetables, curry leaves, and guards in 36*36 models with 5-layer model. iv). coffee plantation, dragon fruit, neem trees, orange, munaga, banana, yalikulu, lavanga, cherry, panasa, chinta, mango, and nerada in the coffee plantations under the 5-layer model. v). Five-layer model of oranges with poly crops**;** 36.*36 model with roots, tubers (radish and onion), Teega jathulu/guards varieties (cucumber, bitter guard, country beans, ridge guard, bottle guard and snake guard), curry leaves (sorrel leaves, spinach, fenugreek leave and amaranthus), 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, custard apple, coconut, sweet lime and citrus) trap crops and flowers.

The existing coffee plantations in the hilly areas have been transformed into the 5-layer model of growing crops. This has ensured continuous flow of income to the tribal farmers. Apart from rotation of crops, raising of the border and bund crops by these farmers has ensured considerable income to meet the investment for growing the main crops in their fields. This has resulted in intensive use of land throughout the year. Local variety of seeds has been used for raising crops under ZBNF. The case studies clearly show that the 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 ensures food security and balanced diet for everyone in the village. It is reported that there is increased vegetation in the village due to ZBNF. The farmer has also reported that the gestation period required to start yielding of orange garden has declined considerably under ZBNF compared to the gardens grown under non-ZBNF practices. Keeping in mind the agroclimatic conditions of the region, the principle of 5-layers cropping pattern with combination of suitable crops in each layer is recommended for cultivation under ZBNF in this region (for details see Appendix 2). The strategic interviews with the district managers also have revealed that there are some other crop growing models (for details see Appendix 3). The adoption of biological inputs, growing mixed crops, bund and border crops and other different models of crop diversification should result in the improvements in soil fertility. The analysis regarding this is in order.

3.3.2 Improvements in Soil Fertility

A large proportion of ZBNF practicing farmers in Kharif season have reported that the soil fertility has gone up due to ZBNF. The farmers have provided evidence through three parameters - softening of soils, presence of earthworms, and increased green cover in the fields.

It is also clear from the reporting of farmers that the green cover is not as widely present as the other two parameters (dimensions) of soil fertility. It is reported by one of the farmers that his saline land has been turned into fertile land, thanks to the rejuvenating role of ZBNF. Similarly, as high as 52 per cent of farmers reported that their soil softened due to practice of ZBNF in Rabi. Further, 43 per cent of farmers have observed that they are now seeing earth worms in their fields and around one third of the farmers have reported that there is increase in the green cover in the fields (Table 3.1 and 3.2 & Figure 3.1) .

Table 3.1: ZBNF Farmers reported enhanced quality of their land due to ZBNF in Kharif season of 2018-19 (in percentages)

Enhanced Quality	Yes	No	Not aware
	83.0	2.7	14.3

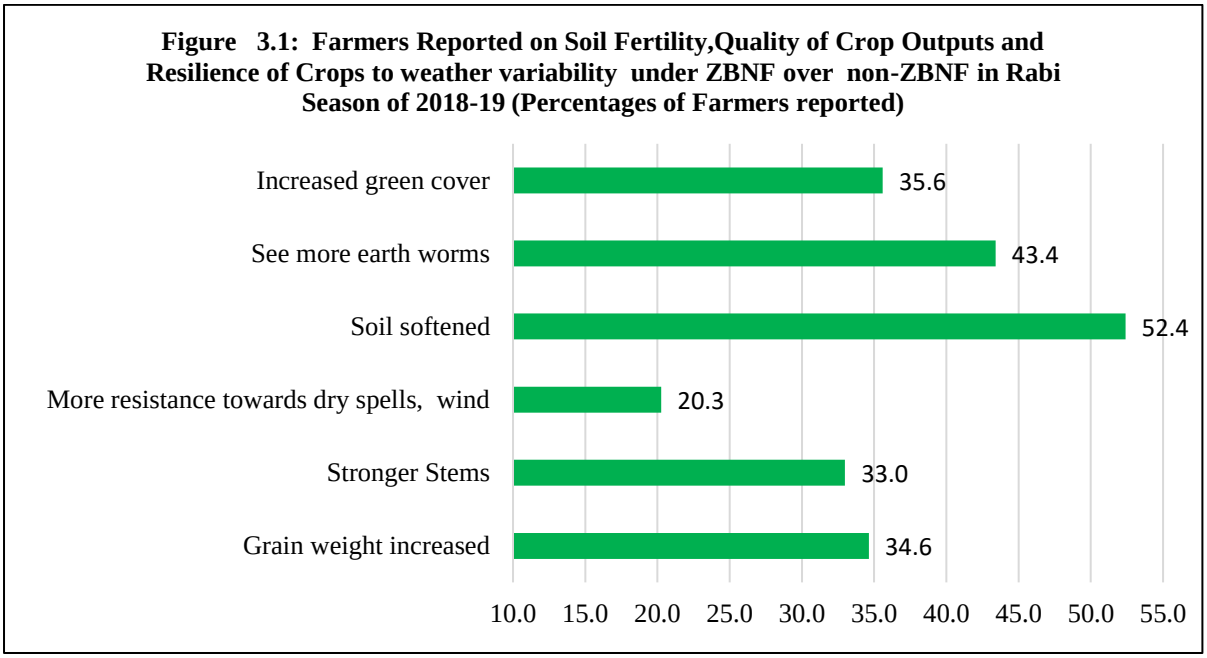
Source: Field Survey

Table 3.2: ZBNF Farmers reported ZBNF practices enhanced quality of land in Kharif of 2018 (in percentages)

Indicators of enhanced quality of land	**Soil softened**	**Now see more earthworms**	**Increased green cover**
	83.38	81.83	56.49

Source: Field Survey

Figure 3.1: Farmers Reported on Soil Fertility,Quality of Crop Outputs and Resilience of Crops to weather variability under ZBNF over non-ZBNF in Rabi Season of 2018-19 (Percentages of Farmers reported)



Source: Field Survey

3.3.3 Yields of Crops

One of the major activities of this study is to collect yield data from crop cutting experiments (CCEs). As the survey for Kharif season commenced in the 3rd and 4th week of November 2018, the study could not do CCEs of all the crops, as by that time many of the crops have been

harvested. The test of significance between the yields of the crops grown under ZBNF and non-ZBNF indicates that there is no significant difference in the yields obtained through CCEs between ZBNF and non-ZBNF in Kharif season (Figures 3.2 to 3.3 & Table 3.3).

Figure 3.2: Yields for Paddy, Maize, Groundnut and Bengal Gram under ZBNF and ZBNF in Kharif Season of 2018-19 (Quintals per hectare)

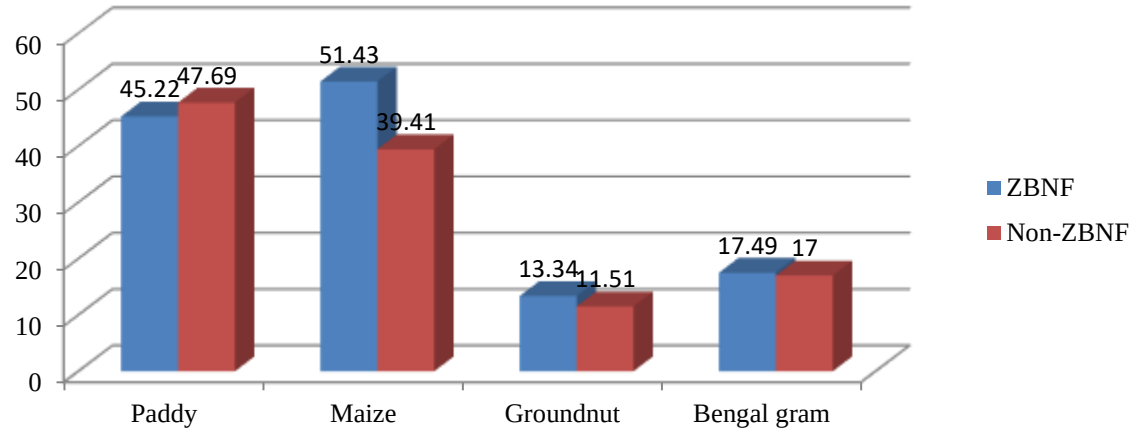


Figure 3.3: Yields of Cotton and Tomato crops under ZBNF and ZBNF in Kharif Season of 2018-19 (Quintals per hectare)

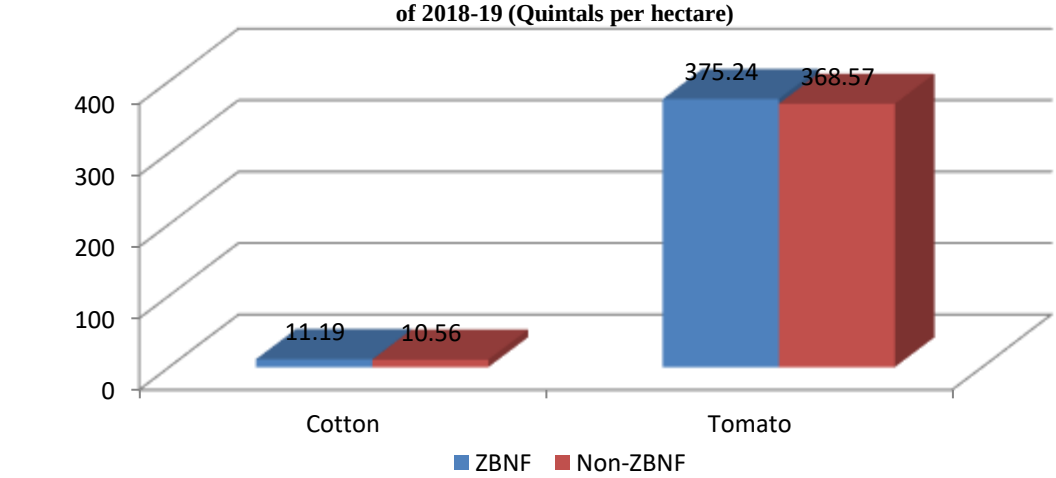


Table 3.3: Differences in Crop Yields under ZBNF and ZBNF in Kharif Season of 2018-19

(Quintals per hectare)

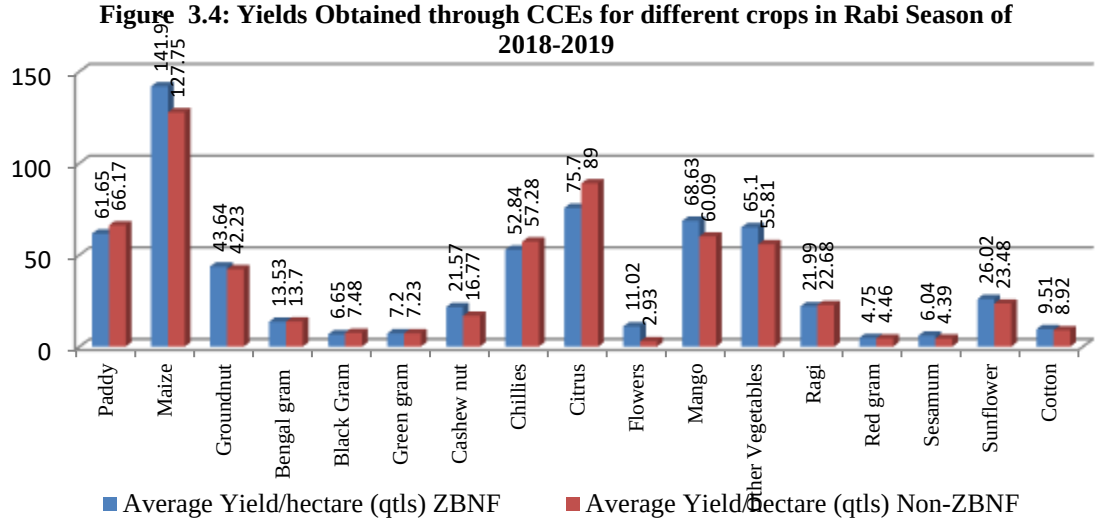
Crop	Yield of Crops Obtained through CCEs		Yield Significantly Differ between ZBNF and Non-ZBNF (Test of Significance)
	ZBNF	*Non-ZBNF*	
Paddy	45.22	47.69	Not Significant
Maize	51.43	39.41	*Significant
Groundnut	13.34	11.51	Not Significant
Cotton	11.19	10.56	Not Significant
Bengal gram	17.49	17.00	Not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

Source: Field Survey

Note: * Significant at 1 per cent level of significance

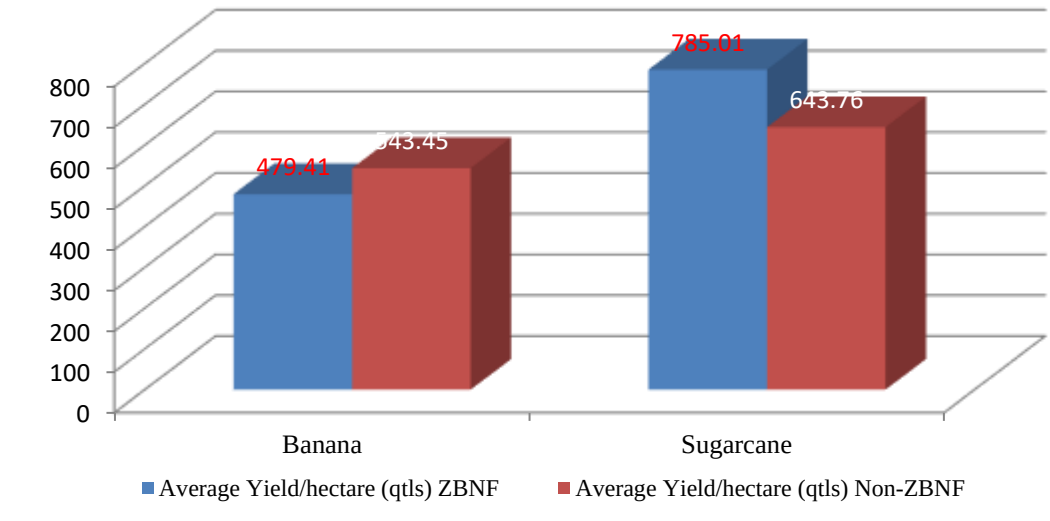
A comparison of yields obtained through CCEs for different crops grown under ZBNF and non-ZBNF of Rabi crops has revealed that there is no statistically significant difference in yields between ZBNF and non-ZBNF in the case of majority of crops considered for the analysis. As a matter of fact, the yields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

Figure 3.4: Yields Obtained through CCEs for different crops in Rabi Season of 2018-2019



Source: Field Survey

Figure 3.5: Yields Obtained through CCEs for Banana and Sugarcane crops in Rabi Season of 2018-2019



Source: Field Survey

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

Season of 2018-2019

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

Source: Field Survey

The use of biological as well as chemical inputs has reflected in the yield of crops. The yields of the crops grown under ZBNF are found to be on par with those grown under non-ZBNF. This is true across all crops. This provides compelling evidence that the yield response to biological inputs is much higher than that of chemical inputs, despite the lower levels (value terms) of use of ZBNF inputs, compared to the levels of use of chemical inputs. This also means that the unlocking of nutrients available in the soil through agroecological practices of ZBNF has resulted in higher yields/ yields on par with those of Non-ZBNF in short run .Hence, it is also an indication that the yields of crops under ZBNF can be higher than those under Non-ZBNF in years to come.

