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Economics of Zero Budget Natural Farming in Purulia District of West Bengal: Is It Economically Viable?

In the light of the growing concerns about the sustainability of the current input-intensive agriculture system, the need for an alternative farming system has arisen. Among the various alternative farming models practised across the world, Zero Budget Natural Farming (ZBNF) has recently come into the spotlight. This paper envisages the economic viability of ZBNF in a local setting. In the empirical survey, the study considers one cluster of farmers practicing ZBNF in Purulia district of West Bengal, India. Empirical evidence presented in this paper is based on the performance of this alternative model of farming in respect of three important parameters, namely cost of cultivation, yield and income. Evidence reveals that the natural farmers have experienced a reduction in per hectare production cost and per hectare yield for their crops in the post-conversion period. More importantly, farmers adopting the ZBNF model (i.e. treatment group) in Purulia were able to enhance their income, compared to their chemical counterparts (i.e. control group). Moreover, an in–depth analysis of performance has been carried out, thereby identifying the factors influencing the long-term sustainability of ZBNF. Results indicate that the long term sustainability of this model of farming is contingent upon the interplay of agro-climatic conditions and various other socio-economic factors.

Keywords: Sustainable Agriculture, Zero Budget Natural Farming, Chemical Farming, Cluster, India

JEL classifications: Q15, Q18

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Introduction

Agriculture has been the backbone of the Indian economy for centuries. More than half of the country's population at present depends on agriculture and allied services for their livelihoods (Tripathi *et al*, 2018). Over the last few decades there has been a major transformation in the Indian agricultural sector. With the introduction of 'Green Revolution' technologies, agriculture in India has transitioned from subsistence to commercial farming. However, in spite of the success, the input intensive 'Green Revolution' in recent decades has often masked significant externalities, affecting natural resources and human health, as well as agriculture itself. Besides, there is also the added impact of neo-liberal economic reforms. Policy measures such as the reduction or withdrawal of input subsidies, privatisation and marketisation of economic activities have adversely affected the Indian peasants' community (Goswami *et al*., 2017). Moreover, the twin effects of the 'Green Revolution' and the neo-liberalisation of the Indian economy have led to a deep agrarian crisis. The smallholders[1] have become its worst victim. The prevailing agriculture system in India is characterised by high production costs, high interest rates for credit, volatile market prices for crops, and rising costs for fossil fuel-based inputs and private seeds. As a result, Indian farmers (especially the smallholders) increasingly find themselves in a perpetual cycle of debt. More than a quarter of a million farmers have committed suicide in India in the last two decades (Parvathamma, 2016).

In the light of these growing concerns about the sustainability of the current input intensive agriculture system, the need for an alternative farming system has arisen. Various forms of alternative low-input farming practices have emerged in different corners across the world, promising reduced input costs and higher yields for farmers, chemical-free food for consumers and improved soil fertility. In the Indian context, implementation of the National Mission for Sustainable Agriculture (NMSA)[2] signifies a policy reversal away from the 'biologically centred green revolution'. In addition, various initiatives such as Paramparagat Krishi Vikash Yojana (PKVY), Rashtriya Krishi Vikash Yojana (RKVY), Mission Organic Value Chain Development for North Eastern Region (MOVCDNER), Participatory Guarantee System (PGS), and National Programme for Organic Production (NPOP), Network Project on Organic Farming (NPOF) have been undertaken by the government of India in order to promote Organic Farming[3]. Interestingly, the PKVY scheme in its revised guidelines has also included various other organic farming models like Natural Farming, Vedic Farming, Cow Farming, Homa Farming and Zero Budget Natural Farming (GOI, 2019). Among these alternative organic models, ZBNF has recently come into the spotlight. In the Economic Survey, 2018-19, and successively in the budget 2019, the finance minister of India has announced that the government will promote ZBNF with the aim of reducing the cost of cultivation and thereby 'doubling farmers' income'[4] (Bhosle, 2019; GOI, 2019). ZBNF promises to end a reliance on loans and to drastically cut production costs, thereby ending the debt cycle for desperate farmers.

In this context, this study seeks to assess the economic viability of ZBNF. Apart from the introductory section, the

[1] The smallholders (include small and marginal farmers) account for more than 85percent of the total farmers in India (GOI, 2019).

