FISH POND SITE SELECTION AND CONSTRUCTION

EXTENSION BULLETIN No. 96

Fisheries Series No 2

Published by

National Agricultural Extension and Research Liaison Services
Ahmadu Bello University,
Zaria.

1994

ACKNOWLEDGEMENT

All the sources of information (documented in Textbooks, Guides, and training papers as cited in this bulletin) are acknowledged. Such inputs contributed in no small measures to putting together the technical message to prospective and practical fish farmers this bulletin is meant for.

Bolorunduro, P.I. and Joseph Awelewa

TABLE OF CONTENT

1.0 Introduction

This bulletin is written to assist prospective and practicing fish farmers, and interested persons on the basics of how to identify good sites for earthen fish pond construction. Fish farming can be a profitable business, if the "rule of the game" are followed in its management. The information contained in the bulletin is meant to lead people to interesting fish farming through proper site selection and construction of durable ponds and profitable enterprise.

A fish pond is an enclosure (earthen or concrete) built to retain water for the purpose of growing fish to table-size for household consumption and for sale to generate additional income. Culturing fish in ponds from which they can rarely escape allows feeding, breeding, growing and harvesting of the fish in a well-planned manner. Fish pond constructed in a proper way and managed under controlled conditions gives the highest possible fish production with respect to the size of the pond or reservoir. Fish pond can be constructed on either small-scale or large-scale basis. Small-scale fish rearing can be carried out in a suitable house backyard (Home-stead). The purpose for this could be to keep the fish for house-hold consumption or as a hobby. On the other hand fish culture may be on a large commercial scale covering a large area of land and made up of many ponds. This set up is often referred to as a fish farm. In addition to fish ponds there are other types of enclosures used for rearing fish. These include tanks, (concrete, fibregiass, platics) cages, pens, reservoirs and raceways.

The practice of growing fish in ponds can be beneficial to a farmer. Such benefits include the following:

1. By growing fish, an avenue is created for additional source of protein. Fish protein is among the richest animal proteins. Protein is necessary in human diet for repairs of body tissues and for healthy growth.

2. Growing fish will provide a farmer an additional source of income. Depending on the cycle of harvesting of the pond, the farmer can be assured of regular income from sales of harvested fish.
3. In large fish farms, employment opportunity can be created for the people that maintain the pond on a daily basis. These people are paid for the work they do. Fish processors and sellers also benefit form such farms.
4. Lands or part of lands that are not productive in growing arable crops can be converted to fish ponds. A farmer therefore maximizes the use of such lands.
5. A fish pond can be easily managed by a family. Once the construction work is over, maintenance work and feeding, etc. require little labour, especially when the family resides close to the pond. In practice the labour requirements for such a pond are such that the owner could attend to his normal business and his fish pond would bring him an additional income with very little extra labour from members of his household.
6. Food requirements necessary for fish to grow fast in ponds can easily be met by the fish farmer. Animal and compost manure can be used to make pond water fertile for production of natural fish foods. Also local source of feed ingredients for feeding fish include plant materials like rice brans, maize (and other grain) brans, cotton seed cake, groundnut cake, blood meal, bone meal, fish meal, palm kernel cake, etc, insects, worms and other smaller organisms.

2.0 General Considerations in Selecting SuitableSites.

Every farmer or individual wants success in business enterprise. Considerations in growing fish in pond can be outlined below. These are general considerations. Technical aspects will be treated in details later in this bulletin as applied to pond excavation.

2.1 Water Source and Supply

Water is the medium for fish growth and it is the major limiting factor in fish culture. Water sources must be free from pollutants. These are substances either in effluent or solid forms that are toxic to fish. Water that gives offensive odour, brownish/muddy or filled with domestic effluents is not suitable for growing fish. Good sources of water for fish pond includes; flowing river/stream, tidal flow from the sea, brackish water from lagoons, spring water, borehole/well water, and good pipe borne water. If the water is too clear then it needs addition of manure/fertilizer; if muddy it required settling by application of lime, if smelly/brown, it is acidic and requires liming. Water supply must be regular to the fish pond. Pipe borne water must be stored in a tank or reservoir for at leeast 24hours before usage. This will allow the chlorine contaned to settle.

