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Factors Influencing Efficiency of Organic Rice Production in Sikkim, India

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Abstract

The objective of this study is to estimate factors influencing technical efficiency in rice production. A stochastic frontier production function model is used in primary survey data collected from four districts of Sikkim. This study finds that there is significant inefficiency among farmers in four districts. The quantity of manure used for East Sikkim and South Sikkim districts were insignificant but for West and North districts it is positive and highly significant. It implied that when the quantity of manure for the production of rice increases by 1 percent it could lead to the increase in the agricultural production by 0.06 and 0.03 percent for West and North districts respectively. The elasticity for seeds quantity used was significant for all districts. besides this, number of labour employed were highly significant and positive for East and West districts. The LR value of rice in East, West, North and South districts is 10.01, 12.19, 15.17 and 16.56 that is more than critical Chi-square value at one percent (4.61). Factors affecting technical efficiency that are included in the study are age, gender, distance of the village from the market, access to loan or credit and training, on farm management, proximity to markets, and access to credit etc.

Keywords: SFA, Rice, Sikkim, Efficiency, Cob-Douglus, Organic farming

JEL Classification: B21, B23, B41, C1, C5, C13, E23

Introduction

Sikkim located in the northeastern part of India is one of the smallest states of the country and has rich biodiversity. The economy of Sikkim is predominantly based on agriculture and almost half of the population is dependent on agriculture. Hill farmers face many challenges like land and water scarcity, few marketing opportunities and forest conservation is the priority. However, they also have specific advantages mainly wide biodiversity. Initially production of food grains made them completely self-sufficient and the population of the state was not dependent on any external sources for supply of food. Soon with increasing population and development, demand for food rose to a level that the traditional agricultural methods had to be replaced with conventional methods. With adoption of conventional farming, many issues had emerged relating to non-sustainability of agriculture like climate change, increased health risks due to harmful chemicals and environmental degradation.

Indeed, the consequences of this situation to sustaining livelihoods and management of land resources are serious. Adding to the problems raised due to conventional farming is increasing human settlements, urbanization, industrialization, and infrastructure development activities that are converting the already scarce agricultural land into nonfarm use. Majority of the farmers own small and marginal lands therefore shrinking operational holdings is a key concern for managing food and livelihoods.

Sikkim state passed a resolution in the year 2003 and aimed to convert the entire state into organic state by 2015 became the first state in the country to adopt complete organic farming (Rao, 2001). The state focused on production for local markets and not for export to other states or countries. The motive was also to make the state self-sufficient. But before selling the products as organically produced, it is important to be certified under National programme for organic

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farming (NPOP) for which the farmers had to provide plan for the production of organic crop. Conversion period into organic farms plays a crucial role as during the period the farmers need to meet the requirements and only then the farms are certified as organic. The states usage of chemical fertilizers was minimal and the farmers were dependent on traditional methods that were based on organic farming. However, the shift to organic farming by banning synthetic fertilizers and pesticides required numerous changes. Mainly the farmers had to become familiar with new agricultural methods and participate in trainings provided by the government for organic farming. The farmers were also trained for pest, disease, and weed management, prepared at the farm from local plants, animals, and microorganisms. The outcomes had been positive mainly owing to well-defined targets made by the government and the implementation of appropriate policies. India is undergoing rapid industrialization and organic farming emerged as a potential alternative for meeting food demand, maintaining soil fertility, and increasing soil carbon level (Pandey *et al*, 2012).

Globally organic farming is recognized and does considered desirable own to the health benefits provided by though it is a bit expensive and involves constant expenditure. The benefits of organic farming over conventional farming are undoubtedly more as it is environment friendly, delivers more nutritious foods despite lower yields and certainly consumers are willing to pay more that helps farmers compensate for lower yields from organic farming. In a time of increasing population growth, climate change and environmental degradation, agricultural systems that promise sustainability is important to adopt and organic farming is one of the healthiest and strongest sectors in agriculture today.

