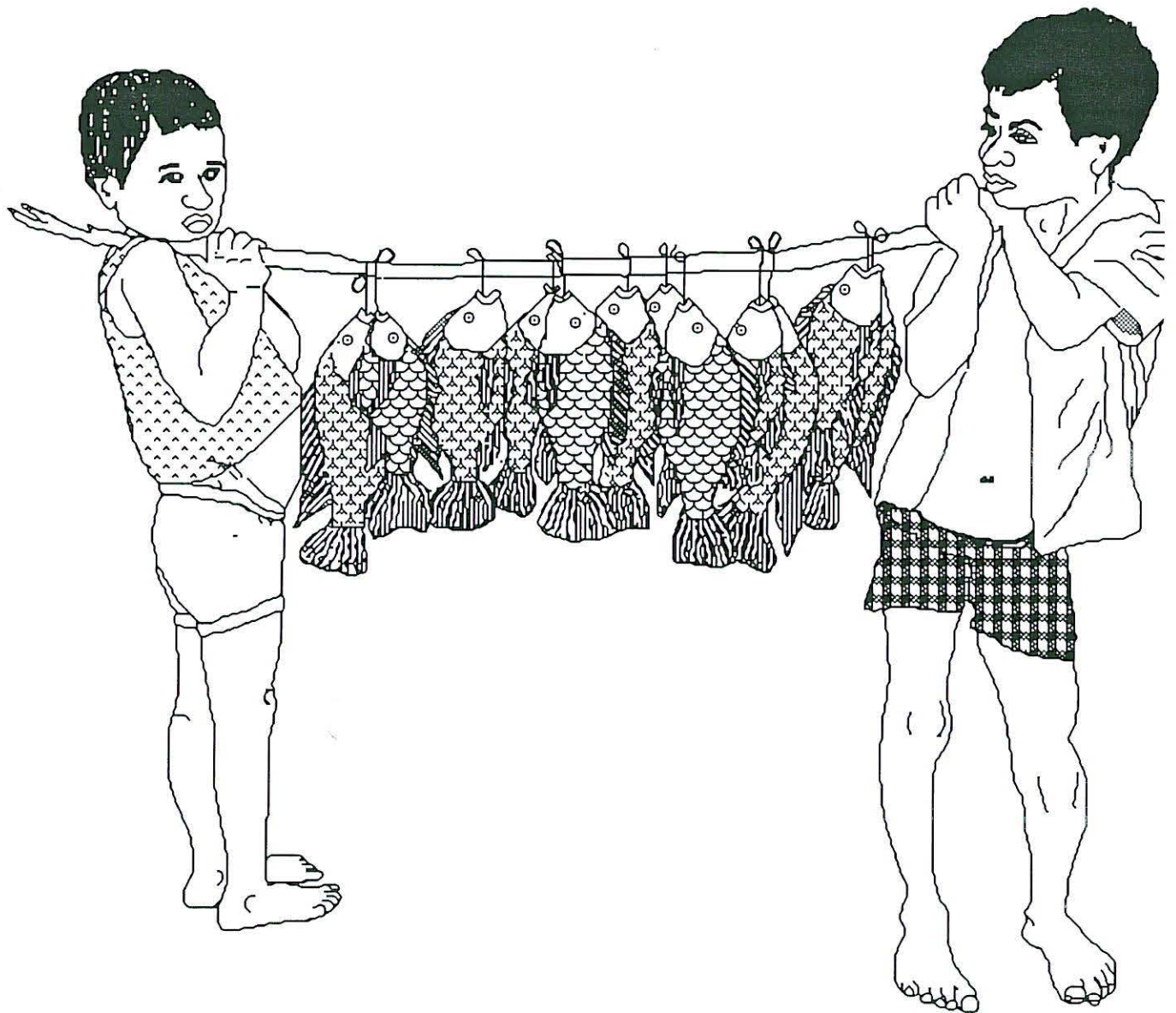

WATER HARVESTING AND AQUACULTURE
FOR RURAL DEVELOPMENT

INTRODUCTION TO TILAPIA CULTURE



INTERNATIONAL CENTER FOR AQUACULTURE
AND AQUATIC ENVIRONMENTS

INTRODUCTION

Tilapia are native to Africa, but have been introduced in many countries around the world. They are disease-resistant, reproduce easily, eat a wide variety of foods and tolerate poor water quality with low dissolved oxygen levels. Most will grow in brackish water and some will adapt to full strength sea water. These characteristics make tilapia suitable for culture in most developing countries. They are most often grown in ponds, cages and rice fields. A brief guide listing characteristics for the important tilapia species is included at the end of this manual.