[2] The principal objective of the NMSA is to make agriculture more productive, sustainable, remunerative and climate resilient by promoting location specific integrated farming systems and to conserve natural resources through appropriate soil and moisture conservation measures.

[3] "Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on the ecological processes, biodiversity and cycles adapted to local conditions rather than use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationship and a good quality of life for all involved" (IFOAM, 2019).

[4] The government of India has set a target to double farmer's income by 2022. It has three pillars: one is increasing the total output from agriculture by increasing productivity, the second is to ensure cost effectiveness thorough efficient uses of resources, and the third is to ensure remunerative prices for the farmers (Nirmal, 2019). ZBNF is considered to be an important strategy aimed at achieving cost reductions and thereby 'doubling farmers' income'.

study has been organised as follows. First, we shall briefly present the concept of ZBNF, its key principles and the current status of ZBNF in India. Next, we shall provide a brief review of relevant past studies in this field. After that, we shall provide the objectives of the study, and it is followed by the database and methodology used in the study. Subsequently, we shall provide a detailed analysis and discussions about the main findings of the study. Lastly, conclusions and policy implications will appear.

Zero Budget Natural Farming (ZBNF)

As per the Economic Survey 2018-19, the word 'budget' refers to credit and expenses, thus the phrase 'Zero Budget[5]' means without using any credit, and without spending any money on purchased inputs. 'Natural farming' means farming with nature and without chemicals (GOI, 2019). Therefore, ZBNF aims to sustain agricultural production with eco-friendly processes in tune with nature in order to produce agricultural produce free of synthetic chemicals by eliminating the use of synthetic chemical inputs and promoting good agronomic practices.

ZBNF originated in Maharashtra in the early 2000s, pioneered by Mr. Subhash Palekar, an agriculturalist, through his on-farm experiments. Later this alternative method of farming is known as Zero Budget Spiritual Farming. Four integral aspects of ZBNF (or four wheels of ZBNF) are identified as (Palekar, 2005; 2006):

- Jivamirta (a soil inoculant): acts as a catalytic agent that enlivens the soil, increasing microbial activity and organic matter. It also helps in preventing fungal and bacterial growth and in increasing earthworm activity.
- Bijamirta (a seed treatment): protects seedlings from seed borne diseases.
- Acchadana (mulching): enhances decomposition and humus formation through activity of the soil biota activated.
- Whapasa (soil aeration/moisture): It is the condition in which there are both air and water molecules present in the soil.

In addition, there is a number of pest management measures such as Neemastra, Agnistra and Brahmstra, which are homemade preparations used for insect and pest control (Palekar, 2005). The ZBNF program is being implemented through a cluster approach under the PKVY and RKVY schemes. Currently a total of 1431 clusters have been set up under both these schemes and so far 163,034 farmers are practicing ZBNF across the country. Among the Indian States, Andhra Pradesh, Himachal Pradesh, Karnataka are progressively practicing ZBNF (GOI, 2019). In fact, the government of Andhra Pradesh is aiming to cover all the 6 million farmers and 8 million hectares in the state under the initiative of Climate Resilient Zero Budget Natural Farming (CRZBNF)[6] by 2027 (APZBNF, 2019). For this purpose, the government of Andhra Pradesh has been in mission mode since 2015-16 and already has covered 83,744 hectares (10 percent of the total area) till 2017-18 (Reddy *et al*., 2019).

Interestingly, Economic Survey 2018-19 describes ZBNF as one of the models of organic farming. However, Subhash Palekar's model of ZBNF is to some extent different to organic farming (ZBSF, 2019). Nevertheless, following Economic Survey 2018-19, in this study we have defined ZBNF as a model of organic farming. The ZBNF practice carried out by the farmers in our study region is a modified version of the ZBNF practices, as originally recommended by Mr. Palekar. However, it is more flexible in using bio-fertilisers and pesticides as compared to the practices recommended by Mr. Palekar.

