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Techmical Efficiency Analysis of Rice Production in Thoubal and Bishnupur Districts of Manipur

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Abstract:- The present study investigates how the farmers in the state are using their inputs in rice cultivation. The productivity of rice would depend on various factors, viz. fertility of the land, rice variety, methods of cultivation, applications of chemicals and fertilizers, level of farm mechanization, irrigation facilities, rainfall, etc. A relationship between production and inputs used is developed in this study at the farm level by using cross section data of 160 farmers in the state from the Field Survey data. The farm specific frontier production model is used to examine the relationship between the combination of inputs used and production in rice cultivation in the state. The study covered eight villages from Thoubal and Bishnupur districts of Manipur, four villages in each district.

Stochastic Frontier Production Function was derived from the Translog production function, and estimated the potential levels of yield of rice for the farmers included in the observation. The estimated potential levels of yield lying along the frontier function were compared with the actual production levels. The stochastic frontier production function is also used for the estimation of Technical Efficiencies.

Majority of the farmers in the sample survey were operating at a moderately high level of Technical Efficiency, i.e. 53(33.12%) and 43 (26.88%) out of the 160 farmers are operating at an efficiency class of (0.7, 0.75) and (0.75, 0.8) respectively. Whereas, 36(22.5%) farmers use the inputs at a very low efficiency level, and only 7(4.37%) farmers can employed the inputs at a high efficiency level.

Yield gap was highest in the case of villages in Bishnupur district at an average of 1096 kg per hectare. The average yield gap for the villages in Thoubal district was found at 995 kg per hectare. The maximum yield gap in the survey of 160 farmers was found at 1572 kg per hectare. The overall yield gap stood at around 1045 kg per hectare.

Keywords:- *Stochastic Frontier Production Function, Translog production function, Technical Efficiency, yield gap.*

I. INTRODUCTION

Agriculture provides employment and livelihood to the majority of the rural masses of Manipur and it is indeed, the mainstay of the state's economy. The most outstanding feature of the cropping pattern in the state is its heavy preponderance of food crops over non-food crops. Cultivation of food crops is almost mono-crop in rice, which is the staple food of the people in this state. Predominance of rice over other crops in respect to cropped area and production is seen in both the hills and the valley of the state.

The present study attempts to explore how the farmers in the state are using their inputs in rice cultivation. Such type of study will be meaningful for matter of policy implications, and address the immediate necessities of the farmers in the state so as to enable them in achieving the potential output in this sector. The productivity of rice would depend on various factors, viz. fertility of the land, rice variety, methods of cultivation, applications of chemicals and fertilizers, level of farm mechanization, irrigation facilities, rainfall, etc. But, how efficiently the farmers were using these inputs in rice cultivation? It would be worth investigating whether the level of output depends on the quantity of chemicals and fertilizers applied or right use of certain inputs or combination of the available inputs or some other factors. This is a crucial area needed to be explored since majority of the people got employment in this sector.

Cost of cultivation is an important component for determination of profitability of the crop cultivated. Therefore, farmers have to account the costs of various inputs used in cultivation. If the increase in productivity is due to the increase in quantity of fertilizers and chemicals applied, then, profitability will be cut down at the rate of the increase in cost of fertilizers and chemicals applied. There may be a situation where profitability of rice production per unit of area with less fertilizer application is the same or greater than that of more quantity of fertilizer application in the same area. Such conditions may equally be applied to other inputs too. Keeping aside the random factors like flood, drought, or quantity of rainfall during the season, it will be necessary to know whether the available inputs were utilized at its best level. Thus, an understanding of technical

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efficiency of the inputs used in rice production would provide the desired answers.

The farmers in Manipur adopted HYV of paddy and new technologies in cultivation for the last decades. In spite of high rate of fertilizer application and new technologies, productivity of rice in the valley of Manipur has been fluctuating over the years. Thus, the study of the levels of technical efficiency could help address productivity gains if there are opportunities to improve socio-economic characteristics and management practices.

A relationship between production and inputs used is developed in this study at the farm level by using cross section data of 160 farmers in the state from the Field Survey data. For this purpose, the most appropriate farm production function model is selected for analysis from among the commonly used production function models in agriculture. After selecting the best model for the analysis, a stochastic frontier production function is developed by the method of Corrected Least Squares (COLS). Recent works in production economics seek to define the best practice frontier production function and to measure the distance of the individual rice cultivator from this frontier. This distance is interpreted as a measure of the level of technical inefficiency of that farm. The stochastic frontier production function developed from the selected model is used for the estimation of technical efficiencies of the farmers included in the Field Survey.

➢ *Objectives*

The present study is pursued with the following specific objectives:

- To identify socioeconomic characteristics and management practices that influences technical efficiency of the rice farmers,
- To examine input use efficiency among the rice farmers with the help of technical efficiency analysis, and
- To suggest appropriate policies derived from the empirical results.

