

# JOURNAL OF ECONOMIC & FINANCIAL STUDIES

A publication of Department of Economics, Banking and Finance  
Adekunle Ajasin University (AAU), Akungba Akoko, Ondo State, Nigeria.

VOL. 1. NO 1 JUNE, 2004

## ECONOMICS OF FISH FARMING IN TRANSITION ECONOMY: EMPIRICAL EVIDENCE WITH MICRO LEVEL DATA FROM NIGERIA.

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### ABSTRACT

*Fish farming is a relatively new investment area in Nigeria as compared to other agricultural activities. However, reports on its potentials as a lucrative economic portfolio in the country are encouraging. This research was therefore designed to investigate the economics of this enterprise in Akwa Ibom State with Etinan and Nsit Ubium Local Government Areas as a case study. It was found that small-scale farming dominates fish farming business in the state, tilapia yields the highest average output per hectare under monoculture while tilapia/heterobronchus/claris combination yielded the highest output under polyculture. The quantity of feed, number of fingerlings and farm size were found to be positively affected by fish output. The results also show efficiency in small farm size. The findings call for adequate and timely provision of these important inputs in order to enhance the contribution of fish from this source to the populace. But with these problems yet to be solved, it could be reasonable if farmers limit themselves to small farm size and the species combination found to yield high. This is to obtain efficiency in production with available resources.*

**Key Words:** *Fish farming, economics, species, farm size.*

### INTRODUCTION

A study by Delgado reported by IFPRI (2003) predicted that rapidly rising demand for fish, especially in developing countries, will lead to surging production in those countries in the next two decades. The study predicted that the demand for fish would be met in large part by aquaculture, since many wild fisheries are already overfished and large-scale commercialization of the fishing industry is likely. However, the artisanal fishermen dominate the fisheries in many developing countries. These fishermen, in the main, use small boats, crafts and other simple gears in their operations. In these countries, there is growing demand for fish as a source of protein and raw materials for industries. Reports on trends in the supply and demand for fish show a widening gap between production and consumption. According to Philippines-based International Center for Living

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Aquatic Resources Management (ICLARM) cited by Wilson (2001) the global marine and inland catch from natural stocks declined from the 1989 peak of about 89million tons to 85million tons in 1993. The report adds that despite a rebound to 90million tons in 1994 and 1995, all indications are that the global catch will not resume the fairly steady production increase that marked the periods from the 1940s to the 1980s. The United Nations Food and Agriculture Organization (FAO) estimates that almost 70% of those stocks of marine fish were fully exploited, overfished, or otherwise in urgent need of management. This description also depicts the situation in Nigeria. The bulk of fish production in the Country comes from the artisanal fishery. Ekpo and Etim (1989), confirming this, who reported that more than 90% of the total fish catch in Nigeria is from the artisanal fisheries sub-sector. The country's total fish consumption estimate for 1990 was put at 2.58million metric tons while domestic production according to current practices is estimated at 0.77million metric tons {Fisheries Society of Nigeria (FISON, 1983)}. Wilson (2001) suggests that with the depletion of the natural stocks and the fast growth in the global population, the world will need to further expand aquaculture to make up for the lost food and income supply to the poor. In Nigeria, government had responded to the decline in fish production through a variety of fisheries development programmes. Such efforts are supported by international development agencies like IFAD, etc.

Nigeria and indeed Akwa Ibom State is a relatively newcomer to aquaculture compares with most Asian countries. In Akwa Ibom State in particular attempts at developing fish farming is recent and had resulted in the establishment of private/government fish farms. Total hectare of functional fish pond has increased due to increase awareness of fish farming development from seminars and workshops mounted by the then Directorate for Food, Road and Rural Infrastructure (DFRRI), (Uzoukwu, 1990).