Review of Literature

In the existing literature, there are very few studies in India that assessed the feasibility of ZBNF, and most of them are based on Andhra Pradesh. For instance, Khadse *et al*. (2017) conducted a survey of 97 farmer households practicing ZBNF in Andhra Pradesh. The results of the survey revealed that 91 percent of the households experienced a decrease in production cost; more than 78 percent of the households witnessed an increase in yield and income has increased for more than 85 percent of the households. In a separate study, a crop cutting experiment (for five major crops i.e. Paddy, Groundnut, Black Gram, Chilly and Maize) was conducted by the government of Andhra Pradesh across ZBNF and non-ZBNF in respect of three important parameters: yield, production cost and income (cited in Mishra, 2018). The results showed that all the crops grown under natural practices had higher yields compared to those produced by means of non-ZBNF practices. The results also indicated that the farmers have experienced a reduction in cost for all crops after converting into ZBNF and more importantly, farmers were able to increase their income by growing crops through natural farming practices. Tripathi *et al*. (2018) made an attempt to map the possible economic, social and environmental impacts of a ZBNF programme led by the government of Andhra Pradesh with respect to specific targets under each Sustainable Development Goal (SDG). Using the data of a crop cutting experiment conducted in all 13 districts of the state, the authors have found that ZBNF could help Andhra Pradesh and India make significant progress towards almost a quarter of the 169 SDG targets. In this context, Naresh *et al* (2018) argued that ZBNF can offer effective options towards the eradication of poverty and hunger while improving the environmental performance of agriculture, but that this requires transformative, simultaneous interventions along the whole food chain, from production to consumption. However, there remains doubt over the efficacy of ZBNF in improving agricultural production and enhancing farmers' income (Vegesna, 2019). In this context, Reddy *et al*. (2019) in their study found that cost of cultivation is lower by 3 to 41 percent for CRZBNF crops in comparison to the Non-CRZBNF crops in Andhra Pradesh. However, the yields rates are found to be

[5] 'Zero budget' does not literally mean that costs are 'zero', but rather implies that the need for external financing is zero, and that any costs incurred can be offset by a diversified source of income which comes via farm diversification rather than dependence on a single monoculture (APZBNF, 2019).

[6] It is a modified version of the ZBNF practices recommended by Mr. Subhash Palekar (Reddy *et al*, 2019).

lower for the same crops to an extent ranging from 6-20 percent even if after the third year of transition to CRZBNF. More importantly, the study has failed to observe any substantial increase in net return even after three years of adoption. The net returns are found to be lower for CRZBNF plots during the first and second years after conversion, a fact which can be explained by the substantial decline in yields immediately after the conversion. Therefore, a number of farmers have suffered huge losses and as a consequence, they have decided to go back to chemical farming. As a consequence, cases of dis-adoption of CRZBNF practices have been rising spreading widely all over the state. In addition, there are questions over its applicability across soil types and agro-climatic zones as it has not been tested on a wider scale (Vegesna, 2019).

In this context, a few pertinent questions may arise: Is Zero Budget Natural Farming economically viable? Can adoption of ZBNF lead to a lower cost of cultivation and higher income for farmer households? Can this alternative form of agriculture be applied on a large scale across different soil types and agro-climatic zones? This study seeks to address these questions.

Methods and data

The study is mainly based on primary survey evidences. Under the scheme of PKVY, around 10,000 clusters (out of which 120 in West Bengal) have so far been formed all over India. In the empirical survey, this study considers one cluster of farmers practicing ZBNF in the Purulia district of West Bengal, India. A multi-stage sampling technique is used for the selection of district and cluster. In the first stage, Purulia district is purposively selected for the present study as it accounts for the highest number of clusters (i.e. 22 clusters out of total of 120) among the districts of West Bengal[7]. In the second stage, Hura block is purposively selected as it has the maximum number of operational clusters in the Purulia district.

In the next stage, 'Dungrigora Harambaba Gaota' cluster of Khairipihira village is purposively chosen as it has been found to practise the ZBNF model of organic farming. For the empirical survey, 25 farmer households practising ZBNF are randomly selected from the cluster. Similarly, an equal number of non-ZBNF (or chemical) farmer households who are not part of cluster but reside within the same village (i.e. Khairipihira) are also randomly selected. Thus, the study comprises a total sample size of 50 farmer households. For the purpose of collecting primary data, a face-to-face interview with the sample farmers was carried out during the agricultural production year 2015-16 (December-June). A structured questionnaire was used and designed in such a way that data for specific crops and farming activities could be collected.