II. METHODOLOGY

The present investigation is based mainly on primary sources of data collected from the farmers in the study area by *multi-stage stratified random sampling method.*

Primary sources of data on related aspects of cultivation method and various inputs used in rice cultivation by the farmers are collected with the help of survey method in a specially designed questionnaire. In the first stage, four villages from each of Thoubal and Bishnupur districts were selected *purposively*. The selected villages were:

1. Charangpat Mamang Leikai (Maklang), Thoubal,
2. Khongjom Sibnagar, Thoubal,
3. Purna Heituppokpi Wangjing Sorokhaibam Leikai, Thoubal,
4. Yairipok Bamon Leikai, Thoubal,
5. Kakyai Mayai Leikai, Nambol, Bishnupur,
6. Keinou Thongthak Maning Leikai, Bishnupur,
7. Toubul Awang Mamang Leikai, Bishnupur, and
8. Heinoubok, Oinam, Bishnupur.

By using Electoral Roll of the respective villages, 50 rice farmers from each village were *randomly* selected. There are, altogether 400 (50 x 8) farmers, 200 each from the two districts in the randomized selection. In the second stage, 20 respondents out of 50 farmers from each village were picked up *randomly*. Altogether, 160 respondent farmers, 80 from each district were selected for the study.

Yield rate and production of paddy is in the form of 'clean rice'. Weight of green paddy is converted into clean rice by using the standard conversion factor (i.e. 1kg of green paddy=0.667kg of clean rice) as given by the Driage Experiment for all the sample villages.

➢ *Technical Efficiency Analysis of the Field Survey Data*

With the measurements of technical efficiency indices from the Field Survey data, an attempt is made to understand the extent to which the rice farmers in Thoubal and Bishnupur Districts of the state are exploiting their resources in the production of rice. Various socio-economic and other geographical factors determine the variations in the efficiency level of the farmers, and thus, it is difficult to assess the level of efficiency of a farmer in his production process unless one is sure of the prevailing condition in which he operates. A farmer may be using all the available inputs in required quantities, but may not be realizing the potential output due to improper management. To capture the ability of the farmers in achieving the maximum realizable crop output with minimum level of inputs under the existing resource environment and given technologies, careful examination of farm specific technical efficiency is necessary. A comparison of output in relation to the level of inputs used reveals the true picture of the farmer's efficiency level. Therefore, an analysis at the farm level is desirable to get a clear understanding of the existence of gap between actual and potential output of pineapple in these four districts. This gap can be studied with the help of technical efficiency measures.

The conceptualisation of agricultural growth suggests two channels of impact for extension in terms of production agriculture. The first channel is to assist in the dissemination of new technologies to farmers as a way of increasing agricultural productivity, thus speeding up the adoption or use of new technology and practices. The second channel is the role of extension in improving human capital and the management skills of farmers, thus assisting individual farmers to improve their level of technical efficiency. In a static context, both channels would have the effect of moving farmers closer to the frontier. In a dynamic context, where the frontier itself is moving, the role of extension in diffusing innovation is underestimated by focusing solely on changes in technical efficiency. When the growth in output for a farm over two periods is taken as the distance between

Y_1 and Y_2 this growth has occurred due to changes in its three separate elements, that is;

Output Growth = change in inputs + change in technical efficiency + technical progress

The change in the patterns of input use and improvement in the levels of technical efficiencies will have the combined effect on technological progress.

The empirical model of Translog production Function model considered for the present study consists of two stages. In the First stage, the Stochastic Frontier Function is estimated and in the second stage, Technical Efficiency indices for each farmer are estimated.

The general form of the Translog Production Function considered for the present study is given as:

$$\log Y = \beta_o + \sum_{i=1}^{n} \beta_i \log X_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{k=1}^{n} \beta_{ik} \log X_i \log X_k + \varepsilon_i \quad (1)$$

The three explanatory variables are fitted in the above Translog Production Function (1) and the fitted model is specified as follow:

$$\log(YD)=\alpha_o+\beta_1\log(AA)+\beta_2\log(MD)+\beta_3\log(FM)+(\beta_4\log(AA)^2)/2+(\beta_5\log(MD)^2)/2+(\beta_6\log(FM)^2)/2+\beta_7\log(AA)\log(MD)+\beta_8\log(AA)\log(FM)+\beta_9\log(MD)\log(FM)+\epsilon_i \quad (2)$$

Where α_o is the intercept and β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8 and β_9 are the parameters to be estimated, and
YD = production of rice in kg,
AA = area under rice in hectares,
MD = human labour in mandays, and
FM = cost of fertilizers, chemicals and hiring farm machineries.