3.3.4 Quality of Crop Output and Resilience of Crops and Human Heath

The farmers have reported in Kharif season that the quality of crop output has improved due to ZBNF. The farmers have considered three dimensions to reflect the quality of output. They include weight of the grains, strength of stems, and taste. Among these dimensions, larger proportions of farmers have reported the crop output of ZBNF is very tasty. Between the other two dimensions, higher proportion of farmers has reported that the plants of the crops have stronger stems and grain weight of crops has increased. As to the resilience of crops

withstanding to dry spells and wind is concerned, 42 per cent of the farmers reported that the crops grown under ZBNF have more resilience to withstand against dry spells and wind. In Rabi season also, farmers also reported that the crops of ZBNF have strong stems compared to crops grown under non-ZBNF. The farmers found more grain weight due to ZBNF. One-fifth of the respondents experienced that crops grown under ZBNF are more resilient towards weather abnormalities like dry spells and wind (Tables 3.5 to 3.7 & Figure 3.1)

Table 3.5: Farmers reported the quality of ZBNF Crops and Output compared to Non-ZBNF Crop in Kharif (in percentages)

Quality of output	Grain weight increased	Stronger Stems
	53.40	60.44

Source: Field Survey

Table 3.6: Farmers reported on the Taste of Crop Output of food crops Produced under ZBNF compared to non-ZBNF crops in Kharif of 2018-19 (in percentages)

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

Source: Field Survey

Table 3.7: Farmers Reported Resilience of the Crops to Weather Variability with the ZBNF crops compared to non-ZBNF crops in Kharif(in percentages)

Resilience to against weather variability	More resistance towards dry spells and or wind
	42.17

Source: Field Survey

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

Conclusions

The agroecological practice of ZBNF have provided ecological services such as improved soil fertility, enhanced quality of crop outputs, crop resilience to climate change, and reduction in health problems related to chemical inputs. The case studies of farmers and input use of biological inputs also provided ecological services. Arresting depletion of natural resource like land is another ecological service provided by agroecological practices of ZBNF. This is evident from the case study of a ZBNF farmer. Soil fertility might have improved through

increased dependency on bullocks for tilling land. This is another dimension of ecological services of ZBNF. The reduction in the use of chemical pesticides due to the use of biological inputs might have reduced environmental pollution. This is also ecological service provided by agroecological practices under ZBNF.

CHAPTER 4

Summary, Conclusions and Policy Implications

4.0 Summary

The basic premise of this study is to assess the impact of ZBNF on farming and farming community in Andhra Pradesh. Firstly, the study focuses on assessing the impact of agroecological practices of ZBNF like use of biological inputs (Beejaamrutham, Ghanajeevamrutham, Dravajeevamrutham, Kashayams and Astrams) for growing crops on production conditions like cost of cultivation of crops, value of crop output including by-products and net crop incomes to farmers and their implications for the relative autonomy of farmers. Secondly, it examines the impact of diversified and intensive use of land through agroecological practices like diversification of crops in terms of raising mixed crops, intercrops, 5-layer models, border crops and bund crops with biological inputs, mulching and waaphasa of ZBNF on fertility of soil through their ecological services. Thirdly, it also focuses on assessing the impact of soil fertility on yields of crops (measured through Crop Cutting Experiments), quality of crop output, and resilience of crops to weather variability and health of the farming community.

The analysis has been conducted basically on the basis of hard data supplemented through the soft data. The study has been conducted in all the 13 districts through a random sample of 130 villages, at the rate of 10 villages from each district, covering a random sample of 1300 ZBNF farmers and 1300 non-ZBNF farmers from the selected villages, at the rate of 10 ZBNF farmers and 10 non-ZBNF farmers per village, in Kharif season. For Rabi season different sample of villages had to be chosen. However, the same scheme of sample design has been followed as per the Kharif. In Rabi, the Study confined to half of the sample size of Kharif season. Thus, a sample of 650 ZBNF farmers and a sample of 650 non-ZBNF farmers are considered, covering totally 1300 farmers. The required quantitative data has been collected through Listing Survey, Farmers Household Survey and Village Survey in the sample villages. The qualitative data has been collected through (i) Focussed Group Discussion with farmers, (ii) Case Studies of farmers, and (iii) Strategic Interviews with District Project Managers (DPMs). The data on costs and returns of crops have been collected from farmers through 2 or 3 visits to the farmers

at their residences during survey in Kharif as well as Rabi seasons. The data on yields of crops has been obtained through Crop Cutting Experiments (CCEs).

The summary of findings emerged from the study are in order.

- The cost of biological inputs and cost of growing crops have come down remarkably due to agroecological practices like biological inputs of ZBNF used in growing crops.
- The net crop incomes of farmers have gone up considerably due to biological inputs.
- The use of biological inputs under ZBNF from locally available ingredients has reduced dependency of farmers on external input markets.
- This reduction in the cost of growing crops implies reduction in working capital required for growing crops under ZBNF and this in turn implies that farmers have freed from credit markets to that extent.
- The increase in the net incomes of crop incomes has unchained farmers from debt to that extent.
- The reduced cost of production of crops due to ZBNF has enabled farmers to withstand against the falling prices of crop outputs in the output markets
- All these impacts of use of biological inputs have improved the relative autonomy of farmers.
- The diversified and intensive use of land with mixed and internal cropping models,5-layer models, border cropping and bund cropping with different crop mixes suitable to the agroclimatic conditions in line with other biological practices like biological input use, mulching and Waaphasa under ZBNF has led to improvement in the soil fertility.
- Increased soil fertility has resulted in the yields of crops of ZBNF (the yields have been assessed with Crop Cutting Experiments) to be on par with /higher than those of non-ZBNF crops both in Kharif and Rabi seasons.
- Increased soil fertility has contributed to ecological services like improvement in the quality of output and enhancement in the resilience of crops against the variability in

weather. Non-use of chemicals has also saved the farming community from health hazards related with storage and use of chemicals.

4.1 Conclusions

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

4.1.1* Unlocking *of nutrients available in the soil through agroecological practices of ZBNF contributed to the growth of crops/plants on par with that of crops/plants of Non-ZBNF that supplied nutrients to soil through external chemical inputs:

- The basic tenet of ZBNF is that the nutrients, required for the growth of crops/plants, are available in the soil itself. Hence, there is no need to supplement nutrients to the soil from external inputs. Therefore, ZBNF contemplates that the release of the nutrients in the soil is enough for the growth of crops/plants. The application of biological inputs that include Beejaamrutham, Ghanajeevamrutham and Dravajeevamrutham facilitate the process of unlocking of nutrients in the soil. The analysis of the use of biological inputs of ZBNF and use of external chemical inputs of Non-ZBNF for growing crops and their relation to the growth of crops, measured through yields of crops, provides substantial evidence to the fact that the unlocking of nutrients in the soil through biological inputs has resulted in the yield of crops that are on par with the yield of the same crops grown with the external inputs. This is true for all the crops, by and large, grown in Kharif and Rabi seasons. The cost incurred for unlocking nutrients available in the soil under ZBNF is far below the cost of external inputs used under non-ZBNF to supply nutrients for obtaining the same level of crop yields. Further, the biological inputs used under ZBNF do not damage the soil fertility, while external chemical inputs used under non-ZBNF cause the damage for which ample evidence is already available in the literature. Thus the yields obtained through the use of costly chemical inputs have also been obtained through very cheap biological inputs prepared from the locally available ingredients without damaging the soil fertility. Thus, the analysis of the empirical data collected in Kharif and Rabi with scientific sample design on costs and yields of crops under ZBNF and non-ZBNF provides compelling evidence to the basic tenet that the unlocking of nutrients available in the soil itself under ZBNF is highly preferable to the use of external chemical inputs under non-ZBNF to provide nutrients for growing crops.

4.1.2 The intensive use of crop land with diversified cropping practices under ZBNF along with the other agroecological practices like application of biological inputs, mulching and whapassa has contributed to the improvements in fertility of soils:

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

4.1.3* The *increased soil fertility due to agroecological practices under ZBNF has contributed to ecological services like improvements in quality of crop outputs and resilience of crops to weather variability:

- The qualitative data collected from farmer households to capture the ecological services shows evidence that such services have resulted from the improvement in the soil fertility due to agroecological practices of ZBNF through conservation, protection and enhancement of the agroecological system. The ZBNF farmers have reported that they have observed improvements in the quality of output of the crops they have grown under ZBNF. They have provided three indications, viz., improved grain weight of food grain crops, stronger stems of plants of crops and increased taste of crop output, in support of their perception that quality of output has increased. They asserted that there is improvement in all these dimensions of quality of output of ZBNF compared to that of non-ZBNF. They further report that the resilience of crops to the weather variability like scarcity in rain fall and winds has increased due to ZBNF practices.

4.1.4 The ZBNF practices led to t***he pattern of changes in input use with the positive results in this type of agriculture: Complete reduction of the use of chemical pesticides to control pests, signalling to the ecological services like reduction in the environmental pollution; and complete replacement of chemical inputs by biological inputs led to conversion of saline land in to fertile land and thereby arresting the depletion of natural resources like land; and reduction in the incidence of health problems (hazards) for the farming community related with the use and storage of chemical inputs; and increased use of bullock services for tilling the crop lands, indicating the improvements in soil fertility.***

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

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

- The biological inputs have replaced the chemical inputs due to ZBNF. This has reduced the dependency of farmers on external inputs. They have also reduced the cost of cultivation of crops and thereby reduced the working capital requirements for growing crops to that extent. This has led to the reduced dependency of farmers on credit markets. The reduced cost of cultivation of crops has also led to the increased incomes of farmers, given the yields of crops. The increased incomes have delinked the farmers from debt trap. The reduced cost of production of crops enabled farmers to withstand against the falling prices of crop outputs. The income from mixed crops, border crops and bund crops, and income flows from these crops and 5-layer models of growing crops ensured the continuous income flows from agriculture and consequently the reduced variability in the income flows throughout the agricultural year. Further the unlocking of nutrients available in the soil through agroecological practices of ZBNF ensured crop yields to be on par with the yields of crops under non-ZBNF. Thus, ZBNF has reduced uncertainties in crop yields, and it is evident that the farmers are able to become resilient to the risks that the farmers generally encounter in the production process of crops due to ZBNF. This has ultimately enabled farmers to harness relative autonomy from all these risks related to different input and output markets.

4.1.6 ZBNF ensures food and nutritional security even for the small and marginal farmers in the context of declining per capita availability of land:

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

4.1.7 The multiple benefits of ZBNF should induce farmers to adopt ZBNF. The farmers have reported that the adoption of ZBNF is on the increase overtime:

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

Figure 4 1: Year-wise Season-wise Per Farmer Average Area under ZBNF (Acres)

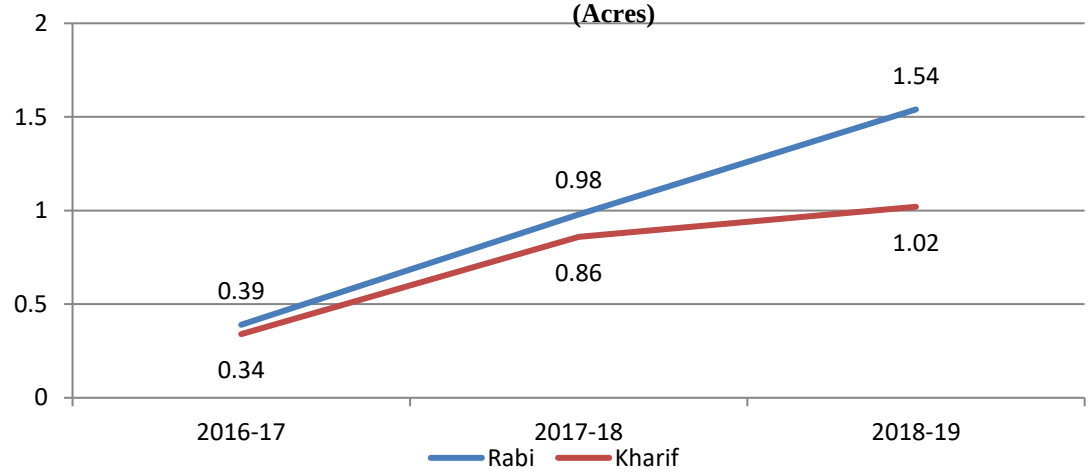
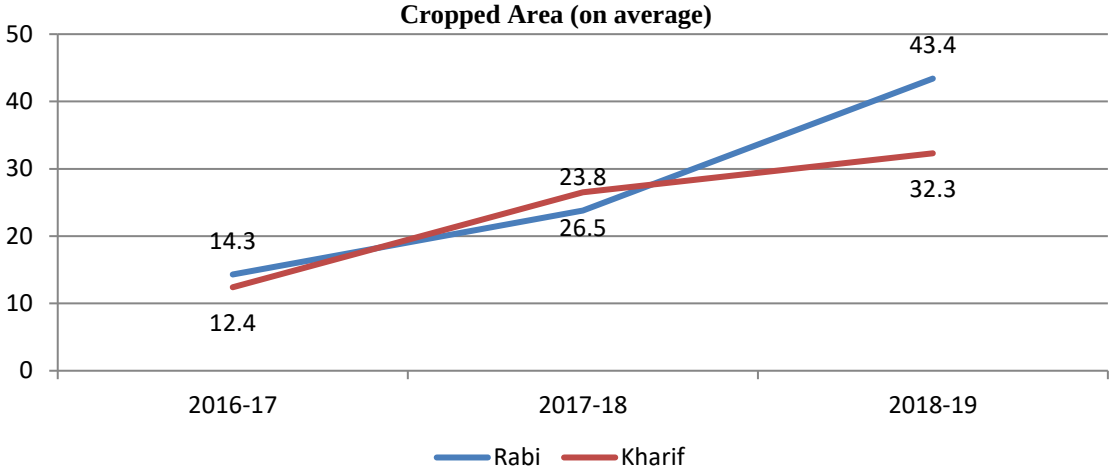


Figure 4. 2: Year wise Season wise Percentage of Area under ZBNF in Total Cropped Area (on average)



4.2 Challenges and Policy Implications

- **T**he analysis has identified four challenges to be addressed by RySS. They include strengthening the extension services; preparation/purchase of biological inputs of ZBNF; marketing support for marketing ZBNF crop outputs; and facilitating farmers to adopt innovative methods of growing crops.

