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ORIGINAL RESEARCH ARTICLE

Yield and revenue of cultured *Clarias gariepinus* in different enclosure systems adopted in Ogun State, Nigeria

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ABSTRACT

Recent trends reveal that fish rearing is popular in Ogun State with the influx of new entrants into fish farming due to increasing demand for fish and fish products as well as an increase in awareness of relevant technologies. The study was aimed at identifying factors influencing the yield and revenue of Clarias gariepinus in two different fish enclosures (dugout and fish tanks) in Ogun state. A three stage sampling technique was used to select 240 fish farmers located in the four Agricultural Development Programme zones in the State. The primary data collected through questionnaire administration was analyzed using descriptive and multiple regressions statistics. Results showed that 47.1% and 39.6% fish farmers adopted fish tanks and dug-out fish ponds respectively, while 13.3% adopted both on their farms. Regression result revealed that agricultural lime and fish enclosure sizes were both significant ($P<0.01$) for the yield of C. gariepinus at harvest. Cost of construction was significant as a factor for revenue in dugout fish ponds, while cost of construction ($p<0.1$) and labour ($p<0.05$) influenced revenue generated from rearing Clarias gariepinus in fish tanks. Cost of agricultural lime was significant at $p<0.05$for revenue from rearing of C. gariepinus in dugouts and fish tanks. Though fish tank was more expensive to construct than dug out ponds, the fish yield was higher. Wetland (fadama) areas of the state should be developed for pond fish culture to reduce the high cost of construction of concrete fish tanks.

Keywords: catfish culture, dug-out ponds, fish tanks

INTRODUCTION

Modern fish farming in Ogun State started in 1954 within the farm settlement of the then Western Regional Government. By 1965, private sector fishponds establishment began at Egbada –Ojelana (Ojelana pond); then Owu –Ikija community (Owu-Ikija community fishpond) and Sanni-Luba (School Fishponds) in 1970 (OGADEP, 1995). The Ogun state Agricultural Development Programme (OGADEP) was established in 1986 to carry out professionalized extension services for increased agricultural production, using the training and visit system of extension to reach out to the farming families. In 1990, the fisheries unit became properly incorporated into the training and visit system under Unified Agricultural Extension Services (UAES) that was formally harmonized in 1991 (Adekoya,1999). The training and visit system of extension services adopted by the Agriculture Development Programme in Nigeria has ensured that improved production technology reach a larger proportion of the fish farmers for increased aquaculture production to meet the national fish demand (Bolorunduro and Fregene, 2000). Fish ponds that were 576 in 1990 had increased to 9996 by 2, 008 (OGADEP, 2008). Rearing of fish in enclosures has become popular in Ogun State due to the low level of fish catch from the wild. Many new entrants have also come into fish farming due to increasing demand for fish and fish products as well as an increase in awareness of relevant technologies. The use of these fish enclosures for rearing fish such as earthen (excavated) ponds, dug-out fish ponds, cages, creels, fish tanks and pens have been documented in works by Bard *et al* (1976), Ben-Yami, (1987) and USAID (1988).

Though different fish enclosures have been adopted, there is insufficient data on type of adopted rearing enclosure and effects on fish yield and revenue (Molnar, 1998). This can provide better technical assistance to existing and prospective fish farmers; as well as to guide technology development and dissemination. Therefore, the need to study yield and revenue of fish cultured in dug-out fish ponds and fish tanks has become crucial for food security and sustainability of fish enclosures for fish production in Nigeria. The study was aimed at identifying the factors influencing the yield and revenue of *Clarias gariepinus* in two different fish enclosures (dugout and fish tanks). In this study, the null hypothesis that no socio-economic variables had any significant influence on the yield and revenue of cultured *C. gariepinus* in dug-out and fish tanks adopted as fish enclosures was tested.

MATERIALS AND METHODS

The study area

Ogun state lies within the longitudes 2^0 4^{11} E and 4^0 35^{11} E and latitudes 6^0 2^{11} N and 7^0 58^{11} N in the tropics. The Republic of Benin borders it in the West, and Lagos state and Atlantic Ocean in the south in the north by Oyo and Osun State and in East by Ondo state. The state operates in four agricultural extension zones namely: Abeokuta, Ijebu-Ode, Ikenne and Ilaro. The zones are divided into blocks and twenty of such blocks are in the state (Figure 1). The blocks disseminate improved and proven technologies to farmers across the state for adoption.

