FISH CULTURE IN PONDS

Extension Bulletin No. 103

Fisheries Series No 4

Published By

National Agricultural Extension And Research Liaison Services
Federal Ministry of Agricultural and Natural Resources
Ahmadu Bello University
P.M.B. 1067, Zaria
Nigeria.

1999

ACKNOWLEDGEMENT

Relevant scientific information pooled together for this bulletin were sourced mainly from the National Institute For Freshwater Fisheries Research (NIFFR) New Bussa, special thanks go to NIFFR's for assistance in providing the needed results of their research work. Other authors indexed in the bibliography are greatly acknowledged.

The support of the Director and Management of NAERLS, the painstaking work of the Publication Review Committee of NAERLS, and the efforts of the Publication and Publicity Programme all combined made this bulletin production possible.

Bolorunduro P.I.

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1.0. Introduction

Fish culture involves the controlled cultivation and harvesting of fish for either family consumption or sales in the market. Although fish culture is over thirty years old in Nigeria, it is yet to develop relatively when compared with arable agriculture and livestock production.

A wide range of practices exist in culturing fish. Fish can be cultured in marine (sea water), brackish (mixture of sea and freshwater i.e. lagoons) or freshwater (rivers, streams and lakes in the inland), Depending on the facilities designed to serve as enclosures in rearing, fish can be grown in earthen ponds, concrete tanks, cages, pens, or run-ways. The level of mangement practices can make a fish farm to be extensive or intensive system. When species combinations are taken into consideration, culture systems can be either monoculture (rearing only one type of fish) or polyculture (rearing two or more species of fish together).

A fish pond is an enclosure (earthen or concrete) built to retain water for the purpose of growing fish. Wooden troughs, fibre glass and plastic tanks are other media of growing fish. Growing fish in ponds from which they cannot escape allows feeding, breeding, growing and harvesting of the fish in a well-planned way.

2.0. POND CULTURE SYSTEMS

Fish ponds can be classified mainly using the following criteria:-

(a) Construction design
(b) Level of management input
(c) Fish culture practices
(d) Scale of production

2.1. Construction Design

1. Earthen Ponds: These are constructed by digging soil in a carefully selected site that is good enough to retain water for fish culture. (Figure 1a) Where the soil structure is weak to retain adequate water, dug out earthen ponds can be reinforced with concrete to make it suitable for fish culture.

2. Conrete/Embarkment Ponds: These are pond constructed on the ground, that is above the ground surface with concrete wall (Fig. 1b). Concrete ponds can be used to raise fish in a place with porous or sandy soil or within living premises.
3. Barrage Ponds: This is a type of pond constructed by building a wall across a stream running in a low valley. The wall ensures enough water retention for fish growth (Fig. 1c)
4. Diversion Ponds: Ponds supplied by water diverted from a river/stream through a channel are called diversion ponds. Such pond, is also known as Relief Pond (Fig. 1d)
5. Rosary Ponds: These are ponds built in a string and each drains into the other and are all managed as a single unit due to their water connection.
6. Parallel Ponds: These are ponds located in an area with each having its own inlet and outlet. (Fig. 1f).

Figure 1a: Earthen Ponds

Fig 1b: Concrete Ponds

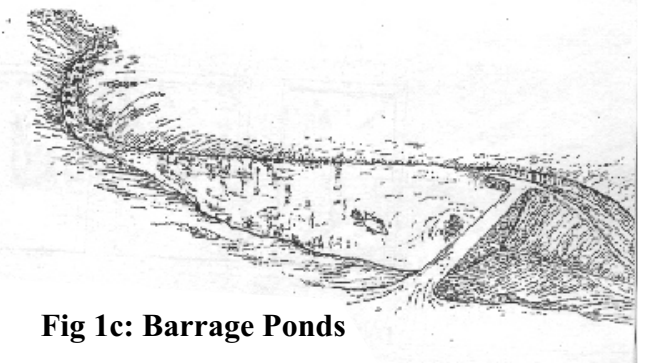

Fig 1c: Barrage Ponds

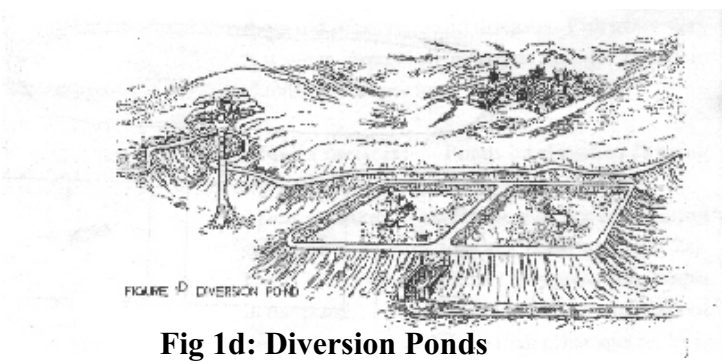

Fig 1d: Diversion Ponds

Fig 1e: Rosary System Ponds

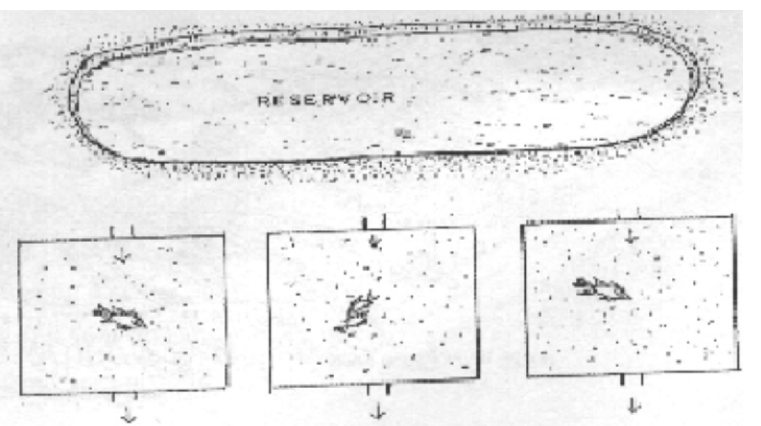

Fig 1f: Barrage Ponds

2.2. Level of Management Input

Depending on the level of management inputs, especially in feeding, fertilization and liming, pond culture systems can be classified as Extensive, Semi-Intensive or Intensive.

