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Profitability and efficiency of pig production in Tamil Nadu

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ABSTRACT

The present study was conducted to explore the cost and returns, profitability in pig (Swine) farming and to analyze the various factors affecting pig production and their level of efficiency in pig production. For the study, a sample of 45 swine farms was purposively selected by a simple random sampling procedure in the North-eastern zone of Tamil Nadu. The data were collected by personal interview method with the help of a pre-tested questionnaire pertaining to the year 2013–2014. The results revealed that minimum cost of production and maximum net return per farm per year from the pig rearing was noticed in large farms. Overall benefit-cost ratio was 1.46, which revealed profitable nature of swine farms in the study area. The results of cobb-douglas production function revealed that the variables, feed, and veterinary care were significant and positively influence the pork production. Allocative efficiency analysis showed that the resource feed was over-utilized and veterinary care was under-utilized. Technical efficiency was calculated using stochastic frontier production function and mean technical efficiency was identified as 76.37% and hence 23.63% of their technical abilities were not realized. Multiple regression was used to identify the factors influencing farm specific technical efficiency and profitability. Thus, the efficiency in pig production in the study area could be achieved through efficient extension programs about advanced scientific management practices for optimum utilization of resources.

Keywords: Allocative efficiency, Pig farming, Profitability, Stochastic frontier production function, Technical efficiency

Among livestock, pig production has a high potential to contribute to high-income gain as pigs have the highest feed conversion efficiency and they gain more live weight from a given weight of feed than any other class of meat-producing animals except broilers. They produce 6–14 piglets in each farrowing from a shorter gestation period of 114 days. Pig farming provides quick returns since the marketable weight of fatteners can be achieved within a period of 6–8 months. There is a good demand from domestic as well as an export market for pig products such as pork, bacon, ham, sausages, etc. Pig production system ranges from simple backyard pigs, pigs living on garbage belts to family-operated farms or large-scale integrated pig industries with sophisticated bio-security measures.

Although, pig farming has many advantages, the population (Livestock Census 2007) of pig shows the negative annual compound growth rate (–4.74%) for India as well as for Tamil Nadu state (–2.99%). This shows that the swine (Pig) husbandry had not gained the main stage in meat production sector in nation as well as the state. To develop the status of pig production in the country, the piggery sector should attract the entrepreneurs with the hope of developing their economic status. To reach a better pig production in our country, proper realistic plans should be implemented throughout various agro-climatic regions of our country. Many studies have been conducted on genetic, nutrition and management aspects of pigs but limited studies were carried out on economics of pig production in our country as well as in Tamil Nadu. Hence, realizing the importance of pig farming, the study on pig production was planned with the aim of exploring profitability in pig farming and to analyze the various factors affecting pig production and their level of efficiency in pig production in the study area.

MATERIALS AND METHODS

For the present study, the North-eastern zone of Tamil Nadu was purposively selected which comprise seven districts, viz. Chennai, Thiruvallur, Kancheepuram, Thiruvannamalai, Vellore, Villupuram and Cuddalore. Chennai district was excluded as there were no swine production farms in the district. A sample of 45 swine farms was selected from the study area by a simple random sampling procedure and the farms were post-classified based on sows maintained in the farm as small farms (up to 8 sows), medium farms (9–16 sows) and large farms (above

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16 sows). The data were collected by personal interview method with the help of a pre-tested questionnaire (pertained to the year 2013–2014). Investment, fixed cost, variable cost and returns from swine farming as well as socio-economic particulars of swine farmers such as age, gender, educational status, landholding, occupation, family size and farming experience and utilization of resources in swine farming were collected. The following methodologies were used to obtain the results to fulfill the objectives of the study.

Profitability: Ratio analysis was employed to calculate the profitability of swine farming. The viability of business can be understood from the benefit-cost ratio analysis and it was calculated by the formula:

$$\text{Benefit} - \text{Cost ratio} = \frac{\text{Gross returns from output sale}}{\text{Total input cost}}$$

Break-even analysis: The break-even analysis was used to determine the optimum size of operating pig farms. Break-even point is one which equates total cost and return without any profit. Break-even point provide an economic tool for business calculations in the area of profit management. The underlying assumptions of this analysis are:

Linear transformation of cost and revenue functions in the form Y= a + bx

Fixed price for factors and products and absence of inventory of produced goods.

The break-even quantity (BEQ) of pig farm was determined by using the formula:

$$\text{BEQ} = \frac{\text{Fixed cost per farm}}{(\text{Return per kilogram of live weight of pork}) - (\text{Variable cost per kilogram of live weight of pork})}$$

Assessing the productivity of resources in swine production

Factors affecting the pig production: To study the factors influencing the pig production, a modified Cobb-Douglas production function was fitted separately. This was done for determining the extent to which the important factors influenced the pig production in the study area. This also helps to determine whether the factors were used optimally in pig production or not. The general form of the function is

$$Y = a\, X_i^{bi} e^u$$

where X_i, variable source of measure; Y, output; i, 1, 2… n (n = number of variables); b, estimates the extent of the relationship between X and Y, when 'X', 'Y' are at different magnitudes. The 'b' co-efficient is also the elasticity of production. The equation is estimated in log-linear form by the method of ordinary least squares.