Studies, however, reveal that any part of the county can support fish farming development (Udoh, 1990). This supports Delgado's prediction of the possibility of fish production being largely supplemented by aquaculture. Therefore, fish farming enterprise can be a good means of increasing local production of fish so as to meet demand. Nevertheless, the hope that fish farming could be practiced on a sustainable basis depends on its profitability. Research findings indicate that economic or profitability of fish culture is a function of fish species cultured, growth rate, locality of culture, cost of materials and labour, level of management and access to market (DFRRI, 1988; Bell, 1976 and Moses, 1983). Akpan (1973) noted that tilapia species under management and intensive care could give yields of 1813.4kg per hectare. Equally, the Technical Center for Agricultural and Rural Cooperation (CTA 1992) reported yields of 50-200kg in unfertilized, poorly managed ponds whereas ponds which benefit from agricultural waste feeding and stock

management yield 5000-10,000kg/ha/year. The possibility of incorporating other agricultural activities into fish farming makes the enterprise even more appealing. Such diversification would ensure the availability of fish and other foods for the family and income for the farmer. However, all those factors that can make for the profitability or otherwise of fish farming venture are subject to the influence of both macro- economics and micro-economics policies of the country that it is operated. Policies have kept changing in many developing countries. Some of these changes are dictated by local national circumstances. Others are by the global economic direction.

In 1986, Nigeria adopted the structural adjustment programme, which had as one of its objectives, the liberalization of the country's trade and payment system. This was to be achieved through a plethora of fiscal, monetary, trade and exchange and other institutional policy instruments. These policies have tended to move the economy from an administratively controlled to an open one. The implementation of SAP policies has been reinvigorated with the current wave of globalization, which is going through both developed, and developing countries. Transition institutions such as Bureau of Public Enterprise (BPE) are established to see to the transition of hitherto public concerns to private enterprises. While many of the public enterprises were subsidized by the government whereas private enterprise's effort are geared towards profit making. These changes are likely to have effect on prices of inputs as well as output. This transition poses a host of uncertainties for users of fisheries, consumers and management institutions. It also provides opportunities because even small actions could have important effects. However, such effects could be assumed to vary from one industry or firm to another. The variation could be determined by the relationship existing between the production variables and the economic parameter e.g. prices. It is therefore, plausible to assess the economics of fish farming – a seemingly promising portfolio, especially in a transition economy like Nigeria. The objectives of this study are:

- (i) To assess fish production per farm size and species;
- (ii) To assess the influence of various inputs on the total fish output and;
- (iii) To determine factor intensity in fish farming in the study area.

Results from this study would be useful to policy makers and fish farmers alike in planning for the optimum farm size, best species combination and appropriate levels of inputs to employ in order to obtain maximum output per least cost.

#### Research Methods:

**The study Area and Data Collection:** The study was conducted in Etinan and Nsit Ubium Local Government Areas of Akwa Ibom State. The areas are located in the

hinterland with few streams and creeks which neither support reasonable artisanal nor industrial fishing. However they contain the largest hectareage of fish pond showing that it can support fish farming development (Uzoukwu, 1990). A survey of fish farmer in the area was carried out in October through December 2000. Data were obtained from 50 fish farmers using structured questionnaire.

### Methods of Analysis:

Apart from the use of summary statistics, the main tool of analysis in this study is the multiple regression, which facilitated the determination of the effects of the inputs on fish output. Four functional forms were tried for exploratory purposes. These include the linear, semi-log, double-log and exponential functions. The double-log was chosen as the lead equation based on economic, econometric and statistical criteria. The implicit form of the function is specified thus:

$$Q = b_0FE^{b_1}FI^{b_2}FS^{b_3}$$

The linearized form of the equation is:

$$\text{Log } Q = b_0 + b_1 \text{Log}FE + b_2 \text{Log}FI + b_3 \text{Log}FS + e_i$$

Where:

- Q = Fish output in kilogramme (kg)
- FE = Quantity of feed in Kg
- FI = Number of fingerlings stocked
- FS = Farm size in hectares (ha)
- E<sub>i</sub> = Error term.

