FISH POND

Construction & Management

(A Field Guide and Extension Manual)

NATIONAL SPECIAL PROGRAMME FOR FOOD SECURITY (NSPFS)

FISH POND CONSTRUCTION AND MANAGEMENT

(A Field Guide and Extension Manual)

TECHNOLOGICAL INFORMATION MATERIALS FROM NSPFS
RURAL AQUACULTURE TRAINING WORKSHOPS IN NIGERIA
(KADUNA BAUCHI, KATSINA-ALA, OWERRI,
IGUORIAKI AND AKURE)
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2005

PREFACE

Since 1999, the Federal Government of Nigeria has been seriously pursuing the quest for self-sufficiency in food production. This commitment to the development of the nations potentials in agriculture resulted in the formulation and implementation, in conjunction with the Food and Agricultural Organisation (FAO) of the United Nations, of the USD 45.2 million National Special Programme for Food Security (NSPFS). Under its Food Security sub-project, the government is promoting rapid investment in agriculture within 109 sites in all 36 States and the Federal Capital Territory (FCT) i.e. one site of 400-600ha in each of the senatorial districts of the country.

The technological information provided in this publication contains material that was used during the hands on NSPFS Aquaculture Training Workshops that were conducted for the 6 geo-political zones of the country in Kaduna, Bauchi, Katsina-Ala, Owerri (Acharaubo-Emekuku), Iguoriaki and Akure between 17th March 8th April, 2003. The purpose was to bridge identified skill gaps and provide training support on fish pond construction and management techniques for site beneficiaries of fish farming credit packages. Over 160 rural farmers, fisheries facilitators and supporting field extension agents were trained.

The publication serves as a quick-reference manual and informative material to arouse the interest of the general public and stimulate investment in fish farming. An encouragement for the publication of this as a field guide and extension manual is based on the workshop evaluation in all centres which rated the technical quality of the course content, fish farming recommendations and resource persons very highly. It is hoped that the simple illustrated text will greatly improve the practices of fish farmers and help promote rapid rural aquaculture development. This field guide for fish farming is compiled to provide quality, field proven technical information to everyone interested in pond fish production in a freshwater environment.

Aquatic science literature review, field experiences as well as local adaptive research and extension results have contributed to what would make a simple yet comprehensive coverage of the treated subject matter. We would like to sincerely acknowledge AGROMISA Foundation and the Technical Centre for Agricultural and Rural Cooperation (CTA) for use of material from their booklet 'Small-scale Freshwater Fish Farming (Agrodok series No. 15)'. We also extend special appreciation to the International Centre for Living Aquatic Resources Management (ICLARM), and the International Institute for Rural Reconstruction (IIRR) for use of graphic illustration from their publication 'Farmer-Proven Integrated Agriculture-Aquaculture: A Technology Information Kit'. We also acknowledge the National Institute for Freshwater Fisheries Research (NIFFR) for use of their field tested fish feed formulation tables using locally available feed stuffs; and the National Institute of Oceanography and Marine Research (NIOMR) for use of graphic illustration from their booklet on live fish transportation.

The roles and contributions of the FAO/NSPFS Fisheries resource persons and workshop coordinators in the persons of Mr. Jim Miller, Mr. A.N. Atanda, and Mr. G. N. Asala are also acknowledged.

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PLANNING THE SITE AND TYPE OF FISH FARM

Site selection

Proper selection of a site is probably the most important factor in the success of a fish farm. However, the ideal site is often not available, so you may have to compromise. There may also be conflicts concerning land and water use which need to be resolved. Before this you should have decided which species to raise based on the available foods (e.g. agricultural by-products) and possible fertilizers (e.g. compost or animal manure).
Site selection will depend on the kind of fish farm you plan to use. For pond construction you need to consider the following factors: soil type, quality and quantity of the water available and the requirements for filling and drainage of the pond.

Soil

The quantity of soil influences both productivity and water quality in a pond. However, it must also be suitable for dike construction. To determine soil suitability the two most important properties to examine are soil texture (particle size composition) and porosity or permeability (ability to let water pass through). The pond bottom must be able to hold water (have a low porosity like clay) and the soil should also contribute to the fertility of he water by providing nutrients (soil texture consists of a lot of clay particles) so the best soil for pond construction contains of a clay. The three ways one should follow to predict whether the soil will be suitable for pond construction are A) the "squeeze method" B) the ground water test and C) the water permeability test.

A) Squeeze method (Figure 1):

- Wet a handful of soil with just enough water to make it moist (Figure 1A),
- Squeeze the soil (Figure 1B) and if it holds its shape after opening the palm of your hand (Figure 1C), the soil will be good for pond construction.

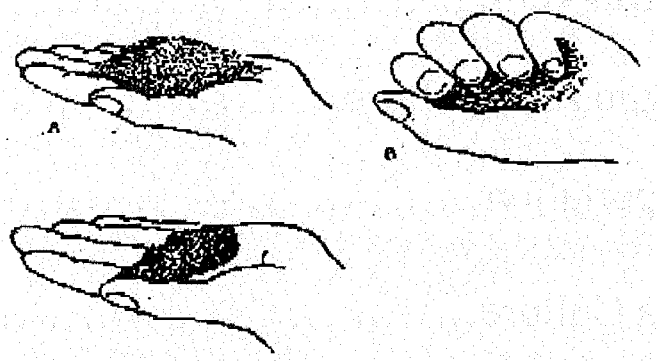


Figure 1: The "squeeze method"

(B) **Ground water test (Figure 2).** This test should be performed during the dry period in order to get reliable results:
(a)Dig a hole with a depth of one meter

(b) Cover it with levels for one night to limit evaporation
(c) If the hole is filled with ground water the next morning a pond could be built. Take into account that you will probably need more time to drain the pond due to the high ground water levels filling the pond again.
(d) If the hole is still empty the next morning, no problems will occur as a result of high ground water levels (Figure 2) and the site will perhaps be suitable for pond fish farming. Now you should test the water permeability.

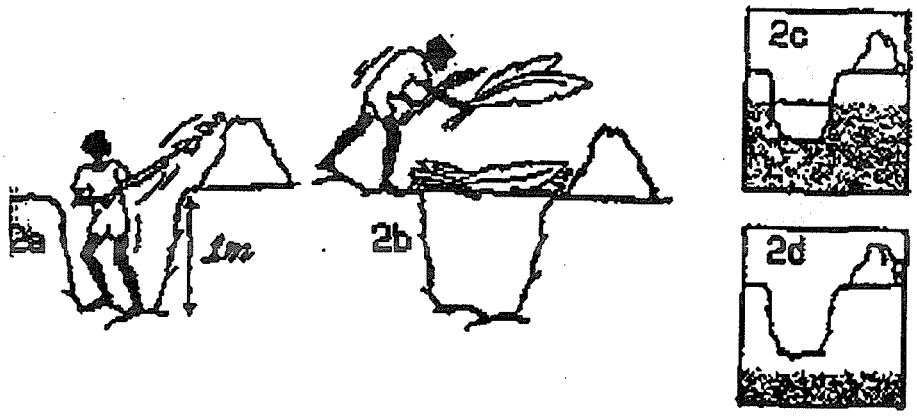


Figure 2: Ground water test

C) Water permeability test (Figure 3):

(a) Fill the hole with water to the top
(b) Cover the hole with leaves
(c) The next day the water level will be lower due to seepage. The dikes of the hole have probably become saturated with water and might hold water better now.
(d) Refill the hole with water to the top
(e) Cover it once more with leaves. Check the water level the next day (d) If the water level is still high, the soil is impermeable enough and is suitable for pond construction.
(g) If the water has disappeared again, the site is not suitable for fish farming, unless the bottom is first covered with plastic or heavy clays.

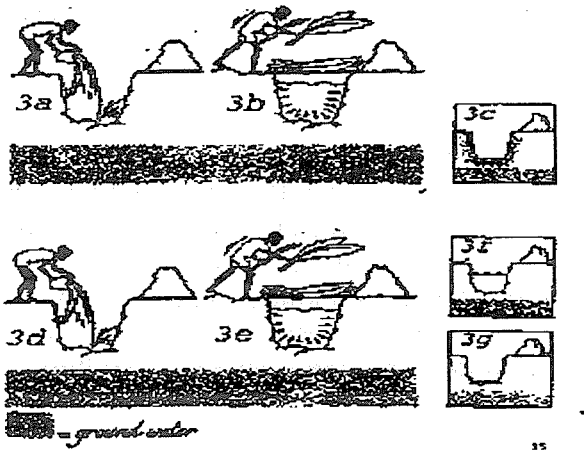


Figure 3: Water permeability test.

The land contour, and especially the land slope, determine the way to build the pond. The slope of the land can be used for the pond's drainage at harvest. Totally flat land and a hilly terrain with a slope of more than 2% - 4% are unsuitable for pond construction so all slopes between 2% and 4% can be used for pond construction. A 2% land slope means 2cm vertical decline for every meter of horizontal distance. If the slope is sufficient you can fill and drain by using gravity. However, you should take care to prevent erosion of the pond dikes.

Water

The availability of good water quality is important for all fish farming systems but water quantity is of even greater importance for land based fish farming systems. A constant water supply is needed, not only to fill the pond, but also to make up for the losses caused by seepage and evaporation (Figure 4).

Investigation of the amount and seasonality of the water sources, as well as their position in the field regarding possible pollution is very important in pond site selection. Ideally, water should be available all year round. Different water sources and their disadvantages are listed in Table 1.

The water temperature is an important criterion in assessing whether the fish species selected can be raise. A water temperature between 20°C and 30°C is generally good for fish farming.

Variation in water salinity (amount of dissolved salts in the water) is also an important environmental factor which must be considered. Some fish species can withstand a wider salinity

range than others: e.g. tilapia and catfish can withstand a wide range from fresh to seawater while carp can only withstand freshwater.

These are the most important water quality criteria for site selection. There are other important water quality characteristics, but these are more easily controlled by management measures.

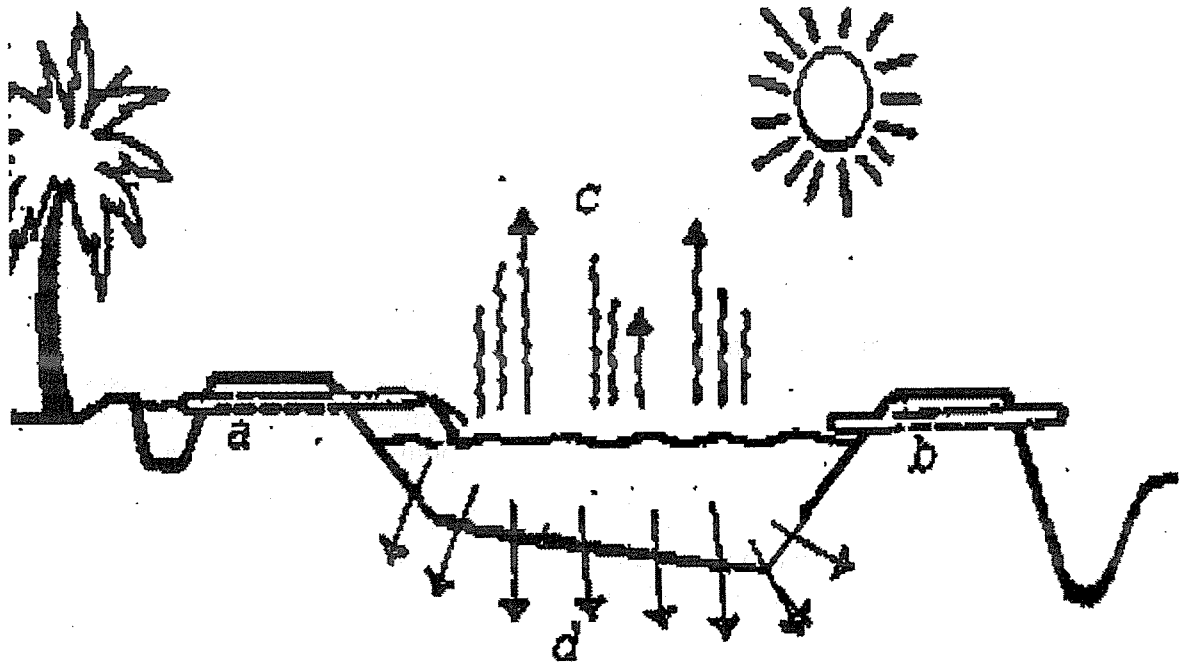


Figure 4: Water supply and water loss in a fish pond.

a: inlet; b: overflow; c: evaporation; d: seepage.

Table 1: Water Sources and Their Main Disadvantages

Water source	Main disadvantage
Rainfall	**Dependency**
"sky" ponds rely on rainfall only to supply water	The supply depends heavily on amount of rain and seasonal fluctuations
Run-off Ponds can be filled when water from the surrounding land area runs into them	**High turbidity** Turbidity is the amount of mud in the water. In case of run-off the water may be muddy. Danger of flooding and pesticides (or other pollutants) in the water.
Natural waters Water can be diverted and brought in from streams, Rivers or lakes	**Contamination** Animals, plants and rotting organisms can cause diseases. Danger of pesticides (or other pollutants) in the water.
Springs Spring water is water under the ground that has found a way to get out. Spring water is good for fish ponds because it is usually clean.	**Low oxygen level and low temperature**
Wells Wells are places where ground water is pumped up.	**Low oxygen level and low temperature**

Type of aquaculture farm

Fish farming may range from large scale industrial enterprises to 'backyard' subsistence ponds. Farming systems can be distinguished in terms of input levels.

In **extensive** fish farming, (economic) inputs are usually low. Natural food production plays a very important role, and pond productivity is relatively low. Fertilizer may be used to increase pond fertility and thus fish production.

In **semi-intensive** fish farming a moderate level of inputs is used and fish production is increased

by the use of fertilizer and/or supplementary feeding. This means higher labour and food costs but higher fish yields more than compensate for this usually.

In **intensive** fish farming a high level of inputs is used and the ponds are stocked with as many fish as possible. The fish are fed supplementary food, and natural food production plays a minor role. In this system the high feeding costs and risks, due to high fish stocking densities and thus increased susceptibility to diseases and dissolved oxygen shortage, can become difficult management problems. Because of the high production costs you are forced to fetch a high market price in order to make the fish farming economically feasible.

Pond culture

The vast majority of freshwater fish are raised in ponds. Water is taken from a lake, bay, well or other natural source and is directed into the pond. The water either passes through the pond once and is discharged or it may be partially replaced so that a certain percentage of the total water in a system is retained and recirculated. However, the pond systems yielding the highest fish production, only replace water evaporation and seepage losses and do not flow through. In general, water flowing reduces the production of pond systems in the tropics.

