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WATER HARVESTING AND AQUACULTURE  
FOR RURAL DEVELOPMENT

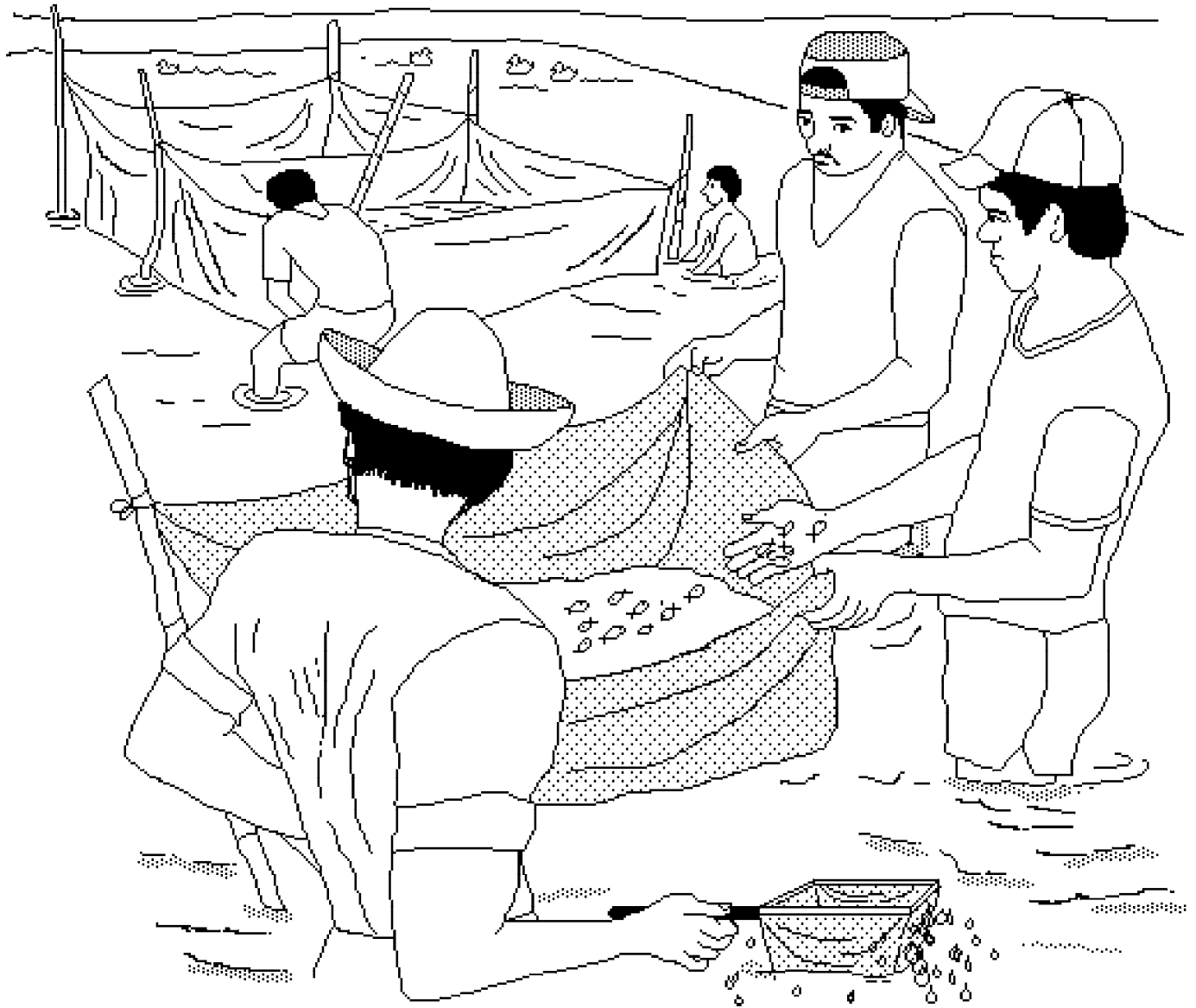
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NET ENCLOSURE SYSTEM FOR *OREOCHROMIS*  
*NILOTICUS* FINGERLING PRODUCTION

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INTERNATIONAL CENTER FOR AQUACULTURE  
AND AQUATIC ENVIRONMENTS  
AUBURN UNIVERSITY

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## INTRODUCTION

Net enclosures can be used in every phase of tilapia culture from fingerling production to growing market size food fish. In Southeast Asia the "hapa" net system for *Oreochromis niloticus* fingerling production is very popular. Hapas protect tilapia from predators and allow high survival. Produced fry and fingerlings are transferred to ponds, other hapas or tanks for further grow-out.



