International Journal of Agricultural Sciences ISSN: 2167-0447 Vol. 2 (1), pp. 059- 066, January, 2012. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Full Length Research Paper

Status, cost and profitability of aquaculture enterprises in Nigeria: implications for food security

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Received December 15, 2011; Accepted January 28, 2012

Although aquaculture in Nigeria has the potential for satisfying the increased demand for protein and has been experiencing unprecedented growth during the last decade, question remains regarding the sustainable development of the industry. This study summarises the aquaculture practices in Nigeria and compares the productivity, costs and benefits across various types of enterprises. The study was based on field survey conducted between 2008 and 2009, with data drawn from 700 fish farmers. More than half (58.3 %) of the fish farmers raised fish in concrete tanks. Monoculture of Clarias species was the most dominant culture practice by 75.0% of fish farmers in the study area. Economic analysis of the production systems using various farming enterprises revealed that the profit margin was found to be as low as ₦207.92 per kilogramme of fish in flow techniques to ₦314.00 per kilogramme in stagnant system. Mean overall profitability was 4.7. The F-value (6.08) showed a significant difference in the profitability ratio of different fish farming enterprises. This shows that fish farming in Lagos State achieved on the average some levels of profitability that should guarantee its economic sustainability.

Keywords: Aquaculture, status, costs, profitability, Nigeria

INTRODUCTION

Despite its long history, aquaculture in Nigeria has only emerged as an industry, and has experienced tremendous growth in production during the last two decades. In 2007, production figures from aquaculture indicated a total production (excluding aquatic plants) of 85,087 metric tones (FDF, 2007). It is currently the fastest growing food-producing sector surpassing both terrestrial livestock meat production and capture fisheries. With stagnation being experienced in the capture fisheries coupled with the growing population, putting increased pressure on resources, aquaculture is viewed as a possible solution to meet growing demand for food security. The issues and the challenge of meeting the Millennium Development Goals (MDGs) also place aquaculture in a central role as an important contributor to the reduction of hunger and poverty, particularly among the vulnerable groups. It is being envisaged that if rising demand is not met by equally fast supply growth, shortages of fish will cause lower fish consumption, especially among the poor, and threaten food security (WorldFish Centre, 2007).

Aquaculture, in Nigeria, is a dynamic industry. New technology and new production enterprises that promise higher returns or lower costs are constantly being introduced. Producers routinely find themselves in the position of evaluating whether or not a new investment or some other type of change to the existing operation will be worthwhile. In evaluating a proposed change to an existing aquaculture operation, the basic issue to be addressed is whether or not the long-term profitability of the farm will be improved. In evaluating these long-term effects, a partial budget can be a very useful tool for fish farmers, lenders, and economic resources in traditional fishery sector need to be evaluated for increasing its efficiency and support the main object of increasing fish production without depleting natural stock of fish.

Nevertheless, the expansion and intensification of aquaculture have raised a number of issues in terms of their negative impact on the environment and on the livelihoods of poor fish farmers (Ahmed, 1997; Kurein, 1998; Piumsombun *et al*., 2005; Dey *et al*., 2005). There have been concerns that poor fish farmers are not able to adopt some of the aquaculture technologies due to their weak capital base (Ahmed *et al*., 1994a, 1994b, 1995). If aquaculture is to continue to grow in Nigeria particularly in Lagos State, It is important to identify appropriate aquaculture technologies that are economically viable, socially acceptable for poor communities and environmentally sustainable. Knowledge of production costs is essential to the successful management of a fish farm, and helps to identify the main items for which cost reduction is worthwhile. Benefit-costs analysis may also assist the manager in decision making and in adjusting to changes. The primary interest in most fisheries is directed toward establishing viable industries for the purpose of stock enhancement, domestic consumption, export, employment opportunities, income distribution, or a combination of these objectives (Shang, 1981; Pillay, 1994). As Shang (1990) noted, elements such as biology, technology, feed and nutrition, engineering, fish pathology, and institutional factors all affect the economics of production.

