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Measurement of Efficiency of Shrimp (*penaeus monodon*) Farmers in Andhra Pradesh

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I

INTRODUCTION

The definition of technical efficiency by Farrell (1957) led to the development of methods for estimating the relative technical efficiencies of firms. The measurement of firm-specific technical efficiency is based upon deviations of observed output from the best production or efficient production frontier. If a firm's actual production point lies on the frontier it is perfectly efficient. If it lies below the frontier then it is technically inefficient, with the ratio of the actual to potential production defining the level of efficiency of the individual firm.

The present study was taken up during 2007-08 in the state of Andhra Pradesh. Stratified random sampling was adopted to select the respondents. A total of 480 respondents were selected from 16 villages across four mandals of the East Godavari district. The selected mandals are predominantly shrimp farming areas, with optimum salinity and excellent irrigation facilities.

II

THE STOCHASTIC PRODUCTION FUNCTION APPROACH

The approaches available to study technical inefficiency include the stochastic production function based on the composed error model of Aigner *et al.* (1977), Meeusen and Van den Broeck (1977) and Forsund *et al.* (1980). Consider a stochastic production function model with multiplicative disturbance of the firm.

$$y = f(x_i, \beta)\, e^{\epsilon} \qquad \text{….(1)}$$

where $\in$ is a stochastic error term consisting of two independent elements

$$\in = \mu + \nu. \qquad \text{….(2)}$$

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The symmetric component, ν, accounts for random variation in output due to factors outside the farmer's control, such as weather and diseases. It is assumed to be independently and identically distributed as $N(0, \sigma^2_\nu)$. A one-sided component $\mu \leq 0$ reflects technical inefficiency relative to the stochastic frontier, $f(x_i, \beta)\, e^{\nu}$. Thus, $\mu = 0$ for a farm whose output lies on the frontier and $\mu < 0$ for one whose output is below the frontier. Assume that μ is identically and independently distributed as $|N(0, \sigma^2_\mu)|$, i.e., the distribution of μ is half-normal.

The stochastic production frontier model can be used to analyse the cross section data. The frontier of the farm is given by combining equations (1) and (2).

$$y = f(x_i, \beta)e^{(\mu + \nu)}. \qquad \text{….(3)}$$

The variance of $\in$ is, therefore,

$$\sigma^2 = \sigma^2_\mu + \sigma^2_\nu. \qquad \text{….(4)}$$

The ratio of two standard errors* is defined by

$$\lambda = \sigma_\mu/\sigma_\nu. \qquad \text{….(5)}$$

Jondrow *et al.* (1982) have shown that measures of efficiency at the individual farm level can be obtained from the error terms $\in = \mu + \nu$. For each farm, the measure is the expected value of μ conditional on $\in$, i.e.,

$$E(\mu|\in) = \sigma_\mu\sigma_\nu/\sigma\ [(\phi(\in\lambda/\sigma)/1- \phi(\in \lambda/\sigma))- \in \lambda/\sigma] \qquad \text{….(6)}$$

Normal distribution function evaluated at $(\in \lambda/\sigma)$. Estimated values for $\in$, λ and σ are used to evaluate the destiny and distribution functions. Measures of efficiency for each farm can be calculated as:

$$TE = Y_i/Y^*_i = \exp\, [E\{\in|\ \mu\}]. \qquad \text{….(7)}$$

In this study, the MLE (Maximum-Likelihood Estimation) method was used for estimation.

III

ESTIMATION OF THE STOCHASTIC FRONTIER PROUDCTION FUNCTION

The equation in the present study was defined as:

$$\text{Log } y_i=\beta_0+ \beta_1 \text{Ln}(x_{1i}) + \beta_2 \text{Ln}(x_{2i}) + \beta_3 \text{Ln}(x_{3i}) + \beta_4 \text{Ln}(x_{4i}) + \beta_5 \text{Ln}(x_{5i}) +\in \qquad \text{….(8)}$$

Where $\in = \mu + \nu$, and $\mu \leq 0$.

The notations y and x refer respectively to quantity of output per ha and quantity of inputs per ha. The independent variables are land (x_1), stocking density (x_2), fertiliser (x_3), feed (x_4) and labour (x_5). The details of output and inputs were recorded based on the unit size (1 ha) of the pond.

