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Farm size, productivity and efficiency nexus: The case of pangas fish farming in Bangladesh

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Abstract

The inverse relationship between farm size and productivity is one of the most debated findings in agricultural productivity researches of developing countries. Aquaculture industries of Bangladesh have been expanded tremendously but most of the aquaculture farms are small and their productivity is not as high as expected. This paper has explored the relationships among farm size, productivity and efficiency of pangas fish farms. A survey was conducted on 125 farmers by direct interviewing in Mymensingh district of Bangladesh. Stochastic frontier production function was carried out to estimates the level of technical efficiency and polynomial regression was employed to show the relationship among farm size productivity and efficiency in pangas fish farming. In general, pangas fish farming was found to be profitable, where the large size farms were more profitable than the small. Feed and salt had highly significant and positive effects on productivity, while human labor had negative influences. Larger farms were found to be more productive and technically efficient than the smaller one, and the more productive farms were found to be more efficient. These findings could be justifiable by the fact that the large size farms enjoy more financial opportunities, management and marketing facilities in commercial mode and all these facilities help them to enhance productivity and efficiency.

Introduction

The inverse relationship between farm size and productivity in agriculture is one of the oldest dilemmas. This debate intensified when Sen (1962, 1966) found inverse relationship between farm size and productivity in Indian agriculture, where Sen noted that small Indian agricultural farms were much more productive than their large counterparts. Afterward several studies have been conducted on this issue and inverse relationship was observed in different countries over the world (Collier, 1983; Barrett, 1996; Akram-Lodhi, 2001; Benjamin and Brandt, 2002; Alvarez and Arias, 2004; Rios and Shively, 2005; Kimhi, 2006).

In Bangladesh, fisheries is one of the important sub-sectors of agriculture that provides considerable employment opportunities and income scopes, and contribute to poverty alleviation (FAO, 2016). Presently, the fisheries sub-sector contributes about 4.43% to national GDP, 22.21% to agricultural GDP and 2.75% to the foreign exchange earnings (BBS, 2016).

Country's fisheries resources are broadly categorized into 3 major groups: inland capture (open waters), inland culture (aquaculture) and marine fishery. Aquaculture is one of the major sectors that includes pond, ditch, baor and semi-closed (flood plain) areas. Pond is the main source of Bangladeshi aquaculture that contributes 52.42% of total fish production and has expanded rapidly all over the country (DoF, 2016, Khan, *et al.*, 2017). Production trend of aquaculture has also considerably increased over the last one and half a decade (Fig. 1). Consequently, Bangladesh has achieved the 5th rank for aquaculture production in the world (FAO, 2018).

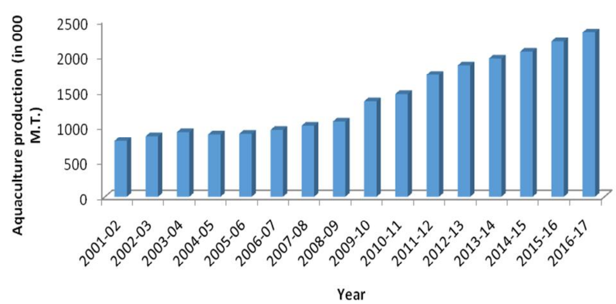

Fig. 1. Production trend of aquaculture in Bangladesh
Source: DoF, (2001-02 to 2016-17)

In recent years, among the fish species, pangas has become the most popular commercial aquaculture species due to well suited weather condition, ease culture, low production cost, higher response to external feeding, availability of seeds and high market demand in Bangladesh (Khan, 2012). It is highly commercial species for its fast growth, year-round production and higher productivity. Pangas evolved to a shape of commercial enterprise having long backward and

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forward linkages providing livelihoods for a wide range of stakeholders. Fig. 2 shows the trend of pangas fish production in Bangladesh during last 12 years.

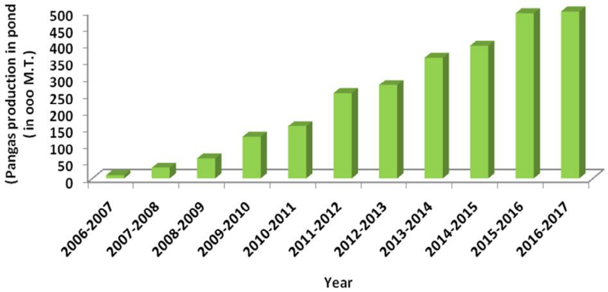

Fig. 2. Pangas production trend (in pond) of Bangladesh
Source: DoF, (2005-06 to 2016-17)

This huge amount of pangas fish production has been increased by the influence of technical support, adoption of new technologies and uses of modern inputs. It is also depends on the other factors such as socioeconomic characteristics of farms, farmers and institutional arrangement.

