WATER HARVESTING AND AQUACULTURE FOR RURAL DEVELOPMENT

INTRODUCTION TO FISH CULTURE IN PONDS

INTERNATIONAL CENTER FOR AQUACULTURE
AND AQUATIC ENVIRONMENTS
AUBURN UNIVERSITY

INTRODUCTION

A pond is a body of standing, as opposed to free-flowing, water that is small enough to be managed for fish culture. Fish production in farm ponds can provide protein and profit for farmers. Fish such as oreochromis and carp are easy to culture and good yields are possible if a management plan is followed (Figure 1). This manual provides simple, practical guidelines for fish culture in ponds.

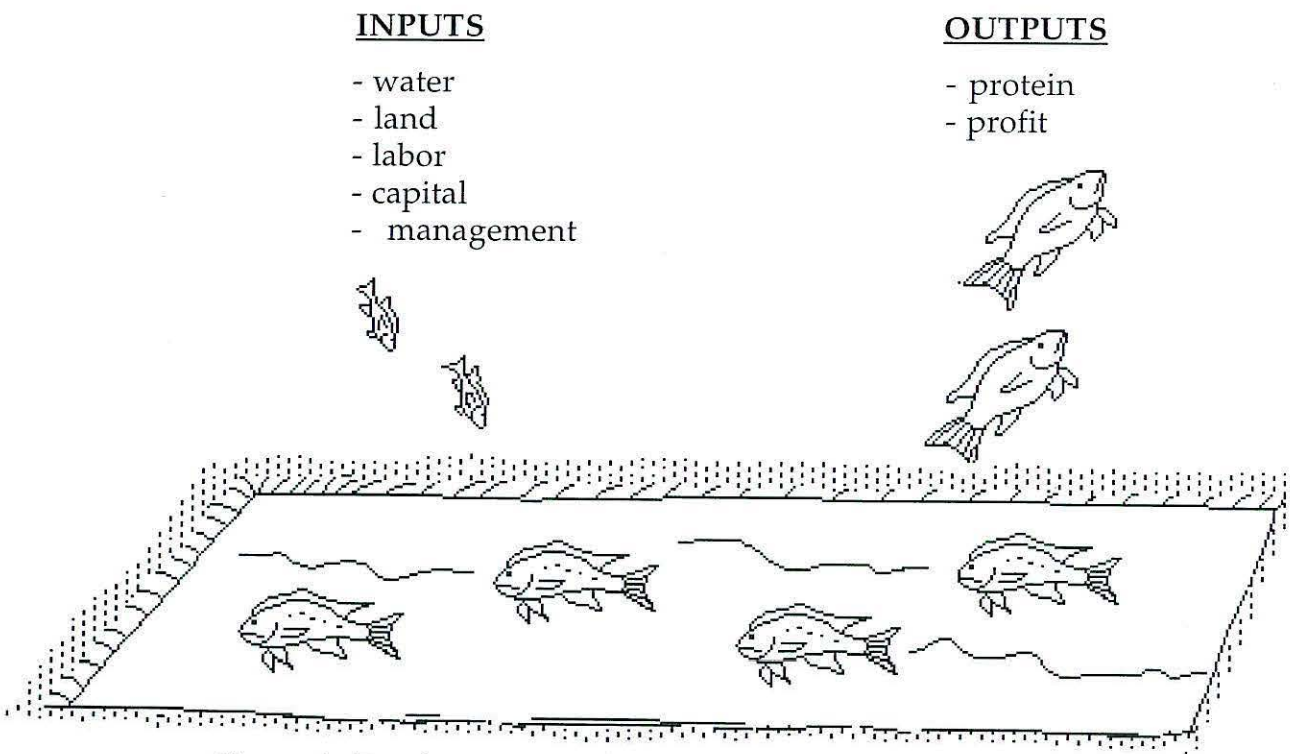


Figure 1: Ponds can provide protein and profit for farmers.

POND SITE SELECTION AND CONSTRUCTION

In most cases, pond size is limited by topography, availability of inputs and construction costs. Construction costs for ponds less than 100 m^2 in surface area are high relative to the weight of fish harvested, and their construction is not recommended. Ponds larger than one hectare are hard to manage and expensive to build.

The site selected for pond construction should be free from flooding and close enough to other farm activities so that the stored pond water is available for multiple uses such as stock watering and supplemental garden irrigation. Common pond sites are small valleys with gradually sloping sides, and flat areas on hillsides or plains (Figure 2). Rainfall, springs and streams are often sources of water for ponds. Water should be free of pesticides and chemicals that can kill fish or harm humans and livestock, and should be available year-round.

Ponds may be constructed without expensive machinery using animal power and/or hand labor. This does, however, greatly increase construction time. Pond dikes should be firmly compacted during construction to avoid seepage problems and possible collapse while the pond is full (Figure 3).

