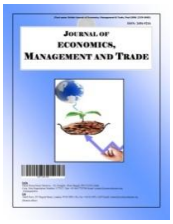

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The Novel Factors for Profitability and Viability for Ponds' Tilapia Farming in Coastal Region of Tanzania

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Authors' contributions

This work was carried out in collaboration between both authors. Authors PDK and KEN designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors PDK and KEN managed the analyses of the study. Author KEN managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The study examined the profitability and the present factors for Tilapia production in Tanzania. A purposive sampling technique used to obtain a total of 92 Tilapia farming households from 120 farming communities provided by the Tanzania government. Primary data are collected through the use of a structured questionnaire and analyzed by using descriptive statistics. The Gross Margin tool used to calculate the profitability of the semi-intensive tilapia pond fish farming. The Ordinary Least Squares regression used to determine the novel factors affecting the profitability and Net Present Values determined the viability of tilapia pond farming, respectively. The descriptive findings have revealed that the majority of tilapia farmers had a mean age of 39 years, while male respondents dominated tilapia farming. Among the costs, the feed cost contributed about 73% of the total cost indicating that feeds availability is among the prominent challenge for tilapia farming. The Gross margin obtained by the respondents was averagely 21.7%. The regression analysis has

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revealed that the cost of feeds, stocking density and the size of seed significantly affected the accrued pond tilapia profit negatively. The result from the Present Net Value was negative; thus, concludes that the current tilapia pond fish farming is not worthy in the study area.

Keywords: Ponds' Tilapia; profitability; viability; semi-intensive; coast region; Tanzania.

1. INTRODUCTION

Fish farming is among the essential economic sub-sectors contributing to Tanzania's economic growth. The sector provides substantial employment, income, livelihood, foreign earnings, and revenue to the country. The sub-sector offers employment to about 20,000 farmers national wide whose production is dominated (75%) with Tilapia [1]. Moreover, Tilapia farming contributes to food production, especially with animal proteins, and achieving self-sufficiency in aquatic products supplies. The sub-sector also heightens families with nutrition, employment, cash generations through fish selling and closing the fish supply gap in many rural areas while adds foreign earnings and revenue to the country [2]. Tanzania has plenty of water bodies such as lakes and rivers, which increases the potentials for aquatic production [3]. The fish industry in Tanzania is under three main scenarios; these include the traditional methods of direct capturing fish from natural water bodies by the use of both conventional and modern tactics. The second method comprises the aquaculture systems where fish are raised under different environments either within naturally occurring water sources like the lakes, ocean, rivers and human-made ponds. The last sources for fish are the importation from other countries, which produce different types of fish in large quantities [1].

Farmers investing in the aquaculture industry faces numerous challenges since they have to control and provide a suitable environment for fish growth [4,5]. Some of the essential requirements include feeds, breeding, disease control, and general protection, which are provided by farmers as opposed to catching fish production [6]. The aquaculture industry has proved profitable in different areas of the world. Therefore, if farmers are given suitable environments and with the best management practices could be possible to receive higher yields [7].

According to [1], the main fish species farmed through the aquaculture system in Tanzania include the African catfish, and the famous Tilapia referred to as *Kambale* and *Sato* in the Swahili language respectively. Moreover, Fresh Tilapia is the most farmed and consumed fresh fish product in Tanzania. Due to its high popularity in both local and regional areas, the lakeside price of Tilapia (US$ 3-5) per kg higher than that of African catfish or the Nile perch (US$ 2-2.5) per kg [1]. The demand for fish products and especially Tilapia has been increasing to surpass the supply; thus, nowadays, the Chinese Tilapia fillets are widely available in the local supermarkets [8]. The trend is because the sub-sector is not well developed in the country, as is only done by the Tanzanian small scale farmers having an average pond of 300 meter square per household [9,10].

In Tanzania, only a few regions are performing in terms of aquaculture farming, including Ruvuma (43%), Njombe (14%), and Iringa (11%) [11]. Most of these regions use subsistence systems where the technology is rudimentary characterized by higher production costs with an average yield of up to 654 kg per pond per production cycle as a contrast to 800 kg per pond per production cycle when using advanced technologies [12]. Therefore, it indicates that there is a potential for increasing fresh Tilapia production in the country to fill the demand and supply gap to improve food security and foreign earning in Tanzania. So, this current study aimed at analyzing the profitability led factors and viability for the ponds' Tilapia farming in Tanzania.