Sampling method and sources of data

A multi-stage random sampling design was used for the study. The first stage was the purposive selection of all the four agricultural extension zones of Ogun state, as used by the OGADEP. The second stage was random selection of ten blocks out of the twenty (OGADEP, 2002). The ten blocks selected were Ilewo, Ilugun, Wasimi, Ala, Ijebu- Igbo, Ijebu-Ife, Isara, Simawa, Ado-Odo and Sawonjo. The third stage was the selection of fish farmers from the compiled list of fish farms from the ten block extension offices. From each of the selected block, 24 fish farmers were randomly selected. Structured questionnaires were administered to 240 fish farmers. One block extension officer per block and two extension agents were trained as coordinators and enumerators to collect primary data from the fish farmers. Primary data collected were fish farmers' demographic features and agro-economic; infrastructure availability, fish management practices (both enclosures), socio -economic factors, reasons for adoption and fish yield by weighing the fish at harvest (from both enclosures).

Analytical tool

Descriptive and inferential statistics were used to analyze the data. The regression analysis was as an inferential statistics used to establish a relationship between fish yield or revenue and the type of enclosure system used.

Regression model

A regression model was used for the analysis and shown below:

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + \ldots\ldots + b_{19}x_{19} + u,$$

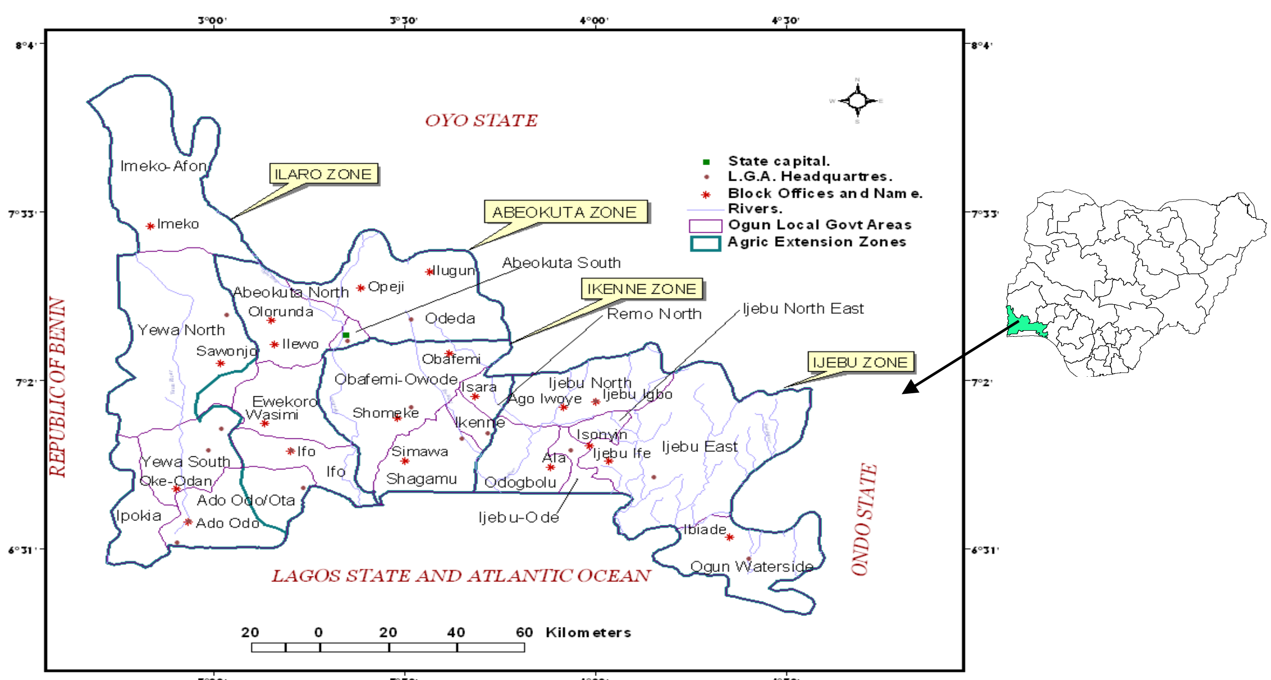

Figure 1: Ogun State ADP Zones

Table 1: Socio-economic characteristics of fish farmers (n=240)