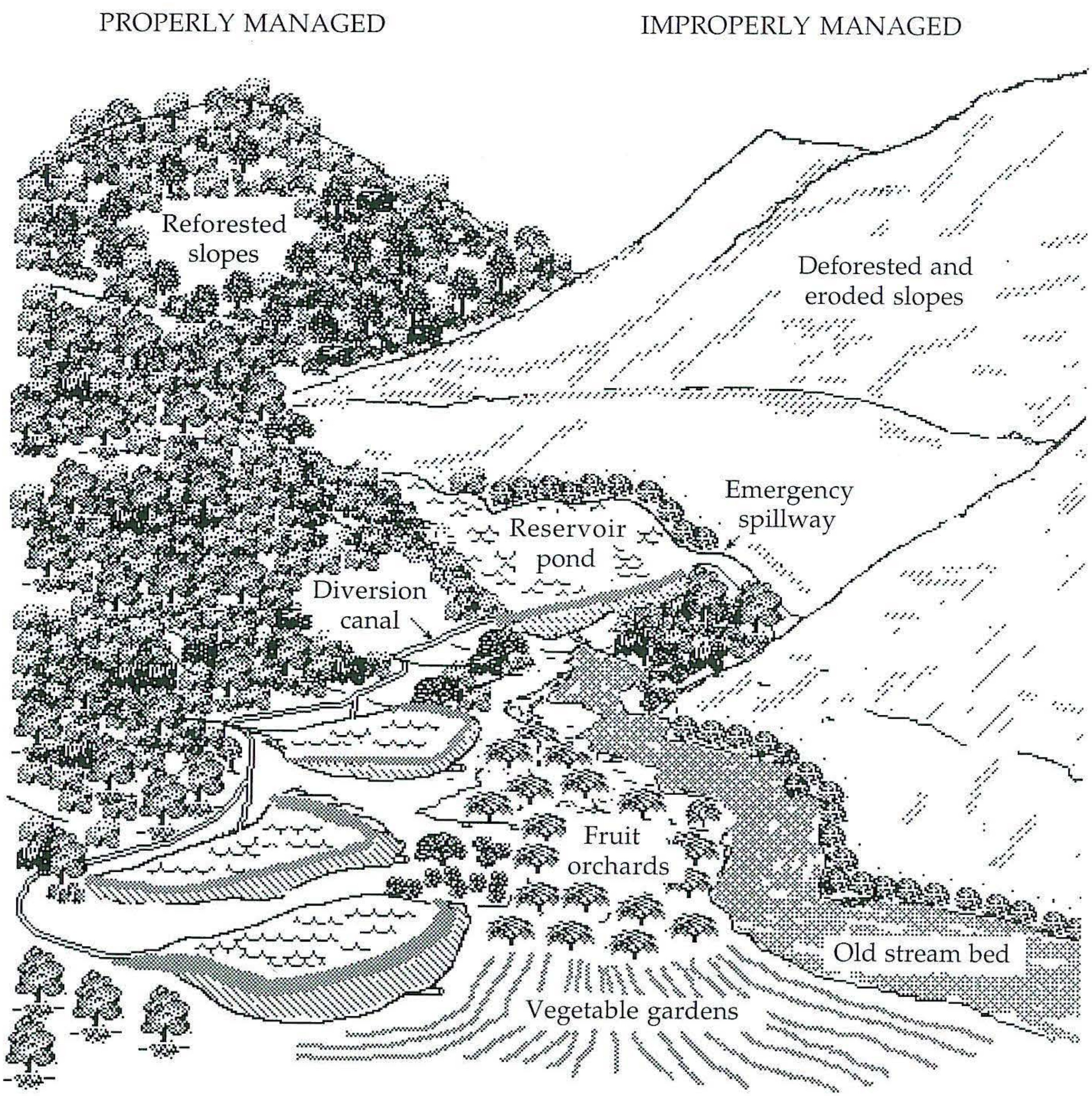


Figure 2: Small valleys like this contain good potential pond sites. Ponds may be built on lower, flatter parts of the valley slope and filled by diverting stream water.

Figure 3: Mule or oxen teams may be used to haul earth for dike construction. Each 10 cm thick layer of soil placed on the dike is compacted.

COMMONLY CULTURED FISH SPECIES

The most frequently cultured fish are oreochromis and common carp. These fish are characteristically hardy, disease resistant, easy to reproduce and fast growing under proper conditions. Oreochromis are native to Africa and grow best in warm water (30° C to 35° C), but have been introduced into many countries around the world. Five tilapia species are commonly cultured. *Oreochromis niloticus* (Figure 4) is the most widely cultured.

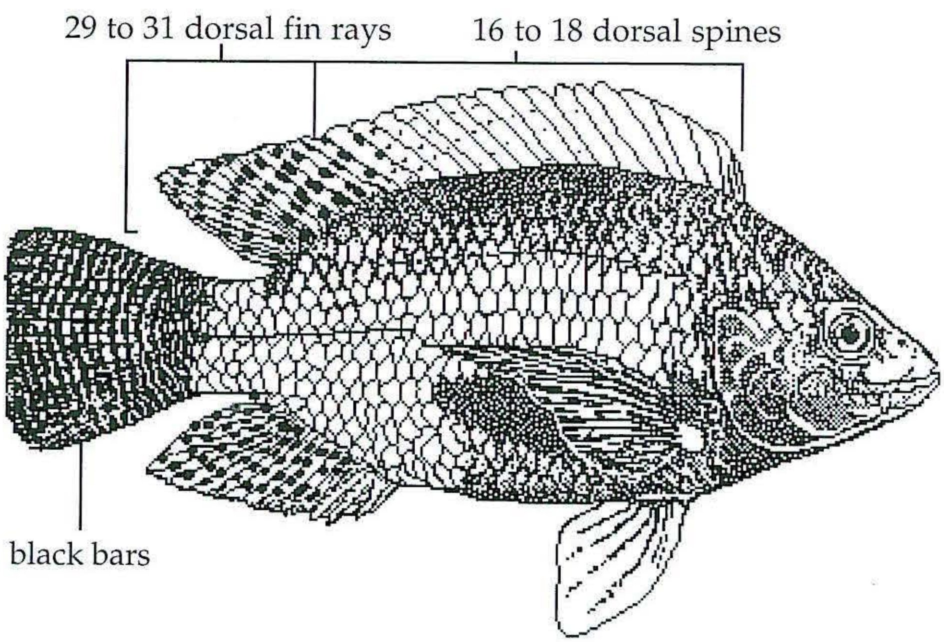


Figure 4: *Oreochromis niloticus*

The common carp, *Cyprinus carpio,* was probably the first fish cultured in ponds approximately 2000 years ago in China. Common carp are temperate climate fish and live in a wider range of water temperatures (1° C to 35° C) than tilapia. Since that time, several different varieties of common carp have been developed which have different scale patterns and body shapes. The normal and mirror scale patterns are most prevalent (Figures 5 and 6).