Impact Assessment Methodology

In order to assess the impact of ZBNF in ensuring economic viability of the farmer households the study employs 'Quasi-experiments with constructed controls' design. The design basically involves comparing the attainment of specified research goals among individual households practicing ZBNF to that of households engaged in non-ZBNF (or chemical) farming practices within the study region. Among the different types of quasi-experimental designs that can be used to assess development impacts, we have used a 'differences-in-differences' (DID) method. The method basically involves five steps. In the first step, relevant performance indicators (i.e. yield, total production costs and total income) are selected. The next step involves the selection of time period. In our study, an assessment on the impact of ZBNF between 2014 (the year before the converting into ZBNF system) and 2015 (the year of shifting into ZBNF system) is estimated. The third step deals with collection of data pertaining to agricultural production, cost of cultivation, selling prices, income from agriculture and other demographic characteristics such as number of members in the family, size of land holdings etc. The data were collected for one crop (i.e. paddy), as it was the only major crop grown by the sample farmers. The next step deals with construction of control group. In this step equal numbers of representative households who are engaged in non-ZBNF practices but reside within the study area (i.e. comparable to the farmer households practicing ZBNF) are selected as control groups. The final step deals with the estimation of impact with the help of DID estimators. The basic objective of this step is to estimate whether by converting into ZBNF the farmer households are more likely to reduce the cost of cultivation and enhance yield and income than comparable control groups (i.e. households not engaged in ZBNF) in the study region and this objective is reflected by the estimators. DID estimators are numerically calculated by using a table (table 1), where the lower right cell itself represents the estimator.

Table 1: Calculation of DID estimator.

y_{it}	t=0 (before adoption of ZBNF)	t=1 (after adoption of ZBNF)	Difference
i=1 (say ZBNF)	y_{10}	y_{11}	$y_{11} - y_{10}$
i=0 (say non-ZBNF)	y_{00}	y_{01}	$y_{01} - y_{00}$
Change	$y_{10} - y_{00}$	$y_{11} - y_{01}$	DID = $(y_{11} - y_{01})$– –$(y_{10} - y_{00})$

Source: own composition

Methodology of Cost Calculation

In order to work out the economics of ZBNF vis-à-vis non-ZBNF the cost of production of the cultivated crop (i.e. rice) has been computed using A_2+F_L method of cost estimation[8]. It includes several cost components which are

[7] On the basis of number of clusters as a proportion of 1 lakh hectare of sown area of the districts of West Bengal, Purulia district (10.03) is chosen as the best performing district in comparison to the state average (4.10) in this relative indicator.

[8] It is one of the most popular methods used in the estimation of production costs in agriculture. The National Commission on Farmers headed by MS Swaminathan opted for this method to compute Minimum Support Price (MSP), a form of market intervention by the Government of India to insure agricultural producers against any sharp fall in farm price. However, the method was not finally chosen (Suresh, 2018). As per the budget 2018, MSP on kharif crops at 1.5 times of their costs was based on the A2+FL costs (FE Bureau, 2018).

calculated following standard cost calculation methodology (CSO, 2008; CACP, 2012; Miglani, 2016) as below:

Cost A_1 (INR[9]/ha) = cost of hired human labour, value of bullock labour, hired machinery charges, cost of seeds, cost of fertilisers, cost of pesticides, irrigation charges, interest on working capital, land revenue and taxes, depreciation on farm implements and machinery, miscellaneous expenses.

Cost A_2 (INR/ha) = cost A_1+ rent paid on leased in land.