1. Extensive Culture System: When food base in a pond is exclusively naturally occcuring without supplementation (either by feeds or fertilizer), the culture system is an extensive one. This practice is popular with small-scale producers

2. Semi-Intensive Culture System In this system, there is occasional supplementary feeds addition and natural productivity is augumented with manures.

3. Intensive Culture System This demands a higher level of management input. Feeds and fertilizers are intensively applied following appropriate recommended rates. Suitable liming materials like agricultural lime are also applied to stimulate productivity and disinfect the pond of parasite and diseases. Fish grow very fast when intensively managed and grow least in extensive management. Most commerical farms adopt this approach.

4 Hyper intesive culture system: Th system demands the highest leel of management inpouts. Ths culture environment is completely under control. Feeding is totally with highly formulated pellets. Mechanical, and automoted feeders are used. The main features are intensive recyclatory with biofiltration tanks. Highest fish yield obtained in this system.

2.2 Fish Culture Practices

Pond can be classified as monoculture or polyculture.

1. Monoculture: This is the practice of culturing only one species of fish in a pond unit (Fig. 2a). Under monoculture, a farmer may grow only Clarias in the pond. He will be able to know more about the management of Clarias than other fish species.

2. Polyculture: This is the practice of culturing more than one species of fish in the same pond. Fish yield under polyculture (Fig. 2b) can be higher and foods in the pond properly utilized, since the different fish species exploit food at different trophic levels.

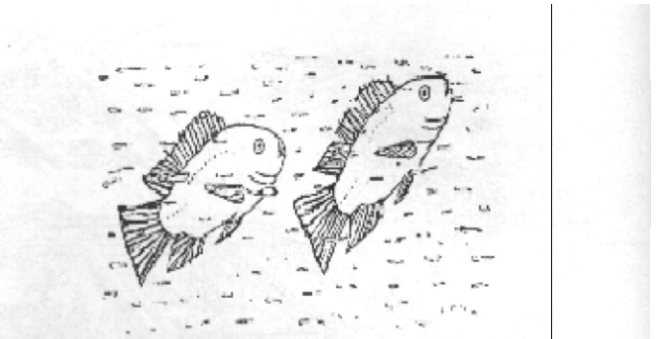

FIGURE 2A MONOCULTURE GROWING SAME TYPE OF FISH IN A POND E·G TILAPIA

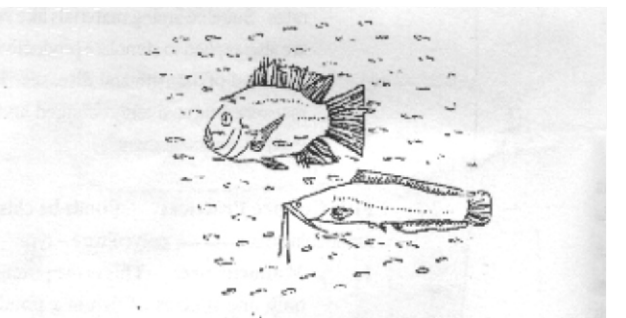

FIGURE 2B POLYCULTURE GROWING DIFFERENT FISH SPECIES IN A POND E·G CLARIAS AND TILAPIA

2.4. Scale of Production

1. Homestead/Rackyard Ponds: This is a fish pond that is managed to augument family protein intake. The size of such a pond could vary according to land space available e.g. 10m x 10m.

2. Commercial Fish Ponds/Farms: This , usually have an area of land not less than 0.25 hectare under culture. Such a farm will demand more attention from the fish farmer, since income generation is the major purpose behind its establishment. Concrete tanks units of not less than 200m^3 can also be intensive as commercial ventures.

3.0. COMMONLY CULTURED FISH SPECIES

Generally the purpose of rearing fish is to have enough to eat and generate additional income especially in commercial farms. Not all fish species perform creditably well in culture. For a profitable venture, the fish farmer's ideal candidate species must have either of these qualities:-

i. Fast grower e.g. Heterobranchus
ii. Accept and utilize properly, supplementary feeds e.g. Tilapia
iii. Must be hardy and resistance to disease, e.g. Clarias
iv. Must be tolerant to poor water quality e.g. Clarias
v. The fish must be easy to breed in captivity. E.g. Tilapia
vi. It must attract low production cost (Tilapia/Clarias)
vii. Acceptable and marketable to consumers, e.g. Carp Clarias.

TABLE:1 Commonly Cultured Fish Species in Freshwater Ponds in Nigeria

COMMON NAME	SCIENTIFIC NAME
Tilapia*	*Oreochromis niloticus (Tilapia nilotica)*
	Tilapia guineensis
	Tilapia melanopleura
	Sarotherodon galilaeus
Mud Cat-fish*	*Clarias (garinpinus)*
Common Carp*	*Cyprinus Carpio*
Spotted Cat-fish**	*Synodontis filamentosus*
Red mud cat-fish**	*Heterobranchus bi-dorsalis*
Niger perch * *	*Lates niloticus*
African bony tongue* *	*Heterotis niloticus*
Grey cat-fish* *	*Chrysichthys nigrodigitatus*
Trunk-fish* *	*Gymnarchus niloticus*
African Carp* *	*Bagrus bayad*
Moon fish* *	*Labeo coubie*
Cat-fish* *	*Citharinus citerus*

from the

- Fingerlings readily available in hatcheries
- Fingerlings not readily available in hatcheries, but can be collected from the wild.