2.2 Nature of the Soil/Land Availability

Land is a major factor of production. Fish ponds are built on land either by excavating the soil or by building embankment structures. A prospective fish farmer should therefore ensure that the land to be used is legally acquired, this is important since a fish pond structure can be maintained for as long as ten to fifteen years in production cycles. Soil at the site to be chosen must be tested for its capacity to retain water. A good soil for fish culture must be able to hold water. Soils may be classified into three major types for fish pond construction purpose:

a. Pervious soil
b. Impervious soil
c. Peaty soil

a) Pervious Soil

Pervious soil have very little water retaining capacity, and are very sandy or of mixed gravel and sand. Such soils should be avoided. However, areas adjoining lakes and lagoons, even if pervious, would be permanently soaked with water. It would then be possible to construct ponds by complete excavation in these sites since there will be no seepage as the soil must have been soaked with water.

b) **Impervious Soil**

Impervious soils consist of silt or clay or a mixture of one or both of these with a small percentage of sand and or gravel. Such soils have good water retaining properties and sites with this type of soil are suitable for constructing fish ponds. Often the soil condition may be a mixture of (a) and (b) above. The selection would then depend on the amount of seepage. Where seepage is excessive the water retaining property of the pond bottom can be improved by spreading a layer of clay or silt, if they are available close by and if it is economical to do so. Alternatively a concrete ponds may be constructed in such places with complete flooring of pond wall and bottom

c) **Peaty Soils**

Peaty soils have a high percentage of partly decomposed vegetation and are spongy in texture. The decomposed vegetation readily change the chemical nature of the pond water in a manner that reduces its productivity. Peaty soils are acidic, although such soils can be treated with lime to increase the PH to acceptable range (PH 6.5-8) and hence fish productivity.

Both pervious and impervious soils may be divided into groups depending on their chemical nature: (i) alkaline and (ii) acidic soils. Alkaline soils (PH >8) are more productive for fish culture than acidic soils (PH<7) and should be preferred when selecting sites.

A simple way of testing soil suitability for pond construction is as follows:

(i) Dig the soil to about 10cm deep and take sample at that depth. Wet a handful of the soil with water and rub it on the palms. If it forms a continuous thread then it is most likely to retain water for fish culture (Fig. 1).

(ii) Squeeze a little amount of the moist soil, if it holds shape then it is good and suitable for pond (Fig. 1)

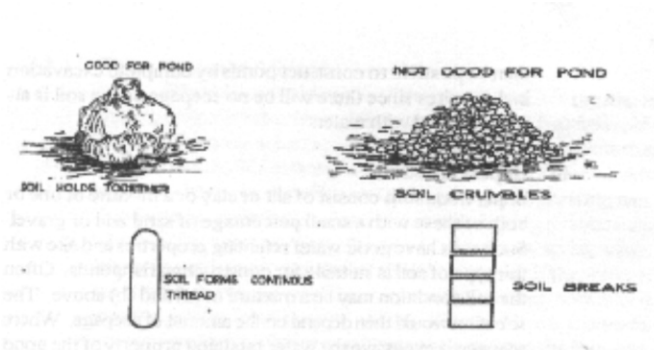

Fig. 1: Testing Good Soil for Pond Construction

(iii) A bucket full of water can also be gradually poured into the dugged hole. If the percolation rate (speed of disappearance of the water into the soil) is fast (i.e. within 1 minute) the site is not likely to retain water for fish pond. Soil experts can also be consulted for analysis in case of large-scale fish farming with huge capital investment. The advantage of detailed soil analysis is that information will be known on soil physical, chemical and biological properties. This wealth of information would ease the management of the pond after construction.

2.3. Topography (Landscape)

This refers to the shape of the land. Land that is sloppy but not exposed to soil erosion is suitable for fish pond. To supply water to the pond by free flow (gravity) the pond site should be at a lower level than the water source. Therefore to select the site for the ponds and mark out the route for the channels a detailed survey of the area should be carried out. The survey helps to plan the layout of the ponds in such a way as to keep the earth work to the bearest minimum. It is desirable that pond sites have a gentle slope (1:2) to permit large ponds to be constructed (Fig. 2). However if the land available is flat, dugout ponds should be constructed with a slanting bottom to facilitate complete drainage of the pond as management practice may required.