For the present study, the Cobb-Douglas type production function was specified as follows:

$$Y = a\, X_1^{b1}\, X_2^{b2}\, X_3^{b3} e^u$$

where Y, quantity of live pork production in kilogram; a, constant term; X_1, feed in kilograms; X_2, labour in man-days; X_3, veterinary care charges (Veterinarian consultation charges, treatment charges, follow up medicines and supplements charges) in ₹; b_i, regression co-efficient; e, exponent and u, disturbance term.

The function was converted into a linear form by making log transformations of all the variables.

$$Y_L = A + b_1Z_1 + b_2Z_2 + b_3Z_3$$

where Y_L= log YA = log aZ_i = log X_i (i = 1, 2, 3).

Allocative efficiency of resources used in pig production: Given the technology, allocative efficiency exists when resources are allocated within the farm according to market prices and it implies the proper level of input used in the production. The marginal value of products (MVP's) was calculated using the per farm production function estimates at the geometric mean levels of total output and the respective mean input levels by using the following formula:

$$M\,V\,P = b_i \frac{\bar{Y}}{\bar{X}} P_Y$$

where $\bar{Y}$, geometric mean of total output; $\bar{X}$, geometric mean of 'i'th input; b_i, the regression coefficient of the 'i'th input and P_Y, price per unit of output.

Allocative efficiency is measured by comparing the computed Marginal Value Product (MVP) with the Marginal Factor Cost (MFC) or opportunity cost of the input. Production is said to be efficiently organized when MVP is equal to MFC. If the ratio of MVP to MFC is equal to one, the resource is said to be optimally used. If more than one, the resource is said to be under-utilized. If it is less than one, the resource is said to be over-utilized.

Stochastic frontier production function: Stochastic frontier production function analysis was done to find out the technical efficiency of swine farms in the study area. The frontier production function represents a maximum possible output for any given set of input setting a limit or frontier on the observed values of the dependent variable in the sense no observed value of the output is expected to lie above the frontier function. Any deviation of the farm from the frontier indicates the extent of the farms' inability to produce maximum output from its given sets of inputs and hence represents the degree of technical inefficiency.

The technical efficiency in production is generally estimated by using the stochastic frontier production function. The stochastic frontier production function was independently proposed by Aigner *et al*. (1977) and Meeusen and Broeck (1977). The stochastic frontier model can be represented as:

$$Y_i = f\,(Xi, \beta_O)\, \exp\,(V_i - U_i)$$

where Y_i, production of ith farm; f (X_i, b_O), a suitable function of the vector X_i, of inputs for the ith firm and b is the vector of unknown parameters; V_i, symmetric component of the error term; U_i, non-negative random variable which is under the control of the farm.

Given the density function of U_i and V_i, the frontier production function can be estimated by maximum likelihood techniques.

Further, farm specific technical efficiency was calculated by adopting the methodology of Jondrow *et al*. (1982) and Battese and Coelli (1988).

Model specification: The stochastic frontier production function of the Cobb-Douglas was specified for this study, and the model specified is as follows:

$$Y_i = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 \log X_3 + v_i - u_i \quad (i = 1, 2, 3... n)$$

where Y, pork production in kilograms; X_1, feed in kilograms; X_2, labour in man days; X_3, veterinary care charges in rupees; β_0, constant term; $\beta_1 - \beta_3$, parameters to be estimated; V_i, random noise variable; U_i, half-normal error term from the residual, farm specific efficiencies were estimated; E_i, Exp ($-U_i$).

Further, to identify the frequency distribution of farm specific technical efficiency similar to Ogunniyi and Ajao (2011), pig farmers were classified based on calculated technical efficiency as most efficient group (above 90%), medium efficient group (between 70 to 90%), moderate efficient group (between 50 to 70%) and the least efficient group (below 50%).

Factors associated with the farm-specific technical efficiency

To analyze the factors associated with the farm-specific technical efficiency of swine farming, the following linear regression model was fitted

$$Y_{TE} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \mu$$

where Y_{TE}, farm specific technical efficiency; β_i's, regression co-efficient; μ, random disturbance term (μ_i~0, σ_i^2); A, constant; X_1, age of the farmer; X_2, gender (1 = if male, 0 = if female); X_3, experience in pig farming (in years); X_4, education status of the farmer (0 = if illiterate, 1 = if primary education, 2 = if secondary education, 3 = if collegiate); X_5, occupation status (1 = if piggery is primary occupation, 2 = if piggery is secondary); X_6, system of rearing, i.e. intensive (animals reared only in confined sheds), semi-intensive (animals reared in confined sheds and allowed to graze in enclosed open spaces) and extensive rearing (free-range grazing/scavenging) [1 = if intensive and semi-intensive rearing, 0 = otherwise] and X_7, access to training on scientific pig farming (1= if access to training, 0= if no access to training).