Source – Ita E,O, 1989.

TABLE 2: Commonly Cultured Fish Species in Brackish Water Ponds

COMMON NAME	SCIENTIFIC NAME
Flat head grey mullet *	*Mugil cephalus*
Tilapia*	*Tilapia Zilli*
	Tilapia guinensis
	Tilapia melanotheron
Atlantic Tarpon * *	*Megalops atlanticus*
Ten Pounder * *	
(West African Lady fish)	*Elops lacerta*
Grey Cat-fish * *	*Chrysichthys nigrodigitatus*
African red Snapper **	*Lutjanus agennes*

- Fingerlings and feeds readily available
- Fingerlings not readily available in hatcheries but can be obtained from the wild.
- Source - Ita E.O. 1989.

In Nigeria, certain fish species are found only in freshwater bodies (that is rivers and lakes) and do very well under culture (Plate 1). Some other species inhabit the marine environment, but can be cultured in brackish water (Lagoons and estuaries) (Plate 2).

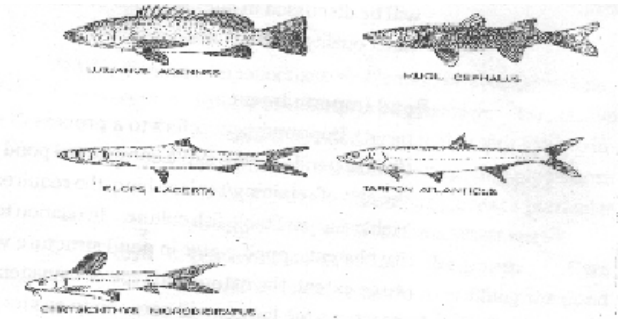

Plate 1.Fresh water fish species.

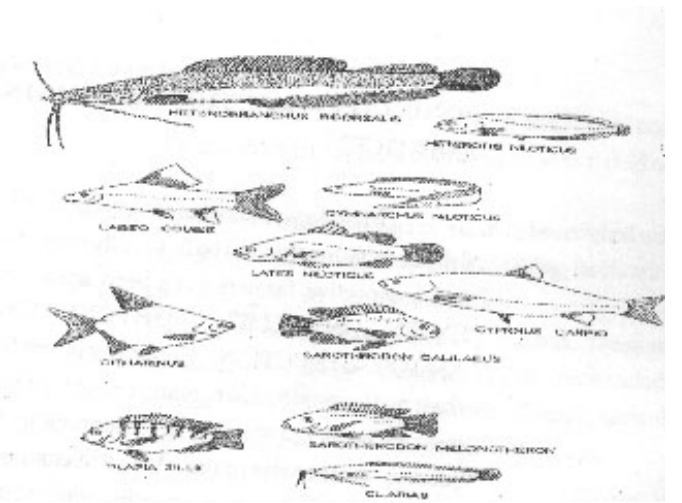

Plate 2. Brackish water fish species

4.0. SITE SELECTION

4.1. Homestead Fish Pond For homestead fish culture, the house backyard is suitable. (Fig. 3). Earthen/Concrete pond can be used for this purpose. Soil at site of the earthen pond should be able to retain water.

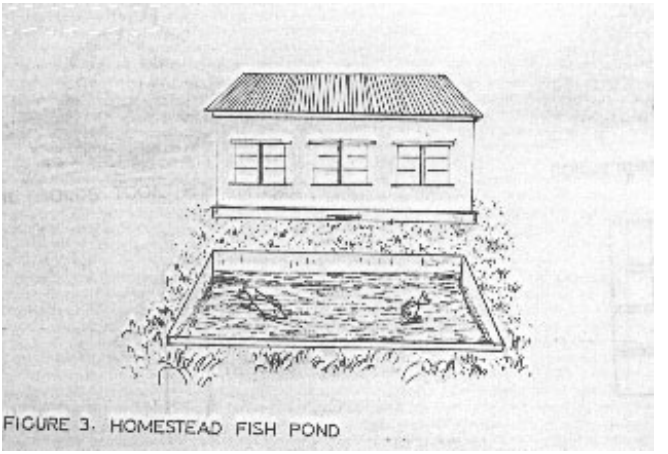

FIGURE 3. HOMESTEAD FISH POND

4.2. Commercial Fish Farm In commercial fish farming, the first requirement is the choice of a suitable land for the establishment of the farm. Such a land must be sited near water with suitable topography for pond construction (Fig. 4). The water source can be river/stream, spring, well or borehole. The water must be free from pollutants. Water is the medium for culturing fish; as a result the supply of water must be guaranteed throughout the culture period. The topography of the land should not be too hilly or too flat. A slightly depressed marshy land that can retain water for a long time is ideal for pond construction.

