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Technical Efficiency of Paddy Production and Factors Affecting the Efficiency in Nagapattinam District, Tamil Nadu

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Abstract **– The study was made to assess the technical efficiency of paddy production and factors affecting the efficiency with special reference to paddy production in Nagapattinam district of Tamil Nadu. Multi - stage random sampling was used to collect data from samples of 120 farmers through well structured questionnaire. Descriptive statistics and stochastic frontier production function were used to analyze the data. Frontier 4.1, a computer program was used to estimate the stochastic frontier production function and tobit model was used to estimate the factors that affecting efficiency. Result found that the average technical efficiency was 80.42 per cent and the coefficients of variables such as organic fertilizer, plant protection chemical, labours and machinery usage are negative which reveals that the volume of output varies inversely to the quantity of these variables while farm size, seed, chemical fertilizer and irrigation are positive which reveals that the volume of output varies proportionately to the quantity of these variables. The factors which have positive response for improving technical efficiency as the result of tobit model is experience, education and adoption of dapog nursery while age, direct sowing, machineries usage have negative responses. Since it is impossible to adopt dapog nursery and change the method of sowing because of water shortage problem, farmers suggested the Government to construct farm ponds and bed dams to improve the technical efficiency which paves way for the adoption of dapog nursery and alternate sowing method.**

Keywords **– Stochastic Frontier Production Function, Technical Efficiency, Factors, Paddy Production.**

I. INTRODUCTION

Rice is one of the prominent cereal crops in India and it is grown in many regions across India. For about 65 per cent of the people living in India, rice is a staple food for them. It is a part of nearly every meal, and it is grown on a majority of the rural farms. Global rice production was 473 million tonnes in 2015-16. India ranked first in area under rice (44.1 million ha) and second in terms of production (104.4 million tonnes) next to China (142.1 million tonnes) in 2015-16 followed by Indonesia and Bangladesh. It contributes 22 per cent of global rice production. Rice occupies about 23 per cent of the gross cropped area in the country [2].

Rice contributes 42 per cent of total food grain production and 45 per cent of total cereal production of the country. Paddy is cultivated in more than 20 states of India for about 400 lakh hectares. The major rice producing states are West Bengal, Uttar Pradesh, Andhra Pradesh, Punjab and Tamil Nadu. It is a staple food in Tamil Nadu and the state is one of the rice growing states in India. Rice is being cultivated in both Kuruvai (June-Sep) and Samba (Nov-Dec) seasons and also in summer in some places. The area under rice in Tamil Nadu is 33.24 lakh ha with a production of 74.58 lakh tonnes and the productivity is 2244 kg per ha in 2016-17.

Even though, paddy producers are facing lot of hurdles in the production process due to various factors. Especially coastal districts are very prone to climatic changes such as storm, cyclone, tsunami, flood, drought and deficit or excess rainfall which causes huge loss in paddy production. Apart from climatic factors the major factors that affect paddy production are grouped into production variables and socio economic variables. The coastal belt of Tamil Nadu consists of 13 districts viz., Thiruvallur, Chennai, Kanchipuram, Villupuram, Cuddalore, Thiruvarur, Nagapattinam, Thanjavur, Pudukottai, Ramanathapuram, Thoothukudi, Thirunelveli and Kanyakumari. Among these districts Nagapattinam has larger coastal length (187.90 Km) next to Ramanathapuram (236.80 Km). The total area of production of paddy in Nagapattinam district is larger which is about 1,64,436 ha then the Ramanathapuram which is about 1,21,742 ha, hence Nagapattinam district is selected as the study area. Hence, the study was made to analyze the technical efficiency of paddy production, to identify the factors (production and socio economic variables) which cause inefficiency in paddy production and suggestions to improve the efficiency of paddy production in Nagapattinam district.

II. METHODOLOGY

Nagapattinam district was formed on 18th October 1991. It is a coastal district of Tamil Nadu situated between 10°10' and 11°20' North latitude and between 79°15' and 79°50' East longitude. The geographical area of the district is 2,71,583 ha. The district comprises of 11 blocks viz., Nagapattinam, Keelaiyur, Kilvelur, Thirumarugal, Thalainayaru, Vedaranyam, Mayiladuthurai, Kuthalam, Sembanarkoil, Sirkali and Kollidam. Samples of 120 farmers were selected through three stage random sampling. In first stage, Nagapattinam district was selected purposively. In second stage, two coastal blocks were selected randomly and the selected blocks were Nagapattinam and Sembanarkoil. In third stage, 120 samples were selected randomly from three villages of each block.