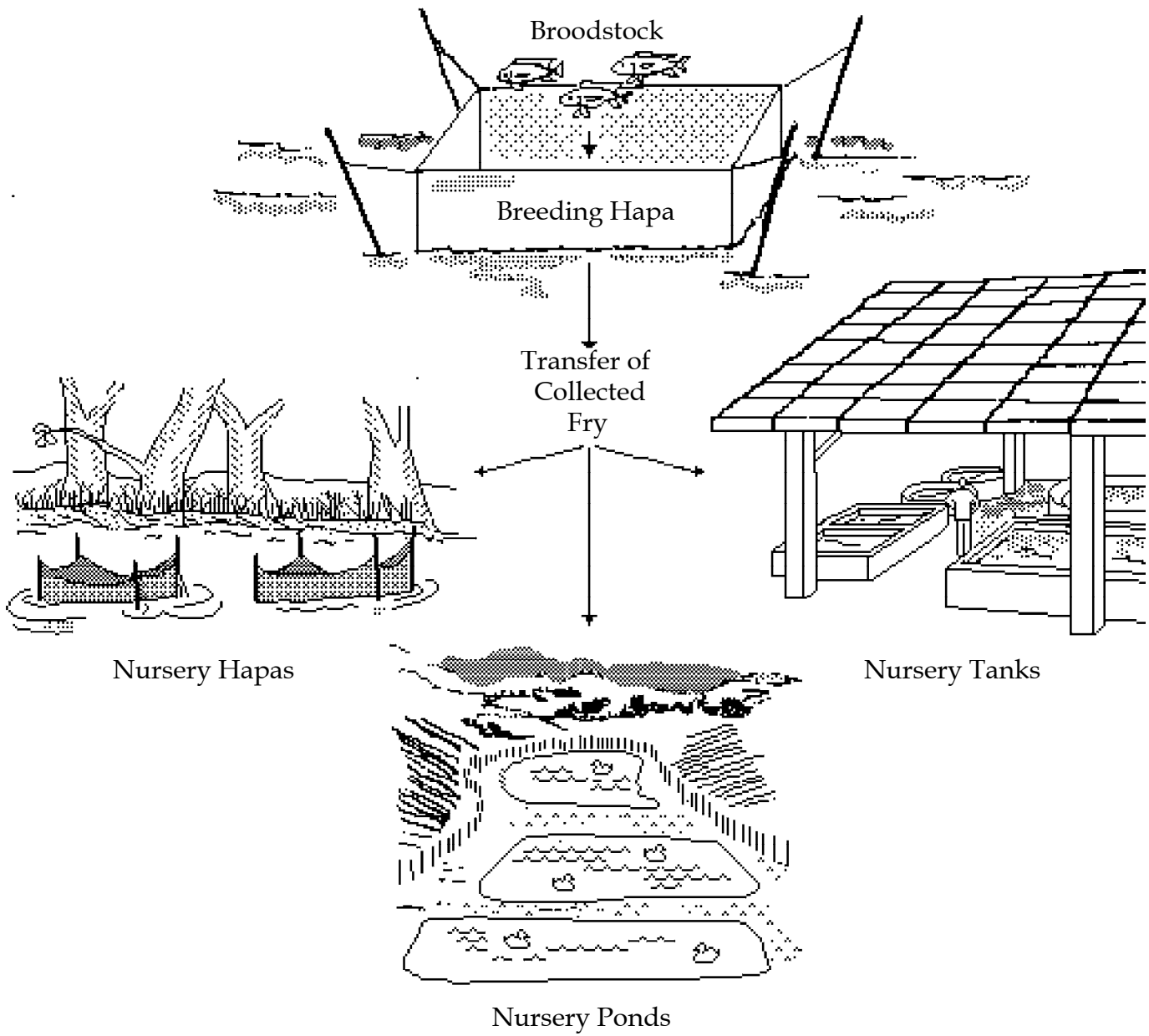


Figure 1: Tilapia fry production in hapas for transfer to nurseries.

