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Farm Size and Aquaculture Productivity Relationship

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Abstract

Due to the influence of many independent variables, productivity being a dependent variable, exhibits wide variation. In the present communication the relationship between farm size and aquaculture productivity has been reported. Data from 79 representative farms collected from July 1998 to July 1999 at the Eluru and Kaikalur blocks of the Kolleru lake area have been considered. The size of farms ranges between 0.8 to 60 ha whereas productivity ranges between 10 to 14 $t \cdot ha^{-1} \cdot yr^{-1}$. Positive correlation between carp productivity and area of the farms has been found ($r = 0.52$). The coefficient of determination ($R^2 = 0.28$; $P<0.001$, $N = 79$) indicates that 28% of the total variability in carp productivity in the two blocks is explained by farm size only. The findings may be justified by the fact that large sized farms are more economical and conducive for better efficiency than small sized farms considering that all the technical advantages applicable to small sized farms are also open to large sized farms and not the other way around. It is claimed that, large farms enjoy economies of production, management, finance and marketing. These economies help in reducing the cost of the farm and in increasing its efficiency. All the scale operations contributing to the above-mentioned relationship are discussed in details in this paper.

Introduction

Many factors contribute to aquaculture productivity but the size of the farm plays a major role in adding to its productivity. Farm size has been a matter of extreme interest, not only in the industrial and agricultural sectors but also in the aquaculture sector because of its definite role in determining gross productivity and income level. Unlike the industry, the optimum size of the farm should ensure minimum cost involvement with the existing technological know how and entrepreneurial ability. The question of whether farm size should be large or small has been a debatable issue. The advocates of both small and large sized farms have their own justifications, but none of these has led to a conclusion. Several writers found an inverse relationship between

farm size and productivity (Orazen 1976, Sadhu and Singh 1996). Sen's (1964) explanation for this is that cultivation is done in small farms up to the point where the marginal product of labor is below the prevailing market wage and stops on the large farms at the point where the marginal product is equal to the market wage. Likewise some hypothetical optimum limit of large sized farms is fixed for optimum productivity. It has been admitted that poor peasantry in third world countries is due to inefficiency and preponderance of primitive technology. In the aquaculture sector if primitive technology is to be wiped out at certain farm sizes, there is the need for a critical study on such aspects. Studies on agriculture though have some relevance in aquaculture but these are hardly applicable to the culture practices in Kolleru lake area. Hence it is affirmed that the present approach to find out the relationship between farm size and aquaculture productivity is new in its kind in the context of the area under study. The concept of farm size in the present communication refers to the water area under culture, not the total holding size of the farmer.

Kolleru Lake is situated between $81^0 5'$ to $81^0 21'$ East Longitude and $16^0 32'$ and $15^0 51'$ North Latitude. It covers a total area of 296,540 ha. There are 15 inflowing channels from the Krishna and Godavari delta connecting to the Kolleru canals. The tanks with inlet and outlet facilities are found well irrigated by those canals. Generally the depth of the rearing and stocking ponds varies from 1.5 to 2 m and 2 to 3 m respectively. The species combination has now been confined to only Catla (*Catla catla*) and Rohu (*Labeo rohita*) in contrast to the multi species combination that previously existed. It is observed that due to faster growth and consumer's preference (market demand) the farmers prefer to stock only the above- mentioned two species. Stocking density is about 10,000·ha of advanced fingerlings out of which about 80% is constituted by *L. rohita* only. Supplementary feed plays a vital role in fish growth and increase in productivity. The main components of feed are deoiled rice bran, groundnut oil cake, soya bean and cotton seed cake. The farmers practice two types of crop cycle, 10 to 12 months and 15 to 16 months. Marketing of fish, the transfer of product from producer to consumer, involves four channels. There are three classes of middlemen: the contractors, the wholesalers and the retailers who take a major share of the consumer's price.

Materials and Methods

The survey for the collection of samples for the project entitled "Technological Innovations in Aquaculture and its Effects on Sustainability of Farming Systems in Andhra Pradesh" was conducted in the Kolleru lake area of Andhra Pradesh, India from 1998 to 1999 and was funded by the Indian Council of Agricultural Research. Kolleru Lake spreads over two districts namely West Godavari and Krishna under which nine blocks fall. The data used for the analysis were collected from two blocks namely Eluru and Kaikalur using stratified random sampling technique. From both blocks 12 villages were surveyed to collect 79 samples. The decision on sample size was based on the consideration of statistical accuracy as determined by the sampling error and eco-

nomic efficiency as determined by the cost of the survey. The data is related to certain ideal time period of complete production cycle of culture duration. For the present study, about 20 parameters like age of the farmers, level of education, tank status, method of pond construction, fertilizers used, feeds, medicines, labor engaged in various activities, and marketing are collected out of which farm size and respective productivity are recorded. In the present study small, medium and large farms relate to the area of ranges between 0.8 to 5 ha, 5 to 10 ha and 10 ha and above respectively. Two variables considered were farm size and productivity. Regression analysis is performed using Microsoft Excel to find the average relationship between the two variables.

