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Adoption of aquaculture management techniques in Delta State, Nigeria

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Abstract

This study used the sigma method to determine the level of adoption of aquaculture technologies in Delta State. Data was collected from 144 respondents in 8 Local Government Areas of the state by use of guided interview schedule. Percentages, means and multiple regression were used to analyse the data. It was found that 55.6% of the fish farmers adopted concrete ponds and 88.9% adopted polyculture system. On management of the ponds, fertilization, weed control, checking pond leakage and control of pond temperature had adoption scores that ranged from 4.94 to 5.65. Liming and pH check, disease treatment and oxygen level check recorded low adoption scores. Of the nine independent variables, farmers income, education level, contact with extension agents and type of fish pond showed significant contribution to adoption score in a regression analysis. The major constraints to fish farming were high cost of pond construction, difficulty in obtaining micro-credit, expensive fish feed and inadequate fishery extension service. A key aspect of addressing food security problem in Delta State is the promotion of fish farming.

Key words: Concrete ponds, polyculture system, fertilization, weed control, checking pond leakage, control of pond temperature, liming, pH check, disease treatment, oxygen level check, farmers income, education level, contact with extension agents, type of fish pond.

Introduction

There is now an increasing knowledge among Nigerians of the importance of fish as a preferred source of protein supply in human diet. Okorie [11] stated that although fish contain no carbohydrates, they are rich in fat, phosphorus, sulphur, potassium, iron, calcium and copper. The flesh of fish is reported to be more quickly broken up by the gastric juices and remains in the stomach for a shorter period of time than does meat. Fish is known to provide 40% of the protein intake of two-thirds of the world's population [6]. Fish ranks amongst the most superior of protein foods because of its balanced amino acid configuration, digestibility and low cholesterol [2].

Given the high quality protein and quick digestibility rate that fish possess, the demand for fish in human diet grew steadily over the last decade. The increased demand for fish in Nigeria could not be met through only artisanal fishing in coastal and brackish water as well as in inland lakes, rivers and lagoons. This can be attributed to intense fishing pressure arising from increase in number of fishers that greatly reduced fish stocks in the coastal areas [7]. This can also be partly attributed to dwindling fish catches in the Niger Delta area of Nigeria as a result of incessant oil pollution.

Delta State is a traditional fishing enclave, particularly artisanal type, because of its vast coastal areas in the deltaic area of the River Niger in Nigeria. It is endowed with flood plains, rivers, streams, creeks and water reservoirs rich in fresh water fish in addition to those from the maritime waters. In order to boost the supply of fish in our communities, it has become imperative to promote fish production through aquaculture techniques. The need to promote aquaculture and increase domestic fish production is even more necessary given that the proportion of aquaculture fish in the total domestic fish production in Nigeria is quite low.

According to Federal Department of Fisheries [4], in the year 2000, total domestic fish production in Nigeria stood at 467,098 metric tons out of which aquaculture fish accounted for 25,720 mt, representing 5.5% of total domestic fish production. Federal Department of Fisheries [5] reported that in 2003, domestic fish production from aquaculture accounted for only 9.9% with 52,000 mt out of Nigeria's total domestic fish production of 524,706 mt. Aquaculture currently provides employment and additional income for a number of people in Delta State. With increase in population growth, demand for fish and fish products will increase astronomically and it is expedient for more people to get involved in aquaculture development in order to increase its share of total potential annual fish yield and help meet the demand for fish in Delta State. The adoption of aquaculture technologies is one way to boost fish production, improve self sufficiency in fish production and contribute to food security in Delta State.

The realization of the full potentials of aquaculture in Nigeria has been limited by expensive fish feed [10]. Aquaculture in Nigeria enables man to culture his desired fish species. Other advantages of aquaculture include utilization of vast available untapped land and water resources that abound in swamps and burrow pits, reduction of pressure on fishing in natural waters, ease of getting fish from a pond relative to catching fish from the river, obtain healthier fish relatively free of pesticides and additional harmful toxicants, and the control of fish growth through supplementary feeding.