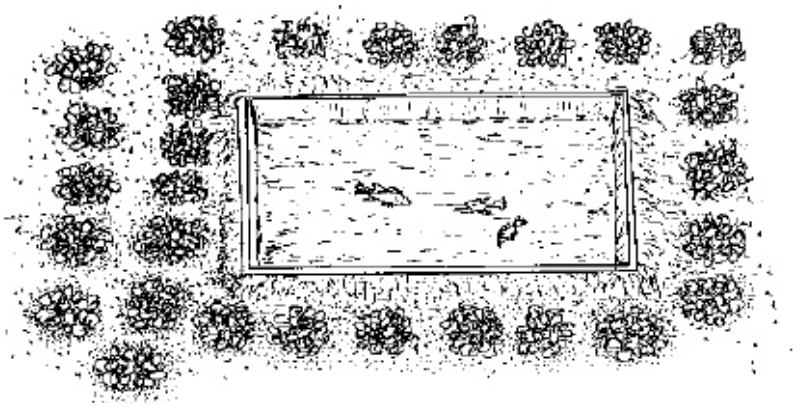

Fig 4. A typical fish pond in farmland.

Soils that are too porous (sandy soil) or too clayey are not good for fish culture. In sandy soils, the water retention capacity is very low, while pond soil with high proportion of clay (above 40% composition) will be turbid (concentration of suspended solids). This is dangerous for fish. A suitable soil is that which has a good proportion of clay and loam (i.e. 40%:60%) simple test of soil for water retention includes the following:-

1. Dig the soil to about 10cm deep and take a soil sample at that depth. Wet a handful of the earth with water and rub it on the palms. If it forms a continuous thread, then it can retain water and is good for fish pond construction (Fig. 5).
2. Squeeze a little amount of the moist soil, if it holds shape, them it is good and suitable for pond (Fig. 5).
3. A bucket full of water can also be poured into the dug hole. If the percolation rate (rate of disappearance of the water) is fast, (i.e. within 1min) the site is not good enough for fish pond construction.

Soil experts can also be consulted for analysis in case of large scale farming with huge capital investment.

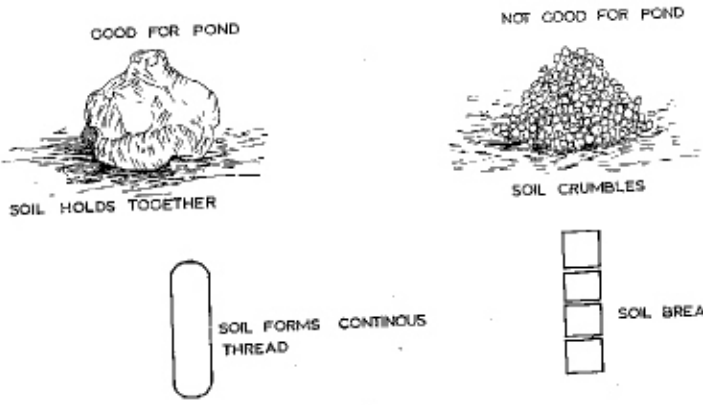

Fig 5. Testing good sol for Pond Construction

5.0. LAND SURVEY AND FISH FARM DESIGN

Once a suitable land has been acquired, it should be surveyed by a registered surveyor and a topographic map produced to permit the design of fish ponds and other structures.

The design of a fish farm varies with the nature of the land. If the slope is gentle enough (a good valley of 1:2 slope) to permit chanelling of water from the stream or river into the farm, the construction of a storage reservoir may not be necessary. In most gentle sloping valleys, channelization may not be practicable hence it might be necessary to block the course of water in order to raise the water level. This is to permit diversion of water into ponds lined along (parallel to) the course of the river or stream. Such a dam may not necessarily form a stroage reservoir suitable for fish production because of the fast flowing nature of the river during the flood season and the difficulty of screening off the fish.

Fig 6. Small vallyes with gentle slope have excellent potential for pond construction

6.0. HINTS ON POND CONSTRUCTION

After conducting a feasibility study and planning on the type and size of pond to build on the site selected, construction work can start (refer to NAERLS Bulletin Fish Pond Site Selection and Construction for details). Depending on the nature of the surrounding land, the construction could be manual or mechanical. In marshy lands, the use of heavy aquipment is not advisable. The is due to the risks and difficulties of using such equipment in those kinds of terrain. Construction of a large farm may require the services of an Aquaculture Engineer or a Technical expert from any Fisheries institution.

The main parts of any fish pond to be constructed are the dam walls (dikes), the water inlet and outlet system (Fig.7). Pond dikes must be well compacted to prevent leakages. Concrete ponds are preferable in areas where the soil is too sandy for earthen ponds or enough land is not available or the pond is required within the living premises. Cost of construction of concrete ponds vary with the size of pond, location, availability and cost of labour, source of water and cost of inputs such as cements, sand, gravel, plastic pipes, solid blocks, etc.

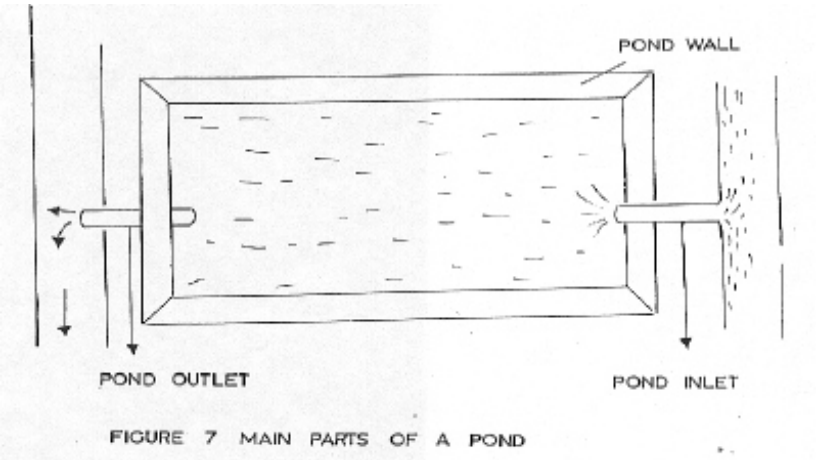

FIGURE 7 MAIN PARTS OF A POND

7.0. POND FERTILIZATION

Two types of fertilizers can be used for pond fish culture. These are organic manures and inorganic or agricultural fertilizers. Application rates of these fertilizers are shown in Table 3.