- It has been brought out by the farmers that they do not have adequate exposure to the method of ZBNF practices. This is more in the context of preparation and application of Kashayams and Asthrams to control pest attacks on crops. The timely availability of extension services to the farmers encourages farmers to adopt ZBNF practices. Hence, there is a need to strengthen the extension services in the villages.

- Farmers have faced challenges in preparing ZBNF inputs due to labour shortage. Further non-availability of readymade ZBNF inputs also has discouraged farmers to adopt ZBNF practices. This issue can be addressed through supply of biological inputs of ZBNF by NPM shops in the villages. This results in the reduction of cost of labour in preparing inputs due to economies of production experienced by the NPM shop owners in preparing inputs.

- The market support for ZBNF crop outputs enhances further net incomes of farmers. The market support also induces farmers to adopt and expand area under ZBNF. The farmers have explored new market channels in marketing by directly selling crop outputs to consumers without the involvement of middle men. In order to obtain higher prices in the local markets and for selling the crop outputs in the external markets, farmers' producer organizations should be promoted. This is evident from the experiences those are in practice at present in some of the districts

- The innovative models of crop growing should be wide spread among the farmers. Integrating ZBNF farmers with all the relevant government programmes may enable farmers to adopt these models.

APPENDIX

APPENDIX 1

Experiences of Farmers in Adopting Biological Practices (Biological Inputs)
Evidence from Focused Group Discussions

Introduction

Five focused group discussions were held in each of the sample villages across all the 13 districts. In all, 65 focused group discussions have been held in the state. The discussions have been centered broadly on three issues, viz., the constraints faced by farmers in realizing benefits from ZBNF; the association between the constraints encountered by the farmers and the overall performance of ZBNF in the villages, which was captured by a score assigned by the focused group farmers on a sale of 1 to 10; and the suggestions offered by the farmers for addressing the constraints to attain the potential benefits from ZBNF.

Constrains identified from the focussed group discussions are broadly grouped into four categories. They are: awareness about ZBNF among the farmers; availability of the resources required to prepare the inputs required for organising agriculture under ZBNF; and mobility of crop land among farmers to adopt ZBNF (tenancy conditions); and marketing support for ZBNF outputs.

Awareness reflects the functioning of the extension agency of ZBNF. Similarly, the inadequacy/ absence of resources required in terms of local cows to supply urine, dung and

other related dairy products to be used as ingredients for preparing inputs for ZBNF. Further, scarcity of family/hired labour for preparing inputs of ZBNF may act as a constraint for adopting ZBNF. The scarcity is also an outcome of other aspects of human labour, like the non-inclination of labourers to participate in the preparation of ZBNF inputs and application of such inputs due to the foul smell of inputs. Thus, a small proportion of labourers (those who are labour force is willing to do such work. Further, the labourers dislike to participate in the preparation of inputs due to its time-consuming nature.

The existing tenancy contracts in terms of smaller period like one season /one year duration of lease period may not enable tenant farmers to realise the potential benefits of ZBNF and hence, tenants may demand for a longer period of contract. Thus, there is every chance that existing tenancy contracts may become barrier for the free mobility of land among farmers and hence tenant farmers may have lower chances of adopting ZBNF for organising agriculture.

The adequacy or otherwise of marketing support to market ZBNF outputs also reflects on the functioning of the extension agency under the ZBNF programme. The farmers growing crops under ZBNF have expected that the ZBNF products should fetch them higher prices over those of non-ZBNF, as their products are chemical-free and good for the health of the consumers. In the absence of the suitable market arrangement, the farmers may not show interest to grow crops under ZBNF. This affects negatively the expansion of area under ZBNF and also discourages the farmers, who would like to grow crops under ZBNF. However, farmers also have grown crops under ZBNF in the part of their cropped area only for the household consumption, due to lack of suitable market arrangements. They may also grow crops under ZBNF in the part of their cropped area in the beginning to experiment with ZBNF and later to expand the area under ZBNF if they convince themselves about ZBNF.

Awareness of farmers has been measured in terms of the percentage of farmers aware of ZBNF from among the farmers in the village. The availability of resources required have been measured in terms of (i) percentage of villages reported the scarcity of desi cows, and (ii) percentage of villages reported scarcity of human labour for preparing inputs of ZBNF. Similarly, the percentage of villages, which reported the existence of tenancy contracts, face serious constraint for the adoption of ZBNF, as also the percentage of villages, which reported the lack of supporting marketing arrangements.

In order to analyse the association between the performance of ZBNF and the constraints identified, the villages have been grouped into four categories and the status of the constraints

against each category of the villages is matched. The villages have been classified into four categories, viz., average performance villages (with a score of 1-3); moderate performance villages (with a score of 4-6); high performance villages (with a sore of 7-9) and very high performance villages (with a score of 10).

The Analysis

The analysis conducted in this regard is in order.

The Constraints Identified in Realising Benefits of ZBNF

The results from the focussed group discussions have revealed that the awareness levels in terms of percentage of farmers aware of ZBNF have varied across villages and districts. Moreover, it has also varied among the villages in a district also. The very pertinent issue that has emerged from the data is that the variations across the villages within the districts are larger than the same across districts. This result suggests that adequate staff should be provided at the village level to reach out each and every farmer within the village. Further, it is evident that the awareness levels are at lower level among the marginalised groups like Scheduled Castes. Hence, focus should be on these communities also. The exposure to extension agencies enhances the chances of adopting ZBNF practices. Thus, extension services that have cascading effects in deriving benefits from ZBNF are very important.

The dung, urine and dairy waste products of local cows as ingredients in the preparation of inputs constitute the central component of ZBNF. Hence, the availability of local cows is fundamental for organising agriculture under ZBNF. The scarcity of local cows as a constraint has been reported in all the villages across the districts. However, farmers have adopted ZBNF despite the scarcity of local 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 goshals 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 the supply source for cow dung and cow urine to farmers in other parts of the districts. But, it is also reported by the farmers from the villages of dry land districts like Ananthapuramu that they sell cows due to lack of fodder. 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 evident that family labour use has increased with the adoption of ZBNF. This is due to the need for more family labour time in the preparation of inputs as well as other operations, including periodic visit and monitoring of farms. Moreover, preparation of inputs of ZBNF is time consuming process. It is also clear from the larger farm households with more number of agricultural workers have higher chances of adopting ZBNF. 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. In addition to this, the households who depend more on agriculture for their livelihood have higher inclination to adopt ZBNF. The farm 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 do not 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 labour from the labour market, causing scarcity of labour for the preparation of ZBNF inputs. Moreover, due to the foul smell of ZBNF inputs, labourers have shown lack of interest to offer their services for their preparation. 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.

Scarcity of ZBNF inputs is another constraint reported by the farmers in the focussed group discussion. They have reported four reasons for this, i.e., the knowledge required to prepare Kashayams and Astrams to control pest is not provided to many of the farmers; the leaves required to prepare these inputs are not available in some villages and hence, farmers are not able to prepare these inputs by themselves; and the same are not available in readymade form in the markets. The 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.

Tenancy is one more constraint reported by the farmers in the focussed group discussions. The existing tenancy contracts are not suitable to conduct land lease contracts under ZBNF. The tenants reported that crop yields are lower during the first three years under ZBNF and yield improvements can be realised only after the third year. This means that tenants are more likely to adopt ZBNF mostly when the tenancy period is, at least, five years. They have also reported that the contribution of ZBNF inputs to yield improvements cannot be realised in a single season, but spread over years due to the positive externalities of the inputs. These considerations represent a major problem for pure tenants. In some the villages, the contract

period for tenancy has been extended by five years to enable the pure tenants to get into cultivation. It is also reported that the owner-cum-tenant farmers have used the land leased in for chemical-based agriculture and their own land for ZBNF cultivation as they are experimenting with ZBNF on their own land. Hence, there is need to address the tenancy issue under ZBNF as the tenancy is wide spread in the villages across all the districts of Andhra.

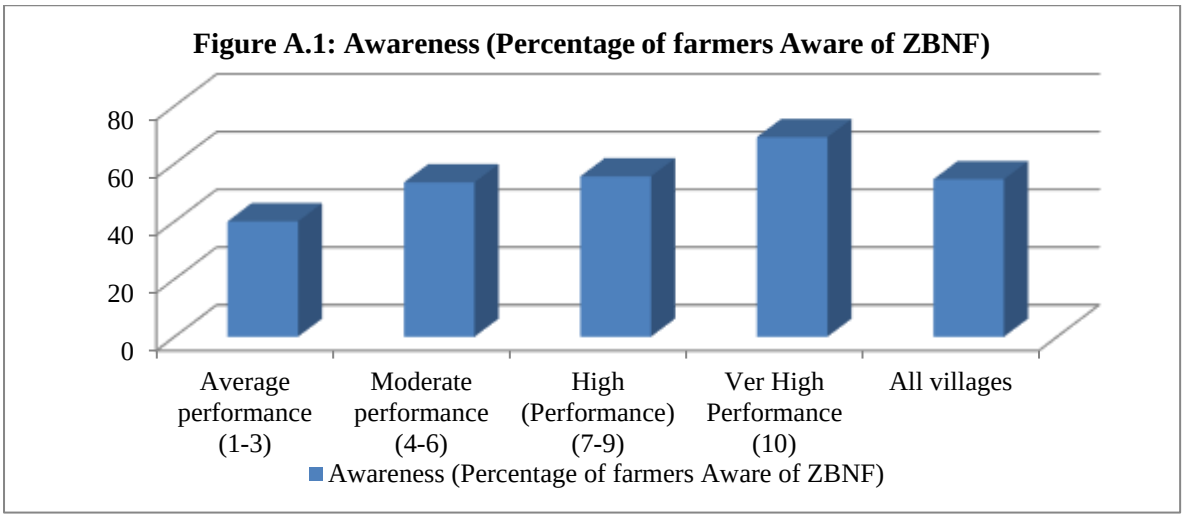
Marketing is one of the constraints prominently reported by the farmers in the focussed group discussions in all the villages across all the districts. There are some farmers growing crops under ZBNF to meet family consumption. This is also the opportunity for the farmers to experiment with the ZBNF. Some other farmers have also shared the ZBNF outputs to friends and relatives, apart meeting their family consumption requirements. The friends and relatives have also started growing crops under ZBNF by realising the benefits of ZBNF products in terms of their taste and health benefits. 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 orders for their outputs 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. Whole sale 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 are demanding that ZBNF farmers should be linked with the departments of government; and particularly, the public distribution systems should be utilised for the market linkages with the ZBNF product markets. These channels are fine to establish market linkages for the food grains. 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. Interestingly, some of 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.

Association of Performance of ZBNF and the Constraints in Realizing the Benefits from ZBNF

Results also show that the percentage of farmers, who are aware of ZBNF, is found to be the highest (69 percent) in very high performance villages, but the lowest (40 percent) in average

performance villages. Further, it is increasing with the increased performance of the villages (Figure A.1). Thus, the awareness has turned out to be one of the dominant factors that have determined the performance of the villages.

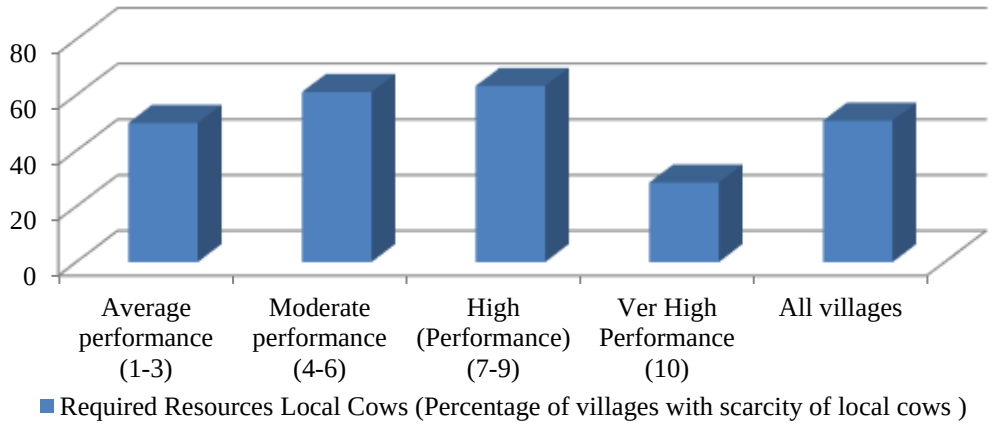
Figure A.1: Awareness (Percentage of farmers Aware of ZBNF)



Source: Field Survey

The resource constraint in terms of non-availability of desi cows which is crucial for ZBNF is found to be the lowest in the very high performance villages. But, interestingly, this constraint is felt more by the farmers among high performance villages like the moderate and average performance villages. This implies that the villages, which have experienced the constraint of local cows, have exhibited high performance. Then, the issue is how the farmers in these villages have overcome this constraint. The development of markets for cow urine, dung and other dairy products in these villages and/ or nearby villages, and /or sharing of these cow related resources within the villages and/or accessing from *gosalas* nearby have enabled the farmers in these villages to overcome the scarcity of local cows. This is further reinforced by the evidence that the absence of NPM shops as well as improper functioning of such shops is also felt by the farmers in the high performance villages (Figure A.2).