As opposed to all the benefits generated by adopting organic farming there are also many disadvantages associated with organic farming mainly high cost of cultivation as it is more labour intensive and the cost of organic inputs are much higher. Another major setback of organic farming that has been found among the farmers practicing organic farming is that the farmers had observed reduced productivity from organic farming than from conventional farming. Though in some places the yields are satisfactory, owing to diseases and insects has caused huge losses to crops and natural options has left crops vulnerable to damage. Also, as most of the farmers in the state were originally producing organically the value of what is sold was mostly same. There are few who are willing to pay more for organically produced items, at the time of low-income people are less likely to buy organic when they can purchase the same product for less price (Muscănescu, 2013; Stevenson, 1980).

Rice is one among the staple food crop in Sikkim as inferred from the epithet "Denzong"-meaning "Valley of Rice". Its antiquity is Sikkim is difficult to trace out but some experts consider the entire NE Region including Sikkim and adjoining area of China shall be the probable home of rice. A large number of landraces are cultivated in Sikkim in addition to introduce since 1970s. Rice is grown in all places having warm and humid climate with shallow water. It is cultivated over an area of about 14.15 thousand hectares (Departments of food-security and agriculture-development department, Government of Sikkim, 2020).

Most of the farmers in Sikkim were not in a position to afford the cost of organic farming, as seeds are costlier, take more time to grow and the storage of the final products are expensive too. Therefore, the government provides government governed subsidy for organic inputs like seeds, bio-fertilizers, and bio-pesticides and the organic farming. The fact that organic production in the districts are initiated, motivated, and promoted by the state government, but is fully supported and continued by farmers. Most of the study on organic farming in has not been focused on inter and intra-districts comparisons and did not address the issues of inefficiency.

Stochastic Frontier models have been widely applied by various researchers in agricultural studies especially in Rice (Battese and Coelli, 1992; Bravo-Ureta and Pinheiro, 1993; Xu and Jeffrey, 1998, Balcombe *et al*, 2007; Coelli, *et al*, 2002; Dhungana *et al*, 2004; Rahman, 2010; Rahman and Rahman, 2009; Yao and Shively, 2007; Battese *et al*, 1988, 1992, 1995). Age and education level of farmers, farm size and years of observation significantly affect agricultural production inefficiencies in the two villages were examined, namely Kanzara and Shirapur (Battese and Coelli (1995). Bravo-Ureta and Pinheiro (1993) uses two stages, where the first stage of Bravo-Ureta and Pinheiro (1993) estimate the stochastic production function to obtain the technical efficiency, allocative and economic efficiency levels by using maximum-likelihood method. In the second

stage, Bravo-Ureta and Pinheiro (1993) used Tobit models to estimate the effect of various attributes of farmers on efficiency. None of the study has focused on measuring factors influencing efficiency of organic rice. Despite the attention organic farming in Sikkim has received, technical efficiency had not been studied. The issues highlighted in the study can help improve organic farming to become more efficient and help benefit farmers. Even with the governments intense attention paid to organic farming, very little accessible information actually exists on the cost and returns of organic farming. Therefore, the study focuses on factors influencing efficiency of organic farming in Sikkim.

Data Sources and Methodology

Description of study area

The study area is selected in the agriculturally diverse districts of Sikkim. Sikkim is located at the northeastern part of the country surrounded by China in north and north east, Bhutan to the east, West Bengal to the south and Nepal to the west. Only in 1975, Sikkim joined India as its 22nd state and comprises of East, West, North, and South districts. Sikkim is a place of multi-ethnic, multi-cultural, and multi-lingual segments of the society living together in harmony. Land was not very steep and most importantly the climatic condition was more favorable for good agricultural cultivation. The districts of Sikkim are located at different altitudes and agriculture varies from one another in all the districts therefore, the sample households were divided between four districts. From the four districts, sample area were selected in consultation with the authorities to ensure prevalence of cultivation of rice, maize and ginger and predominantly agricultural households.

