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Full Length Research Paper

Fish culture technologies in South-eastern Nigeria

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Aquaculture has become an important sector in Nigerian economy and is considered a means of bridging the gap between the supply and demand for fish since the wild stock is fast declining. The study was carried out to assess the status, structure, operation and management options of fish culture systems in three zones of South-east Nigeria and to determine the impact on the economy of the region. Results shows that the number of operational fish ponds in the region was estimated to be 346 consisting of 205 extensive, 105 semi-intensive and 36 intensive fish farms with majority of culturist operating at subsistence level. Common fish cultured were *Clarias gariepinus, Heterobranchus longifilis, Heteroclarias, Oreochromis niloticus, Clarias anguillaris and Hemichromis fasciatus*. *O. niloticus* was most common in all zones accounting for 91.6% while *Heteroclarias* culture was practiced only in Zone C. Earthen ponds were most common in Zone A and accounted for 40.9% while majority of farms (33.3%) in Zone C raised their fish in concrete ponds. More farms in Zone C adopted flow through system constituting 51.9% while stagnant ponds accounted for 74.2 and 56.8% of ponds in Zones A and B, respectively. Most common culture systems in the three zones were polycultured. Rainfall was major source of water in Zone A (71.0%) while rivers/streams were the common sources for culturist in Zones B (52.3%) and C (53.3%). However, well water and borehole take the lead as sources of water during the dry season. Males were the dominant sex among culturists and majority, were of ages between 40 and 70 years. Secondary school education was the least among culturists and fish farm activity was predominantly part-time (61.8%). Low income farmers were dominant in Zone A (79.0%) while majority of farmers (85.7%) in Zone C were high income. Personal savings was the most important source of financing farm operation among fish producers in Zone A (63.8%) while Bank loan was the common (56.3%) source of finance in Zone C. Therefore, to encourage new entrants especially the unemployed in the rural communities to start the enterprise, urgent steps must be taken to make credit facility available.

Key words: Fish culture, culturists, culture technologist, South-east Nigeria.

INTRODUCTION

Fish culture, which is the rearing of fish species under controlled environment has proved to be an important sector in Nigerian economy and a successful method of enhancing fish production in the world (FAO, 2002; IFPRI, 2003). The practice of fish culture technologies in Africa had been documented (Sadek, 1984; Eisawy and El Bolock, 1976; Tony, 1977; FAO, 1999) and all authors confirmed the viability of the practice in Africa.

In Nigeria, Tobor (1993) estimated the aquatic potential to be 1.3 million metric tons of fish from 1.8 million ha of suitable fresh water and marine environment. At present, fish pond production is low; 10,000 mt/yr from 2000 earthen fish ponds and 3000 concrete ponds in 63,000 ha of land (Ita, 1993; FAO, 1999) with middle belt and coastal fishing zone (of which South-east region is a part), topping the list. In 2000, Nigeria aqua products of 25,718 mt or 6.5% of the region's total output ranked second after Egypt in Africa (FAO, 1999). Aquaculture is regarded as been uniquely positioned to reverse declining supplies from captured fisheries (mean captured fish availability in Africa declined by 20% between 1990

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and 1996) and has notable potential for new livelihood opportunities, providing mechanism for lower priced fish, enhanced nutritional security and employment for communities by servicing urban markets (Jagger and Pender, 2001). Recognizing its huge potential for contributing to food security and generating foreign exchange and elevating socioeconomic status of rural communities, Nigerian Government has given high priority to aquaculture in its development plans. However, despite its long history in the region, aquaculture still remains a relatively minor contributor to the national economy relative to crops and livestock sectors. Increased fish production in the past came through expansion in production area and to some extent, improvement in yield associated with intensification of aquaculture practices. Aquaculture, like many other farming systems is dependent upon the use of natural resources such as water, land, seed and feeds. As countries continue to intensify their effort to increase aquaculture production, the demand for these resources will rise, resulting in competition for limited resources and negative environmental impact. These problems can be detrimental to sustainability of the production system and the environment.