Despite tremendous expansion, most of the pangas fish farm in Bangladesh is still prevailing as small size farms. The efficiency of fish farm may vary in relation to its size. The optimum size of fish farm can ensure minimum cost involvement exploiting existing technological know-how and entrepreneurial ability. Now, the question is whether the pangas farm size should be larger or smaller for increasing the efficiency, productivity and profitability? Several studies have measured the technical efficiency (TE) in different sizes of aquaculture farms and reported their performances (Ebo, *et al*, 2018; Verdal *et al*, 2017; Kumaran *et al*; 2017; Sarker *et al*. 2016a; Ghee-Thean *et al*., 2016; Iliyasu, and Mohamed, , 2016; Akenbor and Ake, 2015; Itam *et al*., 2014; Joseph, 2014; Penda *et al*., 2013; Bhuyan *et al*., 2013; Begum *et al*., 2013; Alam *et al*., 2012; Ogundari and Tung, 2010; Khan and Alam, 2003 and Adesina and Djato, 1996). Some studies have marked the positive relationship between farm size and productivity (Bhatt and Bhat, 2014; Helfand, 2003; Dyer, 1996 and Cornia, 1985). In some cases, the inverse relationship is also reported (Mugera and Langemeier, 2011 and Masterson, 2007). Stevenson, (2012); Mburu, *et al*., (2014); Alam, (2011); Singh. *et al*., (2015) and Kumar *et al*., (2008) found an uneven path and a large gap in productivity and efficiency of fish farming due to lack of intensive aquaculture practices. However, based on this background, still an ongoing argument is very common on the relationship among farm size, productivity and efficiency in aquaculture and this study have tried to evaluate the relationship among farm size, productivity and efficiency of pangas fish farming in Bangladesh.

Methodology

Sampling Technique, Study Area and Data Collection

A total of 125 pangas fish farmers of Mymensingh district were selected under this study following a three stages procedure. Firstly, the Mymensingh district was chosen purposively as the geographical location because it is the highest pangas producing area of Bangladesh. In fact, Mymensingh district is favorable for freshwater pangas due to its auspicious resources, good climatic conditions, and availability of ponds, labor and industrially manufactured feed. Secondly, the Trishal, Muktagacha and Fulpur Upazilas were selected as core study area because these Upazilas have the record of highest production of pangas in Mymensingh district. Finally, a total of 125 pangas fish farms were selected of which 60 from Trishal, 35 from Muktagacha and 30 from Fulpur upazila. The data was collected by face to face interview of the respondents using a prescribed survey schedule during the month of March to April, 2016. The survey schedule was pre-tested with a few sample farmers of the study area and moderated as per need. Before collecting the data each respondent was given an outline about the purpose of this study. Data were verified to eliminate the possible errors and inconsistencies. The collected data were categorized as small **(**≤249 decimal), medium (250 to ≤749 decimal) and large (≥750 decimal) following the standard categorization procedures of Bangladesh Bureau of Statistics (BBS, 2016).

Analytical Technique

In this paper, both the descriptive as well as econometric analyses were used to fulfill the objectives. Initially, farm's productivity and profitability were calculated as per hectare basis. Benefit cost ratio (BCR) were calculated for each type of farm sizes.

Technical Efficiency Analysis (TEA)

Farrell's (1957) seminal article on efficiency measurement led to the development of several approaches to efficiency and productivity analysis. Among these, the stochastic frontier production (Aigner *et al.*, 1977; Meeusen and van den Broeck, 1977) and Data Envelopment Analysis (DEA) (Charnes *et al.*, 1978) are the two principal methods. As noted by Coelli *et al.*, (1998), the stochastic frontier is considered more appropriate than the DEA in agricultural applications, especially in developing countries, where the data are likely to be heavily influenced by measurement errors and the effects of weather conditions, diseases, etc. This also applies to the application of frontier techniques to fish culture. Thus following Aigner *et al*., (1977) and Meeusen and van den Broeck, (1977), the stochastic frontier production with two error terms can be modeled as:

$$Y_i=f(X_i,\beta)exp(V_i-U_i) \quad \text{..........................} \quad (1)$$