Following the dissemination of information on aquaculture technologies by Delta State Agricultural Development Programme (ADP) over a decade ago, the provision of loans for aquaculture development in Delta State and the activities of non-governmental organisations on fisheries extension which have created awareness on aquaculture technologies, it has become necessary

to examine the level of adoption of aquaculture management techniques in the state. According to Agbamu [1], the economic status, age, scale of production, education level, cosmopoliteness and socio-cultural situation of farmers are possible factors that could affect adoption of innovations. The rate of adoption of innovations differs greatly according to place and circumstances of farmers.

The specific objectives of his study were to: (i) ascertain the level of adoption of aquaculture management techniques; (ii) determine the factors that significantly contribute to adoption of the techniques; (iii) identify the constraints affecting adoption of aquaculture management techniques. The major hypothesis that was tested is: socio-economic characteristics of fish farmers do not significantly contribute to adoption of aquaculture management techniques.

Methodology

Sampling techniques: Area sampling was used to demarcate Delta State into three equal sampling areas: Delta South, Delta Central and Delta North. These areas coincide with the three agricultural zones in the State which has 25 Local Government Areas (LGAs). Delta South Zone has a higher concentration of fish farmers. Using simple random sampling, 4 LGAs (Isoko North, Warri South, Bomadi and Patani) were selected from Delta South, 2 LGAs (Ethiope East and Ughelli North) from Delta Central and 2 LGAs (Oshimili South and Ika South) from Delta North. By random sampling, one town or village was selected from each of the 8 LGAs to give a total of eight towns/villages. They are Ozoro, Ubeji, Bomadi and Patani from Delta South, Eku and Ughelli in Delta Central and Asaba and Agbor from Delta North.

On selection of fisher folks, there were 1025 homestead fisher folks registered with agricultural extension workers of the State ADP; 14% of this sampling frame was selected as sample size for this study. By stratified random sampling 18 fishers were selected from each of the 8 towns/villages to obtain a total of 144 respondents. The stratified random sampling technique ensured representation of different strata of fishers which consist of heads of households, youth farmers, women groups, contact farmers, members of cooperative societies, leaders of fish farmers association and other unclassified fish pond owners.

Method of data collection: Data were collected by administering questionnaires to the fishers and through field observations for 5 months in 2006. Data was collected on adoption of pond construction techniques and stocking method, adoption of pond management and harvesting techniques and socioeconomic characteristics of the fishers. Variables that were measured included adoption score, age, gender, education level, fishing experience, income level, number of fish ponds owned, type of fish ponds owned, contact with extension agents, household size and constraints to adoption of aquaculture technologies.

Adoption score was calculated by using the sigma method of scoring adapted from Jagne and Patel [8] and Agbamu [1]. In sigma method, ordinary frequency numbers or percentages can be standardized by mathematical procedures in order to obtain normalized standard scores before using them in parametric statistical analysis. The percentage of fishers who adopted a given aquaculture practice was first obtained. For example, if 55.6% of the fishers adopted concrete pond, the adoption score is calculated as follows: 100 - (55.6/2) = 72.2. Next, using the statistical table of normal deviates in Edwards[3], 72 in the vertical row under column 2 gives 0.589. To increase the magnitude of this sigma distance using a constant, we have (0.589 + 2)2 = 5.18. Since the sigma method assigns weights in reverse relation on a 10-point scale, actual adoption score will be 10-5.18 which is 4.82.

Contact with agricultural extension agents was measured by asking the fish farmers to indicate how often extension agents in their locality trained and visited them. The extent of contact with extension agents was categorized in accordance with Likert-type scale, namely very often (26 contacts/year), often (12 contacts per year), rarely (3 - 6 contacts/year) and never (zero contact). These categories were assigned scores of 3, 2, 1 and 0 respectively. The frequency distribution of ratings on this Likert-type scale was then obtained. Education level, age, income level, number of ponds owned, fishing experience, type of pond and household size were disaggregated into descriptive levels and assigned weights using Likert-type scale. The frequency distribution of the disaggregated levels for each variable was then obtained from the questionnaire.