South-eastern region of Nigeria has enormous resources to position aquaculture as a major income earner for the region. The region is dominated by the Cross River; a flood river with numerous tributaries, a drainage basin of 40,000 km^2 and floodplain of 2500 km^2. Fish culture ponds are developed in the floodplains of this inland water with their extensive network of swamps, lakes and ponds through the evolution of appropriate technology for their conversion. Such aquaculture practices represent natural extension of the procedures for keeping the largest possible area of floodplain under as high a level of water as possible during the dry season in order to increase fish production (Offem et al., 2008).

Over the last decade, there has been a dramatic increase in the inland aquaculture production; an average annual growth rate of nearly 20% (Muir, 2003). About 400,000 ha of freshwater ponds and more than 900,000 households are involved in aquaculture (ADB, 2005). The mean annual fish catch from the wild is just 5500 t (Moses, 1986a). Also it has been established that fish stock in the region's continental shelf is commercially unviable (FDF, 1983). With the increasing demand for food fish because of increase in human population, there is steep decline in fish production through captured fisheries which has resulted in the shortage of fish supplies in the market.

Akpet et al. (2005) revealed that the recent ban on the importation of poultry broilers has further put the cost of animal protein beyond the reach of ordinary citizens in Nigeria, especially the rural population, and fish has become the only option. The low cost price per kilogram of fish is a very strong indicator that it can be used to bridge the wide animal protein gap that has become the hallmark of most developing countries (FAO, 2005; Essien et al., 2008; Adinya and Ikpi, 2008). Conditions of the area are quite favorable for the expansion of aquaculture, as the quantity of fish produced has risen rapidly in recent years. However, the development of fish farming in the South-Eastern region had not been fully documented because of diverse and unconventional systems in use. For aquaculture to meet local demands, producers will have to consider the economics of farming taking into consideration most suitable technologies for the region. The above provides the basic backdrop against which national policy for aquaculture development may depend. This study is therefore an attempt to provide a checklist of fish farms in the state, ascertain area of land utilized, farming systems and technologies used and common species cultured to enable formulation of development strategies for improving status of aquaculture in the region.

MATERIALS AND METHODS

Study area

The research study was conducted in Cross River State of Nigeria. The state occupies an area of about 22,342.176 km^2 (QNLMLGA, 2006). It is located at the south eastern part of Nigeria (Figure 1) on Latitude 4°, 25´– 7°, 00´N, Longitude 7°, 15´– 9°, 30´E. It is bounded in the South by the Atlantic Ocean, East by the Republic of Cameroun, the Nigerian states of Benue in the North, Ebonyi and Abia in the West and Akwa Ibom State, South West (Adinya and Ikpi, 2008). The soils of the Cross River State are ultisols and alfisols but predominantly ultisols (FAO/UNESCO, 1974). Cross River State has the largest rainforest, covering about 7290 km^2 described as one of the Africa's largest remaining virgin forest harboring as many as five million species of animals, insects and plants (MOFINEWS, 2004). Cross River State is located within the evergreen rainforest zone. There are two distinct climate seasons in the area; wet (March - October) and dry seasons (November - February). The annual rainfall varies from 2942 to 3424 mm and the average temperature is about 28°C (CRADP, 1992). Cross River State is characterized by the presence of numerous ecological and zoo-geographically important high gradient streams and rapid waterfalls. About 2,888,966 people inhabit the area, of which the Afiks, Ejaghams and Bekwarras are the major ethnic groups (Agbor, 2007) fishing and subsistence agriculture are the major occupation of the people. Crops grown in the locality include; rice, maize, cassava, yam plantain and banana. Population depends largely on natural water sources for all their water related activities. Pipe-borne water supply is limited and grossly inadequate. Health services in the area require improvement. Level of hygiene in the communities is generally poor (Arene et al., 1991; Adinya and Ikpi, 2008) . For the purpose of the exercise the region was divided into three zones; A, B and C. Zone A represents the northern part of the region dominated by rural communities, Zone B was semi-urban while Zone C was predominantly urban.

