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Comparative Cost Structure and Yield Performance Anzlysis of Upland and Mangrove Fish Farms in Southwest, Nigeria

Mafimisebi Taiwo Ejiola[1] and Okunmadewa Foluso Yinka[2]

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Abstract

The bias against mangrove areas in siting fish farms prompted a comparison of the cost structure and yield performance in upland and mangrove locations. Tools utilized included descriptive statistics, budgetary and cash flow analyses and profitability ratios. Empirical results revealed that substantial revenue could be realized from both farms. While the upland farms yielded average gross revenue per hectare per year of $9,183.53, the mangrove farms made $8,135.93 revealing a slight difference. Results of combined cash flow and sensitivity analysis buttressed that of budgetary analysis. NPVs were $10,888.11 and $10,375.84, B/Cs were 1.28 and 1.29 and IRR were 48.55% and 48.51% for the upland and mangrove farms, respectively. Profitability ratios were also comparable but slightly higher in the upland farms. The conclusion is that there was little or no difference in yield performance. However, the high risk of investment loss in years of excessive flood should prompt investors in mangrove farms to compulsorily insure their farms.

Keywords:
Fish farming, Cost structure, Gross revenue,Investment yield, Upland and mangrove areas, Nigeria.

[1] Department of Agricultural Economics and Extension, The Federal University of Technology, Akure, Nigeria.
[2] World Bank Country office, Asokoro, Abuja, Nigeria.
* Corresponding author's email: temafimisebi@futa.edu.ng

INTRODUCTION

The widening demand-supply gap for fish in Nigeria attests to the fact that there is the need to explore all avenues to increase and sustain fish supply. The factors implicated in the demand-supply deficit situation include water pollution from perpetual oil spillages which results in dwindling catches from capture fisheries, constant upward reviews of the prices of petroleum products which depress profit from capture fisheries, and over-fishing which involves large quantities of by-catch sold along with target species (Mafimisebi, 1995, FAO 2000 and Delgado, *et al.,* 2003). A right step towards arresting the demand-supply deficit for fish is aquaculture, which involves raising fish under controlled environment where their feeding, growth, reproduction and health can be closely monitored. Such farm-raised fish is already accounting for a considerable and rising proportion of total fish consumed in Nigeria and other developing countries (Delgado, *et al.,* 2003, Mafimisebi, 2007). The rapidly growing field of aquaculture has been recognized as a possible saviour of the over-burdened wild fisheries sector and an important new source of food fish for the poor (FAO 1995, Williams, 1996).

Most parts of the maritime (coastal) region of Nigeria (about 800km coastline, FDF, 1979) are suitable for aquaculture. The coastal area is in two parts; the upland communities (which make up about 25.0% of the total land area) and the mangrove swamp areas, which are perennially inundated by flood or flooded for most parts of the year. The upland communities are characterized by fresh water while the mangrove areas have brackish water. Aquaculture first started in the upland parts of the coastal areas of Southwest, Nigeria. Today, a good number of private commercial fish farms are found there. However, owing to the relative scarcity and high cost of acquiring land in the upland areas, many prospective fish farmers have not been able to commence the business of fish farming. In comparison, only a few private commercial fish farms are found in the relatively land-surplus mangrove parts. The particularly difficult terrain of the mangrove areas especially with respect to its physiographic nature, water quality, distance from input source, problem of fish pond construction and the possibility of flooding, were cited as reasons why prospective investors shy away from locating their fish farms in the mangrove areas (Mafimisebi, 1995).

The result of this is a vast expanse of mangrove land lying unused while there is serious competition for land in the upland parts. For example, Ondo State, one of the coastal states in Southwest, Nigeria, has an estimated 850 and 2450 hectares of exploitable fresh and brackish water fishing grounds. While more than 80.0% of the fresh water fishing grounds is being exploited with about 10.0% of this under aquaculture, less than 4.0% of the brackish water grounds is being exploited with only about 1.0% under fish farming (Ondo State Agricultural Development Project, 1996). In Nigeria as a whole, the same situation holds. Fish farming is the least exploited fishery sub-sector with the vast brackish water fishing grounds almost unexploited. Less than 1.0% of the fresh water grounds and about 0.05% of the brackish water grounds are under aquaculture to produce a current average yield of 20,500 tonnes of fish per annum. This represents only 3.12% of the estimated fish culture potential of 656,815 tonnes per annum. When the current output is compared with potential yield, one will immediately appreciate the need for increased effort at bringing most, if not all land suitable for aquaculture under cultivation (Ajayi and Talabi, 1984, Tobor, 1990, Falusi, 2003). In fact, apart from increasing the land area under aquaculture, astute management system targeted at doubling the present national aquaculture production rate of 1.5tonnes/ha/yr should be employed. If this can be achieved, total potential yield will increase to 1,831,000 tonnes per year, which will exceed the projected fish demand of between 1,562,670 tonnes and 1,609,920 tonnes per annum by the year 2010 and beyond (Tobor, 1990, Dada, 1996, FOS, 2005).

