HATCHERY MANAGEMENT

For farmers who have the needed resources and who have gained sufficient experience and skill taking care of fish, producing fingerlings for stocking or for sale is another aspect of fish farming that may be of interest. Most fish farmers in Kenya are probably aware that the supply of fingerlings is often insufficient to meet the demand, which means that a farmer who can efficiently produce fingerlings should be able to make a profit by selling them. Specializing in fingerling production involves activities such as maintaining a stock of adult fish (broodfish) for spawning, establishing and preparing spawning areas (ponds, tanks, or hapas), inducing the fish to spawn, incubating eggs, and rearing the young fish (fry) until they are large enough and strong enough to survive in an open pond. This usually requires some additional space and equipment, which may collectively be referred to as a "hatchery." Successful production of fingerlings, whether of tilapia or catfish, will require the use of good hatchery management practices, as outlined in the next two sections.

1: GENERAL HATCHERY CONSIDERATIONS

Introduction

Hatcheries are used to produce fry or fingerlings for stocking fish ponds. A hatchery can also be used as a breeding centre for genetic improvement of fish stock. Many catfish and tilapia farmers who are engaged in food fish production find that an adequate supply of fingerlings is not always available. As long as the demand for fingerlings exists, a well-managed hatchery can be a lucrative business. Farmers are therefore encouraged to set up their own hatcheries to produce fingerlings either for themselves or for sale. As the industry expands, the importance of having a reliable supply of high-quality fingerlings will become more apparent.

Hatchery design

When designing the hatchery, the most important consideration is the water supply, including both its quantity and its quality.

- The hatchery design should incorporate a good filtration system to improve water quality, reduce any pollution, and prevent the entry of predators such as insect larvae.
- Farmers are advised to site their hatcheries on a slope so that water can flow into the hatchery by gravity. Sites should therefore have good soil characteristics and a suitable land gradient.
- All incoming water should be filtered. Alternatively, only ground water should be used where possible.
- Where possible, tanks, incubators, troughs, and other receptacles should be movable to allow for future modification.
- If earthen ponds are to be constructed as part of the hatchery, then sandy or gravelly soils should be avoided. An impervious soil (i.e., one with a sufficient clay content) will hold water and prevent seepage.
- Land that is gently sloped provides drainage and allows the construction of raceways in a series for reuse of water by gravity flow.

Hatchery equipment

- Containers for rearing the fish are the major item needed. Examples include small buckets, long trays or troughs, aquaria, and large circular or oval tanks. You can use containers made from plastic, glass, or wooden materials.
- Other items include weighing scale, netting materials, ruler, towels, trays, syringes and needles, sharp knife, mortar, pair of scissors, salt solution, thermometers, glassware or plastic basins (various sizes), and brushes.

Rearing facilities

- Rearing units include small tanks or troughs for swim-up fry, intermediate-size rearing tanks for fingerlings, and large outdoor rearing ponds or raceways.

- Rearing units should be constructed so they can be drained quickly and independently.
- Rearing units should be adequate not only for the normal everyday water flow in the hatchery, but also for increased volumes of water needed during draining and cleaning of the facilities.

Broodstock selection and maintenance

- Select quality broodstock to improve fish production on your farm.
- Choose pure quality stocks and do not allow them to crossbreed with other strains to preserve their genetic quality.
- Teach your workers the importance of preventing genetic contamination.
- Initially you may have to collect your broodstock from the wild, whereas later you can select them from your own ponds or purchase them from other farmers.
- If buying your fish stocks from others, buy them only from reliable and established sources and avoid introducing breeders from non-accredited sources.
- Use brood fish that are mature but not too old; for catfish and tilapia they should be at least one year old but not more than three years old (> 100 g for tilapia and between 0.5 and 1.0 kg for catfish).
- By using larger brood fish, you can easily identify the original stock after each production cycle.
- You can use the same stock repeatedly, depending on their performance, but should adopt a culling/selection process to eliminate undesirable stock.
- Always eliminate fish that have questionable characteristics by examining breeders carefully when re-stocking after each cycle.

Moving on

With these general considerations in mind, you are now ready to look at seed production practices for tilapia and catfish, which will be covered in the next two sections.