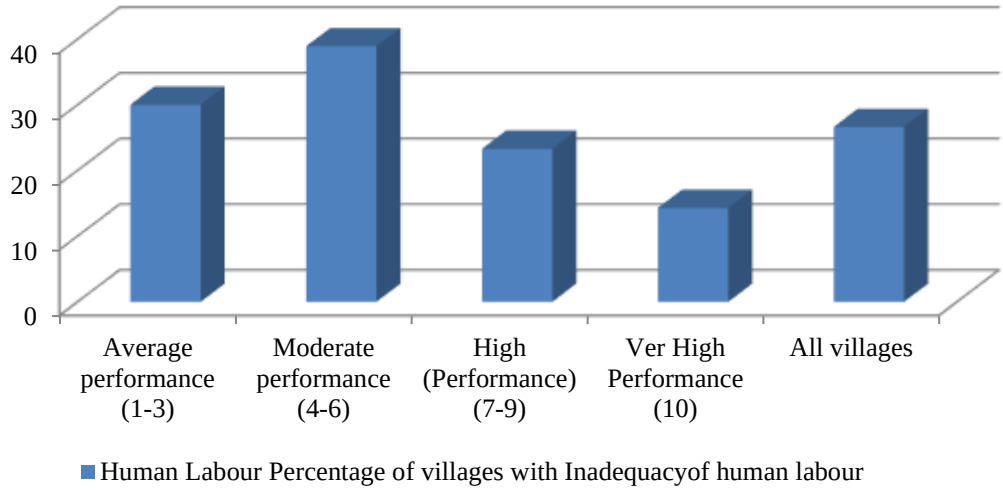
Figure A.2: Required Resources Local Cows (Percentage of villages with scarcity of local cows)



Source: Field Survey

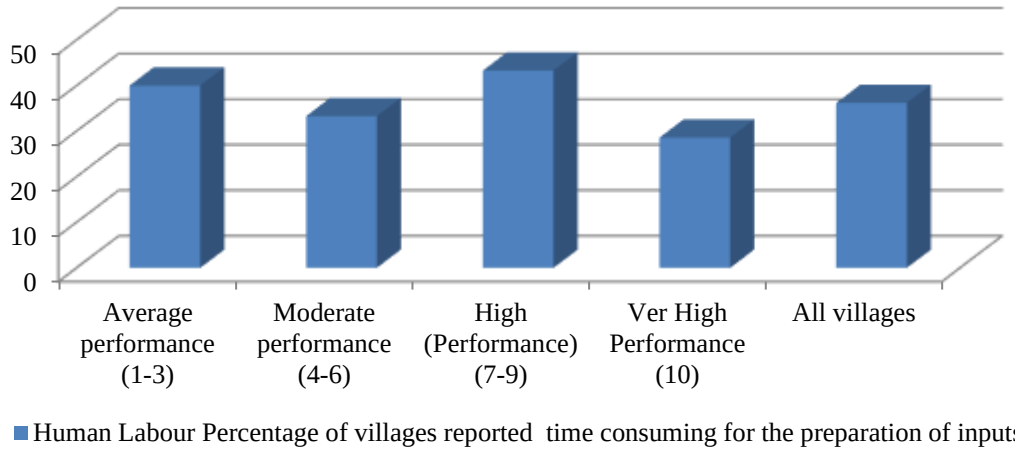
The scarcity of labour for the preparation of inputs is found to be lower in very high performance villages as compared to all the other categories of villages. Thus, it is evident that the scarcity of labour is a very dominant factor determining the performance of villages. Similarly, in contrast to other categories of villages, the opportunity cost of labour is found to be lower in the very high performance villages. Hence, the wage labour in other categories of villages did not incline to participate in the preparation of inputs as they get more wage incomes than they get by participating in the preparation of inputs of ZBNF (Figure A.3 and A.4). The disaggregated data has shown that the districts with high intensity of cropping and/or availability of opportunities for off-farm and non-farm employment have encountered the labour scarcity and thereby exhibited lower performance.

Figure A.3: Human Labour Percentage of villages with Inadequacy of human labour



Source: Field Survey

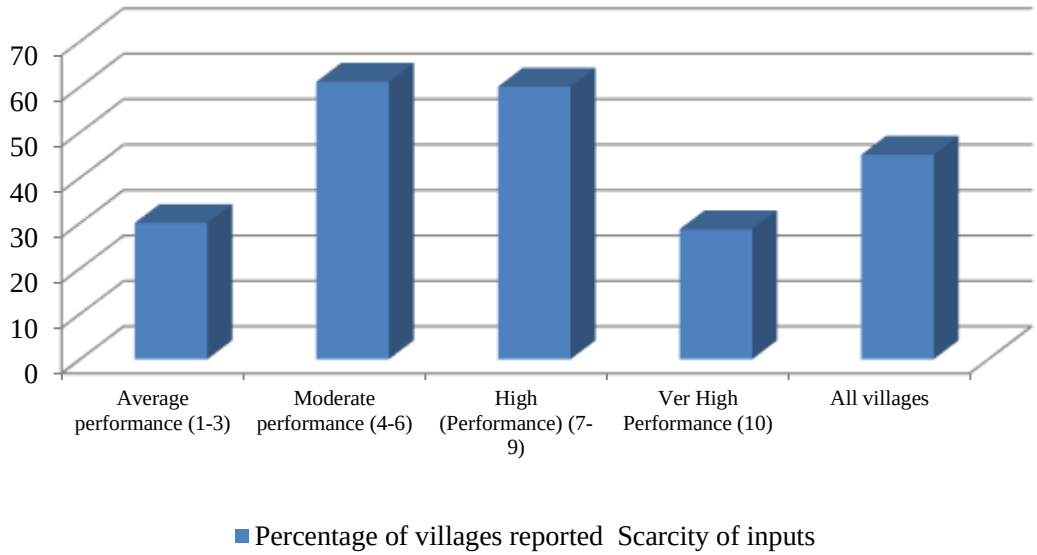
Figure A.4: Human Labour-Percentage of villages reported time consuming for the preparation of inputs



Source: Field Survey

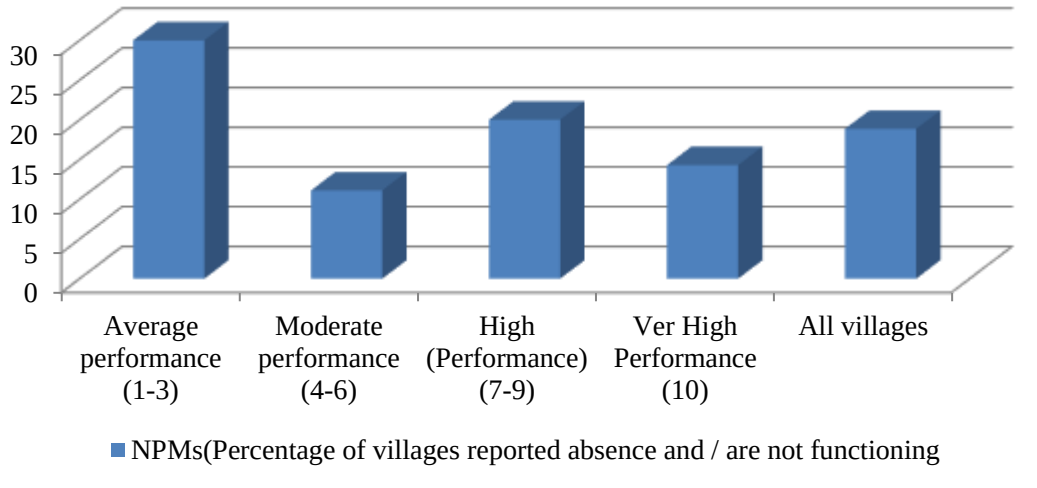
The non-availability of ingredients like leaves and other related materials to prepare inputs of ZBNF is less pronounced in very high performance villages. It is less pronounced in the average performance villages. Thus, the scarcity of raw materials required to prepare inputs of ZBNF has determined the performance of villages. The district level data has shown that the dry land and rainfed districts have experienced scarcity of the ingredient for the preparation of the inputs of ZBNF. Interestingly, the villages with scarcity of ingredients have exhibited high performance (Figures A.5 and A.6). This indicates that the farmers in these villages have obtained readymade inputs from nearby NPM shops and/ or purchased the ingredients from the nearby villages.

Figure A.5: Percentage of villages reported Scarcity of inputs



Source: Field Survey

Figure A.6: NPMs Percentage of villages reported absence and / are not functioning

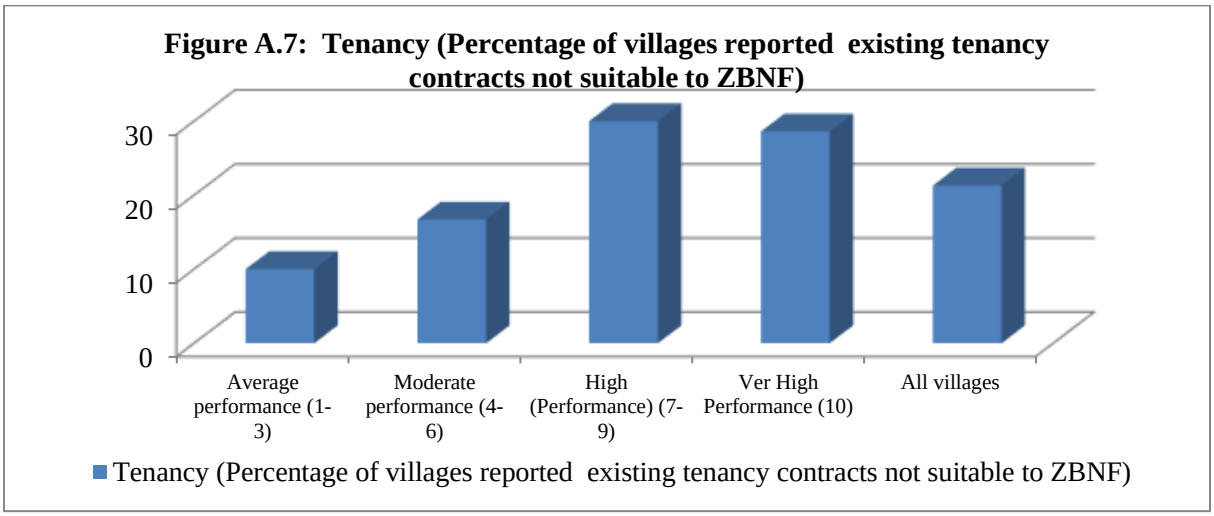


Source: Field Survey

The issue of existing tenancy contracts in terms of short duration of contracts has become a constraint for adopting ZBNF in the rented lands by the tenants in high performance and very high performance villages. This is because of the fact that for the tenant farmers to realize the full benefits of ZBNF, the duration of tenancy contract needs to be, at least, for five years. But, the issue of tenancy contracts has not been a dominant constraint in the case of the average and moderate performance villages. This is due to the fact that the tenant farmers have not adopted ZBNF and hence, they have not negotiated for extending lease period for longer period and/or

the land owners and tenants mutually agreed to extend the lease period for at least five years. But, the issue is how come the villages with tenancy constraint have exhibited high performance and very high performance. The high performance villages have also encountered the scarcity of labour due to higher wages in non-agricultural activities. Further, they have also experienced the problem of non-availability and/or not functioning NPM shops. But, these villages have not experienced the scarcity of labour as compared to the average and moderate performance villages. This means that the farmers in these villages are largely dependent on family labour for adopting ZBNF. Moreover, these villages also have experienced tenancy constrains due to non-suitability of existing contracts to adopt ZBNF (Figure A.7). These villages have the practice of growing crops under chemical-based agriculture in leased in lands and adopting ZBNF in the own lands. These farmers are most probably owner-cum-tenant farmers of small landholders in high performance villages. Similarly, farmers in the very high performance villages might have overcome the same problem of tenancy by adopting a strategy similar to those in the high performance villages.

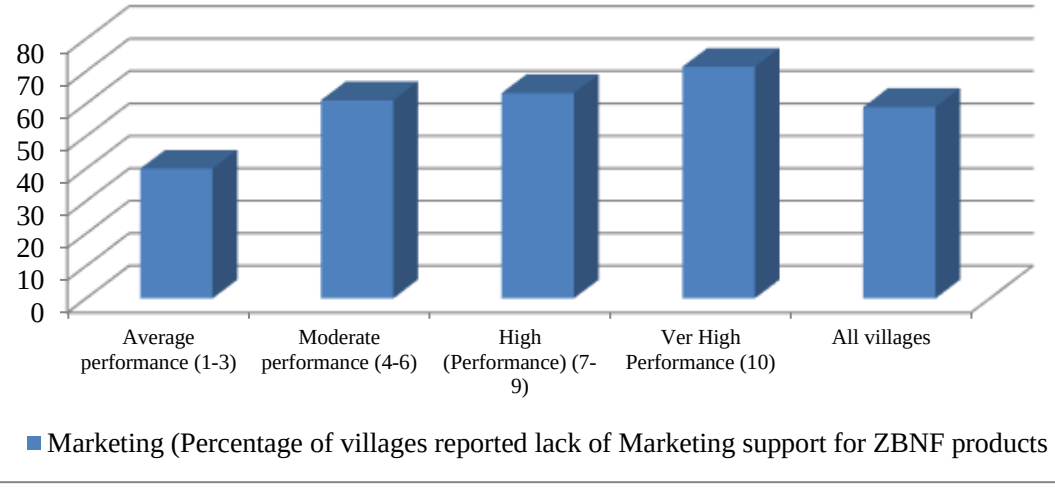
Figure A.7: Tenancy (Percentage of villages reported existing tenancy contracts not suitable to ZBNF)



Source: Field Survey

Interestingly, the lack of market support for ensuring assured market and better prices for ZBNF outputs has become major constraint both among the high and very high performance villages as compared to the other categories of villages. This is understandable because of the fact that the vibrancy of ZBNF is pronounced in the high and very high performance villages requires supporting marketing arrangements to dispose agricultural outputs at premium price (Figure A.8). However, the farmers in these villages may explore the informal channels of marketing for their products through modern technology. The summary Table A.1 is presented below.

Figure A.8: Marketing (Percentage of villages reported lack of Marketing support for ZBNF products



Source: Field Survey

Table A.1: Correlates of Performance of ZBNF in the Villages of Andhra Pradesh

Sl. No	Description of the correlates	Distribution of villages by performance levels				
		Average performance (1-3)	Moderate performance (4-6)	High (Performance) (7-9)	Very High Performance (10)	All villages
1	Awareness (Percentage of farmers Aware of ZBNF)	40.0	53.5	55.6	69.2	54.6
2	Required Resources					
a.	Local Cows (Percentage of villages with scarcity of local cows)	50	61.1	63.3	28.6	50.8
b.	Human Labour					
i	Percentage of villages with Inadequacy of human labour	30.0	38.9	23.3	14.3	26.62
ii	Percentage of villages reported time consuming for the preparation of inputs	40	33.3	43.3	28.6	36.2
3	Percentage of villages reported Scarcity of inputs	30	61.1	60.0	28.6	45
4	Tenancy (Percentage of villages reported existing tenancy contracts not suitable to ZBNF)	10	16.7	30	28.6	21.3
5	Marketing (Percentage of villages reported lack of Marketing support for ZBNF products	40	61.1	63.3	71.4	59.0
6	NPMs (Percentage of villages reported absence and / are not functioning	30	11.1	20	14.3	18.85

***Source*:** Field Survey

APPENDIX 2

The Case Study Perspective on Changes in Farmers' Production Conditions Due to Agroecological practices of ZBNF

Case Studies provide additional qualitative information and help to understand the various dimensions of the phenomena under observation. The case studies are unique in their nature and are not repetitive in narrating the experiences of individual farmers in regard to ZBNF.

The use of inputs of ZBNF which are prepared with cow urine, cow dung and dairy products like curd, buttermilk along with some local material like dry leaves and mulch is another fundamental feature of ZBNF which stands out replacing the chemical fertiliser and pesticide. The case studies cover the experiences of individual farmers in regard to preparation and use of ZBNF inputs and cropping patterns. Further, the experiences of farmers in deriving economic and non-economic benefits from ZBNF are also captured.

Marketing of crop outputs of ZBNF at premium prices due to their taste and healthy features is also a challenge for the farmers. The marketing channels used and the experiences of individual farmers in marketing the crop outputs of ZBNF are captured through these case studies.

The experience of farmers in regard to drivers and barriers which they have encountered in their journey through ZBNF and the suggestions offered by them to overcome the barriers is also documented through these case studies.