Results and Discussion

Analysis of farm size and productivity as indicated in table 1 shows that majority (57%) of the fish farmers have the culture area up to 5 ha, followed by 25% having farms of 5 to 10 ha and nearly 18% having more than 10 ha size. Productivity wise, it is clearly indicated that a larger farm has higher productivity. This varies from a 10.02 $t \cdot ha^{-1}.year^{-1}$ in a smaller farm to 11.14 $t \cdot ha^{-1} \cdot year^{-1}$ in a medium-sized farm to 13.87 $t \cdot ha^{-1} \cdot year^{-1}$ in a larger farm. Positive correlation ($r = 0.52$) was found between farm size and productivity which establishes the fact that as farm size increases, productivity also increases. Farm size is found to range from 0.8 to 60 ha whereas the productivity range is found to vary between 10.02 to 13.87 $t \cdot ha^{-1} \cdot yr^{-1}$. The coefficient of determination ($R^2 = 0.28$, $P<0.001$, $n = 79$) indicates that 28% of the total variability in carp productivity in the two surveyed blocks is explained by farm size only. It confirms that 28% of the total productivity is contributed by farm size only. Of the 79 samples only 10 showed a residual value of more than one and the other 69 residual values are nearer to zero, an indication that the equation is a good fit. Further analysis reveals that all the assumptions of regression like normality, linearity and unequal variance are fulfilled.

From every statistical point of view it is affirmed that farm size has an influential role over productivity. This fact invites establishing the causal factors for a positive relationship. These factors involve the economies of scale that include real and pecuniary economies. Real economies involve the advantages of technical, financial, managerial and marketing aspects. Large sized farms are more economical and conducive to better efficiency than the small sized ones. This is because all the technical advantages open to the small sized farms are open to large sized farms but not the reverse. It is claimed that large farms

Table 1. Productivity of different farm sizes (N= 79)

Farm size (ha)	No. of farmers	Average productivity $t \cdot ha^{-1} \cdot year^{-1}$	Standard deviation
up to 5	45 (57.00)	10.02	1.61
5 – 10	20 (25.30)	11.14	1.17
10 and above	14 (17.70)	13.87	1.62

Figures within parentheses are percentages.

enjoy economies of production, management, finance and marketing. These economies help in reducing the cost of production and in increasing efficiency (Sadhu and Singh 1996). In all the surveyed villages, it is observed that the farmers use proclainers (a huge machine used for earth work) to construct and renovate the tank which otherwise might involve not only a large number of laborers but also a long period of time. The use of proclainers has made this work very easy and convenient. This shows the technological transformation from the primitive to modern one. Division of labor (labor specialization) in the concerned operations of aquaculture is also observed. It leads to economical and unbiased use of resources for greater productivity. Due to labor specialization, it is observed that leisure and income are balanced and this in the long run, adds to better productivity. However, these specializations are not possible in small farms. It means that in bigger farms, a particular person is engaged in a particular activity to utilize his optimum efficiency, but in smaller farms only very few persons are engaged in all the activities, hence they can't show their optimum efficiency. This leads to lower productivity. It is also found that in larger farms, a higher proportion of capital is available for direct productive use with a consecutive reduction in overhead costs (fixed costs) per unit of product produced.

Marketing economies of scale in the area has a significant role in reducing the factor prices and increasing the product prices. It is observed that for a culture period of 10 to 12 months the farmers use a minimum of 20 $t \cdot ha^{-1}$ feed. For such bulk buying the farmers get preferential treatment in prices. Transport cost is also found meager in comparison to total operational cost. These are the advantages when the entrepreneur is also the purchaser. Simultaneously he is also the seller of the product (fish). As the farmers dispose large quantities they enjoy a better bargaining power over the selling price with the contractors. A farmer with a larger farm also enjoys better credit facilities from financial institutions.