From a micro-economic view point the primary motivation of a fish farm may be profit making, but sometimes there can be other considerations such as stock enhancement (Salehi, 2003). Study of fish farming production was carried out to help clarify production costs by different farming techniques. Against this background, the main objective of this paper is to evaluate the existing aquaculture techniques in Lagos State, Nigeria and to identify appropriate technologies suitable for poor households in the State. Specific objectives were:

i. to assess the types and levels of fish culture techniques used by farmers;

ii. to determine the production cost per kilogram of fish and profitability by farming enterprise; and,

iii. analyse the cost contribution of the input factors by enterprise in order to estimate production costs and identify the most important determinant of profitability in Lagos State.

Attention was directed to addressing questions such as (a) which inputs are significant in explaining outputs from various enterprises? and (b) what constraints inhibit increased productivity and production of existing culture systems?

The increase in demand for fish has gradually opened a space for fishing as a business activity. Much of aquaculture is now agribusiness ventures where production is undertaken mainly for the market. This is a welcome development. No production activity that is undertaken principally for self-consumption can attain the scale needed for efficient resource allocation and technological advancement. The relative stagnation of crop agriculture and the very robust growth of aquaculture suggest that aquaculture has the potential to act as one of the major thrust sectors for the economy pushing out the frontiers of production possibilities of the country. This needs to be explicitly recognized by the government and acted upon on the policy front to allow aquaculture to play its due role in national economic development.

Data sources

A multi-stage sampling technique was used to obtain data from 700 fish farmers in all the twenty Local Government Areas (LGAs) in Lagos State during the 2008/2009 farming season. The farmers were drawn from the list of fish farmers compiled by the Lagos State Agricultural Development Authority (LSADA), spread across the LSADA zones and complemented with snowball technique. Information was collected using structured questionnaire. Each copy of the questionnaire asked information on location, organization, operations and performance, types and quantity of inputs used in production, volume of output, prices of inputs and output.

METHODOLOGY

Costs for each farm model were determined using data supplied by farmers, researchers and suppliers of farm inputs and equipment. At this stage, farm model parameters and costs were presented to industry participants for review, and any comments were incorporated into the models for further analysis. Economics of different culture systems were given on annual basis as the duration of different practices varies from six months to one year. While working out the economics, the total cost indicated was the sum of annual fixed cost and annual operating cost. Operating costs include all those costs, which are incurred only when the farms are under operation and fixed costs are those incurred even if there is no culture operation. The fixed cost includes the interest on initial investment, depreciation of the permanent assets and insurance premium. The information collected from various publications has been updated by substituting the current input and output prices (2009-2010). Similarly, the average yield and earnings per hectare for different aquaculture systems were projected irrespective of existing/optimum size of farms advisable and presented only to enable easy assessment of comparative efficiency (Sathiadhas, *et al*, 2009).

Data Analysis

The enterprise budgets analysis method (Jolly and Clonts *1993*) was used to measure the economic contribution of fish culture to total household income of the farmers. Concepts of income measures include:

- *Gross income* is a preliminary measure of income. It assesses the performance of an enterprise purely in terms of the benefits it yields without considering the costs to produce them (Jolly and Clonts, 1993). Gross income thus equals volume of achieved products multiplied by average of farm-gate price. This volume includes all of sold, given and eaten shares of products, leading to two detailed measures of gross income.
- *Variable cost* includes all cost of inputs used in production, except cost of capital used for long period of time

Table 1: Classification of the fish farms based on holding techniques and farming practices

Rearing unit and farming practice	Frequency	Percentage
Rearing unit		
Concrete	303	58.30
Earthen (Dug out)	86	16.50
Fibre	15	2.90
Plastic	116	22.30
Total	520	100.0
Farming practice		
Mono	390	75.00
Polyculture	100	19.23
Integrated	30	5.77
Total	520	100.0

- *Gross margin* for an enterprise is defined by subtracting variable cost from gross income.