5.2: Tilapia Seed Production

Introduction

Although tilapia breed frequently in unmanaged ponds, the small number of fry they produce means that fish farms need to invest in systems for fry and fingerling production. The systems used are ponds, net enclosures (hapas), and tanks. Breeding systems depend on the natural behavior of the fish. Three methods of tilapia seed production are commonly practiced. For all methods, fry collected from the spawning unit are usually stocked into fertilized ponds for rearing to the fingerling stage.

The open pond method

The open pond method is the simplest and most common method of tilapia fingerling production. In this method, a pond serves both for spawning and rearing. Breeders are stocked into the ponds and allowed to spawn naturally.

Follow these guidelines to use the open pond method:

- Stock your broodfish at the rate of 100 to 200 kg brood stock per hectare.
- Stock a sex ratio of 1:3 or 1:4 (males to females).
- A female brood fish of 90-300 g produces as much as 500 eggs per spawning. They should produce 6-15 fry / m^2 / month or 35-100 fry / female / month.
- Harvest fry from the pond every 15-21 days. The frequency should be increased if average temperatures are above 25°C.
- You can continue to use your brood fish continuously for a period of 3-5 years.
- You can increase seed production to 45 fry / m^2 / month or 380 fry / female / month by using larger broodstock (1-1.5 kg) and harvesting fry every 17-19 days.
- It is also useful to collect the fry with hand nets from along the edges of the pond on a daily basis to avoid disturbance of spawners and damage to fry.

The "hapa" method

A hapa is a rectangular or square net enclosure used to hold fish for various purposes. Hapas are usually made of fine nylon, plastic mosquito netting, or cotton mesh. Hapas are very easy to manage because fry cannot escape and harvesting is much easier. A hapa measuring 3 m long, 3 m wide, and 1.5 m deep is the most common size used. Hapas are usually installed in ponds, lakes, or along river banks with slow moving current.

1. Guidelines for using hapas

- Stock broodfish at a ratio of about 1:5 to 1:7 (males to females).
- Use brooders that weigh about 100 to 200 g each.
- Brooders are usually stocked at the rate of 4-5 brooders / m^2.
- Check the hapa daily for the presence of schooling fry. Two weeks

after stocking of breeders, use a fine-mesh dipnet to scoop out fry and transfer them to tanks, other hapas, or a rearing pond.
- Production rates range from 150 fry/m^2/month or 50 fry/female/month to over 880 fry/m^2/month or 300-400 fry/female/month.

2. Feeding
- You must feed fry reared in a hapa on a daily basis.
- Feed fry a diet in powdered form at the rate of 5-10 percent of the total body weight per day.
- Divide the daily feed ration into four feedings per day until the fry reach the desired size (5 g).

3. Advantages of the hapa method
- Production on a per square metre basis is high.
- Fry are more uniform in size.
- Fry and broodfish are easily handled.
- Maximum recovery of fry is possible.
- Hapas may be set up in many different areas of the pond.

4. Disadvantages of the hapa method
- Management is more complicated and intense compared with the other methods.
- Aggressive males may kill females during spawning.
- Broodfish held in hapas are easy targets for poachers.
- Hapas may be destroyed or blown away during stormy weather.
- Feeding of broodfish and fry is a must.
- Netting material may degrade in sunlight and need replacing annually.
- Fish may easily escape if the netting is torn.
- Small organisms and uneaten food in the water may clog the mesh. This limits water circulation in the hapa and may reduce oxygen concentrations to critical levels.
- The net may require periodic scrubbing to remove undesirable organisms from the mesh.

The tank method

Tank-based hatcheries are easily managed but are relatively expensive to build. The following guidelines apply to the tank method:
- Use circular tanks of 1-6 m diameter containing 0.5-0.7 m of water.
- Stock 100-200 g broodfish at 3-5 per m^2 at a sex ratio of 1 male to 2-7 females.
- Feed using a 30-40% crude protein diet at a rate of 1-2% body weight/day.
- Collect eggs every 5 days or collect eggs and fry every 10-14 days; seed yields of up to 400-3,000 fry/m^2/month or 200-1,500 fry/female/month can be achieved by this method.

An advantage of using the tank method is that tanks are very easy to manage. On the other hand, tanks are often relatively expensive to purchase or build.

Production of all-male fingerlings

Regardless of which of the above methods is used to produce tilapia fry, some farmers may want to produce all-male populations of tilapia fingerlings for stocking into ponds. All-male populations can be obtained by at least two practical methods, hand sexing and hormonal sex reversal. Each method has advantages and disadvantages.