Multiple linear regression analysis: To analyze the factors associated with the profitability of swine production, the following multiple linear regression model was fitted

$$Y_p = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \mu$$

where Y_p, farm specific technical efficiency; β_i's, regression co-efficient; μ, random disturbance term (μ_i ~ 0, σ_i^2); A, constant; X_1, age of the farmer; X_2, gender (1 = if male, 0 = if female); X_3, experience in pig farming (in years); X_4, education status of the farmer (0 = if illiterate, 1 = if primary education, 2 = if secondary education, 3 = if collegiate); X_5, occupation (1= if piggery is primary occupation, 2= if piggery is secondary); X_6, system of rearing, i.e. Intensive (animals reared only in confined sheds), semi-intensive (animals reared in confined sheds and allowed to graze in enclosed open spaces) and extensive rearing (free range grazing/scavenging) [1 = if intensive and semi-intensive rearing, 0 = otherwise] and X_7, access to training on scientific pig farming (1= if access to training, 0= if no access to training) and X_8, Farm size (in number of animals).

RESULTS AND DISCUSSION

Profitability and break-even analysis of swine production: The details regarding profitability and break-even analysis of swine production in the study area is given in Table 1. It could be observed that the return per rupee of investment was 1.44, 1.55 and 1.58 for small, medium, and large farms respectively. The results revealed that the profitability of swine farms increased with an increase in farm size which indicated that as farm size increased, the net income over the rupee invested on swine farms also increased. Similar results were reported by Sharma *et al.* (1997) for pig farming. Break-even analysis was done to find out the quantum of live pork to be produced per farm so that the farms reach no profit and no loss point. Technically, break-even could indicate the minimum quantity of pork to be produced to meet the total cost incurred. This would also indicate the minimum number of animals to be kept on each farm. It was observed that small

Table 1. Profitability and break-even analysis of swine farming

Particular	Small	Medium	Large	Overall
Total cost (₹)	280601.50	558841.45	1024735.18	390057.04
Gross returns (₹)	404128.03	865759.67	1628195.18	547283.32
Returns per rupee of investment	1.44	1.55	1.58	1.46
Fixed cost (₹)	136624.50	273913.30	580156.00	191993.20
Variable cost (₹)	143977.00	284928.20	444579.20	198063.82
Quantity of meat (kg) produced/annum	4160.00	8990.00	17200.00	5673.33
Variable cost (₹)/kg	34.60	31.69	25.84	34.91
Return (₹) /kg	97.00	96.30	94.66	96.46
Break even quantity (kg)	2189.84	4239.74	8430.98	3119.37
Break even quantity (no. of live animals)	20 (19.80)	42 (41.70)	93 (93.48)	30 (29.9)

Table 2. Allocative efficiency of resources in pig production

Variable	Co-efficient	Geometric mean	MVP (₹)	MFC (₹)	MVP-MFC ratio
Feed in quantity	0.793	62,802.60	4.394	5	0.878
Labour in man days	0.116	696.02	57.990	60	0.966
Veterinary care charges in rupees	0.241	1,724.17	48.640	1	48.644

farmers need to produce 2,189.84 kg of pork per annum to reach the break-even point. The same for medium and large farmers were 4,239.74 and 8,430.98 kg/annum, respectively. Overall, the break-even quantity of the sample farmers of the study area was 3,119.37 kg. To operate the pig farm without any profit or loss, the farmers had to keep 20, 42 and 93 animals in their farms, for small, medium, and large farms respectively. Overall, farmers had to keep 30 animals for break-even.

Assessing the productivity of resources in pig production

Factors affecting pork production: An attempt was made in this study to estimate the productivity of resources and to analyze whether the resources used in pig production in the study area were optimally allocated or not. In order to accomplish this task, a modified Cobb-Douglas production was fitted for the three variables, viz. feed-in kilograms (X_1), labour in man-days (X_2) and veterinary care charges in rupees (X_3), used in pork production in the study area.

Among the variables (Supplementary Table 1), feed and veterinary care was statistically significant at 1% level. The variable labour did not have a significant influence on pork production. The value of regression coefficients for the variable feed depicted that 1% increase in feed would, *ceteris paribus,* increase the pork production by 0.79%. The co-efficient of the variable veterinary care was 0.241, which indicated that 1% increase in variable veterinary care cost would, *ceteris paribus,* increase the pork production by 0.24%.