Fish farming ponds range in size from a few hundred square meters to several hectares. In general, small ponds are used for spawning and fingerling production. Production ponds larger than 10 ha become difficult to manage and are not very popular with most producers. The ponds presented here are only examples and the kind of pond a farmer will build depends very much on local resources, equipment and conditions.

Ponds are usually located on land with a gentle slope. They are rectangular or square shaped, have well finished dikes and bottom slopes and do not collect run-off water from the surrounding watershed. It is important that sufficient water is available to fill all ponds within a reasonable period of time and to maintain the same pond water level. You should also be able to drain the pond completely when the fish are to be harvested. Side slopes should be 2:1 or 3:1 (each meter of height needs 2 or 3 meters of horizontal distance) which allow easy access, will not encourage vegetation to grow and help to reduce erosion problems. To prevent fish theft, bamboo poles or branches might be put in the pond which make netting and rod-and-line fishing impossible. Another method to keep thieves away from your fish pond is locate the pond as close to your home as possible.

The main characteristics of a fish pond are presented in Table 3.

Table 3: Characteristics of a Good Culture Pond

Location	Select land with a gentle slope and layout ponds to take advantage of existing land contours.
Construction	Ponds may be dug into the ground, they may be partly above and partly in the ground, or they may be below original ground elevation; slopes and bottom should be well packed during construction to prevent erosion and seepage; soil should contain a minimum of 25% clay. Rocks, grass, branches and other undesirable objects should be eliminated from the dikes.
Pond depth	Depth should be 0.5 1.0m at shallow end, sloping to 1.5 2.m at the drain end; deeper ponds may be required in northern regions where the threat of winter-kill below deep ice cover exists.
Configuration	Best shape for ponds is rectangular or square.
Side slopes	Construct ponds with 2:1 or 3:1 slopes on all sides.
Drains	Gate valves, baffle boards or tilt-over standpipes should be provided; draining should take no more than 3 days.
Inflow lines	Inflow lines should be of sufficient capacity to fill each pond within 3 days; if surface water is used, the incoming water should be filtered to remove undesirable plants or animals.
Total water volume	Sufficient water should be of sufficient capacity to fill each pond within a few weeks and to keep them full throughout the growing season.
Dikes	Dikes should be sufficiently wide to mow; road dikes should be made of gravel; grass should be planted on all dikes.
Orientation	Situate pond properly to take advantage of water mixing by the wind, or in areas where wind causes extensive wave erosion of dikes, place long sides of pond at right angles to the prevailing wind; use hedge or tree wind breaks when necessary.

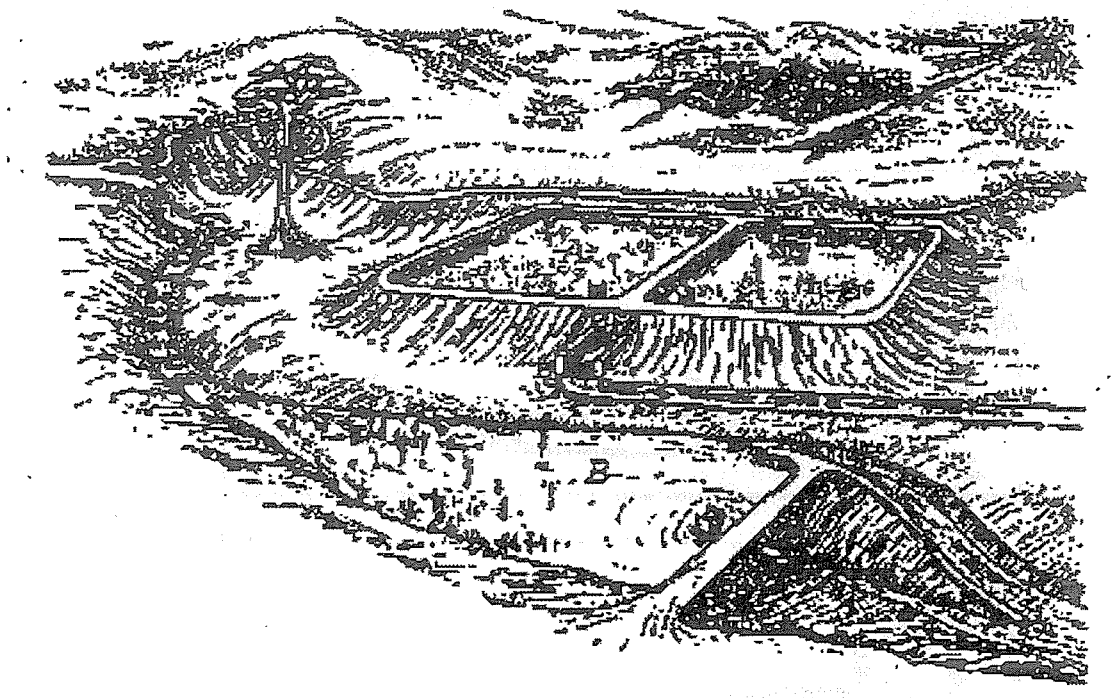


Figure 5: Different pond types A: diversion pond; B: barrage pond.

Depending on the site different fish ponds might be constructed; diversion or barrage ponds (Figure 5).

(I) **Diversion ponds** (Figure 5A) are made by bringing water from another source to the pond.

There are different types of diversion ponds (Figure 6):

A) Embankment ponds:
The dikes of an embankment pond are built above a ground level. A disadvantage of this type of pond is that you may need a pump to fill the pond (Figure 6A).

B) Excavated ponds;
An excavated pond is dug out of the soil. The disadvantage of this type is that you need a pump to drain the pond (Figure 6B),

C) Partially excavated ponds with low dikes;
Soil from digging out the pond is used to build the low dikes of the pond.

The ideal site has a slight slope (1.2%) so the water supply channel can be constructed slightly above and the discharge channel slightly below the pond water level. Since neutral gravity is used to fill and drain the ponds no pump is needed (Figure 6C).

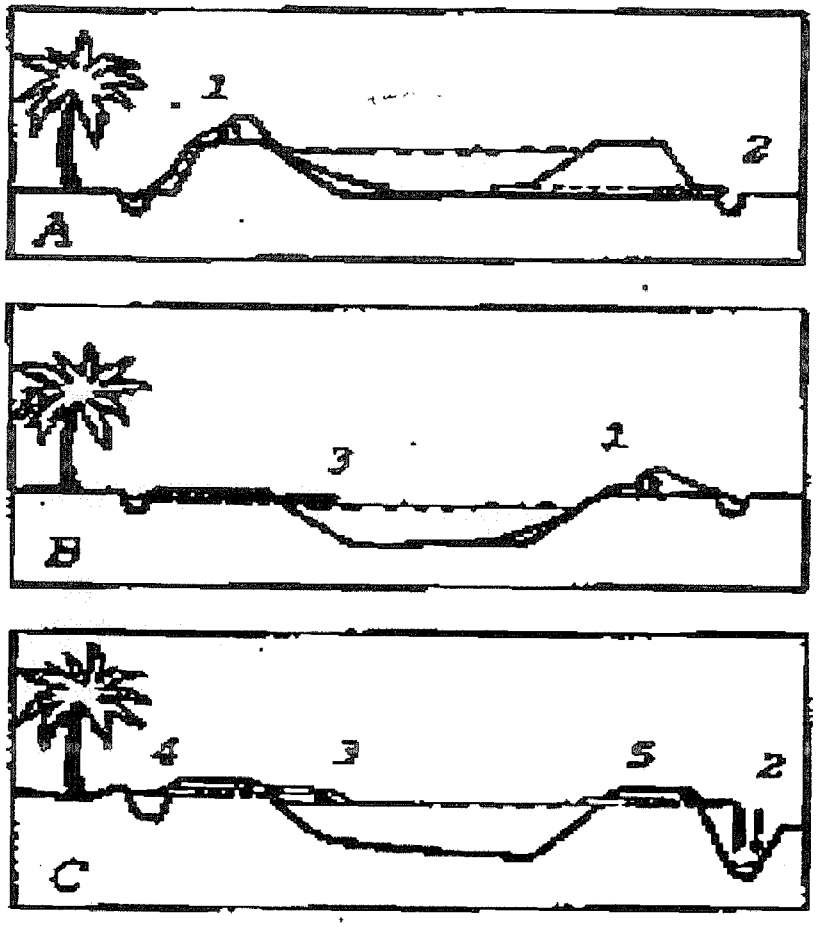


Figure 6: Different types of diversion ponds.
A: embankment pond B: excavated pond; C: partially excavated pond.
See next chapter (Guidelines for Pond Construction and Design) for an example of how to construct a diversion pond.

(II) Barrage ponds (Figure 5B) are made by building a dike across a natural stream. The ponds are therefore like small conservation dams. The advantage of a barrage pond is that it is easy to construct. However, it is very difficult to control this system: It is difficult to keep wild fish out and a lot of food added to the pond will be lost because of the current.

A properly built barrage pond (with overflow) overflows only under unusual circumstances.

GUIDELINES FOR POND DESIGN AND CONSTRUCTION

Size and Shape
Square and rectangular shaped ponds are easiest to build but your pond can have a different shape to fit the size and shape of the land. An area of $300m^2$ is a good size for a family pond, which you can build without the use of machinery. Ponds can be much larger than this, but for family use it is better to have several small ponds rather than one large. With more than one pond you will be able to harvest fish more often.

Depth
The water depth is usually 30cm at the shallow end and 1 meter at the deep end (Figure 1). The pond can be deeper than this if he pond is used as a water reservoir in the dry season. It is important that the water can be completely drained for harvesting.

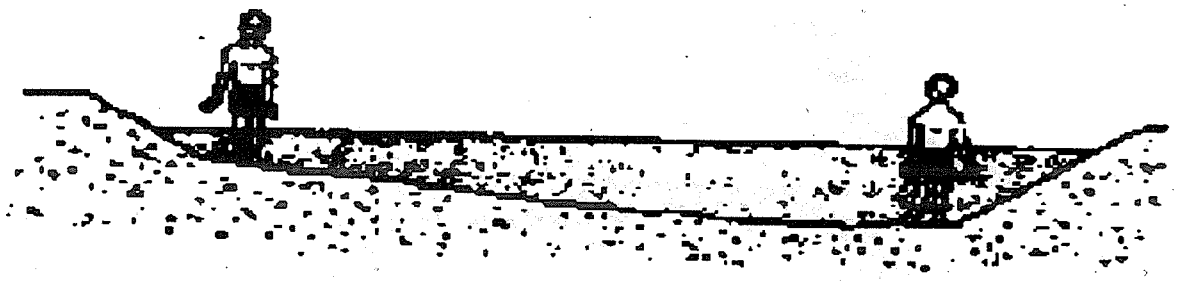


Fig. 1: Cross-section of a pond.

Types
The type of pond you need to build depends on the land contours (topography). Different types of ponds are suitable for flat and hilly areas.

Dugout ponds are built in flat areas by digging out an area as big as needed for the pond. The water level will be below the original ground level (Figure 2).

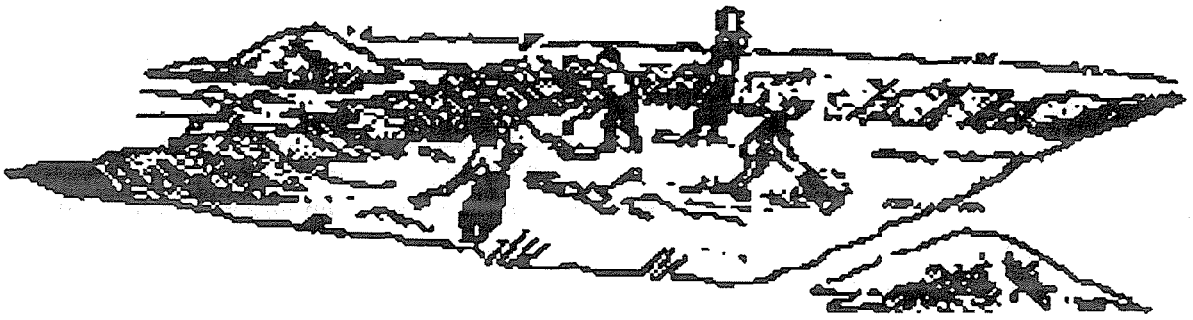


Fig. 2: Dugout pond.

Contour ponds are built in hilly areas on a slope. The soil on the upper side of the pond is dug out and used to build up a dam on the lower side. The dam must be strong because the water level in the pond will be above the original ground level (Figure 3).

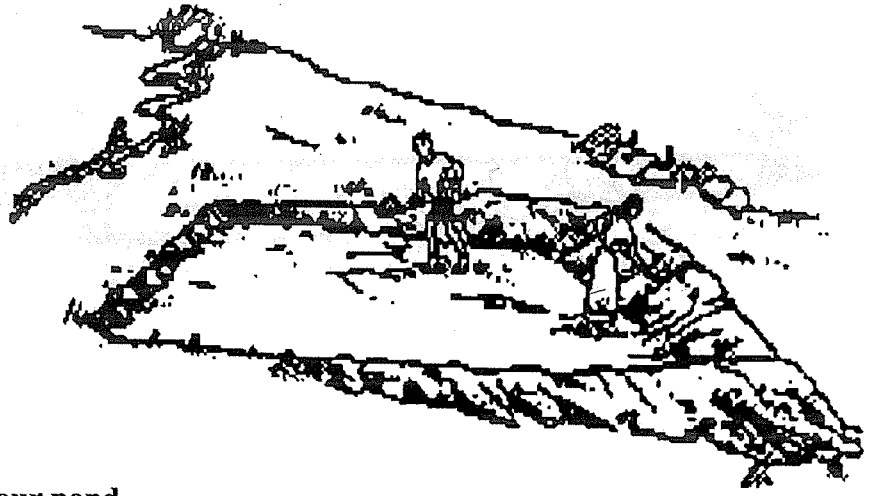


Fig. 3: Contour pond.

Building the fish pond

Building a pond can be the most difficult and most expensive part of fish farming. A well-built pond is a good investment that can be used for many years.

The steps in building a fish pond are:

1. Prepare the site
2. Build a clay core (only necessary for contour ponds)

3. Dig the pond and build the dikes
4. Build the inlet and outlet
5. Protect the pond dikes
6. Fertilizing the pond
7. Fence the pond
8. Fill the pond with water
9. Check for problems before stocking fish

1. Prepare the site

First remove trees, bush and rocks and cut the grass in the area planed to build the pond. Then measure and stake out the length and width of the pond (Figure 4). The pond dikes will extend several meters above the ground level. In hilly areas, try to measure the slope of the land with a level or stick to find the best suitable site and orientation for the pond.