## WHAT IS A NET ENCLOSURE OR "HAPA"?

Hapas are constructed of netting material which is sewn together to form a square or rectangular enclosure. Hapas differ in size and mesh according to use. Breeding hapas hold tilapia broodstock and are constructed of netting which has a mesh size of 1.6 to 2.0 mm. Inverted mosquito nets are often used for this purpose, but the fine mesh will become clogged with plant growth if not cleaned frequently. Clogging prevents fresh water from circulating into the hapa and can result in a low oxygen condition which kills fish. Larger mesh sizes allow greater water exchange in the hapa, and are used for nursing fingerlings stocked at high densities. Figure 2 illustrates the kind of hapa frequently used in Latin America. A cover is often attached over the hapa to prevent brood fish from jumping out and keeps predatory birds from injuring fish. Figure 3 illustrates a hapa typical of Southeast Asia. The support frame is lacking and a cover may be absent.





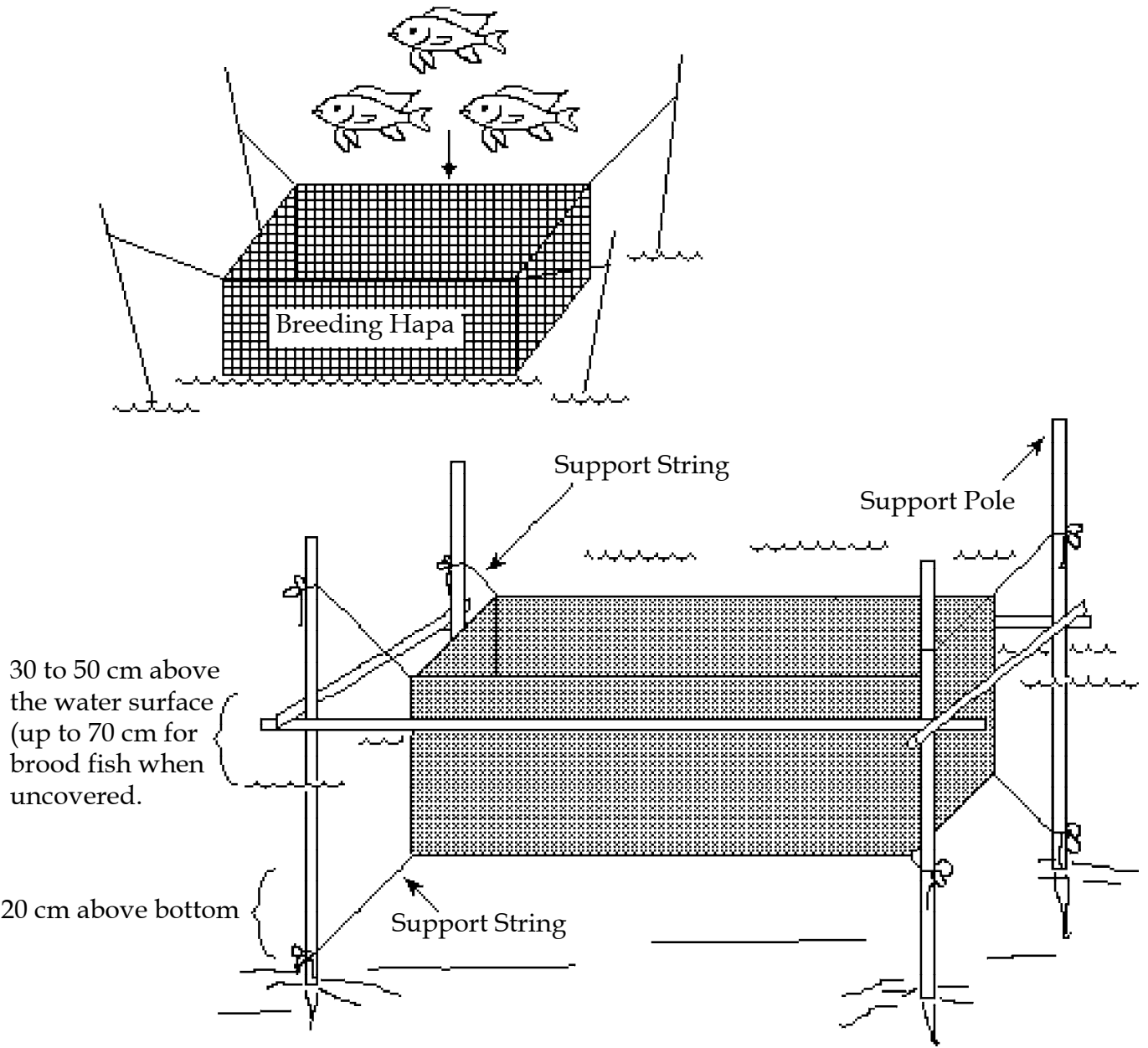


Figure 2: A typical hapa and support frame used in Latin America.

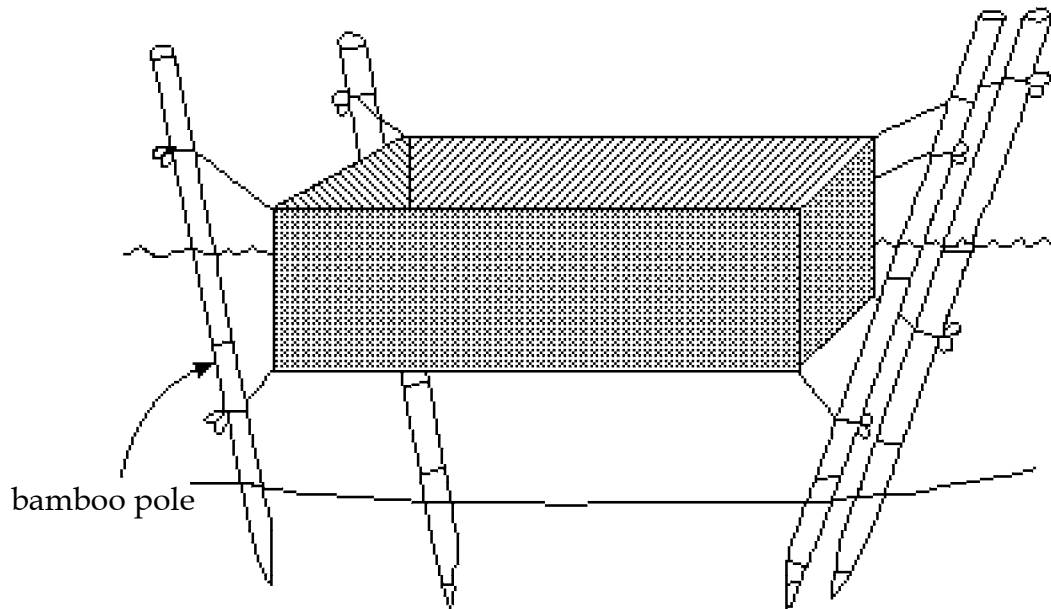


Figure 3: A hapa typical of Southeast Asia.

## HOW DOES THE TECHNIQUE WORK?

### Step 1: Determine where to place the breeding hapas.

Breeding hapas are placed in shallow, protected areas of ponds, lakes and slow moving rivers. Water should be at least 60 cm deep and the hapa tied with the rim at least 30 to 70 cm above the water line. This prevents fish from escaping when water levels rise during floods, and prevents brood fish, which can jump 50 cm, from escaping. The hapa floor should be tied at least 20 cm above the bottom sediments in ponds with soft mud bottoms. If sudden changes in water level of more than 20 to 30 cm are likely to occur from flooding or drainage, hapas may be tied to a floating frame rather than to stakes driven into the mud.