Where Y_i is the production of the i-th farm (i=1,2,3.............n), X_i is a (l x k) vector of functions of input quantities applied by the i-th farm; β is a (kxl) vector of unknown parameters to be estimated $V_i s$ are random variables assumed to be independently and identically distributed $(N(O,\delta^2_v)$ and independent of $U_i s$ and the $U_i s$ are non-negative random variables, associated with technical inefficiency in production assumed to be independently and identically distributed and truncations (at zero) of the normal distribution with mean, $Z_i\delta$ and variance σ^2_u $(|N(Z_i\delta, \sigma^2_u)|)$; Z_i is a (lxm) vector of farm specific variables associated with technical inefficiency, and δ is a (mxl) vector of unknown parameters to be estimated (Sharma and Leung, 2008).

Following Battese and Coelli (1995), the technical inefficiency effects, U_i in equation (l) can be expressed as:

$U_i = Z_i\delta + W_i$ .... (2)

Where W_i are random variables, defined by the truncation of the normal distribution with zero mean and variance σ^2_u, such that the point of truncation is $Z_i\delta$, i.e. $W_i \geq - Z_i\delta$. Beside the farm-specific variables, the Z_i variables in equation (2) may also include input variables in the stochastic production frontier (1), provided that the inefficiency effects are stochastic. If Z variables also include interactions between farm-specific and input variables, then a Huang and Lui (1994) non-neutral stochastic frontier is obtained.

The technical efficiency of the i-th sample farm, denoted by *TEi* is given by:

$TE_i = exp(-U_i) = Y_i/f(X_i\beta)\, exp(V_i) = Y_i/Y_i^*$ .... (3)

Where $Y_i^* = f(X_i\beta)\, exp(V_i)$ is the farm specific stochastic frontier. If Y_i is equal to Y_i^* then TE_i=1, reflects 100% efficiency. The difference between Y_i and Y_i^* is embedded in U_i. If U_i=0, it implies that production lies on the stochastic frontier, the farm obtains its maximum attainable output given its level of input. If U_i<0, production lies below the frontier-an indication of inefficiency.

The maximum likelihood estimate (MLE) of the parameters of the model defined by equations (1) and (2) and the generation of farm-specific TE defined by (3) are estimated using the STATA 12. The efficiencies are estimated using a predictor that is based on the conditional expectation of *exp (-U)* (Coelli, 1996). In the process, the variance parameters σ^2_u and σ^2_v are expressed in terms of the parameterization:

$\sigma^2 = (\sigma^2_u + \sigma^2_v)$ .... (4)
and
$\gamma = (\sigma^2_u/\sigma^2)$ .... (5)

The value of γ ranges from 0 to 1 with values close to 1 indicating that random component of the inefficiency effects makes a significant contribution to the analysis of the production system (Coelli and Battese, 1996).

Two types of functions namely; Cobb-Douglas and translog dominate the technical efficiency literature. Since, the sample number is not very high, the translog specification could not be tried. Therefore, a Cobb-Douglas function was specified. The stochastic production function for the sample pangas fish farmers is specified as:

$lnY_i = \beta o + \beta_l\, ln(X_l) + \beta_2\, ln(X_2) + \beta_3\, ln(X_3) + \beta_4\, ln(X_4) + \beta_5\, ln(X_5) + \beta_6\, ln(X_6) + \beta_7 X_7 + \beta_8 X_8 + V_i - U_i$ .... *(6)*

Where, *ln* = Natural logarithm; Y_i = Fish production (Kg); X_1= human labor (man-days); X_2= number of fingerlings; X_3 = feed (in kg); X_4 = salt (kg); X_5 = lime (kg); X_6 = other cost (Tk.); X_7 = medium farm size (dummy, 1 if farm size is medium and 0 if farms are small as base), X_8 = large farm size (dummy, 1 if farm size is large and 0 if farms are small as base).

Inefficiency Model

This was used in determining the contribution of the socio-economic variables to the observed technical inefficiency (TI) of the fish farmers. The inefficiency model was estimated jointly with the general model, using the statistical software, TI model is composed of vector variables (z), which will be hypothesized to affect the TE of the fish farmers which was specified as:

$U_i = \delta_0 + \delta_1 Z_1 + \delta_2 Z_2 + \delta_3 Z_3 + \delta_4 Z_4 + \delta_5 Z_5 + W_i$ ....(7)

Where:
U_i = Technical inefficiency effect
δ_0= constant term, Z_1= age (years), Z_2=education (years of schooling), Z_3= experience in pangas farming (years), Z_4= training (number of days), Z_5= earning member in a family (number), W_i= unobservable variables.