Fertilizer helps in enriching water nutrients for plankton production on which fish feed. There should be regular application of fertilizer to keep the water colour green. Bright green colour incates that the pond is fertile (rich in organic nutrients).Deep green colour of ponds water indicates over fertility. A farmier should guide against excessive fertilizer/manure application. To avoid depletion of dissolved oxygen in pond water The consequence of such is massive fish death.

TABLE 3: Recommended Fertilizer Application Rate in Ponds

FERTILIZER TYPE	APPPLICATION RATE	COMMENTS
ORGANIC		
1. Cow Manure	500kg/ha/month	3,000kg/ha to be applied to bottom of new ponds before filling, if possible.
2. Poultry Manure	112-224kg/ha/wk	Or 1,000 ducks per ha. In combined culture or 350 layers per ha.
3. Pig Manure	560-1680kg/ha/week	Or 100 pigs/ha at ratio of 1:3 males to females in combined culture.
INORGANIC		
1. Basic slag (15% of $P_2^0{}_5$)	36kg/ha/month	To be applied one week after application of lime.
2. Triple Super Phosphate (T.S.P)	60kg/ha/month	Applied twice monthly
3. Ammonium Sulphate (A.S.)	300-400kg/ha/month	Applied twice monthly
4. Mixture of TSP and A.S.	133-238kg/ha/month	To be applied monthly for four months

Source - Ita E. O. 1989.

8.0. STOCKING

Stocking is the introduction of fish (fingerlings or adult fish) into the new pond environment. Two sources of stocking are possible. Fish can be collected from the wild (rivers, streams, lakes, etc) or from hatcheries/existing fish ponds where fish are already adapted to culture condition. The closer the source of getting the fish to the pond, the better; to reduce to the bearest minimum fish mortality during transportation. Fish should be collected with the water of the environment they have been used to. Hardy fish species like Clarias and Hetero branchus can be transported in plastic basins over a short and fair distance (Fig. 8). For longer distances, fish fingerlings should be transported in polythene bags containing water and oxygen (Fig. 9).

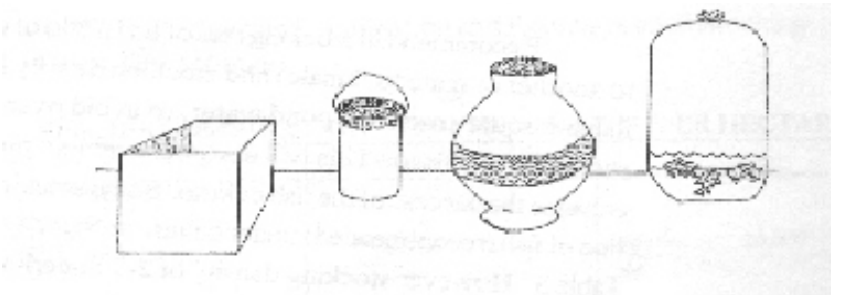

Figure 8. Containers for fish transportation

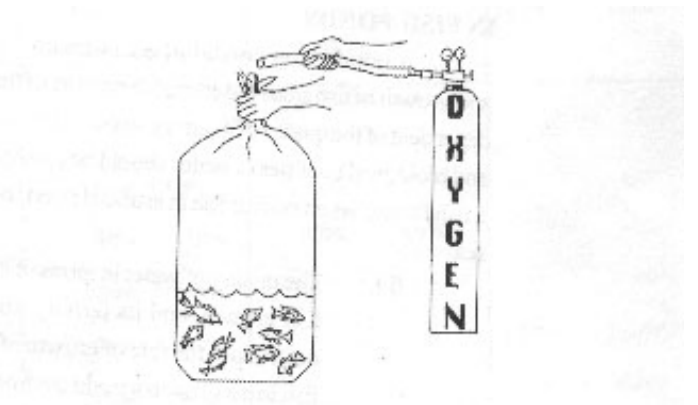

Fig 9. Polythene bag filled with water and oxygen used for fish transportation

Test stocking (pre-stocking) should be practised by introducing few fish into the new environment. Test stocking period range from two days to

one week. If the fish survive well, then the pond can be fully stocked.

Recommended stocking rate of fish (ratio of one species to another or male to female) and stocking density (number of fish per square metre of pond water) to avoid over-crowding, should be practised. This will ease management problems and enhance the success of the fish culture. Some combination of fish under culture in Nigeria are shown in Table 4.

TABLE 4: Species Combination and Recommen ded Stocking Rates (Fingerlings) per hectare.

	Freshwater	Brackish Water
1. MONOCULTURE		
Tilapia spp.	10,000 - 20,000	10,000 - 20,000
Clarias (mudfish)	3,000 - 5,000	-
Heterotis	500 - 1,000	-
Carp	3,000 - 6,000	-
Migil species	-	10,000 - 20,000
Grey Cat fish	7,000 - 8,000	-
2. POLYCULTURE		
Tilapia + Carp	2,000 – 3,000+2500	-
Tilapia + Clarias	40,000- 6,600	-
Tilapia + Tarpon	-	6,000 + 4,500
Tilapia + Mulet	-	8,000 + 10.000
Tilapia + Mugil	-	10,000 + 10,000
Tilapia + Mugil +	-	
Grey Cat Fish	-	10,000 +2,500+1,000

Source: DFRRI 1988 *Note stocking density can be quite higher under intensive recycling system*

9.0. LIMING PRACTICES

(a) What is Liming?

