“SUSTAINABLE FISH FARMING FOR A SECURED FUTURE IN NIGERIA”

A TRAINING WORKSHOP

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DESIGN AND CONSTRUCTION OF FISH PONDS

BY

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1.0 INTRODUCTION

Aquaculture in the country was undergoing a very slow process of development occasioned by the dearth of qualified personnel and poor awareness. However, with the upsurge in the population of the country which inadvertently leads to increase in the protein demand, the need for aquaculture development becomes obvious as it is seen as a veritable option that can complement the protein requirements of the teeming populace. This development has resulted in an increase in awareness and interest in aquaculture by private entrepreneurs. This is expected as aquaculture portends very high prospects to bridge the wide gap between fish supply and demand in the country.

However, fishculture is a sedentary occupation. It can succeed whenever the following requirements are met:-

- Ponds, enclosures or cages correctly built,
- a good management,
- a suitable economic status of the area
- a supply of quality and adequate fish feeds in appropriate forms depending on the age of fish under management.

Text of the Lecture delivered by Mr. Fermi Kudoro (Head of Fisheries),
2.0 FISH POND ESTABLISHMENT

Fish farming through which culture fisheries is effected is mainly an inland feature which involves the construction of fish ponds and other associated structures. A fish pond can be aptly defined as a water body which can be supply with water or drained of its water according to the requirements of fish cultivation. It must provide a suitable environment for fish growth and development. In other words, fish ponds are the structural systems for fish culture. Their designs vary according to the site of location. It could be earthen pond (geophore) in which case the soil forms the embankment and water is retained for fish to grow. Equally, it could be in form of fish tanks; this can be made from Blockwall, Brickwall, Fiber-Reinforced Plastic (FRP), Concrete, Collapsible Plastic Vat, Thermoplastic or metal, Fish Cages etc. Irrespective of whether fish ponds are earthen type or otherwise, the basic principle of improvisation in fish pond enclosures is to simulate the natural environment that obtains in rivers, lakes, etc to achieve optimal fish growth in a specified period of time under a well controlled environment.

The low-income level of the vast number of our fish farmers has been a major constraint to the establishment of the conventional monk-type fish ponds in the past. This problem was viewed with grave concern by researchers and as a way of circumventing the huge capital investment involved in the construction of such fish ponds, pond construction has been re-designed to fit the construction economics of the resource-poor, small scale, rural peasant fish farmers that abound in rural urban communities of the country. Thus, construction of dug out ponds in wetland areas, construction of fish tanks on drainable upland areas with conscious efforts to supply water liberally are common enclosures among our teeming fish farmers in the State.

2.1 Criteria for Selection of an Ideal Fish Pond Site

As in other forms of agricultural ventures, siting of a pond for growing fish has its own specific consideration. Suffice to stress here that the success of a fish farm is hinged on the judicious choice of site selected for fish
pond construction. Thus, we have major and minor factors for consideration in the selection of site for fish pond construction.

The major criteria are:

- Water: (quantity & quality) – physical, chemical properties of water.
- Soil type (retentivity, fertility & PH),
- Topography of the Land:
- Vegetational cover (thickness),
- Capital
- Security.

While the minor criteria are:

- Nearness/Proximity to reputable fish hatchery,
- Access road and Accessible market
- Manpower availability (both skilled and unskilled).

2.2 Fish Pond Construction

Fish Pond construction is a very technical aspect of pond management whose success is based first and foremost on the selection of an ideal site coupled with the technical expertise of a qualified fisheries personnel who will manipulate the available human, financial and natural resources at his/her disposal to get the best result.

The focus of this paper is on the construction of small-scale dug-out fish ponds that have been proven to be reliable, productive and economical in the growing of culturable fish species for optimal yield and fish tank construction.

A procedural stepwise for the construction of a dug-out pond is highlighted below: (Note that this is by no means a rubber stamp but rather a guide)

(i) Visual Survey

(ii) Clearing if the selected site is bushy/forested
(iii) Top soil stripping
(iv) Embankment molding
(v) Pond bottom dressing/grading
(vi) Placement of water bearer structures (importance of free board stressed)
(vii) Grassing of embankments
(viii) Fencing of entire pond area
(ix) Impoundment with water (the various options)

3.0 SHAPE, SIZE AND DEPTH OF A POND

After the most suitable type of fish pond has been determined, its shape, size, depth, the elevations of the water inlet, of the water level in the pond and of the water outlet have to be assessed.

3.1 Shape

With regards to barrage ponds, the shape is directly related to the outline of the ground. On the contrary the contour ponds which are partly digged out in the ground must be shaped so as to reduce down to a minimum the cost of earth work and the length of the dykes.

3.2 Size

The size of a fish pond is estimated from the water surface. The area of ponds used for intensive fish culture varies generally from several hundred square meters to several hectares according to the topographical conditions, the management practices and the income of the owner.

It must be noticed that for a given pond shape; the water surface area is increased fourfold by increasing the total length of the walls only twice. For instance, as 1 square pond has a 40 meter perimeter (or total length of the dikes). Practically speaking, constructing too small or lengthened ponds is not always worthwhile.
3.3 Depth

The depth of a pond should never be less than 0.50m. If the depth value drops below this, weeds may grow on the bottom of the pond and the water easily picks the environmental temperature (fluctuation). The pond must not be too deep so that sun rays can penetrate down close enough to the bottom and enable the phytoplankton to develop in every part of the water body. More, when the pond is very deep, the construction of the walls and of the inlet and outlet structures becomes more complicated and costly. For these reasons the scale of maximum depths of ponds should be ranging from 1.0 – 1.5m.