Farm size, Productivity and Efficiency Relationship Analysis

Polynomial regression model was employed to show the relationship among farm size, productivity and efficiency. Theoretical polynomial regression smoothing model can be describe as: Consider a set of scatter plot data $\{(x_1, y_1), \ldots, (x_n, y_n)\}$ from the model.

$Y_i = m(X_i) + \delta(X_i)\varepsilon_i$ .... (8)

For some unknown mean and variance functions m (·) and σ^2 (·), and symmetric errors with E ( ) = 0 and Var ( ) = 1. The goal is to estimate $m(x_0) = E[Y|X=X_0]$, making no assumption about the functional form of m (·).

Results and Discussion

Socioeconomic characteristics of pangas fish farmers

This section presents the prevailing socio-economic profiles of the selected pangas fish farmers. It is essential to know the socio-economic characteristics to get a complete picture of productivity and efficiency at different farm size of pangas fish farming. Differences in socioeconomic conditions of small and large framers may lead to the input use variation of the fish production process (Khan, 2012). Therefore, the age distribution, education, experience in aquaculture, family size, number of earning member of family and pond size of the respondents were considered as the socio-economic characteristics. A brief discussion of these aspects have been presented in Table 1.

Results revealed that the mean age of small, medium and large farmers were 38.19, 38.48 and 37.90 years respectively that implies there was no significant age differences among the pangas fish farmers. These results are similar to the study of Prodhan and Khan, (2018). Along with age, education is considered as a vital measuring scale for progressive attitude of the farm households towards production technique and it indicates the ability of an individual to read and write up to certain standard. Result demonstrated that the large farmers were more educated (11.52 years of schooling) than the small (9.95 years of schooling) and medium (10.98 years of schooling) farmers. However, on an average, the years of schooling of the selected farmers were 10.56 years.

Family size was defined as the total number of individuals (husband, wife, sons, unmarried daughters, brothers, sisters and parents) in a family living together and taking meals from the same kitchen under the head of the family. The average family size of the selected fish farmers were 3.78 which is lower than the national average household size of Bangladesh (BBS, 2016). Large farmer's family size was 4.19 which was greater than the small (3.45) and medium (4.07) farmers. Number of earning members in a family is another important socio-economic indicator. Family members who don't earn but living together, normally depends on earning member of that family. Study found that, average earning member was 1.97 persons per household whereas it was little bit more in case of large farm size (2.24) than the small (1.77) and medium (2.12) farms respectively. Experience of the farmers is an important practical feature, which normally affects the efficiency of pangas fish production. Current study found that the mean experience of the farmer was 10.12 years, where the large farmers had more experience (12.57 years) than the medium (10.50 years) and small (9.03 years). It is expected that, the farmers who have longer period of experience will acquire better skill for continuing fish production. Along with experience, training is essential for any farming practices. Result revealed that on an average farmer got only 3 days training in the study on aquaculture production and large famers received more training compared to the small and medium scales.

Optimal pond size is the important factors for growth of pangas. A suitable pond size is required to minimize production cost with maximization of profit. Study revealed that, the average pond size for panga fish was 72.41 decimal and the pond size was increased with the size of the farm (Table 1). Average farm size was found 440.14 decimal while the farm sizes of small, medium and large category were 124.43, 431.78 and 1390.95 decimal respectively.

Table 1. Socio-economic characteristics of pangas fish farming

Particular characteristics	Small Farm	Medium Farm	Large Farm	Average
Age (years)	38.19	38.48	37.90	38.24
Education (years of schooling)	9.95	10.98	11.52	10.56
Family size (number)	3.45	4.07	4.19	3.78
Earning member (number)	1.77	2.12	2.24	1.97
Experience in pangas farming (years)	9.03	10.50	12.57	10.12
Training attended (days)	1.75	3.24	6.62	3.06
Pond size (decimal)	34.28	93.65	142.50	72.41
Farm size (decimal)	124.43	431.78	1390.95	440.14
No. of sample	62	42	21	125

Source: Field Survey, (2016)