Cost F_L (INR/ha) = imputed value of unpaid family labour

Total Cost (TC) = cost $A_2 + F_L$

Methodology of Income Calculation

The total income for each of the farmer households under study is calculated as follows:

$$TI= (Y \times P) + S - TC$$

where,
TI = Total Income, INR/ha
Y = Yield, kg/ha
P = Price, INR/Qt
S = Subsidy, INR/ha
TC = Total Cost of production, INR/ha

Yield for the reference crop (i.e. paddy) is calculated by dividing total quantity of production (kg) by the cultivated area (ha) for each farmer households. Here, data on price represents farm-gate price, the price at which individual farmer sells his agricultural produce (in this case paddy) directly from the farm. In order to eliminate the possible response bias on data relating to yield, cost and price, a few specific measures were taken, such as addressing certain questions two or three times for each household, and cross-verifying the response collected from one sample farmer against the responses of other farmers. For instance, in order to validate the data on price, the responses collected from each sample farmer were matched with the responses of other fellow farmers and also with the data collected from the local intermediaries dealing in paddy.

Data collected on yield suggests lower yield for ZBNF crops compared to crops grown under chemical farming. Regarding price, we have failed to notice any price premium for the crop grown under natural farming. Instead, evidence shows that the chemical farmer received higher prices for their cultivated crop as compared to the chemical farmers. Regarding cost of cultivation evidences indicate lower cost for natural farmers compared to the chemical farmers (Table A.1)

[9] The Indian rupee (INR) is the official currency of India. As per the average exchange rate published by the Reserve Bank of India (RBI) $1 US= 61.14 INR or €1=72.52 INR in 2014-15.

Results and Discussion

In order to assess the economic viability of Zero Budget Natural Farming, the study has conducted an empirical analysis on three important parameters: cost of cultivation, yield and income. First of all, we have tried to examine whether the adoption of ZBNF can lead to a reduction in cost of cultivation for the farmers in the study region. In order to proceed with this analysis first we have calculated cost of cultivation per hectare for both ZBNF and non-ZBNF farmers covering a period of both before and after conversion to ZBNF (table A.2). Then difference-in-difference method is applied to measure the impact of shifting into ZBNF on cost of cultivation for the sample farmers.

Considering the chemical farmers as the control group, a change in total production costs per hectare of the farmers practicing ZBNF (i.e. treatment group) is also examined. Change in total production cost per hectare of treatment group (e.g. decrease by INR.587) is compared with that of the control group (e.g. increase by INR.2230) by calculating the difference-in-difference estimator (Table 2). On the whole, it can be seen that, farmers adopting ZBNF practices have experienced a considerable reduction in total production cost, whereas the non-ZBNF farmers have witnessed an increase in production costs in the same period. The relative savings in production cost (the difference-in-difference of the changes in total production cost per hectare) is INR.2817. This is reflected by the negative DID estimator.

Second, we examine whether the adoption of ZBNF can lead to an increase in yield of the crops grown by the farmers in the study region. In order to examine this fact, first we have calculated yield per hectare of the cultivated crop (i.e. paddy) for both ZBNF and non-ZBNF farmers covering a period of both before and after conversion to ZBNF. Then

Table 2: Difference-in-difference estimates of total production costs (INR/ha) before and after conversion into ZBNF.

Farmers	Before adoption of ZBNF (2014)	After adoption of ZBNF (2015)	Change
ZBNF (Treatment)	33,700	33,113	-587
Non-ZBNF (Control)	35,235	37,465	2,230
Difference	-1,535	-4,352	-2,817

Source: own composition based on survey evidence

Table 3: Difference-in-difference estimates of yield (kg/ha) before and after conversion into ZBNF.

Farmers	Before adoption of ZBNF (2014)	After adoption of ZBNF (2015)	Change
ZBNF (Treatment)	2,880	2,700	-180
Non-ZBNF (Control)	3,450	3,600	150
Difference	-570	-900	-330

Source: own composition based on survey evidence the difference-in-difference method is applied to measure the impact of shifting to ZBNF on yield for the sample farmers.

Change in yield per hectare of treatment group (e.g. decrease by 180 kg.) is compared with that of the control group (e.g. increase by 150 kg.) by calculating the difference-in-difference estimator (Table 3). Overall it can be seen that, farmers adopting ZBNF practices have experienced a slight reduction in yield for their crops, whereas the non-ZBNF farmers have witnessed an increase in yield in the same period. The relative loss in yield (the difference-in-difference of the changes in total yield per hectare) is 330 kg. This is reflected by the negative DID estimator.