4.0 FEATURES OF FISH TANKS CONSTRUCTION

(1) Well drained upland area are preferred for tank stability, ease of water drainage and to minimize costs considerably

(2) To maximize space and save costs “twin” or multiples of tanks are recommended as against constructing tanks singly.

(3) Maximum dimension for tanks 4X5X1.2m if bigger than this, there is need for “beam” fortification (i.e. reinforcement with rods at corners.

(4) 9X9X18” inches cement blocks are preferred.

(5) The blocks must be laid to inter-lock at corners.

(6) Thorough plastering (1:4/1:6) of cement to sand ratio is recommended to safeguard water seepage.

(7) At least five coaches of blocks must be laid sequentially.

(8) Artisans are enjoined to fill the holes in the block with rich concrete mix, (1: 3 : 6) as the coaches are being laid.

(9) Outlet pipes with screens to be appropriately located at the formulation level, so that complete water drainage is insured.

(10) Fish tank constructions work should not be rushed while upon completion of construction, farmers are advised to wait for 3 – 4 weeks for the tanks to be completely “cured”.

6
Subsequent upon “curing” you can impound with water from available sources.- river water, bole hole, well, tap water (Ageing of the water ahead of stocking is pertinent).

5.0 FISH POND MANAGEMENT

An ideal water condition is a necessity for the survival and good growth of fish since the entire life processes of the fish is wholly dependent on the quality of its environment. The pond bottom has a vital role to play on the water quality of the medium because the fertility of the pond is directly related to the size of fish at harvest (all things being equal). Hence, it is imperative that fish ponds should be limed and fertilized prior to stocking with fish fingerlings/juveniles.

5.1 LIMING

This is a desirable aquaculture practice. It is the application of lime to ponds. It is usually broadcasted. Liming performs the following functions:

(a) It serves an antiparasitic action in water and on an infected fish.

(b) It increases the pH of acidic water to more desirable level.

(c) It precipitates excessive organic matter in suspension (clay colloids etc) in highly turbid waters, predisposes the water to effective fertilization

(d) Liming of ponds predisposed the water to effective fertilization

(e) The following is the recommended liming rate for ponds.

<table>
<thead>
<tr>
<th>Name of Neutralizers</th>
<th>New Pond Kg/ha</th>
<th>Old Ponds Kg/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agricultural Lime</td>
<td>250-500</td>
<td>200-300</td>
</tr>
<tr>
<td>Slaked Lime</td>
<td>750-1,500</td>
<td>600-1,000</td>
</tr>
<tr>
<td>Quick Lime</td>
<td>750-900</td>
<td>500-800</td>
</tr>
<tr>
<td></td>
<td>250-500</td>
<td>100-250</td>
</tr>
<tr>
<td>----------------</td>
<td>-----------</td>
<td>-----------</td>
</tr>
<tr>
<td>Carbide Waste</td>
<td>250-500</td>
<td>100-250</td>
</tr>
<tr>
<td>Wood Ash</td>
<td>2,500-5,000</td>
<td>1,000-1,500</td>
</tr>
</tbody>
</table>

However, due to the prohibitive cost of the conventional liming materials, fish farmers have over the years evolved and indigenous knowledge system (IKS) in the use of wood ash for the neutralization of their ponds. The neutralizer has been found to be effective, easily and locally available and at a very minimal cost to farmers.

5.2 FERTILIZATION

This simply means the addition of fertilizers to pond. Fertilizers are of two types – Organic and Inorganic. Fertilization is done essentially to provide basic nutrient components and phosphorous primarily for the rapid development of phytoplankton and zooplanktons. This desirable aquacultural practice usually follows liming.

Fish farmers in rural areas make use of organic fertilizers due to its relative availability, abundance and its effectiveness in sustaining the “beer bottle” (green) – coloured water for fish culture. This is another IKS being practiced by fish farmers in the rural areas.

The following is the recommended fertilizer application rate:

**Organic:**
- Cow dung – 500kg/Ha
- Poultry dropping (Guano dropping) 112-224kg/Ha
- Pig manure 560 kg/Ha

**Inorganic:**
- NPK 224 KG/Ha
- Triple Super Phosphate 57kg/Ha

Note that urea fertilizer should never be considered for use in ponds to effect fertilization.
5.3  CULTURABLE FISH SPECIES FOR STOCKING

The choice of fish species to be cultured in prepared pond water is principally governed by the salinity level of the waters for fish culture. For fresh waters fish culture, the species to be selected for stocking must satisfy the following criteria.

(i) Tolerate crowding
(ii) Have fast growth rate
(iii) Have high feed-conversion efficiency
(iv) Utilize efficiently available natural foods
(v) Have high resistance to diseases
(vi) Propensity to breed in captivity
(vii) Command a good market value

Commercially important fish species cultured in our environment include Orechromis nilotrics, Clarias gariepinus, Cyprinus carpio, Heterotis niloticus, Gymnarchus Sp.Chrysichthys nigroditatus, Channa obscura, Hetero-Clarias, heterobranchus bidorsalis.

However, polyculture system, which is the culture of more than one species of fish in the same culture system, it is practised among fish farmers in the country. A polyculture system has been found to utilize optimally the available natural foods at the different tropic levels in ponds thereby increase the production of fish. Stocking manipulation is a phenomenon very related to polyculture. Sequential stocking of the different species of fish considered to be compatible is done by a fisheries expert so that the indiscriminate stocking of different species of fish is regulated/curtailed.