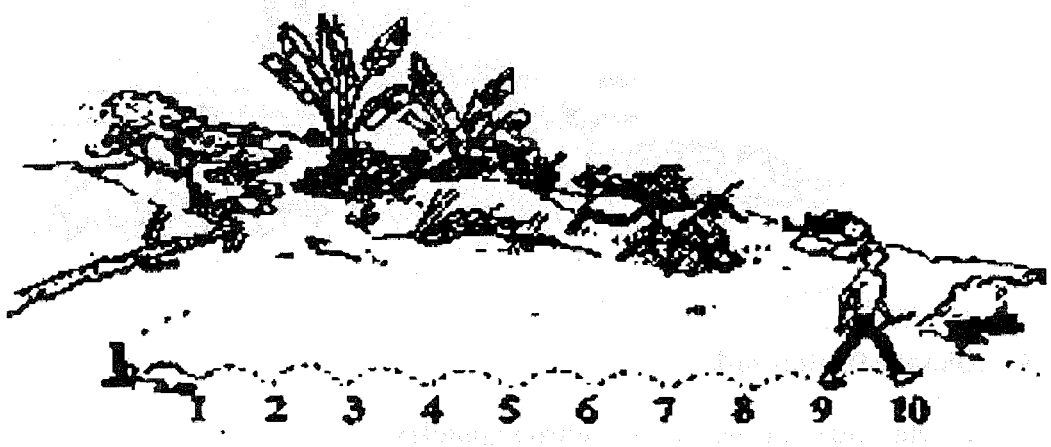


Figure 4: Staking out the pond.

Remove the top layer of soil containing roots, leaves etc. and deposit this outside the pond area (Figure 5). But save the topsoil for later use when grass is to be planted on the pond dikes.

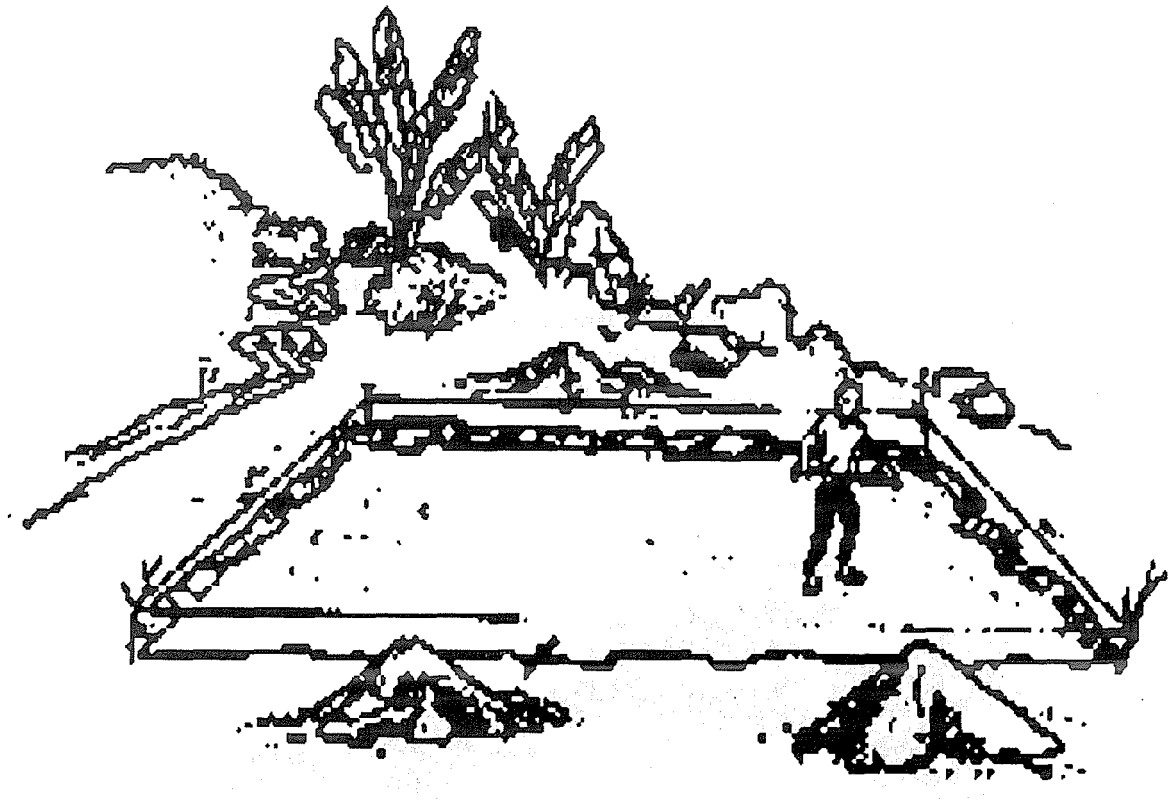


Figure 5: Remove the top soil.

2. Build a clay core (in the case of contour ponds)

A clay core is the foundation for the pond dike which makes it strong and prevents water leaks. A clay core is needed in contour ponds and is built under those parts of the dike where the water will be above the original ground level. A clay core is not needed in dugout ponds because there the water level is below the original ground level.

Remove all the topsoil in the area of the pond dikes and dig a 'core trench' in the same way as you would dig the foundation for a house The trench needs to be dug out along the lower side of the pond and halfway along each short side of the pond (Figure 6). Fill the trench with good clay soil. Add several inches of clay at a time and then compact it well. This will provide a strong foundation upon which the pond dikes can be built.

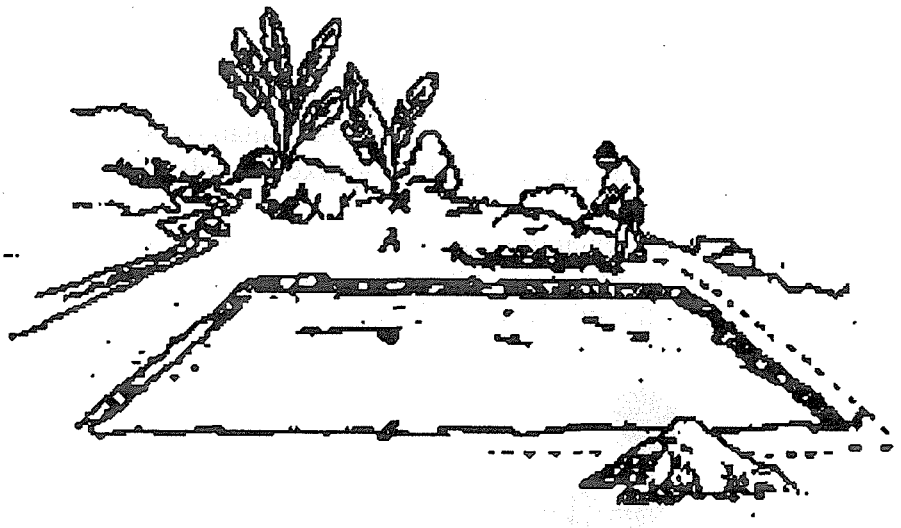


Figure 6: Digging a 'core trench' (A).

The drawing in (Figure 7A+B) shows how a core trench helps to strengthen the pond dike and keep it from leaking. There is a tendency for water to seep away where the new soil joins the original ground layer. In the upper drawing (Figure 7A) there is no clay core, and water seeps out under the new dike. This leaking may eventually cause the entire dike to break down. In the lower drawing (Figure 7B) the clay core stops the water from seeping under the newly built dike.

Figure 7: The function of the core.
A: water; B: pond bank; C: ground; D: seepage; E: clay core.

3. Dig the pond and build the dikes

Use the soil which you dug out when making the trench for the clay core to build up the dike on top of the core trench. Try not to use sandy/rocky soil or soil that contains any roots, grass, sticks or leaves. These will decay later and leave a weak spot in the dike through which the water can leak out.
Compact the soil often while you are building the dike. After adding each 30cm of loose soil trample it down by foot while spraying water on the dike. Then pound it with your hoe, a heavy log, or a piece of wood attached to the end of a pole (Figure 8). This will make the dam strong.

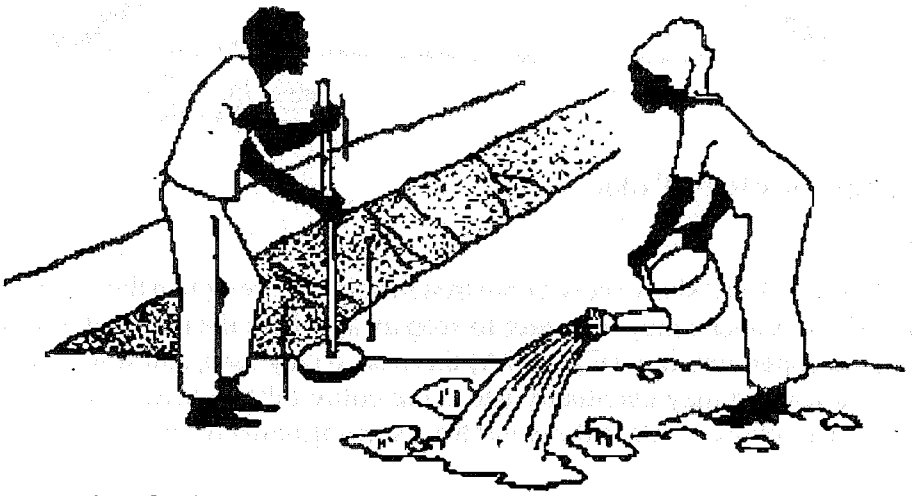


Figure 8: Compacting the dike.

The pond dikes should be about 30cm above the water level in the pond. If catfish will be farmed in the pond, build the dike to 50cm higher than the water level to prevent the catfish from jumping out. Once you have reached this height, add a little more soil to allow for setting. Then do not add any more soil on top of the dikes.

If you have not yet made the pond deep enough, continue digging but bring the soil outside of the pond area. If you put it on top of the pond dikes they will become too high and unstable, and it will be hard to work around the pond.
The pond dikes should have a gentle slope. This makes them strong and prevents them from undercutting and collapsing into the pond. The most easy way to scope the dikes is AFTER digging out the main part of the pond.

The best slope for the pond dike is one that rises 1 meter in height for every 2 meters in length. It is easy to make a triangle as shown in Figure 9 to help obtain this slope. A good way to determine whether the dikes are too steep is to try to walk slowly from the tope of the dike to the pond bottom. If this is not possible then the dike is still too steep!

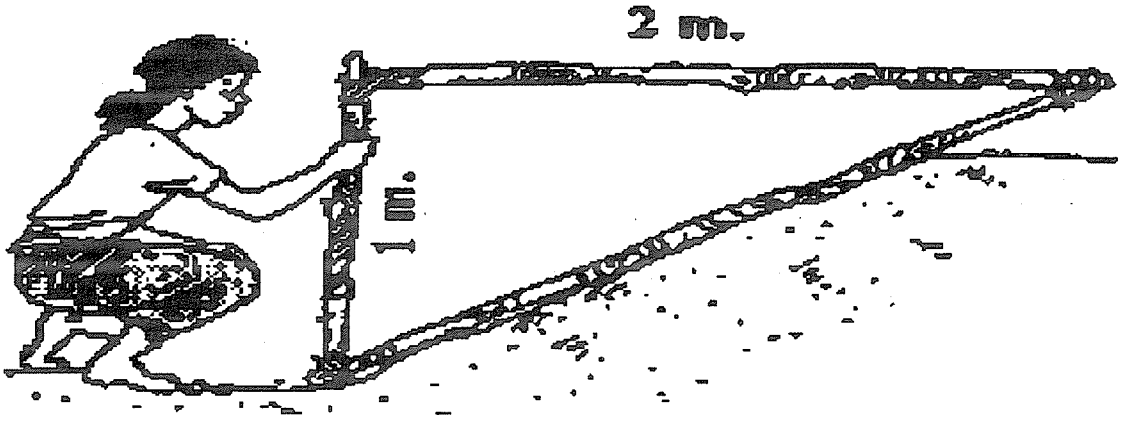


Figure 9: Measuring the slope of the dike.

The pond bottom should also slope so the water varies in depth along its length. Smooth out the pond bottom after reaching the required pond depth. This makes it easy to use nets when harvesting the fish and they will slide easily over the pond bottom.

4. Build the water inlet and outlet

The water inlet consist of a canal to bring in the water, a silt catchment basin, and a pipe to carry water into the pond (Figure 10 and Figure 11).

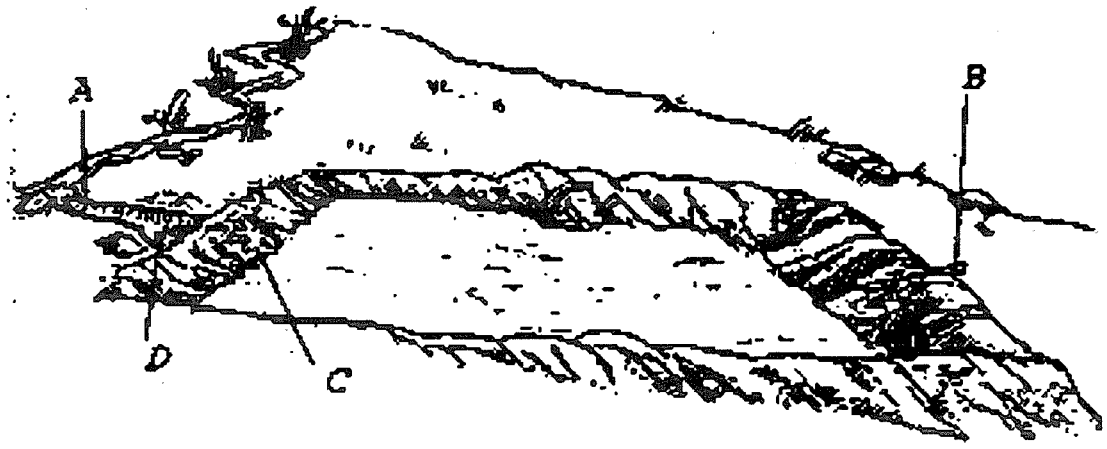


Figure 10: The water inlet and outlet of a pond.
A: inlet canal; B: overflow pipe; C: inlet pipe; D: silt catchment basin.