Fig. 2: Small valleys with gentle slope have excellent potential for pond construction

2.4 Vegetation of the site

The type of vegetation on the pond site would determine the cost of clearing the site for pond construction. Densely vegetated lands can be very expensive to clear, taking into consideration the cost of felling and removing the trees and the root stumps. Stumps left in the soil can decay later and cause pollution. Even if fish grow well in such sites, there is the risk of the stumps tearing nets at harvesting. Therefore as much as possible lands that are thickly vegetated should be avoided or the sites should be properly cleared. Sites in the Savannah belt are cheaper to clear since there are fewer trees and roots to be removed.

2.5 Other Considerations

Other considerations a prospective fish farmer must bear in mind in starting the project include the following:

(i) **Accessibility of the Project Site**

The site must be within reach for ease of management and supervision. Such a site will also facilitate marketing of products especially for large-scale operators.

(ii) **Security**

The project site must be kept to wade off thieves from harvesting the fish. Site must also be protected from natural enemies of fish like water snakes, water birds, frogs, etc. The pond water should be free from domestic interference and access to cattle. Hoofs of cattle can damage pond wall.

(iii) **Labour Availability**

Both skilled manpower and casual labourers must be available to manage the pond especially in large fish farms. Farmers should know the nearest location of research and extension staff in fisheries and other service providers. This formation can be obtained from the Ministry of Agriculture, Research Institutes or Fish Farmers Associations that are nearby.

(iv) **Availability of Inputs**

Fish farming inputs include fish seeds (fingerlings), supplementary feeds, fertilizers/manures, and other fish pond accessories. Prospective farmers should obtain information from the Ministry of Agriculture on how to source these inputs from the locality.

(v) Market for Products

The knowledge of the attitude of consumers within the locality to the species of fish to be cultured is important. This is more relevant in large-scale fish farming where the fish farmer is interested in making additional income. Fish species that are likely to attract high market prices should be grown in the pond.

3.0 Planning the Ponds

The assurance of a regular and good source of water supply and land that can retain water for fish culture is the impetus the farmer needs in planning how large the pond should be and how many of a particular unit or units should be constructed. Having done the survey of the land, it is easy to plan the layout of the ponds and channels on paper. The main objective should be to make the best possible use of the land (topography) at minimum construction cost. Experience has shown that each site has its own peculiarities and problems and solutions have to be found to overcome them. The following are useful hints in planning the ponds.

1. The shape and size of the pond should fit in with the topography of the land. The topography may warrant a pond to be circular, square or rectangular.
2. The bottom of the pond should be sloping to the point close to the embankment where drainage facilities (outlets) will be installed. The slope should be 1:2. The water inlet(s) to the pond should be placed preferably at the shallowest end.
3. If more than one pond is constructed it is better to have independent water supply (inlets) to each pond and also separate outlets. By this it would be possible to drain the water from each pond without the water having to flow through a second pond. Such ponds are called parallel ponds (Fig. 3). The advantage of this construction is that,

in case of parasites and diseases outbreak in one pond, its water can be easily drained and the other ponds will not be affected.

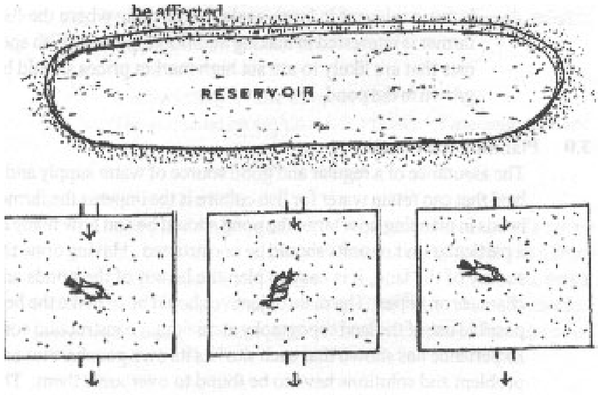

Figure 3: Parallel Ponds.

4. Smaller ponds are easier to manage than larger ones. For family owned ponds it is advisable to limits the size of each pond to a maximum of 0.2 ha if the water supply is adequate and land is available. However ponds of 0.01ha units are suitable for homestead fish culture. Although a single large pond could be cheaper to construct, the smaller size would facilitate stocking and harvesting programs for the family. Earthen ponds meant for commercial purposes should not have total area less than 0.25ha. A farmer needs such a size to attract loans from financial institutions for fish farming projects.
5. Pond depth can vary from 1 to 2 meters. Ponds should not be too shallow or too deep. Shallow ponds can easily be made muddy by action of wind or soil disturbance by human activities. Such ponds also will easily expose the fish to predation by their natural enemies. Ponds that are too deep will pose management problems to farmers

especially during harvesting period. Ponds of average depth of between 1-2 meters are suitable for culture of most fresh water species in Nigeria. Generally water depth in pond should not be less than 1 meter. A fish farmer can use graduated stick to check the water level regularly to ensure replacement of water lost to evaporation or seepage.