The fixed cost includes the interest on initial investment, depreciation of the permanent assets and insurance premium. Similarly, the average yield and earnings per hectare for all type of aquaculture systems has also been worked out or projected irrespective of existing/optimum size of farms advisable and presented only to enable easy assessment of comparative efficiency (Sathiadhas *et al*, 2009). The results from enterprise budgets were used for sensitivity analysis to assess the degree by which the farmers' enterprise gross margin vary when alternative yields/output and prices were substituted for the actual average values used in the budgets.

Duncan Multiple Range Test (DMRT) statistical nonparametric was used to examine the significance of differences in economic returns among the enterprise groups and of changes in each of the groups for the investigated issues. These tests were chosen due to the fact that they do not require a normal distribution of the data.

RESULTS AND DISCUSSION

Status of aquaculture enterprises

In Nigerian, a broad spectrum of systems, practices and species are practiced through a continuum ranging from homestead operations to large-scale commercial fish farming. The choice of technique used and specie cultured is increasingly influenced by the emergence of urbanization, consumer's preference and growth of export trade in fish and fish products. Ponds and tanks remains the major production environment in the country (Table 1). This is similar to the findings of Dey *et al* (2005) in Asia countries where ponds aquaculture is the most popular in terms of area and production. More than half (58.3 %) of the fish farmers operated concrete tanks. Next in importance were fish farmers using plastic controlling above 22.0%. Fish farmers using earthen pond accounted for 16.5 % and fibre tank operators accounted for less than 3.0 %. The gradual shift by fish farmers from earthen pond to other rearing techniques was attributed to pressure on the available land or water bodies in Lagos State. Variations however exist in terms of size, shapes and depth. Three types of farming practices were observed in Lagos State. These include monoculture, poly-culture and integrated fish farming. Monoculture of clarias species is the most dominant form of fish species cultured with 75.0% of fish farmers practicing it. The culture system is becoming increasingly popular for intensive culture in tanks and running water systems. Another emerging technology in the State is flow-through system which may be the beginning of a shift to industrial fish farming. This technology uses concrete and plastic tanks and is suitable where water is abundant. Other economically important species cultured

Table 2: Summary of production costs and profit margin of profitable enterprise technique in Lagos State.

Enterprise technique	Production cost (N/Kg)				Profit margin (N/Kg)			
	Mean	Maximum	Minimum	Total (N)	Mean	Maximum	Minimum	Total (N)
SCFLP	91.61	338.52	18.85	32.00	277.14	406.53	11.48	32.00
SPFLP	127.35	337.75	42.50	30.00	253.65	430.18	12.25	30.00
SPJLT	154.58	339.51	39.49	32.00	207.92	425.09	10.49	32.00
SEFLP	171.17	397.96	35.31	35.00	210.83	351.94	2.04	35.00
SEJLP	141.94	353.46	33.89	31.00	208.38	406.22	10.41	31.00
FTSCJLT	49.36	157.32	19.42	30.00	314.64	380.58	224.14	30.00
FTSCJIT	111.47	333.61	20.61	30.00	235.20	351.70	16.39	30.00
FTSPJLP	138.11	395.28	20.28	39.00	209.71	341.05	4.12	39.00
FTSPJLT	133.09	371.15	17.22	44.00	235.55	401.22	3.85	44.00
WRSDCJLT	54.91	182.47	13.40	49.00	296.11	384.34	167.53	49.00
WRSDCJIT	105.65	276.35	13.00	33.00	265.26	372.07	93.65	33.00
WRSDPJLT	103.13	342.25	13.28	33.00	254.45	470.90	7.75	33.00
WRSNCFLT	138.92	376.92	21.28	33.00	205.47	355.35	5.31	33.00
WRSNCFIT	118.41	390.79	21.39	34.00	232.33	367.03	0.64	34.00
WRSNPJIT	90.73	364.02	24.11	32.00	264.90	400.89	46.83	32.00

Source: Field data, 2010

in Lagos State include *Lates niloticus*, *Oreochromis niloticus* and common carps.

Costs and returns by fish farming enterprise and level of input intensity.