The East district of Sikkim is mainly agrarian, the villages of East Sikkim are closely connected to the main centers like Gantok, and Singtam hence marketing the agricultural products is smooth. However, connectivity of some villages to main marketing centers and towns are under-developed and transportation costs are high. As a result, farmers are forced to sell their agricultural products at minimal price to the intermediaries. While few chose to sell in the market, the products not sold had to be disposed in the market or given for nothing to the locals around market. Therefore, efforts to develop proper channel for agricultural marketing was lacking. The solution for marketing agricultural products found by Radong and Rumtek was through operating roadside vegetable shops and this method helped boost farmer's income. In addition, locations of such shops played a vital role to make it successful. Major problem faced by the farmers in the east district was scarcity of irrigation and destruction of agriculture by animals and rodents.

West district of Sikkim also practices agriculture extensively including rice, maize, and ginger as some of their major crops. Few households do not cultivate rice as it is indeed laborers and lack of irrigation water has made it more challenging. Geyzing being the capital for West district is the only town closest to the villages in the west Sikkim. Transportation of agricultural products to the market is difficult and expensive because of which the farmers are always on loss. Private brokers and intermediaries purchase agricultural products from the farmers at a giveaway prices and the farmers make only marginal profits.

South Sikkim is mostly agrarian and farmers cultivate all the three varieties of crops at the same time more emphasis is given to horticulture with orange farming done extensively by almost all the farmers. Cultivation of ginger has dropped down severely in the recent years in south district. In fact, farmers throughout Sikkim who once were prominent ginger growers gradually switched over to other crops and ginger has became almost extinct from their cropping system. The market for organic products of south district of Sikkim was Namchi, Singtam and Ravangla. Easy transportation of agricultural products to the markets is unavailable as well as costly. Many farmers were not aware of the subsidies provided to them by the government for farming and therefore are not benefitted. At the same time, there are many progressive farmers in the districts practicing agriculture extensively.

North district of Sikkim is located at higher altitude with steep slopes and extreme weather conditions therefore only selected households practice agriculture. In comparison to other districts of Sikkim, farmers practicing agriculture in the district requires more human labour to work in their steep slopes. Kabi village in North district populated mostly by the Sherpa's practice agriculture near the riverbed using only traditional methods of cultivation. Transportation is the major problem and with no facility of cold storage, large number of agricultural products are destroyed. In addition, the farmers grow crops mainly for self-consumption and not for sale in the market. The villagers are self-reliant for food and produce varieties of major

crops.

The agricultural farms had to be certified as organic farms by certification bodies that grant the farms as organic through regular and timely inspection of the agricultural farms. The certification agencies inspect the functioning of organic farms once in a while in order to ensure production rules of organic farming are strictly followed by the farmers. It mainly includes various standards that has to be followed mainly zero use of chemical fertilizers and pesticides that helps in ensuring the quality of organic products. Certification of organic products also ensures product assurance to the consumers. Sikkim state organic certification agency (SSOCA) is formulated to provide certification services in the state and it is accredited by National Programme for Organic Production (NPOP). NPOP aims to provide standards for organic production, accreditation of certification bodies, the logo of the country for organic products and the regulations governing its use (http://apeda.gov.in/). SSOCA based on its inspections provides services to all the farmers that have followed the norms of organic farming religiously and issues certificates recognized through national accreditation (http://www.ssoca.in/).

Sources of data and sampling techniques

Primary survey was conducted with the help of carefully drafted set of questionnaires with mostly closed ended options from all the four districts mentioned above. From each of the four districts, four blocks predominantly practicing organic farming were indentified with the help of the district administration. From each of the blocks, households producing rice, maize and ginger were selected through simple random sampling. The households producing only the given crops were selected with the help of Village Level Workers (VLW) and field assistants of the villages. Homogeneity of the crops was difficult to find among farmers and the farmers grew variety of crops hence three major crops was selected for the study. In every block, households producing the three major crops also varied because of various reasons like altitude, availability of irrigational water, transportation, availability of market, proneness to animals, etc. Therefore, from each block varied number of households was selected for the survey. Distribution of the sample households is shown in the following table.