The estimated equation is given as:

$$\text{Log}(YD)=-10.2-7.5\log(AA)+4.3\log(MD)+4.9\log(FM)+(-2.0\log(AA)^2)/2+(-0.2\log(MD)^2)/2+(-0.1\log(FM)^2)/2+1.1\log(AA)\log(MD)+0.9\log(AA)\log(FM)-0.9\log(MD)\log(FM) \quad (3)$$

The Stochastic Frontier Production Function is given by:

$$\log(YD_F)=\beta_o+\beta_1\log(AA)+\beta_2\log(MD)+(\beta_3\log(FM)+(\beta_4\log(AA)^2)/2+(\beta_5\log(MD)^2)/2+(\beta_6\log(FM)^2)/2+\beta_7\log(AA)\log(MD)+\beta_8\log(AA)\log(FM)+\beta_9\log(MD)\log(FM)+\epsilon_i \quad (4)$$

Where YD_F is the potential rice production at the farm level and β_o is the adjusted intercept term. The estimated equation is given as:

$$\log(YD_F)=-9.89-7.53\log(AA)+4.30\log(MD)+4.95\log(FM)+(-2.02\log(AA)^2)/2+(-0.23\log(MD)^2)/2+(-0.11\log(FM)^2)/2+1.13\log(AA)\log(MD)+0.94\log(AA)\log(FM)-0.98\log(MD)\log(FM)$$

The estimated Frontier Production Function indicates that the elasticity of rice production with respect to area is highest among the other inputs used in production. It means that area under rice has the highest influence on production, and at the same time, human labour has the least impact on production.

Technical Efficiency indices for each farmer can be found out by using either the relations TE = Actual Production/potential production or TE = exp (residuals)/Max (exp(residuals). The estimated technical efficiencies are tabulated into efficiency class indices as presented in Table 1. For comparative purpose, frequency distribution for each efficiency classes is sorted out.

Table 1:- Distribution of Technical Efficiency Indices among the 160 Farmers

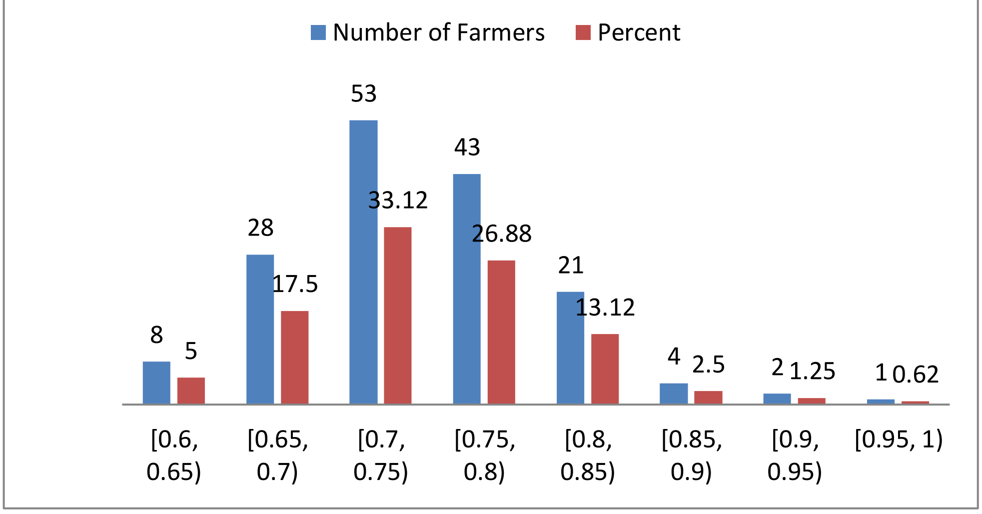
Tabulation of TE Included observations: 160 Number of categories: 8

Efficiency Class	Count	Percent	Cumulative Count	Cumulative Percent
[0.6, 0.65)	8	5	8	5
[0.65, 0.7)	28	17.5	36	22.5
[0.7, 0.75)	53	33.12	89	55.62
[0.75, 0.8)	43	26.88	132	82.5
[0.8, 0.85)	21	13.12	153	95.62
[0.85, 0.9)	4	2.5	157	98.12
[0.9, 0.95)	2	1.25	159	99.38
[0.95, 1)	1	0.62	160	100
Total	160	100	160	100

Source: Estimated from the Field Survey Data

As revealed in the Table 1, efficiency levels of the farmers in this study are concentrated to 0.7-0.8., i.e. 60 percent of the farmers are operating within this efficiency level. Yield of rice in this efficiency level is around 3000 kg/ha to 3400 kg/ha. Farmers operating within the lowest efficiency level of 0.6-0.7 comprised of 22.5 percent of the 160 farmers investigated. These farmers are getting a yield of around 2300kg/ha to 2800kg/ha with the available inputs they employed. 13.12 percent of the farmers are operating at the efficiency level of 0.8-0.85, i.e. with a yield rate of around 3300kg/ha to 3400kg/ha. Farmers operating the efficiency level of 0.85-0.95 is 3.75 percent with a yield rate of around 3400kg/ha to 3600kg/ha.