The observation that investors are biased against the mangrove areas of Southwest, Nigeria in siting of their fish farms, was the motivation to compare the yield performance and profitability in the two fish farm locations of upland and mangrove. This is necessary because commercial fish farmers have two major objectives; the provision of fish for human consumption and employment opportunities, which can only be realized when maximum income and profitability are achieved in farmed fish production (Fagbenro, 1987). The specific objectives of the study are to (1) describe the operational characteristics of the fish farms (2) compute and compare indices of yield performance in the two sets of farms and (3) identify the constraints encountered by farmers in the two locations.

MATERIALS AND METHODS

Study Area and Sampling Technique

The study was carried out in Southwest, Nigeria. Multi-stage sampling technique was used in collecting the data analyzed in this study. Two out of the six states that make up Southwest, Nigeria; Ondo and Ogun States, were purposively selected on the basis of having the highest aquaculture production figures. Four (4) Local Government Areas (LGAs), two from each state, were also purposively selected for having both upland and mangrove communities with exploitable fishing grounds. The two LGAs selected from Ogun State were Ijebu Waterside and Ijebu East while Ilaje and Ese-Odo LGAs were selected from Ondo State. From a list of registered commercial fish farms got from the Agricultural Development Programme (ADP) offices in the two states, thirty (30) and fifteen (15) commercial fish farms from the upland and mangrove areas were systematically selected.

Data and Data Collection

A well-structured questionnaire was used to obtain information on characteristics and management of fish farms, fish species cultured and items of costs and returns on the production process between years 2002 and 2006. Farm records of the farms surveyed were also made available to the data collectors. The fixed costs incurred in production were calculated as annual cost or rental values of fixed items. The depreciated cost (obtained through the straight-line method) represents annual lost in value of the facilities and equipment arising from wear and tear. The expected useful life (in years) of fixed items are indicated as follows: fish pond (20), boat/canoe (10), net (5), wheel-barrow (5), bowl (5), refrigerator/pumping machine (10), weighing scale (10), outboard engine (10), farm building (25) and hatchery (10). Copies of a set of questionnaires were administered to the owners or farm managers of the farms surveyed. The questionnaire was earlier pre-tested on fish farmers in the riverine areas of Irele and Ado-Odo/ Ota LGAs of Ondo and Ogun States respectively. In all, forty-five (45) fish farmers provided the data analyzed in this study.

Analytical Techniques

The data collected were analyzed using descriptive statistics which included frequency counts, percentages and tables. The budgetary model was used to determine the level of profit generated. The budgetary analysis was first carried out for all the five years (2002-2006) pooled together and then on a year-by-year basis. From the results of the yearly budgetary analysis, certain ratios of profitability and efficiency were obtained. These are:

i) Operating Ratio (OR) TVC/ GR (1)

ii) Returns on Sales (ROS) NP/GR (2)

iii) Returns on Assets (ROA) GM/ TCA (3)

Where TVC = Total Variable Cost, GR= Gross Revenue, NP = Net Profit, GM = Gross Margin and TCA = Total Cost of Assets.

The combined cash flow and sensitivity analysis was done to ascertain the extent of profitability of the aquaculture business and the factor(s) to which profitability is responsive. The profitability indicators used to measure the extent of returns from aquaculture are:

i) Benefit-Cost Ratio (B/C): This is the ratio of discounted costs to discounted revenue. A B/C of greater than unity is desirable for a business to qualify as a good one. Mathematically, B/C is stated as:

$$B/C=\frac{\sum_{t=1}^{n}\frac{Bt}{(1+r)^n}}{\sum_{t=1}^{n}\frac{Ct}{(1+r)^n}} \quad (4)$$

where

Bt = benefit in each project year
Ct = cost in each project year
n = number of years
r = interest or discount rate

ii) Net Present Value (NPV): This is the value today of a surplus that a project makes over and above what it would make by investing at its marginal rate. Alternatively, it is defined as the value today of all streams of income which a project is to make in future. For a good business, NPV must be positive at the chosen discount factor. Mathematically, NPV is given as:

$$NPV = \sum_{t=1}^{n} \frac{Bt - Ct}{(1+r)^n} \quad (5)$$

Where B_t, C_t, n and r are as earlier defined.

