

DETERMINANTS OF PRODUCTION AND PROFITABILITY OF SHRIMP FARMING IN BATTICALOA DISTRICT, SRI LANKA

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A study was conducted to determine the factors affecting production and profitability of shrimp production in the Batticaloa district. The survey covered 90 farmers from 8 villages, located in 6 D.S. divisions in the Batticaloa district. Stratified random sampling method was used in this survey and data were collected through pre-tested structured questionnaires. Data were analyzed for descriptive statistics, frequencies and multiple regressions were done. Factors affecting shrimp production was determined by the Cobb-Douglas production function. Cost of feed per crop, cost of pond preparation and feed conversion ratio had a significant impact on shrimp production. Average price of shrimps/kg, total production of shrimps, and cost of leasing of land/year had an impact on the profitability. It was evident from the results that profitability of shrimp production was significantly affected by sale price of shrimps, total production of shrimps, other expenses (fuel, medicine) and cost of land used for pond construction.

Keywords: shrimp farms, production, profitability, price, Cobb Douglas function

INTRODUCTION

Farmed shrimp export accounts for approximately 50% of the total export earnings from Sri Lankan fisheries. More than 90% of the harvested cultured shrimp are exported to Japan, USA and the European Union [FAO, 2004]. The black tiger shrimp, *Penaeus monodon* L. is the main species cultured. The majority of grow out shrimp farms in Sri Lanka follows semi-intensive culture practice [Cattermoul and Devendra, 2002]. Farmed shrimp production was 2,220 MT in 2008 compared to 9,240 MT from wild capture. Aquaculture production peaked in 1998 at 6,520 MT. The shrimp industry was responsible for 50,000 direct and indirect jobs in 2010 [Arthur, 1998] representing 11% of the total employment in the fisheries sector [Siriwardena, 1999].

Shrimp farming has emerged as one of the available solutions to improve the living conditions of the local population in an environment where the coastal fishery has reached the optimum sustainable yield (Edirisinghe *et al*, 1997). During the past two decades, shrimp farming has become a multibillion dollar industry which has created not only hundreds of thousands of jobs, but also much needed foreign exchange earnings in many Asia's developing countries (FAO, 2004).

In Batticaloa district, shrimp farming commenced in the late 1980's at Kokaddicholai in a small scale and the first commercial production entered into the market in 1984 in very small quantities. During 1992, the total production of shrimp was around 1200 tones (Jayasinghe, 1995). Over 60 small farms with an average farm area of between 1–2 ha., were in operation as at the end of 2002, with a total pond area of 155 ha. This area had 94 operational shrimp ponds and some ponds were not in production. These ponds varied in size from 0.5 ha to 1 ha.

The National Aquaculture Development Authority of Sri Lanka (NAQDA) has prepared a zonal plan for development of shrimp farming in Batticaloa district, where shrimp farming is done in three brackish water bodies; namely the Batticaloa Lagoon, Valachenai Lagoon and the Upparu Lagoon. Farmed shrimp production in Batticaloa district in 2009 was 19,600kgs. Main shrimp farm production areas are Koralaipattu North, Koralaipattu South, Koralaipattu (Valaichchenai), Manmunai North, Eravurpattu and Manmunai West (NARA, 2007).

This study was carried out to identify the factors affecting production and profitability of shrimp production in Batticaloa district. Specifically the goal of the study was to understand the current problems faced by shrimp farmers, to identify the factors affecting production and profitability of shrimp production.

LITERATURE REVIEW

Shrimp farming commenced in mid 80's as an export oriented activity in the north western province of Sri Lanka. Shrimp is a high value sea food, with a global market especially in Japan, the USA and Europe. With the development of shrimp aquaculture in Sri Lanka, the quantity of shrimp exports remarkably increased but subsequently indicated a drastic drop in both quantity and value due to frequent outbreaks of diseases (Wimalasena, 2010). Shrimp farming has great potential to diversify and secure income in rural Sri Lanka, but production has significantly declined in recent years due to civil conflicts, some unsustainable practices and devastating outbreaks of disease (Munasinghe *et al*, 2010; Jayasinghe and MacIntosh, 1993).

The current shrimp aquaculture industry in Sri Lanka is concentrated in the north western coastal belt covering a farm area of more than 4500 ha with 70 hatcheries of the total farm area the ponds themselves occupy an area of around 3000 ha. There are a total of 1344 farm establishments, of which 47.7 percent are considered to be establishments operating without proper licenses (Siriwardena, 2003). In Batticaloa district shrimp farming started in the early 1980s and the first commercial production entered in the market in 1984 in very small quantities. During 1992, the total production of shrimp was around 1200 tones (Jayasinghe, 2001).