Inventory survey

Data for this study were collected between January 2005 and December 2008 using a structured questionnaire to interview fish culturists in the South-east region of Nigeria. Total number of 287 out of 346 fish culturists, were randomly selected for the study. The sample consisted of 120, 97, 60 culturist from zones A, B and C,

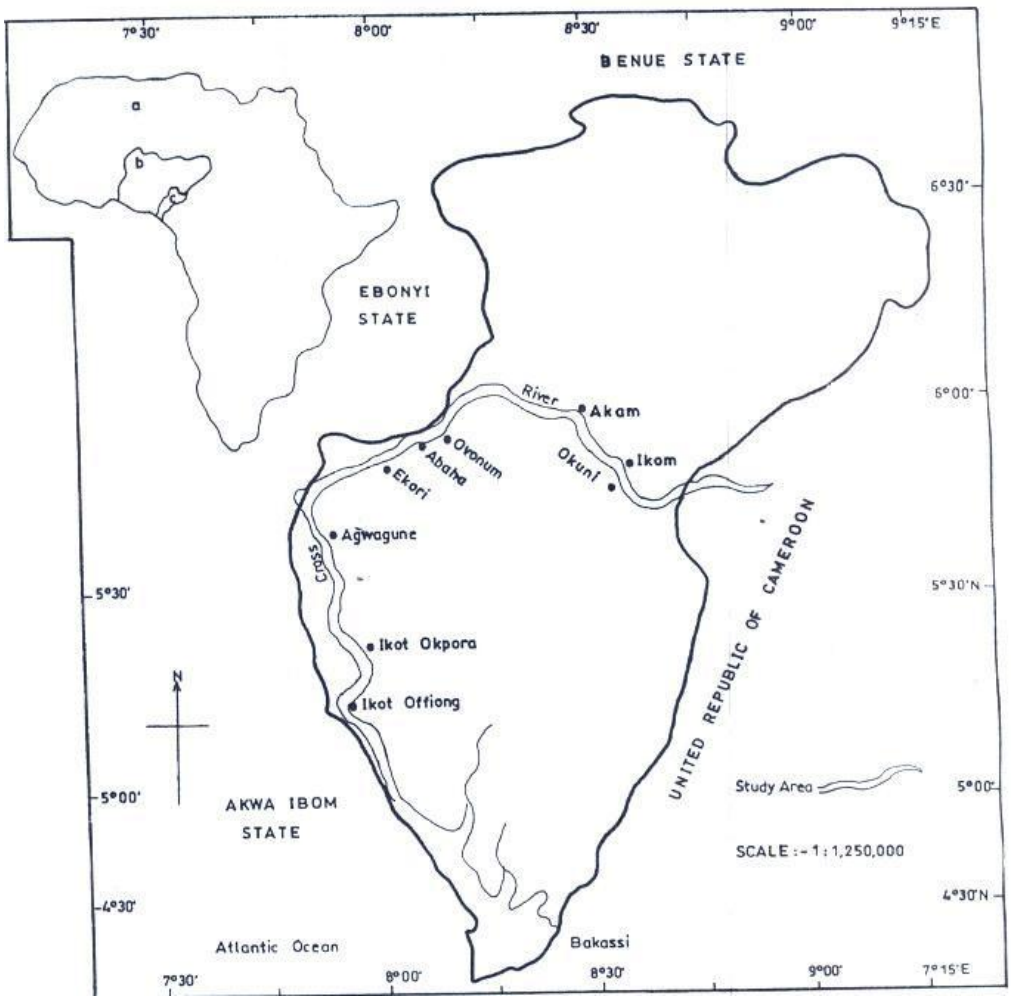

Figure 1. Map of Cross River State showing study area.

respectively representing 90% of the culturists in each zone. Data generated consisted of number of farms, type, location, date of commencement, area in use (ha), water source, fish species, potential area and culture systems.

Data were analyzed using descriptive statistics (mean, standard deviation, frequencies and percentage). Comparison of data from zones was carried out using analysis of variance (ANOVA) (Steal and Torrie, (1980).

RESULTS

Status of fish culture

Table 1 shows that the number of operational fish ponds in the region was estimated to be 346 consisting 37 Government commercial fish farms, 66 Government experimental farms 24 community/cooperative farms, 108 private commercial farms and 111 subsistence farms. 205 were extensive, 105 were semi-intensive and 36 intensive fish farms all in 25.25 ha of land with potential yield of 49.42 t. $ha^{-1}yr^{-1}$ table fish and 20 million fry yr^{-1}.