iii) Internal Rate of Return (IRR): It is the rate of return that is being expected on capital tied down after allowing for recoupment of the initial capital. The IRR is the rate of interest which equates the NPV of the projected series of cash flow payments to zero. It is also called the yield of an investment. Mathematically, it is given as:

$$IRR = \sum_{t=1}^{n} \frac{Bt - Ct}{(1+r)^n} = 0 \quad (6)$$

Practically, the IRR is usually obtained through a series of manipulations where two discount factors give rise to two NPVs. The NPV must be positive at the lower discount factor and negative at the higher discount factor indicating that the project can earn higher than the lower discount factor and lower than the higher discount factor. In this trial and error method, according to Adegeye and Dittoh (1985), the IRR is given as:

$$IRR = \overset{\text{lower discount}}{rate} + \overset{\text{difference between the two}}{\text{discount rates}} \left(\frac{NPV \text{ at lower discount rate}}{\text{absolute difference between the two NPVs}} \right) \quad (7)$$

RESULTS AND DISCUSSION

Operational and Farm Characteristics

The total farm size (area covered by fish ponds) of the 30 upland farms was 332,558m^2 while the total number of pond units was 168. Therefore, the average size of an upland fishpond was 1978m^2. The total size of the 15 mangrove farms was 1,226,575m^2 and the number of fishpond units was 154 giving an average size of 7,965m^2. Thus, fishponds have bigger sizes in the mangrove areas. The two possible reasons for this finding are that land is relatively cheaper in the mangrove areas and also that most mangrove farmers use the polyculture method while majority of upland farmers, use the monoculture method. About 96.0% and 68.2% of upland and mangrove farmers respectively, were engaged in purely table fish production while the balance in each case combined table fish with fingerlings/post-fingerlings (jumpers) production. The higher proportion of mangrove farmers combining both table fish and fish seeds production compared with the upland farms is probably owing to the presence of larger water bodies from which seeds of spawning fish can be harvested and further reared to jumpers before being used to stock ponds. This is a saving on cost of inputs but has a negative effect on capture fisheries since the fingerlings are the ones expected to grow into table fish in the natural water bodies (Touminen and Esmark, 2003).

Majority (60.0%) of the farmers procures their fish seeds from the wild (Table 1). According to the farmers interviewed, the natural source of fish seeds is cheaper and more readily available. The farmers in the upland parts contract out fish seeds procurement to people to whom they give part payment to facilitate timely delivery. Alternatively, fish farms sometimes assign that duty to some of their workers if they have enough workforce. In comparison, some workers of mangrove farms have fish seeds procurement as their major responsibility. They harvest fish seeds of various fish during the spawning seasons. Such harvested seed stocks are furthered reared in a special pond. During this period, stunted, deformed and unhealthy seed stocks are removed and the remaining used for stocking fish ponds. A higher proportion of mangrove farmers got their fish seeds from the wild. Procuring fish seeds from the wild by most mangrove farmers and some upland farmers, is an economic response to the problem of acute shortage of high quality fingerlings from government or private hatchery which is capable of crippling production. They claimed that where fish seeds produced in modern hatcheries are available, the cost is prohibitive more so because of the transportation cost incurred. Thus, despite the fact that farmers using fish seeds from the wild are aware of the negative impact of their action on yield from capture fisheries, they asserted that they will continue to use this source until there is an alternative arrangement that is acceptable to them. There had also been frequent bloody clashes between fish seeds harvesters and capture fisheries fisher folks in the study area. This means that an urgent alternative has to be found to procuring fish seeds from the wild if the problem of threatened stocks of wild fish reported by FAO (1995, 1998 and 2000) is not to be further compounded in Nigeria.

From Table 1, it is obvious that about 88.9% of farmers depend on the wild for their fish seeds. Only about 6.7% and 4.4% of farmers procure their fish seeds from own modern hatchery and government-owned hatchery. There is a need to re-orientate farmers away from using fish seeds from the wild to stock their fishponds. Most of the farmers which depend on the wild indicated that they would have preferred seed stocks from specialized private or public hatcheries because of their high quality if the prices can be reduced and if some hatcheries can be sited close to them.