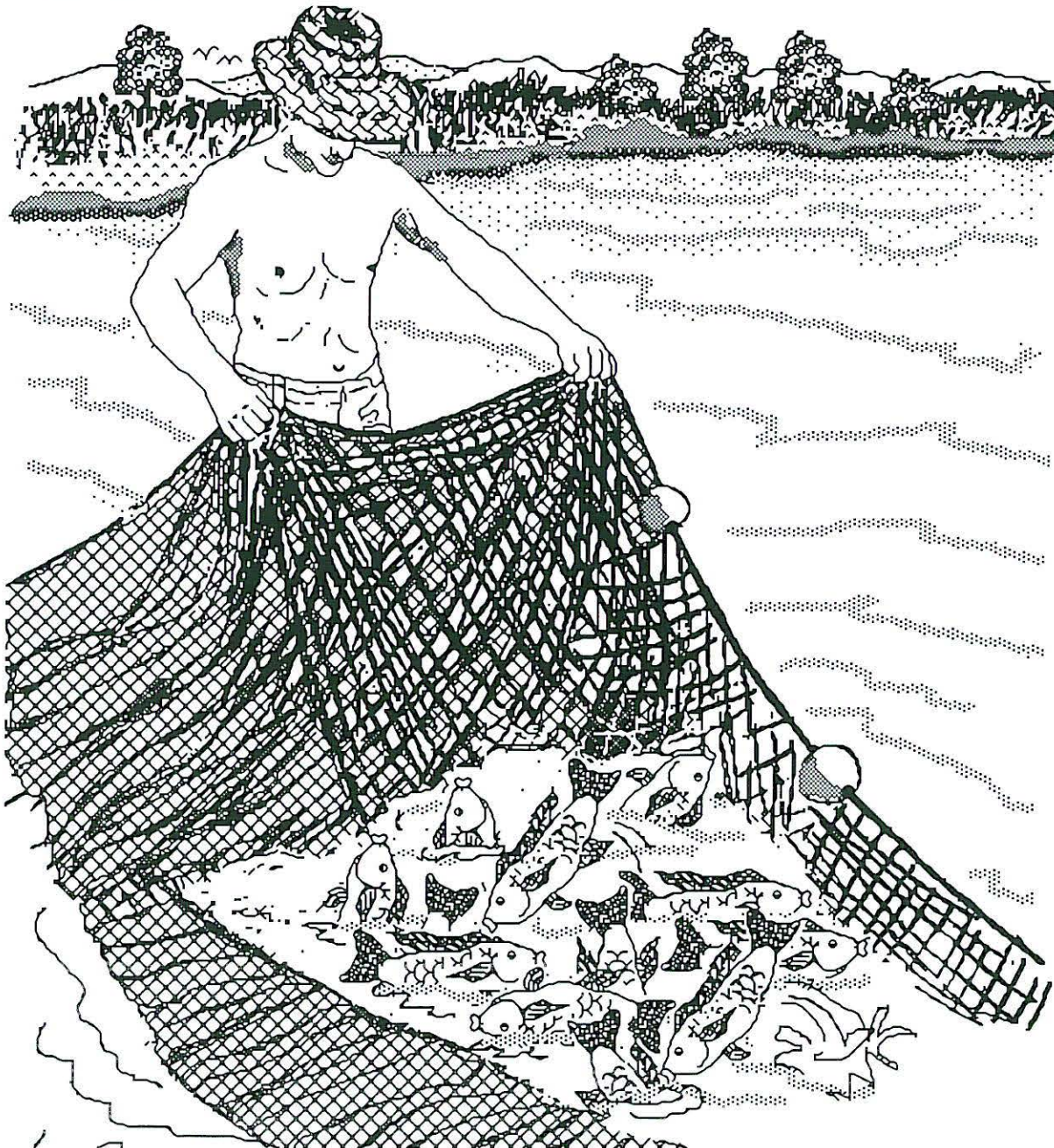


Figure 1: Culture in ponds

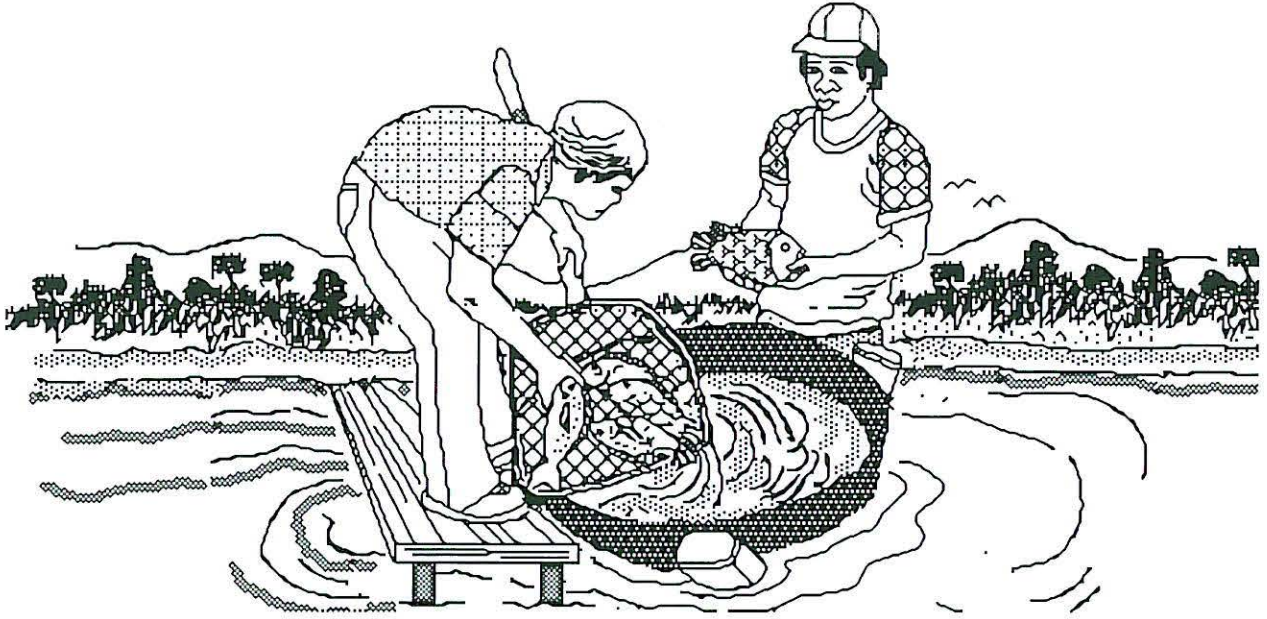


Figure 2: Culture in floating or anchored cages



Figure 3: Culture in rice paddies

THE PROBLEM OF OVERPOPULATION IN PONDS

Natural reproduction of cultured tilapia species occurs in one of two ways. The species *Oreochromis aureus*, *O. mossambicus* and *O. niloticus* are called mouth-brooders. The female incubates and hatches her eggs in her mouth after they are laid and the male fertilizes them.

The species *T. rendalli* and *T. zillii* are called substrate spawners because eggs are laid and hatched on bottom substrates in a nest dug by the male and female. Parents guard their eggs and fry, but do not protect them in their mouths.

The ease with which tilapia spawn and produce offspring makes them a good fish to culture. However, this trait also creates problems. Survival of young is high and grow-out ponds can become crowded. Fish become stunted as the supply of natural food organisms in the pond is depleted. Nearly 75% or more of the stock may be less than 100 grams in such cases. This may not present a serious problem in the Orient where even tiny fish are

eaten. However, if fish larger than 150 g are preferred by the market, special culture techniques may be required to grow them. These technologies require different levels of skill and management and yield varying degrees of success in producing large tilapia. Some may be combined for efficiency in resource use.