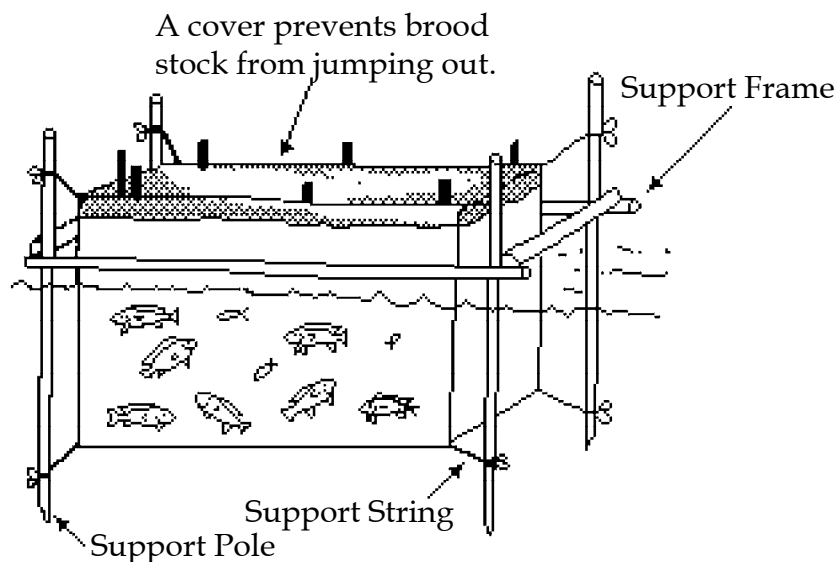


Figure 4: Hapa tied to support stakes contains broodstock and fry.

A female tilapia will lay eggs on the hapa floor, and pick them up in her mouth for incubation after the male has fertilized them. If the mesh size of the floor netting is larger than 1.6 mm (1/16 inch), the eggs will pass through and be lost. To prevent the loss of eggs, materials such as fine mesh mosquito netting, a piece of plastic, a weighted board or anything with a flat surface that is not very heavy may be placed on the hapa floor to serve as a substrate for egg laying. If hapas are set up in concrete tanks or in ponds with a hard bottom the net floor may rest directly on the bottom. Water circulation will, however, be reduced.

Step 2: Determine how large the hapa system will be.

A farmer must be able to calculate how many brood fish are needed to produce a given number of fry. Assumptions must be made about the number of fry a female will produce. The assumptions presented in this manual are general and will not give the same results in all areas of the world. They are provided only as an example which can be adjusted according to local conditions.

The number of eggs and fry produced by a female depends largely on her weight. A 200 g female will produce roughly twice as many fry as a female weighing 100 g. Tilapia smaller than 50 g are normally immature and are not satisfactory as brood fish.

Brood fish are stocked into hapas at rates of about 500 g per m<sup>2</sup> (usually 3 to 7 fish depending on size) and in a ratio of 1 male to 3 females (or 1 out of 4 fish is a male). Under these conditions, 500 g of brood fish on average may produce 250 to 300 fry every 5 weeks. This is about 2500 to 3000 fry per m<sup>2</sup> of hapa per year in countries where the average temperature is at least 25 degrees centigrade all year.

Breeding hapas with the following measurements are commonly used. One large hapa is less expensive to build than several small ones.

<u>Hapa Dimensions</u>	<u>Surface Area</u>	<u>Weight of Brood Fish Held</u>
a. 1 m long x 1 m wide x 1 m deep	1 m <sup>2</sup>	0.5 kg
b. 2 m long x 1 m wide x 1 m deep	2 m <sup>2</sup>	1.0 kg
c. 3 m long x 3 m wide x 2 m deep	9 m <sup>2</sup>	4.5 kg

Example problem:

If a farmer in a tropical country needs 60,000 fry per year, how much broodstock and how many hapas are needed for this operation?

1) Surface area of hapas needed:

60,000 fry needed - 2500 fry per m<sup>2</sup> of hapa = 24 m<sup>2</sup> of hapa needed.