2. MATERIALS AND METHODS

This study was conducted in the Bagamoyo District in the Coast Region of Tanzania. The district experiences a modified type of tropical climate. It is warm and temperate throughout the year, with an average temperature of 26.60ºC. The highest temperature is experienced in January with an average of 28.4ºC and lowest in July with an average of 24.4ºC. These conditions are favorable for Tilapia farming. Bagamoyo district is divided into 25 villages with a population of 311,740 and an average household size of 4.2 [13].

2.1 Data Collection

A Snowballing sampling technique was adopted for reaching the desired 92 semi-intensive pond tilapia farming households for this study. This sampling method was desirable due to the nature of the aquaculture industry. Therefore, only the initial respondent was identified by a researcher and later on, the same respondent was asked to nominate another respondent with the same traits—the primary data collected by the use of structured questionnaires through a face to face interview. At the same time, other secondary data was obtained through various sources such as District offices, Sokoine University of Agriculture-Morogoro, Mzumbe University and Chinese Academy of Agricultural Sciences Library. The primary data solicited include; the socio-economic and demographic characteristics of the households undertaking semi-intensive tilapia farming, tilapia production status, farm management, costs, and sales incurred by farmers. The questionnaires were prepared in the English language, but due to language barrier was then translated into the Swahili language, especially for English non-speakers. The focus group discussion was carried with the key stakeholders who are involved in the agricultural sector in the Bagamoyo district. These include village leaders, agricultural extension officers, and other experienced individuals from different villages.

2.2 Analytical Approach

The study involved three types of analytical approaches regarding the objectives. To determine the Profitability of aquaculture enterprises involved several steps, such as calculation of the total revenues accrued by farmers through selling their tilapia. Also, the determination of the cost of goods sold (COGS) which involved the overall costs incurred by tilapia farmers in the production process such as seed purchase, feeds, water, labor, fertilizer, etc. Subsequently, the difference between the total revenue (TR) and the COGS as a ratio of TR is calculated to give the Gross margin (GM). The second analytical approach was the determination of the critical factors affecting the economic performances of the tilapia industry. In this case, the multiple regression model was applied to estimate the essential parameters which determine the profitability of a semi-intensive tilapia production by using ponds system. The final approach was the determination of the viability of the semi-intensive pond tilapia enterprise by a discounted measure of the project worthiness by the use of the Net Present Value (NPV) Technique.

2.2.1 Profitability analysis

The profitability of small agricultural enterprises is essential to determine as it demonstrates the real economic well-being of such micro-enterprises [14]. Different indicators were calculated, such as GM, TR, and COGS. The use of GM as a tool for determining the financial strength of an enterprise and farming production decisions has been adopted in various studies. For example, GM used in the determination of profitability of rice production in the Mbeya region of Tanzania [14,15] to analyze the profitability of cassava production in Nigeria; also [16] applied the same technique in Nigeria, [6] in the determination of profitability of aquaculture fish farming in Nigeria, and also [17] to determine profitability in coffee production in Brazil. Their results revealed that profitability analysis was essential to making essential farm decisions regarding various farm enterprises. Therefore, the mathematical expressions for Profitability determinant were performed as follow;

$$GM = \frac{TR - COGS}{TR}$$

Where:

TR= Total revenue obtained by multiplying unit price of harvested fish and Total fish output in kilograms.

COGS= Deduced Cost of Goods Sold, which is the cost of fish farming, and in this approach, all the fixed costs were assumed to be zero. Therefore to obtain the profitability of fish farming, the calculated GM was converted into percentage by multiplying by 100.

$$Profitability = \frac{TR - COGS}{TR} \times 100$$

2.2.2 Determinant factors for profitability

The multiple regression model was applied to estimate the parameters for profitability. In this model, the obtained Profitability was used as the dependent variable and several other factors affecting profitability were treated as independent variables in the regression model. The multiple regression equation could be modeled as:

$$Y_i = \beta_0 + \beta_1 d_{1i} + \beta_2 d_{2i} + \beta_3 d_{3i} + \cdots + \beta_k d_{ki} + \beta_{k+1} D_i + \mu_i$$

Where,

Yi = Profitability of the Semi-intensive pond Tilapia accrued by the household
β_0= intercept of the regression model
$\beta_{1i}\ldots\ldots\beta_{k+1}$ = Estimated parameters
$d_{1i}\ldots\ldots d_{ki}$= The set of deterministic variables of the regression model
D_i= The dummy variables
μ_i= error term, which assumes to have a zero mean and constant variance.