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Analytical tools used in the study were descriptive statistics, stochastic frontier production function and tobit model. Descriptive statistics included mean, frequency, standard deviation and percentage analysis which were used to describe the variables. Stochastic frontier production function was used to examine the relationship between dependent and independent variables and to find out the technical efficiency through a computer program, Frontier 4.1. Tobit model was employed to know the factors affecting efficiency through Gretl 1.9.92.

Refers the technical efficiency was referred as the ability of the firm to produce the maximum possible output from a given set of inputs and technology [3]. Technical efficiency is defined as a given firm (at a given time period) as the ratio of its mean production (conditional on its levels of factor inputs and firm effects) to the corresponding mean production if the firm utilized its levels of inputs most efficiently [4]. Frontier production function is the maximum feasible or potential output that can be produced by a production unit such as farm, given level of inputs and technology [14]. Stochastic frontier was states as it involved two random components, one associated with the presence of technical inefficiency and the other being a traditional random error [4]. Stochastic frontier production was used to analyse the technical efficiency [1] [5] and determinants of efficiency [9] [10].

In measuring the technical efficiency this study assumed that yield of paddy production (Kg) is dependent on farm size (ha), quantity of seeds (Kg), chemical fertilizers (Kg), organic fertilizers (t), plant protection chemicals (Lit), labor (man day), irrigation (no.) and machinery usage (hr).

The stochastic frontier model was specified as,

$$\ln Y_i = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + (v_i - u_i)$$

Where,

Y_i = Paddy yield per season per hectare (Kg)

X_1 = Farm size (ha)

X_2 = Quantity of seeds per hectare (Kg)

X_3 = Quantity of chemical fertilizers per hectare (Kg)

X_4 = Quantity of organic fertilizers per hectare (tones)

X_5 = Quantity of plant protection chemicals (litre)

X_6 = Labor per hectare (man days)

X_7 = Irrigation per hectare (numbers)

X_8 = Machineries usage per hectare (hours)

β_0 = Constant

$\beta_1 - \beta_8$ = Coefficients of independent variables X_1 - X_8

v_i = Random error term which is assumed to be independent and normally distributed as N $(0, \delta^2)$

u_i = Technical inefficiency which is assumed to be independent and a truncated normal distribution at zero with mean μ_i and variance δ_u^2 , N (μ_i, δ_u^2)

Production and socio-economic factors affecting production was analysed to know the determinants affecting production [6][7][8]. Tobit model regression had employed since the efficiency score had range from 0-1 [13]. Socio economic variables were regressed with estimated efficiency score to know the variables affecting technical efficiency of paddy production through tobit model [11].

The tobit model was used in this study to examine the factors that could cause inefficiency in paddy production. Hence, efficiency was regressed with socio economic variables such as age (yrs), experience (yrs), house hold size (no.), education (binary variable) and other independent variables such as method of sowing, usage of dapog nursery, trans planter and harvester as binary variables. Thus, specified tobit model is,

$$TE = \alpha_0 + \alpha_1 AGE + \alpha_2 EXP + \alpha_3 HHSIZE + \alpha_4 PRIMARY + \alpha_5 SECONDARY + \alpha_6 COLLEGIATE + \alpha_7 SOWING + \alpha_8 DAPOG + \alpha_9 TRANSPLANTER + \alpha_{10} HARVESTER + \varepsilon_i$$

TE = Technical efficiency

AGE = Age of the farmers (yrs)

EXP = Experience in paddy production (yrs)

PRIMARY = Primary level education (1 if yes, 0 otherwise)

SECONDARY = Secondary level education (1 if yes, 0 otherwise)

COLLEGIATE = College level education (1 if yes, 0 otherwise)

SOWING = Method of sowing (1 if direct sowing, 0 otherwise)

DAPOG = Dapog nursery (1 if yes, 0 otherwise)

TRANSPLANTER = Paddy transplanter (1 if yes, 0 otherwise)

HARVESTER = Paddy harvester (1 if yes, 0 otherwise)

α_0 = Constant

$\alpha_1 - \alpha_{10}$ = Coefficients of independent variables

ε_i = Error term

III. Result and Discussion

This part deals with the statistical summaries of parameters used for the estimation and draw results from tobit model using gretl software and frontier 4.1 software.

Summary of the descriptive analysis of variables which were used for the estimation of production function is given in the table 1. The estimated average output per farmer is 9682.11 kg/ha. On an average, 175.78 kg/ha for seeds, chemical fertilizer use is 920.96 kg/ha, organic fertilizers use is 4.86 t/ha, plant protection chemicals is 0.84 Lit/ha, 220 (man day/ha) for labour, number of irrigation 56, 11.94 hrs for machinery usage.