Brackish water shrimp farming has been the most lucrative commercial aquaculture activity in Sri Lanka since the late 1970s. Although the industry initially emerged in the Eastern Province (Batticaloa district), it collapsed due to civil disturbances. The industry recorded its peak performances in the year 2000, earning Rs. 5041 Million worth of foreign exchange and the quantity of shrimp exported was 4855 MT (NARA, 2007). In 2008, shrimp farming industry showed a 38 per cent decline in production mainly due to White Spot Disease. The high maintenance cost of water treatment with chlorine for disinfections and higher fuel cost also affected the prawn farming industry (Senerath and Visvanathan, 2001; Siriwardena, 2001).

Economic issues have reduced shrimp production in Sri Lanka and significantly restricted farmers' willingness or ability to invest in biosecurity. Aquaculture extension in Sri Lanka will need to recognize this reality and explore low cost ways to improve the capacity for farms, especially smallholder farms (Munasinghe *et al*, 2010).

Sri Lanka has gradually increased her shrimp exports and at present well over 90 percent of the shrimp exported from Sri Lanka is derived from farming. Shrimp exports have increased from 1855 MT in 1990 to 5092 metric tons in 1998. This generated Rs.4474 million of export revenue to Sri Lanka (Jayasinghe, 2001).

Shrimp feed accounts for 50-60 percent of the total cost of production of a shrimp farm. The price of shrimp feed has been escalating over the years. Therefore, high price of feed is bound to affect the competitiveness of Sri Lankan shrimp exports in the long run. The high price of feed will have significant impact on working capital requirement in farming. This will lead to a reduction of profitability from shrimp farming (Jayasinghe, 2001).

MATERIALS AND METHODS

A survey was carried out to study the production and marketing of shrimps in the Batticaloa District. The necessary data for this study was collected from the shrimp farmers using pre tested structured questionnaires. Secondary data were gathered from the National Aquaculture Development Authority of Sri Lanka (NAQDA), private feed Companies and Divisional Secretariat.

This survey was carried out in the Batticaloa district using an exhaustive list of shrimp farmers prepared by the NAQDA Regional office, Batticaloa, Batticaloa District Small scale shrimp farmer organization and private feed company. A total sample of 90 shrimp farmers, including 55 registered farmers and 35 non-registered farmers was used for the study. Selection of samples was by stratified random sampling of registered shrimp farmers and non- registered shrimp farmers. A structured pre-tested questionnaire was used for the field data collection. Data were analyzed for descriptive statistics, frequencies and multiple regressions were done. Factors affecting shrimp production was determined by the Cobb-Douglas production function.

PRODUCTION FUNCTION ANALYSIS

The data obtained were processed to calculate shrimp production and other relevant information. The Cobb-Douglas production function was used to determine factors affecting production, and the following algebraic form is used.

$$Y = a_0 X_1^{a_1} X_2^{a_2} \dots \dots \dots X_n^{a_n} e_i$$

Where the exponents a_1, a_2, \dots, a_n respectively, denote exponent coefficients a_1, a_2, \dots, a_n .

When the input and output quantities are transformed to logarithms, the resultant function is linear.. The Model used can be depicted as follows:

$$\text{Log } Y = \text{Log } a_0 + a_1 \text{Log } X_1 + a_2 \text{Log } X_2 + \dots + a_n \text{Log } X_n$$

where:

Y: Total production of shrimps per crop (Kg/ acre)
 X_1 : Cost of construction of pond (Rs/acre)
 X_2 : Total feed cost (Rs/ crop/100,000 fingerlings)
 X_3 : Total cost of labour per crop (Rs/crop)
 X_4 : Cost of fingerlings per crop (Rs/100,000 fingerlings)
 X_5 : Total cost of equipments per crop (Rs/ crop)
 X_6 : Miscellaneous cost per crop (Rs/crop)
 X_7 : Feed Conversion ratio

A multiple linear regression analysis was done to identify the factors affecting shrimp production. The coefficients of the model were obtained from the regression results and are presented.

Profitability analysis

Gross margin analysis was done to obtain profit of shrimp production. A linear profit function model was used to determine factors affecting profitability of shrimp production.

Factors affecting profitability was hypothesized as sale price of shrimps, fingerlings cost, labour cost, equipments costs, feed conversion ratio, land cost, and total shrimp production.

Model used: $Y = f(X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8)$

where:

Y: Profits per harvest (Rs.).
 X_1 : Sale price of Shrimp (Rs/ Kg)
 X_2 : Cost of fingerlings per crop (Rs.)
 X_3 : Miscellaneous cost per crop (Rs.)
 X_4 : Total cost of labour per crop (Rs.)
 X_5 : Total cost of equipment per crop (Rs.)
 X_6 : Feed Conversion Ratio.
 X_7 : Cost of leasing of land (Rs/ Year).
 X_8 : Total production of shrimps per harvest (kg)

Feed Conversion Efficiency is known as the amount of feed required to produce one kilogram of shrimp weight and it is one of the performance indicators in shrimp production (Berneje, 1992). A multiple regression analysis was used to estimate the model.