Changing Land Use Pattern and Cropping Pattern

The seven case studies of farmers spread across the districts of Andhra Pradesh clearly reflect the successful strategies adopted by the RySS in bringing about changes in land use pattern and cropping patterns. It is evident from the case studies that the farmers have adopted mixed cropping, inter cropping, border cropping, and bund cropping methods of growing. They have

also adopted the 5-layer model and 36*36 models in growing crops in cultivating different varieties of crops to ensure steady and regular incomes. The farmer households could generate additional income from the bund and border crops. The tallest contribution of ZBNF is changing the cropping pattern from mono to poly Cropping.

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 with intercrops like chillies/ benda/ vegetables like brinjal/ flowers/ colocasia (chema)/ turmeric/ ginger. iii). 25 multiple seasonal based horticultural species, 25 types of leafy vegetables, curry leaves, and 25 types of guards in 36*36 models with 5-layer model. iv). 219 coffee plantation, 40 dragon fruit, 25 neem trees, 25 orange, 25 munaga,25 banana, 15 yalikulu, 5 lavanga,10 cherry, 2 panasa, 4 chinta, 1 mango, and 2 nerada in the coffee plantations under the 5-layer model. v). Five-layer model of oranges with poly crops**;** 36.*36 model with roots, tubers (radish and onion), teega jathulu/guards varieties (cucumber, bitter guard, country beans, ridge guard, bottle guard and snake guard), curry leaves (sorrel leaves, spinach, fenugreek leave and amaranthus), 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, custard apple, coconut, sweet lime and citrus), trap crops and flowers.

The existing coffee plantations in the hilly areas have been transformed into the 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, the border and bund crops raised by these farmers has ensured considerable income to meet the investment for raising the main crops in their fields. This has resulted in intensive use of land throughout the year. Local variety of seeds has been used for raising crops under ZBNF. The case studies clearly show that the 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 have been put to use effectively by the farmers under different models of growing crops under ZBNF which also ensured food security and balanced diet. The farmers have also reported that the gestation period required to start yielding of orange garden has declined considerably under ZBNF compared to the gardens grown under Non-ZBNF practices. Keeping in mind the agroclimatic conditions of the region, the principle of 5-layer cropping pattern with combination of suitable crops in each layer is recommended for cultivation under ZBNF in this region.

Changing Input Use, Output Levels, Output Prices and Marketing, and Incomes to Farmers

The case studies of farmers clearly show that the use of chemical fertilisers and pesticides in farming has come down to zero level. The use of Beejammurtham, Ghanajeevmrutham, Dravajeevamrutham, kashayams and Astrams has entered the input combinations of crop growing practices under ZBNF. The inputs of ZBNF are of low cost and can be prepared locally by the farmers using the locally available ingredients like 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 their own labour and locally available ingredients for preparing the inputs. This has not only led to the regaining of the lost employment under chemical farming but also brought down the input costs in farming. Further, the incidence of occurrence of seasonal pests to the crops also declined due to ZBNF. The farmers are saved from the exorbitant costs of chemical pesticides and are also protected from the health hazards caused due to the use of chemical pesticides. They reported reduced health costs of the family members as they are saved by not inhaling the powerful chemical pesticides stored in the houses or when sprayed in the fields. It is also reported that as the use of family labour increased under ZBNF, the paid out costs in farming have also come down to that extent.

The next issue in question is, whether these changes in type and combination of inputs have resulted in the increase of crop yields grown under ZBNF. It is evident from the case studies that the yields of horticulture crops, vegetables, pulses, oilseeds, sugarcane (under non-flood irrigation) have gone up. This also implies that the crops grown under dry land, rain fed and irrigated dry conditions (providing irrigations when required), the inputs of ZBNF have contributed to enhancements of crop yields. But, the paddy cultivation under flood irrigation conditions, especially under public canal irrigation in delta regions has shown mixed results in the enhancement of yields. The case studies in this regard have attributed this to two reasons: The first being insufficient quantity of inputs used under ZBNF. This is evident from the low cost-low yield relationship in the case of paddy in the first year and the low cost-high yield relationship in the subsequent years. It is also reported by one of the farmers that many a time, the dosage prescribed by the ZBNF staff is not enough for the crops and has cited the example of the banana bunches in his field which are not robust in size when compared to the bananas in the neighbouring field which is under inorganic farming. So he says more inputs are to be used than prescribed quantities for getting output in good quality and quantity. He expressed that soil testing is important before prescribing the dosage. Though the yields are low in his farm, he is able to manage because of the low production cost.

The second reason cited is wrong proportion and wrong combination of ingredients used to prepare the inputs. Due to lack of continuous and effective monitoring by the extension agencies, the farmers often made mistakes in preparation of the inputs which is more so in the preparation of kashayams and astrams at the village level. It is not out place to recall the focussed group discussion held in one of the villages of Kadapa District where the farmers reported that the astrams prepared and used by the farmers under ZBNF could not control the pests on the chilly crop. This provides substantial evidence that the right mix of ingredients in preparation of astrams and kashayams does matter in getting good yield.

Then the other issue under observation was whether the incomes of the farmers have increased due to adoption of ZBNF. The case studies have brought out clearly that the incomes of the farmers have increased due to increase in the yields due to ZBNF. Changes in the cropping patterns from mono to poly cropping, and rising of border and bund crops have resulted in higher yields and also ensured continuity of incomes.

The case studies indicate that the farmers could have derived more income under ZBNF, had there been proper marketing support in place for them. It is observed that farmers adopted different channels to market their produce as: some farmers have sold through their collectives while a few sold their produce through linking with Government Department like anganwadi centres (AWC) and government market yards. One farmer is found to be utilising information technology and market melas to develop market linkages with the far off customers. Another farmer has explored his market through social networks. One farmer even tried to link with private companies but was not successful. Farmers maintained links with local and external markets in Telangana and Andhra Pradesh to sell their produce. It is observed that supplying to the external markets fetched them better prices compared to selling in local markets. For example, one farmer reported that donda vegetable fetched him Rs.20/- per kg in the local market but he could sell the same in Hyderabad at Rs.40-50 per kg. The farmers faced a number of problems in marketing including difficulty in establishing the differentiation of ZBNF products from non-ZBNF products because of which they could not claim a higher price for the ZBNF output. One farmer has suggested that certification of ZBNF farm produce is essential for informing the consumers that the produce of ZBNF is chemical free. This will be helpful for the farmers in obtaining premium price for ZBNF produce. He has also suggested that the ZBNF farmers have to be given ZBNF identity cards for selling ZBNF produce in the Rythu Bazaars. Thus these case studies clearly provide evidence that the farmers can increase their incomes further if proper marketing support is provided by the RySS.

CASE STUDY 1

Five-Layer Model in Upland Areas of Krishna District

Mahalaxmudu is 33 year old and a resident of Vadlamanu village of Agiripalli mandal in Krishna district. He used to help his parents in their farming activities since his childhood. He had developed interest in agriculture but his parents wanted him to pursue higher studies and get a good job and settle well in life unlike them. He studied M.Sc and subsequently he did B.Ed also. As a science student, he has developed interest in the areas of environment and global warming. He used to listen, read and follow the current discussions and deliberations on the issues relating to causes, consequences and remedial measures to curb global warming. After completing his studies he got employed as a lecturer in one of the corporate colleges in the nearby urban area. He was not comfortable and found the job to be very stressful and monotonous. As there was no job satisfaction he left the job and meanwhile he came to know about ZBNF that addresses the concerns of global warming as well. He was aware of the crisis conditions created by the chemical- based agriculture which was practiced by his parents all along; and he was determined that he should do something different and not cause damage to the environment. His life ambition of working towards curbing of global warming has profoundly motivated him (the educated farmer) to get in to ZBNF four years back. He is happy that he is able to work and contribute to environment protection through ZBNF.

He has six acres of land at his disposal of which three acres is what he has leased from his relatives. He brought the entire land under ZBNF cultivation. He has 4.5 acres of mango garden and is growing paddy in 1.5 acre of his own land. In the leased land, he is growing paddy in Kharif followed by green gram in Rabi season. He has adopted the Five-layer- model of growing crops in his mango orchard. He has grown 18 varieties of leafy vegetables and other vegetables in his mango orchard as intercrops. This farmer has grown red gram as border crop along with some bund crops. He now gets continuous income from these crops. He is very enthusiastic and has also experimented with different periods of sowing, the number and dosage of application of Dravajeevamrutham, etc. He himself prepares all the inputs of ZBNF for the use in his field. He also experiments with kashayams and astras. He prepares Jeevamrutham with different ingredients. He meets different scientists to acquire new knowledge and experiments with the newly acquired knowledge. He is also a good teacher and delivered lectures in the agricultural programmes on TV channels on the preparation of different inputs of ZBNF. He also shares the outcomes of his experiments on ZBNF with his fellow farmers. He has experimented ZBNF practices in his brinjal field with carrot as intercrop.

He utilises information technology for marketing his produce. He participates in different market melas for marketing his agricultural products and to establish contacts with the consumers and tries to widen his marketing network. He transformed himself from ***Learning to Earning*** farmer and has become a source of inspiration to many fellow farmers.

He has reported that he is greatly inspired by the lectures of Sri T. Vijayakumar, Adviser, RySS and Sri Subash Palekar. In turn, he is motivating other farmers and promises to work like a warrior and spread ZBNF practices among the farming community. He proudly claims that he is able to transform other farmers by sharing his knowledge and experiences in the experimentation on ZBNF.

CASE STUDY 2

Inter Cropping in East Godavari District

Sri G.Srinu, from Bendupudi village in Tondengi mandal of East Godavari district was motivated by ZBNF staff to undertake natural farming. He, jointly with his father, Shri Ranga Rao, is cultivating 2.5 acres of leased land. In 25 cents land, he grows vegetable, in 95 cents he planted banana with flower and fruit inter crops. He also cultivates chillies/benda/ brinjal/colocasia (chema)/turmeric/ginger and flowers as intercrops. The lease agreement is for 3 years @ Rs.15000/- per year as lease rentals. There are 50 coconut trees in the land which help him meet some of his expenses. For additional income he works as a mason for half day before he goes to work in his field. Though he has the lease certificate for the land, the financial benefits are still enjoyed by the land owner and he does not even get any crop loan or bank credit.

He received a subsidy of Rs.50,000/- to construct the cattle shed and to establish ZBNF shop. He prepares the inputs with one cow. According to him, it takes one day to prepare the inputs, and the labour wage is Rs.500/- but the returns on their sale is not even Rs.300/-. Right now there is not much demand for the inputs but if more farmers take up ZBNF farming, the input market may become profitable. He says, ZBNF staff regularly visit and advise the farmers and because of their advice, he got good returns from coconut trees. Mr. Sreenu maintains Crop Card incorporating all details of the inputs used right from the time of land preparation till harvesting of each crop.

He mostly sells his produce in the local market in a phased manner. (2-3 bunches of banana he harvests each time and sells for Rs.350/- each). He is not happy as he gets the same price as the non-organic farming produce. According to him, unless premium price is given for the ZBNF produce, farmers will not be encouraged to take up this method of farming. The ZBNF staff have promised to get higher price for the produce but they did not fulfil their promises. Recently, 7-8 farmers of the village were told by the ZBNF staff that their produce (up to 500 bags of rice) will be procured by Reliance Fresh at a good price (Rs.2000/-per bag). On hearing this, many farmers have held their stocks without selling after the harvest at the then ruling price of Rs.1500/- per bag. But finally Reliance did not come forward to buy and the farmers, after waiting for 3 long months had to sell their produce at the old price (Rs.1500/-). Further, due to storing of the produce, there was loss in weight and additional storage charges to be paid by the farmer. Another farmer who had 30 bags was asked to wait by the ZBNF staff assuring him a good price in future. But after 3 months of waiting, the farmer lost 2 bags due to damage and had to sell the produce at the same old price. There are 200 farmers with 10-15 acres and 300 farmers with 2-4 acres of land, in the village who are enthusiastic but these incidences have caused negative impact on them towards implementing ZBNF. Now the farmers do not believe the marketing assurances given by the ZBNF staff. Around 80 farmers in the village are doing ZBNF farming but only 8-10 farmers produce for market and the rest all use for self consumption.

They are not happy with the services of the ZBNF staff as very often the dosages of inputs prescribed by them are inadequate and badly affected the crop yield. There is no proper soil

testing done before fixing the dosage and often wrong prescription is given by them. He says that because of the small scale of operation and self prepared inputs he somehow manages even with the low yield.

He says ZBNF staff does not provide any assistance in marketing the produce. Though they have established a ZBNF stall at Prattipadu village, it is difficult for the small farmers with little surplus, to go there and sell the produce. It takes away almost one day to travel to these markets which they cannot afford. So many farmers prefer selling at the farm gate or in local market. Annavaram temple consumes a lot of farm produce but they are not showing much interest in taking the ZBNF produce. The village is situated strategically for easy exports to Vizag, Kakinada, Rajahmundry and Vijayawada or Hyderabad but the ZBNF farmers could not avail the advantage due to lack of proper guidance and non availability of basic infrastructure for exporting.

The farmer also reported that the ZBNF staff brings many visitors to his farm and by seeing these visitors his fellow farmers are getting an impression that he is getting a lot of subsidies and other benefits from the government which is not actually true. He further fears that this may instigate the land lord to increase the lease rate.

He reiterated that unless sustained marketing support is provided, the ZBNF scheme will not take off as expected. He concluded by saying that he is hopeful that with assured marketing support, more farmers from the village will adopt the ZBNF cultivation.

CASE STUDY 3

5-Layer Model in the Irrigated Area of Nellore District

Mr.Santi Reddy Muniswamy Reddy is a resident of Sri Purandapuram of Buchireddypalem mandal of Nellore district. He is a young, innovative and an early S2S adopter of zero budget natural farming (ZBNF) in the canal tail end area. He started S2S Farming since Kharif season of 2016-17. He has totally entered into ZBNF and is also practicing the 5-layer model.

Mr. Reddy has attended Sri. Subash Palekar's training at Hyderabad during 2013. He has extensively gone through the relevant literature and also toured ZBNF fields in different places and interacted with the farmers. He says these visits have helped him know and understand the strengths and weaknesses of ZBNF. The training programmes and exposure visits to places like Bangalore, Chennai, Pune, Kurnool, Ongole and Guntur have been highly educative and useful.

He is practicing ZBNF as S2S paddy cultivation as the main crop and he is also practicing 36*36 Model in 0.30 acres. He is following all the 4 pillars and the recommended principles of ZBNF as suggested by the District Project Management Unit (DPMU) of ZBNF. He is practicing line or space sowing technique, bund cultivation, border and trap crops in paddy cultivation under ZBNF. For the last two years, he has been practicing 36*36 models. He has made 5-layers in this method using 25 multiple seasonal based horticultural species, 25 types of leafy vegetables, 25 types of curry leaves and 25 types of guards for layering. He also practices crop rotation and is able to get the yield throughout the year. He sells his produce directly to the households and some vegetable vendors.