Fish Species Cultured

The species commonly reared in the upland farms were Tilapia, Alestes, Heterotis and Catfish and these fish species were raised by over 70.0% of the farmers. The other fish species which are reared but not as frequently as the above species are Mudfish, Heterobranchus, Ophiocephalus, Aeroplane fish and Mormyrus. These species were reared by less than 25.0% of the sample farms. The reasons given for preference for the most popularly cultured species include (1) ease of procurement and high rates of survival of the seeds (2) easy culturing (3) fast growth and reproductive rates when supplementary feeding is practised (4) high yield and (5) high demand and price in the study area. In the mangrove farms, however, the commonest fish species reared in order of frequency are Alestes (78.13%), Tilapia (60.75%), Gymnarchus (56.25%) and Heterotis (46.88%). Other fish species were Catfish, Aeroplane fish and Ophiocephalus. Only about 30.0% of the sample mangrove farms had these fish species reared in them.

Cost Component Analysis for Fish Farms

In both farm situations, the single most expensive item of variable cost was fish feeds. It accounted for 51.43% of variable cost in upland farms and 57.79% in the mangrove farms. This difference is probably owing to the astuteness of the upland farmers who formed small groups of 5-10 and pooled their money together to buy fish feeds directly from feed milling companies whereas most mangrove farmers bought their feeds from the dealers in the headquarters of their LGAs. Travelling long distances to the headquarters of their LGAs to buy small quantities of feeds, each time they run out of stock, leads to increased transportation cost. Added together, seed stocks and fish feeds accounted for 68.73% and 69.67% of variable cost in the upland and mangrove farms respectively. This high proportion

Table 1: Distribution of Farmers by Source of Fish Seeds

Source of Fingerlings	Frequency	Percentage
From wild	27	60.00
From own modern hatchery	03	6.67
From other farmers rearing	13	28.89
wild fish seeds	02	4.44
From government hatchery	45	100.00
Total		

Source: Survey data, 2007

Table 2: Fixed and Variable Cost for One-Hectare Upland and Mangrove Fish Farms

Fixed Items	Upland Farms		Mangrove Farms	
	($)%	Composition	($)%	Composition
Land	335.54	4.10	120.36	1.10
Pond construction	872.41	10.67	875.57	8.08
Farm buildings	374.58	4.58	202.85	1.86
Vehicles + boats	979.64	11.98	1,761.66	16.18
Nets	183.54	2.25	624.54	5.74
Boreholes + Water pumps	1,814.98	22.53	1,103.20	10.13
Wheel Barrow + Basins	96.64	1.18	116.65	1.07
Generators/Deep freezers/ Weighing Scale	35.98	0.04	344.37	3.16
Local hatchery + Fencing materials	35.10	0.43	483.12	4.44
Labour (permanent)	3,419.83	41.83	5,252.95	48.24
Sub-total	**8,175.23**	**100.00**	**10,890.00**	**100.00**
Variable Items				
Fingerlings & Jumpers	5,721.47	17.30	3,549.06	11.88
Fish feeds	17,012.70	51.43	17,264.76	57.79
Fertilizer + Other Chemicals	8,740.02	2.64	1,614.42	5.40
Transportation + Fuelling	4,352.90	13.16	3,797.43	12.71
Repairs + Maintenance	3,034.72	9.18	2,479.21	8.30
Casual labour	2,081.96	6.29	1,171.51	3.92
Sub-total	**33,078.49**	**100.00**	**29,876.39**	**100.00**

Source: Survey data, 2007.
Note: For the period covered by the data used for this study, the average exchange rate was N127= $1 while the value fluctuated between N125 and N129.

accounted for by seed stocks and fish feeds as items of variable expenses is in accordance with the findings by Zadek (1984), Inoni, (1992) and Mafimisebi, (2003) that cost of feeds and seed stocks accounted for more than 50.0% of total production cost in aquaculture (Table 2).

The depreciated average fixed cost, per hectare of upland fish farm was $8,175.23 in the five years covered by the study. The corresponding value for the mangrove farm was $10,890.00. The depreciated cost of pond construction and vehicle/boats carried 10.67% and 11.98% respectively in the upland farms while the same items accounted for 8.08% and 16.18% respectively in the mangrove farms. The cost of pond construction was higher in the mangrove farms because the mangrove species have had to be cleared first before pond construction proper begins. Not only that, the problem of pond edge stabilization gulps a lot of money compared with upland ponds. This is more so because fish pond construction in the mangrove areas involves putting special structures in place to prevent escape of fish into the wild during slight or excessive flood. Table 2 also shows that land is cheaper in the mangrove areas. However, the cheap cost of land as an item of fixed cost is eroded by the heavy expense on pond construction in the mangrove parts.