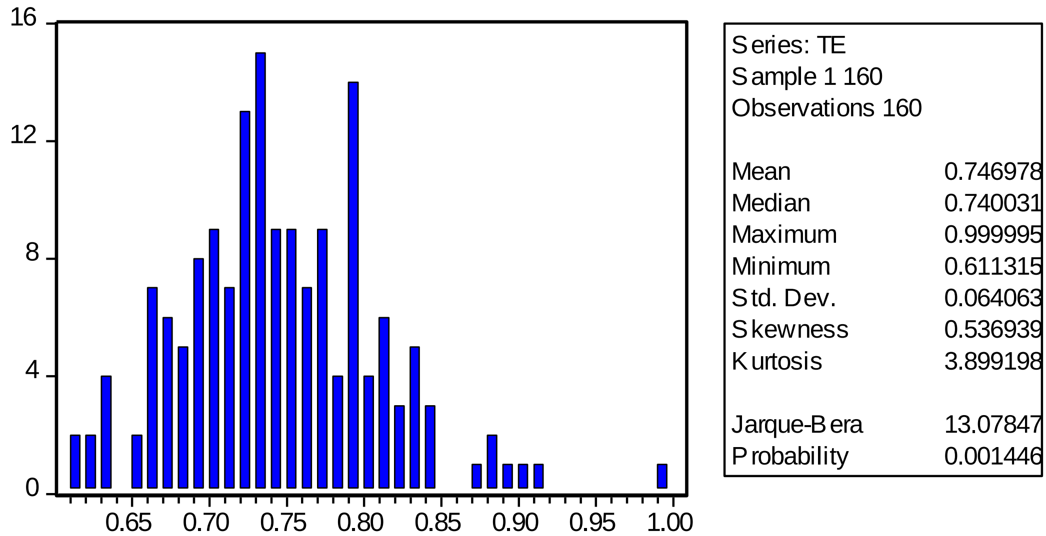
Figure1: Technical Efficiency Class of 160 Farmers



Source: Field Survey Data

The above figure (1) shows that 53(33.12%) and 43 (26.88%) out of the 160 farmers are operating at an efficiency class of (0.7, 0.75) and (0.75, 0.8) respectively; i.e. the majority of the farmers used their inputs at a moderately high efficiency level. Whereas, 36(22.5%) farmers use the inputs at a very low efficiency level, and only 7(4.37%) farmers can employed the inputs at a high efficiency level. A look into the histogram and stats of technical efficiency (figure 2) for the farmers depict similar situation as discussed above, except the gap between the maximum and minimum values of technical efficiency. The most efficient farmer operated at an efficiency level of 0.999 whereas the most inefficient farmer operated at the level of 0.611, i.e. there is a large gap of 0.388. Mean and median of the efficiency levels show the dominance by the technically inefficient farmers.

Figure 2:- Histogram and Stats of Technical Efficiency for 160 Farmers



Source: Field Survey Data

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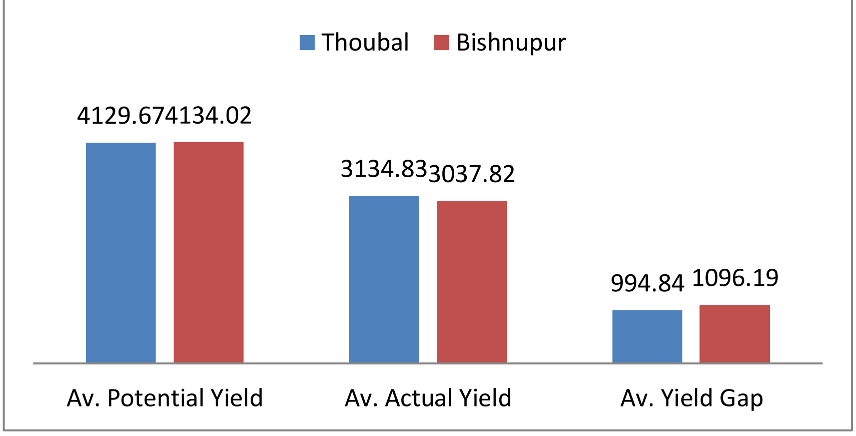
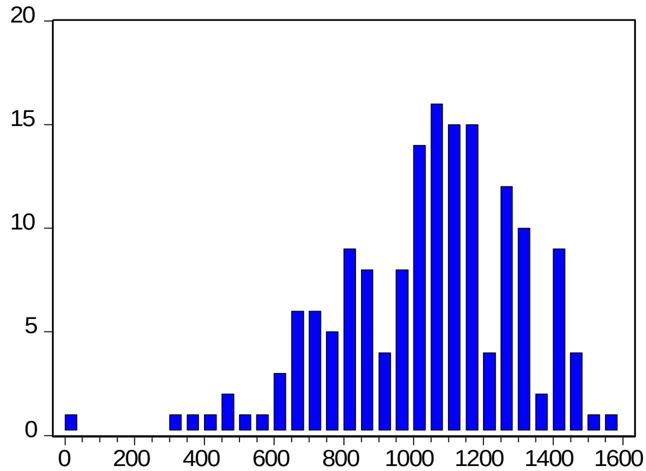


Figure 3: Average Yield Gap of Thoubal and Bishnupur

Source: Field Survey Data

Figure 4:- Histogram and Stats of Yield Gap/ha for 160 Farmers



Series: YGHA	
Sample 1 160	
Observations 160	
Mean	1045.518
Median	1078.049
Maximum	1572.585
Minimum	0.017502
Std. Dev.	266.6582
Skewness	-0.696537
Kurtosis	3.793274
Jarque-Bera	17.13291
Probability	0.000190

Source: Field Survey Data

A look into the histogram and stats of yield gap per hectare show that maximum yield gap per hectare is 1572.585 kg and minimum yield gap per hectare is 0.0175 kg. The average yield gap is 1045.5 kg per hectare for the 160 farmers covered in the survey. Number of farmers concentrated in the yield gap 1000-1200 is seen highest in the histogram.

