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Determinants of Profitability of Fish Farming in Cameroon

Cynthia Jeh Mkong[1, 2, *], Ernest Lytia Molua[1, 2], Stephanie Mvodo[2]

[1]Centre for Independent Development Research, Buea, Cameroon

[2]Department of Agricultural Economics and Agribusiness, University of Buea, Buea, Cameroon

Email address:
mkongcynthiajeh@gmail.com (C. J. Mkong)

[*]Corresponding author

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Abstract: Aquaculture remains an important source of food, nutrition, income and livelihoods for millions of people around the world. In Cameroon, like in most Sub-Saharan African countries, natural breeding and traditional fishing occur in virtually every river, lake and pond and the aquaculture sector predominantly comprises of small-scale producers with some larger-scale commercial activities. Although so many Cameroonian natives are involved in aquaculture, little profit is realized from their activities. Barriers to fish production include insufficient quality and quantity of fingerlings, inadequate quality of feed, inadequate financing and weak technical capacities. These problems lead to a core challenge of low supply of fish, coupled with low returns to fish farming and marketing. The study therefore sought to determine the level of profitability of fish farming as well as assess the main determinants of profitability of fish farming in Cameroon. It used data collected from 60 fish farmers in the Fako Division of Cameroon through personal interviews, using a pre-tested questionnaire. The study adopted net profit analysis to determine profitability and a Cobb-Douglas power function to quantify the effects of various factors on profit. The study found that fish farming is a profitable business with a mean net profit of 1 896 443 FCFA per production cycle of 4 months. Linear regression revealed that profitability of fish farmers was influenced by the price of feed, price of fingerlings and the cost of labor. The implications of the findings are that profitability can be enhanced by building the capacity of fish farmers on how to make fish production and marketing more cost effective. Farmers therefore need to know how to manage both variable and fixed costs in order to maximize profits.

Keywords: Profitability, Fish Farming, Cameroon

1. Introduction

Millennia after terrestrial food production shifted from hunter-gatherer activities to agriculture, aquatic food production has transitioned from being primarily based on capture of wild fish to culture of increasing numbers of farmed species [1]. A milestone was reached in 2014 when the aquaculture sector's contribution to the supply of fish for human consumption overtook that of wild-caught fish for the first time [2]. Fish farming has emerged as one of the major food processing occupations of mankind with economically and socially backward people being employed in this profession as in ancient times [1].

With capture fishery production relatively stagnant since the late 1980s, aquaculture has been responsible for the remarkable growth in fish supply for human consumption. Whereas aquaculture provided only 7% of fish for human consumption in 1974, this share increased to 26% in 1994, 39% in 2004 and 50% in 2015 [2]. According to FAO [3], top producers of aquaculture are China, India, Vietnam, Indonesia and Thailand. China, with one-fifth of the world's population, accounts for two -thirds of the worlds reported aquaculture production.

Aquaculture now remains an important source of food, nutrition, income and livelihoods for millions of people around the world. World per capita fish supply reached a new peak of 20 kg in 2014, thanks to vigorous growth in aquaculture, which now provides half of all fish for human consumption, and to a slight improvement in the state of certain fish stocks due to improved fisheries management.

Moreover, fish continues to be one of the most-traded food commodities worldwide with more than half of fish exports by value originating from developing countries. In Sub-Saharan Africa and parts of Asia, more than 1 billion poor people obtain most of their average per capita intake of animal protein from fish with fish representing 18% of total animal protein consumption and 9% of the total animal energy intake [2].

About 43% of the African continent is assessed to have the potential for farming Tilapia, African Catfish and Carp [4]. Aquaculture was introduced in Sub-Saharan Africa in the 1950s, having as main objectives to; improve nutrition in rural areas, generate additional income, diversify activities to reduce risk of crop failures and create employment in rural areas [5]. In Cameroon, aquaculture, in the form of fish farming, was introduced before the 1960s and since then, the country has been party to several bilateral projects and a variety of different programs in this sector to encourage the adoption of this new form of fish culture. It has been done rather timidly, and the output has been modest. In Cameroon, like in most Sub-Saharan African countries, natural breeding and traditional fishing occur in virtually every river, lake and pond [6]. The species which contribute to the bulk of the national fish production are tilapia, North African catfish and common carp. The tilapia is a sturdy species which is able to support extreme water temperatures and low levels of dissolved oxygen. There are several species in Cameroon, of which the Nile tilapia (*Oreochromis niloticus*) is the most attractive for fish farming purposes. North African catfish belong to the Siluriforme order. It is a bony fish, characterized among other things by a scale-less body and mandibular whiskers. It is an endemic species and is used in polyculture with tilapia, to reduce pond overloading. The most common species in Cameroon is *Clarias gariepinus*. The common carp (*Cyprinus carpio*) belongs to the Cyprinid family imported from Israel in 1969. It has adapted well to the tropical climate in the Western highlands of Cameroon and reproduces naturally in ponds.