Constraint to adoption of the techniques was measured using a three-point Likert-type scale of 0 for not serious, 1 for "serious and 2 for very serious constraints which were attached to a list of constraints" for the fish farmers to rate on any of the three points. The constraints took cognisance of economic, technical, support agency-related and socio-cultural issues.

Data analysis: Having obtained the frequency distribution of ratings on the Likert-type scales for various variables measured, normalized standard scores were then calculated for each disaggregated rating as shown in Table 1 in the case of "contact with extension agents". It is these normalized standard scores that were used in parametric statistical analysis. Percentages and means were used in the analysis of scores for adoption level and constraints to adoption. Constraints with mean score of 1.0 and above were regarded as more important to adoption of the techniques. Regression analysis was used to ascertain the contribution of socioeconomic variables to adoption level of aquaculture management techniques.

Table 1. Standard scores for contact with agricultural extension agents.

Graduation	a Freq. n = 144	b Cum. freq.	c Cum. freq. to midpoint (b/2)	d Cumul. proportion to midpt. c/n	*Z table value	(Z +2)2	** Approx. standard score
Zero contacts/yr (Never)	20	20	10	0.07	-1.48	1.04	1
3-6 contacts/yr (Rarely)	25	45	22.5	0.16	-0.99	2.02	2
12 contacts/yr (Often)	63	108	54	0.38	-0.31	3.38	3
26 contacts/yr (Very often)	36	144	72	0.50	0.00	4.00	4

* Values are obtained from normal probability table, Z. ** Normalized standard scores; a farmer with 26 extension contacts/yr. is therefore given a score of 4

Table 2. Distribution of selected characteristics of respondents.

Characteristic		Freq (n = 144)	Percentage	Cumulative percentage	Mean/Mode
Age	20–29 years	6	4.2	4.2	
	30 – 39 years	54	37.5	41.7	
	40 – 49 years	61	42.4	84.1	
	50 years and above	23	15.9	100.0	41.5 yrs.
Gender	Male	112	77.8	77.8	
	Female	32	22.2	100.0	Male
Educational level	No formal edu. (0)	13	9.0	9.0	
	Adult education (1)	10	7.0	16.0	
	Primary edu. (2)	16	11.1	27.1	
	Secondary edu. (3)	22	15.3	42.2	
	Tertiary edu. (4)	83	57.6	100.0	3.1 points
Household size	1 – 5 persons	42	29.1	29.1	
	6 – 10 persons	74	51.4	80.5	
	11 – 15 persons	23	16.0	96.5	
	16 – 20 persons	5	3.5	100.0	8 persons
Income level per year	₦80,000 – ₦200,000	12	8.3	8.3	
	₦200,001 - ₦320,000	44	30.6	38.9	
	₦320,001 – ₦440,000	18	12.5	51.4	
	₦440,001 – ₦560,000	21	14.6	66.0	
	Above ₦560,000	49	34.0	100.0	₦386,694.4
Fishing experience	1- 5 years	54	37.5	37.5	
	6 – 10 years	70	48.6	56.1	
	11 – 15 years	11	7.6	93.7	
	16 yrs and above	9	6.3	100.0	7.3 years
Contact with exten. agents	26 contacts/year	20	13.8	13.8	
	12 contacts/year	25	17.4	31.2	
	3 – 6 contacts/year	63	43.8	75.0	
	Zero contact/year	36	25.0	100.0	4 contacts/year
Type of fish ponds owned	Earthen pond	64	44.4	44.4	
	Concrete pond	80	55.6	100.0	Concrete pond
No. of fish ponds owned	1 – 4 ponds	102	70.8	70.8	
	5 – 8 ponds	39	27.1	97.9	
	9 – 12 ponds	3	2.1	100.0	3.8 ponds

Results and Discussion

Fish farmers' socioeconomic characteristics: The average age of fish farmers involved in aquaculture in Delta State is 41.5 years, majority of whom are males (Table 2). On the average, their education level is slightly above that of secondary education with a majority (57.6%) having tertiary education. Their household size has an average of 8 persons per household with a low annual income of ₦386,694.40 or $2,974.57 US.