The result of output oriented technical efficiency in percentage of the paddy producing farmers is displayed in the table 2. The average technical efficiency estimated here is 80.42 %. There are 12 farmers fall in the range up to 60% technical efficiency which is 10% to the total sample size. 20 (16.67%) farmers are in the range of 60-70% and 70-80% efficiency level. 18 (15%) farmers producing paddy at 80-90% efficient level of technical efficiency and 50 farmers producing paddy at more than 90% technical efficiency which is about 41.66% to the total samples. It is evident from the result that 56.66% of

the producers are ranged from above the average technical efficiency and 43.34 % of the producers are ranged to have less than the average technical efficiency.

Table 1. Descriptive Statistics of Variables

Variables	Mean	Standard Deviation	Maximum	Minimum
Yield	9682.11	9231.51	75000.00	1250.00
Farm size	2.06	1.97	12.00	0.30
Seed	175.78	166.44	900.00	22.50
Chemical fertilizer	920.96	979.91	6000.00	48.00
Organic fertilizer	4.86	11.91	120.00	0.00
Plant protection chemical	0.84	2.14	11.50	0.00
Labour	220.00	209.73	1425.00	0.00
Irrigation	56.00	89.84	600.00	0.00
Machinery usage	11.94	21.11	140.00	0.75
Age	53.00	12.00	80.00	27.00
Experience	33.00	16.00	70.00	5.00
House hold size	5.00	2.00	14.00	2.00

Table 2. Frequency Distribution of Technical Efficiency

Technical Efficiency (%)	Farmers (no.)	Percentage
Up to 60	12	10.00
60-70	20	16.67
70-80	20	16.67
80-90	18	15.00
More than 90	50	41.66
Total	120	100

Table 3, shows the estimated results of production function parameters. To test the overall fitness of the model Maximum Likelihood (ML) ratio test is used. The calculated value is 63.74 and the theoretical value of chi-square is 11.1 at 5% level of significance. The model is adequate since the calculated value is greater than the theoretical value. Collegiate education is a variable which was excluded due to multicollinearity. The estimated stochastic frontier production function reveals that the coefficients of the variables farm size and irrigation are significant at 1%, chemical fertilizer is significant at 5% and machinery usage is significant at 10%. The coefficients of variables such as organic fertilizer, plant protection chemical, labours and machinery usage are negative which reveals that the volume of output varies inversely to the quantity of these variables while farm size, seed, chemical fertilizer and irrigation are positive which reveals that the volume of output varies proportionately to the quantity of these variables. Since the soil fertility has been declined due to salinity, response of the organic fertilizers became slow and therefore coefficient of organic fertilizer is negative.

The variable which has high elasticity (0.75) is farm size followed by chemical fertilizer (0.30) which says that if farm size and chemical fertilizers increases by 10% then there will be 7.5% and 3% increase in the output.

Table 3. Result of Parameters Estimation for Technical Efficiency

Variables	Coefficient	Standard Error	t-ratio
Constant	6.215909	0.812027	7.654802***
Ln farm size	0.74848	0.159131	4.703539***
Ln seed	0.019306	0.083093	0.23234
Ln chemical fertilizer	0.300032	0.142631	2.103549**
Ln organic fertilizer	-0.00965	0.01377	-0.70086
Ln plant protection chemical	-0.03966	0.053425	-0.74239
Ln labours	-0.04527	0.088083	-0.51394
Ln irrgation	0.076139	0.010424	7.304108***
Ln machinery usage	-0.03234	0.021774	-1.48521*
Sigma-square	0.1051648 (9.101256)		
Log likelihood	0.39608519		
LR	63.742199		

Note: *, ** and *** indicate significance at 10%, 5% and 1% respectively

The estimated efficiencies are regressed with variables such as age, experience, house hold numbers, education level, method of sowing, usage dapog nursery, paddy transplanter and paddy harvester using tobit model to know the factor affecting it. The calculated value is 52.65 and the theoretical value of chi-square is 16.92 at 5% level of significance. The model is adequate since the calculated value is greater than the theoretical value. The summary of the result is displayed in the table 4.

It shows that variables such as experience, house hold numbers, primary education, secondary education and dapog nursery are positively related with the technical efficiency which reveals the a unit increase in these variables result in improving technical efficiency of paddy production. Age, method of sowing, paddy transplanter and paddy harvester are negatively related with technical efficiency which reveals that these are variables are responsible for technical inefficiency of production. Coefficients of primary education and dapog nursery is positively significant at 5% and 1% respectively whereas coefficients of paddy transplanter and paddy harvester are negatively significant at 1%.