Hand Sexing

- Sexual features distinguishing males from females are clear when fish mature, which occurs at about 10 cm in Nile tilapia.
- Males have two orifices situated near the ventral (anal) fin. One is the urogenital opening and the other is the anus. Females have three orifices, the genital opening, the anus, and a urinary orifice which is difficult to see with the naked eye.
- Hand sexing requires extensive nursery facilities for rearing the fry to produce advanced fingerlings for sexing at around 20 g. It is a relatively inefficient means of producing an all male population, however.
- Separation of males and females can be made easier by applying dye (India ink, halcyon blue, or indigo) to the papilla with a soft brush or cotton swab to outline the male and female openings. Skilled hatchery workers can achieve over 95 % male populations on 5 to 7 cm fish.
- Manual sexing should be done early in the morning so fish will not be stressed by high water temperatures.
- Culled females may be used as brood stock, eaten, sold, fed to livestock, or preserved by drying, salting, or smoking.

Hormonal sex reversal

- A tank-based or hapa-based (small cage net) hatchery is needed so that fry can be collected at the yolk sac or first feeding stages, no later than one week after they have been released from the female.
- Healthy fry of uniform size are transferred to the tank or hapa, where they are fed the hormone-containing diet for a period of 21-28 days.
- The method for preparing sex reversal feed is as follows:
- Mix 30-70 mg of hormone (methyl or ethynyl testosterone) in 700 ml of 95% ethanol.
- Add 700 ml of hormone solution to each kg of finely ground feed.
- Mix thoroughly and dry.
- Add any supplements.
- Refrigerate (if the feed is not to be used immediately).
- Feed at a rate of 10-30% of body weight per day, at least four times a day, for 21-28 days.
- The fry must eat the feed containing the sex reversal hormone and no natural food.

Moving on

This section has considered seed production techniques for tilapia. The next section addresses seed production techniques for the African catfish.

.3: CATFISH SEED PRODUCTION

Introduction

Under pond conditions catfish mature after 7-10 months and weigh about 200 to 500 g. Spawning does not normally occur in managed ponds because the final stimulus associated with a rise in water level and inundation of marginal areas does not occur. However, catfish can be induced to spawn by hormonal treatment using pituitary glands from donor fish. Catfish raised from egg to maturity in a hatchery remain mature all year round and regression of the gonads does not occur. This suggests that adequate supplies of fry should be obtainable throughout the year.

Broodfish maintenance

- Maintain a conditioning/fattening pond of about 100-200 m^2 for your broodfish. This size of pond will hold 300 brooders (150 males and 150 females). The pond should be sufficiently deep—about 1.0 to 1.50 m.
- Prior to filling and stocking the pond, fertilize it with organic or inorganic fertilizers to maintain its natural food production. Also apply lime in areas where the pond waters are acidic (see Section 4.1 in this guide).
- Stock the conditioning pond at a density of 2-5 brooders per m^2.
- Feed your broodfish with a 40% crude protein feed three times a day at 1% of their body weight. Whenever possible it is advisable to stock small tilapia with the brooders to serve as supplemental food.
- Stop feeding the broodfish one day prior to collecting them for spawning.

Spawning

1. Selection and handling of brooders

- Capture and transport fish early in the morning or late in the evening when it is cool. Ice can be used to reduce sudden changes in water temperature. Anesthetics have also been used to reduce fish stress during transportation and transfer to tanks.
- Handle your broodfish as little and as gently as possible to avoid stress. Damage to the slime (mucus) layer can lead to infection.
- Use a seine to gently capture enough fish to be able to select sufficient males and females for spawning.
- After collection of the fish from the conditioning pond, disinfect them in a formalin bath to prevent the transfer of pathogens from fish to eggs and fry.
- Selection involves separating males from females and checking for maturity. Do this by gently pressing the abdomen with the thumb; fecund females release shiny greenish eggs. Mature males cannot be stripped and can only be selected by their size.
- Choose females of about 0.5 to 1.0 kg; this size has a substantial

quantity of eggs and is easier to handle than larger fish.
- For each female use at least two males of the same total weight.