Third, an empirical investigation is made to understand whether the adoption of ZBNF can lead to an increase in income for the farmer households in the study region. In order to establish this fact, the total income per hectare of both ZBNF and non-ZBNF farmers covering a period of both before and after conversion to ZBNF has first of all been computed (Table A.2). Then the difference-in-difference method has been applied to measure the impact of converting into ZBNF on income for the sample farmer households.

A general trend of increasing total income per hectare is noticeable in the post-conversion period in Purulia. The change in total income per hectare of the treatment group (e.g. increase by INR.3732) is compared with the change in total income of the control group (e.g. increase by INR.2105) by calculating the difference-in-difference estimator (Table 4). The relative gain (the difference-in-difference of the changes in total income per hectare) is INR. 1627. On the whole, it has been seen that change in total income of farmers adopting ZBNF is more prominent in comparison to the income change for chemical farmers in the study region. This is reflected by the positive DID estimator. So it can be said that the farmer's decision to convert into ZBNF resulted in an increase in income vis-à-vis non-ZBNF (or chemical) farmers in Purulia.

The entire study revolves around the performance of the cluster based on ZBNF model in rural West Bengal. Evidence from the primary survey suggests that the cluster is still continuing its natural farming activities, in spite of several challenges in the form of low yield, inaccessible markets, the absence of a price premium etc. In this section, we have tried two identify the factors that might have an impact on the long-term sustainability of this alternative model of farming in practice.

The long term sustainability of this alternative model of farming can be explained by the agro-climatic and socio-economic condition of the study region. Purulia district falls under 'Eastern Plateau and Hill Region' (Zone VII) among the six agro-climatic sub-climatic sub regions of West Bengal (Ghosh, 2019). Due to the adverse agro-climatic conditions characterised by the presence of shallow soil, soil with low water holding capacity, a shortage of rainfall (spread over only three months covering a period from mid-June to mid-September), the farmers of Purulia district predominantly practise rice based mono-cropping. Evidence from the primary survey indicates that due to this unpromising agricultural setting, the farmers of the study region are mainly engaged in a subsistence mode of farming. Evidence also reveals that before shifting into ZBNF, they were already practising a low external input-based form of farming by mainly using their family resources (such as, homemade fertilizers and family labour) and getting almost similar yields[10] like ZBNF for their cultivated crops. But after the conversion into ZBNF, the farmers were able to get agricultural inputs such as bio-fertilisers and pesticides free of charge and also received financial assistance from the government on a regular basis, which, in turn, reduced their cost of cultivation and thereby contributed to increasing their income. As a result, the farmers adopting the ZBNF model in Purulia remain economically viable and are still carrying out natural farming activities. Interestingly, any change in the above specified factors can turn this alternative model of farming into an economically non-viable livelihood strategy. For instance, in a similar study by Koner and Laha (2019) it is found that after shifting from a high input intensive chemical farming to eco-friendly organic farming the farmers in Burdwan have experienced a significant reduction in yield corresponding with no significant reduction in the cost of cultivation or increase in price (i.e. price premium) for their organic crops. As a result, this model proved to be economically non-viable.

Table 4. Difference-in-difference estimates of total income (INR/ha) before and after conversion into ZBNF.

Farmers	Before adoption of ZBNF (2014)	After adoption of ZBNF (2015)	Change
ZBNF (Treatment)	3,740	7,472	3,732
Non-ZBNF (Control)	10,650	12,755	2,105
Difference	-6,910	-5,283	1,627

Source: Own composition based on survey evidence

Conclusions and Policy Implications

In the light of growing concerns about an agrarian crisis in India marked by reduced profitability due to rising cost of inputs and stagnant output prices, the wider adoption of organic agriculture is considered to be a key strategy in effectively addressing these issues. With this in mind, the government of India is trying to promote organic farming by introducing several schemes. Various Organic models like Natural Farming, Vedic Farming, Cow Farming, Homa Farming and Zero Budget Natural Farming is being practiced across India. In this backdrop, the study has selected one cluster formed under the PKVY scheme from rural west Bengal based on the ZBNF model. The main objective of this paper has been to examine the economic viability of this alternative model of farming. For this purpose, the study has evaluated the performance of this model in terms of three important parameters: cost of cultivation, yield and