The costs and profitability for the production of catfish farming enterprise is presented in Table 3. Farm were classified by enterprise such as types of water exchange, rearing techniques, feed types (natural foods, supplementary feed or relying on nutritionally complete concentrated feeds and fertilizers), size of fish (fingerling, juvenile or adult) stocked in ponds and harvesting strategy (Edwards, 1993, Dey *et al*, 2000). Economic analysis of the production systems using various farming enterprises revealed that the costs of catfish production per kilogram varied from less than ₦50.00 per kilogramme of fish in flow system to ₦171.00 per kilogramme in stagnant system (Table 2). The resulting profit margin was found to be as low as ₦207.92 per kilogramme of fish in flow (Type CXII) to ₦314.00 per kilogramme in stagnant system (Type XXV). These levels were achieved as a result of optimum combination of

Table 3. Costs and returns structure (N) for different fish farming enterprises

Techni-que	SCFLP	SPFLP	SPJLT	SEFLP	SEJLP	FTS CJLT	FTS CJIT	FTS PJLP	FTS PJLT	WRSD CJLT	WRSD CJIT	WRSD PJLT	WRSN CFLT	WRSN CFIT	WRSN PJIT	Total
Output ('000)	8.3^{d}	7.1^{d}	8.7^{d}	6.1^{d}	7.6^{d}	20.1^{c}	20.5^{c}	16.9^{c}	42.2^{a}	31.2^{b}	22.0^{c}	22.0^{c}	22.6^{c}	20.4^{c}	20.3^{c}	274.4
Price (Naira/ kg)	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360	360
Revenue (N'000)	2,988.0	2,5560	3,240.0	2,160.0	2,880.0	7,200.0	7,560.0	6,120.0	15,120.0	11,520.0	7,200.0	9,720.0	6,480.0	6,480.0	8,280.0	98,784.0
Variable costs (N'000)																
Feed	141.7	160.4	381.5	255.7	220.6	670.1	664.8	906.8	458.2	600.0	741.2	1670.6	690.2	788.9	1076.4	10778.7
Seed	83.6	114.5	148.8	238.8	129.2	449.7	292.4	270.7	390.8	252.8	331.2	414.5	230.3	254.9	315.7	4,222.90
Labour	101.5	138.7	133.2	199.4	146.3	114.3	164.7	132.6	207.9	131.7	179.9	159.3	221.4	157.4	176.3	2,344.60
Fuel	22.9	120.8	92.3	19.9	14.7	1.8	215.8	15.9	61.8	76.8	74.9	27.9	34.5	29.7	57.7	867.4
Transportation	6.1	4.8	8.7	10.7	6.8	2.2	13.3	5.1	8.9	7.8	7.5	6.2	4.8	5.2	6.3	104.4
Water	21	14.3	10.9	18.2	11.7	7.9	11.6	8.5	11	8.1	7.7	11.3	8.8	6.7	9.1	166.8
Fertilizer	3.1	0	1.6	1.2	3.8	0	0	0	0	0	0	0	0	0	0	9.7
Lime	1.1	0	0.8	0.5	2.2	0	0	0	0	0	0	0	0	0	0	4.6
Chemicals	0	0	8.9	0	0	0	0	0	0	0	0	11.5	2.2	0	2.6	25.2
Electricity	0	0	0	0	0	40.8	10.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	198
Maintenance	4.9	3.9	4.6	3.4	2.6	1.7	3	1.4	2	8.7	1.9	0.9	2.3	1.8	1.5	44.6