Majority of the culturists were operating at subsistence level as intensive fish culture system was practiced by few culturists.

Fish culture technologies in the region

Common fish cultured in the three zones were *Clarias gariepinus, Heterobranchus longifilis, Heteroclarias, Oreochromis niloticus, Clarias anguillaris and Hemichromis fasciatus*. The culture of *O. niloticuus* was most common in all zones with average percentage stock of 91.6. *C. gariepinus* accounted for 70.0% in Zone A, *Heteroclarias* sp. culture was practiced only in Zone C while the culture of *Hemichromis* was least (9.7%) and was used for the control of tilapia overpopulation. Zone C recorded the highest number of ponds (198) while Zone A had the least (58). Figure 2 shows that fish culture in earthen ponds was most common in Zone A and accounted for 40.9% while most farms (33.3%) in Zone C raised their fish in concrete ponds. Flow through system

Table 1. Status of fish farming in South-eastern region of Nigeria.

Private commercial fish farms	Culture systems	Description		Production		
		No. of farms	Area (ha)	Table fish (No.)	Table fish (t/ha/yr)	Fry (Million/yr)
Private commercial fish farms	Extensive	61	3.48	26	4.38	
	Semi-intensive	47	1.80	29	5.82	
Subsistence farm	Extensive	111	4.35	2	5.33	
Government commercial farm	Extensive	2	0.01			
	Semi-intensive	35	2.55	55	14.33	
Government experimental fish farms	Extensive	7	1	17	0.76	
	Semi-intensive	23	4.9	90	7.69	
	Intensive	36	5.4	40	5.28	
	Catfish hatchery	2	0.04			20.8
Community/cooperative fish farms	Extensive	24	1.8	5	5.83	
Total		346	25.29		49.42	20.8

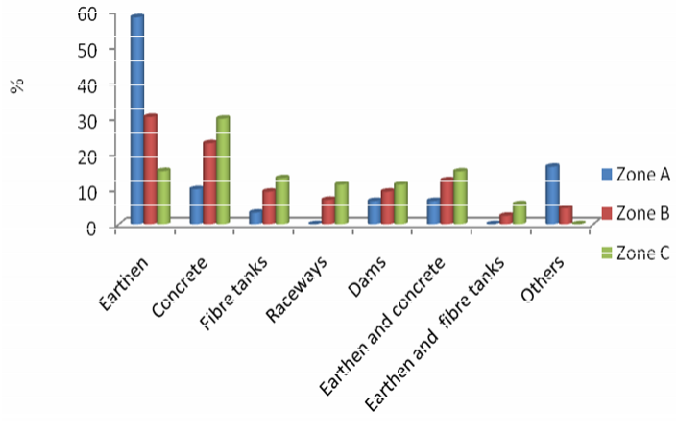

Figure 2. Types of rearing facilities.

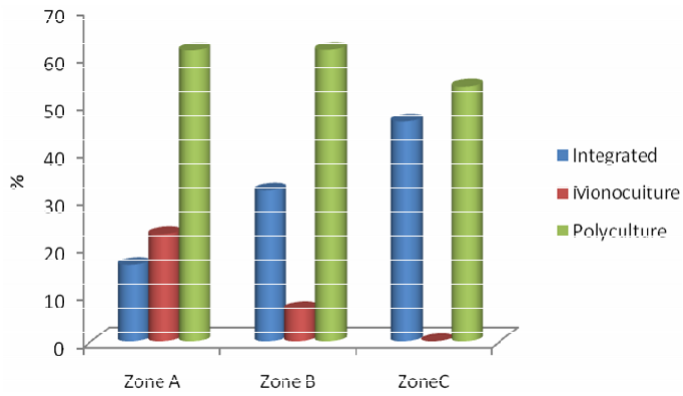

Figure 4. Fish production systems.