[10] The yield behaviour of farms during conversion period largely depends upon the agricultural practices followed before conversion. Conversion from a traditional low external input system of cultivation rarely results in lower yields. However, when switching from external input intensive forms of agriculture, the yield may decline significantly, at least in the initial years of conversion, until the natural soil tilth and fertility are sufficiently developed. After that it may stabilize at a comparable, lower or even higher level depending on the efficacy of organic management, quality of organic fertilizers applied, etc. (Das, 2007).

income. Evidence suggests that farmers shifting into ZBNF have experienced a reduction in production costs in the post-conversion period compared to their non-ZBNF counterparts. However, in respect of yield the evidence indicates that farmers practising ZBNF have suffered a loss as a result of their decision to convert into ZBNF, whereas the non-ZBNF farmers in the same regions have experienced an increase in yield for their crops in the same period. Though the magnitude of such loss is not massive, empirical evidence does raise some doubts as to the ability of this alternative model of farming to achieve higher yield for the cultivated crops. However, empirical evidence strongly suggests that ZBNF can play an important role in income generation for the farmers in Purulia.

The study provide insights on the challenges of this alternative method of cultivation, and factors leading to the success of ZBNF, that may be useful to the policy makers. Evidence suggests that the long term sustainability of this model is contingent upon the interplay of agro-climatic conditions and various socio-economic factors (such as the economic conditions of the farmers, past agricultural practices, yield and cost of cultivation, subsidy from the government and the presence of a market premium for agricultural produce). In the design of an appropriate policy on ZBNF, appropriate selection of crops and targeting of farmer households (small farmers' community practising a low external input-based farming) need to be accorded priority in accordance with the agro-climatic condition of that particular region. Besides, government measures are required in linking farmers practising ZBNF with the market, implementing a price support mechanism, and the provision of other forms of assistance (disbursement of a subsidy element, technical assistance with both the operation of and certification procedure for natural farming, and supplying fertilisers and pesticides) to ensure a smoother transition into ZBNF.

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Appendix

Table A.1. Descriptive statistics on Yield, Price, Cost, Revenue and Income under both farming system.

	ZBNF		Non-ZBNF	
	2014	**2015**	**2014**	**2015**
Average Yield (kg/ha)	2,880	2,700	3,450	3,600
Average Price (INR/Qt)	1,300	1,350	1,330	1,400
Average Total Revenue (Yield × Price) (INR/ha)	37,440	36,450	45,885	50,400
Average Subsidy (INR/ha)	–	4,135	–	–
Average Total Cost (INR/ha)	33,700	33,113	35,235	37,465
Average Total Income (INR/ha)	3,740	7,472	10,650	12,755

Source: own composition based on survey evidence

Table A.2. Total income and cost of cultivation of farmers in Purulia district

Farmers	ZBNF in Purulia			
	Before conversion		After conversion	
	ZBNF	**Non-ZBNF**	**ZBNF**	**Non-ZBNF**
Cost Items				
Hired human labour wage	–	20,663	–	21,880
Value of bullock labour	4,725	–	4,782	–
Hired machinery charges	–	7,125	–	7,500
Cost of seed	1,350	1,568	1,020	1,688
Cost of fertilizers	808	1,895	0	2,034
Cost of pesticides	280	1,735	0	1,910
Irrigation charges	170	220	208	275
Interest on working capital				
Land revenue				
Depreciation on farm implements	95	116	110	163
Miscellaneous Expenses	142	375	158	450
Cost A_1	**7,570**	**33,697**	**6,278**	**35,900**
Rent paid on leased in lands	830	1,138	830	1,138
Cost A_2	**8,400**	**34,835**	**7,108**	**37,038**
Family Labour (F_L)	25,300	400	26,005	427
Total Cost (A_2+F_L) (INR/ha)	**33,700**	**35,235**	**33113**	**37,465**
Total Revenue (TR) (INR/ha)	37,440	45,885	36,450	50,400
Total Income (TR- Cost A_2+F_L) (INR/ha)	6,150	10,650	3,337	12,755
Total Income (INR/ha) **(incl. subsidy)**	**6,150**	**10,650**	**7,472**	**12,755**

Source: own composition based on survey evidence