Table 3. Cont'd

Total Variable costs	385.9	557.4	791.3	747.8	537.9	1,288.5	1,376.4	1,361.8	1,161.4	1,106.7	1,365.1	2,323.0	1,215.3	1,265.4	1,666.4	18,766.9
Fixed costs ('000)																
Machinery	43.5	61	48	51.4	44.1	82.4	54.6	71.2	59.3	68.6	50.4	49.3	46.3	45.5	33.4	769
Vehicle	35.2	41.3	23	20.9	146.9	0	164.3	69.7	105	53.8	73.2	96.9	87.9	61.5	6.3	981.5
Building	0.2	0.2	0	0	0	1.9	2.3	12.8	24.9	14.6	2.6	3.3	4.8	24.7	7.6	100
Pond	23.8	12.7	16.7	22.9	32.6	30.7	21.2	31.9	49.6	16.9	46.1	67	44.4	56.8	30.2	492.5
Total Fixed Costs	102.7	115.2	87.7	95.2	223.6	115	242.4	185.6	238.8	153.9	172.3	216.5	183.4	188.5	77.5	2342.9
Total costs (TC)	488.6^{f}	672.6^{f}	879.0^{ef}	843.0^{ef}	761.5^{ef}	1,403.5^{cd}	1,618.8^{bc}	1,547.4^{cd}	1,400.2^{cd}	1,260.6^{def}	1,537.4^{cd}	2,539.5^{a}	1,398.7^{cde}	1,453.9^{cd}	1,743.9^{b}	21,109.8
Gross margin	2,602.1	1,998.6	2,448.7	1,412.2	2,342.1	5,911.5	6,183.6	4,758.2	13,958.6	10,413.3	5,834.9	7,397.0	5,264.7	5,214.6	6,613.6	80,017.1
Profit	2,499.4^{efg}	1,883.4	2,361.0^{efg}	1,317.0^{g}	2,118.5^{fg}	5,796.5^{bcd}	5,941.2^{bcd}	4,572.6^{defg}	13,719.8^{a}	10,259.4^{b}	5,662.6^{bcd}	7,180.5^{bc}	5,081.3	5,026.1	6,536.1^{cd}	77,674.2
Profitability	6.1^{cd}	3.8^{de}	3.7^{de}	2.6^{e}	3.8^{de}	5.1^{bc}	4.7^{bc}	4.0^{cd}	10.8^{a}	9.1^{ab}	4.7^{bc}	3.8^{de}	4.6^{bc}	4.5^{bc}	4.7^{bc}	4.7^{bc}

Means with the same letters are not significantly different

inputs and multiple annual productive cycles. A large number of the flow systems put their ponds into production more twice a year. However, it must be noted that the use of averages hides great variability in the financial computations of the farms surveyed as well as the riskiness of fish farming. Thus, the study clearly indicates that fish farming with various levels of typologies in the study area achieves on average healthy levels of profitability that should guarantee its economic viability in the near future.

The focal point of this study was to determine fish farming enterprises that is productive, profitable, cost effective and less capital intensive. In this study, gross margin (gross return less total variable cost or return over variable cost), net return (gross return less total cost), return on variable cost (gross margin divided by total cost) as the measures of profitability was used. On the other hand, total variable costs, total cost, return on variable cost, and return on total cost were used as the measures of cost effectiveness (Dey *et al*, 2005).

It is evident from the analysis that the costs and returns of different fish farming enterprises varied substantially by type of technique. Findings show that all the fish farming enterprises were productive and profitable. In terms of cost-effectiveness, SCFLP was found to be most cost effective (N385,900). Fish farming enterprise FTSPJLT had a return of N12.02 for each Naira investment in variable inputs. This enterprise (FTSPJLT) was the most productive and profitable (i.e. higher net return) than other enterprises. The mean gross revenue of prominent techniques presented in Table 3 varied from ₦2,160,000 in SEFLP to N15,120,000 in FTSPJLT. The overall mean gross revenue for all the farming techniques was ₦6,664,462. The difference in mean gross revenue is attributed to the different gross output levels of the techniques. The ANOVA shows that the means for all the techniques were significantly different (F = 16.38). This implies that level of mean revenue is associated with the choice of technique. Technique FTSPJLT has the highest mean and is significantly different from other techniques. Ranked second was WRSDCJLT and was also significantly higher than other techniques except FTSPJLT. The least was SEFLP which was not different from SCFLP, SPFLP, SPJLT and SEJLP.