2) If 2 m<sup>2</sup> hapas are used: 24 m<sup>2</sup> - 2 = 12 hapas needed

If 9 m<sup>2</sup> hapas are used: 24 m<sup>2</sup> - 9 = 3 hapas needed

3) Total weight of brood fish needed:

24 m<sup>2</sup> of hapas x 500 g of brood stock per m<sup>2</sup> = 12,000 g (or 12 kg)

4) Number of broodfish needed if 100 g brood fish are used:

a) 12,000 g of brood fish - 100 g per fish = 120 brood fish

b) 120 brood fish x 1 male per 4 fish = 30 males

c) 120 brood fish - 30 males = 90 females

### Step 3: Managing the hapas to produce fry.

The following procedure for producing fry is followed after the number of broodstock and hapas needed have been calculated.

1) Place the hapa where it will be protected from strong currents. If hapas are placed in ponds, the pond should be prepared 2 weeks prior to stocking brood fish using standard fertilization practices. This allows phytoplankton to grow as food for the brood fish. Brood fish may be fed at 1% of their body weight daily with a good quality feed.

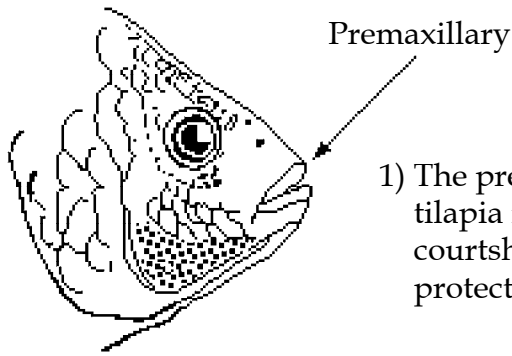
2) Examine the hapa for fry every 10 to 14 days after stocking brood fish. If the time period is shorter, females will still be incubating eggs. After more than 14 days, fry numbers will be reduced from cannibalism. Fry may be seen swimming in schools near the water surface. They can be scooped out with a fine mesh dip net, placed in pails and transferred to nursery ponds, tanks or hapas. This procedure for fry collection is described later. Great care is needed since fry are delicate at a young age.

3) Collected fry are graded to uniform size to reduce cannibalism and stocked into nursing facilities at rates of 1000 to 2000/m<sup>2</sup> and grown for 1 month. Adequate natural and/or supplemental food must be provided during this time, and phytoplankton density in the rearing unit kept high. Visibility from the water surface should extend to a depth of only 25 to 30 cm, and the water should be a rich green color. The number of fry should be reduced by half if no supplemental food is given. Survival may range from 50 to 75% during this first month.

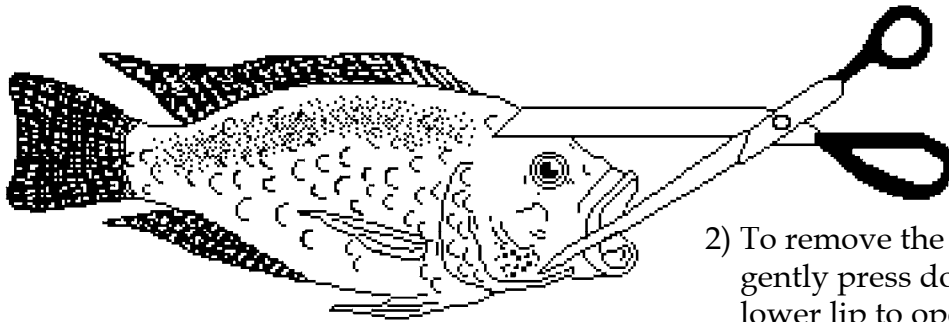
4) Fry are then thinned and stocked at rates of 10 to 20/m<sup>2</sup> in secondary nursery units. Phytoplankton density is maintained as above. Supplemental feeds should also be provided or the number of fry stocked should be reduced by half.

5) Some scientists in Asia believe brood fish produce more fry when males and females are separated and allowed to "rest" about 2 weeks after each breeding. In this case, twice the number of brood fish are needed, but more fry would be produced. Replace broodstock at least once a year. Brood fish should be changed more frequently if good quality food is not available. This should be done when the number of fry collected drops constantly with each subsequent collection.