Table 1. Distribution of survey sample in the districts of Sikkim

District	Block	No. of HHs surveyed
East	Duga	80
West	Gyalshing	100
North	Kabi	20
South	Yangang	100
Total		300

A questionnaire was framed covering various items to understand economics and efficiency perspective of organic farming in the state. In light of the information collected from the authorities, necessary changes were incorporated. The main survey was conducted during September 2019 to February 2020 and altogether, 300 households from the four districts were surveyed.

Samples were selected in probability proportion to size of number of farmers. In addition to the questionnaire-based study about the village, focused group discussions with the resource person from every district helped in gathering general information about organic farming in their respective villages.

Empirical framework of the study

For measuring efficiency, various techniques are available and are classified majorly into parametric and non-parametric. The parametric models are further divided into deterministic and the stochastic frontier models while deterministic model assumes that any deviation from the frontier is due to inefficiency, the stochastic modeling technique allows for statistical noise. Stochastic modeling also addresses random shocks that are not under the control of the farmer but can affect output. The stochastic frontier models acknowledge the influence of random errors and data noise on agricultural production (Kumbhakar *et al*, 2000). On the other hand, Data Envelopment Analysis that is non-parametric approaches assumes the absence of measurement or sampling errors and deviations from the production frontier are under the control of the production unit being considered. The impact of several factors on the efficient performance of farming systems cannot be overlooked.

Two major approaches are used in determining factors effecting technical efficiency namely two-step and single step approach. In the single step, approach factors affecting technical inefficiency are included

directly therefore it is found more suitable for the study. Technical efficiency can be analyzed using output-oriented and input-oriented approaches. In the output approach the interest is by how much output could be expanded from a given level of inputs while input-oriented approach also known as input over-use approach focuses on amount of inputs that could be reduced to achieve technically efficient level of production. In the study output, approach is used as the study focuses on output shortfall and not on over-use of inputs.

In the study Cobb-Douglas model is used because of its simplicity though translog model is much more flexible but many of the resulting coefficients are insignificant. A Cobb-Douglas functional form includes conventional inputs and exogenous factors affecting inefficiency therefore it is found fit for the analysis. The stochastic frontier model can be expressed as:

$$\ln Y_i = \ln f(X_i ; \beta) + \varepsilon_i$$

Y_i denotes production, X_i is the inputlevel, and β is the vector of the unknown parameter to be estimated. ε_i isthe composed error term and is decomposed into two components:

$$\varepsilon_i = v_i + u_i$$

v_i is two-sided noise component, symmetric error term and is not under the control of the producer. The distribution of v_i is independently and identically as N $(0, \sigma^2_u)$. On the other hand, u_i is one-sided efficiency component, positive random variable and represents management inefficiency. In addition, the distribution of one-sided efficiency component is assumed half-normal that is distribution of u_i is independently and identically as N $(0, \sigma^2_v)$ and follows:

$$\sigma^2 = \sigma^2_v + \sigma^2_u$$

Both v_i and u_i are independent of one another. The estimation of stochastic frontier production is done by two ways that are maximum likelihood or corrected ordinary least squares. As availability of software Frontier Programme has mechanized the maximum likelihood method, hence for the study maximum likelihood method is used for the estimation.

The variance ratio parameter γ relates the variability of u_i to total variability (σ_2) is calculated as follows:

$$\gamma = \sigma_u^2/\sigma^2$$

Here, $0 \leq \gamma \leq 1$

If the value of γ is close to zero, it indicates that the divergence between obtained and maximum attainable level of output is due to random factors outside the control of the producer. On the other hand, if γ is greater than one then the loss in production is controlled by technical inefficiency.