METHODS FOR CONTROLLING TILAPIA REPRODUCTION

The following seven methods are used to control tilapia reproduction. Figure 4 is a flow chart showing where these methods fit into different production systems.

1. Periodic harvesting of tilapia fry and fingerlings with nets to reduce competition for food.
 - effective in small ponds.
 - labor intensive.
 - requires little skill.
2. Separation of sexes after an initial growth period (monosex culture).
 - males grow faster than females.
 - difficult for large ponds since large numbers of fish are needed and the process is slow.
 - mistakes are made and sexing is about 90% efficient.
 - requires trained labor.
3. Stocking hybrid "all-male" fingerlings.
 - males grow faster than females.
 - requires pure strains of broodstock.
 - requires special hatchery facilities and skilled labor.
 - hybrid fingerlings are expensive to produce.
4. Culture in cages which are suspended above the pond bottom.
 - spawned eggs fall through the cage mesh and die preventing overcrowding.
 - cage materials may be expensive.
 - requires intensive feeding with high quality ration.
5. Culture at very high densities in ponds or raceways.
 - crowding reduces the urge to reproduce.
 - intensive feeding with a high quality ration is required.
 - good water supply must be available.
 - requires electric, gas or diesel aeration devices.
 - requires skilled management.

6. Stocking predacious fish as fingerlings or adults in the tilapia pond.
 - controls excessive reproduction.
 - produces two different kinds of fish.
 - large tilapia must be stocked initially or they will be eaten.
 - often difficult to get adequate numbers of predator fingerlings

7. Feed tilapia fry with male hormones to produce "all-male" fingerlings.
 - hormones are difficult to obtain.
 - hatchery facilities and skilled labor are required.