6) Male tilapia are aggressive and can injure unresponsive females while attempting to mate. Dense phytoplankton reduces visibility in water and reduces aggressive behavior. If fish are to be kept in clear water, the premaxillary or "upper lip" of the male can be removed with scissors or a sharp razor to provide protection for the female. The following illustrations show how this is done.



1) The premaxillary has small teeth. Aggressive male tilapia may injure females with these teeth during courtship. The lip can be removed with scissors to protect the female brood fish.



2) To remove the premaxillary, gently press down the male's lower lip to open the mouth, and extend the upper lip. This can be done with one hand. Then clip off the upper lip with scissors held in the free hand.

3) The cut will heal without harming the male. The lip may be retrimmed if it grows back.

Premaxillary removed

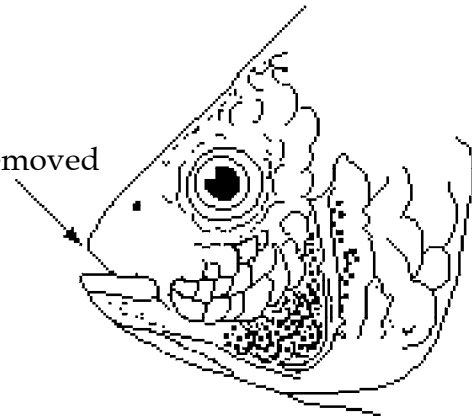


Figure 5: Removing the male's premaxillary.

## INSPECTING A HAPA FOR FRY

Small breeding hapas are easily inspected for fry. The bottom support strings are untied and a piece of bamboo, wood or plastic pipe (crowding bar) is pulled under the net from one end to the other to crowd the fish into one end of the hapa. Objects inside the hapa should be removed to avoid injuring fish. Floating crowding bars (3-inch diameter bamboo or sealed 3-inch diameter plastic pipe) are easier to use and require only two people to handle the inspection and fry removal procedure. Non-floating crowding bars require two people to move the bar and may require an additional person to remove fry with a dip net. The

following figure illustrates the inspection procedure using a non-floating crowding bar which slides over the hapa support frame.