Before adopting ZBNF, he used to cultivate only paddy under Mono-Crop System using improved varieties but never used to grow any bund or border crops. At present, he is practicing multiple crop system under ZBNF and cultivates local varieties of paddy. Under 36*36 model, he is also cultivating fruits and vegetables which are new crops as well as local varieties. He reported that the paddy yield under ZBNF is low for the last three years when compared to non-ZBNF yield. But the yield under ZBNF is increasing slowly while it is stagnant under non-ZBNF cultivation. According to him ZBNF is a better method as soil erosion is controlled and soil fertility is increased under this method. Further, the ZBNF produce fetches higher prices compared to non-ZBNF produce. The added advantage of adopting ZBNF is that the consumption of ZBNF products develops immunity and improves the health of the people. As a result households can save up to Rs.10,000 p.a. on medical expenditure.

He suggested that certification of ZBNF farm produce is essential for assuring the consumers that the produce of ZBNF is reliable and chemical-free. This will be also helpful to the farmers in easy marketing their produce and also helps them to get better price. He has also suggested that the ZBNF farmers should be given ZBNF identity cards for selling ZBNF produce in the Rythu Bazaars.

CASE STUDY 4

5-Layer Model in Tribal Areas of Visakhapatnam District

Mr. Kuda Nanaji is the resident of Karkaputtu village in the Gonduru cluster of Paderu Mandal of Visakhapatnam district. He has studied up to Intermediate and presently cultivates 3 acres of his own land. Coffee plantation along with pepper is grown in one acre on the hill area; and crops like paddy, millets, pulses, guliragi are grown in the remaining two acres of plain rain-fed land under ZBNF.

Earlier millets were grown in the same land in which the coffee plantations are now grown. Those days millets cultivation used to give very little income so his father started coffee plantation in 1998. First he planted the silver oak in 1995 and in 1998, after three years he developed the coffee plantation. The Government's main objective of encouraging coffee plantations was to take away the tribals from felling of forests for shifting cultivation (Podu cultivation) to settled agriculture and also to provide gainful employment round the year to the tribals. But at that time it was not very helpful to the tribals as they produced very small quantity of coffee (80 to 100 Kgs). And it was also tough for the tribals to sustain with this meagre income.

Nanaji shifted to ZBNF in 2016 with the support of the Kovel Foundation. The Kovel Foundation has helped him adopt the 5- Layer Model of cropping under ZBNF in the coffee plantations. He planted 219 coffee plantations, 40 dragon fruit, 25 neem trees, 25 orange, 25 munaga, 25 banana, 15 yalikulu, 5 lavanga, 10 cherry, 2 panasa, 4 chinta, 1 mango, and 2 neredu trees in the coffee plantations under the 5-layer model under ZBNF. He prepares the inputs of ZBNF like Ghanajeevamrutham, Dravajeevamrutham and Kashayam in the fields. He has traditional cows and other cattle to ensure dung and urine for the preparation of the inputs.

Pepper has a very good international market and thus supplements the income generated from coffee. Practice of ZBNF has increased the yield of coffee and pepper; and adopting multi-cropping and border cropping methods have helped to increase the income further. ZBNF practices benefited the crop in terms of increased vegetation, healthy, strong and increased growth of the plants with a number of branches which increased the size and weight of the bean and also the total yield. ZBNF also helped in soil conservation.

To help the tribals and improve their lives, The Girijan Co-operative Corporation (GCC) has taken up marketing of coffee in Araku and Paderu. The private traders both national and international are also available in this area for marketing the coffee products. Coffee board is another important agency promoting coffee plantations in this area. Farmers Produce Organisation (FPO) was formed in 2014 and formally registered in 2016. They charged 1 Rupee per Kg. for the maintenance of FPO and for providing marketing assistance. The formation of FPO has enabled farmers from tribal community to market their agricultural crop at remunerative prices.

CASE STUDY 5

5-Layer Model in Rain Fed Areas of Anantapur

Mr.Venkatappa has five acres of land of which 2.5 acres is dry land and 2.5 acres is irrigated land with two bore wells. His father and grandfather were also cultivators. He maintains two local cows that provide enough dung and urine for preparing Ghanajeevamrutham and Dravajeevamrutham.

Adopting the Five-layer model he planted orange seedlings with 19 yard spacing in September 2016 which is now 2 ½ years old. Since September 2017, he has been practicing the ZBNF, using Ghana and Dravajeevamrutham and mulching with tangeda and adavivepakulu leaves. He applied 2 Kgs of Ghanajeevamrutham per plant, 4 times from September 2017 onwards and has also given Dravajeevamrutham through drip system once in 10 days after providing irrigation water through the drip system. Now the plants have started yielding oranges and he has removed the first crop for the purpose of strengthening the plants. Now the second crop with a good number of oranges will be ready for sale in the next few days. He has opined that generally it takes 4 to 5 years for the orange crop to begin yielding but because of ZBNF practices the crop is got early within two years and is also of very good quality.

During the last week of August, 2018 he broadcasted caster, cowpea, Welvet and Jabbeens. The seeds of these crops were supplied by the district project manager free of cost. Because of proper spacing of orange plantation which is currently 9 yards he is able to cultivate other poly crops and benefits more. He adopted all the ZBNF practices including the initial mulching with thangedu and adavivepakulu. Beejaamrutham, Ghanajeevamrutham was given two times and the application of Dravajeevamrutham has helped the poly crops grow healthy and start yielding within two months.

He grows the rare medicinal plant Velvet which grows only in Araku. The crop yielded 50 Kgs and fetched nearly Rs. 250 per Kg. He also grows good amount of Jabbeen (70Kg) and caster (200Kg) which have good market and fetched nearly Rs.70 per Kg. Following the advice of DPM, he wants to sell only to NFFS and ICRPS. Over all, he has been a successful ZBNF practitioner getting good yield and also good rate for his produce by carefully selecting the marketing channel.

CASE STUDY 6

5-Layer Model in Kurnool District

K.V.Homendra, a B.Sc (Agriculture) graduate working as NFF (Natural Fellow Farmer) is a resident of Balapanur, Panyam mandal of Kurnool district.

He is cultivating one acre of land which is next to a stream (*Vanke*) in which Water flows throughout the year. The land is rich with black cotton soil with a slight mix of sand.

He has very meticulously planned the layout of the land for the 5-Layer Model. The one acre land is divided into two parts consisting of one measuring 33 cents and the other measuring 63 cents. In both the segments, the Five-layer model is adopted. In the first part of the land the layers are (a) Mango with 36 feet spacing, (b) between two mangos sweet lemon (mosambi) or figs at a distance of 18 feet (at the centre of two mango trees) and (c) at a distance of 9 feet (centre of two mousambi trees), either papaya, drumstick, guava or perennial red gram were planted. In the fourth layer, leafy vegetables, vegetables and tubers and in the fifth layer creeper vegetables are grown. The Five-layer model is applied based on the sun light requirement of the plants, the height and coverage/ space occupied by the plant over a period of time and the gestation period. For example mango starts giving yield from the 6th year onwards while the sweet lemon and figs start from the 4th year itself. The third layer gives yields from the 6th month onwards while the leafy vegetables from 20 days onwards. The rest of the crops start giving yield from the 3rd month onwards. In the second part of the land, the first two layers are the same as that is in the first part of the land. The third layer has papaya, the fourth layer marigold and the fifth layer vegetables. The roots of the plants of first three layers were dipped in Beejammurthamand planted in the months of September and October of 2018. Fourth and fifth layers were used for vegetables planted in November, 2018.

The ZBNF practices are carefully implemented in the field. To begin with, the land was ploughed and 500 Kgs of Ghanajeevmrutham was applied. Markings for the first, second and third layers were made and pits were dug. The pits were filled with neem powder. Trenches were dug with a depth of one foot by using a tractor. Beds were made in the size of 6'*3'. Protective plants like teak and linseed are planted. Marigold and red gram are grown as trap plants.

Minimal cost is incurred in preparing the Ghana and Dravajeevamrutham and the kashayams as most of the materials are collected personally at free cost. Timely spraying of neemastram for white & yellow flies (sucking pest), and other sprays such as neem oil, pogamia oil, lactic acid bacteria, pullatimajjiga, aloverakashyam, jeevamrutham, dashaparnikashyam, mustikashyam, vavilakukashyam, pedamuthrainguvadravanam and neem powder were very effective in controlling the pests and were also very cost effective.

The other expenditure incurred for establishing the 5-layer model includes 150 rock poles costing Rs.37500/-, transport and installation of poles, chain link- Rs.42471, drip irrigation- Rs.20,000/-, and the cost of 45 mango plants-Rs. 3150, 140 sweet lemon plants - Rs.11200, 150 guava pants - Rs. 7500/-, papaya plants- Rs.25,500/- and 400 vegetable seedlings each of – tomato, brinjal, cabbage, cauliflower, chillies, beetroot and radish - Rs.1100/-. But the red gram seeds were collected free of cost.

He was happy to mention that the quality of the vegetables from his farm is superior compared to those produced using chemical inputs. The villagers liked his vegetables as they know that they are organic and grown without using any chemicals. So they were ready to pay higher price for his products. The shelf life of these veggies is also more than that of vegetables grown under chemical farming. Adoption of ZBNF practices made the land more porous and friendly insecticides and earthworms which are good for the crops are seen in the field. The income accrued to this farmer is nearly Rs.72,000 till January 2019.

CASE STUDY 7

ZBNF 36*36 Model in Mundlamuru Cluster of Prakasam District

Gandham Yesu, aged 50 years, is a B.Tech graduate from Singanapalem village. His main activity is farming but also works as a church paster. He is a medium size farmer having 4.50 acres of own land and 2.50 acres of leased-in land. His wife runs the Anganwadi center in the village.

Inspired by the media, he started ZBNF initially with one acre in 2015-16. Later, after the Rythu Sadhikara Samstha (RySS) entered the village educating the farmers on ZBNF practices, he started to extend one acre every year under ZBNF. Now he brought all his 7.00 acres including 2.50 acres of leased-in land under ZBNF method. He is cultivating the long duration variety of paddy in the 4 acres of bore well irrigated land and rotated with short duration paddy. In the remaining 3 acres of rain-fed area, he grows red gram with sesamum as an inter crop.

He has been practicing the 36.*36 model since 2017-18. On a pilot basis he cultivated 8 types of crops in 0.20 acres of land. He tied up with the Anganwadi which is run by his wife to supply vegetables for their mid- day meal programme. He grows many varieties of vegetables including roots, tubers (radish and onion); teegajathulu or guard varieties (cucumber, bitter guard, country beans, ridge guard, bottle guard and snake guard); curry leaves (Sorrel leaves, Spinach, Sorrel Leaves, Fenugreek leave and Amaranthus); vegetables (brinjal, green chilli, tomato, ladies fingers, Indian Beans or chikkudukaya and cluster beans and drumstick); red gram and castor. He also has fruit bearing crops (guava, mango, papaya, pomegranate, custard apple, coconut, sweet lime and citrus fruits); and trap crops (flowers) in his farm.

The Anganwadi centre, run by his wife, has about 69 children (0.5 to 6 years of age) and 12 pre- and post-natal care women who are served food on a regular basis. Earlier he or his wife used to go to the market, which is 15 kms away from the village, for bringing the required vegetables for the AWC kitchen. The price was high and poor quality vegetables were sold in those markets. Now with his tie up, the AWC gets fresh and good quality vegetables at reasonable rates. Further they could also save on the transport cost and the strain of travelling all the way to the other village. The children and women at Anganwadi appreciate the healthy and tasty food made using the vegetables supplied by him and the attendance at the centre also improved considerably. He is happy as his produce is enjoyed by them, and he has assured market with the tie up with the AWC. He is very proud to say that his idea of practicing Zero Budget Natural Farming (ZBNF), 36*36 Model, benefited his family as well as the village women and children at large.

CASE STUDY 8

Marketing

Shri A.Jyotibabu is from Singarajupalem of Nallajerla mandal of West Godavari district. He studied up to 3rd class and has practiced ZBNF since 3 years in his 3 acres of land. He has another 2 acres of land in which lemon is grown. He got inspired by Palekar's speeches in a meeting at Amravati (Maharashtra). From childhood he was environmental conscious and used to seriously think about the environmental problems of water table depletion in his village. According to him, water which was available at a depth of 10 feet in those days has now gone to 200 feet deep and still not adequate enough for the village needs. He has 2 cows and also a ZBNF shop, Prakruti Vyavasaya Vanarula Kendram. He received Rs.50,000/- as subsidy to do chemical free farming and was also given the basic machinery to prepare the ZBNF inputs. At a time he prepares 100-150 litres of inputs (Jeevamrutham) and sells in the village and also to the farmers from other villages. He now plans to purchase six more cows to meet the increasing demand for the inputs in the village. To encourage other farmers, sometimes he gives free samples to them. He opened a ZBNF vegetable stall at Nallajerla on the highway side, but presently it is closed due to manpower problem. In his 3 acres ZBNF farm 1.5 acres is under paddy cultivation and the rest is under vegetables. In the first year of ZBNF farming, he got 24 bags (25 kgs each) of paddy and in the second and third years the yield increased to 36 and 34 bags respectively per acre. He says, some farmers in the village got up to 38 bags of rice per acre. He markets the rice among the known customers but vegetables are sold through commission agents. He supplied vegetables to the Godavari Organic shop at Eluru, but the price he got was the same as that of inorganic farming produce.

There are nearly 1600 cows in the village and around 250 farmers (10-15 are dedicated) are trying to do chemical free farming, mostly for their own consumption. He says, the entire village can be converted into ZBNF village, if marketing support is assured for the produce. All the farmers in the village are aware of the advantages of ZBNF farming and are receptive to new ideas. He demonstrated to the villagers, how a wilting palm oil crop of one of the village farmers wass rejuvenated by spraying Jeevamrutham. After experiencing this, he said that the farmer, who experienced it, has now gone for full scale ZBNF farming in all his 13 acres of oil palm. He is now getting 14 tonnes of output per acre in his farm.

Shri Jyotibabu stressed the need and importance of marketing support for the success of ZBNF by quoting the experiences of other farmers. A farmer in his village has grown sugarcane under ZBNF farming and also prepared chemical free jiggery but is suffering from marketing problems. Similarly, another farmer, Shri.Ratnaji has grown paddy under ZBNF farming but not able to sell his produce for the last 3 years. Seeing the problems faced by his fellow farmers he made efforts to organize a cooperative marketing channel by forming an association with 24 farmers who are practicing chemical free farming. He named the producer organization as "Sri Kalpataru Goadharita Utpattula Sangham". He is now trying to register it with the ZBNF authorities to formalize its functioning. If proper guidance is given, he wants to extend the services to a larger area and help the farmers in other villages also to get assured market and remunerative price for their output.