The development of aquaculture in Cameroon since the 1970s has been largely driven by donor support through technical assistance and subsidies and most projects have collapsed once the subsidies are withdrawn [7]. A new framework to develop the rural sector including aquaculture was undertaken by the government of Cameroon through the implementation of the Sectorial Plan [8]. Overall, the implementation of this framework is to improve the quality of life of the people. Currently, Cameroon's aquaculture sector predominantly comprises of small-scale producers with some larger-scale commercial activities. The small scale fish farming, in most cases, is based in the rural zones, while the development of small scale commercial fish farming is around big cities such as Yaoundé, Bafoussam, Bertoua, and Ebolowa [7]. The predominant form of aquaculture being practiced in Cameroon is in freshwater ponds [9]. It has developed considerably in terms of culture techniques and the species cultivated. The first ponds to be built in the country were dammed ponds that could not be completely emptied, running parallel to the valleys. In view of the difficulty of managing those ponds, the second series of ponds, built after 1974 have been diversion ponds, all of whose production parameters are controllable [10]. Table 1 shows annual aquaculture production in Cameroon between the year 2000 and 2003.

In spite of various efforts since the 1950s, returns on government and international aquaculture investments appeared to be insignificant with less than 5% of the suitable land area being used [11]. A number of reasons have been suggested for the poor rate of growth in aquaculture development in the region. These include causes relating to insufficient quality and quantity of fingerlings, inadequate quality of feed, inadequate financing and weak technical capacities, fish consumption preferences, the general level of economic development in rural areas, the policy and governance environment, and limiting social factors together with a lack of access to available information and profitable markets [10]. In most cases, these constraints are the cause of low productivity and low levels of profitability [12].

Table 1. *Annual Aquaculture Production in Cameroon from 2000-2003.*

Species	FAO English name	Unit	2000	2001	2002	2003
Cyprinus carpio	Common carp	Tons	NA	NA	6	6
		FCFA/kg	NA	NA	1 300	1 400
Oreochromisniloticus	Nile tilapia	Tons	40	40	210	210
		FCFA/kg	1 000	NA	1 000	1 000
		US$/kg	1.41	1.45	NA	NA
Clariasgariepinus	North African Catfish	Tons	10	10	114	114
		FCFA/kg	1 300	1 300	1 300	1 400
		US$/kg	1.83	1.85	NA	NA

Source: Fisheries Directorate MINEPIA, 2003

This setback means the government must annually import about 200 000 metric tons of fish to meet domestic demand. Barriers to fish production in the country are scientific and even more pertinent to fish farmers are the problems of insufficient quality and quantity of fingerlings, inadequate quality of feed, inadequate financing and weak technical capacities. These problems lead to a core problem of low supply of fish and low returns to fish farming and marketing. The fall in fish supply in Cameroon is thought to be caused by a fall in profitability of aquaculture which is due to both socioeconomic and bio-physical factors. High input cost (transportation, feeding and labor costs) coupled with

inadequate technical knowledge and limited access to credit facilities (thought to be caused by poor level of infrastructural linkages, low level of education of actors, limited media exposure, limited number of extension workers and limited membership in groups and cooperatives) and social problems such as poisoning of the pond, make up the socioeconomic causes. The main biophysical cause is the high level of disease incidence, caused by improper pond management, poor water quality and small pond sizes. Given that most farmers practice fish culture primarily for profit, the fall in returns results in high rates of abandoned ponds [7]. Understanding the determinants of the fall in supply and profitability of fish farming offers an important means to address the problem. This study therefore seeks to determine the level of profitability of fish farming and assess the main determinants of the profitability of fish farming.