5.4  FISH STOCKING

After the pond water preparations have been concluded and allow to equilibrate for a minimum of one week, the pond is then said to be ready to “receive” fish. Fish stocking is the process of introducing selected, culturable, compatible and fast growing fish seed into ponds for culturing or growing. This is usually done in
the early hours of the day or late in the evening when the ambient temperature is expected to be cold. The quantity of fish to be stocked is a factor of owner’s financial resources, the hectarage of pond and the level of impoundment (volume of water).

It is pertinent to emphasize that fish juveniles are highly recommended for stocking as against fish fingerlings that are more vulnerable to predation. However, stocking with fish fingerlings in a newly constructed pond devoid of any remnant fish, with fenced environment is recommended too.

5.5 FISH FEEDING

In culturing fish in captivity, provision of well-balanced diets and adequate feeding are very important. If there is no utilizable feed intake by the fish, there will be no growth and the stocked fish may eventually die. An undernourished or malnourished fish is never able to maintain its health and be productive, no matter the quality of its environment.

Fish requires a very high level-protein feed for good growth and development. The desirable protein content of fish feed varies with the stage of growth of the fish and the species of fish in question.

Thus, the protein requirements of Clarias fingerling/juveniles ranges between 40-44% crude proteins while for sub adults Clarias it ranges between 36-40% crude proteins for Tilapia, 32% crude protein gives a very satisfactory result.

The protein requirements reduce with age and size of fish. In feeding fish, consistency in timing coupled with periodic review of the feed intake based on the body weight gain over time are crucial factors that should be viewed with grave concern. Feeding frequency too is an integral aspect of feeding management.

By and large provision of good quality feed in adequate and in the right form (powdery/sinking pellets/floating pellets) are very vital to successful fish culture in a controlled environment.

5.6 TEST CROPPING

At the end of the first 2-4 weeks of stocking, test cropping of the stocked pond is usually recommended to ascertain the growth response of fish to the feeds provided, as well as to sort out the shooters among the fish
stocked as a way of reducing cannibalism and territorial dominance in the pond water environment. (Fingerlings – juveniles stock).

However, bimonthly assessment of the stocked fish in tanks is recommended to ensure uniform growth as much as possible.

5.7 ENVIRONMENTAL SANITATION

It is imperative that fish pond environment must be devoid of thick vegetation that harbours fish predators while at the same time renders pond surveillance extremely difficult. The menacing activities of poachers are curtailed when the pond environment is clean.

5.8 FISH HANDLING

Fish, being a highly perishable foodstuff must be handled with greatest care and speed for it to reach the consumer in good condition for the product to attract good price from fish eaters and buyers alike.

In as much as production is not complete until the goods have reached the consumers in good quality. The maintenance of fish quality (freshness) should always be paramount in the minds of fish farmers.

5.9 HARVESTING OF FISH

Harvesting of fish is usually done using appropriate fishing gears. The type of fishing, gears employed to harvest fish play a significant role in determining the quality of the catch. (Freshness). Also, the size of the water body dictates which fishing gear to employ to get the fish out of water.

Fishes are caught in inland waters by the use of gill-nets hook and line, cast-nets, seine nets and various immobile traps. In ponds, the use of drag-nets, and cast nets predominate over other fishing gears.

Ideally, fishing/harvesting should be done in the early hours of the day or late in the evening when the ambient temperature is expected to below, so that the microbial spoilage of fish is put in check. When the stocked fish have reached marketable sizes (0.5kg on the average), they can be cropped. Prior to cropping, adequate publicity must be made on the sales of the fish. Owing to the low level of income of most rural people, fish ponds located in the rural areas should, as a matter of must source for a better market for their fish in urban areas. However, the cost benefit ratio of this should be borne in mind so as not to reduce the marginal profit.
(MP) expected (via transportation). Where possible, middlemen should be avoided because of their exploitative tendencies.

6.0 FISH MARKETING

Fish production in the early days was production oriented which is liable to end in economic loss. Modern production is market oriented whereby the market or the demand is identified with the intention of meeting consumers need as dictated by their income. The fish products for sales could be frozen, cured, sold fresh or in fish meal form. It is pertinent to note that when fish produced exceeds subsistence level, market strategies have to be adopted.

Macro Environmental Factors the affect fish marketing are:

- The economic environment
- The technological environment
- The political environment
- The legal environment
- The cultural environment

By and large, an efficient marketing system for fish and fish products should critically appraise and criticize the noble roles of the middlemen fish production since production is not complete until the goods reach the final consumers in desirable forms.

4.1 CHALLENGES IN FISH FARMING

The widespread adoption of fish farming by all and sundry has led to the enterprise to be faced with myriad of problems, some are self inflicted some accidental while some are unavoidable. Underneath are some of the limiting factors that are quite important to surmount to be able to succeed in fish farming.