Results in Table 2 revealed that the respondents have an average of over 7 years of fishing experience with 48.6% of them having between 6 to 10 years of fishing experience. It was also found that the fish farmers had a mean of 4 contacts per year with agricultural extension agents and covered 75.7% of the fish farmers. Most of the fish farmers have concrete-type ponds with an average of approximately 4 ponds per fish farmer.

Adoption of aquaculture techniques: The adoption scores of pond construction techniques and stocking method as well as those of pond management and harvesting techniques are presented in Tables 3 and 4. For pond construction techniques and stocking method, concrete pond and polyculture recorded the highest adoption scores of 4.82 and 5.72 respectively, while monoculture and sealing of pond bottom had lowest adoption scores of 2.80 and 4.06 respectively. The respondents have noted that polyculture method of fish rearing enables them to rear fish of different species in the same pond at the same time. As much as 44.4% of the fish farmers use earthen pond and 43.1% adopted appropriate stocking density. It was found that ponds that can normally accommodate 200 fingerlings are usually overstocked with as high as 800 fingerlings.

On pond management and harvesting techniques, supplementary feeding, use of nets for harvesting, repairs of pond leakage, weed control and pond fertilization had high adoption scores that ranged from 5.14 to 6.0. As much as 79.9% of the fish farmers adopted weed control measures that had an adoption score of 5.49. The weed control in pond management enabled sufficient sunlight to penetrate the water and keep the prevalence of predators under check within the pond environment. Disease treatment recorded the lowest adoption score of 3.13. Application of antibiotics along with fish feed is rarely done. Migratory bird perching on ponds, nutritional deficiencies, protozoan, fungal, bacterial, worm and crustacean parasites as well as improper pH status of the water could cause fish diseases. Other techniques that had low adoption scores are oxygen level check (3.28), liming of pond and pH check (4.15) and use of water pump to aid harvesting of fish (4.22).

Constraints to adoption: The constraints to adoption of recommended aquaculture techniques identified by this study are presented in Table 5. High cost of pond construction with a mean score of 1.58 and inadequate fishery extension service with a mean score of 1.31 were found to be the two major important constraints. Other constraints that were found to be important and crucial to adoption of the aquaculture techniques are expensive fish feed (1.11), inadequate credit facilities (1.08) and high cost of fingerlings with a mean score of 1.01. The constraints that were not deemed important by the respondents and which showed the lowest mean scores were water supply problem (0.13), inadequate labour availability (0.24), cultural restriction on given species of fish (0.27) and cost of disease treatment (0.36).

Table 3. Adoption of pond construction techniques and stocking method.

Technique	No. of adopters	% of adopters (n = 144)	Adoption score
Earthen pond	64	44.4	4.47
Concrete pond	80	55.6	4.82
Sealing of pond bottom	48	33.3	4.06
Monoculture	16	11.1	2.80
Polyculture	128	88.9	5.72
Appropriate stocking density	62	43.1	4.43
Total score			26.30
Mean adoption score			4.38

Table 4. Adoption of pond management and harvesting techniques.

Technique	No. of adopters	% of adopters (n = 144)	Adoption score
Fertilization of pond	96	66.7	5.14
Liming of pond and pH check	51	35.4	4.15
Weed control	115	79.9	5.49
Supplementary feeding	144	100.0	6.00
Disease treatment	22	15.3	3.13
Repair of leakages in pond	124	86.1	5.65
Checking pond temperature	86	59.7	4.94
Checking of oxygen content	25	17.4	3.28
Use of hooks for harvesting	78	54.2	4.78
Use of baskets	96	66.7	5.14
Use of net/seine net	131	91.0	5.77
Water pump to aid harvesting	54	37.5	4.22
Total score			57.69
Mean adoption score			4.81

Table 5. Mean scores of constraints to adoption of the techniques.