Results and Discussion

The analysis of the data revealed very interesting facts about the efficiency of shrimp farms in East Godavari district of Andhra Pradesh. The information from Table 1 indicates that the average estimated efficiency of the shrimp farmers is 93 per cent and about 70 per cent of the total farmers are very efficient, i.e., more than 90 per cent efficient in shrimp farming. The high efficiency may be due to the use of better quality seed stock, good quality feed and adoption of latest technology. The results of the stochastic frontier function analysis show that the independent variables those were chosen in the model were appropriate and explain the variation effectively (Table 2).

TABLE 1. FARM SPECIFIC TECHNICAL EFFICIENCIES IN THE STOCHASTIC FRONTIER PRODUCTION

Efficiency category (1)	No. of farms (2)	Percentage of farms (3)
<80 per cent	23	4.93
80-85 per cent	45	9.64
85-90 per cent	73	15.63
>90 per cent	326	69.81
Total	467	100.00
Mean		93.05
SD		7.39
Min.		70.10
Max.		132.27

TABLE 2. MAXIMUM-LIKELIHOOD ESTIMATES OF THE FRONTIER PRODUCTION FUNCTION

Variables (1)	Coefficients (2)	t-ratio (3)
β_0	-2.506	0.1754**
Land	0.019	0.0050**
Stocking density	0.526	0.0305**
Fertilisers	0.028	0.0138*
Feed	0.455	0.0363**
Labour	0.039	0.0132*
λ	1.696	
σ	0.110	
σ^2_ν	0.003	
σ^2_μ	0.009	
Log-likelihood	522.007	

** and * Significant at 1 and 5 per cent level, respectively.

IV

DETERMINANTS OF TECHNICAL EFFICIENCY

The measure of technical efficiency of a farm indicates that if any farm is successful in converting all the physical inputs into output and the efficiency of converting is equal to the hypothetical frontier production function, then it is said to be an efficient farm and if any farm falls short of this requirement then the farm is termed as technically inefficient farm. This discrepancy could be due to the latter group not having adequate technical knowledge. Timmer (1971), Muller (1974) and Kalirajan and Shand (1989) have suggested that the technical efficiency of farmers is determined by the socio-economic and demographic factors.

The determinants of technical efficiency can be estimated by the following equation:

$$TE_i = \alpha + \beta_1 AG_1 + \beta_2 EX_2 + \beta_3 ED_3 + \beta_4 SD_4 + \beta_5 LN_5 + \beta_6 TR_6 + \nu_1 \qquad ....(9)$$

The independent variables included in the analysis are as follows:

AG = Age of the respondent,
EX = Experience in farming,
ED = Education of the respondent (years of schooling),
SD = Stocking density (thousands per ha),
LN = Farm size (ha),
TR = Training received (a dummy variable, i.e., "1" if the respondent is trained and "0" otherwise).

The results from regression analysis are presented in Table 3. The coefficient for constant is positive and highly significant, and indicates that mean yield per hectare is high with the given mean quantities of inputs. The variables, viz., age, education,

TABLE 3. ESTIMATES OF THE INFLUENCE OF FARM SPECIFIC FACTORS ON TECHNICAL EFFICIENCY

Variable (1)	Coefficients (2)	t-value (3)	Mean (4)	Standard deviation (5)
Constant	98.78	2.45**		
Age	2.87	3.19**	36.09	7.60
Experience	-2.68	-1.27	9.33	3.33
Education	6.46	1.22	3.27	1.20
Stocking density	0.02	52.79**	60203.43	17951.30
Land	9.15	3.48**	3.20	2.48
Training received	-3.23	-0.16	0.10	0.31
R^2	0.87			
F-statistic	492.54			

** and * Significant at 1 and 5 per cent level, respectively.

stocking density and land had positive coefficients and are highly significant. It implies, with increase in the use of the above inputs the yield will also increase. Though not significant, experience and training has negative influence on efficiency, which may be due to the inappropriate training and experience, and lack of technical knowledge.

V

CHARACTERISTICS OF THE EFFICIENT FARMS

Large size farms, using optimum density of seed, having enough credit at their disposal, are able to perform efficiently. Also those farmers who are following the latest technical advancements are achieving good results in spite of having less experience in this field. The reasons for lower efficiency can be ascertained as small farm size, lack of timely availability of credit and lack of proper training regarding the changing technology. The outbreak of white spot disease also created limitations for stocking density. The shrimp farming in this region is prone to high risk as the farmers invest huge amount of capital for inputs like seed stock and feed, which account for nearly half of the capital requirements of the crop. The success of the crop also depends on the crucial weather parameters like temperature, rainfall and diseases like white spot. In this regard farmers need accurate and timely technical support with suitable training in latest technology that might help them in improving the efficiency.

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