For the two farms, labour was the single most expensive item of fixed cost. While labour accounted for 41.83% of fixed cost in the upland farms, the value for the mangrove farms was 48.24%. Also revealed in Table 2 is the fact that seed stocks constituted about 17.00% of variable cost in the upland farms while the corresponding value in the mangrove farms was 12.00%. This is attributable to the fact that more upland farmers than mangrove farmers procured seed stocks from sophisticated private and public hatcheries. The seed stocks bought from such hatcheries were more expensive than the ones bought from local hatcheries.

Gross Revenue

Gross Revenue (GR) is the amount realized from sale of table fish, fingerlings and jumpers. However, because revenue from sales of fingerlings and jumpers is negligible, only revenue from table fish production is considered in this study. The information on GR from the various fish species cultured is provided in tables 3 and 4.

While the upland farms made net revenue of $87,171.39 per hectare for the period studied, the mangrove farms got $81,446.06 per hectare for the same period. Therefore the average net profit per hectare per year was $9,183.53 and $8,135.93 in the upland and mangrove farms respectively. Table 3 shows that in the upland parts, Heterotis contributed the highest proportion of GR followed by Gymnarchus and Alestes while Ophiocephalus, Heterobranchus and Mormyrus together amounted to just about one-fifth of GR. It can thus be concluded that Heterotis, Gymnarchus and Alestes were the major commercial species cultured in the upland areas. Table 4 showed that Alestes accounted for the highest proportion of GR followed by Heterotis, Gymnarchus and Tilapia, in that order in the mangrove farms. Catfish, Ophiocephalus and Aeroplane fish contributed less than one-fifth of GR. The major commercial species in the mangrove parts were Alestes, Heterotis, Gymnarchus and Tilapia

For both farms, there was positive net revenue indicating that aquaculture is operating at a profit in the two locations. This finding of positive net revenue in the mangrove farms contradicts earlier findings by Inoni (1993), Falusi (2005) and Zadek (1984) that mangrove farms in Delta and Ogun States, Nigeria and Port Said, Egypt respectively, sustained losses during an operational period of between 1987 and 2003.

Profitability and Efficiency Ratios

The year-by-year results of the budgetary analysis are shown in Table 5. From the values given in the table, profitability ratios that enabled us to arrive at a conclusion as to the efficiency of operation of the two fish farms, were calculated.

The data presented in Table 6 showed the profitability ratios by year of the two sets of farms. A decrease in OR over time is an indication of a good and efficient business. A decline in OR in the study indicates either increasing TR

Table 3: Gross Revenue on a One-Hectare Upland Farm

Fixed Items	Gross Revenue per year ($)					
	2002	2003	2004	2005	2006	Total 2002-2006
Heterotis	4,336.18	4,711.20	4,701.75	5,475.05	6,544.36	25,768.54
Gymnarchus	3,869.69	3,710.66	4,152.84	4,475.54	5,565.61	21,774.34
Alestes	2,543.66	1,687.22	3,150.56	3,799.76	4,302.56	15,483.76
Tilapia	1,146.18	1,100.48	1,425.83	1,297.55	1,333.61	6,309.38
Catfish	905.79	1,020.44	1,267.51	1,529.09	1,705.11	6,427.94
Heterobranchus	735.33	821.90	1,170.59	1,261.75	1,604.48	5,594.05
Mudfish	248.05	185.26	321.26	401.57	354.33	1,510.47
Ophicephalus	659.29	584.21	818.12	924.16	1,314.05	4,299.83
Mormyrus	0.44	0.32	0.57	0.69	1.06	3.07
Total	**14,444.61**	**13,821.70**	**17,014.75**	**19,165.17**	**22,725.17**	**87,171.39**

Source: Survey data, 2007.

Table 4: Gross Revenue on a One-Hectare Mangrove Farm

Fixed Items	Gross Revenue per year ($)					
	2002	2003	2004	2005	2006	Total 2002-2006
Heterotis	3,032.48	2,869.13	3,618.94	3,834.44	4,466.87	17,821.87
Gymnarchus	2818.32	2,583.13	3,276.63	3,784.87	3,961.48	16,424.43
Alestes	3,830.15	3,520.86	4,125.83	4,821.94	5,624.02	21,922.80
Tilapia	1,926.61	1,637.28	2,191.20	2,792.60	3,065.33	11,613.02
Catfish	1,529.54	1,338.63	1,710.50	1,993.95	2,487.39	9,060.16
Ophiocephalus	733.53	618.66	867.52	1,009.74	1,321.36	4,550.81
Aeroplane fish	6.90	6.02	9.63	14.01	16.56	53.11
Total	**13,877.53**	**12,573.72**	**15,800.24**	**18,251.54**	**20,943.02**	**81,446.06**

Source: Survey data, 2007.