4.0 Constructing the Pond

Once a suitable site has been selected and the land has been surveyed, depending on the nature of the area, the size and number of the ponds, construction can be done manually or mechanically. Manual labour can be used if a small size pond is planned or in swampy or marshy area where machines can not be used. Use of machine (Bulldozer scraper, etc) is advantageous where large ponds are to be constructed. In general, steps in pond construction can be outlined as follows:

4.1 Surveying and clearing land site

For homestead ponds visual survey on water sources, topography and soil is sufficient. But for larger ponds, detailed survey by registered surveyors is necessary. Such survey is to determine land slopes and position of inlet and outlet structures.

4.2 Marking out area of pond

This is length and breath measurement. Pegs and measuring tapes are used. The actual area to be dug is the inner core, while the outer core is the eventual pond dike.

4.3 Measuring and marking out the walls

Wall or dikes (dam) for fish ponds should be up to 0.5m thick and 0.5m high above the ground level. Strong pond wall will prevent collapse of pond structure at flooding periods.

4.4 Excavating the pond

This can be done manually or with machine Earth moved from the pond serves for construction of the dikes. The main parts of the pond to be constructed during excavation are the pond walls/

embankment, the pond water inlet structure and outlet structure.

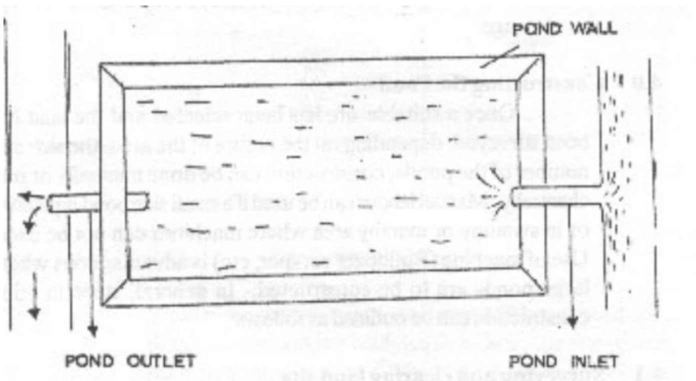

Figure 4: Main parts of a pond

4.5 Embankment/Pond Wall Building

To impound and retain water in a pond, in most cases, it is necessary to construct embankments. Embankments (also known as dikes) are reinforced walls built above the ground level. The embankments should be strong enough to withstand water pressure and should be leak proof. The height of the embankment should be at least 60cm above the highest water level that will be reached within the pond. The dimensions for the embankment i.e. the width of the crest and base, height and slopes would depend on depth of water to be retained in the pond and type of soil to be used, for the construction of the embankment. For 1m to 1.5m depth of water the crest should have a minimum width of 1m. Sandy soils, which are pervious, should not be used for the construction of embankment, as it would result in the loss of water by leakage. A mixture of impervious soils like clay or slit and pervious soils like sand or laterite is best. The advantage of such a mixture is that it remains firms both under wet and dry conditions.

4.6 Drainage structure

a) Pond Inlet Structure

The inlet structure is built to supply water into the pond. Where the source of water is by diversion from a stream/river, it is best to construct the junction of the diversion channels with concrete to prevent the water from eroding the channel way into the pond (Fig. 5). To prevent predators and other unwanted fish species from getting to the pond a screen can be used at the channel junction. For small ponds diverted from slow flowing water bodies plastic pipes can be used as diversion channels. Generally the inlet structure should be raised above desired level of water so that water falling into the pond can help in aeration. Large ponds are water fed through sluice gates. Sluice gates consist of concrete gate built fit into the grooves. The wooden boards are slipped in and out of the grooves to allow water in or stop water going into pond. One of the grooves is usually provided with screen to prevent wild-fish going into the pond.