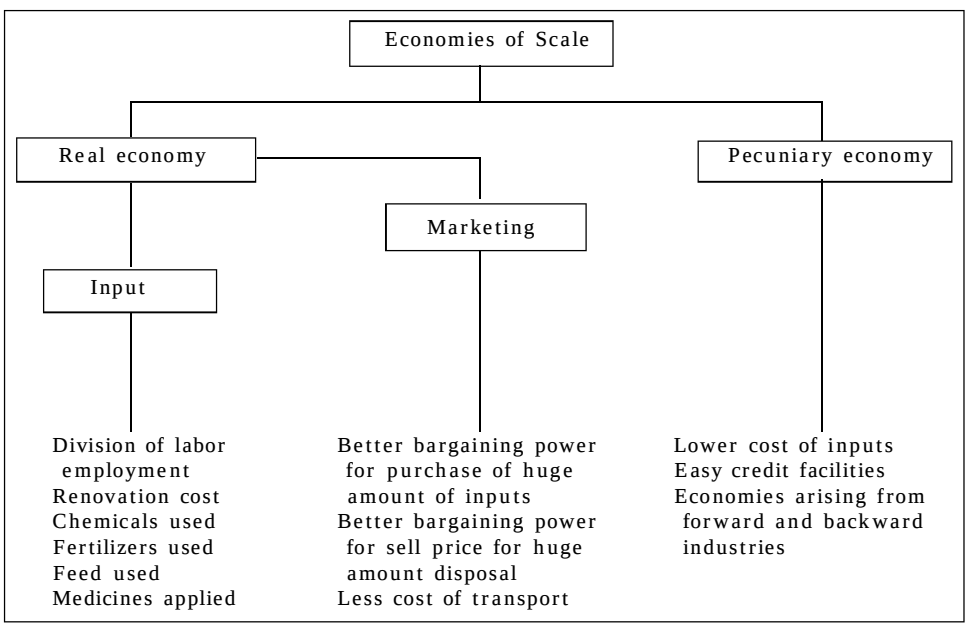

Fig. 1. Economies of scale applicable in big farms.

It is further observed that the pecuniary economies of scale operating in the aquaculture business add to better productivity. These factors contribute indirectly to better productivity and consequently to more profitability. Farmers who have larger farms pay the price of some variable factors at big discounts when they purchase in bulk. It is also observed that during harvest the number of laborers engaged in bigger farms is proportionately less than the number of laborers engaged in small farms. It is found that for a 2 ha farm, the labor requirement for harvesting is 12 whereas for a 10 ha farm, only 40 laborers are required. It shows that in terms of harvesting cost, bigger farms are proportionately less expensive. In some cases it is found that renovation cost in a 4 ha farm is about $ 330·ha, whereas in a 10 ha farm, renovation cost is only $ 220·ha. It is estimated that the need for organic and inorganic fertilizer for plankton growth is proportionately higher in small sized farms. The permanent labor employment was found to be 1 for every 4 ha in a farm whose area is less than 8 ha but it is one for every 6 ha in a farm whose area is more than 8 ha. Supplementary feeding which plays a pivotal role in fish growth has a significant contribution to the positive correlation between farm size and productivity. It is observed that in a 10 to 12 month culture period the average feed requirement in a farm whose area is less than 5 ha is 27 $t \cdot ha^{-1}$, whereas in a farm whose area is more than 5 ha, the figure is 23 $t \cdot ha^{-1}$. The quantity of chemicals used in bigger tanks is found proportionately lesser than that of the smaller tanks. All the above expressions that reveal the fact that better productivity creeps in from larger farms, are expressed in the following equation forms.

$$y_1 = f(r_1 + c_1 + f_1 + l_1 + d_1 + m_1) \quad (1)$$

$$y_2 = f(r_1 + c_2 + l_2 + l_2 + d_2 + m_2) \quad (2)$$

Equations 1 and 2 are the production functions of small and large farms respectively where:

y = average productivity
r = average cost of renovation
c = average cost of chemicals used for weed control
f = average cost of organic and inorganic fertilizers
l = average wage for labor for various activities
d = average cost of feed
m = average cost of medicine applied for disease control and;

$y_1 < y_2$

whereas $r_1 > r_2$
$c_1 > c_2$
$f_1 > f_2$
$l_1 > l_2$
$d_1 > d_2$
$m_1 > m_2$

The above equations show that the input used in small farms is more in quantity whereas productivity is higher in large farms.

Conclusion

From the above analysis it can be said that better productivity and consequently better profitability are ensured from bigger farms. Though nothing is being said about the optimum farm size, it is suggested that aquaculturists enhance the farm sizes up to that level when disutility of greater size creeps in.

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