2.2.3 Viability of the semi-intensive tilapia farming

To realize whether a project is viable or not, we streamlined the numerical value of the resulted NPV. For a project to be considered viable and risk-free if its NPV discounted at its cost of capital has to be positive. On a similar note, the semi-intensive pond fishing Tilapia would have been considered viable if its NPV is equal to or greater than zero and otherwise not. Therefore, NPV could be defined as the difference between the present value of the project benefit (B) and the value of the present value of the project cost (C). Mathematically the Net Present Value is expressed as;

$$\text{NPV} = \sum \text{Bt}/(1+r)t - \sum \text{Bt}/(1+r)t$$

Where r is a rate of discount, t is the number of years from the base year, Bt and Ct are total benefits and total costs respectively in year t.

3. RESULTS AND DISCUSSION

3.1 Socio-economic Characteristics

The descriptive statistics have revealed that the majority (56%) of the households are married, 30% are single while widow and divorced households each counted to 3%. Out of 92 respondents, male respondents dominated by 83.7%, and the rest 16.3% were female farmers. It indicates that a lesser number of female households' head practices fish pond farming in the study region. This argument in line with the findings of [18] as they pointed forward that the fish industry characterized by a very high degree of gender inequality, whereby females farmers are limited with resources like land, capital and income [19,20]. Further statistics have shown that the majority fish farmers have an average age of 39.8 years, denoting that they have the potential as they are young and energetic to perform farming activities. Most of the activities in the tilapia fish pond farming are challenging, thus require energy and courage to take them on board and make potential managerial decisions. A similar claim presented by [12] in which he added that the average age of up to 41 years was very crucial for fish farmers to make a positive impact on the production process. Regarding the education level of the respondent, it calls that majority of fish farmers had attained formal education (91.3%). This finding implies that fish farmers have from primary education and above, which is vital for individuals to manage their ponds well, participate in extension services and increase their marketing search and bargain power.

Based on primary occupation, the results revealed that farmers involved themselves to more than one economic activity for a living. Therefore, 21% had permanent employment, 19% had temporary employment, while 27% were self-employed, and the rests (33%) were casual labour. Another attribute is the households' size; the finding disclosed that the average household size was 7 per fish farming household, which is a relatively reasonable number since most activities are conducted by household members to avoid hiring external labour. The current claim is concordance with [14] as they added that majority farmers in Tanzania have an average of 5 to 7 family members that could be the potential to cut down farming production costs.

3.2 Fish Production Characteristics

The results indicated that two types of fish pond systems are carried by the respondents, including the Concrete and Earthen ponds. Of these two production systems, 73.9% of the fish farmers are using concrete ponds, while 26% uses the earthen pond system. On the other hand, the results depicted that pond tilapia farmers adopted a different rate of stocking density. Majority farmers (41.7%) used a stocking density of 5 fingerlings/m^2, 21.1% used a stocking density of 4 fingerlings/m^2 and the last group (36.9%) was doing a stocking density of 3 fingerlings/m^2. This is similar to the recommended stocking densities by [21,22,23]. According to the respondents, the majority (73%) reported their farming cycle length of equal or less than seven months, while 27% spent above seven months to reach the harvesting weight. On average, the results also displayed that farmers

in the study area planted their seeds or fingerlings at a weight of 2.54 g.

3.3 Economic Cost Associated with Fish Farming

Pond tilapia fish farmers incurred a variety of costs as they account before production, during production, on and after harvesting. The average cultivation cost reported by the respondents was Tanzania Shillings (TZS) 80,453. The small scale pond tilapia farmers claimed that the price paid for a unit tilapia seed ranges from 150 TZS to 300 TZS, and on average, it cost up to 668,468.75 TZS per cycle. At the same time, the feeds cost averaged to 2,385,886.98 TZS per cycle. Based on the findings, the prices varied depending on the type of feeds. However, majority farmers reported using formulated feeds which are sourced from commercial suppliers outside the Coast region, including Dar es Salaam and Morogoro regions, although there was a relatively higher price of up to the US $ 1.28 per kilogram (1 US $ is equivalent to 2340 TZS). The average cost payable to hired labour was 114,273.7 TZS per production cycle. Majority farmers attested to use chicken manure for fertilizing their fish ponds, and as an average, they spent up to 25,318.75 TZS. The main reasons for applying chicken manure were because they are rich in nutrients required for pond fertilization and readily available at a reasonable price in their localities.