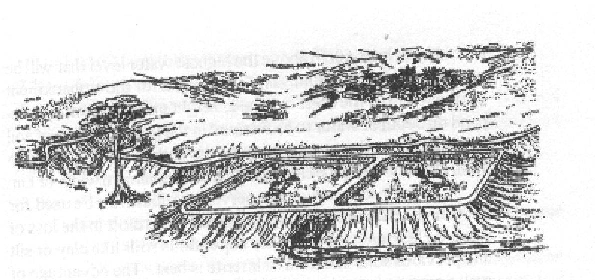

Figure 5 Diversion pond

b) **Pond Outlet Structure**

Fish ponds have to be emptied either partially or fully, especially during harvesting time. When there is excess water in the pond it has to be drained to required level to prevent pond wall from being weakened and collapsing. A good drainage system is enhanced when ponds are built on a good slope. The system must be built before the walls because most of them go through the base of the main pond wall. Drainage structure should be screened with fine wire mesh to prevent escape of fish. For large ponds, sluice and monk built on concrete base to prevent possible erosion are the drainage structure (Fig. 6). The monk functions only as an outlet structure. Monk consists of a vertical tower shaped like 'U' and it opens towards the pond. A pipe goes through the pond wall from the back of the monk to the outside. The two side walls of the monk have three parallel grooves, which are continuos with that on the concrete floor. The grooves are where the wooden boards can be slotted to stop water from seeping. The monk is much like a sluice gate, but it is not built into the pond wall. Monk should be constructed at least 0.5meters away form the foot of the wall in the deepest part of the pond and at least 40cm above the water level, but not more, as this will make the removal of boards difficult. The drainage pipes should be at least 0.3 meter below the pond and slopes at 45° for good draining.

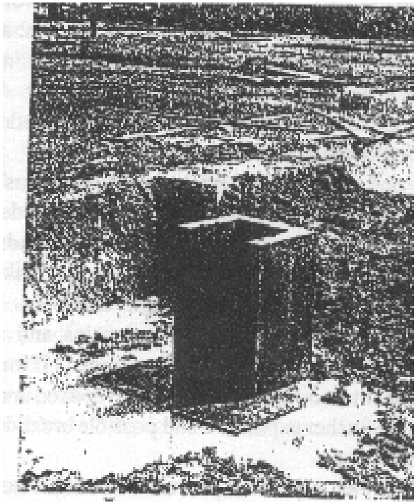

Figure 6. Monk Structure

5.0 Pond Structure Maintenance

A fish farmer should develop maintenance culture for the pond constructed, whether the pond is large or small, resources have been invested in constructing it. Fish ponds that are well maintained can serve the farmer for between 10 – 15 years or even more. The following are practical hints that will help in pond structure maintenance.

i. Newly constructed pond should not be stocked with fish species immediately. Such a pond should be flooded with water to the desired level and observe for 1 – 2 weeks. This will allow for observation on the pond capacity to retain water, as well as monitoring the rate of water loss. The strength of the pond wall will also be known so also the efficiency of the inlet and outlet structures.

ii. The crest of the pond and the pond surroundings should not be left bare, as this will encourage erosion during rainfall. Grasses like vetivar, carpet grass and bahama

Grass can be planted around dam wall to prevent erosion. These will also help the dam to maintain structural rigidity. A pond surrounding that is well-grassed will also have an added advantage of beautifying the environment.

iii. Pond environment should be cleared of bushes. Natural fish enemies that are harmful to fish and man hide in bushes. Parasites of fish are mostly transferred to ponds through predators. A healthy pond environment will make fish pond management practices interesting to a farmer.

iv. Regularly check the pond structures, and any noticed damages should be immediately amended. If for instance the embankment is leaking, it should be repaired immediately to forestall further expansion and possible breakdown of the entire structure.

v. As much as possible prevent cattle and other large ruminants from exploiting the pond environment. Hoofs of animals can break pond wall constituting extra maintenance cost to farmers. Walls of concrete ponds should be regularly cleaned. This is because remnant foodstuff and phytoplanktons readily gets attach to the wall. Fish can easily contact skin diseases (lesions) by contact with such materials.

vi. After an average production cycle of 12 – 18 months, pond water should be totally drained and expose to sunlight. This will help in disinfecting the pond.

6.0 Possible Construction Problems and Solutions

1. Area of ponds (earthen or concrete) should not be less than 25m^2, but ideally 100m^2. Smaller ponds don't provide adequate space for fish biotic activities thus hindering fish growth rates. Smaller ponds are also easily prone to frequent water quality problem especially in feeding and fertilization.