The present study indicates that most of the farmers were employing their inputs inefficiently in rice production; there is sufficient room for increasing yield of rice with the same amount of inputs used. There is a large gap between average actual production per hectare and average potential production per hectare. It means that there is sufficient room to increase efficiency of the currently employed inputs so as to narrow down the yield gap.

III. CONCLUSION

The present study used farm specific frontier production model to examine the relationship between the combination of inputs used and production in rice cultivation in the state. The study covered eight villages from Thoubal and Bishnupur districts, four villages in each district. Six production function models commonly used in agriculture were tested for selecting the most appropriate model to analyse technical efficiency of the rice farmers. The models selected for testing were (i) Cobb-Douglas type production function, (ii) Translog Production Function, (iii) Transcendental Production function, (iv) Log-Linear functional form, (v) Linear-Log functional form, and (vi) Linear functional form. It was found that Translog production function model had all the variables statistically significant and estimates of Akaike Info Criterion (AIC) and Schwarz Criterion were sufficiently low. This Translog production function had also a considerably high adjusted R-squared estimate. Therefore, Translog production function was chosen for further analysis of technical efficiency in rice production for the selected villages in the two districts of Manipur.

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The production function selected for the purpose was estimated by taking yield of rice in kg (YD) as dependant variable, and area under rice in hectare (AA), human labour in mandays (MD) and cost of fertilizers, chemicals and farm machineries (FM) as the explanatory variables. The above explanatory variables were also found to be statistically significant and other models in which the variables are statistically insignificant were discarded from the study.

Stochastic Frontier Production Function was derived from the Translog production function, and estimated the potential levels of yield of rice for the farmers included in the observation. The estimated potential levels of yield lying along the frontier function were compared with the actual production levels. The stochastic frontier production function is also used for the estimation of Technical Efficiencies.

It was found that majority of the farmers in the sample survey were operating at a moderately high level of Technical Efficiency, i.e. 53(33.12%) and 43 (26.88%) out of the 160 farmers are operating at an efficiency class of (0.7, 0.75) and (0.75, 0.8) respectively. Whereas, 36(22.5%) farmers use the inputs at a very low efficiency level, and only 7(4.37%) farmers can employed the inputs at a high efficiency level.

Finally, it was found that yield gap was highest in the case of villages in Bishnupur district at an average of 1096 kg per hectare. The average yield gap for the villages in Thoubal district was found at 995 kg per hectare. The maximum yield gap in the survey of 160 farmers was found at 1572 kg per hectare. The overall yield gap stood at around 1045 kg per hectare.

REFERENCES

[1]. Amaza, P. S., Bila, Y., Iheanacho, A. C. (2006). 'Identification of Factors that Influence Technical Efficiency of Food Crop Production in West Africa: Empirical Evidence from Borno State, Nigeria'. In Journal of Agriculture and Rural Development in the Tropics and Subtropics, Vol. 107, No. 2, Nigeria, pp139–147

[2]. Amaza, P. S., Maurice, D. C. (2005), 'Identification of Factors that Influence Technical Efficiency in Rice-Based Production Systems in Nigeria'. In the paper presented at Workshop on Policies and Strategies for Promoting Rice Production and Food Security in Sub-Saharan Africa, November 2005, Cotonou (Benin), pp.6-8

[3]. Anuradha, N., Zala Y.C. (2010), 'Technical Efficiency of Rice Farms under Irrigated Conditions in Central Gujarat'. In *Agricultural Economics Research Review,* Vol. 23, pp 379-380

[4]. Aigner, D.J., Lovell, C.A.K., Schmidt, P., (1977). 'Formulation and Estimation of Stochastic Frontier Production Function Models'. In Journal of Econometrics (vol. 6).