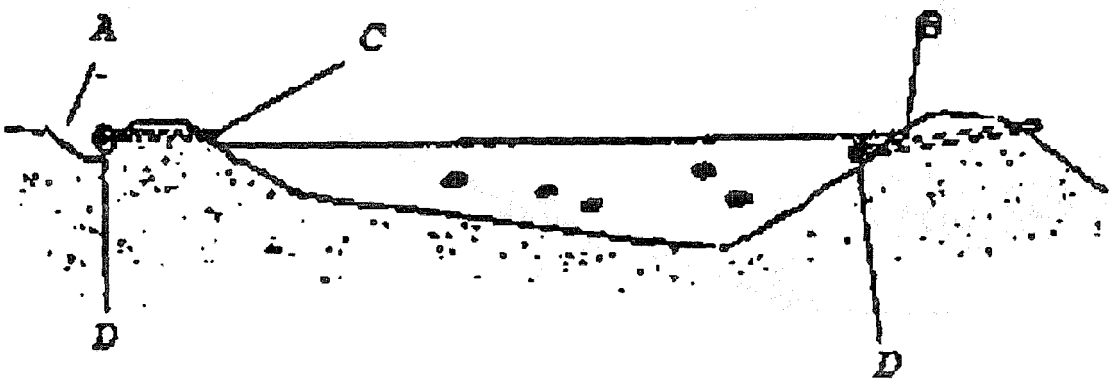


Figure 11: cross-section of the water inlet and outlet of a pond.
A: silt catchment basin; B: overflow pipe; C: inlet pipe; D: screen.

The water coming into the pond often contains a lot of soil and silt. This will make the pond very muddy. A silt catchment basin will stop this soil from entering the pond. Widen and deepen the inlet canal right outside of the pond dike. The soil will settle into this hole, called a silt catchment basin, instead of entering the pond.

The water inlet pipe runs from the catchment basin through the pond dike into the pond. It should be about 15cm above the water level so the incoming water splashes down into the pond. This will prevent fish from escaping by swimming into the inlet pipe. It also helps to mix air (and thus oxygen) into the water.

The water outlet is an overflow pipe which is used only in emergencies. Water should NOT flow out of the pond on a daily basis. During heavy rains the overflow pipe takes excess rainwater and run-of water out of the pond.

The overflow pipe can be installed at an angle as shown in Figure 11. If you install it with the intake underwater as shown, this will prevent the screen from clogging with debris that may be floating on the pond surface.

The inlet and outlet pipes can be made of metal, plastic, bamboo, wood or other material, install the pipes through the pond dike near the water surface.
Pipes should have screens to stop fish from entering or leaving the pond. The INLET pipe is screened at the edge which is outside the pond to stop wild fish and things like branches and leaves from entering. The OUTLET is screened inside the pond to stop fish from escaping.

Screens can be made from many types of materials. Anything will do that allows water but not small fish to pass through (Figure 12);

- Picce of metal with holes punched in it (Figure 12A);
- Screen or wire mesh (Figure 12B);
- A clay pot with holes punched in it (Figure 12C);
- A loosely woven grass mat (Figure 12D),

The screens should be cleaned daily.

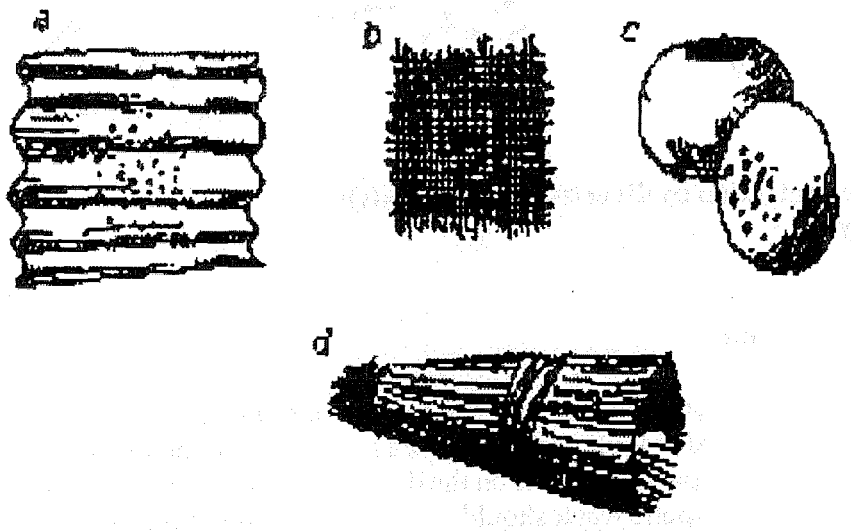


Figure 12: Materials for screens.

5. Protect the pond dikes

When the pond dikes are finished, cover with the topsoil that was saved when digging the pond. Plant grass on the dikes. Do not use plants with long roots or trees because these will weaken the dikes and may cause leaks. The fertile topsoil will help the new grass to grow and the grass will help to protect the dikes from erosion.
In heavy rains the pond dikes can be destroyed by flooding if too much rainwater and run-off water flow directly into the pond. This problem is most common in contour ponds built on hillsides.

To prevent this, divert the run-off water around the sides of the pond. You can do this by digging a ditch along the upper side of the pond. Using the dirt from this ditch, build a small ridge below it. The ditch will carry run-off water away from the pond. This will prevent flooding and protect the pond dikes (Figure 13).

Figure 13: Dike protection by diverting run-off water
A: ditch; B: dyke.

6. Fertilizing the pond

The natural fish food production in the pond can be increased by applying fertilizer to the pond. Fertilizers which can be used include animal manures, compost or chemical fertilizers. Before filling the pond with water, spread fertilizer on the dry pond bottom. When the pond is filled with water, adding fertilizer to the pond water should take place at regular time intervals (e.g. each day) and preferably in the late morning or early afternoon. This continuous adding of fertilizer will ensure a continuous production of natural fish food.

If the soil is acidic, add lime or wood ashes to the pond bottom in addition to fertilizer before filling the pond. Use 10-20kg of lime or 20.40kg of wood ashes for each $100m^2$ of pond bottom.

7. Fence the pond

Putting a fence around the pond will protect children from falling into the pond and it can help keeping our thieves and predatory animals. To make a low cost and sturdy fence, plant a thick hedge around the edge of the pond or build a fence using poles and thorn branches.

8. Fill the pond with water

Before filling the pond, put rocks on the pond bottom where the water will splash on when coming from the inlet pipe. This will keep the water from making a hole and eroding the pond bottom. Then open the inlet canal and fill the pond.

Fill the pond slowly so that the dikes do not subside due to uneven wetting. While the pond is filling, the water depth can be measured with a stick. Stop filling the pond when the required depth is reached.

Do not fill the pond too full so it overflows. The overflow pipe is used to get rid of too much rain and run-off water. Water in the pond should not flow through (and thus be stagnant) as water flowing through the pond slows down fish growth by flushing away the naturally produced fish food. The only water added to the pond should be for the water losses due to evaporation and seepage.

New ponds often seep when they are filled with water for the first time as the soil partly takes up the water. Keep adding new water for several weeks and slowly the pond should start to hold water.

9. Check for problems before stocking the fish

Wait 4 7 days before stocking the pond with fish so the natural food production has enough time to reach a sufficient level for the fish. From this point onwards it is important to maintain the pond in a good state and monitor water quality.

AQUACULTURE MANAGEMENT

Fish growth rate and yields from aquaculture enclosures can be greatly increased through emphasizing adequate management techniques, steps or procedures that would enhance maximum productivity. This necessarily involves manipulating a complex of interacting biological, physical, chemical, and environmental factors that promote high stocking rate, growth rate, survival rate, good pond structure and water quality. Under Earth Pond Culture, which is being discussed, these practices will be treated under

- Pond preparation and maintenance
- Fertilization
- Liming
- Feeding
- Stocking of Culturable Species (including Monosex Tilapia Culture)
- Water Quality maintenance
- Aquatic Weed and Predator Control
- Harvesting, Marketing and Record-keeping

The aquaculture management theory and techniques are based on the ideal SPFS module and are presented as simply as possible bearing in mind the resource limitation and needs of the rural dwellers and extension agents who will be handling the technological information. The tailored recommendations are not exhaustive and cheaper, more productive techniques and approaches for solving various highlighted field problems could still be suggested or developed. A good summary (selected highlights) of general routine (daily, periodic) management procedures for maximum productivity to be employed by the fish farmers is hereunder presented. These are amplified and further explained in the following sections to help understanding.

GOOD MANAGEMENT PROCEDURES AND EXTENSION MESSAGES

(1) Stock healthy and disease-free fingerlings, preferably obtained from fish hatcheries and not the wild.

(2) Avoid overcrowding, and stock correct number of fingerlings per unit area

(3) Maintain good water level and quality always

(4) Watch out for fish enemies (including human poachers!!) and eliminate or control undesirable and unwanted organisms inside and around the pond area

(5) Feed fish regularly twice daily, at same times (usually 9-10am and 5pm in the morning and evening) from the same feeding spot, by gradual broadcast.

(6) Avoid excessive feeding in order to prevent pond fouling and pollution

(7) Maintain normal pond water green colour. Replenish water if colour is too deep green or when the fish begins to gather at the surface to gulp for air.

(8) Watch fish behaviour for abnormalities and immediately remove diseased, dead or dying fish (or any other dead animal found in the pond area).

(9) Maintain pond structures. Routinely check for blockages and damages and repair pond walls, pond bottom, screens, inlet and outlet water supply structures.

(10) Keep accurate records of fish farming activities

These could be called The Ten Commandments of Aquaculture Management which all stakeholders should learn and know.

APPLICATION OF FERTILIZER, LIME AND POND PREPARATION

Preparation of old and new ponds is done to create a requisite environment for the well-being and growth of the fish to be stocked. The principles of preparation are basically the same for old and new ponds though there are minor contingent differences. It generally involves lime and fertilizer treatment of pond bottom (to reduce loss by seepage, improve pond fertility and stimulate plankton production), flooding of the pond and maintenance of optimum water depth, checking of pond walls and bottom as well as water inlets and outlets to repair damages, sanitation and disinfection of ponds, as well as desiltation.

The techniques involved with the above are given as extension recommendations in greater detail below:

IMPORTANT EXTENSION MESSANGES AND RECOMMENDATIONS

Messages on Liming

(1) Contact site facilitator/extensionist to determine if liming is necessary and at what level

(2) If liming is necessary the following rates are recommended

Quicklime/Slaked lime	-	20-50gm/m^2
Agricultural lime	-	50-200gm/m^2

The ground and powdered lime should be broadcast or spread over the entire dried pond bottom and left to dry on the soil for 14 days (2 weeks). The pond is then flooded up to 60cm (above the knees), fertilized and left for 7 days for plankton to develop before flooding completely with water to 1-1.5m level in readiness for stocking with fish.

Messages on Fertilisation

(3) Apply inorganic fertilizer (NPK, SSP, TSP etc) or preferably animal manures (e.g. Cow, Pig, Poultry, etc) to already flooded ponds to stimulate natural fish food production.

(4) Use the GREENWATER PRINCIPLE, as stated below, to regulate fertilizer application in fish ponds:

(i) Green colour of water indicates good plankton production, while clear water indicates lack of enough plankton

(Ii) If you dip your hand in the water half-way up to your below and you can still see your

fingers (palm) then your pond is insufficiently fertilized, and you should increase fertilization.

(iii) If your palm disappears half-way to your elbow (i. e. you cannot see your fingers through the blue-green or water colour) it means sufficient plankton.

(iv) If the palm disappears immediately after dipping at the wrist, it means a plankton bloom with deep green colour and over fertilisation. This can deplete oxygen in pond water especially during the night and cloudy days, clog the gills and can result in fish mortality. Stop feeding and fertilization till the water colour becomes lighter, and possibly drain the pond partially before re-introducing clean water as a means of dilution. (SEE DIAGRAM).

(5) Apply inorganic fertilizer as follows:

(i) fill a jute bag with fertilizer and submerge it under water

(ii) dissolve the fertilizer in water inside a plastic bucket and sprinkle over the entire surface.

(6) Apply organic manures using the following methods:

(i) fill a jute bag with cow-dung or chicken manures, and tie to stakes at various points in the water

(ii) collect manure in a large tank then mix with reasonable quantity of water. After mixing use the liquid part of the mixture in the fish pond.

(iii) Use bamboo/wooden stakes to fence off a semi-circular or triangular area of 1-2m^2 at one corner of the pond inside the water. Dump the compost or manures into this area, and replenish from time to time.

Filling of Pond

(7) Fill ponds slowly and gradually to avoid mud stirring at pond bottom, turbidity (from silt, sand, clay particles), and possibly dyke collapse from uneven wetting. If the pond is filled with over-head pipes a sizeable stone, gravel, blocks or wooden board should be placed on the bottom to break the fall of water first.

(8) Maintain a reasonable freeboard (minimum 15-20cm), and avoid filling pond water to same level as top of pond walls.

(The Freeboard is the distance between the maximum water level and the top of pond walls)

Preparation of Drained Pond for Next Production Cycle

(9) Remove silt, mud, detritus and clay (from dyke erosions, turbid water, organic fertilizer, rain run-off, etc.) from pond bottom to maintain pond depth.

(10) Completely plough and expose pond bottom to sun and air for some days or until the soil cracks.

(11) Clear the bottom of twigs, branches, leaves, dead fish etc and destroy all predators that feed on fish (e.g. snakes, frogs)

(12) Smoothen the ploughed and cleared bottom

(13) Check any fences for damage, repair holes which let in piscivorous (fish eating) animals, and clear weeds and unnecessary vegetation in and around the pond to keep pests and predators away.

(14) Check outlets and inlet for damages, and all screens for removal of clogs. Replace if necessary.

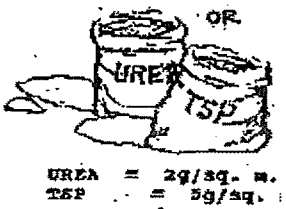
(15) Check for any cracks, leaks or weak points in the walls, and repair them.

(16) Attend to any replanting of grass cover (regrassing) on pond walls, or mowing.

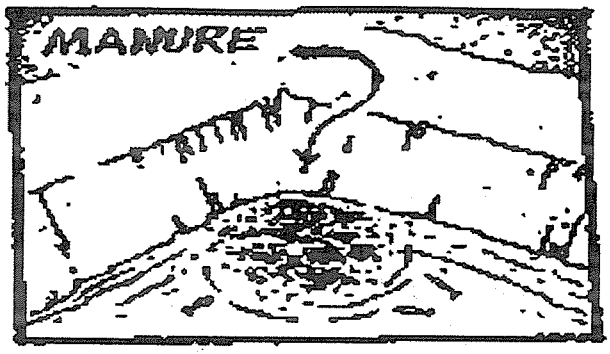
After the above procedures, the next procedure will be liming, flooding with water and fertilisation as previously described, before stocking.