2. Pond depth should be within a range of 1-2m. Shallower ponds

ponds (less than 1m) will not have enough water for fish activities. Ponds that are too deep (above 2m) pose management problems especially at harvesting.

3. Pond bottom should slant in such a way that a provision of 0.2 – 0.3m difference is made between the upper slope and lower slope. This is for easy pond drainage either by gravity or water bailing/pumping during harvesting period.
4. Pond wall (dike) should be reinforced with boulders and compacted well for strength to withhold possible flooding.
5. As much as possible pond wall should be planted with grasses and watered regularly. This helps in structural rigidity.

7.0 Fish Pond Construction Cost Items

Construction cost items are difficult to estimate since prices of inputs vary from place to place and even year to year. Below is information that would help in arriving at useful estimate depending on the pond size, and area of location.

1. Earthen Pond

i. Cost of land acquisition
ii. Cost of labour to excavate the land, to required depth
iii. Cost of construction of pond well
iv. Cost of fencing materials to prevent human and animal intrusion.
v. Cost of pipes for water inlet and outlet (and other accessories).
vi. Cost of fingerlings to be purchased
vii. Cost of feeds – e.g. Grains brans, Groundnut cake etc.
viii. Cost of fertilizer/manure/lime
ix. Cost of harvesting net/gear

x. Miscellaneous cost of repairs, and other minor maintenance practices (operating cost).

2. Concrete Pond

i. Cost of blocks

ii. Cost of cement, sand gravel and five stone.

iii Cost of plumbing accessories

iv Cost of concrete nylon and nettings

BIBLIOGRAPHY

Board J. P; de kimpe, Js Lazard; J. Lemasson and P. Lessent (1976) Handbook of Tropical Fish Culture, Centre Technique Forester Tropical, France 165p.

Bolorunduro, P.I. (1993). Fish pond site selection, construction and management. Training paper at orientation workshop for Livestock Extension Agents under the unified Agricultural Extension System in Nigeria, held in NAERLS, ABU, Zaria 21st – 25th June.10P

DFFRI (1988). Directorate for Food Road and Rural Infrastructure Extension Guide No. 1.1 16p

Sivalingam S. (1974). A guide to construction of fish ponds Federal Fisheries Occasional paper No. 20. 28p

5.3 Methods of Feeding Fish

Fish can be fed supplementary feeds in two ways - Manually or Mechanically.

1. Manual Feeding

   This is carried out by a process called broadcasting i.e. throwing feeds into the pond by hand either on one spot in the pond or over a wide area (Figure 4). Broadcasting is a good method of feeding fish because the farmer can observe the behavior of the fish. This practice is however labor intensive, especially in large fish farms. It is however very suitable for small-holder aquaculturists. When a farmer feeds the fish from one spot in the pond, feeding frames can be placed at one or 2 spots in the pond to minimize feed wastage (Figure 5).

Figure 4. Feeding Fish in the pond by broadcasting.

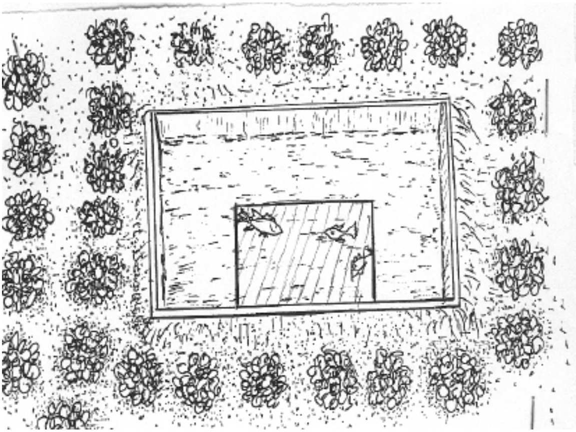

Figure 5. Feeding Frames in a Fish Pond.

2. Mechanical Feeding

This is suitable for large-scale commercial fish farms. The method is capital intensive and is performed by mechanical feeders, which could either be demand type or automatic.

i Demand Feeder.

This makes feeds available to fish on "demand". It operates through a simple funnel shaped device with a metal trigger hanging into the water. A measured amount of feed is placed in the funnel and the feed is released when the fish shakes the metal trigger (Figure 6).