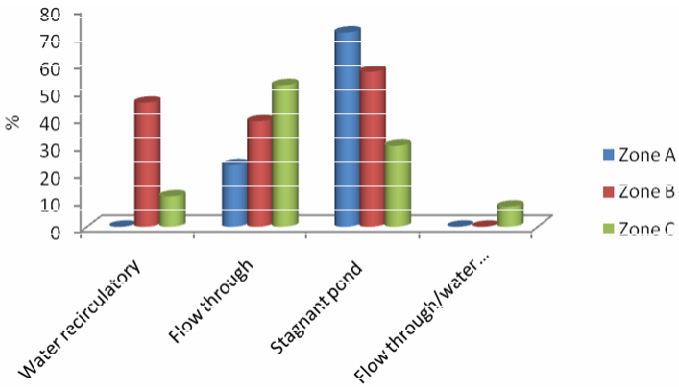

Figure 3. Fish culture systems.

was gaining more importance in Zone C with 51.9% of the farmers adopting the system while stagnant ponds dominated Zones A and B, accounting for 74.2 and 56.8%, respectively (Figure 3). There was also a significant expansion in catfish production in the region using water recirculation systems with about 18.5% of the farms in Zone C adopting the system while only 4.6% of the farmers practice it in Zones A and B. Polyculture of catfish and tilapia was the common production system in the three zones (Figure 4). Integrated farming was practiced only in Zones B (31.8%) and C (46.2%) while monoculture was completely absent (0.0%) in Zone C. Only two functional hatcheries were identified and were located in Zones B and C. Water was sourced mostly from rainfall in Zone A (71.0%) while rivers/streams were the source of water for culturist in Zones B (52.3%) and C (53.3%)(Table 2). However, during the dry season when

Table 2. Fish culture technologies.

Criteria	Kind	Zone A		Zone B		Zone C		Pooled data	
		Freq.	(%)	Freq.	(%)	Freq.	(%)	No.	(%)
Purpose of culture	Food	18	58.1	10	22.7	6	11.1	34	30.6
	Commercial	10	32.3	25	56.8	38	70.4	73	53.2
	Research	1	3.2	3	6.8	1	1.9	5	4.0
	Recreation	2	6.4	6	13.6	9	16.7	17	12.2
Sources of fingerlings	Wild	15	48.4	18	40.9	8	14.8	41	34.7
	Hatchery	6	19.4	10	22.7	36	66.7	52	36.3
	Fish farms	10	32.3	16	36.4	10	18.5	36	29.1
Fish cultured (10^3)	*Clarias gariepinus* (mud fish)	11	35.5	17	38.6	34	70.0	63	43.0
	Oreochromis nilticus (tilapia)	28	90.3	41	93.2	50	92.6	119	91.6
	Heterobranchus longifilis	2	6.4	3	6.8	11	20.4	16	11.1
	Heteroclarias	0	0	1	2.3	23	42.6	24	16.0
	Hemichromis fasciatus	7	22.6	2	4.5	1	1.9	10	9.7
Sources of water	Rainfall	21	71.0	12	27.3	4	11.9	37	36.7
	River/stream	5	16.2	23	52.3	29	53.3	57	40.6
	Well/borehole	3	9.7	6	13.6	15	27.8	24	17.0
No. of ponds	Extensive	21	57.6	56	62.2	97	48.9	187	54.1
	Semi-intensive	5	40.0	30	33.3	44	22.2	107	30.9
	Intensive	3	1.6	4	4.4	57	28.9	62	17.9

most rivers and streams were dried up, especially in Zone A, well water and borehole became the major source of water. Fish was cultured for commercial purpose in Zone C (70.4%) and for food in Zone A (58.1%) while the culture for research and recreation was minimal being 4.0 and 12.1%, respectively.

Demographic characteristics of fish culturist

Fish culturists in the study area were predominantly men (87.5%) and the demographic features of the fish culturists between the zones were significantly different ($P < 0.05$) (Table 3). Most of the culturists were of ages between 40 and 70 years. Younger culturists were found in Zone C. All the respondents have at least secondary school education and majority of them, especially in Zone C, had experience in fish culture beyond eleven years. The distribution of farm income earned by producers during the farming season showed that farmers with lowest average annual income (<N1000000) were common in Zone A (79.0%) while farmers with average income >1000000 (that is, large-scale farmers) formed a majority (85.7%) in Zone C. The most important source of financing farm operation among fish producers interviewed, were farmers personal savings (75.8%) and loans (13.3%) from financial institutions. About 63.8% of farmers in Zone A depended on personal savings while Bank loan constituted the highest (56.3%) source of finance in Zone C. In all the zones, fish farm activities were carried out on part-time (61.8%) bases with little supervision (Figure 5).