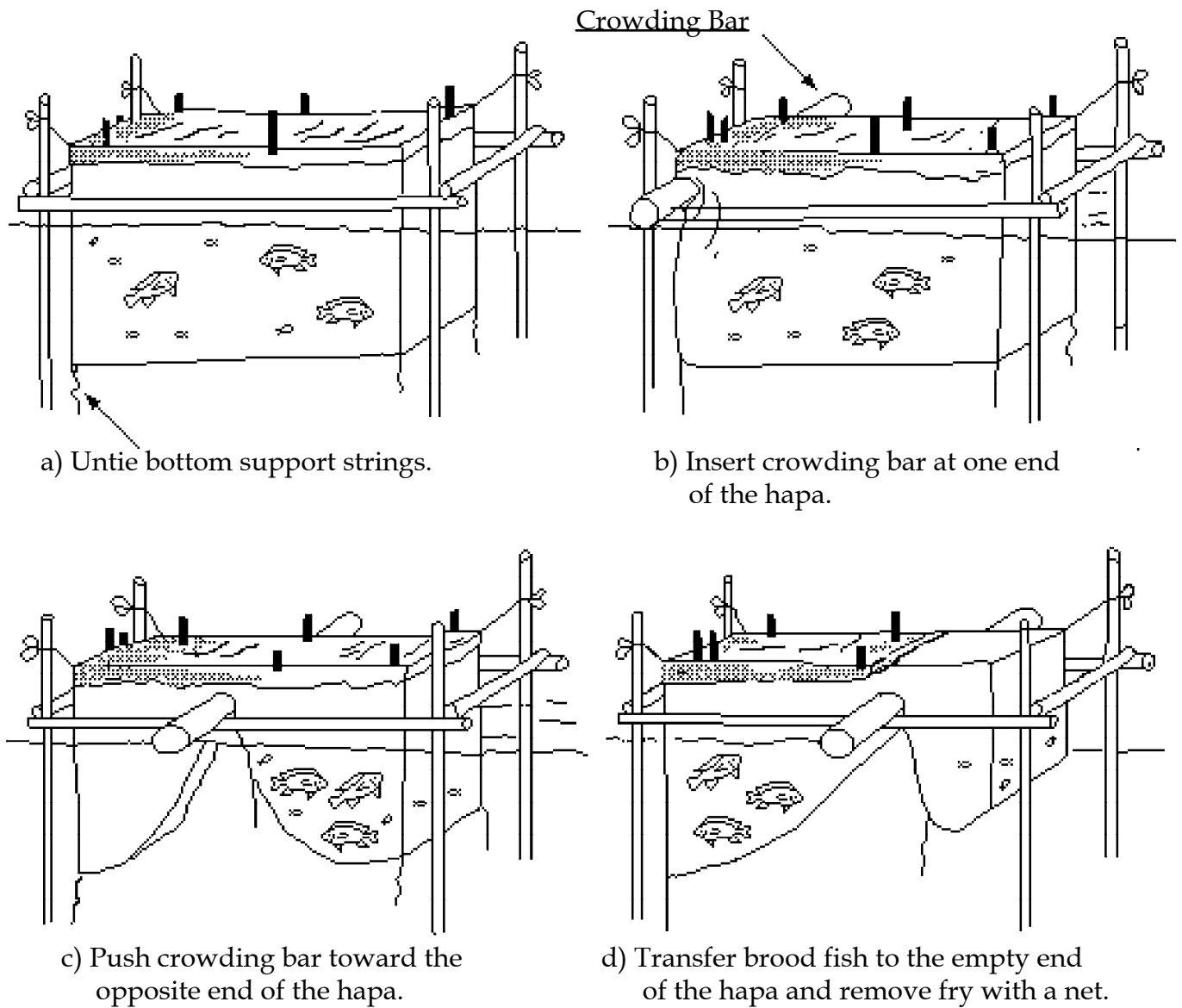


Figure 6: Inspecting a hapa for fry.

#### ADVANTAGES OF THE HAPA SYSTEM

1. Maximum recovery of fry is possible because broodstock are enclosed in nets.
2. Hapas may be set up in many different areas where it might normally be impossible to stock brood fish or nurse fry.
3. Separation of brood fish and fry is easy.
4. Fry may be produced continuously under favorable temperatures without having to drain the reproduction ponds.

#### DISADVANTAGES OF THE HAPA SYSTEM

1. Netting for hapa construction may not be available or may be expensive.
2. Netting material may degrade in sunlight and need replacing annually. To avoid this do not dry nylon nets in direct sunlight. Properly cared for nets may last 5 years.
3. Fish may easily escape if the netting is torn.
4. Organisms in the water and uneaten food may clog the mesh. This limits water circulation in the hapa and may cause low oxygen problems. The net may need periodic scrubbing to remove fouling organisms from the mesh.
5. Fish may be easily stolen from hapas.
6. Females incubating eggs may spit them out when hapas are inspected for fry. These eggs will be abandoned.
7. Aggressive males may kill females while attempting to mate.
8. If brood fish are used for an extended time, a better quality food is needed than in an open pond where much natural food is available. This disadvantage can be overcome by changing brood fish more frequently.

## GLOSSARY OF TERMS

brood fish - sexually mature fish selected for reproduction.

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

fingerling - a fish ranging in weight from 1 g to 25 g or greater than 2.5 cm in total length.

food fish - fish cultured and marketed for human consumption.

fouling organisms - organisms that attach to nets and retard water circulation through the mesh.

fry - recently hatched fish 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.

hapa - an enclosure of fine mesh net used for breeding fish and nursing fry.

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

nursery pond/facility - a pond or other facility used to culture recently hatched aquatic animals to a size suitable for stocking into a grow-out facility.

oxygen depletion/low oxygen - a condition, normally occurring at night, in which dissolved oxygen 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 mostly microscopic aquatic organisms (plants and animals) that serve as food for larger aquatic animals.

premaxillary - a mouth bone on the upper lip containing teeth.

school - a group of fish swimming together.

supplemental food - a food that does not contain all the vitamins and nutrients essential for growth.

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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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