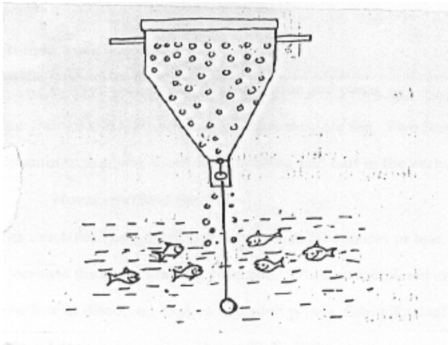

Figure 6.Demand Feeder.

Figure 6. Demand Feeder.

- **Automatic Feeder**

  This is a clock work programmed device that discharges a measured amount of feed at specified intervals in a day. It is highly capital-intensive and not suitable to small-scale fish farmers **(Figure 7).**

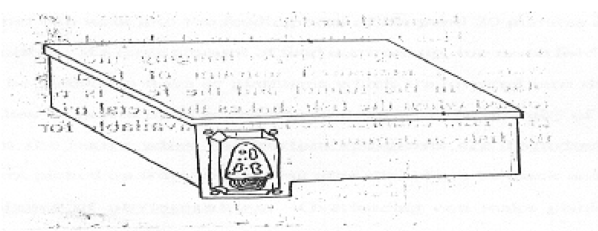

Figure 7. Automatic Feeder.

5.4 Golden Rules in Feeding Fish

RULE 1: Always feed fish at the same time and place.

Fish become trained and learn when and where they are fed. Two feedings per day are normal. Half of the daily amount is given about mid-morning and half in the early afternoon.

RULE 2: Never overfeed the fish

Give only as much feed as the fish will consume in 20 minutes or less. Uneaten feed will pollute the water and increase the cost of raising your fish. When accumulated uneaten feed decomposes water may become low in dissolved oxygen. In such ponds, fish will usually be seen at the pond surface in the predawn hours gulping air. They will die if the oxygen concentration in the water becomes too low. Steps must be taken to exchange or aerate the pond water. Feeding should be temporarily suspended when dissolved oxygen is low to improve water quality.

Signs of overfeeding are listed below.

1. An obvious inability of the fish to consume all of the feed offered within a 20-minute period. A farmer can walk into the feeding area of his pond 20 minutes after feeding and feel the pond bottom. If a large amount of feed is stirred up, too much feed is being offered. Feed may also be placed on trays or plat forms, which are lowered into the water. These platforms can then be pulled up after feeding to determine the quantity of feed consumed.
2. A foul smell in the water when the bottom sediments are disturbed. A handful of bottom sediment picked up from the feeding area should not be black and foul smelling.
3. An overabundance of phytoplankton. Overfeeding can make plankton become so abundant that a submerged object can only be seen at depths less than 25cm. This should be a warning sign to farmers that indicates possible overfeeding.

RULE 3: ***Do not feed on harvest day***

Stop feeding fish 24 to 48 hours before they are harvested. This allows them to clean their intestines and makes them better able to survive the stress of handling and transportation. It will also save feed.

RULE 4 ***Regulate feed quantities at cold season***

The daily ration for fish should be halved during cold season (<20°c temperature) Most fish will not feed on floating pellets at such season, continuous feed addition to the pond, since there will be low feed utilization. At such periods sinking pelletes are preferable. Most tropical fish are off-feed when temperature is below 20°c

Bibliography

1. Aduku,.A.O (1992). Practical Livestock Feeds Production in the tropics. Asekome and Co.Publishers, Zaria.

2. Bolorunduro P.I (1994) Feeding and Management of Fish in Ponds. Technical Paper for training of ADP Subject Matter Specialists in Monthly Technology Review Meetings.

3. Bolorunduro P.I. (1995) Practical Method of Formulating Com pounded Feeds using Locally Available Ingredients for Small Scale Producers of Poultry and Fish. Technical paper for training of ADP Subject Matter Specialists in Monthly Technology Review Meetings.

4. Eyo. A.A. (1996). Fish Feed Formulation NIFFR Extension Guide Series NO. 4. In collaboration with GTZ and NAERLS.

5 Eyo. A.A. (1996). Feeding Practices in Fish Farming. NIFFR Extension Guide Series NO. 7. In collaboration with GTZ and NAERLS.

6 ICA (1991) International Centre for Aquaculture and Aquatic Environments. Feeding your Fish. Water Harvesting Manuals. GTZ. Auburn University.