RESULTS AND DISCUSSION

Production, Cost and Returns analysis

Intensive shrimp farming was adopted by 67.8 percent of shrimp farmers in Batticaloa district. Under intensive system; fingerlings are cultured and their requirements were provided to the fingerlings, such as large amounts of feed, manures and fertilizer may be used and ponds are aerated by mechanical means. Other 32.2 percent of farmers had adopted the semi intensive culture.

Cost of production per One Kilogram of shrimp was Rs. 339.61. As shown in the Table above the major share of the cost of production goes the purchase of feeds, followed by labour cost. The profit margin of the farmer solely depends upon the difference between the various cost factors and the income that is generated through output of the farm (Yung, 1981). In Batticaloa district shrimps are marketed at average size of 27.18g (37 prawns / kilogram). The market price of one kilogram of shrimp was about Rs.606.67.

Factors affecting shrimp production

Results of the multiple regression analysis on factors affecting shrimp production are presented in Table 1. The model

summary was indicted that R square value = 0.724, and adjusted R square was 0.701.

Table 1: Summary of the total Cost of Production (1 Acre pond size)

1	Fixed Cost	Rs/ crop	(%)
	Cost of pond preparation	750.00	0.07
	Cost of Equipments	11,216.60	1.16
	Total Fixed Cost	11,966.60	1.24
2	Variable Cost		
	Cost of fingerlings	83,000.00	8.63
	Cost of feed	641,803.74	66.71
	Labor cost	116,388.90	12.09
3	Miscellaneous Cost	108,900.00	11.31
4	Total Variable Cost	950,092.64	98.75
5	Total Cost (1+2+3) LKR	962,059.24	100

(Source: Data Analysis, 2009)

Table 2: Results of Regression Analysis- Factors affecting shrimp production

Variables	Coefficients		t value
	B	Std. Error	
(Constant)	6.641	1.946	-3.412***
Cost of fingerlings (log)	6.800E-02	0.080	0.849
Cost of Feeds (log)	0.603	0.083	7.297**
Cost of labour (log)	1.728E-02	0.102	0.169
Cost of equipments (log)	2.724E-02	0.184	0.148
Miscellaneous cost (log)	0.214	0.087	2.469**
Cost of pond preparation (log)	0.232	0.061	3.806***
Feed Conversion Ratio (log)	-0.738	0.079	-9.366***

Dependent Variable: Total production of shrimp per crop (log).

** Significant at 5% level, *** Significant at 1% level, Adj.R² = 0.701

(Source: Data Analysis, 2010)

As it can be seen from the table, amongst the explanatory variables, the cost of feeds per crop (X_2), miscellaneous cost per crop (X_6), cost of pond preparation per crop (X_1) and feed conversion ratio (X_7) were significant in the model. This implies the need for capital for expenditure on feed purchases and ponds construction, as well as the lowering of the Feed Conversion ratio to increase production.

Factors affecting Profitability

The data obtained were processed to calculate profit per kg shrimp live weight and other relevant information for inclusion in the profit function model. A linear profit function model was used to determine factors affecting profitability of shrimp production. Each coefficient demonstrates the marginal impact of an independent variable in question on the total production of shrimps.

Table 3: Results of Regression Analysis – Factors affecting Profitability

Model Variables	Coefficient		t- value
	B	Std. Error	
(Constant)	1,663,319.45	576434.82	2.886***
Average price of shrimp/Kg	-2427.47	843.99	-2.876***
Cost of fingerlings	0.829	1.065	0.779
Cost of labour	- 0.454	0.862	-0.527

Continuation of **Table 3**

Total shrimp production/ crop	345.32	74.277	4.649***
Total Cost of equipments	-4.307	2.692	-1.600
Miscellaneous cost per crop	- 2.916	1.170	-2.491**
Feed conversion ratio	31801.06	80747.09	0.394
Cost of land/ Year	-7.863	3.051	-2.577**

a Dependent Variable: Profit per crop; **, *** significant at 5% and 1 % level.

Adj. R² = 0.965, (Source: Data Analysis, 2010).

The estimated regression results are presented in Table 2, the factors average price of shrimps/kg , total production of shrimps per crop, miscellaneous cost per crop and cost of leasing of land / year were significant in the model. It was evident that profitability of shrimp production was negatively affected by sale price of shrimps, total production of shrimps per crop, other expenses per crop, and cost of land/year which caused a decline in profits to the farmers.

CONCULSIONS

The major factors affecting small-scale shrimp production were the cost of feed per crop, cost of pond preparation and feed conversion ratio, which had a significant impact on shrimp production. The profitability of small-scale shrimp production was affected by several factors, such as price of shrimps sold, total shrimp production, miscellaneous costs (fuel, medicine etc) and cost of land used as pond, which had a significant impact. Hence shrimp farmers should focus on reducing expenses on feeds, investment on pond construction and increasing the Feed Conversion Ratio to improve production. The profitability in shrimp production ventures in future could be enhanced by obtaining higher prices through adjusting production, reducing investment on large shrimp ponds, and better disease control measures

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