Estimating of efficiency using stochastic frontier analysis (SFA*)*

There are various models developed to understand technical inefficiency including parametric and non-parametric models. Most focus on estimating efficiency levels with no regard to the analysis of the factors causing inefficiency. The Stochastic frontier model (parametric) is different from data envelopment analysis as it addresses influence of random errors and data noise on agricultural production. It helps in understanding that deviations from the production frontier may not be entirely under the control of farmers and helps in distinguishing the effects of stochastic noise from the effects of other inefficiency factors. The following model was used in the analysis.

Cobb-Douglas Model

$$\text{LnPDRIC} = \beta_0 + \beta_1 \text{ Ln MNR} + \beta_2 \text{ Ln SED} + \beta_3 \text{ Ln LBR} + vi - ui$$

The total error term in is decomposed into where vi is the symmetric error term accounting for random variations in output due to factors outside the control of the farmer such as weather, disease, bad luck, measurement error, etc. Whereas ui represents the technical inefficiency relative to the stochastic frontier and assumes only positive values.

$$Ui = \delta_1 AG + \delta_2 GEN + \delta_3 DST + \delta_4 LON + \delta_5 TRN$$

The motive is to determine factors contributing to inefficiency besides understanding farmer-level technical efficiency. They are the exogenous factors assumed to affect inefficiency. The details of the variables considered have been provided in table below.

The technical efficiencies can be predicted using the FRONTIER program, which calculates the maximum-likelihood estimator (Battese and Coelli, 1995). The results of the stochastic frontier production function estimates for East district is shown in the table below.

Results and Discussion

Information from primary sources and results

Table 2. Description of variables

Variable	Description
Dependent variable	
PDRIC	Production of rice per hectare (kg)
Regressors	
MNR	Quantity of manure used per hectare (kg)
SED	Quantity of seeds used per hectare for rice for East district(kg)
LBR	Number of human labor per hectare (hired)
Inefficiency effects	
AG	Age of household head (years)
GEN	Sex of the household head (dummy) =1 if HH head is male; 0= otherwise
DST	Distance of market (km)
LON	Access to credit or loan(dummy) =1 if yes; 0= otherwise
TRN	Training facilities (dummy) to farmers =1 if yes; 0=otherwise

obtained from analysis of the survey data is described in this section with the help of summary statistics, tables, and appropriate regression results. A table showing basic socio-economic indicators of the sample households across four districts is provided below.

From the above table it is obvious that most of the farmers involved in agriculture are male (78%) and maximum farmers belonged to the age groupof 30 to 50 years (46%). Caste is categorized into four namely scheduled caste, scheduled tribal, other backward caste, and general. The analysis showed that majority of the respondents belonged to general category (67.67%) while respondents belonging to scheduled caste category was least (0.67%). The table also shows the religion composition of the sample population, Hindus were of majority (80%), and Christians accounted for a smaller share (2.67%). Occupational profile of the farmers has also been categorized into primary and secondary. Primary occupation consists of farmers and secondary occupation majorly included government salaried employment, private salaried employment, and business. Larger proportion of sampled households had taken up primary occupation (76.33%) and only 23.67% of sampled households had members working in secondary occupation since the focus was more on agricultural households. The respondents were distribution according to income categories and the results revealed that as they move up the income ladder the share claimed by the household tends to decrease and almost half of the households had an income below 1 lakh (51%). Traditional production system in the hills includes terraced farming and the land type is broadly divided into wet land and dry land, locally called as Dhanbari and Sukhabari. Dhanbari is the agricultural plot suitable for growing paddy and has sufficient amount of irrigational water whereas Sukhabari is steeper with less irrigation water and farmers mostly practice agroforestry and mixed cropping in such plots. There were few households owning only wet lands (17%) while half of the sample's households had mixture of both wet and dry land (50%), indicating farmers grow both paddy and other crops.