Table 4. Result of Tobit Model for Technical Efficiency

Variables	Coefficient	Standard Error	Z value	P-value
Constant	0.813847	0.0734374	11.0822	<0.00001 ***
Age	−0.00155808	0.00152029	-1.0249	0.30543
Experience	0.000692923	0.00109433	0.6332	0.52661
House hold numbers	0.00382083	0.00746355	0.5119	0.60870
Primary education	0.121783	0.0542005	2.2469	0.02465**
Secondary education	0.0629832	0.0653613	0.9636	0.33524
Method of sowing	−0.0484597	0.0311584	-1.5553	0.11988
Dapog nursery	0.30424	0.114955	2.6466	0.00813 ***
Paddy transplanter	−0.398499	0.104526	-3.8125	0.00014 ***
Paddy harvester	−0.1016	0.0340049	-2.9878	0.00281 ***
Log-likelihood	70.61492			

Note: ** and *** indicate significance at 5% and 1% respectively

IV. CONCLUSION

If the farmers change their sowing method from direct sowing and reduce the use of machineries they can improve the technical efficiency of paddy production. Adopting dapog nursery may also improve the efficiency. But due to water and labour shortage it is quite impossible to do so. These farmers are mostly depends on rain water and less depends on other sources for their cultivation. They are utilizing farm pond water during non-rainy seasons but not throughout year since water holding capacity of the soil is poor. Even though, farm ponds and bed dams are highly useful for the paddy production during non-rainy seasons. Hence ultimately water is the main reason for the technical inefficiency and the farmers are suggested the Government to construct more number of farm ponds and bed dams in the study area.

REFERENCES

[1] Aboki, E., A. A. U. Jongur, J. I. Onu and I. I. Umaru, 2013, "Analysis of Technical, Economic and Allocative Efficiencies of Cassava Production in Taraba State, Nigeria", *IOSR Journal of Agriculture and Veterinary Science,* Vol. 5(3), pp. 19-26.

[2] Anuradha Narala, 2010, "Technical efficiency rice farmers under irrigated conditions in central Gujarat", Unpublished M.Sc Thesis submitted to Anand Agricultural University, Gujarat.

[3] L. Ara, F. Alam, M. M. Rahman and M. A. Jabbar, 2004, "Yield Gaps, Production Losses and Technical Efficiency of Selected Groups of Fish Farmers in Bangladesh", *Indian Journal of Agricultural Economics*, Vol. 59(4), pp.808-818.

[4] G. E. Battese and T. J. Coelli, 1992, "Frontier Production Functions, Technical Efficiency and Panel Data: with Application to Paddy Farmers in India", *Journal of Productivity Analysis*, Vol. 3, pp. 153-159.

[5] Benpomaa and H. De-Graft Acquah, 2014, "Technical Efficiency Analysis of Maize Production: Evidence from Chana," *Applied Studies in Agribusiness and Commerce,* APSTRACT, Vol. 2(23), pp. 73-79.

[6] T. A. Hassan and S. E. Suliman, 2015, "Economic Analysis of Factors Affecting Crop Production in South Darfur State-Sudan," *ARPN Journal of science and Technology,* Vol. 5(5), pp. 242-245.

[7] M. Z. Hoque and M. E. Haque, 2014, "Socio-Economic Factors Influencing Profitability of Rice Seed Production in Selected Areas of Bangladesh," *The Agriculturists,* Vol. 12(1), pp. 33-40.

[8] N. L. Jamaludin, A. Amer and H. F. B. A. Hasan, 2010, "A Study on Factors Affecting Rice Production in Malaysia", Conference Paper in *International Journal of Cost Metals Research* (iCAST).

[9] S. Kea, H. Li and Linvolakpich, 2016, "Technical efficiency and its Determinants of Rice Production in Cambodia", *Economies,* Vol. 4, pp. 22.

[10] K. H. Koirala, Ashok K. Mishra and S. Mohanty, 2014, "Determinants of Rice Productivity and Technical Efficiency in the Philippines", *Southern Agricultural Economics Association* (SAEA) Annual Meeting.

[11] Lira Mailena, Mad Nasir Shamsudin, Alias Radam and Zainalabidin Mohamed, 2014, "Efficiency of rice farms and its determinants: Application of Stochastic frontier analysis", *Trends in applied sciences research*, Vol. 9, pp. 360-371.

[12] K. R. Shanmugam and Atheendar Venkataramani, 2006, "Technical Efficiency in Agricultural Production and its Determinants: An Exploratory Study at the District Level", *Indian Journal of Agricultural Economics,* Vol. 61(2), pp. 172.

[13] K. R. Sharma, P. Leung and H.M. Zaleski, Technical, 1999, "Allocative and economic efficiencies in swine production in Hawaii: A comparison of parametric and nonparametric approaches", *Agricultural Economics*, Vol. 20, pp. 23-35.

[14] Y. Y. Tun and Hye- Jung Kang, 2015, "An Analysis on the Factors Affecting Rice Production Efficiency in Myanmer", *Journal of East Asian Economic Integration,* Vol. 19(2), pp. 167-188.

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