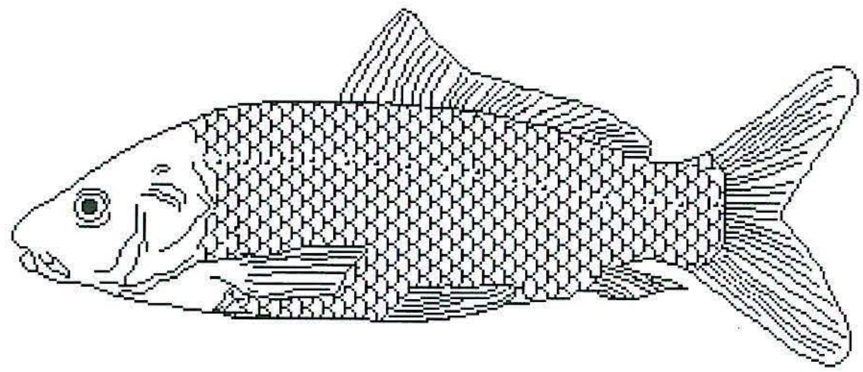


Figure 5: Normal scale pattern of common carp.

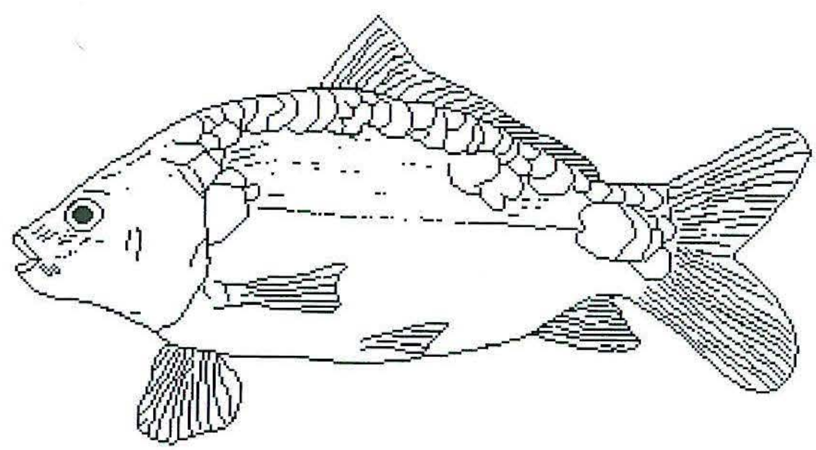


Figure 6: Mirror scale pattern of the common carp.

POND MANAGEMENT

Fish ponds require management and maintenance. Some basic practices should be followed.

1) Keep unwanted fish out of the pond.

Carnivorous fish can eat fingerlings stocked into a pond (Figure 7). Other wild fish will compete with stocked fingerlings for food causing slow growth. Wild fish should be removed from fingerlings being stocked into a pond. Pond water inlets should be covered with a fine mesh screen or similar materials to prevent entry of wild fish. Screens should be inspected daily and cleaned if necessary to prevent clogging. The pond should be completely drained and dried (preferably until cracks appear in the mud) before refilling and stocking new fish. Any fish remaining in undrainable areas may be killed with poisons which are not dangerous to humans. A booklet available in this series describes these poisons.

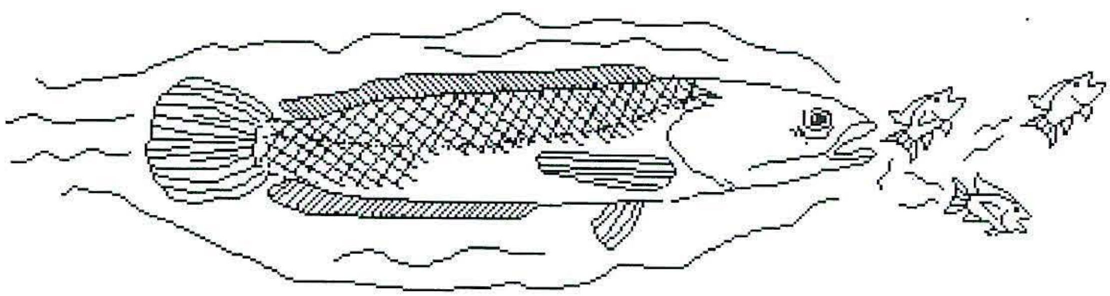


Figure 7: Carnivorous fish will eat fingerlings and should be kept out of a pond.

2) Lime and fertilize the pond.

Natural fish food organisms are usually not abundant in clear pond water, but are abundant in ponds having greenish colored water. The green color indicates the presence of phytoplankton and other natural food organisms. Liming (Figure 8) and fertilization help increase the abundance of these organisms. Lime is not available in many areas and may not be necessary if the pond soils and/or water are not acidic. Soil and water may be tested in a laboratory or with a kit to determine whether liming is required. Testing for acidity can save a farmer time, labor and expense. An agricultural extension agent should be contacted for information on soil and water testing and lime requirements.

Chemical and organic fertilizers may be applied separately or in combination to ponds (Figure 9). Figure 10 illustrates a useful technique for determining whether enough fertilizer has been added to a pond. Numerous factors are linked to the effectiveness of liming and fertilization on stimulating natural fish food production. Further details on liming and fertilization are contained in brochures from this series entitled: "Introduction to Fish Pond Fertilization", "Chemical Fertilizers For Fish Ponds" and "Organic Fertilizers For Fish Ponds".