The quantity of manure used for the production of rice in East and South districts were insignificant but for West and North districts it is positive and highly significant. It implied that when the quantity of manure for the production of rice increases by 1 percent it could lead to the increase in the agricultural production by 0.06 and 0.03 percent for West and North districts respectively. The elasticity for quantity of seeds used for the production of rice were significant for all the four districts hence, quantity of seeds used for the production of crops remains an important contributor to the improvement of technical efficiency for the production of rice. The results also showed that the number of labour employed for the production of rice

Table 3. Socio economic indicators for Sample Households

Particulars		East	West	North	South	Total (%)
		Farmers (%)	Farmers (%)	Farmers (%)	Farmers (%)	
Gender	Male	49 (61.25)	75 (75)	20 (100)	90 (90)	234 (78)
	Female	31 (38.75)	25 (25)	0	10 (10)	66 (22)
Age of farmers	Less than 30	8 (10)	7 (7)	1 (5)	5 (25)	21 (7)
	30-50	32 (40)	48 (48)	7 (35)	51 (51)	138 (46)
	50-70	34 (42.5)	38 (38)	11 (55)	41 (41)	124 (41.33)
	More than 70	6 (7.5)	7 (7)	1 (5)	3 (3)	17 (5.67)
Caste	GEN	62 (77.5)	83 (83)	0	58 (58)	203 (67.67)
	OBC	9 (11.25)	0	0	0	9 (3)
	SC	1 (1.25)	1 (1)	0	0	2 (0.67)
	ST	17 (21.25)	7 (7)	20 (100)	42 (42)	86 (28.67)
Religion	Buddhist	12 (15)	4 (4)	20 (100)	16 (16)	52 (17.33)
	Christian	2 (2.5)	3 (3)	0	3 (3)	8 (2.67)
	Hindu	66 (82.5)	93 (93)	0	81 (81)	240 (80)
Occupation	Primary	51 (63.75)	66 (66)	20 (100)	92 (92)	229 (76.33)
	Secondary	29 (36.25)	34 (34)	0	8 (8)	71 (23.67)
Income category	below 1 lakh	25 (31.25)	40 (40)	15 (75)	73 (73)	153 (51)
	between 1-3 lakh	35 (43.75)	48 (48)	5 (25)	26 (26)	114 (38)
	between 3-4 lakh	19 (23.75)	12 (12)	0	1 (1)	32 (10.67)
	above 4 lakh	1 (1.25)	0	0	0	1 (0.33)

Note: Figures in parentheses indicate per cent to total

Table 4. Parameter Estimates of the Stochastic Production Function for Rice

Particulars	East		West		North		South	
	PDRIC		PDRIC		PDRIC		PDRIC	
	Coeff.	std-error	Coeff.	std-error	Coeff.	std-error	Coeff.	std-error
LnMNR	-0.020	0.078	0.060	0.030**	0.972	0.267***	0.034	0.041
LnSED	0.341	0.087***	0.264	0.050***	0.086	0.077***	0.797	0.057***
LnLBR	0.425	0.128***	0.422	0.082***	0.073	0.016	0.094	0.084
Constant	4.876	0.680***	4.334	0.401***	-0.797	0.084**	3.645	0.487***
Explanatory Variables: Technical Inefficiency								
AGE	-0.009	0.009	-0.007	0.016	-0.046	1.948	0.075	0.049
GEN	0.142	0.253	0.496	0.739	0.103	0.708	0.762	0.746
DST	0.010	0.013	-0.042	0.042	-0.046	0.712	-0.083	0.059
LON	-0.129	0.229	0.248	0.965	-2.707	0.708	-0.243	0.571
TRN	-0.107	0.180	0.519	0.678	0.103	1.948	-2.833	1.701*
Constant	1.093	0.661*	0.558	0.961	-2.707	0.712	-2.553	2.120
Sigma-square (σ^2)	0.249	0.090***	0.368	0.185**	2.081	1.000**	0.608	0.177***
Gamma (γ)	1.000	0.000***	1.000	0.032***	1.000	0.000***	0.768	0.091***
Number of observations	43		48		20		100	
LR test	10.014		12.189		15.167		16.559	

*Note: ***, **, * indicates significance at 1%, 5%, 10% level of significance respectively.*

was highly significant and positive for East and West districts however it was insignificant for North and South districts.