1. Huge Capital Outlay (harmonization of available resources to get production on course at minimum cost possible)

2. Site section (Appropriateness of sites to infrastructural Development)

3. Presence of Quack serving as Consultants in Fisheries Development.
(4) Pond Construction errors (designs and appropriateness)
(5) Water supply (Quantity, Quality and Sustainability)
(6) Water treatment ahead of fish stocking (Turbidity, over fertilization etc)
(7) Choice of fish species to stock and where to source from (acceptability and commercial value)

(a) **Stocking Density Issues**
- Under stocking
- Over stocking
- Optimal stocking

(b) **Culture systems**
- Mono culture – Merits & Demerits
- Poly culture - Merits & Demerits

(8) Choice of Fish seed to stock: Fingerlings Vs Juveniles
- Credibility of hatcheries

(9) Fish Feeding:

The various options are:
- Floating fish feeds (pelleted)
- Sinking fish feeds (pelleted)
- Pulverized fish feeds
- Adequacy factor
- Quality factor
- Frequency factor
- Underfeeding Vs Over feeding
- Locally formulated pelleted fish feeds Production technique
- Progressive Upward Review of Fish Feeds Quantity

(10) Fish mortality: Causes and how to curtail its incidence
(11) Fish diseases: various causal agent prevention and control.

(12) Handicaps in fisheries test cropping

(13) Fish Cannibalism: Its peculiarities and how to minimize it.

(14) Menance of Predator: How to keep them at bay.

(15) Poaching/Pilfering: How to circumvent its occurrence

(16) Environmental Issues: Effluents disposal, managing unpleasant odour, disposal of carcass of fish etc.
    - How to appropriately dispose waste water without having delitereous effects on the immediate environment

(17) Marketable size of fish for sale (1kg less than or above)

(18) Fish Cropping (its sensitivity and timeliness)

(19) Fish Marketing: (The need for continuity in production of fish)

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<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Fish Mongers</td>
<td>Direct Consumers</td>
<td>Hotels &amp; Eateries</td>
</tr>
</tbody>
</table>

(20) Adequate Record Keeping
INTRODUCTION

Feed is the compounded mixture of different ingredients in the right proportion. It contains all nutrients needed by fish to grow well. Just as other animals, fish also needs carbohydrates for energy, proteins for growth, replacement of depleted and for repair of damaged tissues, fats and oils for energy, transportation of fat soluble vitamins. It also serve as a structural component of cell membranes. Vitamins and mineral salts are for proper metabolic reactions and growth.

Since fish have different stages of growth, there are appropriate feed for every stage viz. Fry/fingerling, fingerling/juvenile and juvenile/adult. As the growth stage progresses, there is progression in the particle size of feed but decrease in nutrient composition.

PRODUCTION OF FISH FEED

Materials needed are: ingredients like,

(a) Carbohydrate or energy sources like maize, cassava chips, wheat, biscuit waste, noodle waste, flour waste etc.
(b) Protein sources like fish meal, soybean cake and meal, groundnut cake cotton seed cake, sunflower meal etc.

(c) Fat and oil sources like fish oil and vegetable oils.

(d) Vitamins and minerals premix and calcium and phosphorus sources like bone meal or di-calcium phosphate (for bone development).

(e) Salts e.g. common salt or agricultural salts and binders. All these materials can be acquired from local feed mills or local markets.

**Preparation**

As there are different stages of growth, one should define which stage the feed to be prepared is meant for as there are different nutritional levels across the stages.

1. For fry/fingerlings, range of crude protein needed is between 40% - 50% and particle size of 0.2 – 0.5 mm. The major component of this will be animal protein source which is high in protein. Other components are plant protein like soybean meal or cake, ground nut cake (GNC) etc. Carbohydrate sources are maize, wheat, biscuit waste, cassava chips, noodle waste and flour waste. These contain less protein but more readily available or non protein energy.

   Note: Fish utilizes energy from protein sources as well as carbohydrate energy.

   Feed for fingerling/juvenile stage should contain crude protein between 35 – 45% and particle size of 0.8 mm – 3.0 mm while feed for the juvenile/ adult stage contains 30 – 40% crude protein, particle size of 4.5 mm and above.

   All the feed ingredients should be milled to powdery form to enable proper digestion. They are then mixed thoroughly together with a little amount of water to enable proper binding together as it passes through the pelleting machine.
The pellet can then be grounded to powdery form to enable consumption for fish in fry/fingerling stage.

Sample feed formulae for different stages in fish culture.

1. Sample formula for fry/fingerling

<table>
<thead>
<tr>
<th>Ingredient &amp; % CP</th>
<th>Rate (%)</th>
<th>Crude protein %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish meal (72)</td>
<td>40.0</td>
<td>28.8</td>
</tr>
<tr>
<td>Full-fat Soya (43)</td>
<td>25.0</td>
<td>10.75</td>
</tr>
<tr>
<td>GNC (45)</td>
<td>10.0</td>
<td>4.5</td>
</tr>
<tr>
<td>Maize (10)</td>
<td>14.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Flour waste (0.5)</td>
<td>5.0</td>
<td>0.025</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>3.0</td>
<td>Nil</td>
</tr>
<tr>
<td>Vit. Premix</td>
<td>1.0</td>
<td>Nil</td>
</tr>
<tr>
<td>Di-calcium phosphate</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>Salt</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>100</strong></td>
<td><strong>45.48</strong></td>
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</tbody>
</table>
2. Sample formula for fingerling/juvenile