	ADP Zones								Total	
Variables	**Abeokuta**		**Ijebu-ode**		**Ikenne**		**Ilaro**			
Gender	F	%	F	%	F	%	F	%	F	%
Male	49	25.3	50	25.8	48	24.7	47	24.3	194	80.8
Female	11	23.9	10	21.7	12	26.1	13	28.3	46	19.2
Age										
<30 years	5	20	11	44	9	36	0	0	35	14.6
31 – 40 years	10	20.4	15	30.6	14	28.6	10	20.4	49	20.4
41 – 50 years	26	26.3	16	16.2	26	26.3	31	31.3	99	41.3
51 – 60 years	4	7.8	10	19.7	10	19.7	17	52.0	41	17.1
60 – years	5	31.3	8	50	1	6.3	2	12.5	16	67
Marital Status										
Single	5	11.4	10	22.7	19	43.2	10	22.7	44	18.3
Married	50	27.3	49	26.8	39	21.3	45	24.2	183	76.3
Others	5	38.5	1	7.1	2	15.4	5	38.5	13	5.4
Religion										
Christianity	34	25.4	38	28.4	32	23.8	30	22.4	134	55.8
Islam	24	24.2	20	20.2	26	26.3	29	29.3	99	41.3
Others	2	28.6	2	28.6	2	28.6	1	14.3	7	2.9
Educational Level										
None Formal	0	0	2	22.2	3	3.3	4	.4	9	3.8 8.3
Primary	1	5	10	50	5	25	4	20.0	20	18.8
Secondary	12	26.7	10	22.2	12	26.7	11	24.4	45	69.2
Tertiary	47	28.3	38	22.9	40	24.0	41	24.7	166	
Household size										
< 5	22	24.4	27	30	22	24.4	19	21.1	90	37.5
6 – 10	38	30.6	31	25.0	30	24.2	25	20.2	124	51.7
11 – 15	0	0	2	7.7	8	30.8	16	61.5	26	10.8
Fish Farming Experience										
< 5 years	43	24.8	48	27.6	43	24.7	40	22.9	174	72.5
6 – 10 years	14	30.4	7	15.2	15	32.6	10	21.7	46	19.2
11 – 15 years	3	18.7	1	6.4	2	12.5	10	62.5	16	6.7
16 – 20 years	0	0	4	100	0	0	0	0	4	1.7
Full /Part Time										
Full Time	35	26.1	42	31.3	31	23.1	26	19.4	134	55.8
Part Time	25	23.5	18	16.9	29	27.4	34	32.1	106	44.2
Extension Service Access										
Easily Available	4	66.7	2	33.3	0	0	0	0	6	2.5
Moderately Available	31	20.8	45	30.2	39	26.2	34	22.8	149	62.1
Not Readily Available	25	29.4	13	15.3	21	24.7	26	30.5	85	35.4
Sources of Finance										
Personal saving	32	26.7	28	23.3	31	25.8	29	24.2	120	50.0
Cooperative	15	25.8	16	27.6	17	29.3	10	17.2	58	24.2
Banks	6	17.6	8	27.6	5	14.7	15	44.1	34	14.2
Credit Agencies	7	28	8	32	6	24	4	16	25	10.4
Contribution from Friends	0	0	0	0	1	33.3	2	66.7	3	1.3

Where
- Y_1=Yield; a = Constant.
- Y_2= Revenue; a = Constant
- X_1 =ADP zone.
- X_2 =Type of fish enclosure.
- X_3 =Access road
- X_4 =Age of farmers in years.
- X_5 =Gender.
- X_6 =Level of education
- X_7 =Marital status
- X_8 =Household size
- X_9 =Land

X_{10} =Affordability of cost of construction
X_{11} =Technology of feeding and management practices
X_{12} =Sources of credit
X_{13} =ADP extension office
X_{14} =Linkage with Universities /Research Institutes
X_{15} =Fish enclosures size ranges
X_{16} =Sources of fingerlings
X_{17} =Labour employed.
X_{18} =Total feed used (Kg)
X_{19}=Membership of cooperative