Fertilization

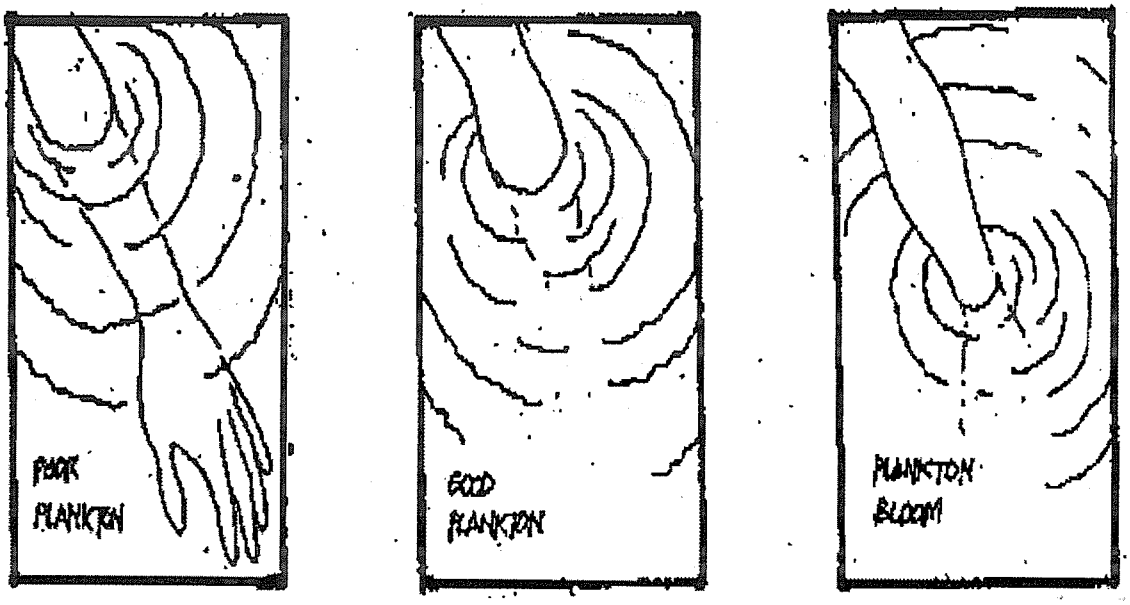
- For good production of fish food organisms (plankton) in the pond, on which depend growth of fish, the pond needs to be fertilized. Organic manures or chemical fertilizers can be used for the purpose. Cattle dung (100 g/sq m) or chicken manure (50 g/sq m) or urea (2 g/sq m) and triple superphosphate (5 g/sq m) need to be applied once every two weeks.



- Organic manure can be heaped in the comers of the pond while chemical fertilizers need to be dissolved in water and spread in the pond.



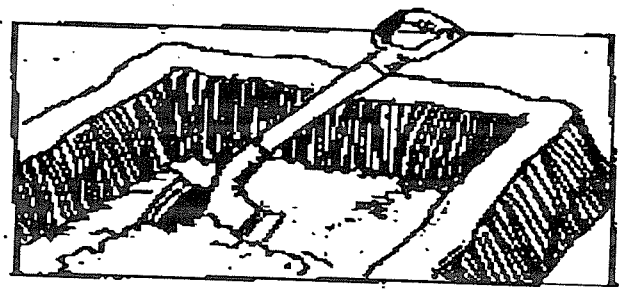
- A pond of 500 sq m needs every two weeks 25 kg of cattle dung or 15 kg of chicken manure or 1 kg of urea and 2.5 kg triple superphosphate.



Green color of water indicates good production of fish food organisms (plankton). Clear water indicates lack of enough fish food. By dipping your hand in the water, seeing it half-way to the elbow indicates lack of enough fish food. In such cases, increase fertilization. If the hand disappears half-way to elbow, it indicates sufficient plankton. If it disappears after dipping the palm, it indicates plankton bloom, with deep green color and this can deplete oxygen in pond water, especially during night and cloudy days and can result in mortality of stocked fish. Stop feeding and fertilization till the water color becomes lighter.

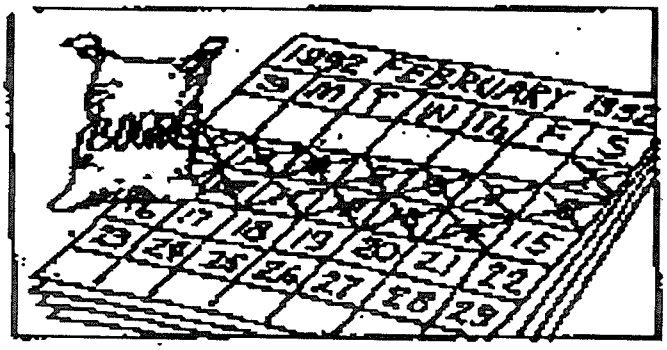
Pond Preparation and System Establishment

- Drain the pond (if the pond is an old one from which the fish have been harvested). Remove silt on the pond bottom, this can be used as fertilizer.



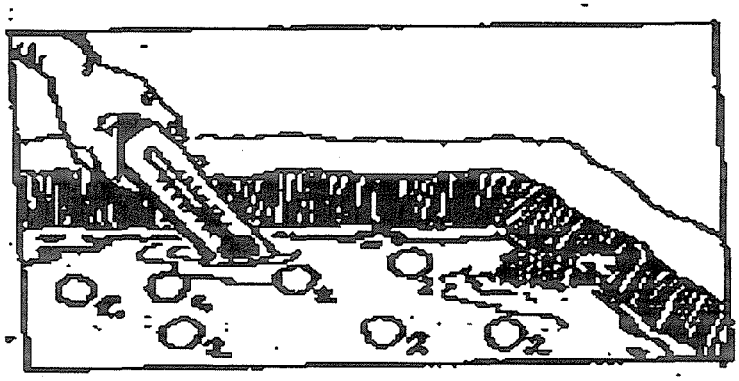
- Dry the pond bottom until the soil cracks. Plowing it first turns the soil over and facilitates drying.

- Apply lime to condition the soil. Liming activates fertilizers and controls acidic soils which may harm the fish.

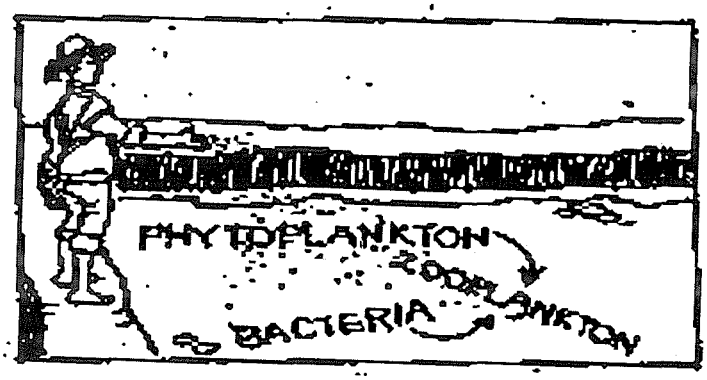


Quicklime is most commonly used at 200kg/ha.

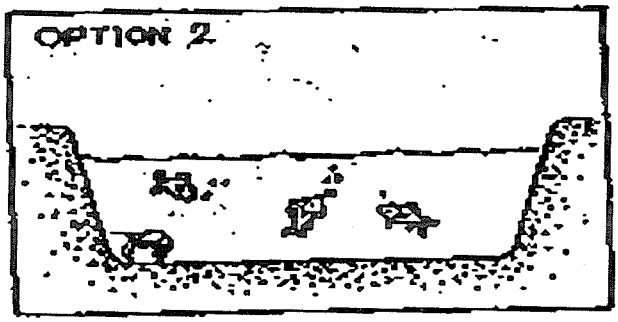
- Fill the pond with water 2 weeks after liming. Water should fall from the water inlet into the pond below, so that the water mixes with oxygen from the air.



- Add fertilizer to the pond to provide nutrient for fish and plankton growth. Chicken manure can be applied at the following rates:



- Stock the pond, preferably in the evening.



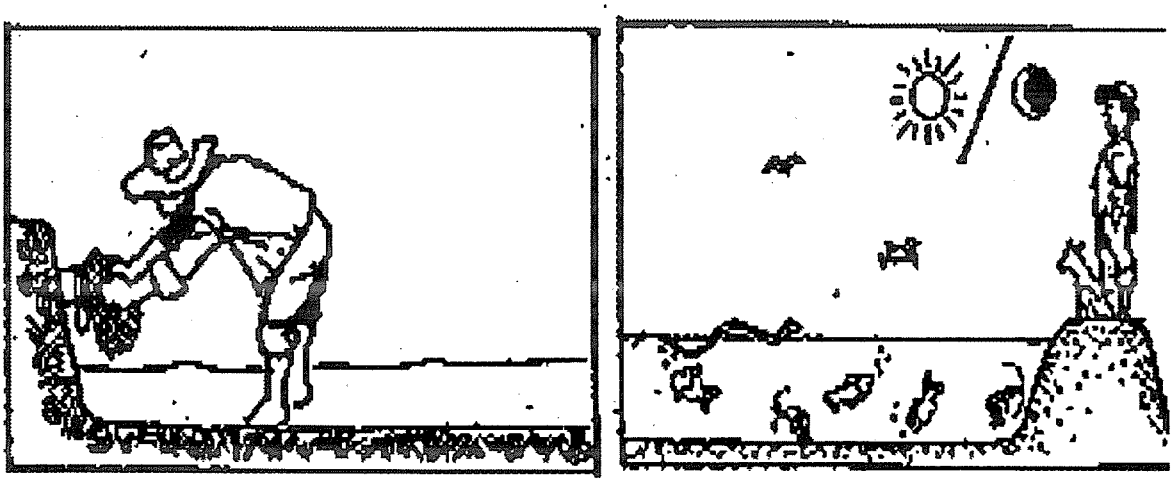
- **Daily management of fish ponds.**

- Check the pond for leaks. Clean filters

- Watch fish behavior.

If the fish are at the pond surface, feeds are needed. If they are gasping at the surface or they are in the periphery of the pond, aeration is needed. Aerate the pond by stirring the water with a tree branch.

- Also, watch for predators.



FISH POND STOCKING

Stocking normally takes place after pond preparation, liming and fertilization, and is the means of introducing an adequate number of selected fish species of proper size into the ponds for culture. It involves live fish transportation from the wild or hatcheries and avoidance of stress before and during introduction. Being kept in a relatively small container at high density creates the twin problems of high oxygen requirement and rapid deterioration of water quality due to accumulation of metabolic waste which could cause stress and high mortality. These are usually the problems of suppliers and hatchery managers who should have the necessary facilities and skills. Some valuable guidelines that should be followed by fish farmers are hereunder given.

EXTENSION MESSAGES AND RECOMMENDATIONS

(1) To reduce stress during live fish transportation, stop feeding fish 1-3 days before and during transportation, avoid too much handling of fish, handle and stock fish in the cool hours of the morning and evening, keep the water cool and relatively constant in temperature, and reduce haulage time as much as possible.

(2) Contact Site Facilitator or extensionist to assist with live fish transportation from hatcheries

(3) Be careful to stock only known species, and beware of releasing unknown or undesirable fish into the pond .

(4) Select, introduce and culture commonly stocked freshwater species in Nigeria like Tilapia spp, Heterobranchus spp, Clarias spp, hybrid Heterobranchus and Clarias, and Common carp.

(5) Obtain fingerlings preferably from a hatchery. However if supply is from the wild, invite the attention of facilitators and extension agents to help identify the correct species of fish.

(6) Stock only healthy and disease free fingerlings

(7) Make efficient use of the growth space and total pond feeding environment by adopting a polyculture system. (i.e. culture of 2 or more compatible species at the same time). Contact your facilitator or extension agent for appropriate stocking ratio.

(8) Acclimatize the fish to conditions of the environment where it will be stocked before introduction.

The technique for this is as follows:

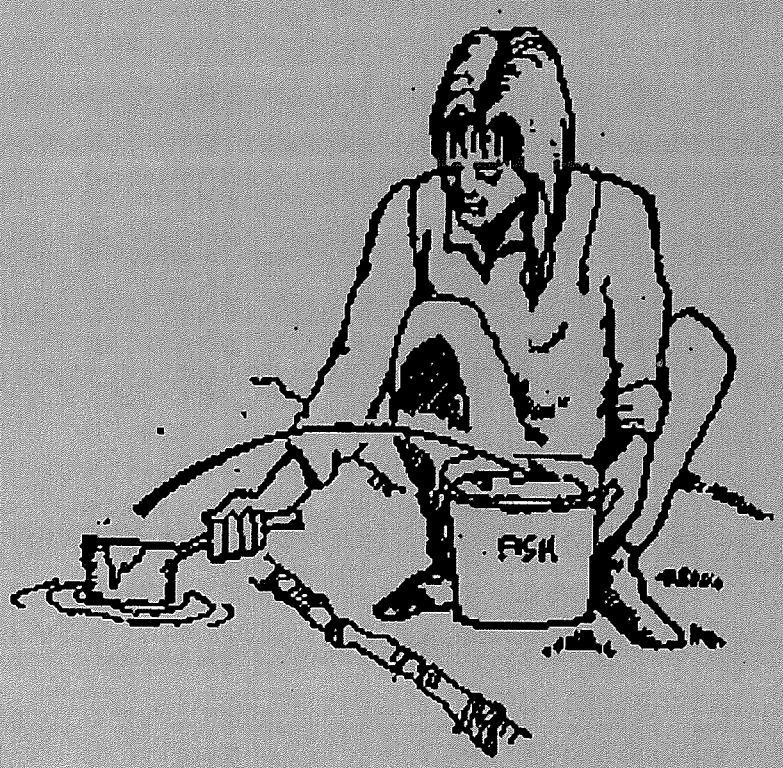
(i) Transfer fingerlings into a plastic basin or bucket containing some water used for transportation

(ii) Immerse container into the pond without mixing its contents and leave for 30 minutes to acclimatize.

(iii) Collect water from the pond and mix gradually with that in container.

(Iv) The container is then gently lowered into the pond and the fingerlings allowed to swim off into the pond on their own (SEE DIAGRAM).

(9) Use recommended stocking density (i.e. total number or weight of fish species stocked per unit pond area). Generally recommended stocking rates of sub-adult fish species (3-15cm) vary from 1-5 fish/m^2.



- When stocking fingerlings in the pond, a large difference in water temperature between the container used to transport the fish and the pond can lead to fish loss and a poor survival rate. Therefore, it's recommendable to mix water from the pond with the water in the container to slowly regulate the temperature differences and allow the fish to adjust to the water temperature of the pond.

WATER QUALITY MONITORING AND MAINTENANCE

The quality of water used for fish culture is one of the significant factors affecting fish yield. For optimum performance of species being cultured good quality water must neither be too acidic or alkaline, contain enough dissolved oxygen, not be muddy or turbid, not have offensive colour, be of suitable temperature, salinity and colour, be free from pathogens as well as pollutants (e.g. oil films, petrochemicals, detergents, agrochemicals). Interactions between the water, fish, soil, and other organisms during the production cycle changes these water quality parameters and beyond certain tolerance levels this imposes stress on the fish population. It is therefore very important for the fish farmer to maintain good water quality desirable for fish culture.

The following recommendations are made for the maintenance of good water quality.