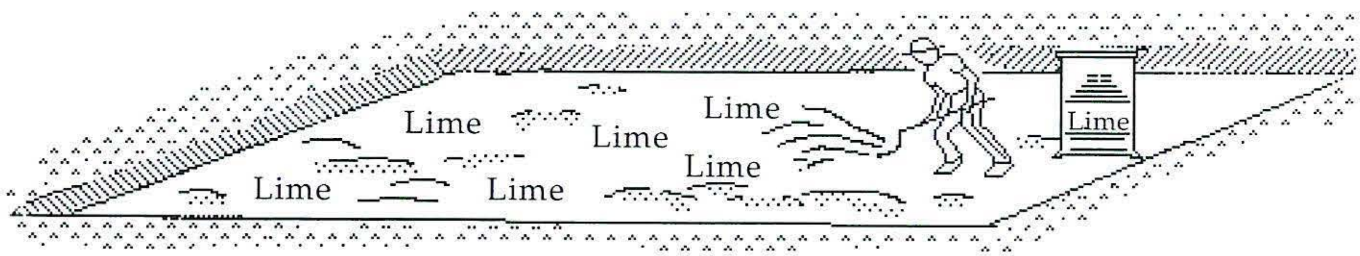


Figure 8: Spread lime evenly over the pond bottom.

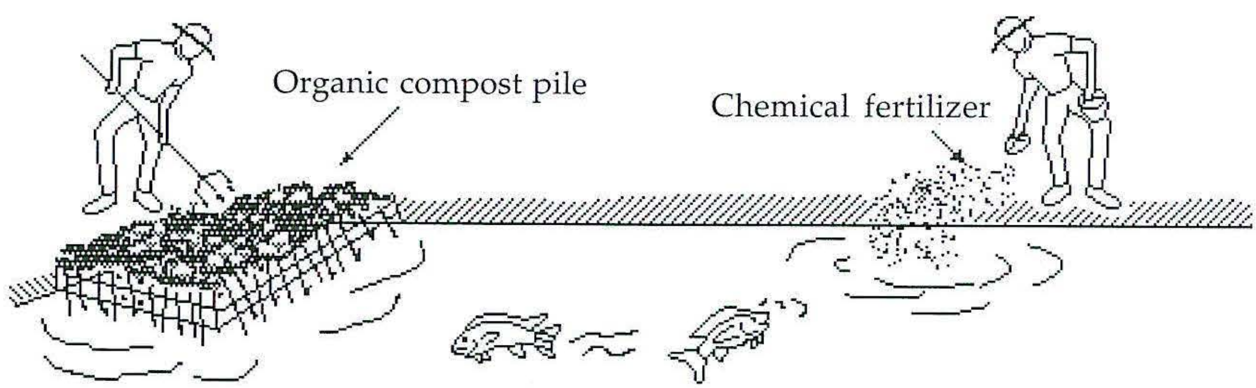


Figure 9: Add manure and/or chemical fertilizer.

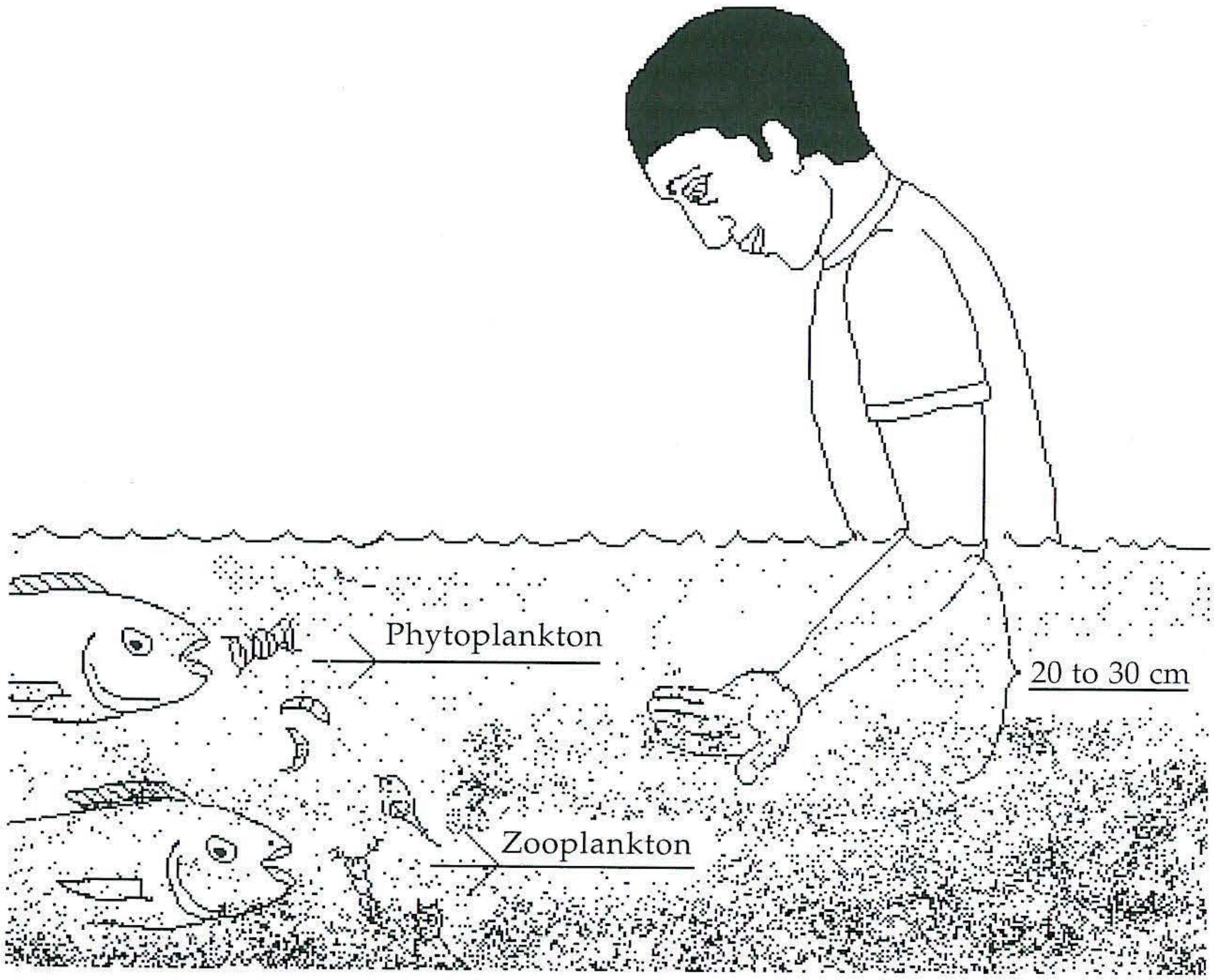
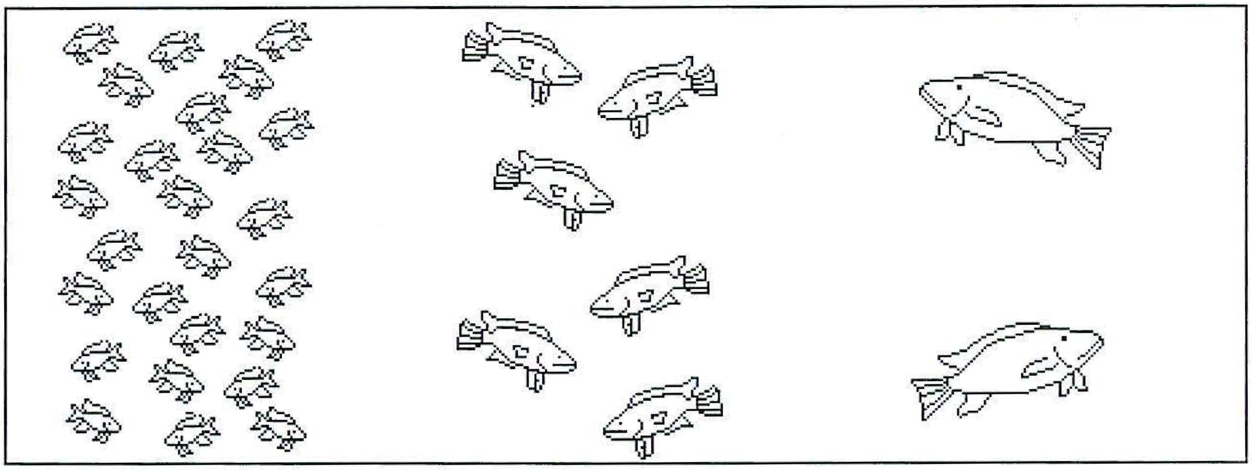