RESULTS AND DISCUSSION

Socio-economic characteristics of fish farmers

Table 1 showed that majority, 80.8% were males, while 76.3% were married having household size of 6-10 (55%). This implied that there were more males in fish farming than women in the state. A proportion of 61.7% were between the ages of 31-50 years. Results reveal that majority of the farmers are still in their active and middle age, hence could actively participate in agricultural production. It is interesting to note that 69.2% of the farmers had tertiary education. This is a practical evidence of high-level education among the fish farmers in the state. This agrees with the finding (Abay and Admassie, 2002) that education consequently enhances farmer's ability to receive and interpret all available information and make decision with small errors. Farmers in the state adopted easily most disseminated management practices techniques in fish farming (OGADEP, 2008).

Adoption of fish enclosures

A total of 95 farmers (39.6%) adopted dug-out fish ponds, 113 farmers (47.1%) adopted fish tanks while 13.3% adopted both on their farms (Table 2). This was the case for Abeokuta, Ijebu- Ode and Ikenne Agricultural extension zones; while in Ilaro zone, there were more dugout fishponds (12.5%) than fish tanks (9.6%). In Abeokuta, Ijebu-ode, and Ikenne zones, there was an increase in the use of fish tanks in urban/peri-urban locations by fish farmers. The use of fish tanks by fish farmers could be due to limited para-riverine sites available in those zones. The adoption of fish tanks (47.1 %) was more widespread among sampled fish farmers across the zones than that of dugout (39.6%). Fish tanks seemed to be more convenient to develop within urban/peri-urban locations, since their sites were easily obtainable compared to the scarce wetland sites. The urban/peri-urban locations provide greater security for investors, and reduce additional management costs of transportation and marketing (OGADEP, 2008). Fish tanks also offer greater convenience of management with other urban-located investments and as well provide more employment opportunities **(**OGADEP, 2008**)**. Fish yield in tanks was higher because the fish stocked were well fed; sorting exercise was routinely carried out and the environment was better controlled **(**OGADEP, 2008**)**. Mean fish yield from tanks across the zones were: Abeokuta 23.6 ± 0.1 kg/m^2; Ijebu-ode 17.9 ± 2.7kg/m^2; Ikenne 17.7 ± 2.3kg/m^2 and Ilaro 10.7 ± 2.2kg/m^2 which were also significantly different ($p < 0.05$). Mean fish yield from dug-out fish ponds across the zones were: Abeokuta 22.8 ± 1.2kg/m^2; Ijebu-ode 16.1 ± 2.5 kg/m^2; Ikenne 16.9 ± 2.4kg/m^2 and Ilaro 12.5 ± 3.2kg/m^2.

Test of hypothesis

Linear regression results in Table 3 revealed that catfish yield from fish tanks had significant relationship with size of land (p<0.01). Yield of fish was positively influenced by lime application, fish feed and fish enclosure size ($p <0.01$) for *C. gariepinus* cultured on farms where both dug out ponds and concrete tanks were adopted (both enclosures). Fish yield at harvest depends on the quality and quantity fish feed offered to fish during culture and it has been estimated that fish feed accounts for over 70% of management cost (IDBPR, 2007). This result confirms field practices in fish farming in Ogun State where all fish farmers use agricultural lime for fish enclosure curing (ageing/ acclimatization) procedures (Ajana *et al* 2006) and hygiene management (Schwedler and Johnson, 2000). Fish enclosure size is important as a factor in the yield of *C. gariepinus*, because number stocked depends on enclosures size. The larger the size of the tank the more number of fish that can be stocked and directly proportional to yield at harvest (Ajana *et al.*, 2006).