2. Collecting and injecting the pituitary
- To avoid temperature shock it is advisable to use a thermostat or heater where available.
- Brooders should be held without food for 24-36 hours in a container at 25- 30°C prior to injection with pituitary.
- Pituitary can be collected from either male or female fish.
- For each female spawner, two pituitary donors of 500 g average weight are used.

Figure 5.3-1. Adult male and female African catfish (*Clarias gariepinus*) can be distinguished by features in the urogenital area. Note that the genital papilla of the male (right) is much more pronounced than that of the female (left).

- When using fresh pituitary, kill and decapitate donors less than an hour before planned injection. Open the palate of the mouth with a pair of pincers and locate the pituitary just below the ventral side of the brain.
- Collect pituitary from the donor and place it in a mortar containing 2 ml physiological salt solution (9 g salt in 1 litre water).
- Grind the pituitary, mixing it well with the saline solution.
- Alternatively, pituitary can be stored for months in 1 ml acetone in a cool dry place to be used later.
- Using a syringe with a needle 2.5 to 3.0 cm long and a diameter of 0.7 mm, draw the pituitary suspension and prepare to inject the fish.
- Cover the head with a hand towel and insert the needle at an angle of 45 degrees in the dorsal muscle. Inject and finger-rub the intramuscular area to distribute the suspension evenly.
- Place the fish back in the container and wait for about 12 hours