Liming is the process of application of agricultural/industrial limes to fish ponds. If pond soils/or water are not acidic, liming may not be necessary. Soil and water may be tested in a laboratory or with a water analysis kit to determine whether liming is required.

(b) Why Should A Pond Be Limed?

Liming of fish ponds is important for the following reasons:-

1. Lime corrects the acidity of pond water to the suitable PH range(Hydrogen Ion Concentration). A of 5 – 9 is considered suitable for fish gro
2. Lime makes available phosphorus added in fertilizer for plant use. Phosphorus promotes the growth of algae (the microscopic plants) which are the base of natural fish food production in ponds.
3. Lime acts as disinfectants of pond bottom, especially in newly constructed ponds or ponds in fallow.
4. Lime helps in reducing water turbidity i.e. in settling soil particles in muddy ponds.

(c) How to Apply Lime

Lime can be applied to pond bottom before impoundment (in filling with water) or to a flooded pond.

Pre-Impoundment Application

The following steps should be followed in applying lime to a prepared pond.

i. If lime is in lumps, break the lumps to fine powder by matching on the bag.
ii. Spread the lime evenly on the pond bottom (Fig. 10)
iii. A disc harrow or rake can be used to mix the lime with the pond soil manually.

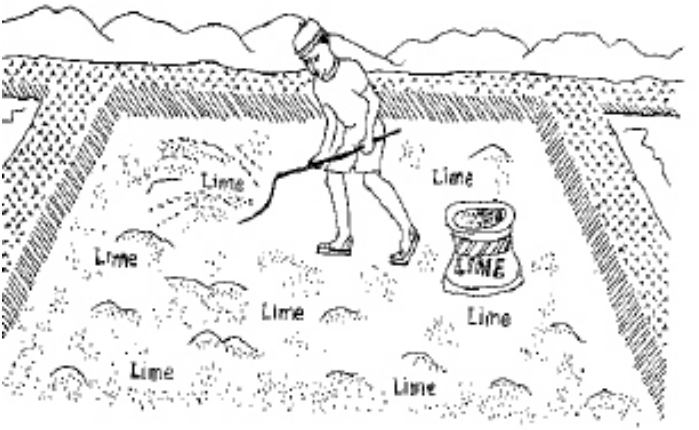

FIGURE 10 SPREAD LIME EVENLY OVER THE POND BOTTOM

Precaution

1. Wear protective clothes and shoes (preferably rain boots) in applying lime to pond bottom.
2. As much as possible, avoid inhaling the lime dust. This is dangerous to health.
3. After application, take a bath.

Post-Impoundment Application.

If the pond is already infilled with water, then take the following steps.

1. Tie the mouth of the sack containing the lime material.
2. Tie the bag to a pole and allow the lime to sip freely into water (Fig. 11).
3. After about 48 hours (2 days) retrieve the sack from the pond. By this time, the lime material must have sipped completely into the pond.

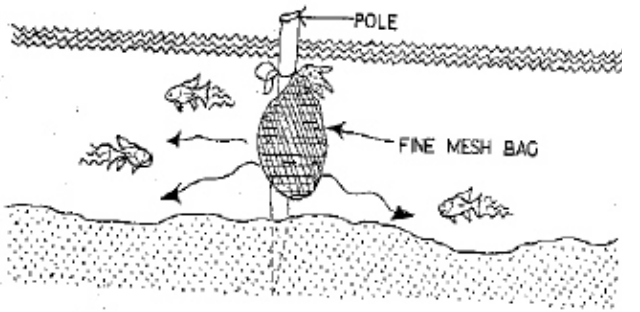

FIGURE 11 LIME / FERTILIZER PLACED IN A BAG AND TIED TO A POLE.

(d) Liming Materials Good For Fish Ponds

These include:-

1. Limestone/Agricultural lime – $CaCO_3$
2. Caustic/slacked or hydrated lime - $Ca(OH)_2$
3. Quicklime – CaO

Agricultural lime is the best liming material for fish pond. It is also the cheapest and readily available. They are by-products of cement factories and can be obtained from such places.

(e) Liming Rates

The recommended liming rate using agricultural lime is shown below in Table 5.

TABLE 5: LIMING RATES OF POND USING AGRICULTURAL LIME

SOIL TYPE	NEW PONDS	OLD PONDS
1. Clay soil	1680 - 2240kg/ha/year	1120kg/ha/year
2. Sandy soil	1120 - 1680kg/ha/year	560 - 1120kg/ha/year

Source: DFRRI (1988)

10.0. FEEDING OF POND FISH

Fish feed on a variety of foods. These include food produced from the natural pond environment and feeds given as supplement to the pond.

(a) Natural Fish Foods

Living organisms are natural fish foods and they are produced in the water where the fish live. Phytoplankton (microscopic plants), zooplankton (microscopic animals), and large aquatic organisms like insects, crustacea, molluscs, and aguatic plants are all examples of natural foods (Fig. 12) Fertilization increases their abundance..

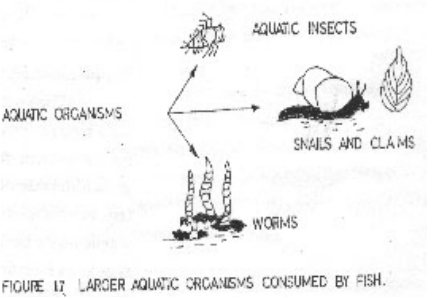

Fig 12. Lager aquatic organisms consumed by fish

(b) Supplementary Feeds

When natural foods are not availanble in sufficient quantity to provide adequate nutrition for fish growth, feeds that are manufactured or grown outside of the fish pond may be fed at regular intervals (daily, weekly, etc). These feeds supplement natural foods. Supplementary feeds should include finely divided artificiel food like egg yoke, bloodmeal, fish meal, shrimp flour, bean flour, oil cakes, bone meals, cereal brans, etc. Adult fish prefer feeds available in pellet form. Sinking pellets are more suitable to bottom feeders like Clarias and Heterotis spp., while for Tilapia, floating pellets are suitable. Pelleted feed of not more than 3.2mm in diameter is suitable for fish species. It is recommended to feed fish with pellets since the whole nutrients in the food will be readily taken by the fish. Good quality feed for fish farming purpose should have the following proximate composition.