### Factor Intensity:

Factor intensity was measured by the ratio of coefficient eg.  $B_1/b_2$ . From our example the higher the ratio, the more feed intensive aquaculture production. Similarly, the lower the ratio of  $b_1/b_2$ , the less feed intensive aquaculture production. Efforts were also made to compute the returns to scale in fish farming in the study area. This was measured as the sum of the coefficients ( $b_1 + b_2 + b_3$ ).

$$\text{Return to scale} = E(dy/dx)(x_i/y), \quad i = 1, 2, 3$$

Applying this to equation (4), we obtain

$$\begin{aligned} \text{Return to scale} &= b_1 + b_2 + b_3 \\ &= \sum E b_i, \quad i = 1, 2, 3. \end{aligned}$$

Thus, the summation of the powers of all the input variables provides us directly with a ready estimate of returns to scale as well as the degree of homogeneity of the

production function. For a homogeneous production function, the scale economies may be less than equal to or greater than unity, but for a given function, the return to scale are invariant with respect to initial input levels and are equal to the sum of the production elasticity. Frisesh (1965) and Ferguson (1969) have established that even for non-homogeneous functions, the returns to scale are equal to the sum of elasticity of production with respect to the different inputs. Thus, for the power function, - a non-linear production function, the returns to scale are invariant with input levels.

## RESULTS AND DISCUSSION

### Farm Size and Fish Output:

The result data in table 1 presents the fish output by farm size. Sizeable variation existing in the quantity of fish produced in each of the farm size groups. The result reveals economic efficiency in small farms as the average per hectare production tends to decrease with size. The model farm size is 0.5 hectares or less. This confirms earlier assertion by researchers that small-scale farmers dominate farming in Nigeria. The largest farm size group of 1.6 – 2.0 hectares has the least number of respondents and invariably the smallest total fish output. This may not be unconnected with the land tenure systems practiced in the study area which lead to land fragmentation thus making owning of large farm size rather difficult. The fact of low output as farm size increases indicates under capacity utilization. Over the survey period, discussions with farmers revealed two important problems. These are inadequate feed and fingerlings. The shortage of these two important inputs could as well be responsible for the low capacity utilization of the fishponds. This situation makes it rather difficult to determine the optimum feeding and stocking rate for maximum yield in the study area.

### Species Combination and Fish Production:

The results of fish production by species combination are presented in table 2. Fish species commonly cultured include tilapia, heterobranchus and clarias. The farmers equally practice both monoculture and polyculture. The striking feature of the information contained in the table is that production per species combination remains high in small farms. Interestingly, tilapia gave the highest output at farm size 0.60 – 1.0 hectare while tilapia / heterobranchus/clarias (THC) combination yields the highest output of 6200kg/annum under farm size of 1.50 ha, which falls within the range reported by CTA (1992). Tilapia is known to breed fast in captivity thereby increasing its population and thus total annual output. THC combination on the other hand comprises fish that occupy different levels in the food chain. While heterobranchus and clarias are bottom feeders, tilapia is a shallow

feeder. Thus, there is likelihood of efficient utilization of feed at different depths of the pond. In addition, the bottom feeders can also prey on fry of the tilapia which thus ensure availability of food to other species. This type of arrangement could bring about maximum use of feed, space and other resources giving a higher yield as compared with monoculture species.

**Table 1: Fish Production by Farm Size**

Farm size (Ha)	Total Farm Size (Ha)	No. of Farmers	Total quantity produced (Kg)	Average production/hectare(Kg).
< 0.5	7.50 (21.55%)	21(42%)	38427	5118.14
0.6- 1.0	12.86(36.95%)	18(36%)	54763	4258.40
1.1-1.5	10.99(31.58)	9(18%)	31094	2829.30
1.6-2.0	3.45(9.91%)	2(4%)	7710	2234.78
Total	34.80(100%)	50(100%)	131994	3792.06