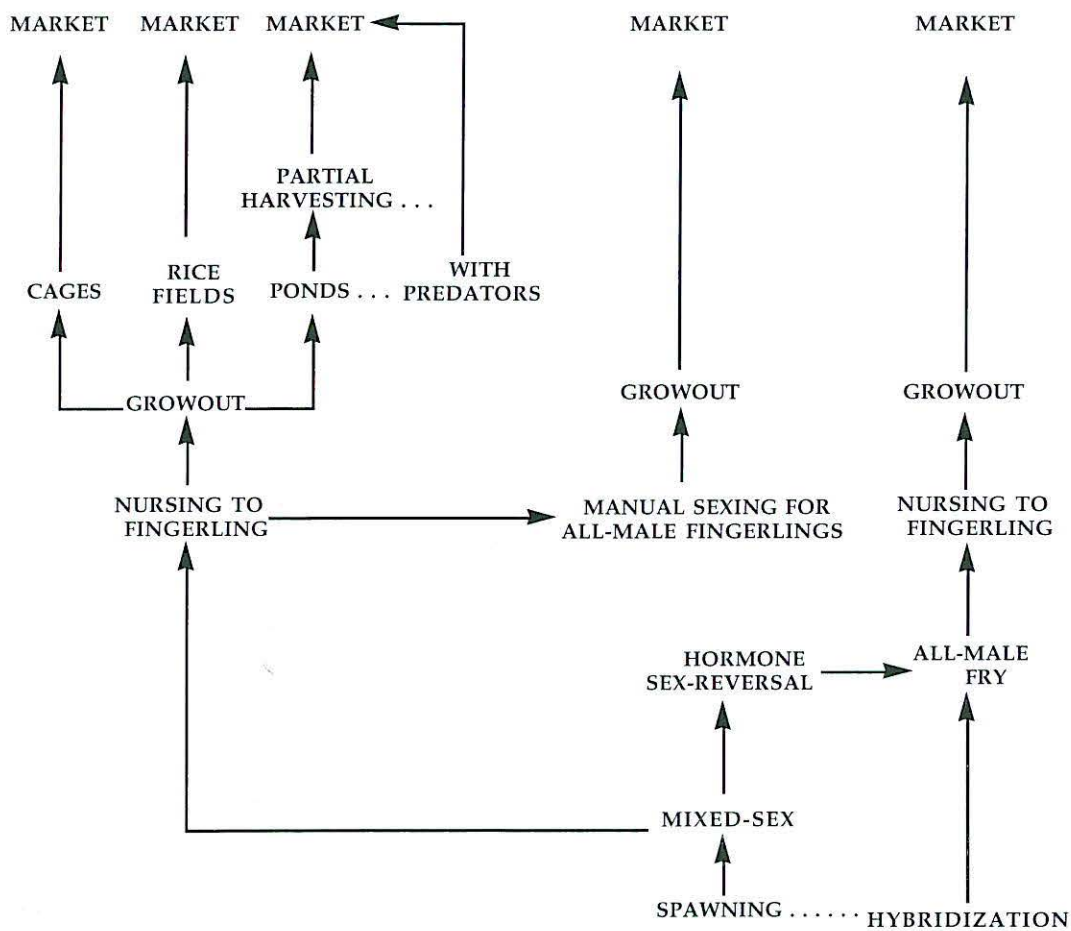


Figure 4: Flow chart showing the points in a production system where different methods for tilapia population control are used in obtaining marketable fish.

SUMMARY OF CONSIDERATIONS FOR TILAPIA CULTURE

The following table summarizes the main considerations for tilapia culture in ponds, cages and rice fields. It is intended as a checklist for those interested in tilapia culture.

<u>Consideration</u>	<u>Culture Area</u>		
	<u>Pond</u>	<u>Cage</u>	<u>Rice Field</u>
1. Culture Methods			
- mixed sex	yes	yes	yes
- monosex	yes	yes	yes
- polyculture	yes	yes	yes
- integrated with crops	yes	no	yes
- livestock integration	yes	yes/no	yes
2. Minimum size of culture unit			
	100 m ²	1 m ³	100 m ²
3. Stocking Rates for culture methods*			
- no fertilization or feeding	---	---	0.3
- fertilization only	1 - 2	50 - 100	0.3 to 0.5
- feeding only	1 - 2	250 - 500	0.3 to 0.5
- fertilization and feeding	2	250 - 500	1 - 2
4. Size of stocked tilapia**			
- mixed-sex culture	5 - 15 g	10 - 15 g	5 - 15 g
- monosex culture	20 - 40 g	20 - 40 g	20 - 40 g
5. Grow-out period in months			
	4 - 6	4 - 6	variable
6. Average yield per harvest			
	1 - 4 tons ⁺	5 - 50 kg	300 - 500 kg ⁺
7. Average harvest size			
- mixed-sex culture	50 - 100 g	80 - 150 g	50 - 100 g
- monosex culture	150 - 300 g	150 - 300 g	100 - 200 g

* Ponds and rice fields are stocked on the basis of fish per square meter of water surface

area and cages on a per cubic meter basis.

** Tilapia at least 20 g are needed for monosex culture.

+ Ponds and rice fields are computed on a per hectare basis and cages on a per cubic meter basis.

SHORT GUIDE TO CULTURED TILAPIA SPECIES

There are many tilapia species but only a few are cultured widely around the world today. The following list broadly groups important tilapia species into mouth-brooders and substrate spawners.

Mouth-brooders

1) *Oreochromis aureus* biology and culture.

a. Reproduction:

1. Female incubates eggs in her mouth.
2. Optimum temperature 23 to 28 degrees centigrade.
3. Spawn 3 or more times per year with 1500 to 4300 eggs produced per year.
4. Eggs hatch in 3 to 5 days and female guards fry for an additional 8 to 10 days after hatching.

b. Food:

1. Fry eat zooplankton.
2. Adults eat zooplankton and phytoplankton, and graze on bottom organisms. They also eat manufactured food.

c. Culture:

1. Prefers temperatures of 25 to 30 degrees centigrade.
2. Low temperature tolerance 8 to 9 degrees centigrade.
3. Grows well up to salinities of 16 to 20 parts per thousand.