Similar studies have been done in Sub-Saharan Africa. Assessing the factors affecting profitability of catfish in aquaculture in Odun State Nigeria using profit function approach, the study [13] used the maximum variable profit as a measure of profitability which is affected by price of output, price of feed, price of fingerlings, price of labor and drugs or veterinary services. The study concluded that fish trading is a profitable enterprise that can be a sufficient source of household income and that, all variable costs affect variable profits except labor costs. The conclusions here were similar to that on smoked fish in Nigeria [14]. An investigation was similarly undertaken on farmers' perception and adoption of new aquaculture technologies in the western high lands of Cameroon [15]. Using the univariate dichotomous logit model, the study found that the main determinants of the adoption of fish farming in temperate aquaculture zone in West Cameroon include strong commercial orientations, coupled with the positive perception of its profitability, frequent contact with extension agents and high level of education of masculine gender.

Another study assessed the feasibility of aquaculture in Cameroon through operations of small-scale polyculture fish farming of mixed-sex Nile tilapia (*Oreochromis niloticus*) with African catfish (*Clarias gariepinus*) in the Noun Division West Region of Cameroon [16]. A production planning model and a profitability model were applied to analyze operations of production and her findings show that aquaculture in the Noun Division is feasible. In addition, the Debt Service Coverage Ratio showed that investment in aquaculture production generates substantial cash flow and the repayment of debt is done at the time required.

2. Materials and Methods

2.1. Empirical Model

In order to assess the profitability, net profit analysis was used. Data was based on the last consignment a farmer harvested and traded fish. Data on the particular quantity and price of fish sold was collected from the Fako Division in the Southwest region of Cameroon. Fish consumed was valued in order to quantify the gross income. Net returns were calculated per fish farmer using the formula given as:

$$NR = P_Y Y - \sum P_i X_i \quad (1)$$

Where NR= Net Returns in FCFA, P_Y = Price of fish per Kg, Y= Quantity of output in Kg, Pi = Price for each ith input (both variable and fixed) unit and $\boldsymbol{X_i}$ = Quantity of input (both variable and fixed) used.

Factors affecting profitability were assessed using Cobb Douglas type function [17]. This function was employed to quantify how different cost related variables and socio-economic factors affect net returns of fish farmers. The function is stated as:

$$\pi = \beta_0 P_i^{\beta_i} X_j^{\sigma_j} \quad (2)$$

Where π = Net Returns (in FCFA), P_i = Price of input factors, β_i = Price elasticities, X_j= other input factors, σ_j= elasticities of other factors.

The function is linearized and specified as follows:

$$\ln \pi = \beta_o + \beta_1 lnP_1 + \beta_2 lnP_2 + \beta_3 lnP_3 + \beta_4 lnP_4 + \sigma_1 lnx_1 + \sigma_2 lnx_2 + \mu \quad (3)$$

Where π = Net profit (in FCFA), P_1= Cost of feed (in FCFA), P_2= Cost of fingerlings (in FCFA), P_3= labor cost (in FCFA), P_4= transportation cost (in FCFA), x_1= years of experience, x_2= years of education and μ= error term.

2.2. Type of Data

This study was conducted in Fako Division of Cameroon and made use of both primary and secondary data. The main instrument for collecting the primary data was the structured questionnaire. Information was collected on input and output as well as the socio-economic characteristics of fish farmers through personal interviews and participatory rural appraisal (PRA)

A multistage sampling technique was adopted for this study. After preselecting Limbe, Muyuka, and Buea towns, a stratified random sample consisting of 60 fish farmer was drawn from these three towns. The OLS estimations were obtained using the STATA.14 software.

3. Results and Discussion

Fish farmers' level of education was appreciable - 30% had been to primary school, 63% to secondary school and 7% to the university. Fish farming was strictly male dominated, with a 100% male representation. Cultured fish does not go into any kind of processing but is sold fresh at the pond site for direct consumption as fresh fish. Table 2 presents mean cost distribution per fish farming cycle of 4 months. It is observed that the main variable cost items of fish farmers are the cost of fingerlings, cost of the catchment, cost of feed, cost of fertilizer, cost of sampling nets, cost of brushes and

security cost. The fixed cost however consists solely of the cost of construction of the ponds.

Table 2. *Mean Cost Distribution per Fish Farming Cycle of 4 Months.*

Variable Cost Item	Mean Amount (FCFA)
Fingerlings	559 000
Catchment	150 000
Feed	900 000
Fertilizer	3 500
Sampling Nets	35 000
Brushes	24 000
Security	60 000
Total Mean Variable Cost	1 558 797
Fixed Cost Item	Mean Amount
Construction of the pond(s)	600 000
Total Mean Fixed Cost	600 000
TOTAL COST	2 158 797

Source: Field Survey, 2017. 1USD = 600 FCFA

Table 3 reveals that fish farmers in the Fako Division make a mean net profit of 1 896 443 FCFA per production cycle of 4 months. Though the total cost is significant, the revenue realized make up for the variable and fixed costs to yield positive profit levels for the fish producers.