Profitability Analysis

This section mainly concerned with the estimation and analysis of cost and return of pangas fish production. All costs and returns were calculated according to small, medium and large farm to evaluate the financial performance of pangas fish farm that shown in Table 2. Costs were calculated for all the purchased inputs at prevailed current market price. In pangas fish farming variable cost included human labor cost, and the cost for fingerling, feed, fertilizer, salt, lime, water exchange cost, aqua-clean, zerolux, MP, timsen, baking powder, zeolite, diesel, electricity and mobil. On the other hand, total fixed cost (TFC) was inclusive of the cost of bamboo, sallow tube well, drum/fishing trap, feeding tray, weight machine, boat, net, gher/pond house, equipment, building and structure, and lease value. Considering all inputs (variable and fixed inputs), per hectare total cost (TC) of pangas fish production was estimated as Tk. 1853127. The average feed conversion ratio (FCR) was found to be 1.64 that implies 1.64 kg feed was required to produce 1 kg pangas which is supported by the study of Sarker *et al.* (2016b). Thus, per hectare production of pangas fish was found to be 26600 kg. On an average per hectare gross margin and net return from pangas fish farming was estimated as Tk. 872169 and Tk. 746243 respectively. The production volume as well as returns were more in large farms compared to those of small and medium farms. At end, the estimated benefit cost ratio (BCR) was found to be 1.40 in the study area, which is consistent to the study of Shawon *et al.*, (2018), Sarker *et al.* (2014) and Kumar *et al.*, (2016).

Table 2. Costs and return of pangas fish farming (per hectare)

Particulars	Small Farm	Medium Farm	Large Farm	Average
Total variable cost (Tk.)	1525830	1685144	1811161	17,27201
Total fixed cost (Tk.)	119956	128044	116099	125926
Total cost (Tk.)	1645786	1813188	1927260	1853127
Feed Conversion Ratio (FCR)	1.44	1.68	1.69	1.64
Productivity (kg/hectare)	23452	28325	32447	26600
Total return (Tk.)	2212930	2679545	3126352	2599370
Gross margin (Tk.)	687100	994401	1315191	872169
Net return (Tk.)	567144	866357	1199092	746243
BCR	1.34	1.48	1.62	1.40

Source: Field Survey, (2016)

Technical efficiency of pangas fish farming

Pangas production function has been explained by several variables such as human labor, fingerling, feed, salt, lime, others cost and farm size. These estimated parameters following the maximum likelihood estimation method of production frontier has been shown in Table 3. Data revealed that all the explanatory variables had significant effects on production volume except fingerling and lime. Human labor was inversely related with the volume of pangas production at 10% level of significance, which implies that the production volume is decreased with the increase of labor involvement. It might further indicate that the pangas fish farmers use more labor than the optimal requirement during production process. Feed was positively related to the volume of production that explain more use of feed can increase the production volume additively.

Table 3. Maximum likelihood estimates of stochastic production function

Variables	Coefficient	Standard error
Human labor (man-days)	-0.043*	0.022
Fingerling (number)	0.042	0.050
Feed (kg)	0.382***	0.047
Salt (kg)	0.022***	0.005
Lime (kg)	0.002	0.010
Other cost (Tk.)	0.052**	0.022
Medium farm (dummy, base is small farm)	0.253***	0.049
Large farm (dummy, base is small farm)	0.319***	0.068
Constant	0.622***	0.086
Mean technical efficiency	0.77	

Source: Field Survey, (2016)
Significance level: *** for 1%, ** for 5% and * for 10%

Inefficiency function

Inefficiency model was used in determining the contribution of socio-economic variables to the technical inefficiency (TI) of pangas fish farmers (Table 4.) Inefficiency function has been explained by age, education, experience, training and number of earning member. As expected, we find that fish farmers with young age, education, training days, and experience are less likely to be inefficient in fish farming. Pangas fish farming is relatively a new technology in Bangladesh. Access to training services is indeed important factors which can improve farming efficiency and productivity. In essence, well trained farmers have a higher potential of establishing better input-output combination along with less inefficiency than that of the untrained farmers. Similarly, having more experience implies that the farmers update their knowledge and skills in fish farming over time. The findings of current study is consistent with the report of Al-Amin, *et al*., (2016), who observed that experienced farmers were able to reduce the production inefficiencies and losses by gaining more information.