Constraint	Mean
Inadequate credit facilities	1.08 *
High cost of fingerlings	1.01 *
Water supply problem	0.13
Inadequate land space	0.62
Fish poaching/theft	0.83
High cost of pond construction	1.58 *
Cost of disease treatment	0.36
Inadequate fishery extension service	1.31 *
Cultural restriction on given species	0.27
Expensive fish feed	1.11*
Inadequate labour availability	0.24
Prevalence of fish parasites and predators	0.65
Marketing of fish	0.88
Fingerlings mortality due to poor handling	0.66

*Constraints with mean $\geq$ 1.0 and deemed more important.

Results of regression analysis: The contributions of nine independent variables to adoption of aquaculture techniques were determined by multiple regression. The analysis of the multiple regression is presented in Table 6. The multiple regression coefficient is 0.78, a standard error of 0.12 with an F statistic of 2.08 which is significant at 0.05. All the variables combined explained 61% of the total variation in the adoption scores of the techniques.

Of the nine variables examined, the four variables that made significant contribution at 0.05 to adoption are education level, income level, contact with extension agents and type of fish pond, all of which have positive regression coefficients. It was income level that made the highest contribution (R = 0.72 at p = 0.05) to adoption of aquaculture techniques. This finding is in harmony with that of Ladebo [9] who found that farmers enjoying high income would be expected to be favourably disposed to try out new ideas that would yield them optimum returns. This study has shown that the higher the level of education and the more the extent of contact with agricultural extension agents, the more the fish farmers are likely to adopt aquaculture management techniques. This study also found that fish farmers with better type of ponds are more likely to adopt new techniques.

Table 6. Summary of multiple regression analysis (semi-log model).

Predictor	Regression coefficient	t-ratio	P
Constant	0.821	0.79	0.56
Age, X_1	0.450	1.31	0.14
Gender, X_2	0.084	0.53	0.03
Education level, X_3	0.592	2.41	0.05 *
Household size, X_4	-0.163	-1.11	0.18
Income level, X_5	0.716	1.22	0.05 *
Fishing experience, X_6	0.094	0.41	0.90
Contact with exten.agents, X_7	0.611	2.34	0.03 *
Type of fish pond, X_8	0.523	1.85	0.04 *
No. of ponds owned, X_9	0.260	0.27	0.95 *
Multiple regression coeff.,	R = 0.78	R^2 = 0.61	
Standard error	0.124	F = 2.08 *	

* Significant at 0.05

Conclusions

The profile of the fish farmer in Delta State that emanated from this study is one that is predominantly male and experienced in fishing with an average fisher having up to secondary education, rare access to fishery advisory service and low income. The overall average adoption score stands at 4.59, which in simple terms can be considered to be an adoption level of 46%. In general, it can be concluded that 46% of the fish farmers in Delta State adopted the recommended aquaculture management techniques, a score considered to be at medium level.

One conclusion that can be drawn from the findings is that the highest adoption scores were recorded in polyculture as a stocking method, supplementary feeding, use of nets in harvesting and repair of pond leakage. Another conclusion derivable from the study is that the lowest adoption scores were found in monoculture, disease treatment and checking of oxygen content. A third conclusion from the findings is that high cost of pond construction and inadequate fishery extension service are the most critical constraints to adoption of the techniques under study, while income level and contact with agricultural extension agents are the most significant predictors of adoption of aquaculture management techniques. Given that fish is a preferred source of protein, the promotion of fish farming is a key aspect of addressing food security problem in Delta State.

In light of these findings, the following suggestions are made. (1) The fishery advisory services should be intensified in Delta State by deliberately offering services in aspects that showed low adoption scores in this study, including training fishers in fish multiplication techniques such as hormone injection, care for eggs and fries and stripping of fish. (2) The fish farmers should be encouraged to form strong cooperative societies and pool their financial resources together from where members can borrow for reinvestment and through cooperative societies they can also benefit from government sponsored micro-credit schemes to boost aquaculture business.

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