- Protein - 35%
- Minerals and Vitamins 32 – 33%
- Fat - 11%
- Carbohydrate 6 - 10%

Feed ingredients should be free of toxicants, e.g. Haemagglutinins in raw soyabeans and Gossypol in cotton seed meal. These toxicants can be removed by roasting the feed stuffing redients. The following are hints for feeding fish in ponds:

1. In polyculture, the feeding habits of fish species stocked should be considered. A combination of species like Tillapia, Clarias and Heterotis in the same pond will require sinking and floating pellets/crushed meals.
2. Feed fish at definite points in the pond. This will make the fish to respond more to feeding spots.
3. Feed fish on daily basis – best times are morning before 7.00 am and evening around 6.00pm. Irregular feeding will retard the growth rate of fish.
4. Avoid overstocking of pond with feeds. Overstocking can result

in water pollution and death of fish. Feed fish according to the recommended rates.

The recommended feed formular in preparing varying percentages of rich protein feeds is as shown in Table 6.

Table 6: Feed Formulae for Preparing Feeds of Various Crude Protein Levels Using Locally Available Feed Ingredients.

% Crude Protein	Palm Kenel Cake (kg)	Corn Bran (kg)	Rice Bran (kg)	Fish Meal (kg)	Soya bean Meal (kg)	G/nut Cake (kg)	Total Weight (kg)
20	45.30	45.30	-	3.1	3.1	3.1	99.99
20	-	35.80	35.80	-	11.20	11.20	100.00
35	-	24.0	24.0	17.3	17.3	17.3	99.99
40	21.2	21.2	-	19.2	19.2	19.2	100.00

Source – NIFFR 1989. Annual Report..

11.0 CONTROL OF DISEASES AND PREDATORS

(a) Common Fish Diseases

Fish diseases are caused mostly by fish parasites. Maintaining a hygienic pond environment is the best preventive method of checking diseases outbreak. Diseases can occur in fish pond due to:-

1. Overcrowding, i.e. high density stocking.
2. Poor water quality resulting in fish kill
3. Erratic feeding practices. Starved fish are highly susceptible to diseases attack.
4. Intrusion of predators into the pond. Most predators act as intermediate host to fish parasites.
5. Over fertilization of pond water leading to high density algal bloom can reduce the amount of dissolved oxygen (DO), affecting fish health.

Broadly, diseases can be classified into:-

i. Bacterial and viral
ii. Fungal
iii. Protozoan
iv. Worms
v. Crustacean
vi. Environmental, and
vii. Nutritional

(A) Fish Fredators

Predators are natural enemies of fish. Common fish predators that should be prevented from causing fish losses in ponds include water snakes, turtles, frogs, water birds (king fisher and water duck, etc), crocodiles, crabs, etc. Wild carnivorous fish intruding into ponds are also predators and as such should be prevented.

1. Ensure regular clearing of pond site. Predators hide in bushes.
2. As much as possible, the farmer should fence the pond site.
3. Most aquatic predators get into the pond through flood water. Measures should be taken to protect the pond from flood water.
4. Hunt the predators, using traps or point blank killing.

Common fish diseases, causative factors or agents, symptoms and treatment recommended are highlighted in Table 7.

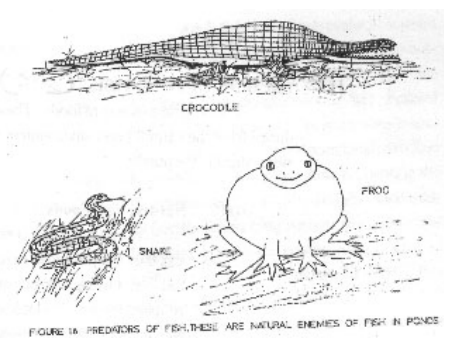

Fig. 13 Some common Predators of fish

Table 7: Common Fish Diseases, Causative Agents, Symptoms and Recommended Treatment

DISEASE	CAUSATIVE FACTOR/AGENT	SYMPTOMS	TREATMENT
1. Bacterial Infectious abdominal dropsy (I.A.D.)	Pseudomonas Puntata	Swelling of belly	Antibiotic such as chloramphenicol. 1gm/kg of feed or 5ml injection
2. Fungal a) Gill or Branchiomyiosis b) Saprolegnia infection	Branchimyces anguimis Saprolegnia	Red spots on the gill Appears as fussy, grey whitish blotches on skin	Avoid dense stocking. Remove affected fish. Isolate the fish and treat with CuS04 dust.
3. Protozoan Ichtyophthirriasis	Icthyophthirius	Red patches on gill & skin	Difficult to treat when parasites are in the dermis. Drain & lime the pond.
4. Worm Diseases a) Fish Leeches b) Fish Fluke	Piscicola geomatra Dactylogyrus vastator	Skin covered with the leach cause excessive weakness Gills swells and turn grey	Drain the pond. Put fish in solution of 1m1 Lysol and 5l of water for 5 seconds. Drain the pond. Treat fish in salt solution of 25gm per litre of water for 10 seconds.
5. Disease Caused. By Crusacean Argutus Infection	Argutus foliaceus	The string of the fish lice cause red patches on the fish skin	Drain and lime pond. Treat fish in solution of KMn04 or Lysol both 1gm/1tr. Of water for 40 seconds.
6. Environmental Diseases a) Acidic water b) Alkaline water b) Low DO	Low PH below 5 High PH above 9 Asphyxia	Fish skin covered with whitish film, gills turn brownish. Mortality of fish Mortality of fish Fish regularly come out to gasp for atmospheric air. Mass mortality of fish with wide open mouth and gillss wide apart.	Apply 500kg of a $CaCo_3$ha/ha of pond. Apply lime in a sufficient quantity according to PH level. Drain pond and change water Aerate the pond if device is available or flush fresh water by high velocity into the pond
7. Nutritional Disease	Enteritis	If abdomen is pressed lightly a yeloow-red liquid flows from the anus Intestine is red congested and highly inflamed	Use balance diet fed with high proportion of protein or vitamin to correct nutritional deficiency.