He inspired Shri Kakarla Sreeram, who has 16 acres of land in which he grows oil palm with banana, chillies and chrysanthemum as intercrops and paddy in 10 acres. Presently, in oil palm field, he is doing organic and inorganic mix farming but wants to shift to hundred percent ZBNF at the earliest. Inspired by Shri. Jyotibabu, Sreeram's paddy cultivation is completely under ZBNF method.

He says, minimum 3 years are required for the farmers to get the benefits of ZBNF farming. But sometimes the ZBNF staff does not give true picture about the initial yields of ZBNF and mislead the farmer which is wrong. The farmers should be properly oriented to the practices and outcomes of ZBNF along with marketing support, so that more farmers willingly adopt and benefit from this method of farming.

CASE STUDY 9

Marketing

Shri. Mane Rambabu, who hails from Velicheru village, Atreyapuram mandal of East Godavari fistrict, has studied up to fourth class. After listening to Shri Palekar at Chittibabu Ashram in Seethanagaram, near Rajahmundry, he took interest in chemical free farming in 2011. He has adopted the ZBNF method in 90 cents of farm land which includes 45 cents taken on lease from his brother. He is growing banana, turmeric, ginger, tomato, and Bengal gram and peas in his farm. On the boundaries, he grows chrysanthemum which he says acts as a repellent to pests. He prepared the land by mulching with Crotalaria juncia, which is a fodder crop (Janumu). Today, the land has become soft and holding good number of earthworms which keep the land porous and healthy and does not require frequent ploughing. The soil gives enough aeration to the roots and the roots spread well. Because of this, there was no need for him to plough the land for the last 4 years.

In the initial 2 to 3 years of adopting ZBNF he suffered losses due to poor yield but did not give up his commitment to biofarming and continued to improve the practices. He is now a successful practitioner of ZBNF and encourages other farmers to adopt the method. He says, chemical free farming will fetch good returns over the years as the yields will improve and sustain in the long run. He sells good quality produce to the non-local wholesalers from Hyderabad, Rajahmundry and Vijayawada and the rest of the produce is sold locally at low price. Generally the average quality vegetables are sold locally (donda Rs.60, kera Rs.30, papaya Rs.20 and arakakara Rs.100 per Kg.)

He is conscious of the buyers reputation also which mainly depends on the quality of produce supplied by the farmers. He says, if buyer gets losses, he will stop giving orders to the farmers and it is a loss to the farmers.

He explores new markets by sending samples of his produce and tries to get more orders. According to him the buyers/ wholesalers are very important in the marketing channel. If the quality of the output is good the buyers will come back for repeat purchase. He develops brand image by maintaining quality. He quotes his experience of marketing bananas where he has sent two bunches of banana to a trader in Hyderabad as sample and today the same trader is regularly purchasing bananas from him. Another customer once bought arakakara from him and took to the U.S. He repeatedly purchased from him as he found the product to be good, remained fresh for long and did not get spoiled even in transport. Since then this customer not only buys regularly from him but also he has introduced his friends and relatives to the farmer. He also sells some quantity of his produce to Patanjali stores at Rajahmundry. He sends twice in a week, vegetables to Hyderabad market by road from the collection centre located at Ravulapalem. He says upcountry market is better to get good price so one should look for a market that gives the best price. He cited the example of donda vegetable which fetches only Rs. 20/- in local market but is sold at Rs.40-50 per kg in the Hyderabad market.

Farmers in his village experience labour problem because of the nearby quarries who pay high wages (Rs.100 per day). Therefore, some ZBNF farmers started using chemical weedisides which he says is not correct. Many farmers in the village left ZBNF farming mainly because of labour problem.

He has a cow and received plastic drums from ATMA and a grinder donated by one of his customers. Labour being expensive, he does most of the farming activities with the help of his two sons who are studying in the elementary school. When need arises, he buys cow urine from Surabhighoshala at Kateru, a village near Rajahmundry. He said by giving two times spraying milk and one time each Jeevamrutham and neem oil, he could control the pests effectively whereas, his fellow farmers are spending up to Rs.4000 for the same. He supplies the available inputs to the fellow farmers and also trains some of them to prepare the inputs.

Shri Rambabu also encourages fellow farmers by telling them about the benefits of improved soil health and low cost agriculture under ZBNF. One farmer Mr.Shiv Prasad who has a farm in Kondaparvatam near Nuzveed, used to visit his farm and ask him to help making ZBNF inputs for his guava farm. Solely to help and encourage him, Shri Rambabu used to take dung and urine from Kovvur to the farm of Mr Prasad to guide him in the preparation of inputs.

He encourages other farmers by sharing information on marketing and farming methods. He wants to try in one plot, dry sowing in the next crop season. He says, his aim is to get Rs.2 lakhs profit from the 90 cents of land instead of the present one lakh rupees. He wants to concentrate on the farming and therefore refused the subsidy offered to establish the input shop under ZBNF scheme.

He says that some of the ZBNF staff is misleading the farmers by saying that they will get good profits in the first year itself and when the farmers fail to get profits, they immediately shift to chemical farming. This type of false assurances given by the extension staff is giving a negative impact on the spread of ZBNF. ZBNF staff should stop giving false assurances of increasing yiealds with highly exaggerated figures, because many farmers who attend the ZBNF meetings imagine to get such exaggerateed yields and income from ZBNF. ZBNF staff try to impress the participating farmers in their meetings; and this is not correct and advisable, as the failure to get returns as expcted within a short span reverts them back to non-ZBNF. . He says farmers should be given correct information, encouraged and brought under the ZBNF farming voluntarily.

Though he is a small farmer with little education, his vision and zeal is admirable and his innovative marketing strategies are noteworthy. Appreciating his practices, his farm is chosen as a Model ZBNF Farm and he was also recognized as one of the best ZBNF farmers.

CASE STUDY 10

Marketing

Sri.K. Chandra Rao is a resident of Ibrahimbad of Etherla cluster of Etherla mandal in Srikakulam district. He is aged 56 years and belongs to backward caste. He has two children who work in private companies. He has NPM shop of ZBNF and sold the inputs to ZBNF farmers at reasonable prices. He owns four acres of land of which 2.5 acres are under vegetable crops under ZBNF cultivation and in the remaining land, paddy is cultivated with border crops under ZBNF. He is also ICRP in that village. He motivated other farmers in the village to adopt ZBNF cultivation. Currently, out of 400 farmers in the village, 150 farmers have shifted to ZBNF cultivation. Chandra Rao has adopted the ZBNF cultivation since 2016 and sells his ZBNF products, particularly vegetables in the nearby markets. He has also motivated other ZBNF cultivators to adopt similar marketing practices. As the ZBNF products are very tasty and have longer shelf life compared to non-ZBNF products, they could command higher price. Establishing separate retail and whole sale shops for ZBNF products in the local markets will not only help the farmers but also popularise the ZBNF cultivation.

CASE STUDY 11

Marketing

Sri L. Ganga Raju hails from Bandaluppi village of Bandaluppi cluster of Parvathipuram mandal in Vizianagaram district. He is a group leader for ridge marketing. He. along with his wife and father, is undertaking agricultural activity. He studied up to intermediate and belongs to backward caste. In his village there are two societies namely, the Rythu Mitra and the Self-Help Groups for Women. The vegetables are collected through the Rythu Mitra Sangam and Mahila Sanghalu and handed over to L. Ganga Raju who is the group leader. Vegetables like Beera and chikkudu are exported collectively by a mini-van or a lorry to Visakhapatnam, Vijayawada and Hyderabad markets. These products are disposed either in the retail or the wholesale markets in these cities. The transport cost is distributed among the farmers on a proportionate basis. The group leader deducts the transport charges and other charges on a proportionate basis and distributes the balance among the farmers in proportion of their contribution of vegetables. The cluster Assistant (CA) has been helping the farmers whenever his services are needed.

Before ZBNF these farmers were growing crops under NPM method of cultivation. But they used to get low income due to the single crop pattern of cultivation. These farmers shifted to ZBNF in 2016 with the assistance of CRPs, Cluster Assistant (CA) in Bandaluppi cluster of Parvathi Puram mandal of Vizianagaram district. After adopting ZBNF, these farmers are using the same land now for mixed crops, bund crops and border crops and are getting more income compared to that of the previous method of farming. The CRPs and CAs along with Agricultural Officers are monitoring the farmers and helping them to carry out ZBNF. The farmers have expressed that the ZBNF products are healthier and also the fertility of the land has improved. The expenditure on cultivation is reduced due to ZBNF practices and the income per acre has also increased under the new practice.

APPENDIX CHAPTER 3

Crop Growing Models under ZBNF

The outcomes of the Strategic Interviews with the District Project Managers on crop growing models in the districts are in order. Farmer to farmer dissemination, video dissemination, farmer-friendly content and package of practices, strong ownership of agricultural department, easy accessibility of ZBNF inputs, farmers' institutions, location-specific method of growing crops, new ways of arresting pests, dry-sowing, new crops and mixtures, and a comprehensive ICT support are some of the key innovations in ZBNF. Other innovative principle in ZBNF is the use of multiple crops that take care of food security as well as income flow from different crops throughout the year. Good agronomic practices are encouraged under ZBNF besides using Pheromone traps (yellow sticky slips to attract enemy insects) and water use efficiency measures such as WHAPHASA. These include alternate rows for dry crops and water supply in alternate furrows. Another important innovation is mulching, which means covering every inch of land with green canopy. DPMs of Guntur and Ananthapuramu opine that dry-sowing is a new innovation model which is successful in their districts (see photo below). 5-layer models and new combination of mixed crops, i.e., cotton as major crop and all other crops grown are traditional varieties. Innovations have been made by the farmers in some of the districts under ZBNF. Water use efficiency followed in ZBNF that include SRI cultivation, growing paddy under drip irrigation that too with desi varieties, dry paddy consuming 10 percent of water compared to normal paddy in the region are also some of the innovations in the state.

Photo 1: Dry-sowing of *Navadhnyalu* in Ananthapuramu in the third week of May 2018 and the Picture is taken in 2019.

There are instances of growing 450 varieties as inter-crops, which was not observed earlier. Some of the farmers are growing paddy as the main crop with 20 other crops as supplemental crops. This is also an innovation in some of the districts. In Krishna district, Sri. Gopalakrishna of Vadlamanu village and Nagiripalle village has *grown one mango tree, which has 18 varieties of mangoes,* i.e., each branch of the tree is intercepted with a different variety of mango tree (see photo below). He is successful in his experiment. Such innovations are observed in other districts also.

Photo 2: One Mango tree with 18 Varieties of Mangoes grown in Krishna District

In Nellore, growing paddy in mango garden, aqua plus paddy and 5-layer model with horticulture crops, growing different leaves and vegetables are some of the innovations made by farmers. Some of the farmers are experimenting and growing new combination of crops such as cotton+drumstick; cowpea+jowar, etc. In Chittoor, one of the CRPs and farmer together have prepared "*vepalepanam" (meaning neem paste)* and applied to the trunk of mango trees to prevent pests and diseases. This is also a successful invention.

Photo 3: In Chittoor District, CRP and Farmer explaining the impact of *Neem paste* applied to the trunk of the tree which controls pests and diseases to the mango trees

Integrated farming involving fish-paddy farming and border and bund cultivation crops, i.e., is an innovation in Godavari districts and there are 25 such units in West Godavari alone. There are new initiatives in the horticulture crops in these districts. In Krishna district, a farmer, Sri. K. Gopala Krishna, cultivated 53 types of desi varieties of paddy for seed purpose with irrigation only in the last stage of the crop, which is a successful model (see photo). Such innovations are also observed in Vizianagaram district.

Photo 4: 53 types of Paddy - *Desi* Varieties for Seed purpose with irrigation only in the last stage of the crop in Krishna District

DPM Srikakulam district observed that the innovation of *"Tootikada Kashayam"* for effective prevention of mosquito bite or flies for crops is originated from Srikakulam district and it is widely spread to other districts where that menace is rampant. The main ingredients of this Kashayam are *tootikada* leaves and local cow urine. As observed by DPM, it is a very effective protection from the bite of mosquitos and flies and also other insects.

One of the principles of ZBNF is to use every inch of land that include borders and bunds. Majority of the farmers are following, wherever possible, and hence, there is a change in the land use pattern as well as cropping pattern. Under ZBNF, farmers are encouraged to go for new crops; and some farmers are following new crops such as dragon fruit, black rice, wheat, pine apple, and sugarcane in non-sugarcane districts. Practice of border crops, bund crops, and new crop mixes lead to less pest attack since border and bund crops restrict not only the pests to main crop but also attract crop friendly insects and birds.

In Krishna district, new integrated farming is in vogue, i.e., horticulture with agriculture crops but not aqua. Some of the farmers are growing crops all through 12 months in their lands. Practice of mulching with green canopy leads to drought resistance. Farmers are trying new crops and also new combination of crops, leading to visible changes in the cropping pattern. Substantial increase in the soil coverage is noticed especially in dry land areas. New crops emerged such as velvet – a costly cropland area of this crop is increasing year after year. Emergence of poly cropping, leafy vegetables, fruit crops with drip irrigation certainly lead to increased use of land - many DPMs observed. In some districts, area under field crops declined, but area under vegetables, turmeric, papayya and fruit crops increased. The area under turmeric, a commercial crop is increased due to ZBNF. Multi-crops in place of mono-crop are clearly visible as acknowledged by the DPMs. However, no major changes in the cropping pattern in delta areas are seen as it is difficult to change the crops.

Photo 5: Guli Ragi Cultivation under ZBNF in Vizianagaram District

Suggestions for Universal Spread

Constraints for the spread of ZBNF vary from district to district. For instance, in Chittoor and other districts in Rayalaseema, there is a hesitation among farmers to implement ZBNF because of their single-season cultivation that requires them to wait for a year, if their current crop fails or has low yield. Other major hurdles for the expansion of ZBNF as perceived by some of the DPMs are: lack of resources such as local cows, NPM shops, pulverisers, required leaves in delta areas and power weeders. It is, therefore, better to supply these items on 100 percent subsidy to the farmers to encourage the spread of natural farming, the DPM opined. Awareness on ZBNF is also low; and farmers are habituated to readymade inputs and not able to spend time for the preparation of inputs required in advance. In ZBNF, family members must cooperate for timely preparation of inputs; and one of the officers observed that it is now a testing period and these experiments will take time to spread to other farmers. Further, farmers have a strong belief that yields in the initial years of ZBNF are not attractive and are afraid of loss of income and as a result, they are not expecting immediate positive impact of ZBNF. ZBNF inputs need to be prepared by family members by themselves which some farmers feel a time consuming task and not inclined to do such practices. Also noticed is the fact that nuclear families are increasing over time and hence, there is a dearth of family members. Besides, lack of labour supply and locally available inputs are some of the other reasons for the slow growth of area expansion under ZBNF. One of the DPMs observed that at present, ZBNF is practiced mostly for self-consumption and changes in the attitudes of the farmers take time. Further,

tenants are not coming forward because they are not sure of tenancy continuation as they believed that the investments in ZBNF will yield results after two years.