[5]. Christopher, M, Cornwell, Jens-Uwe Wachter.(1999). In 'Productivity Convergence and Economic Growth: A Frontier Production Function Approach', Working Paper, Center for European Integration Studies, Germany, (http://www.zei.de, accessed on 22-12-07)

[6]. Battese, G. E.(1991). 'Frontier Production Functions and Technical Efficiency: A Survey of Empirical Applications in Agricultural Economics'. In the 35th Annual Conference of the Australian Agricultural Economics Society, University of New England, Armidale, 11-14 February, 1991, pp-13-28

[7]. Bele´n Ira´ izoz, Manuel Rapu´ n, Idoia Zabaleta, (2003). 'Assessing the technical efficiency of horticultural production in Navarra, Spain'. In Agricultural Systems 78, pp.387–403 (www.elsevier.com/locate/agsy, assessed on 14 July, 2014)

[8]. Basnayake, B.M.J.K. et al (2002). 'Estimation of Technical Efficiency and its Determinants in the Tea Small Holding Sector in the Mid Country Wet Zone of Sri Lanka'. In Sri Lankan Journal of Agricultural Economics, Volume 4, Part-1, p-137

[9]. Battese, G.E., and Coelli, T.J. (1995), 'A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data'. In Empirical Economics, 20(2), (as referred by Jaume Puig-Junoy andJosep M. Argiles (2000): 'Measuring and Explaining Farm Inefficiency in a Panel Data Set of Mixed Farms'Pompeu Fabra Univ., Barcelona, Spain, P. 5

[10]. Chowdhari, T.P.S. et al. (1963), "Optimum Combination of Competitive Crops in Intensive Cultivation Scheme Area'. In Indian Journal of Agricultural Economics, Vol. 18, pp. 143-153

[11]. Dina, P., Fernandez, M., and Peter L. N. (2009). 'Technical Efficiency in the Production of Sugar Cane in Central Negros Area, Philippines: An Application of Data Envelopment Analysis'. In *J. ISSAAS Vol. 15 No. 1: 77-88*

[12]. Damodar, N. Gujarati (2004), 'Basic Econometrics'. Fourth Edision, Tata McGraw-Hill Publishing Company Limited, New Delhi, pp. 536-38

[13]. David, L. Debertin (1986), 'Agricultural Production Economics', Macmillan Publishing Company, New York, p. 190

[14]. GoM, Directorate of Economics & Statistics, (2012), 'Report on Crop Estimation Survey, Manipur 2011-12', pp-25-26

[15]. Huynh, V.K., Misuyasu, Y, (2011). 'Technical Efficiency Analysis of Rice Production in Vietnam'. In J.ISSAAS, Vol. 17, No. 1, pp.135-146

[16]. Jayaram. H. Et al (1992), 'An Economic Analysis of Technical Efficiency in Rice Cultivation in Mandya-Some Issues in Resource Pricing'. In Indian Journal of Agricultural Economics, Vol. 47 No. 4 Oct. – Dec. 1992, p. 671

[17]. Jaume, P. J. et al (2000), 'Measuring and Explaining and Farm Inefficiency in a Panel Data Set of Mixed Farms'. Pompeu Fabra University, C/Ramon Trias Fargas pp. 25-27,Barcelona

ISSN No:-2456-2165

[18]. Lyubov, A. K., Helen, H. J.(2000). 'Technical Efficiency of Grain Production in Ukraine'. In Working Paper 00-WP 250, Center for Agricultural and Rural Development, Iowa State University, Ames, IA 50011-1070(www.card.iastate.edu, assessed on 10th March 2015), pp-17-19

[19]. Klacek J. (2007), 'KLE Translog Production Function and Total Factor Productivity'. In Statistika 4/2007, p. 2

[20]. Olorunfemi, O., Ogundele, Okoruwa, V. O. (2006). 'Technical Efficiency Differentials in Rice Production Technologies in Nigeria'. In AERC Research Paper 154, African Economic Research Consortium, Nairobi, April 2006, (Published by: The African Economic Research Consortium, City Square, Nairobi 00200, Kenya) pp-4-27

[21]. Omonona, B.T., Egbetokun, O.A., Akanbi, A.T. (2010). 'Farmers Resource – Use and Technical Efficiency in Cowpea Production in Nigeria'. In Economic Analysis & Policy, Vol. 40 No. 1, Nigeria. pp-87-94

[22]. Panda, R.C. (1996), Efficiency and Productivity – The Case of Sericulture Farms in Tamil Nadu', In Indian Journal of Agricultural Economics, Vol. 51. No. 3 July-Sept. 1996, p. 354

[23]. Pouchepparadju, A. et al. (2005), An Econometric Analysis of Green Technology Adoption in Irrigated Rice in Pondicherry Union Territory'. In Indian Journal of Agricultural Economics, Vol. 60 No. 4 Oct. – Dec. 2005, pp. 660-675

[24]. Panchamukhi, V.R. (1978), 'A Survey of Research in Economics', Vol. VII. 1978, Econometrics, ICSSR, New Delhi, pp. 121-130

[25]. Rubinos, R. et al (2007), "Comparative Economic Study of Organic and Conventional Rice Farming in Magsaysay, Davao Del Sur". In the 10th National Convention on Statistics, University of Southeastern Philippines (USEP), Davao City, October 1-2, 2007

[26]. Ramanathan, R. (2002), 'Introductory Econometries with Applications'. Thomson Asia Pte Ltd., Singapore, Fifth Edition, pp. 151-152.