Table 5: Year by Year Budgetary Analysis of a One-Hectare Farm

	Total Variable Cost ($)		Gross Revenue ($)		Gross Margin ($)		Net Profit ($)	
Year	Upland	Mangrove	Upland	Mangrove	Upland	Mangrove	Upland	Mangrove
2002	6,456.50	5,795.91	14,365.83	13,877.53	7,988.07	8,081.17	7,608.72	6,931.37
2003	5,481.22	5,090.61	13,821.70	12,573.72	8,340.48	7,483.11	7,280.60	6,280.16
2004	5,244.86	4,612.34	17,014.75	15,800.24	11,769.89	11,187.90	8,962.55	7,891.71
2005	7,272.51	6,695.12	19,165.17	18,251.54	11,892.66	11,556.44	10,095.28	9,116.05
2006	8,623.40	7,682.41	22,725.16	20,943.02	14,101.76	13,260.62	11,970.52	10,460.36

Source: Survey data.

Table 6: Profitability and Efficiency Ratios for a One-Hectare Farm

Operating ratios			Return on sales		Return on sales	
Year	Upland	Mangrove	Upland	Mangrove	Upland	Mangrove
2002	0.447	0.418	0.527	0.499	1.680	1.434
2003	0.397	0.405	0.527	0.499	1.754	1.327
2004	0.308	0.292	0.527	0.499	2.475	1.985
2005	0.379	0.367	0.527	0.499	2.501	2.050
2006	0.379	0.367	0.527	0.499	2.965	2.352
Average	**0.382**	**0.370**	**0.527**	**0.499**	**2.275**	**1.830**

Source: Survey data.

or decreasing TVC. For the upland farms, OR was 0.447 in 2002 which decreased to 0.397 and 0.308 in 2003 and 2004. The value took an upward turn to 0.379 which was maintained in 2006. The same pattern was observed in the mangrove farms. OR fell from 0.418 in 2002 to 0.405 and 0.292 in 2003 and 2004 respectively but picked up to 0.367 in 2005 which remained same in 2006. For the period studied, average OR was 0.382 in the upland farms and 0.370 in the mangrove farms. Judging by these ratios, the mangrove farms seemed to promise a better efficiency in future years as OR was falling faster than in the upland farms. The increase in OR in years 2005 and 2006 on both farms is clearly not a desirable situation. The farmers must do all that is possible to achieve a consistently decreasing OR. This can be achieved by a more efficient use of farm resources. For example, feeding fish beyond a stipulated market weight should be avoided as the rate of growth slows down compared with the quantity of feeds consumed. Also, farmers should explore avenues for wider market outlets so that mature fish can be promptly disposed off. This scenario will lead either to a decreasing TVC or an increase in TR which will depress OR.

An increasing return on sales over time indicates a stable, profitable and efficient business. Return on sales was constant in the period studied on both farms. It was 0.527 for the upland farms and 0.499 for the mangrove farms. Fish farmers in both farm locations need to take steps to ensure an increasing return on sales.

The indication that assets are being more increasingly utilized is increasing returns on assets. On the upland farms, there was an increasing trend of returns to assets from 2002 to 2005 but there was a fall in the value in 2006. On the mangrove farms, the trend in returns on assets was towards an increase except in years 2003 and 2006 in which the figures fell below the year preceding them.

Combined Cash Flow and Sensitivity Analysis

Some assumptions were necessary in carrying out this analysis. These assumptions are as follows:

(1) The average bank lending rate to agriculture in the thirteen (13) years covered by the analysis is 25.0%.

(2) A risk-discounted factor of 5.0% is added to the bank lending rate meaning that a discount factor (DF) of 30% is used.

(3) There is a 20.0% and 10.0% projected annual increase in variable cost and unit price of fish between 2006 and 2014. This is in accordance with the farm management maxim which says it is better to be optimistic about cost rise and pessimistic about revenue increase in the estimation of future profitability of a business (Adesimi, 1985).

The result of the combined cash flow and sensitivity analysis for the upland and mangrove farms are shown in Tables 7 and 8 respectively. The results indicate that aquaculture is profitable at both locations at the assumed bank lending rate in spite of prices of key production inputs rising faster than output price. For the upland farms, the NPV stood at $10,887.24, the B/C was 1.28 and IRR was 48.55%. The corresponding values for the mangrove farms were $10,375.84, 1.29 and 48.51%. Thus, the results are comparable and do not show any considerable difference in yield performance between the two types of farms. While at the assumed bank lending rate, the upland farms would return $0.19 for every $0.79 invested, the farms located in the mangrove areas will also return approximately $0.19.