EXTENSION MESSAGES AND RECOMMENDATIONS

(1) Maintain pond water at green colour (too deep green colour should be avoided)

(2) When PH of water is consistently low i.e. acidic condition (water tastes sour, prevents phytoplankton growth despite fertilization, etc) the pond should be limed (using Agricultural lime) to bring to the desirable PH level of 6.5 - 9.0. Contact your facilitator and extension agent for assistance.

(3) Avoid or watch out for causes of low dissolved oxygen (excessive fertilization of ponds and heavy plankton blooms, excessive feeding/high feeding rates, overcrowding very high stocking densities and extended periods of cloudy weather). Symptoms include when fish come up to the water surface to gasp for air, when the water has offensive colour, and presence of scum over surface water.

(4) If symptom of low dissolved oxygen are detected take immediate action (i.e. stop fertilization, decrease feeding rate, renew water completely or replace with fresh oxygenated water, etc).

(5) Prevent run-off water (which may contain irritating silt, clay or sand which clog gills and cause anoxia, or pollutants) from entering the pond by construction of proper drainage channels across flow of water. Also install sand-gravel filters or siltation tanks along supply channel.

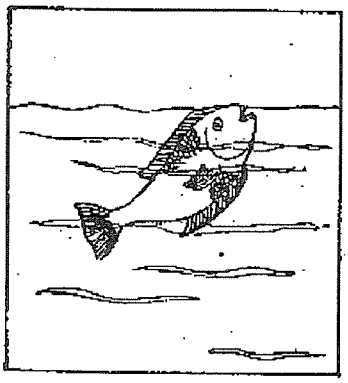
(6) Prevent toxic pollutions from entering your pond by proper site selection. Locate ponds away from industrial centers, oil fields and chemically treated agricultural farms.

(7) Maintain water depth at 1-1.5 m.

(8) Maintain pond water level especially during the hot, dry season. Deplete and replenish water in pond by adding new fresh water to influence the water temperature to tolerable range of 20° c 30°c. Also plant economic trees to provide shade and cool pond.

(9) Remove thick black mud frequently from pond bottom because they contain bacteria which lead to increased Biological Oxygen Demand (BOD) and oxygen depletion.

INDICATORS OF LOW DISSOLVED OXYGEN



1. When plenty of fish are on the water surface gasping for air.

2. When air or gas bubbles are obtained in the water.

3. The pond water is brownish or greyish.

4. The pond water smells or tastes pungent.

WHAT TO DO WHEN DISSOLVED OXYGEN IS LOW

1. Stop manure loading.

2. Add fresh water into the pond. While doing so, drain water off the pond bottom.

3. Stir the pond water by striking the water surface with tree branches or other appropriate materials; row repeatedly across the pond.

4. Make provisions for flow-through system (if water is readily available).

FISH FEEDS AND FEEDING

Fish growth and yields are usually much higher with lining/fertilization and supplementary feeding than without. Besides complementing natural pond food organisms and supporting high stocking density, it enables the fish farmer to observe the behaviour, healthy status, feeding level and size changes during feeding.

Generally supplemental feeds are usually obtained from agricultural by-products (e.g. oil cakes, brans), industrial residue (e.g. brewers waste), animal by-products (e.g. blood meal), and wastes (e.g. Chicken droppings). The most commonly practiced feed supplementation locally is the dispensation of ground feedstuffs such as cereal brans and domestic left-over/kitchen waste to feed fish. Though these are known to enhance growth they may not be complete or balanced. Fishes fed on incomplete feeds will suffer deficiency diseases or symptoms attributable to the lacking ingredient. Balanced/complete diets are formulated by the combination of different essential nutrients in different proportions (Protein, Carbon hydrates, Lipids, Vitamins, Minerals). Important messages/recommendations on fish feeds storage and feeding techniques are treated hereunder.

EXTENSION MESSAGES AND RECOMMENDATIONS

(1) Feed your fish to shorten the production period and maximize your profit

(2) Use locally available feedstuff to reduce the cost ot making your fish feed

(3) For a complete balanced diet, adapt local combinations of feed ingredients in your environment for producing your feed and/or prepare feed according to the scheme provided by your site extension agent or facilitator (See section/paper on artificial feed formulation).

(4) Prepare feeds in small quantities to avoid prolonged storage with possible physical losses (from vermin and mould attack) and nutrient deterioration.

(5) Package and store your feed in sealed containers like jute bags with polythene lining, b i n s with lids etc (to avoid insect/rodent infestation), in cool, dry places (to avoid moisturisation and deterioration), on pallets/shelves at least 10cm off the floor and 30cm from walls (for adequate air circulation and rodent control).

(6) Observe simple feeding techniques, procedures and rules below:

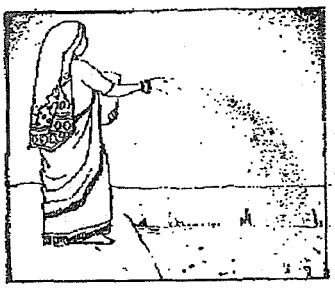
(i) Always maintain the pond water at green colour

(ii) Feed fish regularly twice daily, at specific times (usually 10.00 a.m. and 5.00p.m.), at specific feeding spots, and by gradual broadcast till the fish cease to come up to feed.

(iii) Avoid overfeeding or application of excess feed to prevent fouling and pollution of water. (Unconsumed feed decompose to form smelly and harmful gases like ammonia, hydrogen sulphide, and carbon-dioxide which have adverse effects on fish growth and survival).

(iv) Drain part of pond water and replace with fresh-water if you notice fouling.

(v) Monitor growth performance of fish by visual observation during feeding

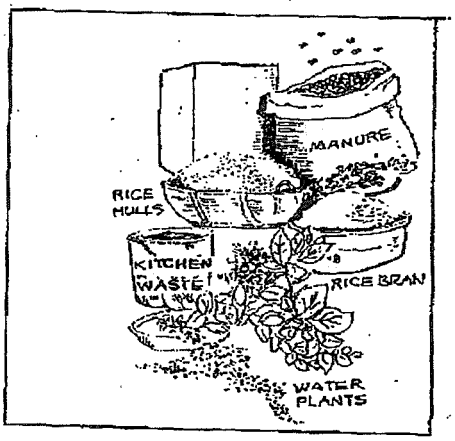


During feeding the observation of fish behaviour, growth response to feeds, and health status is very important in fish pond management.

6. Feeding

- For good production, supplementary feeds should be given in the pond. Kitchen waste, duck weeds, azolla, green leaves of kangkong, sweet potato and tender terrestrial grasses can be given. Rice bran or wheat bran will increase growth and production of fish.

- The family participate in the feeding of fish. feed the fish at the same time, twice daily (in the cool hours of the morning and evening), from the same feeding point, by gradual broadcast, till they stop coming up for feed.



Feeds

- Fish can feed on many things such as rice bran, rice hulls,kitchen wastes and leftovers, different kinds of water plants kinds of water plants (e.g. duckweed), leaves (e.g. cassava, cabbage, banana) termites, earthworms, maggots, slaughter house wastes, spoiled fruits, beer waste, cakes (e.g. groundnut, cotton, palm kernel, soyabean), cassava wastes, grain mill sweepings, animal manures,and unused dead animals, entrails or body parts.

PREPARATION OF COMPLETE ARTIFICIAL FEEDS

The dispensation of ground feed stuffs is the most commonly practiced feed supplementation locally. These may not be nutritionally balanced or complete, and as such will not adequately enhance fish health, growth and yields. Complete diets are formulated by the combination of different essential nutrients in proportions (i.e. proteins, carbohydrates, lipids, vitamins, and minerals). They can be produced at low-cost by using locally available ingredients chosen from agricultural by-products, industrial residue, animal by-products, and wastes. Economic factors, availability etc. play a major role in selecting these ingredients. Some essential nutrients and their sources include:

Protein Fish meal/powder, groundnut cake, Soyabean meal, blood meal, cotton seed cake, palm kernel cake, dead animals.

Carbohydrate - Cereal grains, meals and brans, Cassava waste, fruits

Lipids Palm, groundnut, soybean, palm-kernel and fish oils

Vitamins Vitamin pre-mix

Minerals Bone meal, Mineral pre-mix, common salt.

Steps involved in preparation of complete artificial feeds are stated hereunder.

STEPS IN FISH FEED FORMULATION

Step 1 - Collect the raw feed stuffs

Step 2 - Weigh the required quantity of the various feed ingredients according to the attached formulation specifications or any other that is recommended (use a container as a measure, not a weighing balance e.g. buckets, pails, bowls).

Step 3 - Grind the ingredients to powder

Step 4 Cook the mixture with small water, and add cooked cassava or corn starch as binder/gum

Step 5 Keep turning (stirring) the mixture as cooking in going on to get a consistent paste like bread dough. (The feed so produced may be fed wet if the quantity is for immediate use).

Step 6 Pellet the feed by extrusion of the resulting dough using a meat grinder or other device e.g. perforated cylindrical can. The feed paste is pressed against the uniform perforation on the bottom plate.

Step 7 - Cut the pellet strands with a knife to uniform sizes

Step 8 - Sun-dry the pellets

Step 9 - Package or bag the dried pellets and store for use as and when needed.

Table 1 - Fish Feed Formulations for Catfish, Tilapia and Common Carp

CATFISH (MONOCULTURE)		
Feedstuff	**Quantity (kg)**	**Quantity (Mudu)**
Maize	13	13
Fish meal	15	15 (unmilled clupeids)
Groundnut Cake	30	30
Soya bean meal	38	38
Oil	1	1 bottle
Bone meat	1	0.5
Premix	1	0.5
Common salt	0.5	0.5
Starch	0.5	0.5
Total	**100 kg**	0.5 (dried)
TILAPIA/CARP (MONOCULTURE)		
Maize	52.50	52.5
Soya bean meal	25.00	25.00
Groundnut Cake	15.00	15.00
Fish meal	5.00	25 (unmilled)
Bone meal	1.00	0.5
Premix	1/00	0.5
Salt	0.50	0.5
Total	**100 kg**	

Table 2 - Fish Feed Formulation Using Two Main Feedstuffs

S/ No,	Feedstuff Combination	Crude Protein (%)	Specie	Management purposes
1.	Soyabean and groundnut meal Ratio: 1:1	40	Catfish	Monoculture
2.	Maize, Soyabean and groundnut cake Ratio: 5:3:2	25	Tilapia	Monoculture
3.	Maize, Soybean and beniseed Ratio: 2:5:3	30	Tilapia, carp catfish	Polyculture
4.	Soyabean, beniseed, maize Ratio: 5:3:2	30	Catfish and carp	Polyculture
5.	Fish, soybean, GNC and Maize Ratio: 2:6:1:1	42	Heterobranchus	Polyculture
6.	Soyabean and maize Ratio: 1:1	25	Tilapia	Monoculture
7.	Soyabean, and millet/Sorghum Ratio: 4:1	30	Catfsih and tilapia/carp	Monoculture
8.	Beniseed and maize offal Ratio: 1:2:7	20	Tilapia	Polyculture
9.	Fish meat, maize, soyabean Ratio: 1:2:7	40	Cat fish only	Monoculture
10.	Fish meal, maize, soyabean, GNC Ratio: $1:1:2^{1/2}:2$	40	Cat fish only	Polyculture

Note: **Add one full spoon of salt and premix to every ten mudu if available.**

- Mudu is a local measure in Northern parts of Nigeria (which is about 1 kg)

AQUATIC WEEDS, PREDATOR & DISEASE CONTROL

Uncontrolled predation and competition from animals and plants greatly reduces fishing populations, available food and space, promotes disease, generally makes production systems unprofitable, dampens enthusiasms and fish culture technology adoption. Common unwanted predators include insects, bids (e.g. king fisher), frogs, reptiles (e.g. snakes, turtles, alligators, monitor lizard), "wild" fish, (and of course, man). Fish disease and loss could be due to overcrowding, nutritional deficiencies, and/or deteriorated environment/water quality. In other words fish that are well fed, uncrowded, and in a good environment are less likely to develop disease. Aquatic weed infestation causes serious problems in tropical fish culture. These include stress and fish kill by oxygen depletion and gill entanglement, fouling (and further oxygen depletion) by decomposition of dead weeds, provision of shelter and breeding places for disease vectors and predators, contribution to water loss by evapotranspiration, critical reduction in primary productivity by covering/shading water surface, as ell as restriction of fish movement and netting operations. Common weeds in fish culture can be classified into filamentous algae/scum, floating, emergent, submerged and marginal weeds (SEE FIGURE).

Some routine general management measures to control aquatic weeds, predators and disease are provided to assist rural fish farmers.

EXTENSION MESSAGES AND RECOMMENDATIONS

(1) Destroy all pests (animal, plants) in the pond area

(2) To control/eliminate predators do the following:

- (i) Dry and treat pond bottom regularly
- (ii) Ensure the water supply structure inlet is always properly screened (as many harmful organisms may enter through the water supply)
- (iii) Constantly clear floating, submerged and marginal water weeds and unwanted vegetation (which provide hiding places for pests and predators) in and around the pond
- (iv) Install and maintain good fences around ponds
- (v) Use palm fronds on surface or stakes at different points to hinder netting activities of human poachers

(vi) Watch out for and conduct routine checks for fish enemies and eliminate (Use gillnets, traps and guns for shooting or trapping invading reptiles and birds).

(vii) Stock sizeable/advanced fingerlings (minimum 10g, 9 10cm middle finger length) to make it impossible for frogs to feed on them.

(viii) Suffocate predatory air-breathing aquatic insects by applying 0.75 litres of diesel fuel (or kerosene) per $100m^2$ of pond surface area. Otherwise spray an emulsion of 0.5 litres diesel and 17.5 gm or detergent/soap on the water surface.

3. Observe Disease control measures. These include:

(i) Dry and treat pond regularly. (Apply lime to destroy pathogens and unwanted eggs. See chapter on Pond Preparation)

(ii) Supply good quality water

(iii) Screen the pond inlets properly to prevent entry of wild fish, etc.

(iv) Maintain good water quality conditions by preventing in-flow of run-off (which might contain petrochemicals, pesticides from agricultural farms, detergents or heavy metals from industrial wastes/effluents).