Allocative efficiency of resources in pig production: MVP-MFC ratio was less than unity for the variable feed (0.878), indicating that the resource was over-utilized (Table 2). The ratio was more than unity for veterinary care (48.64), indicating the variable was under-utilized and there was scope for enhancing the use of these resources in the study area.

Table 3. Stochastic production frontier function analysis of pig production

Variable	Stochastic co-efficient	't' statistics
Feed in quantity	0.467**	5.635
Labour in man days	0.002	0.206
Veterinary care	0.027*	2.189
Constant	1220.490	0.548
Variance ratio	0.683	
Mean technical efficiency	76.370	

**, Significance at 1% level; *, Significance at 5% level.

Stochastic frontier production function: To estimate the level of efficiency in pork production, the stochastic frontier production function was used. On the basis of the frontier, the efficiency of the management practices in pork production was estimated (Table 3). Out of three variables used in the analysis, the frontier co-efficient for the variable feed was found to positively influence the pork production and was highly significant statistically ($P<0.01$) in the frontier function estimation. Similar results were reported by Adetunji and Adeyemo (2012) in pork production. The variable veterinary care was also positively influencing the pork production and statistically significant at 5% level ($0.01<P<0.05$). The variable labour was positive but statistically non-significant. The result for labour was in contrast with the results of Adetunji and Adeyemo (2012) in pig production.

The value of variance ratio was 0.683, which indicated that 68.3% of the variation in pork production between the farmers in the study area was due to farm-specific technical efficiency (Table 3). In other words, the differences between observed and maximum production frontiers were due to the differences in farmers' level of technical efficiency by adopting different management practices. These factors were under the control of the farm and the influence of which could be reduced to enhance the technical efficiency of swine farmers in the study area.

The mean technical efficiency of sample farmers in the study area was 76.37, which indicates that on average the sample farmers tended to realize 76.37% of their technical abilities and the remaining percent of their technical abilities were not realized.

Farm specific technical efficiency: The study also found (Supplementary Table 2) that majority of the farmers (33.34%) in the study area were in the most efficient group. However, 26.66% of farmers were in medium efficient group while 22.23% of the farmers were in the least efficient group with 17.77% of the farmers falling in the moderate efficient group.

Factors influencing farm-specific technical efficiency: Among the seven variables (Supplementary Table 3) considered for analysis, education, and experience in pig farming (farmers previous experience in pig rearing) were highly significant ($P<0.01$) and positively influencing the technical efficiency of the swine farmers, which implied that increase in educational level and experience leads to increase in technical efficiency of swine farmers in the study area. This might be because highly educated farmers could easily adopt scientific rearing and management practices in swine farming due to their learning skills. Farmers with range of experience could come at grips with the innovations for profitable pig farming.

The variable access to training (training on scientific pig farming) from the institution was significant at 5% level (0.01<P<0.05) and positively influencing the technical efficiency of farmers in the study area, which implied that the farmers in the study area acquired knowledge about profitable pig production by participating in training programs from various extension agencies. Hence, imparting training in profitable pig farming would increase the technical efficiency of swine farmers. Other variables such as age, gender, occupation, and type of rearing were statistically non-significant.

Factors influencing the profitability of swine production: Among the eight variables (Supplementary Table 4) considered for analysis, experience in pig farming and system of rearing were highly significant (P<0.01) and positively influenced the profitability of the swine production in the study area.

The variable education had significant (P<0.05) influence on the profitability of swine farming. The educated farmers have capabilities of easy understanding about scientific technologies and management than less educated and illiterate farmers and hence the variable education had positively influenced the profitability of swine production. Other variables such as age, gender, occupation, training, and farm size were statistically non-significant.

It can be concluded that there exists an economy of scale in pig farming in the study area. Minimum cost of production and maximum net return per farm per year from the pig rearing was noticed in large farms. The variables feed and veterinary care were significant and positively influencing the pork production. The resources feed was over-utilized and veterinary care was under-utilized. The mean technical efficiency was 76.37% and hence 23.63% of their technical abilities were not realized. The socio-economic factors, viz. education, past experience in pig rearing and access to training were found to be positively and significantly influencing the technical efficiency of individual farmers. The profitability of the swine farms was positively influenced at a significant level by the socio-economic factors such as past experience in pig rearing, type of rearing (intensive and semi-intensive methods of rearing system) and educational level of the farmer.

Thus, farmers in the study area were realizing only about three fourth of their technical efficiency. Hence, it is suggested that the farmers should be made aware about advanced scientific management practices and optimum utilization of resources through efficient extension programs. To improve the efficiency in pig production in the study area, feed lot system of fattening could be implemented and, the farmers could be advised to ensure triple mating practice in the breeding program to improve the litter size.

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