Cost structure by enterprise

The mean variable cost (VC) structure of prominent techniques is presented in Table 3. Fish feed constituted the highest variable cost of about ₦1.0 million Naira or 57.5 % of the TVC. WRSDPJLT has the highest fish feed cost (₦1,670, 600) and the least was SCFLP (N141,700). Findings show that the mean TVC varied from ₦386,000 (or 2.1 % of TVC) in SCFLP to as high as ₦2,323,200 (or 12.4 % of the TVC) in WRSDPJLT with overall mean of N1, 316, 699. The high cost was due to capital intensity associated with some of enterprises particularly, flow techniques. ANOVA on TVC showed significant *F* (6.49) implying that TVC was different across fish farming enterprises. Thus, at least one enterprise incurred significantly different TVC in the day to day operations. The mean comparison shows that WRSDCJLT has the highest mean TVC and was significantly different from other techniques except WRSDCJIT. Ranking second was technique WRSDCJIT which was also significantly different from SCFLP, SPFLP, SPJLT, SEFLP, SEJLP, FTSCJLT, FTSPJLP, WRSDPJLT, and WRSNPJIT but not from FTSCJIT, FTSPJLT, WRSNCFLT and WRSNCFIT. Technique SCFLP has the lowest TVC. It however did not produce any significant difference from SPFLP, SPJLT, SEFLP, SEJLP, FTSCJLT and WRSNPJIT in that order. The amount spent on fertilizer, lime and chemicals was less than ₦40,000 per season while cost incurred on electricity (₦44,600) was less than fuel consumption (N867,400).
Depreciation on vehicles represented the largest cost in fixed cost structure of all the farming enterprises (₦981,500). Ranked second was machinery accounting for ₦769,000. ANOVA on TFC showed that F (18.85) was significantly different, meaning that TFC differ significantly from one another across the enterprises. The mean comparison however shows that FTSCJIT has the highest mean and is significantly different from other techniques. Techniques FTSPJLT, SEJLP and WRSDPJLT ranked second and were significant from others. The least in ranking were SPJLT, SEFLP, FTSCJLT and WRSNPJIT. All of these techniques were not significantly different from SCFLP and SPFLP. Overall mean TFC was ₦227,523.6.

Total cost structure varied from ₦488,600 in technique SCFLP to ₦2,539,500 in WRSDPJLT. Finding shows that WRSDPJLT has the highest mean TC of N3,117,200 while enterprise SCFLP has the lowest mean TC of ₦488,600. The high TC of WRSDPJLT is as a result of high variable cost of items such as feed and fish seed. SCFLP has the least TC as a result of low variable inputs used in fish farming. The overall mean total cost was ₦1,434,024. The result of the F-test (7.98) was statistically significant and it implies that the TC of production varies across enterprises. WRSDPJLT has the highest mean TC, which was significantly different from other techniques. SCFLP ranked least in TC of production, it was however not significantly different from SPFLP, SPJLT, SEFLP, SEJLP and FTSCJLT.

The component of variable costs of production as a proportion of total cost by enterprise is presented in Table 4. The amount spent on fish feed varied from 23.8 % in SPFLP to 65.8 % in WRSDPJLT. The mean cost of fish seed ranked second as the most important cost component (20.0 %). It however varied from 16.3 % in enterprise WRSDPJLT to 32.0 in FTSCJLT. The mean cost of labour ranked third (11.1 %). It varied from 6.3 % in WRSDPJLT to 20.8 % in technique SCFLP. The variable cost components analysis showed that feed, labour and fish seed were the three largest operating costs for all the techniques accounting for 82.2 % of the total costs of production in Lagos State. In all, feeds formed the main cost items in most of the enterprise accounting for half of the total costs of fish production (51.1 %). This finding was in line with the study conducted by Katiha, *et al.* (2005) on inland aquaculture in India where it was discovered that feed was the most important cost component, accounting for more than 50.0 % of the total cost. Demand for labour was found to be higher in SCFLP, SPFLP, SPJLT, SEFLP, and SEJLP compared to FTSCJLT, FTSCJIT, FTSPJLP, FTSPJLT, WRSDCJLT, WRSDCJIT, WRSDPJLT, WRSNCFLT, WRSNCFIT and WRSNPJIT. The high demand in the former enterprises may be attributed to farm land preparations, fish sorting, harvesting and pond de-silting associated with techniques. Fuel was relatively