<table>
<thead>
<tr>
<th>Ingredient (%)</th>
<th>Rate (%)</th>
<th>Protein (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish meal (72)</td>
<td>35</td>
<td>25.2</td>
</tr>
<tr>
<td>Full-fat soya (43)</td>
<td>20</td>
<td>8.6</td>
</tr>
<tr>
<td>GNC (45)</td>
<td>13</td>
<td>5.85</td>
</tr>
<tr>
<td>Maize (10)</td>
<td>08</td>
<td>0.8</td>
</tr>
<tr>
<td>Biscuit waste (16)</td>
<td>12</td>
<td>1.9</td>
</tr>
<tr>
<td>Flour waste (0.5)</td>
<td>06</td>
<td>0.03</td>
</tr>
<tr>
<td>Vegetable oil</td>
<td>03</td>
<td>Nil</td>
</tr>
<tr>
<td>Vit. Premix</td>
<td>1.0</td>
<td>Nil</td>
</tr>
<tr>
<td>Di-calcium phosphate</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>Methionine</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>Salt</td>
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<td>Nil</td>
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<tr>
<td><strong>TOTAL</strong></td>
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<td><strong>42.38</strong></td>
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</table>
3. Sample formula for juvenile/adult

<table>
<thead>
<tr>
<th>Ingredient (%)</th>
<th>Rate (%)</th>
<th>Protein (%)</th>
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</thead>
<tbody>
<tr>
<td>Fish meal (68)</td>
<td>30</td>
<td>20.4</td>
</tr>
<tr>
<td>Full-fat soya (43)</td>
<td>20</td>
<td>8.6</td>
</tr>
<tr>
<td>GNC (45)</td>
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<td>6.75</td>
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<tr>
<td>Maize (10)</td>
<td>05</td>
<td>0.5</td>
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<tr>
<td>Biscuit waste (16)</td>
<td>18</td>
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<td>Vit. Premix</td>
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<td>Di-calcium phosphate</td>
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<td>Nil</td>
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<tr>
<td>Methionine</td>
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<td>Nil</td>
</tr>
<tr>
<td>Lysine</td>
<td>0.5</td>
<td>Nil</td>
</tr>
<tr>
<td>Salt</td>
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<td>Nil</td>
</tr>
<tr>
<td>TOTAL</td>
<td>100</td>
<td>39.16</td>
</tr>
</tbody>
</table>

FEED APPLICATION IN PONDS

Feeds are majorly organic materials; therefore, their application in ponds should be strictly controlled. Many farmers who had experienced mortalities in the ponds might have been as a result of lack of control in feed dispensed to their fish.

The most effective way to feed fish is by establishing a point where the feed can be dispensed in the water. This method of feeding fish is called point feeding method. The fish soon get used to feeding at this point and they gather around the feeding area. This method enables the farmer to observe fish while feeding. It also helps to know if
the feed is actually being consumed or not. It helps to know when to stop dispensing the feed before it become excess and begins to pollute the water. Care must be taken to stop dispensing feed if the fish are not taking it to avoid water pollution which if not quickly arrested may result to fish mortality.

Note also that the right particle size of feed should be given to the right stage of fish. If too big, fish will not be able to take it, and if it is too small, fish will expend more energy to feed.
CULTURABLE FISH SPECIES, CULTURE SYSTEMS AND MEDIUM MANAGEMENT

BY

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Text of the paper presented on training workshop on sustainable fish farming for a secured future in Nigeria to Ode Lemo farmers held at Ode Lemo Community, Sagamu Local Government Area on 31st January, 2013.

FISH FARMING

What is fish farming?

Fish farming involves raising fish commercially in tanks or other enclosures, usually for food and profit.

It is sometimes called fish culture. Fish farming is however, the most assuring way of fish production known worldwide. It is the most cost-effective form of fish production especially in Nigeria where a national fish demand-supply gap of 1.06 million metric tons exists (Omitoyin, 2007).

Why do we need to raise fish?

By raising fish we make better use of our land and our waters. Fish farming is needed to supply protein for populace and enhance income generation.

What do you need to raise fish?

You will need a piece of land where you can build fish enclosures.

Fish Enclosures

Fish enclosures are rearing systems usually known as ponds in aquaculture. Most commonly used are: Fish tanks and Earthen/dug-out fish ponds. Any of these may be adopted depending on the location and circumstances on which extensionist/Fisheries specialist may advise.

Medium Preparation for Newly Constructed Concrete Fish Tank

- Fill the tank with water.
- Place in manure bags for 30 days (dry poultry manure is preferred)/any other animal manure).
- Brush wash after 30 days.
- Air dry for one day.
- Soak with Potassium permanganate (KmNO4) for one day.
Air dry for one day.
Fill with water and stock healthy fingerlings. As from third day of re-impoundment.

CONSTRUCTION OF EARTHEN POND

- Clear site of weeds/vegetation.
- Peg out the required area.
- Remove the top soil until a firm lateritic basement is reached with respect to the nearness to the water table.
- Ensure proper gradient of the sides of ponds.
- Dress dykes, slopes and grass properly all the sides of ponds.
- Insert the overflow pipes on the dyke to cater for the release of excess water.
- Fence round with wire mesh and not mosquito net to deter predator and or fish escape.

Cultivable Fish species

Fishes that can be grown in fish ponds or (fish enclosures) are called cultivable fishes.

These fishes are shown in Table 1 below:

### Table 1. Some Cultivable Fishes.

<table>
<thead>
<tr>
<th>S/N</th>
<th>COMMON NAMES OF FISHES</th>
<th>YORUBA NAMES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mud Fish</td>
<td>Aaro; Abori</td>
</tr>
<tr>
<td>2</td>
<td>Mango Fish</td>
<td>Epiya</td>
</tr>
<tr>
<td>3</td>
<td>Slap Water</td>
<td>Aika-Odo, Alapa</td>
</tr>
<tr>
<td>4</td>
<td>Trunk Fish</td>
<td>Eja Osan</td>
</tr>
<tr>
<td>5</td>
<td>Cat Fish</td>
<td>Obukun</td>
</tr>
</tbody>
</table>

**NOTE:** The first two are most commonly grown in Nigeria.
**STOCKING**
Fishes recommended for stocking are *Clarias gariepenus* and *Tilapia*. The stocking rate varies from 5 – 50 fish/m².