Source: Field data 2000

**Table 2: Fish Production By Species combination (in kg)**

Pond Size (Ha)	Tilapia	Hetero Branchus	Clarias	Tilapia/hetero-branchus	Tilapia/Clarias	Tilapia/Hetero-branchus/Clarias
< 0.50	3796.00	4612.80	5817.48	5483.87	5317.93	5605.42
0.60-1.0	6794.12	3980.00	2492.75	3909.75	5511.11	4959.46
1.10-1.50	309.90	-	2297.31	2364.46	-	6200.00
1.60-2.0	-	2232.78	-	-	-	-
Mean Production Per ha.	4673.25	3287.28	2916.31	3108.41	5372.27	5646.37

Source: Field data

**Results Of Regression Analysis**

$$\text{Log } Q = 3.2721 - 0.3270\text{LogFE} + 0.3566\text{LogFI} + 0.3171\text{LogFS}$$

(3.8577)\*\*\*      (3.1461)\*\*\*      (1.9671)\*\*\*

$$R^2 = 0.73$$

$$F = 40.42***$$

$$D.W. = 2.16$$

\*\*\* = significant at 1%; \*\* = significant at 5%; values in parenthesis are calculated t-values.

The regression results presented above indicate that all the variables carry the expected signs. The  $R^2$  of 0.73 indicates a high explanatory power of the variables included. The F-statistics is significant at 1% level and the Durbin-Watson statistics (2.16) is within acceptable level. These show that the model is well specified. The results show that quantity of feed (FE) and number of fingerlings (FI) are significant positive explanatory variables of fish output at 1% level while farmsize (FS) is significant at 5% level. All the variables explain 73% of the variability in the quantity of fish produced. However, when the amount of feed, number of fingerlings and farm size enter the system, an additional use of feed will lead to an increase of about 33Kg of fish output; fingerlings, 36Kg and farm size 14kg, *ceteris paribus*.

**Factor Intensity and Return to Scale:**

An examination of factor intensity shows that fish farming in the study area is less feed intensive given that the ratio of the coefficient of feed to fingerlings ( $b_1/b_2$ ) is 0.92, which is less than unity. However, when feed and farm size were compared, fish farming operation was found to be fish fingerling intensive. In the same vein, the ratio of the coefficients of fingerlings and farm size indicates that fish farming is fingerlings intensive. The return to scale in fish farming in the study is decreasing. This is evidence by the value of 0.82, which is less than one. Skankhange (1982) states that the returns to scale are decreasing, constant, or increasing, depending on whether the coefficients is less than, equal to or greater than one.

**Table3: Factor Intensity and Return to Scale in fish farming**

Resource (input)	Coefficients	Factor Intensity
Feed (FE)	0.3270	$b_1/b_2 = 0.92$
Fingerlings (FI)	0.3566	$b_1/b_3 = 2.39$
Farm size (FS)	0.1371	$b_2/b_3 = 2.60$

Return to Scale = 0.82.

### Conclusion and Recommendations

This paper investigated the economics of fish production under culture condition. Results indicate that feed, fingerlings and farm size are influential factors in determining fish output. Tilapia under monoculture and Tilapia/heterobranchus/clarias combination under polyculture gave the highest yield respectively.

That the fish farming enterprise in the study area is dominated by small scale farmers serving as food for thought for policy makers. When this is viewed against the background of urgent need to increase fish supply from other sources due to low rate of increase catch from the Nigerian waters and inadequate meat supplies, it then calls for adequate provision and even distribution of important inputs like feed and fingerlings in order to enhance production from fish culture. This could be done by government or through cooperative efforts of the farmers themselves. The training of fish farmers on the technology of fry production could enhance the availability of fry and fingerlings of various species thereby sustaining farmers' interest in poly-culture and indeed in the fish farming business. Again, there is the need to ensure full implementation of land Use policy to enable enterprising farmers acquire enough land to increase their level of output. In the meantime, with the problems identified in this study still persisting, farmers and potential fish farmers could limit their farm size to within one hectare as there appears to be efficiency in small farm size. Also, farmers should concentrate on tilapia/heterobranchus under poly-culture as this tends to give encouraging yields under the different systems. This way, effort in making fish available to the teeming Nigerian population can be achieved with profitability in the fish farming sub-sector.

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