In delta areas, farmers do not have options for promoting ZBNF essentially due to the dominance of canal irrigation with fixed water supply schedule and reliance on flood irrigation method. But, the district units and farmers are making efforts to find the ways for spreading. Majority of the DPMs interviewed admitted that their unit is under-staffed to meet the demand of required personnel for managing various activities on hand in time. Field staff in the district units need to be strengthened immediately for taking more activities in spreading the programme. DPMs are more burdened with administrative works or deskwork and finding it difficult to monitor field activities. Proper monitoring of fieldwork is essential especially in the new programmes like ZBNF, but due to lack of appropriate staff, there is lacunae in the monitoring activities of CRP/ICRPs/CAs and farmer. Print material and other related books are supplied at the state level but not at the district level. DPM of the Srikakulam district observed that wherever the traditional cows are available, the spread of ZBNF cultivation became easy. Farmers in delta area are more entrepreneurial and confident in earning much more income in the time spent for the preparation of ZBNF inputs. Further, in delta area, dearth of local cows and other natural ingredients required for preparing ZBNF inputs is a barrier in the spread of programme. Another major hurdle in the spread of ZBNF is marketing. Those practicing ZBNF are expecting higher price for their output as the output is chemical-free and is an outcome of intensive and careful personal labour. RySS is aware of this aspect and efforts are being made to strengthen the marketing. However, individual farmers are successful in getting a good price for their output due to tie up with traders in Bangalore city. Best example is a farmer from Siddotam mandal, Kadapa district practicing ZBNF for the last three years growing Guava crop in his 7 acre land and had a tie up with traders in Bangalore and they are approaching him directly and buying the output from farm at a good price (see photo). District official observed that on an average each Guava fruit weigh around 600 grams and there are many visitors to his field and interacting with him on the market arrangement.

Photo 6: Farmers grading the Guava fruits while loading the output to a Lorry

Majority of the officials interviewed opined that the government must create confidence among farmers by increasing the number of demonstration plots; increased number of exposure visits; assurance of better output price; create local market awareness with a separate stall in Rythu bazaars, private super bazaars and in every mandal headquarters. There is a need for convergence of different departments in the district headquarters; and ZBNF staff need to be involved in all the departmental meetings, Janmabhoomi programmes, civic meetings, etc. In other words, personnel from top to grassroots levels such as Joint Director, mandal level officers and village officials need to be involved and they should own ZBNF programme to create confidence among the farmers for achieving universal spread. Agriculture and allied departments such as horticulture, animal husbandry, DWAMA, medical department, marketing department, etc., must work together in spreading the ZBNF. At present, ZBNF is treated as a separate wing within the Agriculture Department, but convergence of related departments is very important. Government must establish certification agency to test the produce and such certification will fetch farmers a premium price for their produce. ZBNF fields also need to be demarcated and a code number has to be given for wide publicity.

Government should initiate steps to buy the ZBNF products for PDS, student hostels, AWCs, temples, etc. SHGs and NPMs need to be encouraged to supply ZBNF inputs on subsidised prices in every village. Government should also support in marketing aspects by creating awareness about ZBNF to the consumers and separate processing units and facilities in the market yards. Just as government succeeded in its efforts in creating awareness among the public in arresting the AIDS, similar efforts have to be initiated to bring about the awareness

among the people on the ill effects of chemical agriculture so that they can use ZBNF products.. FPOs have to be encouraged and DPMs have to be supported with sufficient number of staff to universalise the ZBNF.

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

A separate platform in the market yards for ZBNF outputs with government certification has to be provided to create confidence among the consumers so that ZBNF farmers will also get better output price. It is also suggested to arrange on-farm testing for the chemical residue to get the consumer confidence. There is also a need for separate rice mills for ZBNF rice as there are complaints that ZBNF and non-ZBNF rice are being hulled in the same rice mills, because both varieties are likely to get mixed; and as a result, a suspicion on the ZBNF quality among farmers and consumers is generated. In such a case, farmers have to compromise with low prices being paid by consumers. . It is also suggested that exclusive seed multiplication centres for ZBNF are to be established. Similarly separate market stalls, separate MSP for ZBNF products and linking NREGS works with ZBNF activities may go long way in spreading ZBNF.

In addition to regular motivation of staff and farmers, extension activities, periodic training to CRPs/ICRPs, involvement of social activists, regular media briefings and publication of district-specific literature are also needed to expand the spread of ZBNF. Notably, a separate helpline for ZBNF may go a long way for receiving suggestions for improvement including marketing related aspects. From a long-term perspective, there is also a need to explore how

digital technology can be used to achieve better coordination; and it is also important to include ZBNF as part of the curriculum of all agricultural courses.

APPENDIX TABLES OF CHAPTERS

APPENDIX TABLES OF CHAPTER 1

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

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

Source: Field Survey

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

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

Source: Field Survey

Table A1.3: District wise Total Number of Households Listed in the Selected Villages for Kharif and Rabi Sample of 2018-19

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

Source: Field Survey

Table A1.4: District, Mandal and Villages Surveyed in Kharif of 2018-19

District	Mandal	Village
Anantapur	Amadaguru	Gunduvaripalli
Anantapur	Bukkapatnam	Siddarampuram
Anantapur	Chilamattur	Tekulodu
Anantapur	Kuderu	Korrakodu
Anantapur	Madakasira	Melavoi
Anantapur	Raptadu	Marur
Anantapur	Rayadurgam	Mallapuram
Anantapur	Settur	Chintarlapalle
Anantapur	Somandepally	Chinnabaabayyapalli
Anantapur	Vajrakarur	Ragulapadu
Chittore	Byreddypalli	Gounithimmepalli
Chittore	Byreddypalli	Pathurnatham
Chittore	Madanapally	Madanapalle (Rural)
Chittore	Penumarru	Caharavaganipalli
Chittore	Pulicherla	Venkatadasaripalli
Chittore	Ramachandrapuram	Kuppambadur
Chittore	Tottambedu	Peddakanaparthi
Chittore	Gangadhara Nellore	Velkuru
Chittore	Srikalahasthi	Melachur
Chittore	Srikalahasthi	Kalavagunta

District	Mandal	Village
East Godavari	Devipatnam	Choppakonda
East Godavari	Gangavaram	B.Sivaramapatnam
East Godavari	Gangavaram	Molleru
East Godavari	Gokavaram	Gangampalem
East Godavari	Korukonda	Kotikesavaram
East Godavari	Pattipadu	Vommangi
East Godavari	Shankhavaram	Pedamallapuram
East Godavari	Y. Ramavaram	Dadalikavada
East Godavari	Y. Ramavaram	Singavaram
East Godavari	Yelleshwaram	Siripuram
East Godavari	Shankhavaram	Shankhavaram
East Godavari	Gangavaram	R D Puram
Guntur	Bellamkonda	Nandirajupalem
Guntur	Bollapalle	Gummanampadu
Guntur	Edlapadu	Kottapalem
Guntur	Kollipara	Bommavaripalem
Guntur	Kollipara	Chakrayapalem
Guntur	Kollipara	Davuluru
Guntur	Mangalagiri	Pedavadlapudi
Guntur	Pittalavanipalem	Alluru
Guntur	Bhattiprolu	Konetipuram
Guntur	Bollapalle	Vellatur
Kadapa	Chakraipeta	Rajupalle
Kadapa	Chinnamandem	Chinnarasupalle
Kadapa	Chinnamandem	Paramatikona
Kadapa	Kalasapadu	Pullareddypalle
Kadapa	Lakkireddypalli	Lakkireddypalli
Kadapa	Mydukuru	Mittamanipalle
Kadapa	Pendlimarri	Nandimandalam
Kadapa	Rayachoti	Gorlamudiveedu
Kadapa	Vempalle	Vempalle
Kadapa	C K Dhinne	Ippapenta
Krishna	Bapulapadu	A.Seetarampuram
Krishna	Bapulapadu	Bommaluru
Krishna	Chatrai	Arugolanupeta
Krishna	Machilipatnam	Kona
Krishna	Nagayalanka	T.Kothapalem (marripalem)
Krishna	Nuziveedu	Meerjapuram
Krishna	Nuziveedu	Mukkollupadu

District	Mandal	Village
Krishna	Pamarru	Nemmakuru
Krishna	Tiruvuru	Ramannapalem
Krishna	Unguturu	Atkuru
Kurnool	Atmakur	Kottalacheruvu (Kurukunda)
Kurnool	Chagalamarri	Muthyalapadu
Kurnool	Dhone	Kothakota (N V Pally)
Kurnool	Gudur	Budidapadu
Kurnool	Orvakal	Uyyalawada
Kurnool	Panyam	Alamur
Kurnool	Panyam	Bhupanapadu
Kurnool	Panyam	Gonavaram
Kurnool	Dhone	KothaBuruju
Kurnool	Peapally	N.Rangapuram
Nellore	Dagadarthi	Chennuru
Nellore	Ojili	Chillamanuchenu
Nellore	Ojili	PedaParia
Nellore	Sydapuram	Cheekavolu
Nellore	Udayagiri	Gandipalem
Nellore	Vidavaluru	Parlapalle
Nellore	Nellore Rural	Amancherla
Nellore	Naidupeta	Kuchiwada
Nellore	Vidavaluru	Mannadaraopeta
Nellore	Gudur	P R Kandriga
Prakasham	Kondepi	Peridepi
Prakasham	Mundlamur	Mundlamur
Prakasham	Naguluppalapadu	Naguluppalapadu
Prakasham	Naguluppalapadu	Pothavaram
Prakasham	Naguluppalapadu	Raparla
Prakasham	Marturu	Kolalapudi
Prakasham	Mundlamur	Pasupugallu
Prakasham	Ballikaruva	Nakkabokkalapadu
Prakasham	Mundlamur	Polavaram
Srikakulam	Etcherla	Bontalakoduru
Srikakulam	Etcherla	Kesavaraopeta (Shermahammadpuram)
Srikakulam	Kothuru	Sirusuvada
Srikakulam	Nandigam	Routhupuram
Srikakulam	Patapatnam	Baddumarri
Srikakulam	Patapatnam	Ganguvada

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

Table A 1.5: District, Mandal and Villages Surveyed in Rabi of 2018-19

District	Mandal	Village
Anantapuram	Vajrakaurur	Venkatampalli
Anantapuram	Kuderu	Korrakodu
Anantapuram	Amadaguru	Peravandlapalli
Anantapuram	Vajrakaurur	J.r. Kottala
Anantapuram	Kuderu	M.M.Halli B.C Colony
Chittoor	Bangarupalyam	Kallurupalli
Chittoor	Nagalapuram	Adavikandriga
Chittoor	Gangadhara Nellore	Velkur
Chittoor	Kuppam	Kothaindlu
Chittoor	Thamballapalli	Yeddulavaripalle
East Godavari	Tuni	Hamsavaram
East Godavari	Thondangi	PE Chinnayipalem
East Godavari	Yeleswaram	Ramanayyapeta
East Godavari	Gangavaram	Jaggampalem
East Godavari	Thondangi	A Kothapally
Guntur	Bhattiprolu	Vellaturu
Guntur	Kollipara	Attota
Guntur	Kollipara	Davuluripalem
Guntur	T.Sundur	T.Sundur
Guntur	Nakrikallu	Narasingapadu
Kadapa	Chakrayapet	Gandikovvuru
Kadapa	Vempalli	Kuppalapalli
Kadapa	Vempalli	Musalreddygaripalli
Kadapa	Badvel	Chinthalacheruvu
Kadapa	Chakrayapet	K.Rajugaripalli
Krishna	Bapulapadu	A.Seetharampuram
Krishna	Nuzvid	East Digavalli
Krishna	Reddygudem	Naguluru
Krishna	Machilipatanam	Potlapalem
Krishna	Machilipatanam	Buddalapalem
Kurnool	Owk	Sunkesula
Kurnool	Nandavaram	Nagaladinne
Kurnool	Allagadda	Ahobilam
Kurnool	Kalluru	Bollavaram

Table A 1.5: District, Mandal and Villages Surveyed in Rabi of 2018-19

District	Mandal	Village
Kurnool	Nandyala	Ayyaluru
Nelloore	Rapur	Pangili
Nelloore	Kavali	Kothapalli
Nelloore	Dagadarthi	Tirivedipadu
Nelloore	Muthukuru	Pidathapolur
Nelloore	Sullurupeta	Mannarpoluru
Prakasham	Naguluppalapadu	Mattigunta
Prakasham	Sonthamaguluru	Kommalapadu
Prakasham	Korsipadu	Ravinuthala
Prakasham	Parchuru	BVG palem
Prakasham	Singarayakonda	Sanampudi
Srikakulam	Pollaki	Gollavalasa
Srikakulam	Gara	Poosarlapadu
Srikakulam	Vajrapukothuru	Synooru
Srikakulam	Narasannapeta	Sriramapuram
Srikakulam	Laveru	Kottakunkam
Vishakha	V Madugula	Chintaluru
Vishakha	Cheedikada	Cheedikada
Vishakha	Chodavaram	Lakshmipuram
Vishakha	Chodavaram	Rayapaurajupeta
Vishakha	Elamanchili	Rukminipuram
Vizianagaram	Gajapathinagaram	Lingalavalasa
Vizianagaram	Vizianagaram	Gunkalam
Vizianagaram	Gajapathinagaram	Pidiseela
Vizianagaram	Parvathipuram	Chinabondapalli
Vizianagaram	Cheepurupalli	Karlam
West Godavari	Chintalapudi	Pothunur
West Godavari	Polavaram	Polavaram
West Godavari	Polavaram	Gutala
West Godavari	Buttaigudem	Kamayakunta
West Godavari	Buttaigudem	Rajanagaram

Table A1.6: District wise Number of Sample Farmers Covered in Kharif and Rabi Seasons of 2018-19

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

Source: Field Survey

APPENDIX TABLES OF CHAPTER 2

Table A 2.1: Cost incurred on Biological inputs per hectare under ZBNF and Non-ZBNF for the Crops Grown in Kharif of 2018-19

Description of Crops	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-ZBNF input
1	2	3	4=(2/3) *100	5= 3-2	6=(5/3)*100
Paddy			20.07	9032	68.00
Maize	4611	6029	76.48	1418	23.52
Groundnut	2759	3732	73.97	973	26.03
Cotton	2863	9041	31.68	6178	68.32
Tomato	5085	16705	30.44	11620	69.56
Bengal Gram	4535	8191	55.35	3656	44.65

Source: Field Survey

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

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

Source: Field Survey

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

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

Source: Field Survey

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

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

Source: Field Survey

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

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

Source: Field Survey