**STOCKING SIZE/TYPE**: Stock fish size from 5 – 12 cm, that is, fingerlings or juveniles.

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**DAILY FISH TANK AND EARTHEN POND MANAGEMENT SCHEDULE**
- Visit fish tank/earthen pond site early morning (7-8am), midday (12 – 1pm) and night (6-7pm).
- Observe fish for movement for stress or disease.
- Feed with appropriate feed at least 3 times daily at three-hour intervals.
- Feed at designated feeding spots (using corners of the tank/earthen ponds)
- Increase feed particle size as fish grow. (See feed schedule table 2).
- Ensure partial drainage through flushing (at least 10%) and topping of pond water preferably every three days especially for fingerlings/juveniles in tanks till two months old.
- Drain pond water at least 70% and replace with fresh water every 10 – 12 days throughout the culture period in tanks, in earthen use water pumps to flush in water.

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**FISH FARM SECURITY**
Security must be provided in all cases to prevent investment loses.
- Wire fencing with chicken wire to deter predators.
- Cover surface tanks with mosquito netting to deter predatory birds.
- Use of security guards.
- Use of Dogs.

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**FISH FARM RECORD KEEPING**
It is important to keep records in order to:
- afford evaluation of the profitability and general economics of fish farm investment.
- provide vital management information for future planning and development of the farm.
- provide necessary grounds to obtain credit or funding from financial institutions.

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**FISH HEALTH MANAGEMENT**

**WHAT IS FISH DISEASE?**
- Fish disease can be defined as a deviation of fish body from its normal or healthy state to an unhealthy, discomfort or sick conditions as a result of infectious agents or non infectious conditions.
- It is also a set of interactions among the host, the pathogen and the environment.
- Host factors include species of fish, size or age, immune status and general physiological conditions.

What are the causes of diseases and stress?
- Poor management practices.
- Overstocking/crowded population of fish
- Stagnant nature of most ponds or culture systems

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Improper handling of fish during stocking, sorting
Poor water management
Sudden pH surge
Excessive application of fertilizer
Application of excess supplementary feed

CAUSATIVE AGENTS
Bacteria, Fungi, Viruses and Environmental stress factors

SIGNs OF DISEASES
Fish is suspected to be diseased when there is a change in the normal behavior and the physical nature of the fish.

There are two major signs
Behavioral signs and Physical signs

Behavioural signs of diseases
Stocked fish will:
- Swim sluggishly in an uncoordinated manner
- Gasp at the surface for air
- Lose appetite
- Float with underside up
- Fail to respond to fright stimulus
- Scratch body against side of ponds

Physical Signs of diseases
Stocked fish will
- Gapping mouth
- Lose weight
- Have pale gills
- Have lesions or sores in the body
- Bloated stomach
- Red patches on belly

TYPES OF DISEASES
Infectious, Parasitic, Nutritional and Environmental diseases

METHODS OF TREATMENT
- Dip Treatment
- Flush Treatment
- Feed Treatment
- Injection Treatment
REFERENCES


INTRODUCTION

Aquaculture (aqua farming) is the science, art, and business of cultivating marine or freshwater food fish or shellfish, such as oysters, clams, salmon, and trout, under controlled conditions. The cultivation of fresh-water and marine species (the latter type is often referred to as mariculture). It is also the rearing of fish, shellfish, and some aquatic plants to supplement the natural supply. Aquaculture is the cultivation and harvesting of fish, shellfish or aquatic plants (such as seaweed) in natural or controlled marine or freshwater environments. The most economically important form of aquaculture is fish farming, an industry that accounts for an ever increasing share of world fisheries production.

Particular kinds of aquaculture include fish farming, shrimp farming, oyster farming, algaculture (such as seaweed farming), and the cultivation of ornamental fish. Particular methods include aquaponics and Integrated multi-trophic aquaculture, both of which integrate fish farming and plant farming.

FISHERIES SUB-SECTORAL CONTRIBUTION

- INDUSTRIAL: 5.0 – 7.0%
- ARTISANAL: 87.0 – 90.0%
- AQUACULTURE: 5.0%
IMPORTANCE OF FISHERIES

- Economic
- Nutritional
- Food Security
- Employment Generation
- Income Generation
- Earning Foreign Exchange
- Health Benefit

FISH DEMAND AND SUPPLY

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DEMAND</td>
<td>2.1 MILLION TONS</td>
</tr>
<tr>
<td>SUPPLY</td>
<td>1.19 MILLION TONS</td>
</tr>
<tr>
<td>DEFICIT</td>
<td>981,000</td>
</tr>
<tr>
<td>PER CAPUT</td>
<td>85.2KG</td>
</tr>
<tr>
<td>WORLD BANK</td>
<td>15.0KG</td>
</tr>
</tbody>
</table>

REASONS FOR GROWTH POTENTIAL FOR FUTURE AQUACULTURE

- Stagnating capture fisheries
- Contribution to food security and nutrition, foreign exchange, employment and poverty alleviation
- Increase production through improve technology
- Expand production areas by conversion of land unsuitable for agriculture
- Numerous fish species suitable for aquaculture
Table 1: Nigeria fish supply by sectors (2000 - 2008) Tonnes