Constraints to Upland and Mangrove Fish Farming

Fish farmers in the two farm locations were asked to rank the constraints identified in their business. The problems encountered by the mangrove farmers in rank order were (1) financial constraints; (2) high and rising cost of feeds; (3) flooding which leads to total loss of investment whenever it happens as fish escape into the wild. Numerous studies have named potentially negative effects of escaped farmed fish on wild populations (Naylor *et al.,* 2000); (4) silting up of ponds which result in massive death of cultured fish; (5) pests which include snakes, water-dogs and piscivorous birds; (6) attack by capture fishermen during sourcing of fish seeds from wild; (7) water pollution and (8) inadequate access to extension services. Only about 30% of mangrove farmers had had a contact with extension agents since commencement of business.

The problems commonly encountered by farmers in the upland areas were (1) financial constraints occasioned by high running costs; (2) drying up of ponds owing to seepage of water through dykes; (3) massive loss of fish owing to polluted or high-temperature water; (4) scarcity of high quality seed stocks and (5) problems of

Table 7: Cash Flow and Sensitivity Analysis for a One-Hectare Upland Farm (2002-2014)

Year	Cost ($)	Revenue ($)	Incremental Benefit ($)	DF 30%	NPV 30% ($)	DF 50%	NPV 50% ($)	Discounted Cost ($)	Discounted Revenue ($)
2001	21,774.18	-	-21,774.18	0.769	-16,744.35	0.667	-14,523.38	16,744.35	-
2002	6,456.50	14,444.57	7,988.07	0.592	4,728.94	0.444	3,546.71	3,822.25	8,551.19
2003	5,481.22	13,821.70	8,340.48	0.445	3,711.51	0.296	2,468.78	2,439.14	6,150.66
2004	5,244.86	17,014.74	11,769.89	0.350	4,119.46	0.198	2,330.44	1,835.70	5,955.16
2005	7,272.51	19,165.17	11,892.66	0.269	3,199.13	0.132	1,569.83	1,956.30	5,155.43
2006	8,623.40	22,725.17	14,101.76	0.207	2,919.06	0.088	1,240.96	1,785.04	4,704.11
2007	10,348.08	24,997.45	14,649.37	0.159	2,329.25	0.059	864.31	1,645.35	3,974.59
2008	12,417.70	27,497.19	15,079.49	0.123	1,854.78	0.039	588.10	1,527.38	3,382.15
2009	14,901.24	30,246.91	15,345.67	0.094	1,442.49	0.026	398.99	1,400.72	2,843.21
2010	17,881.49	33,271.60	15,390.12	0.073	1,123.48	0.017	261.63	1,305.51	2,428.83
2011	2,142.82	36,598.76	15,140.98	0.056	847.89	0.012	181.69	1,201.64	2,049.53
2012	2,576.11	40,258.64	14,509.30	0.043	623.90	0.008	116.07	1,107.22	1,731.12
2013	30,899.21	44,284.50	13,385.29	0.033	441.71	0.005	66.93	1,019.67	1,461.39
2014	37,079.47	48,712.95	11,633.90	0.025	290.85	0.003	34.90	926.98	1,217.84
					10,888.11		**-854.04**	**38,717.24**	**29,031.78**

Source: Field data and projected figures

Notes: (1) 2001 is the investment year (year zero), so there is no revenue

(2) Costs and Revenues for 2002-2006 are actual flows recorded by the fish farms

(3) Cost and revenues for 2007 – 2014 are projected figures

NPV at 30% = 10,888.11 IRR = 48.55% B/C = 1.28

Table 8: Cash Flow and Sensitivity Analysis for a One-Hectare Mangrove Farm (2002-2014)