Figure 10: Inspect pond water for plankton abundance using the upturned palm of hand and elbow as guides. Visibility of the palm to a depth between 20 to 30 cm (elbow depth) indicates abundant plankton.

A common misconception about growing fish in ponds is that fish require continuously flowing water. Fresh water is added to a pond only as needed to correct poor water quality, as will be mentioned later, or to replace evaporation and seepage. Excess water flow washes out fertilizer nutrients and inhibits plankton growth. Diversion canals channel excess water away from ponds and prevent fertilizer nutrients and natural food from being flushed out of the ponds.

3) Stock the right number of fish.

The proper number of fish should be stocked into ponds to ensure good fish growth and yield (Figure 11). Overstocking results in crowding and slow growth. Understocking results in poor utilization of natural food organisms in the pond and low fish yield. Proper stocking rates for tilapia range from 1 to 2 fish per m^2 of pond surface area. Common carp are stocked at 1 to 2 fish per 10 m^2 of pond surface area. The higher stocking rate is used for both tilapia and carp when fish are given supplemental feed. Stocking more than 2 carp per 10 m^2 will cause the water to become muddy as a result of bottom feeding activity.



Overstocking results in:	Proper stocking results in:	Understocking results in:
- scarce food	- adequate food	- underutilized natural food
- small size	- large size, high yield	- large size, low yield
- slow growth	- fast growth	- fast growth

Figure 11: Stocking rates affect the growth of fish, their utilization of natural food and their final size at harvest.

FEEDING YOUR FISH

Fish in fertilized ponds will grow faster when they are provided with supplemental feed. Tilapia and carp will consume a wide variety of feeds, many of which are available to rural farmers. Examples of supplemental feeds are rice bran, wheat bran, corn gluten, African palm seed meal, dried and ground leaves from mullberry and ipil-ipil trees and manioc plants, dried blood, chopped earth worms, termites, chopped snails and insects. Two daily feedings (morning and mid-afternoon) are suitable under most situations. The amount fed depends on the number of fish stocked and their average weight. Fingerlings are generally fed 10 to 12 % of their body weight. The feeding rate is gradually reduced to 2 to 3 % of body weight by the time fish reach market size.

WATER QUALITY MANAGEMENT IN PONDS

Low oxygen can kill fish. The decay of excess feed and organic fertilizer consumes oxygen from pond water. Fish will die of asphyxiation if too much oxygen is consumed. Ponds receiving large applications of fertilizer and/or feed must be closely monitored to determine if oxygen levels in the pond are satisfactory for fish. Low oxygen occurs most frequently just before sunrise. Farmers should visit their ponds early in the morning to see if fish are suffering from low oxygen. Fish will come to the water surface seeking higher oxygen levels from water in contact with the atmosphere. The fish appear to be "drinking" the surface water (Figure 12).