(v) Stock good quality healthy and disease free fingerlings collected from a reputable hatchery

(vi) Avoid overcrowding of ponds

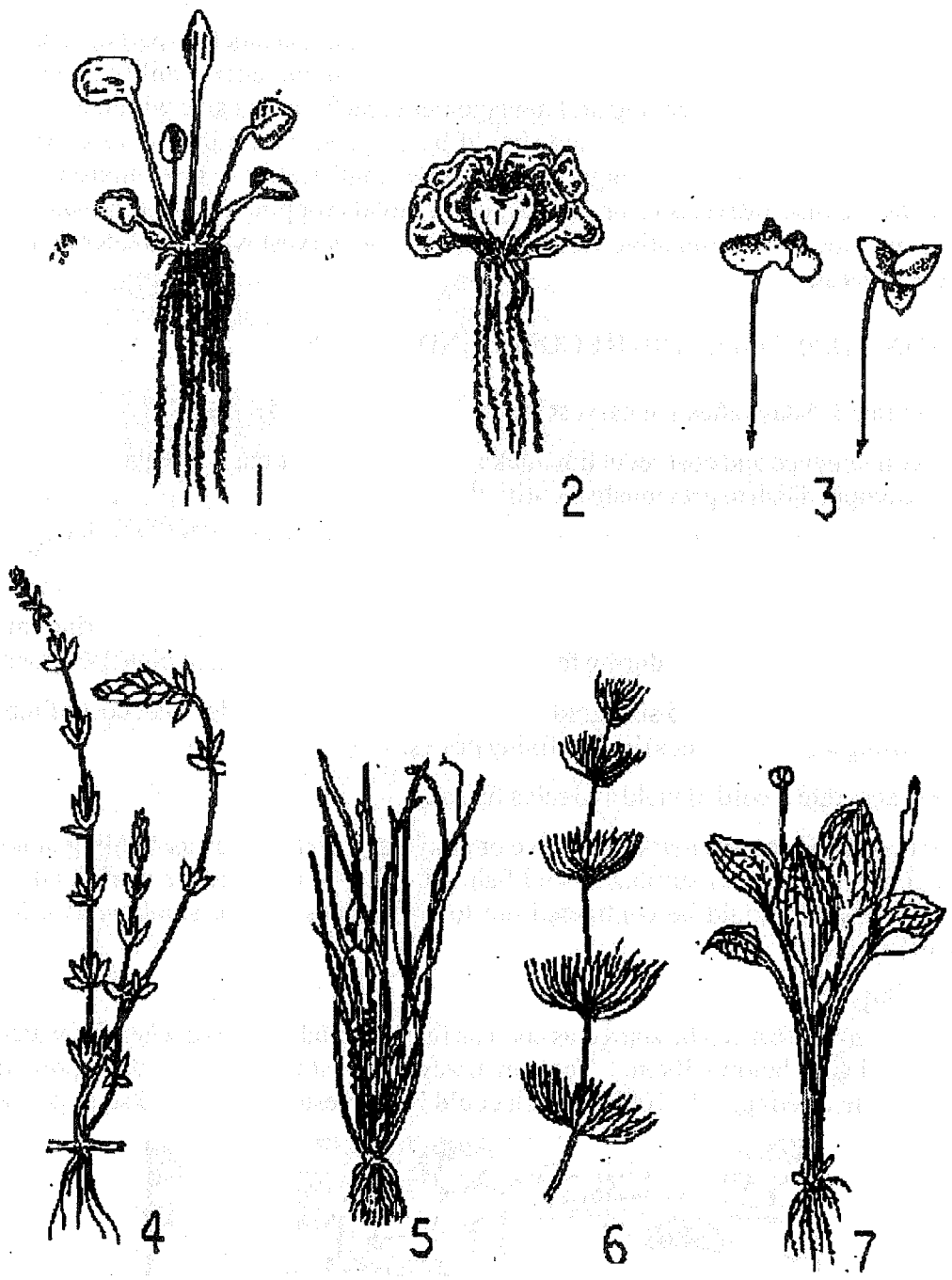
(vii) Provide complete/balanced feeds to avoid nutritional diseases and mortality, and avoid overfeeding/fouling

(viii) Remove infected individuals, and dying fish from ponds immediately

(ix) Avoid the sue of decaying or mouldy feeds to feed fish.

4. Control or remove water weeds manually (by using simple hand weeding, cutlasses, rakes or hooks attached to poles, etc). The water plants could be used as animal feeds or composted.

5. Avoid application of toxic chemical control methods. Consult expert or your facilitator extension agent.



1..Eichhornia 2. Pistia 3. Lemna 4. Hydrilla 5. Valliance 6. Ceratophyllum 7. Ottelia

HARVESTING AND MARKETING

Cropping or harvesting of a fish pond is undertaken when the fish stock or part of it has attained market size. The market size of fish is determined by consumer acceptability and preference. Most fish species with proper feeding and management reach market size within 6 9 months of stocking (or maximum of 12 months) and should be cropped within this period. Moreover if partial cropping or the removal of bigger fish to allow smaller ones to grow more is repeatedly done at reasonable time intervals (2 or 3 times) before total cropping (or the removal of all pond fish at the same time), the cumulative yield due to multiple harvest will be greater than the yield from a single harvest.

EXTENSION MESSAGES AND RECOMMENDATIONS

(1) Advertise 3 5 days ahead of harvest in previously identified markets

(2) For convenience and cost reduction make sales on farm, or make adequate arrangement to move cropped fish to previously identified markets.

(3) Stop feeding fish 1 3 days before harvesting, and crop when weather is cool especially in the early morning

(4) For economic reasons and optimum profit crop within 6 9 months of stocking (maximum of 12 months), preferably during festival periods and by partial cropping 2 -3 times

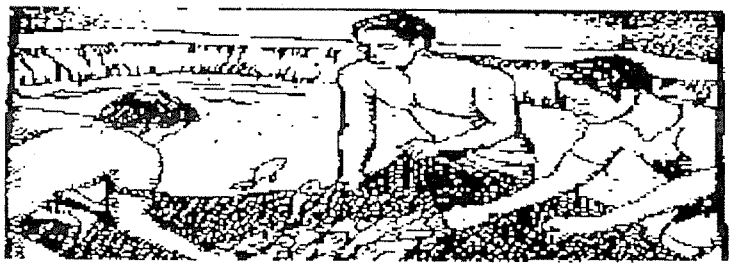
(5) Sort fish into species and size grades for marketing and consider total cost of inputs (and prevailing local price rates) before fixing prices.

(6) Keep accurate record of yield and sales figures

(7) For maximum returns market fish live or smoked (For this, prepare holding tanks, cages, etc for live storage of surplus/unsold fish. Furthermore to reduce work load and avoid losses, the fish could be contracted out to fish processors for smoking at a fee before marketing).

Harvesting

Harvesting of fish can be started as soon as fish reach table size or when the water level in the pond goes below 50cm. You can always harvest for family consumption or at one time for marketing. 75 100kg of fish could be harvested from a 500 sq m period in 5 6 months.



The ideal fish for culture is the one that attains table size before sexual maturity

RECORD KEEPING IN AQUACULTURE

It is important to keep record of fish farming activities in a notebook. Book-keeping or Recording-keeping can be said to be the core of fish farm management practices. It helps to achieve the maximum possible rate of fish production. It records all aspects of fish farm operation, and is important to the fish farmer, site manager, or extensionist for 3 reasons.

(i) it aids in evaluating the profitability and general economics of the fish pond/farm investment

(ii) it provides vital management information for future planning, improvement, and development (Part of this includes provision of better support services to fish farmers by projects).

(iii) It provides necessary ground to get credit or funding support from financial institutions/projects.

The book-keeping system pays attention to 2 major aspects of recording:

(i) Account Keeping - This is concerned with registering all receipts (Sales, money received, incoming cash) and payments (expenditure, money spent, outgoing cash)

(ii) Operational Activities This records aspects pertaining to the description of the fish ponds/Farm, plan of work, pre-stocking stocking and post-stocking operations, as well as harvesting and sales details.

Simple Formats (1 6) for use in collecting these essential data are attached.

IMPORTANT EXTENSION MESSAGES AND RECOMMENDATION

(1) Extension Agents should stress the three-fold ideas behind record-keeping to fish farmers (Investment Evaluation, Development & Improvement Planning, Credit Support).

(2) Farmers should keep record of Pond Construction (and maintenance) Costs

(3) Farmers should keep record of all inputs like stock material, fertilizers, manure, feeds, lime, etc.

(4) Farmers are to keep Cropping/Harvest and Sales records

(5) Extension Agents should make regular contact with fish farmers, and ensure their records are up to date.

Table 1. Pond Construction and Maintenance Records

Pond Owner_____ **Pond No.**___ **Site Location**_____ **State**_____

Date	Operation/Particulars A. Pond Construction	No. Labourers	Time Spent (days, hours)	Cost (₦)	Remarks
	* Land Acquisition				
	* Land Clearing				
	* Preparation				
	* Excavation/Dyking				
	* Water Inlet/Drain				
	* Others				
	Total				
	B. Pond Maintenance and Repairs 1/ *				
	*				
	*				
	*				
	*				
	*				
	*				
	*				
	*				
	*				
	*				
	*				
	Total				
	GRAND TOTAL				

1/ Indicate type of pond repair/maintenance activity (e.g. Pond dyke, Pond bottom, Desilting, Water Inlet, Water outlet, Mowing, Grassing, etc.

Table 2. Fish Farm Equipment and Tools

Fish Pond Owner_____ **Pond No.**_____ **Site Location**_____ **State**___

Date	Item 1/	Quantity	Cost Unit (N)	Total Cost (N)

1/- Specify the item (e.g. bucket, basin, basket, pots, rake, cutlass, hand net (scoop net), Seine, net Water pump)

Table 3. Input Records

Fish Pond Owner_____ **Pond No.**_____ **Site Location**_____ **State**_____

Date	Input Type 1/	Quantity (No., kg, items, etc.)	Cost/Unit (N)	Total Cost (N)	Remarks

1/ - Input Types Include Fish Fingerlings (catfish, tilapia, carp, etc.) Lime (agricultural lime, quicklime) Manures (cow dung, poultry dung, etc.) Fertilizers (NPK, Urea, etc) Feeds (cakes, cereals, pelleted, etc) Fuel (where a pump is used, etc.) or Pump Hiring Charges. Total estimates of feeds from Kitchen waste/miscellaneous sources could be filled in periodically (e.g. biweekly). Total cost of formulated/commercial feeds should be filled in, indicating the type, the period of use, etc.

Table 4. Daily Operational Labour Records

Fish Pond Owner_____ Pond No._____ Site Location_____ State_____

Date	Type of Operations	1/Time Spent (days, hours)	Cost (N)	Remarks

1/- Specify each type of operation on a separate line for each date (e.g. pond weeding, harvesting, netting, security, stocking, environment sanitation, feeding, fertilization, etc).

Table 5. Harvest and Sales Records

Fish Pond Owner_____ Pond No._____ Site Location_____ State_____

Date	T ype of Fish Crop -1/	Quantity Kg	Nos.	Price or Sales Value (₦)	Total Sales Value (₦)

1/- Record Adults (table size fish) and Fingerlings separately; and specify Species Types.
(e.g. Adult tilapia, catfish, carp; Fingerlings tilapia, catfish, carp; Others / Unwanted fish).

Table 6. Monthly Costs and Sales Summary

Fish Pond Owner_____ Pond No._____ Site Location_____ State_____

Days		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total
Month 1	S																																
	C																																
Month 2	S																																
	C																																
Month 3	S																																
	C																																
Month 4	S																																
	C																																
Month 5	S																																
	C																																
Month 6	S																																
	C																																
Month 7	S																																
	C																																

Note: S = Sales; C = Costs

Comments: .....

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LIVE FISH TRANSPORTATION

Fish culture practices involve one form of fish transfer or the other within the farm or between farm sites and other distant areas where they are needed. Developing skills for safe delivery of live fish whether fry, fingerlings, or adults to their destination is important for avoiding mortalities, low yields, and financial loss.

Receptacles for transport include plastic, wooden, or metal containers, and they can be transported in open containers (over short distances) or in air-tight closed containers supplied with pure oxygen (over long distances). During live transportation, fish are crowded into small containers. This situation results in high oxygen consumption, accumulation of poisonous metabolic products such as ammonia and carbon dioxide which are the main causes of stress conditions, and sudden death which must be managed to avoid or minimize mortalities. Tranquilizers and anaesthetics (like MS 222, Benzocaine, Chlorobutanol, Quinaldine) are used to reduce metabolic rate but these are totally discouraged except when undertaken by experts. Type (species) of fish, size (age) of fish, density (number) of fish, health condition of fish, distance or duration of transport, water temperature, dissolved oxygen, water quality conditions of transport and final water, and means of transport are factors which need to be taken into consideration when planning for transportation .

EXTENSION MESSAGES AND RECOMMENDATIONS

(1) Do not feed the fish before and during transportation to reduce metabolic waste, and so that their excrement and uneaten food does not foul the water. Stop feeding fish 24-48 hours prior to transport.

(2) Use tube well, chlorine free tap water (leave open for 24-48 hours to allow the gas evaporate), clear pond, or river water for transporting fish.

(3) Avoid overcrowding live fish in containers as this can lead to suffocation. (The number in containers depends on the size of fish. As a guide transport 500-2000 (2-3cm size), 200-300 (4-5cm size), 40-80 (6-8cm) in 18 litre capacity polythene bag).

(4) Sort out fish that are weak, sick, or injured before transportation because they may die from stress conditions and foul the water.

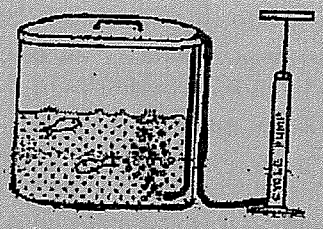
(5) Avoid transporting diseased or infected fish so as not to spread disease from one farm to another. If it is necessary to provide curative treatment before and after transport, consult an expert. Such treatments include short baths of 0.1-0.2ppm Malachite Green, (1 minute), 2-3ppm Potassium Permanganate (1-2 minutes), 20ppm Tetracycline (1-2 minutes), and 10ppm Chloramphenicol (1-2 minutes).

(6) Make haste and transport collected live fish to the desired destination at the shortest possible time. Avoid unnecessary delay and long stoppages.

(7) Transport fish in cool weather (early morning, late evening), and maintain low temperature conditions in the transport water to prevent oxygen depletion and reduce fish respiration. Do this by avoiding direct exposure of containers to sunlight, insulating fish from heat during transport, and using ice if available (but do not put ice inside transport water). Note that warm water holds less oxygen than cold water, and that respiratory

requirements of fish are also greater at higher temperatures.

(8) Maintain sufficient oxygen in the transport water throughout the whole journey. This can be done by keeping water at low temperature, periodic water renewal partial not complete), or supply of atmospheric air or pure oxygen from aeration devices like hand pumps and oxygen cylinders.



Pumping air into a transport container

(9) Avoid abrupt transfer or dumping of fish from one different water environment to another without proper acclimatization (or equalization of temperature, PH, salinity) to prevent mass mortalities.