Table 4: Cost components as percentage of total costs

Technique	SCFLP	SPFLP	SP JLT	SEFLP	SEJLP	FTS CJLT	FTS CJIT	FTS PJLP	FTS PJLT	WRSD CJLT	WRSD CJIT	WRSD PJLT	WRSN CFLT	WRSN CFIT	WRSN PJIT	Total
Variable costs																
Feed	29.0	23.8	43.4	30.3	29.0	47.7	41.1	58.6	32.7	47.6	48.2	65.8	49.3	54.3	61.7	51.1
Seed	17.1	17.0	16.9	28.3	17.0	32.0	18.1	17.5	27.9	20.1	21.5	16.3	16.5	17.5	18.1	20.0
Labour	20.8	20.6	15.2	23.7	19.2	8.1	10.2	8.6	14.8	10.4	11.7	6.3	15.8	10.8	10.1	11.1
Fuel	4.7	18.0	10.5	2.4	1.9	0.1	13.3	1.0	4.4	6.1	4.9	1.1	2.5	2.0	3.3	4.1
Transportation	1.2	0.7	1.0	1.3	0.9	0.2	0.8	0.3	0.6	0.6	0.5	0.2	0.3	0.4	0.4	0.5
Water	4.3	2.1	1.2	2.2	1.5	0.6	0.7	0.5	0.8	0.6	0.5	0.4	0.6	0.5	0.5	0.8
Fertilizer	0.6	0.0	0.2	0.1	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Lime	0.2	0.0	0.1	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Chemicals	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.2	0.0	0.1	0.1
Electricity	0.0	0.0	0.0	0.0	0.0	2.9	0.7	1.3	1.5	1.7	1.4	0.8	1.5	1.4	1.2	0.9
Maintenance	1.0	0.6	0.5	0.4	0.3	0.1	0.2	0.1	0.1	0.7	0.1	0.0	0.2	0.1	0.1	0.2
TVC	79.0	82.9	90.0	88.7	70.6	91.8	85.0	88.0	82.9	87.8	88.8	91.5	86.9	87.0	95.6	88.9
Fixed costs																
Machinery	8.9	9.1	5.5	6.1	5.8	5.9	3.4	4.6	4.2	5.4	3.3	1.9	3.3	3.1	1.9	3.6
Vehicle	7.2	6.1	2.6	2.5	19.3	0.0	10.1	4.5	7.5	4.3	4.8	3.8	6.3	4.2	0.4	4.6
Building	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.8	1.8	1.2	0.2	0.1	0.3	1.7	0.4	0.5
Pond	4.9	1.9	1.9	2.7	4.3	2.2	1.3	2.1	3.5	1.3	3.0	2.6	3.2	3.9	1.7	2.3
TFC	21.0	17.1	10.0	11.3	29.4	8.2	15.0	12.0	17.1	12.2	11.2	8.5	13.1	13.0	4.4	11.1

substantial (4.1 %). It varied from 0.1 % in technique FTSCJLT to 18.0 % in SPFLP. Electricity and transportation accounted for 0.9 % and 0.8 % of the total costs respectively. The use of fertilizer, lime and chemical were not common across all the techniques. Fertilizer and lime were used in earthen pond and concrete tanks to enhance phytoplankton growth in the ponds. In all, the cost of inputs fluctuated according to the required intensity of their use across different techniques. Total variable cost was 88.9 % of the total costs of production.

Table 4 highlights the summary of fixed cost components of the total cost of production. The cost constituents were depreciation on machinery, vehicle, building and pond. The TFC components varied from 4.4 % in WRSNPJIT to 29.4 % in SEFLP. Vehicle was the most important cost component of the fixed cost, accounting for 4.6 % while machinery ranked next with 3.6 %. Depreciation on pond was 2.3 % while building was 0.5 %.