<table>
<thead>
<tr>
<th>Sectors / Year</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTISANAL: SUB TOTAL</td>
<td>418.06</td>
<td>433.53</td>
<td>450.96</td>
</tr>
<tr>
<td>Coastal &amp; Brackish water</td>
<td>236.80</td>
<td>239.31</td>
<td>253.06</td>
</tr>
<tr>
<td>Inland: Rivers &amp; Lakes</td>
<td>181.26</td>
<td>194.22</td>
<td>197.90</td>
</tr>
<tr>
<td>% CONTRIBUTION</td>
<td>89.5</td>
<td>89.2</td>
<td>88.1</td>
</tr>
<tr>
<td>Aquaculture (fish farm)</td>
<td>25.720</td>
<td>24.398</td>
<td>30.664</td>
</tr>
<tr>
<td>% CONTRIBUTION</td>
<td>5.5</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>INDUSTRIAL (COMMERCIAL TRAWLER)</td>
<td>23,308</td>
<td>28,378</td>
<td>30,091</td>
</tr>
<tr>
<td>% CONTRIBUTION</td>
<td>5.0</td>
<td>5.8</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>---------------------</td>
<td>----------</td>
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<td>----------</td>
</tr>
<tr>
<td>Fish (Inshore)</td>
<td>13,877</td>
<td>15,792</td>
<td>16,065</td>
</tr>
<tr>
<td>Shrimp (Inshore)</td>
<td>8,056</td>
<td>12,380</td>
<td>12,979</td>
</tr>
<tr>
<td>EEZ (OFFSHORE)</td>
<td>1,375</td>
<td>206</td>
<td>1,229</td>
</tr>
<tr>
<td>DISTANCE WATER</td>
<td>557,88</td>
<td>468,19</td>
<td>681,25</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>1,024,982</td>
<td>1,134,510</td>
<td>1,192,872</td>
</tr>
<tr>
<td></td>
<td>982</td>
<td>510</td>
<td>872</td>
</tr>
</tbody>
</table>

*Source: Federal Department of Fisheries (FDF), 2009*
Harvest is one of the most important parts of fish farming and is frequently overlooked. This phase is often under-equipped and poorly planned. In cages and raceways, harvest may be as simple as partial draining; then herding, confining and removing fish with a dip net. However, harvesting pond raised fish can be the most labor intensive aquacultural activity. Ponds are harvested by the drain-and-seine (total) or the multiple (partial) harvest method. Harvest should take place during cool weather (water temperature, 60-65°F) if possible. When water temperatures are 80°F or higher, harvest fish in the cool, early morning hours. It is helpful to have cool well water nearby.

**Deciding when to harvest**

- The decision to harvest the fish from a pond is made for two main reasons:

  1) The fish has attained the right size at which it gives maximum profit in the market and any further waiting may reduce the profit.

  2) When the prevailing market opportunities (like Christmas and Easter) offer the highest profit and the opportunity may be lost with delay.

**Harvesting Strategy**

- Harvesting of farmed fish is dependent on the type of culture system operated.
- With advancement in technology, harvesting starts from 4-6 months from date of first stocking.
- Average size of fish at harvesting time is 500g – 1,0kg for catfish; 250g and above for Tilapia species.

**Guiding Principles for Harvesting Farmed Fish**

- **Prior to harvesting fish should be purged of any residual hormones drugs, feeds or algae material likely to cause harm or off flavor.**
- Harvest when weather is cool: morning or evening
- Handle carefully to avoid bruising and stress
- Harvest should be quick and efficient to reduce damage and contaminations.
- Harvested fish should be sorted into sizes, counted, weighed and stored in separate containers in water.
- Harvested fish must not be exposed to high ambient temperature.

**Harvesting Methods**

**Partial Pond Drainage:** This method involves reduction in volume of water (20-25%) to enable the fish to be headed together and easy to crop, this have gained popularity in recent years because of limited water supplies and the high cost of pumping. **Types:** selective and non-selective partial harvesting
COMPLETE POND DRAINAGE: For total cropping. The easiest way is to underlay the tank with netting materials or perforated tarpolin/nylons with twines or retrieving ropes attached to the outer edges. Water automatically drains out and fish is collected en-mass when lifted.

Frequency of Harvest

- Partial/intermitted harvesting is done once or twice a week or a month – removal of table size fish and selling.
- Complete harvesting can be done – drain pond completely, harvest, sort into sizes, count and weigh.
- Occasional harvesting during festive period is also common
- Frequency of harvest depends on;
- Demand and supply situation.
- Inability to continue feeding after attaining market size.

![Harvesting in earthen pond using drag net](image)

Fig 1: Harvesting in earthen pond using drag net

HARVESTING USING CAST NETS

- A cast net is a net made like an umbrella. It is tied on a rope. It opens out when cast over the pond. As it sinks deep into the pond the mouth is closed, trapping whatever fish that will be in the water space enclosed

Cast net attributes

- The cast nets is cheap
• It is simple to operate, but requires training in the skills
• Does not require large labour force (only one person)
• Catches by chance and the operator does not have much choice of the fish to catch
• It does not harm fish, the fish can be returned into the pond
• Its operation is limited to only small ponds (10x 20m) and is time wasting for larger ponds.