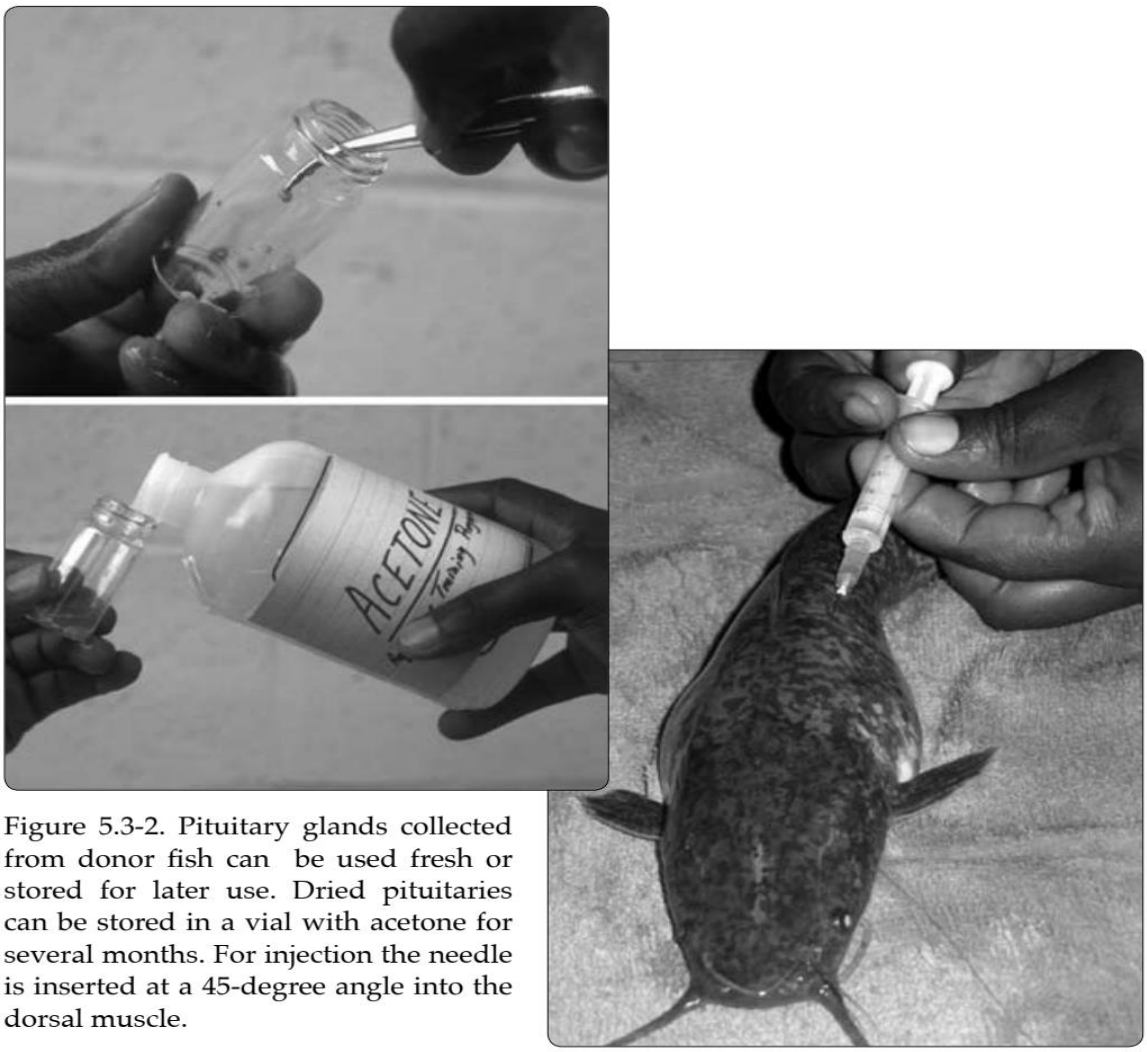

Figure 5.3-2. Pituitary glands collected from donor fish can be used fresh or stored for later use. Dried pituitaries can be stored in a vial with acetone for several months. For injection the needle is inserted at a 45-degree angle into the dorsal muscle.

until all eggs have matured (see Table 5.3-1).

- During ovulation, the belly of the female will swell due to water absorption of the ovary. If the female has responded well, eggs will easily run out from the genital papilla when the belly is gently pressed.

3. Stripping the female and fertilizing the eggs

- Gently strip eggs from the female into a dry bowl and estimate the number of eggs (One gram contains about 600-700 eggs).
- Male gonads can be removed and macerated (mashed) and the milt mixed with eggs at the time of stripping the female.
- Squeeze the freshly dissected testes and distribute the milt droplets evenly.
- Immediately add some clean water to the bowl and mix eggs with the sperm by gentle swirling of the bowl.
- Use a feather to mix the eggs and milt.

Table 5.3-1. Time interval (Hrs) between injection and stripping (latency time) of the female fish and incubation time in relation to water temperature.

Water Temp (°C)	Latency Time (h)	Incubation Time (h)
20	21	57
21	18	46
22	15.5	38
23	13.5	33
24	12	29
25	11	27
26	10	25
27	9.0	23
28	8.0	22
29	7.5	21
30	7.0	20

Incubating the eggs

- Pour the fertilized eggs into an incubating tray in a single layer. Within a few minutes after fertilization, the eggs will absorb water and sticky attachment discs will develop.
- Incubate the eggs in flowing water with a flow-through rate of 1-3 litres per minute.
- Healthy developing eggs have a transparent greenish-brown colour whereas dead eggs are white; dead eggs must be removed immediately to avoid fungal infection.
- Depending on ambient water temperature, eggs will take 20-57 hours to hatch (Table 5.3-1).
- Where a screen is used to incubate eggs, hatchlings will fall to the bottom upon hatching. They can also be siphoned out into a tank where they will rest as they absorb their yolk.
- Hatchlings must be separated from the egg shells to avoid infections that can lead to mortality. At this stage of development, the hatching rate will be about 50-80%.
- Hatched fry are 5-7 mm in length and weigh about 1.2-3.0 mg. They look like tiny needles with a green globe, the yolk-sac.
- Due to the weight of the yolk-sac, hatchlings will fall to the bottom of the container. They will cluster together in dark places in the tank and will require a cover and aeration.
- Within 3 days the yolk sac will be absorbed and the swim-up fry will start to search for food. With good management, 90-95% of the larvae will survive and develop into fry.
- Transfer fry in buckets to weaning tanks or nursery ponds (weaning tanks preferred).

Larval rearing

Several factors are of great importance when nursing catfish larvae:

- Start them out in a protected hatchery environment (rather than stocking them directly into ponds) to increase survival rates.
- Stock them at an appropriate density (about 100 larvae per litre) to get better growth and survival.
- Availing large quantities of zooplankton (for example, rotifers or *Artemia*) as starter feeds for the first 10-14 days helps increase growth and survival rates.
- Transfer the fry to hapas (feed well with live and artificial feeds) or to a well-prepared (zooplankton-rich) nursery pond to increase survival.

Figure 5.3-3. Aquaria can be used to rear catfish larvae in the hatchery.

Figure 5.3-4. Hapas can be placed in ponds to protect catfish fry during the early pond-rearing period.