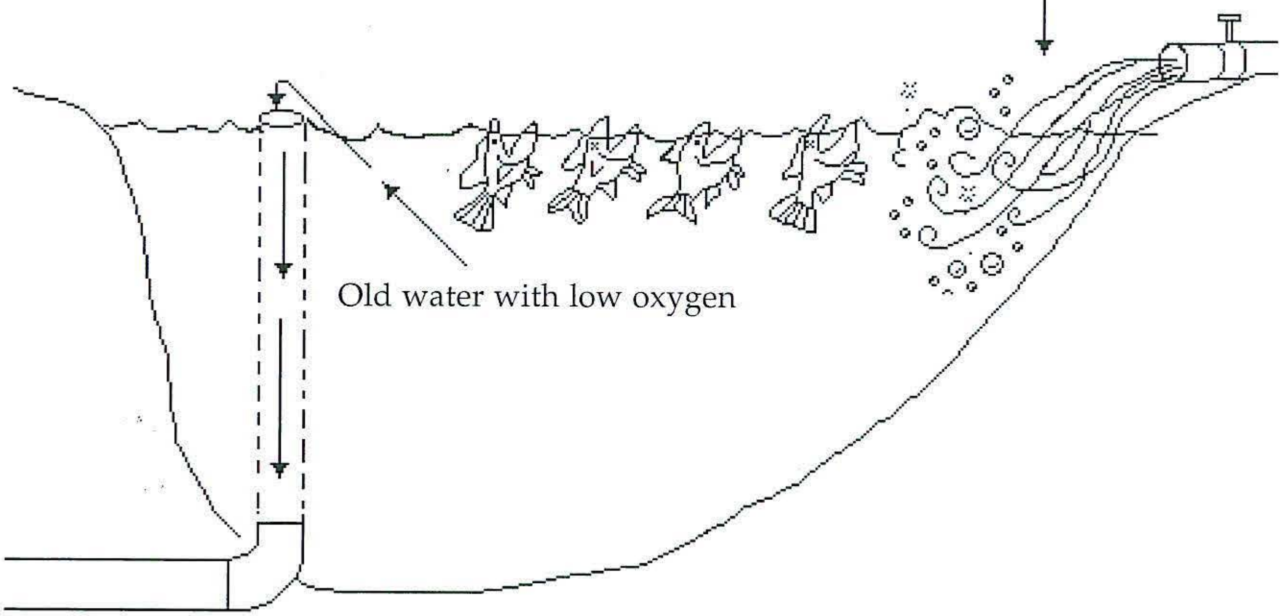


Figure 12: Pond with low oxygen and fish gasping at the surface.

Almost all fish in the pond will be evenly dispersed over the pond surface and gasping for air. When scared, they will make a splash and dive for deeper water, but will quickly return to the surface. This behavior is sometimes confused with feeding. However, feeding fish will not return to the surface quickly if scared. Fish suffering from low oxygen will usually not eat. Take immediate action to remedy low oxygen using the following steps.

Correcting low oxygen in ponds

1) Add fresh water to the pond to replace water with low oxygen until fish stop gasping at the surface. More oxygen may be added to the fresh water by letting it run over a terraced structure before it enters the pond (Figure 13).

2) Stop fertilization and feeding for several days. Observe fish behavior closely during this time. If low oxygen has been corrected, fish will resume their normal feeding habits. When plankton abundance decreases and a submerged object (Figure 10) is visible at a depth of 30 cm, fertilization may be resumed.

3) If low oxygen becomes a chronic problem, reduce the amount of fertilizer and/or feed placed in the pond.

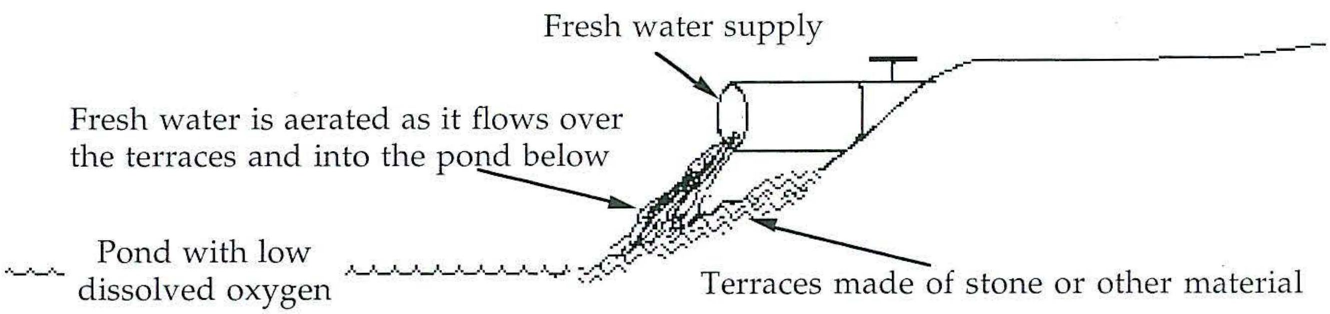


Figure 13: Adding new, aerated water to a pond with low oxygen.

HARVESTING THE POND

Harvesting may be partial (using nets) or complete (draining) and is part of the management cycle of ponds. Pond management and harvesting are made easier if a drain is installed. Many different types of drains are used. In small ponds, a portion of the dike may be cut out to allow drainage during harvest (Figure 14). The dike must be rebuilt prior to refilling the pond for the next production cycle. Other drainage structures are more permanent and require special construction and installation (Figure 15). Large ponds are typically harvested with nets (Figure 16).