12.0. CROPPING (HARVESTING) POND FISH

In fish pond culture system, three types of cropping are practised in routine management.

(a) Test cropping
(b) Partial harvest
(c) Total pond harvest

(A) Test Croping: Fish pond should be test cropped routinely to monitor fish growth and health. After examination, test cropped fish should be returned to the pond water. A scoop net is suitable for test cropping (Fig. 14). Wounding gears e.g Gull not should not e used for test harvesting.

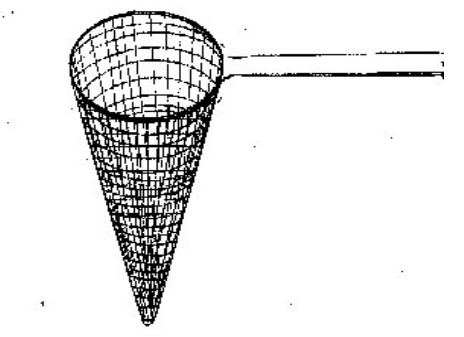

Figure 14 - A Scoope Net for Test Harvesting

(B) Partial Harvesting When different age group of the same fish species or different species combination are reared together in pond, the fish are bound to mature to table sizes at different times. Partial harvest of pond should be done with appropriate mesh size. Matured fish can be selected for market sale or family consumption while undersized ones should be returned to the pond. Periodical harvesting of pond fish enables a farmer to generate revenue periodically. Draw net is most suitable for harvesting pond fish.

(C) Total Harvest: Ponds that have been used to rear fish for over 10 years can be totally drained and the whole fish harvested. Total pond harvest from management point of view can be carried out at the end of a production cycle or in cases of emergency like diseases outbreak. A Draw Net or Drag Net is most suitable for total cropping of pond fish. (Fig. 15). Nets should be cleaned and spread in the sun to dry after each harvesting operation. This is to preserve and prolong their operational life span.

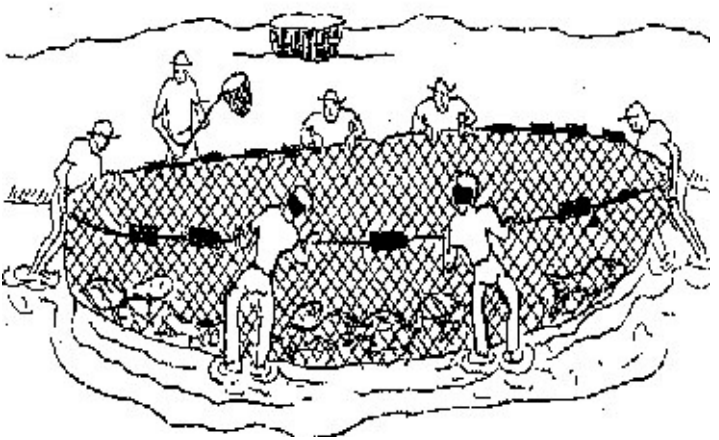

Figure 15 - Nets are frequencly used to harvest ponds

13.0. KEEPING FARM RECORDS

It is important for prospective fish farmers to keep record of events and statement of expenditures and income throughout the production cycle of the fish pond.

(a) The Log Book This should contain information on the following:-

1. Location of fish pond
2. Nature of soil at site
3. Pond ownership type (whether private, cooperative/communal)
4. Pond area and depth
5. Sources of water supply
6. Date of commencement of construction
7. Date of completion of construction
8. Thickness of dam wall
9. Agricultural/Economic activities practised around
10. Date of pond impoundment
11. Sources of Fingerlings/breeders
12. Stocking rate
13. Species of fish stocked
14. Date of stocking
15. Water analysis result (where possible)
16. Fertilizers applied/fertilization practice
17. Limes/liming practices
18. Supplementary feeds applied, including sources and forms (i.e. pellets or grounded).
19. Water management practices
20. Diseases identified
21. Record of fish mortality
22. Staff strength on farm
23. Number of days of contact with advisors, i.e. Extension/Research staff.

(B) Total Expenditure This includes cost.

i. Fixed Cost

1. Land
2. Pumps/Tanks and farm equipment
3. Farm structures
4. Brood stocks.

ii. **Variable Cost**

1. Fish seed
2. Fertilizers
3. Limes
4. Feeds
5. Labour/maintenance
6. Medication
7. Transportation
8. Consultancy

(c) **Income Statement**

Income projection/record can be conclusive after harvest. Financial analysis for project profitability can be easily arrived at with proper records of expenditure and income.

For details on profitability estimation, refer to NAERLS Extension Bulletin No 107, Economics of Aquaculture Production.

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