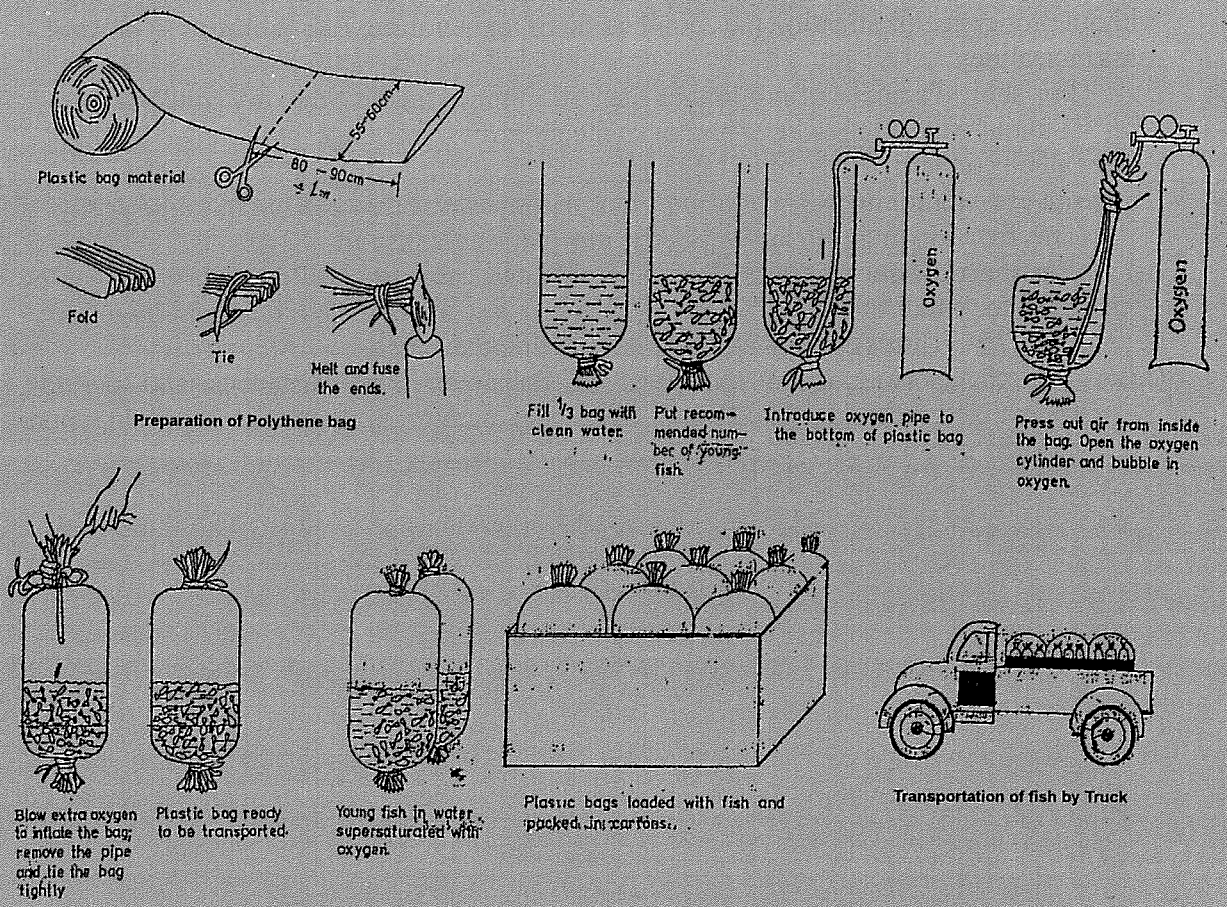
(10) (i) For short distances of not longer than 30 minutes transit time, dry transport (i.e. Without water) in buckets, baskets, wheelbarrows, jute bags, etc. Can be used for ad ults of hardy fish like catfish (Clarias, Heterobranchus) which can stay alive out of water for up to 3-4 hours without stress because they can breathe air directly. The fish skin must however be kept moist during transport.

(ii) For short distances, small cans, clay pots and calabashes filled with water can be used for small quantities of swim-up fry or few average size fish; and large jerry-cans (20-50 litres), drums and basins for average size fish.

(iii) For transporting large quantities of fish over long distances and periods, specialized vehicles fitted with tanks and aerator systems for supplying pure oxygen continuously or intermittently from outside are used.

Transportation Using Oxygenated Polythene Bags

The use of this commonly employed means of transportation is illustrated below. It primarily requires polythene (PVC or other plastic) bags, clean water, oxygen cylinder, rubber hose, rubber bands and a wooden/foam box or empty carton. The bags can be obtained directly from the market or made from cylindrical rolls.



Stages in the use of a Polythene bag to transport live fish

MONOSEX TILAPIA CULTURE

Excessive reproduction and subsequent stunting of fish due to overcrowding and competition is a major problem of pond cultured tilapia. This sours the ready availability and cheapness of its fingerlings. This can be overcome by polyculture with a predator species (e.g. catfishes), or by culture of all-male tilapia which grow 2 or 2.5 times as fast as the females.

For farmers with few financial resources, the latter procedure involves manual separation of the males from females when tilapia reach about 20gm or 10cm in length (adult middle finger size). The sexes can be distinguished by inspecting the general papilla, a small fleshy appendage which projects from the underside. This can be done with 80 90% accuracy (i.e. it is not 100% effective, and there will still be some, though very limited reproduction). It is also tedious and stresses fish, but can be rewarding.

PROCEDURE FOR CULTURE OF MALE TILAPIA

(1) Under high rates of fertilization and/or supplementary feeding, stock tilapia fingerlings (4-5gm, 5cm or small finger length) at a density of $10/m^2$, and culture them for about 60 days (2 months) to reach 20 40 gm.

(2) Slowly drain and partially harvest the fingerlings, then separate males and females into different containers. **The female has two openings in the papilla for passage of Urine (the Ureter) and eggs (the Oyiduct), while the male has only ONE opening for urine and sperm (the Uro-genital Pore).** Staining the sexual papillae with Ink or dyes (e.g. India ink, indigo applied with soft feather or cotton swab can help clarify the opening.

(3) To reduce stress do not feed the fish 2 days prior to sexing, avoid high water temperatures by doing manual sexing early in the morning, avoid overstocking containers being used for separation, and regularly supply fresh water to renew water in holding containers.

(4) Stock males in grow-out ponds at $2/m^2$, and culture for 4 months using fertilizer or manure and feeds. A few carnivorous fish can be stocked to eat offspring from females stocked inadvertently. Also, since tilapia fries move in schools along the banks of ponds they can be removed, using a scoop net. They can either be sold or crushed and given as feed in the pond.

(5) Females can be used as brood stock, eaten, sold, processed, or fed to livestock. The males can also be stocked in a polyculture sy stem.

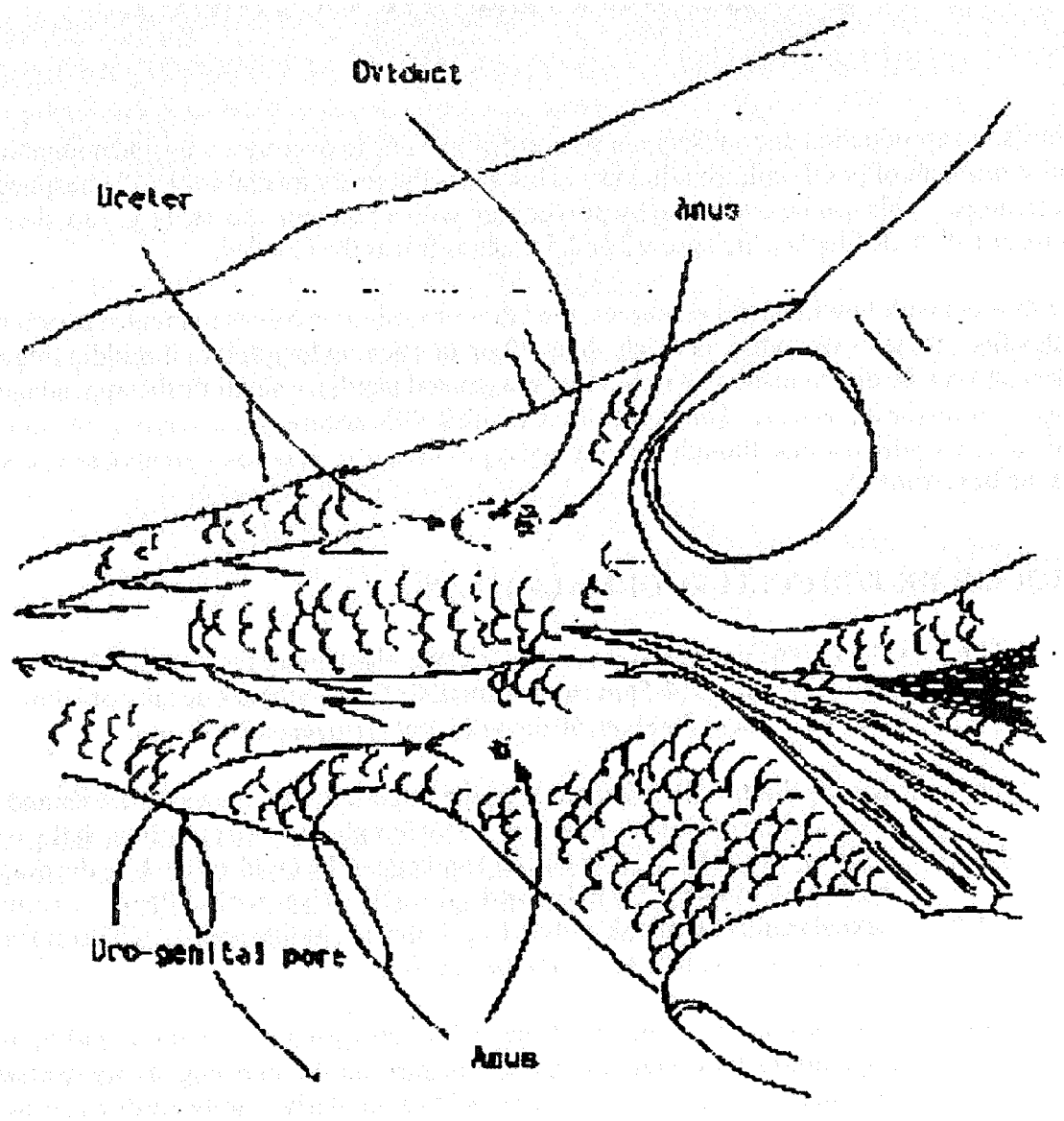
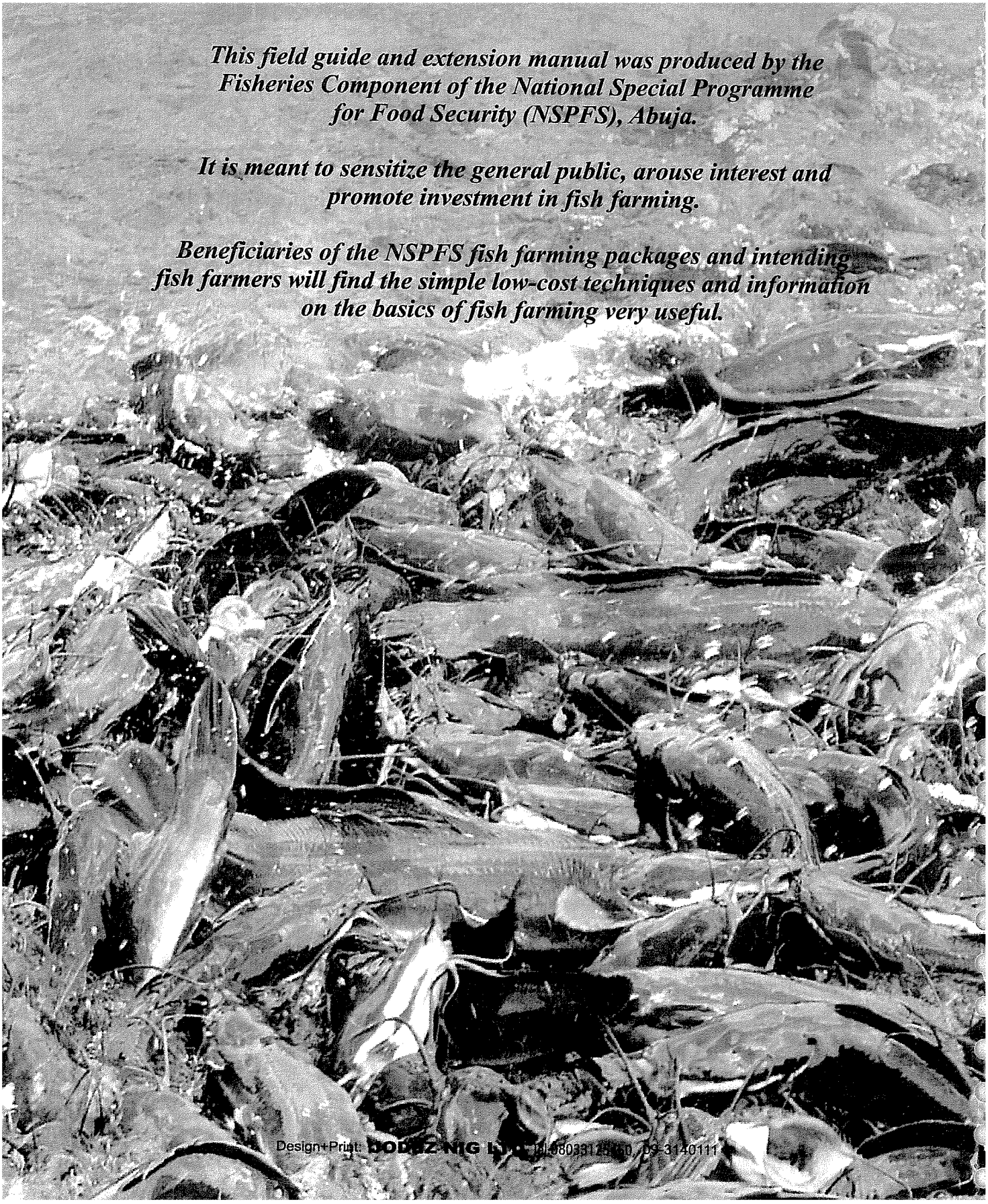


Figure1: This close-up shows a female (top) and male (bottom) tilapia together. Note that the female has two openings in the papilla for passage of urine and eggs, while the male has only one opening for urine and sperm passage.

This field guide and extension manual was produced by the Fisheries Component of the National Special Programme for Food Security (NSPFS), Abuja.

It is meant to sensitize the general public, arouse interest and promote investment in fish farming.

Beneficiaries of the NSPFS fish farming packages and intending fish farmers will find the simple low-cost techniques and information on the basics of fish farming very useful.



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