2) *Oreochromis mossambicus* biology and culture.

a. Reproduction:

1. Female incubates eggs in her mouth.
2. Optimum temperature 23 to 28 degrees centigrade.
3. Can breed 6 to 12 times per year with 2000 to 10,000 eggs produced per year.
4. Eggs hatch in 2 to 5 days and the female guards the young for an additional 8 to 10 days.

b. Food:

1. Fry eat zooplankton.
2. Adults eat zooplankton, phytoplankton and manufactured food.

c. Culture:

1. Optimum temperature is 25 to 30 degrees centigrade.
2. Low temperature tolerance is 10 to 12 degrees centigrade.
3. Spawn and grow well in full strength sea water.

3) *Oreochromis niloticus* biology and culture.

a. Reproduction:

1. Female incubates eggs in her mouth.
2. Optimum temperature 25 to 29 degrees centigrade.
3. Average of three spawns per year with about 750 to 6000 eggs produced per year.
4. Eggs hatch in 3 to 5 days and female guards young for 8 to 10 days after hatching.

b. Food:

1. Fry eat zooplankton.
2. Adults eat phytoplankton, zooplankton, insects and other bottom organisms. They also eat manufactured food.

c. Culture:

1. Optimum temperature is 25 to 30 degrees centigrade.
2. Lower temperature tolerance is 11 degrees centigrade.
3. Grow well in water up to 20 parts per thousand salinity.

Substrate spawners

1) *Tilapia rendalli* biology and culture.

a. Reproduction:

1. Both parents dig a nest and incubate the eggs and fry.
2. Optimum temperature 25 to 30 degrees centigrade.
3. Spawning may occur at 7-week intervals with 12,000 to 20,000 eggs produced per year.
4. Eggs hatch in 5 days.

b. Food:

1. Fry eat zooplankton.
2. Adults eat aquatic weeds, insects, algae and manufactured food.

c. Culture:

1. Optimum temperature is 28 degrees centigrade.
2. Low temperature tolerance is 12 to 13 degrees centigrade.
3. Can tolerate brackish water.

2) *Tilapia zillii* biology and culture.

a. Reproduction:

1. Both parents dig a nest and guard the eggs and fry.
2. Optimum temperature 22 to 26 degrees centigrade.
3. Six spawnings per year possible with about 6000 to 42,000 eggs produced per year.
4. Eggs hatch in 3 to 5 days.

b. Food:

1. Fry eat zooplankton.
2. Adults eat phytoplankton, leaves, stems, rooted aquatic vegetation and manufactured food.

c. Culture:

1. Optimum temperature is 28 degrees.
2. Lower temperature tolerance is 8 to 9 degrees centigrade.
3. Grows well in full strength sea water.

GLOSSARY OF TERMS

brackish water - a mixture of fresh and salt water.

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

fry - recently hatched fish which weigh less than 1 g or measure less than 2.5 cm in total length.

grow-out pond/facility - a pond or other facility used to grow aquatic animals to marketable size.

integrated aquaculture - aquaculture systems integrated with livestock and/or crop production. For example, using animal manures to fertilize a pond to enhance fish production and water from the pond to irrigate a garden.

male hormone - a substance that, when fed to tilapia fry, induces undifferentiated tissue to develop into male gonads (testes).

manual sexing - examining a fish to determine its sex.

manufactured food - commercially processed food for fish or livestock.

mixed-sex culture - culture of males and females in the same grow-out facility.

monosex culture - culture of all-male fish for market.

mouth-brooder - a fish that hatches its eggs in its mouth.

partial harvesting - periodic harvesting of a portion of the fish from a culture facility during a culture cycle.

phytoplankton - the plant component of plankton.

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

polyculture - simultaneous culture of two or more aquatic species with different food habits.

predacious fish - a fish species that eats other fish as food.

spawning - the act of depositing eggs and producing young.

substrate spawner - a fish that lays its eggs on some form of substrate or surface where they will hatch.

zooplankton - the animal component of plankton.

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