Table 2: Mean annual fish yield for fish culture in dug-out fish ponds and fish tanks

ADP Zones	Dug-out fish ponds			Fish Tanks			Both Enclosures	
	Freq	%	Fish Yield Kg	Freq	%	Fish Yield Kg	Freq	%
Abeokuta	22	9.2	912.50	29	12.1	947.37	9	3.8
Ijebu-Ode	21	8.8	647.06	32	13.3	717.11	7	2.9
Ikenne	22	9.2	678.95	29	12.1	708.33	9	3.8
Ilaro	30	12.5	500	23	9.6	403.36	7	2.9

Table 3: Factors influencing yield of *Clarias gariepinus* in different fish enclosures adopted

	Dugout fish pond		Fish Tanks		Dugout fish ponds and Fish Tanks	
Variables	Reg. Coeff	T-value	Reg. Coeff	T-value	Reg. Coeff.	T-value
Constant	6.024	17.773***	5.467	8.316***	4.519	4.939***
Land (Ha)	-0.024	-0.895	0.257	0.061***	0.033	0.659
Labour (Man days)	0.053	1.429	0.069	1.180	0.025	-0.551
Fingerling (Kg)	-0.019	-0.809	-0.000	-0.118	0.000	-0.195
Feed (Kg)	0.000	1.43	0.014	0.339	0.396	3.811***
Lime (Kg)	-0.001	-1.120	0.091	1.456	0.100	-2.892***
Fish enclosure sizes (Ha)					0.396	3.811***
R^2	0.094		0.046		0.635	

*Significant at p<0.1,**Significant at p<0.05, ***Significant at p<0.01

Table 4: Factors influencing revenue from culture of Clarias *gariepinus* in different fish enclosures adopted

	Dugout Fish Pond		Fish Tanks		Dugout fish ponds and Fish Tanks	
Variables	Reg. Coeff	T-value	Reg. Coeff	T-value	Reg. Coeff.	T-value
Constant	10.577	9.698***	9.060	4.783***	9.621	2.267
Cost of land (₦)	-0.034	-1.237	-0.067	-0.381	0.101	0.322
Cost of lime ((₦)	-0.010	-0.374	-0.069	-1.751	-0.199	-2.979**
Cost of fingerling ((₦)	-0.002	-0.025	0.018	0.289	0.054	0.461
Cost of labour ((₦)	0.062	1.355	0.133	2.056**	-0.088	-0.067
Cost of construction (₦)	0.152	2.646**	0.236	4.438***	0.065	0.378
Cost of feed (₦)	-0.038	-0.806	0.060	0.778	0.176	2.027*
R^2	0.135		0.261		0.489	

*Significant at p<0.1, **Significant at p<0.05, ***Significant at p<0.01

Only cost of construction was significant as a factor for revenue in dugout fish ponds, while cost of construction (p<0.1) and labour (p<0.05) influenced revenue generated from rearing *Clarias gariepinus* in fish tanks (Table 4). Though fish tank is more expensive to construct than dug out ponds, the fish yield is higher. There was also access to more enlightened, more capable semi-skilled labour for fish tank management than for dug –out fish ponds. Hence, it was more popular among fish farmers in Ogun State. The cost of construction influenced revenue derivable from culture of C. *gariepinus.* It is important because when included in farm budge, it results in increased input cost and eventually determines price at which the catfish will be sold at harvest. Costs of agricultural lime was significant at p<0.05 for revenue from rearing of *C. gariepinus* in both dugouts and fish tanks. The cost of agricultural lime with reference to revenue returns in the rearing of *C. gariepinus* was significant because agricultural lime increases P^H of soil (7-9) which is desirable for good fish growth and kills pathogens. Thus, its importance is appreciated as an important material for the curing (ageing/ acclimatization) of newly constructed fish enclosures for both dugouts and fish tanks (Schwedler and Johnson, 2000). The null hypothesis that no variables had any significant influence on the yield of cultured *C.* g*ariepinus* in dug-out was accepted for dugout ponds, but rejected for fish tanks adopted.

CONCLUSION

The study showed that more fish farmers adopted the use of fish tank as fish enclosures than dug-out ponds for culturing catfish. There was an increase in fish yield from production in fish tanks. Despite the cost of construction of fish tanks, the increase in yield compared to culturing in dug-out ponds encouraged more fish farmers to adopt the technology. There should be renewed efforts towards the development of wetland (*fadama*) areas of the state for pond fish culture to reduce the high cost of construction of concrete fish tank currently being experienced by fish farmers in the state.

CONFLICT OF INTEREST

Authors declare that there is no conflict of interest concerning this manuscript.

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