Table 4. Estimating inefficiency function

Variables	Coefficient	Standard error
Age (years)	-0.050*	0.029
Education (years of schooling)	-0.037*	0.071
Experience (years)	-0.294***	0.112
Training (no. of days)	-0.198**	0.242
Earning member (number)	0.047	0.479
Constant	-0.800 ***	0.198

Source: Field Survey, (2016)
Significance level: *** for 1%, ** for 5% and * for 10%

Technical efficiency (TE) scores were not found to be skewed towards higher or lower level of efficiency (Fig. 3). A significant level of inefficiency exists and TE score varies from 0.34 to 0.99. Only 1.6% farmer had TE score ranging from >=0.30 to <=0.40, whereas 30.4% farmer had a score of >=0.80 to <=0.90. More than 74% farmer's TE score was greater than 0.70. However, higher TE score (80) was found in large farms compared to that in small (>1) and medium (76) farms (Fig. 3).

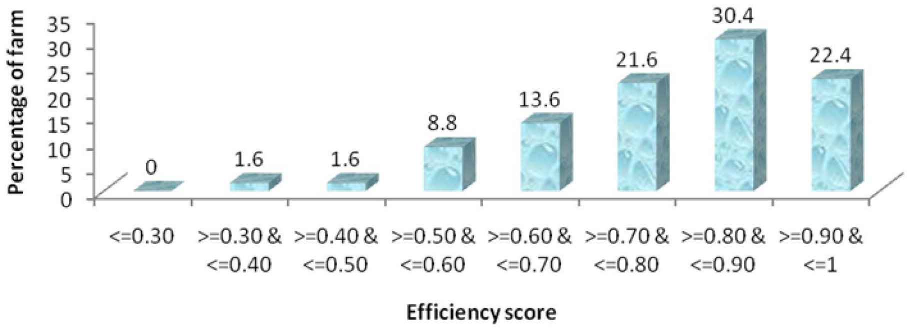

Fig. 3. Frequency distribution of technical efficiency scores
Source: Field Survey, (2016)

Relationship between farm size and productivity

Farm size and productivity relationship is a debatable issue in literatures. This relationship may positive or negative with respect to certain production factors. The output of local polynomial regression (Fig. 4) under this study revealed the relationship between farm size and productivity is positive that means productivity increases with the increase of farm sizes. The reason behind this observation might be that the large farmers were financially more capable and followed capital intensive cultivation practices compared to small farms. Besides, large farm has more access to land and credit than that of small farmers. Cornia (1985) opined that if large farmers have first access to long-term asset with segmentation in input markets then it also seems to have positive relationship between farm size and production.

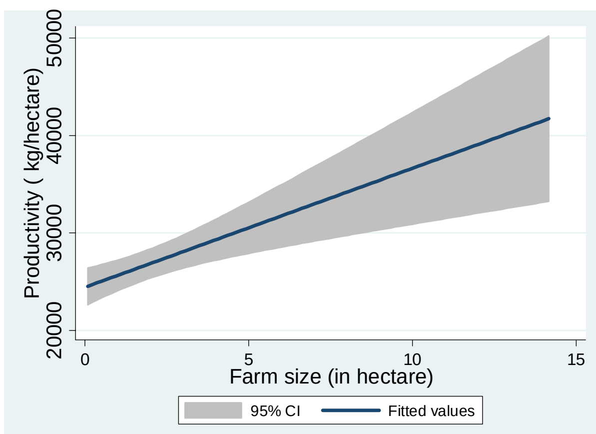

Fig. 4. Relationship between farm size and productivity

Relationship between farm size and efficiency

A farm is said to be technically efficient if it is producing maximum output from minimum quantity of inputs, such as labor, capital and technology. In this study, the mean technical efficiency was found to be 0.77 (Table 3) that was supported by the study of Ebo, O.E. *et al.*, (2018). TE of small, medium and large size farms were found to be 0.76, 0.77 and 0.80 respectively. The plotted polynomial regression (Fig. 5) shows that there is a significant positive relationship between farm size and efficiency. That means efficiency increases with the increases of farm size. This circumstance can be explained by the fact that the small farm may not be economically capable as the larger ones (Fernandez and Nuthall, 2012; Bhuyan *et al.*, 2013; Yin *et al*, 2014; Bhatt and Bhat, 2014). Moreover, large farms generally have higher labor productivity through the use of new technology and mechanization (Mishra, 2014). Optimization in use of inputs by large farms through mechanization may lead the higher efficiency than that of the small and medium farms. Moreover, large farmers may financially become more capable to hire efficient labor for smooth operation of the pangas fish farming.