Net profit of different fish farming techniques

The net profit attributed to various inputs for different fish farming techniques depend on the total quantity harvested, cost of various inputs and the relative price of the fish. The net profit generated by techniques varied from ₦1,317,000 in SEFLP to N13,719,800 in FTSPJLT (Table 3). The overall mean profit was ₦5,230,438. This shows that all the techniques were characterized by some levels of profit. The F- test was 13.91 implying a significant difference in the profits among the techniques. The mean comparison indicates that of all the techniques, FTSPJLT delivered the highest mean profit and significantly differs from all other techniques. Technique WRSDCJLT ranked second and the least was SEFLP.

Profitability analysis of different fish farming techniques

The result of the profitability ratio varied from 2.6 in technique SEFLP to 10.8 in FTSPJLT (Table 3). Mean overall profitability was 4.7. The F-value (6.08) showed a significant difference in the profitability ratio of different fish farming entreprises. This shows that fish farming in Lagos State achieved on the average some levels of profitability that should guarantee its economic sustainability. Further analysis reveals that FTSPJLT has the highest mean profitability and was highly significant from other techniques except WRSDCJLT. This equally explains that both techniques (FTSPJLT and WRSDCJLT) are characterized by a high level of profitability and the difference profitability between the two techniques may be as a result of random error. This finding shows that a one Naira invested in FTSPJLT would generate ₦10.60k.

CONCLUSION

This study provides an overview of the development of fish farming in Lagos State. The culture of fish is considered from an economic perspective (an enterprise), analyzing the current cost structure of different aquaculture techniques. Study shows that scientific advances have stimulated the growth of aquaculture. The modes of fish farming have been greatly diversified with major system such as intensive culture system which has become a trend coupled with techniques such as formulated feed, improved rearing tanks, better water quality management and indoor recirculation system. An economic analysis of different fish farming technique indicates that fish farming irrespective of the technology, is generally profitable although costs and return varied substantially with production environment.

RECOMMENDATION

It is obvious from the analysis that fish farming in Nigeria requires substantial start-up capital and relies heavily on input feed. This development has a far reaching implication for the expansion fish farming and food security of the vulnerable groups in the country.
Owing to the high start-up capital investment, promotion of these techniques are likely to benefits the rich and those that have access to capital. Resource poor farmers can benefit by way of government intervention in reducing the cost of fish feed which accounted for over 50% of the operating cost. The use of semi-intensive systems which require lower operating costs with high rate of return may be consider by the extension personnel and government for resource poor farmers in driving fish production in Lagos State.

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Appendix 1:

Abbreviation	**Typology of fish farming enterprise techniques**
SCFLP	Stagnant-Concrete tank-Fingerling-Local feed-Partial harvesting
SPFLP	Stagnant-Plastic tank-Fingerling-Local feed- Partial harvesting
SPJLT	Stagnant-Plastic tank-Juvenile-Local feed-Total harvesting
SEFLP	Stagnant-Earthen pond-Fingerling-Local feed-Partial harvesting
SEJLP	Stagnant-Earthen pond-Juvenile-Local feed-Partial harvesting
FTSCJLT	Flow Through System-Concrete tank-Juvenile-Local feed-Total harvesting
FTSCJIT	Flow Through System-Concrete tank-Juvenile-Imported feed-Total harvesting
FTSPJLP	Flow Through System-Plastic tank-Juvenile-Local feed-Partial harvesting
FTSPJLT	Flow Through System-Plastic tank-Juvenile-Local feed-Total harvesting
WRSDCJLT	Water Recirculatory System Dutch- Concrete tank-Juvenile-Local feed-Total harvesting
WRSDCJIT	Water Recirculatory System Dutch-Concrete tank-Juvenile-Imported feed-Total harvesting
WRSDPJLT	Water Recirculatory System Dutch-Plastic tank-Juvenile-Local feed-Total harvesting
WRSNCFLT	Water Recirculatory System Nigeria-Plastic tank-Fingerling-Local feed-Total harvesting
WRSNCFIT	Water Recirculatory System Nigeria-Plastic tank-Fingerling-Imported feed-Total harvesting
WRSNPJIT	Water Recirculatory System Nigeria-Plastic tank-Juvenile-Imported feed-Total harvesting