[27]. Sauer, J. et al. (2006), "Stochastic Efficiency Measurement – The Curse of Theoretical Consistency'. In Journal of Applied Economics, Vol. IX, Universidad del CEMA, ISSN, Argentina, p. 139

[28]. Suzanne O'Neill et al. (1999), 'Farm Technical Efficiency and Extension'. In Paper presented at the Irish Economics Association in April 1999, Dublin, p. 24

APPENDIX (A)

Technical Efficiency (TE), Actual Yield of Rice in kg (YD) and Potential Yield of Rice in kg (YDF) of 80 Farmers, Bishnupur District

Sl. No.	AA	FM	MD	TE	YD	YDF
1	0.35	8	30	0.73231	1012	1381.929
2	0.26	5.5	30	0.659278	710	1076.935
3	1.102	36	120	0.700394	2960	4226.192
4	0.25	7	25	0.70983	752	1059.409
5	0.75	21	75	0.732994	2276	3105.073
6	0.506	14	50	0.7447	1612	2164.63
7	0.379	10	30	0.685159	1071	1563.14
8	0.9	28	80	0.791414	2922	3692.128
9	0.506	14	40	0.682326	1452	2128.014
10	0.255	8	20	0.712221	792	1112.014
11	0.75	27	85	0.759403	2326	3062.934
12	0.27	9	30	0.668281	794	1188.124
13	0.26	8	28	0.691533	782	1130.821
14	1.265	35	150	0.627049	2970	4736.474
15	1.012	32	120	0.696062	2720	3907.699
16	0.758	24	105	0.790661	2380	3010.14
17	1.26	40	140	0.727885	3400	4671.065
18	0.758	24	90	0.679312	2100	3091.362
19	0.253	6.5	35	0.673985	740	1097.947
20	0.38	13	42	0.729809	1224	1677.151
21	0.365	10	32	0.736434	1140	1548
22	0.955	28	110	0.799979	3024	3780.099

23	0.74	22	60	0.744312	2310	3103.538
24	1.112	27	100	0.693948	2940	4236.627
25	0.5	18	48	0.814396	1824	2239.696
26	0.375	13	36	0.773726	1311	1694.398
27	0.253	9	24	0.685341	786	1146.874
28	0.38	9	40	0.759736	1218	1603.188
29	1.265	35	120	0.782935	3740	4776.897
30	2.24	56	160	0.791425	5612	7091.007
31	0.506	12	65	0.788626	1740	2206.37
32	0.758	16	90	0.827217	2636	3186.587
33	0.758	18	85	0.875708	2750	3140.315
34	0.28	8	30	0.795282	960	1207.119
35	0.36	11	34	0.767326	1214	1582.118
36	0.76	22	62	0.732543	2310	3153.397
37	1.112	28	80	0.731528	3028	4139.278
38	2.265	68	225	0.798561	5750	7200.448
39	0.35	11	30	0.772994	1200	1552.405
40	0.5	14	50	0.885629	1900	2145.367
41	1.012	32	112	0.667753	2640	3953.56
42	1.012	32	130	0.812473	3128	3849.975
43	0.506	11	70	0.799196	1804	2257.269
44	0.758	22	105	0.7246	2228	3074.8
45	0.253	7	30	0.731493	794	1085.451
46	0.25	7	20	0.740482	764	1031.76
47	0.3	9	25	0.761501	990	1300.064
48	0.506	14	48	0.72788	1572	2159.697
49	0.25	7.5	24	0.727849	784	1077.146
50	0.255	7	20	0.729968	760	1041.142
51	0.5	13	50	0.660151	1400	2120.727
52	0.355	10	30	0.832591	1260	1513.349
53	0.5	14	44	0.73765	1572	2131.093
54	0.56	14	44	0.70214	1584	2255.961
55	1.012	30	120	0.639152	2520	3942.724
56	0.55	14	48	0.632095	1436	2271.81
57	1	28	80	0.722511	2856	3952.881
58	1.253	37.5	140	0.611315	2860	4678.441
59	1.012	36	120	0.73958	2840	3840.018
60	0.506	18	62	0.718568	1540	2143.151
61	0.253	7	40	0.722701	792	1095.888
62	1.265	27.5	150	0.661898	3250	4910.122
63	0.225	6	40	0.797773	780	977.7219
64	0.506	16	60	0.756744	1642	2169.823
65	0.253	7	28	0.738915	798	1079.962
66	0.379	10	40	0.700755	1140	1626.818
67	0.95	27	105	0.747419	2828	3783.686

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68	0.25	8	24	0.705185	774	1097.584
69	0.74	25	72	0.690162	2160	3129.701
70	1.112	30	96	0.670973	2880	4292.272
71	0.35	11	45	0.751926	1140	1516.106
72	0.379	41	45	0.720009	1112	1544.426
73	0.8	27	90	0.710494	2308	3248.446
74	0.9	25	105	0.734365	2656	3616.728
75	0.25	7	24	0.71836	758	1055.181
76	0.255	8	24	0.821635	916	1114.85
77	0.38	11	40	0.751374	1242	1652.973
78	0.253	7	25	0.741217	792	1068.512
79	0.26	8	28	0.673847	762	1130.821
80	0.38	10	38	0.770159	1248	1620.445