3.4 Profitability and Viability of the Fish Pond Farming

The results indicate that the obtained GM was ranging from -692.39 to 83.22% with 21. 7% as an average profit margin. In the real sense, the high pitched variability could be due to inputs demand like fertilizers, lime, fingerlings, and fish feeds, availability of suitable water, access to quality fish farming technical advice, disease/parasites, design and construction of fishpond, etc. on the other hand, the findings have revealed that the mean value profit discounted to 10% as the discount rate at ten years of operation as NPV was -3775498.473 (Table 1).

3.5 Factors Affecting the Profitability of Semi-intensive Pond Tilapia Farming

The results presented in Table 2 indicate that the feed cost was statistically significant at 5% level of probability with the accrued profit obtained from the pond fish farming in the study area. It is therefore claimed that an increase of a unit cost of feed is associated with a decrease in farmers' profitability by 1.156E-005 TZS. The current finding is consistent with Mwenesi [5] as he accounted that fish feed costs have a remarkable profit reduction on the Semi-Intensive Tilapia production. Based on the stocking density, it was revealed that the stocking density was statistically significant at 1% probability level. Therefore, it concludes that as a unit increase in stocking density decreases the profitability level by 4.501 TZS provided other factors included in the regression model are kept constant. Additionally, the size of the seed was statistical significance at 10% level of significance and, for each unit increase of the fish seed is associated to a decrease in farmer profitability by 14.328 TZS at ceteris paribus.

Therefore, for improved farmers' profitability efforts geared towards reducing costs of feeds, stocking density and sizes of seeds are needed.

Table 1. Viability of fish farming

Discount rate	Years	Profit	Discount factor	Present value
10%	0	-12330000	1	-12330000
	1	1392205.7	0.909090909	1265641.572
	2	1392205.7	0.826446281	1150583.247
	3	1392205.7	0.751314801	1045984.77
	4	1392205.7	0.683013455	950895.2455
	5	1392205.7	0.620921323	864450.2232
	6	1392205.7	0.56447393	785863.8393
	7	1392205.7	0.513158118	714421.6721
	8	1392205.7	0.46650738	649474.2473
	9	1392205.7	0.424097618	590431.134
	10	1392205.7	0.385543289	536755.5763
			NPV	**-3775498.473**

Table 2. Regression results for factors affecting fish farming

Variables	Coefficients	Std. error	t	Sig.
(Constant)	136.683	72.379	1.888	.062
Gender of farmers	6.666	21.253	.314	.755
education level	3.710	5.600	.662	.509
age of a farmer	-.370	.831	-.446	.657
cost of seed	8.687E-006	.000	.855	.395
cost of feed	-1.156E-005	.000	-2.350	.021**
cost of labour	.000	.000	-1.348	.181
cost of fertilizers	.000	.000	-.531	.597
stocking density	-4.501	1.391	-3.235	.002***
length of farm cycle	-2.147	8.497	-.253	.801
size of the seed	-14.328	7.830	-1.830	.071*

*Note: *** P<0.01, **P<0.05, *P<0.1, R^2=0.33, Adj R^2= 0.25, F= 0.000*

4. CONCLUSION

Different factors for profitability and viability of the pond fish tilapia are revealed. The factors include socio-economic, demographics, and production inputs cost. Some of these factors contributed positively to profitability, whereas others had a negative impact to the industry performance. From the findings, the tilapia pond fish project is not worthy undertaken in the study areas due to the negative Net Present Value calculated. Although the profit earned was relatively low, there is a high possibility for revamping this industry through operational costs reduction like the cost of feeds. Therefore, other feed sources, including the locally available materials but with high nutritive value, need to be incorporated in the feeds. The study recommends to the government and other stakeholders to provide functional environments for financial assistant accessibility, capacity building to all stakeholders, subsidy provision, especially for the essential inputs like feeds, seeds and adopting new technology.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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