For the production of crops, technical efficiency is likely to be affected by a wide range of factors associated with farmers or farm management practices of the farmers. Few factors that are included in the study are age of the household head, gender of the household head, distance of the village from the market, access to loan or credit and training on farmland management, proximity to markets, and access to credit. In this study, factors that affect the technical inefficiency of peasant farmers are considered in the maximum likelihood estimates (MLE).

Among the different factors that might impact the technical inefficiency of the farmers for the production of rice, most of the factors were not statistically significant though variables had both positive and negative relation. Only training provided to the farmers in the South district had a positive and significant relation for the production of rice indicating that with access to better training, technical inefficiency will be decreased.

The gamma value of the MLEs of stochastic frontier production model is 1, 1, 1 and 0.77 for East, West, North and South districts respectively and is statistically significant for all the districts. The results indicate that the technical inefficiency effects are a significant component of the total variability of production for rice in all the district. If the value of gamma equals zero the difference between farmers output and the efficient output is entirely due to statistical noise. On the other hand, a value of one would indicate the difference attributed to the farmers technical inefficiency (Battese, *et al*, 1995; Dhungana *et al*, 2004). The likelihood-ratio tests were also performed and the test statistic has an asymptotic chi-square distribution with degrees of freedom equal to the difference between the numbers of parameters minus one. Moreover, the presence of technical efficiency is tested by Likelihood Ratio (LR) test. The LR value of rice in East, West, North and South districts is 10.01, 12.19, 15.17 and 16.56 that is more than critical Chi-square value at one percent (4.61). Therefore, for rice the null hypothesis of no technical inefficiency is rejected.

Conclusion and Policy Implications

Organic farming was adopted with the aim to curb chemical fertilizers and pesticides on agricultural holdings. It was concerned with protecting the environment and seeks to promote sustainable agricultural development. The study helped to understand that the state has been successful in the production of products that contain no chemical residues, and has successfully restored and maintained its rich soil fertility. Adoption of organic farming has been largely successful in playing a major role about providing reasonable level of income to the farmers. It has encouraged farmer's investment to increase production and aimed to achieve self- sufficiency. These tasks of production, procurement, and distribution would not have been possible without the efficient working of the state's policy for organic farming. The state has problems of supply of organic products because of low production owing to complete boycott of chemical fertilizer and pesticides but it does not mean that there were no shortcomings instead households were not completely efficient in practicing organic farming. Any such problems are to be rectified immediately by the government.

The concept of organic farming emerged in response to the questions raised on health, environment, and sustainability issues. Hence, state should pay proper attention to the constraints faced by the farmers affecting their productivity if it aims to be fully efficient in organic farming.

The results also showed that the number of labour employed for the production of rice was highly significant and positive for East and West districts however it was insignificant for North and South districts. Only training provided to the farmers in the South district had a positive and significant relation for the production of rice indicating that with access to better training, technical inefficiency will be decreased. Government should focus on providing better training facilities to the farmers which will improve organic rice production.

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Annexure I
Production of rice in Sikkim

Year	Area (000' hectares)	Production (000' tones)	Productivity (kg./ha)
2003-2004	14.74	21.19	1437.00
2004-2005	14.74	21.61	1466.00
2005-2006	14.74	22.69	1539.35
2006-2007	14.15	21.45	1515.90
2007-2008	14.00	22.85	1632.14
2008-2009	13.00	22.23	1709.23
2009-2010	12.27	20.93	1705.79
2010-2011	12.14	20.97	1727.63
2011-2012	12.00	21.08	1757.00
2012-2013	11.92	21.34	1790.27
2013-2014	11.16	20.26	1815.74
2014-2015	11.04	20.18	1828.20
2015-2016	10.67	19.69	1845.25
2016-2017	10.48	19.45	1856.02
2017-2018	9.50	17.64	1856.24