Table 2

APPENDIX (B)

Technical Efficiency (TE), Actual Yield of Rice in kg (YD) and Potential Yield of Rice in kg (YDF) of 80 Farmers, Thoubal District

Sl. No.	AA	FM	MD	TE	YD	YDF
1	0.758	24	90	0.679312	2100	3091.362
2	0.253	9	28	0.713743	800	1120.851
3	0.38	13	42	0.747697	1254	1677.151
4	0.506	18	62	0.718568	1540	2143.151
5	1.012	30	120	0.639152	2520	3942.724
6	0.253	9	30	0.733201	812	1107.472
7	1.265	37.6	150	0.822602	3850	4680.272
8	0.225	8	30	0.750819	720	958.9531
9	0.35	11	45	0.751926	1140	1516.106
10	1.153	37.5	140	0.846436	3960	4678.441
11	1.012	36	120	0.999995	3840	3840.018
12	2.265	63	225	0.782304	5670	7247.818
13	0.35	11	30	0.772994	1200	1552.405
14	0.95	27	120	0.844685	3168	3750.508
15	0.25	8	24	0.796295	874	1097.584
16	0.74	25	72	0.690162	2160	3129.701
17	1.112	30	96	0.670973	2880	4292.272
18	0.5	18	48	0.814396	1824	2239.696
19	0.375	13	36	0.773726	1311	1694.398
20	0.253	9	24	0.728938	836	1146.874
21	0.25	7.5	24	0.635011	684	1077.146
22	0.255	7	20	0.729968	760	1041.142
23	0.5	13	50	0.660151	1400	2120.727
24	0.365	10	32	0.736434	1140	1548
25	0.955	28	96	0.791753	3024	3819.372
26	0.64	12	60	0.905146	2310	2552.074

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27	1.112	27	100	0.693948	2940	4236.627
28	0.506	15	48	0.763608	1672	2189.606
29	0.9	27	90	0.893877	3256	3642.557
30	0.25	7	24	0.81313	858	1055.181
31	0.255	8	24	0.839575	936	1114.85
32	0.355	10	30	0.832591	1260	1513.349
33	0.5	15	44	0.769888	1672	2171.745
34	0.56	14	44	0.70214	1584	2255.961
35	0.36	11	34	0.792608	1254	1582.118
36	0.76	22	62	0.732543	2310	3153.397
37	1.112	28	80	0.765351	3168	4139.278
38	0.9	28	80	0.810373	2992	3692.128
39	0.506	14	40	0.682326	1452	2128.014
40	0.255	8	20	0.712221	792	1112.014
41	0.38	11	35	0.797569	1313	1646.252
42	1.265	35	120	0.782935	3740	4776.897
43	2.24	56	160	0.805527	5712	7091.007
44	0.506	14	50	0.776114	1680	2164.63
45	0.253	7	20	0.809639	840	1037.5
46	0.25	7	20	0.837404	864	1031.76
47	0.3	9	25	0.761501	990	1300.064
48	0.35	11	25	0.702508	1089	1550.16
49	0.26	7	20	0.796482	836	1049.616
50	1.102	29	80	0.61277	2560	4177.753
51	0.25	7	25	0.747587	792	1059.409
52	0.5	14	50	0.885629	1900	2145.367
53	0.75	21	75	0.765199	2376	3105.073
54	0.506	14	50	0.753939	1632	2164.63
55	0.379	10	30	0.685159	1071	1563.14
56	0.55	14	48	0.658506	1496	2271.81
57	1	28	80	0.722511	2856	3952.881
58	0.758	24	60	0.846574	2736	3231.851
59	0.758	21	75	0.91039	2850	3130.528
60	0.28	8	30	0.795282	960	1207.119
61	1.265	35	150	0.627049	2970	4736.474
62	1.012	32	120	0.696062	2720	3907.699
63	0.758	27	95	0.745923	2244	3008.352
64	1.26	40	140	0.727885	3400	4671.065
65	0.758	24	90	0.704544	2178	3091.362
66	0.506	16	60	0.77057	1672	2169.823
67	0.253	7	28	0.738915	798	1079.962
68	0.379	10	40	0.700755	1140	1626.818
69	1.012	32	112	0.667753	2640	3953.56
70	1.012	32	120	0.810707	3168	3907.699
71	0.506	14	65	0.837854	1824	2176.991

72	0.379	11	38	0.660892	1089	1647.772
73	0.8	27	90	0.772061	2508	3248.446
74	0.75	27	85	0.775727	2376	3062.934
75	0.27	6	35	0.69009	805	1166.515
76	0.26	8	28	0.806494	912	1130.821
77	0.38	11	40	0.751374	1242	1652.973
78	0.253	7	25	0.741217	792	1068.512
79	0.26	8	28	0.806494	912	1130.821
80	0.38	10	38	0.733132	1188	1620.445

Table 3