On the other hand, most of the small farmers use their family labor due to lack of financial feasibility. Sometimes they do not want to hire labor even if they required and their family labor never become sufficient as needed in aquaculture farming. For this reason, generally the small pangas fish farmers are not as efficient as the large farmers.

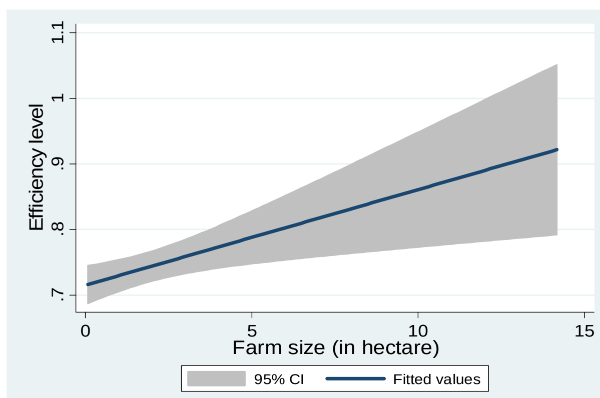

Fig. 5. Relationship between farm size and efficiency level

Relationship between productivity and efficiency

Farm productivity mainly depends on some factors that are enhanced by efficiency. Polynomial regression (Fig. 6) output indicates a significant positive relationship between the productivity and efficiency. It means that if farms use different inputs efficiently then the productivity will increase. This result is similar to the study of Singh *et al*., (2015). Suited and appropriate farm mechanization may be the main cause of this relationship Mburu, *et al*., (2014). However, the cause of low agricultural productivity may be the lack of appropriate machineries that cater to and suit the requirements of small scale farmers. For this reason, many small farms are deemed as unproductive and inefficient.

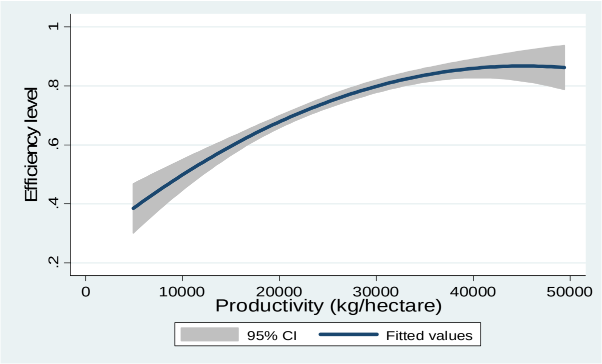

Fig. 6. Relationship between productivity and efficiency

The above results indicate that the large farms are more productive and efficient compared to small one, which is inverse of the inverse farm size-productivity relationship. However, many factors may contribute to this relationship such as technological, intuitional and input market facilities for large farms.

Conclusion and Policy Recommendation

In this paper, stochastic frontier production function was used to estimate the farm's efficiency and relationship between productivity and farm size. In addition, polynomial regression was employed to see the relationship among the farm size, productivity and efficiency. Study result revealed that the pangas fish farming was profitable business. The inputs like feed, salt and other items had significant positive effects on production while the human labor had negative effects. Results indicated that the farmer's age, education and experience were the most socioeconomic determinants of inefficiency. In addition, farmers who received more training on pangas fish production could reduce the inefficiency. Stochastic production function revealed that large and medium farms were statistically more productive compared to small and large farms. These results were confirmed by the polynomial regression line where the productivity and farm size was found to be positively related. Again, farm size and efficiency relationship was found to be positive i.e. farm's efficiency increases with the increase of the size of farms that implies large farms are more efficient compared to small ones. Relationship between productivity and efficiency was also found to be positive that means productive farms are more efficient. All these results indicated that farms productivity and efficiency increases with the increase of farm size. The most important reasons behind this positive relationship could be that the large farms use more intensive technologies and inputs those can enhance productivity. It is observed that young and educated persons have come forward to pangas farming business that reduced the inefficiency in production. The educated people have well communication with the extension worker that helps them to increase their production efficiency. Large farms enjoy institutional facilities such as training, financial opportunities and input market facilities which helps them to increase the productivity and efficiency. There are important policy implications that can be derived from this study is if we could create an environment where small and medium farms will have similar access to modern technologies, inputs, financial opportunities, input market facilities and productivity enhancing institutions, then these farms could produce their products as efficiently as large ones. In other way, zone specific pangas fish farming policy can be generated where only the large farms will operate their business.

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