DISCUSSION

The rapid development of fish culture practices in the urban region (Zone C) compared to other zones could be attributed to the high poverty level prevalent in the rural areas which makes adoption of modern farming techniques difficult (Okere, 1986; Larsson, 1984). The existence of only two hatcheries in the region implied that the supply of fingerlings to culturists was inadequate and were depending on the wild source from the surrounding rivers. The culture of common hardy species like *Clarias, Heterobranchus*, *Hemichromis* and *Oreochromis* species was probably due to their tolerance of poor environmental conditions and fast growth (Falaye, 1996). Percentage frequency of *Hemichromis* stocked was low in all ponds as it was only used for the control of tilapia prolific breeding and over-population in the ponds (Madu et al., 1986). The conduct of fish culture in stagnant ponds especially in Zones A and B was due to the absence of skilled labor to manage flow though ponds in these areas.

Table 3. Demography of fish culturist in the South -Eastern region of Nigerian, by zone.

Feature	Fish culturist	Zone A		Zone B		Zone C	
	(No.)	Freq.	(%)	Freq.	(%)	Freq.	(%)
Sex							
Male	105	29	27.6	39	37.1	46	43.8
Female	15	2	13.3	5	33.3	8	53.3
Age (yrs)							
<20	1	0	0.0	0	0.0	1	100
20-29	5	1	20	1	20	3	60
30-39	9	2	22.2	1	11.1	6	66.6
40-49	55	10	21.8	16	29.1	31	52.7
50-60	50	18	30.0	17	26.0	21	38.0
>60	42	26	83.9	12	36.4	4	7.4
Education							
No education	0	0	0.0	0	0.0	0	0.0
Primary	0	0	0.0	0	0.0	0	0.0
Secondary	15	0	0.0	4	26.7	11	73.3
Tertiary	35	11	31.4	18	51.4	15	42.8
Vocation	70	20	36.4	22	31.4	28	40.0
Experience (yrs)							
< 1	8	0	0.00	2	25	6	75
1 - 5	37	10	16.2	11	30.0	16	43.2
6-10	55	12	33.0	20	36.3	33	60.0
>11	20	5	25	6	30	9	45.0
Annual farm income							
(10^3) (N)	44	30	68.2	8	18.2	6	13.6
<500	24	18	75.0	5	20.8	1	4.2
500 - 999	15	1	6.7	3	20.0	11	73.3
1000 - 1499	7	1	14.3	0	0.0	6	85.7
1500 - 1999	5	1	20.0	1	20	3	60.0
2000 - 2499	3	0	0.0	1	33.3	2	66.7
2500 - 3000	2	0	0.0	1	50.0	1	50.0
>3000							
Sources of fund							
Personal	91	58	63.7	23	25.3	10	10.9
Government	3	I	33.3	1	33.3	1	33.3
Bank loan	16	3	18.8	4	25.0	9	56.3

High percentage of earthen ponds in Zone A was attributed to land and water availability for fish culture. Lack of space for expansion and prevention of environmental pollution were some of the reasons adduced for the large increase in the use of concrete and fiberglass tanks in urban areas (Zones B and C). The existence of only two hatcheries in Zones B and C despite the urban nature of their locations was due to scarcity of skilled labour and the lack of capital in the state for investment in this direction. Pond size and shape varied according to the location of the farm, type of system and rearing facility. A study of fresh water aquaculture by Legaspi (1997) revealed that the average land holding of tilapia farmers in the Philippines was about 3.53 ha. However, in this study, an average size of 1.0 - 4.9 ha was observed to be common in all the zones. The high number of ponds in Zone C could be attributed to more demand for fish, accessibility to market, technology, information, credit facility and economy of scale enabling expansion in the zone (Adikwe, 1999).