Fig 2: Harvesting in earthen pond using cast net
MARKETING OF CULTURED FISH

- High potential market demand for farmed fish
- Lack of systematic marketing of products – e.g. 90% farmed fish are sold at farm gate.
- Implication is that PRICE is solely controlled by marketers or buyer

MARKETING STRATEGY

1. Co-operation of fish farmers’ association/group in the area of:
   - Collective marketing of product to ensure farmed fish are delivered at cheaper prices.
   - Collective procurement of inputs such as fish seeds, feed, fertilizers, lime, drugs etc. to reduce production cost.

2. For expansion of markets and maintenance of favourable prices – specific information on consumers, marketing channels, utilization of fish and fish products should be regularly provided by the relevant authority

Fig 4: Weighing of harvested cultured fish for sale
Marketing and market information

Marketing information is a broad concept that comprises information about the supply of, and demand for, commodities. It includes information about the availability and costs of farm inputs such as seeds, fertilizers, breeding stock, and value-adding. It is also data on prices and quantities exchanged, duly processed and available to market actors (e.g. agents, traders).

A marketing information system is a system that collects, processes, manages and disseminates marketing information using a variety of channels, which may include:

- An extension services, which may consist of public (government) and private-sector service providers.
- Institutions such as rural resource centers or commodity exchanges.
- The use of ICT’s such as mobile phones, internet and radio.

**MERITS OF MARKETING INFORMATION**

- Know what products the market wants so that you can plan well to meet the market requirements
- Bypass middlemen and reach the market directly
- Improve your bargaining power with buyers in the marketing place
- Obtain better input and product prices
- Be efficient in your production and competitive in your marketing activities
- Reduce costs and improve revenue and profit.

![Figure 3: Fish Marketing Channel](image)

**Table 2: Marketing problems, causes and coping strategies**
<table>
<thead>
<tr>
<th>Problems</th>
<th>Causes</th>
<th>Coping Strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Insufficient working capital</td>
<td>• Inadequate sources of credit and timely availability</td>
<td>• Personal savings, ‘Esusu’, ‘Ajo’</td>
</tr>
<tr>
<td></td>
<td>• Inadequate sources of credit</td>
<td>• Borrowing money/social connection</td>
</tr>
<tr>
<td></td>
<td>• Inadequate sources of credit and timely availability</td>
<td>• Individual savings, contributions</td>
</tr>
<tr>
<td></td>
<td>• Personal savings, ‘Esusu’, ‘Ajo’</td>
<td>• Local market information</td>
</tr>
<tr>
<td></td>
<td>• Borrowing money/social connection</td>
<td>• Local measure and pricing</td>
</tr>
<tr>
<td>2. Lack of institutional support</td>
<td>• Lack of credit</td>
<td>• Individual savings, contributions</td>
</tr>
<tr>
<td></td>
<td>• Inadequate sources of credit</td>
<td>• Local market information</td>
</tr>
<tr>
<td></td>
<td>• Personal savings, ‘Esusu’, ‘Ajo’</td>
<td>• Local measure and pricing</td>
</tr>
<tr>
<td>3. Poor transport and communication</td>
<td>• Isolation and scattered location</td>
<td>• Sell to fish mongers, smoking, drying</td>
</tr>
<tr>
<td>4. Insufficient storage &amp; preservation facilities</td>
<td>• Insufficient insulated containers and lack of ice plants</td>
<td>• Smoking of fish</td>
</tr>
<tr>
<td>and spoilage losses</td>
<td>• Inadequate sources of credit</td>
<td>• Quick disposal to fish buyers</td>
</tr>
<tr>
<td>5. Poor savings &amp; credit facilities</td>
<td>• Insufficient savings and credit</td>
<td>• Personal savings</td>
</tr>
<tr>
<td></td>
<td>• Middlemen are not registered and not control by any authority</td>
<td>• Informal savings &amp; credits (‘Esusu’, ‘Ajo’)</td>
</tr>
<tr>
<td>6. Negative activities of middlemen</td>
<td>• Middlemen are not registered and not control by any authority</td>
<td>• Personal trust and negotiation capabilities</td>
</tr>
<tr>
<td>7. Poor market organization</td>
<td>• Scattered nature of the fish farmers.</td>
<td>• Individual potentials in bargaining power</td>
</tr>
<tr>
<td></td>
<td>• Lack of market information</td>
<td>• Scattered nature of the fish farmers.</td>
</tr>
<tr>
<td></td>
<td>• Lack of market information</td>
<td>• Lack of/ poorly organized cooperatives</td>
</tr>
</tbody>
</table>

**CONCLUSION**

- Contributions of aquaculture to the national economy is important—generates employment, income, foreign exchange and food security.
- Aquaculture is the only alternative to the country’s self-sufficiency in fish production hence, government development effort is focused on production and export.
- Grouping together with other farmers in an association or cooperative will help you harvest and market collectively and enable you to:
  - Bulk individual small quantities into reasonable volumes for marketing
  - Enhance your opportunities to access large-volume buyers such as processors or supermarkets
  - Enhance your bargaining power for higher prices when selling products, or lower prices (discounts) when purchasing inputs, and thus earn higher profits and incomes.
RECOMMENDATIONS

Government should support and encourage the contribution aquaculture makes to the economy through:

- Policies that promote development, improvement, innovation and adoption of sustainable aquaculture for a secured future.
- Expansion and development of aquaculture into a market-oriented industry through provision of credit facilities at single-digit interest rates.
- Provision of social infrastructures to reduce marketing cost.
- Provision of market information to the stakeholders to stimulate trade.
- Encourage association/groups to embark on collective procurement of farm inputs, harvesting and marketing.
- Provision of market outlets for cultured fish and elimination of middlemen effect.

REFERENCES