Table 3. *Mean Estimation of the Net Profit of Farmers in the Fako Division of Cameroon.*

Total Revenue (FCFA)	Total Cost (FCFA)	Net Profit(FCFA)
4 055 240	2 158 797	1 896 443

Source: Field Survey, 2017

Prior to running the regression analysis, two pretests were conducted; the Cronbach Alpha test for the overall reliability of the data set and test for correlation between the independent variables. The scale reliability coefficient of 0.0199 confirmed the reliability of the data set collected from fish farmers. The test for multi-collinearity among independent variables (years of experience, price of feed, price of fingerlings, cost of labor and cost of transportation) permitted the inclusion of these variables in the model since the variables were not strongly correlated.

Table 4. *ANOVA Summary of the Model.*

Variable	Mean	F-value	((Prob>F)
Model	0.441	0.793	0.0070***
Cost of labor	0.486	0.862	0.0021***
Cost of transportation	0.121	0.210	0.3512

Notes: *** p<0.01, ** p<0.05, * p<0.1
Source: Field Survey, 2017

Two of the five explanatory variables (cost of transportation and price of fingerlings) produce the expected positive outcome and four of these variables (experience, cost of labor, and price of feed and price of fingerlings) have a significant effect on the profitability of aquaculture. Experience and cost of labor are significant at 5% whereas price of feed and price of fingerlings are significant at 1%. We therefore attempt to present additional answers the second research question that profitability of aquaculture is determined by experience, cost of labor, and price of feed and price of fingerlings. The coefficients, standard error, t-values and levels of significance of factors are presented on table 5.

Table 5. *Determinants of Profitability.*

Variable	Coefficient	Std. Err	T	P>|t|
Constant	2.081	1.191	-1.750	0.093**
Price of feed	0.009	0.122	0.080	0.001***
Price of fingerlings	- 0.131	0.106	-12.26	0.000***
Cost of labor	1.96e-06	1.46e-06	1.34	0.010***
Transportation cost	-4.87e-07	0.000	-0.04	0.965
Experience	-0.005	0.050	0.100	0.918

R^2= 0.9369; Adjusted R-squared = 0.9237; F (5, 24) = 71.25; Observations = 60. *** p<0.01, ** p<0.05, * p<0.1.
Source: Field Survey, 2017

Table 5 shows that profitability of aquaculture is significantly affected by price of fingerlings. The results show that a unit increase in price of fingerlings will lead to 13% decrease in the net profit (p<0.01). It also shows a positive relationship between price of feed and net profit (p< 0.1). A unit increase in price of feed will lead to a 0.94% increase in net profit. This is most probably due to the fact that a higher feed price may indicate better quality which leads to bigger fish sizes in a shorter time and/or increase resistance of the fish to diseases, hence reducing pre and post-harvest losses. Cost of labor was significant at 1% (p<0.01), indicating that a unit increase in labor cost will lead to a 0.49% increase net profit from marine fishing. This is contrary to *a priori* expectations but might again be explained by the fact that increase labor cost may indicate improved labor quality which will positively affect fish output and consequently, profitability. Years of experience and cost of transportation had no significant effect on net profit. The R^{-2} value indicates that about 92% of variation in the net profit of fish farmers in the Fako is accounted for by years of experience, price of feed, the price of fingerlings, transport cost and labor cost. The significance of the F-value (p<0.01) suggests that the sample data provides sufficient evidence to conclude that our model fits the data better than a model with no independent variables. Hence, years of experience, price of feed, price of fingerlings, cost of labor and cost of transportation, improve the fit of the model.

4. Conclusion

The implications of the findings are that profitability can be enhanced by building the capacity of fish farmers on how to make fish production and marketing more cost effective. Farmers need to know how to manage both variable and fixed costs in order to maximize profits. While high costs may erode competitiveness and push some fish farmers out of business, the government should improve the local transportation and marketing infrastructure. The study concludes that fish farming is a profitable business in Cameroon, levels of profitability being determined by price of feed, price of fingerlings and the cost of labor.

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