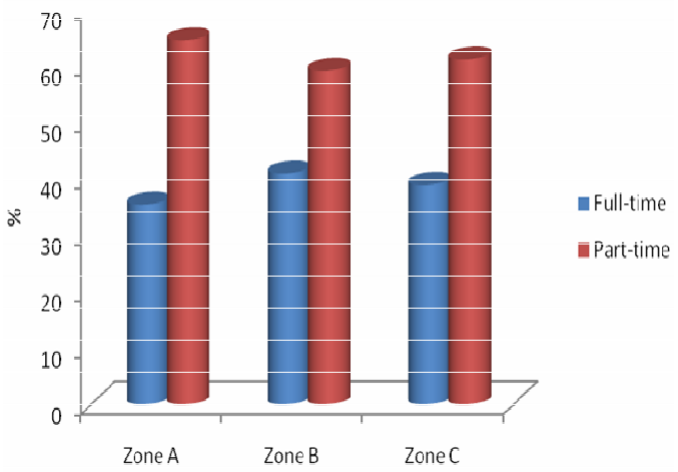

Figure 5. Mode of fish farm operation.

Polyculture of catfish and tilapia as the major fish production system in all the zones was in line with the study conducted by FAO (2000) which revealed that Nigeria has been the main catfish producing country in sub-Saharan Africa in the last decade, accounting for at least 90% of catfish supply in the region. Hence, with policies in place that promote growth and development of fish culture, catfish production could increase substantially in future to meet, in part, the demand for fish in the country. Apart from culturing only fish, farmers are also into enterprise combination, for effective utilization of land. That is why integrated fish farming is gaining tremendous grounds in Zone C due to the scarcity of land in this region. Major reasons for integration were to increase farm income and to spread risk. With growing markets, and despite more farmers entering the business of aquaculture, a major switch took place in the primary motive of fish farmers in Zones B and C; producing more fish for sale in markets and fewer being reserved for household consumption. Clearly, profit motivates those engaged in aquaculture in the two zones. An assessment of freshwater aquaculture industry (especially tilapia farming) in the country by ICLARM (1998) found it to be a highly lucrative business, as it generates substantial profits for fish farmers who operate fish ponds. The emergence of female entrants into fish production, though very few in this study, was seen as new development in the region. Fish production was found to be the purview of men in the zones in line with Williams (1968) who attributed it to capital intensive requirements of fish culture. Women were found actively involved in fish processing and marketing. The age of farmers gene-rally affects perception of new technologies, adoption decisions and investment behavior. Agbor (2007) stated that with advancement in age, risk aversion increases and investment in aquaculture which sometimes requires long gestation periods were usually avoided. However, the age of majority of the producers in this study ranged from 40 - 70 implying that people at both active (<65 years) and inactive (>65 years) ages could be fish culturists in the area. Younger farmers were also involved in fish farming enterprise especially in Zone C. Dey et al. (2000) found out that the average age for younger fish farmers were within the age bracket of 30 - 40 years. The increasing trend of younger entrants in Zone C could be attributed to high rate of returns in fish farming as observed by Adeogun et al. (1998). On the other hand, in Zone A, 83.9% of farmers were above 60 years probably because majority of civil servants from Government retire into fish farming in the rural area where land is available at no cost. The level of education attained by any farmer is known to influence the adoption rate of innovations (ADB, 2005). The adoption of any innovation is positively related to the level of farm investment and capital outlay. The high rate of producers with secondary and post-secondary education in fish farming could be attributed to the high economic gains, unemployment, underemployment among the graduates, diversification of business enterprises and planning for retirement (Dey et al., 2000). The average farm income was calculated based on the gross output of the fish harvested at the end of each cropping season, irrespective of the technology adopted by the producers. In this study, higher farm income observed in Zone C can be attributed to higher purchasing power of consumers in urban centers (Adeogun et al., 1998). In a situation where personal savings is presently the major source of capital, as is the case in Zone A, however, poses danger to the industry. Urgent steps must be taken to make credit available for expansion and sustainability because lack of capital might prevent new entrants, especially the unemployed, from starting the enterprise.

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