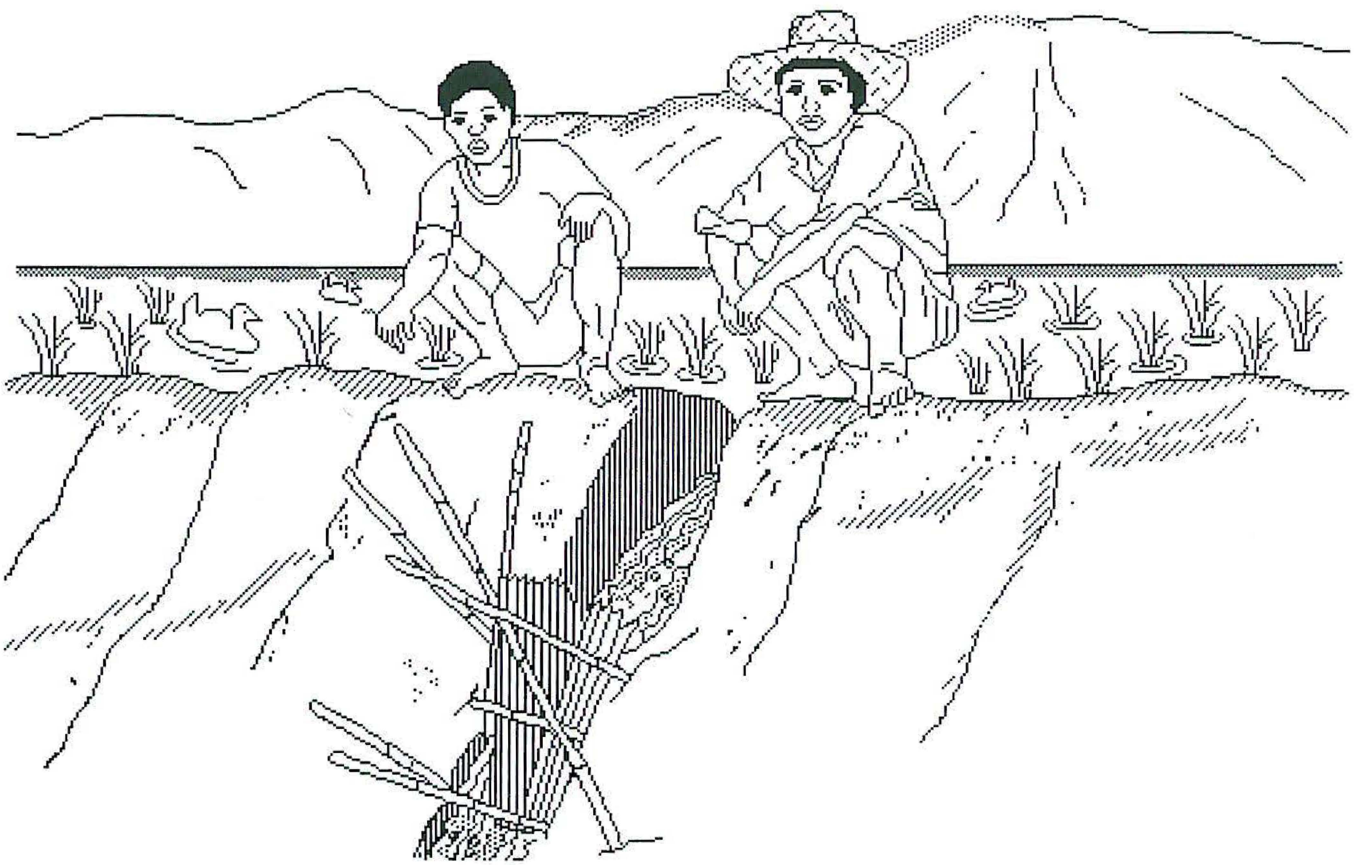
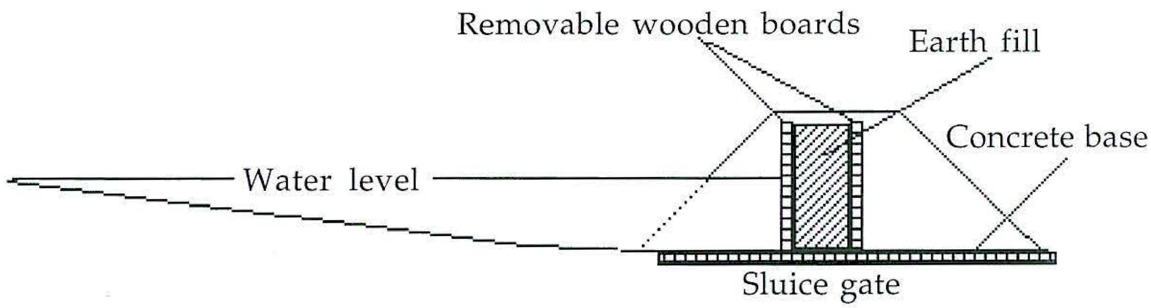
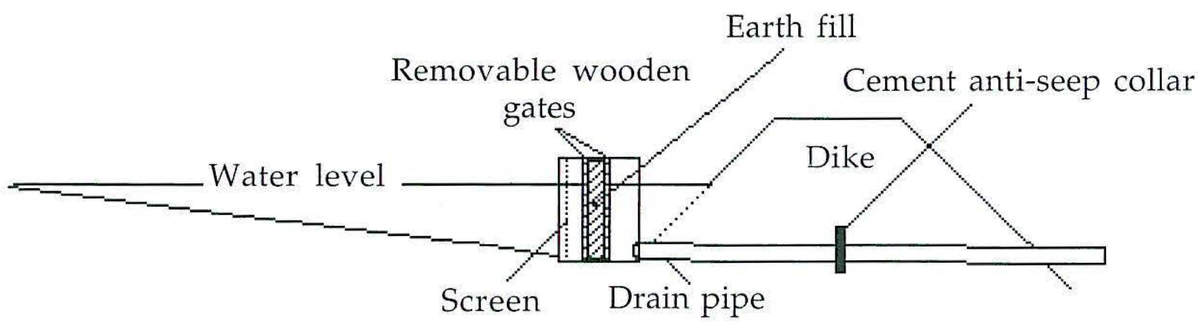