1. Hatchery rearing

- After removal of dead eggs from the incubation trays or screens, transfer the live yolk-sac larvae to tanks or aquaria in the hatchery for further rearing.
- Rear the young fish in the hatchery for 7 to 14 days (depending on water temperature) to achieve optimal survival when they are later transferred to nursery ponds.
- Stock the larvae at a density of about 100 larvae per litre of water.
- Maintain the water temperature at about 28°C.
- Feed the larvae as much as they will eat in 15 minutes every two hours (around the clock) during the hatchery phase (about 14 days).
- With this management you can expect a highly acceptable growth rate and a survival rate of 80% or better at a low cost.

2. First feeding of catfish larvae
   - Catfish larvae normally begin feeding on the second or third day after hatching, before the yolk sac is completely absorbed; therefore you must begin to feed them at this same time when rearing them in the hatchery.
   - When they begin feeding, the larvae normally utilize live feeds and their systems are not sufficiently developed to utilize dry (manufactured) feeds; it is therefore recommended that dry feeds be supplemented with *Artemia* nauplii or rotifers during at least 3 of the 10 to 12 daily feedings for the first three to four days of feeding.
   - If an abundance of live food is available, maintain a constant concentration of live food organisms in the larval rearing system, as this greatly enhances their growth rate.
   - It has been shown that a continual supply of food produces the highest growth rates; you should therefore feed your larvae as much as they will consume in about 15 minutes by hand every 2 or 3 hours for 16 to 18 hours each day.
   - Feeding with live feeds such as *Artemia* nauplii or rotifers has advantages over dry feed; for example, the best growth is obtained when larvae are fed *Artemia* only (250 mg average weight after 11 days).
   - Feeding with *Artemia* nauplii or rotifers is stopped on the second or third day after the start of exogenous feeding, when the larvae are big enough to ingest inert food particles or zooplankton (usually *Daphnia*).
   - The larvae grow very rapidly after the start of feeding (about 100% body weight/day).

3. Predation on the larvae
   - One of the most serious predators in ponds is toad tadpoles. The presence of tadpoles is also a nuisance because they compete for food resources within the pond.
   - Other predators include backswimmers, insect larvae, copepods, etc.
   - It has been observed that predation pressure can be very high (100% mortality) during the yolk-sac stage but decreases gradually as the larvae increase in size.
   - It is therefore suggested that fry be transferred to nursing ponds only after they have reached a size greater than 10 mm to avoid losses to predation during the primary nursing phase.

4. Transferring catfish fry to nursery ponds
   - After approximately 14 days in hatchery tanks, the fry can be transferred to ponds.
   - Ponds should be well prepared to receive the fry. This includes proper pond bottom drying between crops, liming when needed, and proper fertilization to develop abundant supplies of natural foods for the fry to be stocked.
   - Where possible, use hapas in ponds to further protect your fry and

Figure 5.3-5. Tadpoles can be one of the most serious predators for catfish larvae stocked in open ponds.

increase their growth and survival rates. For best results, totally cover the tops of the hapas with cut grasses or other materials to provide the maximum possible amount of shade for the fry.

- After 14 days in the hatchery, fry transferred to hapas or nursery ponds should be reared an additional 14 days, or until they reach a length of 2-3 cm. This is a suitable size either for stocking into production ponds or for use as baitfish.

Factors contributing to the growth and survival of catfish fry

Factors that influence the growth and survival of catfish fry include:

- Stocking density: High stocking densities result in poor growth and survival; low stocking densities enhance growth and survival, but are less economical.
- Cover or shading: Cover and shading enhance growth and survival, whereas exposure to light lowers growth rates and increases mortality by contributing to increased cannibalism and stress.
- Production period: Most mortalities occur during the early part of the nursing phase. The first 30-45 days is critical; thereafter survival is often close to 100%.
- Cannibalism: Loses due to cannibalism can be minimized by providing cover (shade) and adequate amounts of high quality feed.
- Predation: Predation by tadpoles significantly reduces survival.
- Feeding: The availability of live feeds greatly reduces mortality.

Moving on

This section concludes this manual's consideration of technical aspects of fish farming such as site selection, pond design and construction, and pond and hatchery management. In the next chapter we will consider the basic economic aspects of fish farming, focusing on tools such as enterprise budgets and cash flow analyses, which can assist the farmer in evaluating a fish farming enterprise, whether it is one already in operation or is a potential system still under consideration.