Year	Cost ($)	Revenue ($)	Incremental Benefit ($)	DF 30%	NPV 30% ($)	DF 50%	NPV 50% ($)	Discounted Cost ($)	Discounted Revenue ($)
2001	20,898.93	-	-20,898.93	0.769	-16,071.28	0.667	-9,215.18	16,071.28	-
2002	5,795.91	13,877.53	8,081.62	0.592	4,784.32	0.444	3,588.24	3,431.18	8,215.50
2003	5,090.61	12,573.72	7,483.11	0.445	3,329.98	0.296	2,215.00	2,265.32	5,595.30
2004	4,612.34	15,800.24	11,187.90	0.350	3,915.77	0.198	2,215.20	1,614.32	5,530.09
2005	6,695.12	18,251.54	11,556.44	0.269	3,108.68	0.132	1,525.45	1,800.98	4,909.67
2006	7,682.41	20,943.02	13,260.62	0.207	2,744.95	0.088	1,166.93	1,661.12	4,335.21
2007	9,218.73	23,037.33	13,818.44	0.159	2,197.13	0.059	815.29	1,465.80	3,662.93
2008	11,062.67	25,341.06	14,278.39	0.123	1,756.24	0.039	556.82	1,360.71	3,116.95
2009	13,275.20	27,875.16	14,599.96	0.094	1,372.40	0.026	379.60	1,247.87	2620.27
2010	15,930.24	30,662.68	14,732.44	0.073	1,075.47	0.017	250.45	1,162.91	2,238.39
2011	19,116.29	30,662.68	14,612.66	0.056	818.31	0.012	175.35	1,070.51	1,888.82
2012	22,939.55	33,728.95	14,162.30	0.043	608.98	0.008	113.30	986.40	1,595.38
2013	27,527.46	37,101.84	13,284.57	0.033	438.39	0.005	66.42	908.41	1,346.80
2014	33,032.95	40,812.13	11,860.28	0.025	296.51	0.003	35.58	825.82	1,122.33
					10,375.84		**-835.92**	**35,801.77**	**46,177.60**

Source: Field data and projected figures
Note: NPV at 30% =10,375.84 IRR = 48.51% B/C = 1.29

theft which can lead to over-night harvesting of fish ponds with marketable fish if security is not beefed up around ponds. These are the problems that must have solutions proffered to them for the operation of these farmers to be enhanced.

CONCLUSION AND RECOMMENDATIONS

The study explored the operational characteristics of upland and mangrove farms, compared costs and profitability of investment in the two locations and determined the production variables to which profitability is more sensitive. The study also examined the constraints to fish farming in the two locations.

Empirical results show that mangrove farms are about four times bigger in size than the upland farms. Monoculture method was prevalent among mangrove farmers while the upland farmers mostly practised polyculture. The commercial species reared in the study area were Tilapia, Alestes, Heterotis and Gymnarchus while Ophiocephalus, Catfish, Heterobranchus and Mormyrus were the minor commercial species. The depreciated fixed cost in the upland farms was lower than that of the mangrove farms. However, the level of variable cost in the upland farms was greater than that of the mangrove farms. In both farms, the cost of labour was the single most expensive item of variable cost. G.R per hectare was comparable in the two farm situations but slightly higher in the upland farms. Profitability ratios which indicate efficiency did not show any considerable difference in the yield of investment from the two farm locations. The result from the combined cash flow and sensitivity analysis shows that investment in aquaculture is profitable at both farm locations. All performance indicators show that profitability is not different between farms in the two locations to justify the avid preference for the upland locations in the siting of fish farms in the coastal areas of Southwest, Nigeria.

The magnitude of cost involved in establishing and managing a fish farm is clearly beyond that affordable by a peasant farmer. Investible funds in form of loans should be made available to prospective investors wishing to site their farms in the mangrove areas at affordable interest rate. The study has shown that fish farmers can repay loans advanced to them conveniently if given a moratorium of two years.

There is also the need to encourage investors in hatcheries to produce fish seeds for use by fish farmers especially in the mangrove areas where majority of the farmers depend on the wild for their fish seeds. Once the government has succeeded in attracting investors in hatcheries to the mangrove areas, a campaign against the use of fish seeds from the wild in the study area should be launched. As soon as the hatcheries can produce enough seed stocks to satisfy all identified fish farmers, the practice of procuring fish seeds from the wild should be banned. This is a matter of priority if yield from aquaculture is to be increased and natural fisheries resources conserved. Finally, since the level of capital investment for establishing fish farms is very high, the government can subsidize cost of fish feeds for new investors in the mangrove areas only in the first year of operation. This may serve to attract investors into the area so that the vast mangrove land can be put to productive use. There is also the need to step-up extension visits to fish farmers.

It is also recommended that farmers in the mangrove areas take policy with the Nigerian Agricultural Insurance Company so that they can be indemnified if there is loss of investment from fish escapes during periods of excessive flood.

All performance indicators show that profitability is not different between farms in the two locations to justify the bias against the mangrove areas in the siting of fish farms in the coastal areas of Southwest, Nigeria. Solving some of the identified problems of fish farmers in both locations is a step towards cheap and affordable animal protein production especially in the vast mangrove areas with its hydrographic characteristics.

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