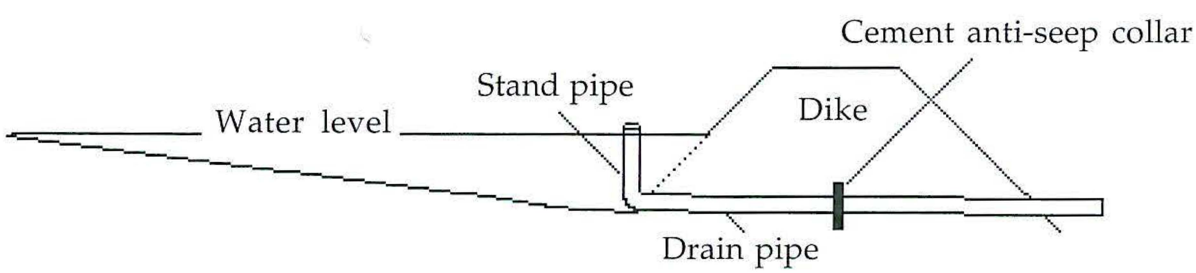
Figure 14: Small ponds may be drained and harvested by cutting out a section of the dike.



SLUICE GATE STRUCTURE



MONK STRUCTURE



DRAIN WITH STANDPIPE

Figure 15: Cross sections of three structures used for draining ponds.

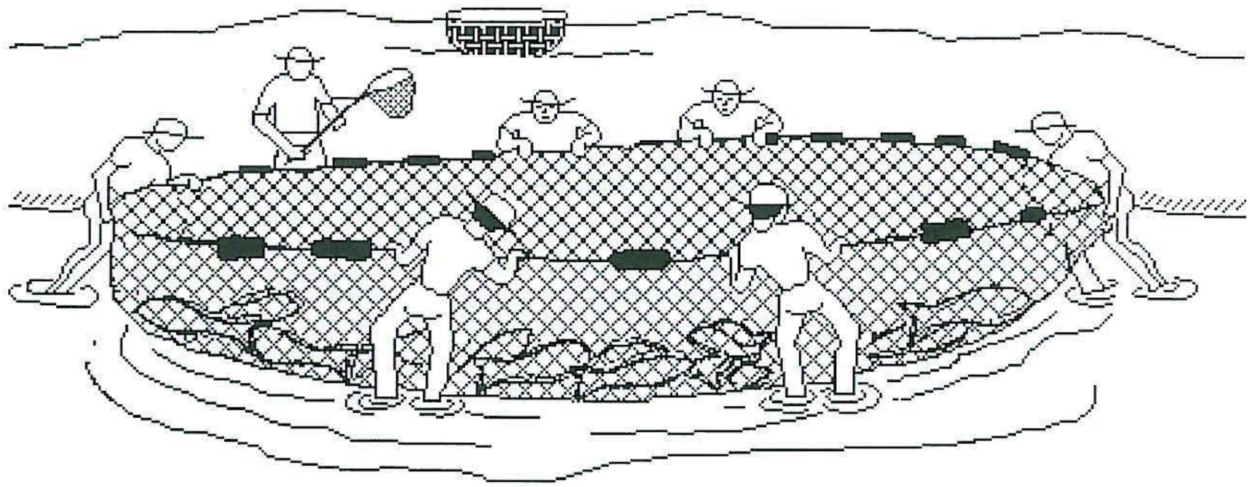


Figure 16: Nets are frequently used to harvest ponds.

IMPORTANT RULES TO FOLLOW WHEN HARVESTING PONDS

1) Stop feeding fish 48 hours prior to harvest. This allows them to clean out their intestines and promotes higher survival.

2) Harvest during the coolest part of the day. When doing a complete harvest, water should be lowered the night before the harvest. Fish should then be harvested in the early morning before temperatures rise above 28° C.

3) Harvesting requires advanced planning. Market contacts should be made and reconfirmed before harvesting occurs. All necessary transportation should be prearranged. Ice should be available to preserve the freshness of fish not sold live. Arrangements should be made in advance if fish are to be sold to processors.

GLOSSARY OF TERMS

anti-seep collar - a plate, usually constructed of cement or steel, which is attached around a drain pipe and extends about two feet outward from it. It is buried in the pond dike to retard the seepage of water through the dike along the drain pipe.

chemical fertilizers - manufactured fertilizers containing nitrogen, phosphorous and potassium in varying proportions.

fertilizer - a substance added to water to increase the production of natural fish food organisms.

fingerling - a fish weighing from 1 g to 25 g or measuring longer than 2.5 cm in total length.
fish toxicant/poison - A substance used to kill fish in ponds prior to stocking fingerlings.

manure/organic fertilizer - animal or plant matter used as fertilizer in ponds.

natural fish food organisms - plankton, insects and other aquatic organisms that fish eat.

oxygen depletion/low oxygen - a condition, normally occurring at night, in which oxygen dissolved in pond water has been depleted mainly because of the decomposition of organic matter and respiration of organisms in the pond.

phytoplankton - the plant component of plankton.

plankton - the various, mostly microscopic, aquatic organisms (plants and animals) that serve as food for larger aquatic animals.

pond dike - the wall of a pond which is constructed to hold in the water.

predacious/carnivorous fish - a fish species that eats other fish.

supplemental/incomplete feed - a feed that does not contain all the vitamins and nutrients essential for growth, and which is produced outside of the pond.

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Alex Bocek, Editor
International Center for Aquaculture and Aquatic Environments
Swingle Hall
Auburn University, Alabama 36849-5419 USA

Suzanne Gray, Illustrator

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