3: Species Suitable for Culture in Kenya

Culture systems found in Kenya include semi-intensive culture of Nile tilapia (*Oreochromis niloticus*) and African catfish (*Clarias gariepinus*), practiced by small-scale fish farmers in static ponds, and intensive culture of trout in raceways. The species used at any given site are mainly endemic to the region and more or less appropriate to the agroclimatic zone. For example, tilapia is a warmwater fish and is mainly cultured in a freshwater environment. Catfish are grown in the same agroclimatic region as tilapia, but trout, an introduced coldwater fish, is best grown in high altitude regions where the water is cooler. The major drawback of culturing tilapias in ponds is the risk of uncontrolled reproduction. The challenge with catfish production is high mortality of fry, especially during the first 14 days after the eggs hatch. Trout production is presently limited by the availability of seed and quality feeds in the country.

Desirable characteristics for cultured fish species include:

- Ease of reproduction
- Attainment of market size prior to reaching sexual maturity
- Acceptance of supplemental and/or manufactured feeds
- Feeds low on the food chain, i.e., eats plant material
- Rapid growth
- Efficient feed conversion
- Resistance to diseases
- Tolerance to relatively high stocking density and poor environmental conditions
- Is highly desired in the marketplace

Few species have all of these characteristics, but both the Nile tilapia and the African catfish have enough of them that their popularity in the market and the ready availability of technical information about their culture make them suitable candidates for warmwater fish farming in Kenya.

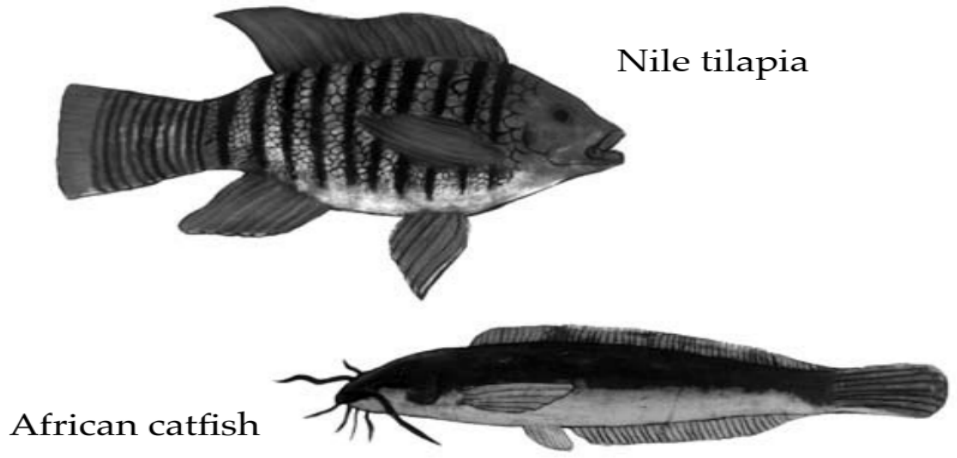

Figure 3.1 The Nile tilapia and the African catfish are the two most-commonly cultured species in Kenya.

3.1: Nile Tilapia

Introduction

Tilapia grow best in waters with a temperature range of 20-35°C. They can grow up to 500 g in eight months if breeding is controlled and food supply is adequate. Juvenile tilapia feed on phytoplankton, zooplankton, and detritus, but adults feed almost exclusively on phytoplankton. Tilapia can reach sexual maturity at two months of age or at 10 cm or less in length. Hence, the major drawback with tilapia culture is their tendency to over breed, which can result in a large population of stunted (undersized) fish. Some relevant characteristics of tilapia are described here, along with information about husbandry techniques.

Figure 3.1-1. Nile tilapia, *Oreochromis niloticus*.

Temperature tolerances

- Various strains of Nile tilapia differ with respect to their tolerance to cold, but growth is generally limited at temperatures below 16ºC and most strains become severely stressed at 13ºC.
- Death begins to occur at 12ºC, with few fish surviving temperatures below 10ºC for any period of time.
- Nile tilapia do not feed or grow at water temperatures below 15ºC and do not spawn at temperatures below 20ºC.
- The normal water temperature should be 20-30ºC, preferably about 28ºC, which is considered the ideal temperature for good health and growth. At higher temperatures their metabolic rate rises, leading, in extreme cases, to death.
- Gradual conditioning would allow tilapia to live within a range of 8-40ºC.

Tolerance of low dissolved oxygen (DO) concentrations

- Tilapia are able to survive levels of dissolved oxygen (DO) below 2.3 mg/L as long as temperature and pH remain favourable.
- In fertilized ponds, a bloom of algae can reduce oxygen levels to as low as 0.3 mg/L with no fish mortality in tilapia.
- Larger fish are known to be less tolerant than fingerlings; this is due to metabolic demand.

Maturation

- It has been observed that under natural conditions tilapia mature at a larger size and later age than they do when cultured in ponds. This can take two to three years.
- The age and size at which maturity is reached also depends on conditions in the water body.
- Tilapia cultured in ponds sometimes mature at as early as two months, but generally mature in four to six months.

Feeding habits

- Nile tilapia are omnivorous, feeding lower on the food chain on phytoplankton, zooplankton, aquatic insects, and macrophytes.

Breeding behaviour

- Mature tilapia can spawn about once a month all year round if temperatures remain above 22°C; below 22°C spawning will be seasonal.
- In actively breeding populations of tilapia, much of the energy resources of females are tied up with reproduction, either while producing eggs or during mouth brooding; this means that the growth rates of males are much higher than females.
- Males make nests and attract ripe females to the nest with courtship displays.
- The female lays eggs in the nest, where they are fertilized by the male and immediately picked up in the mouth of the female.
- Males will continue to court other females, while the female that has just spawned retreats away from the nest to incubate the eggs.
- Males play no part in parental care and can mate with many females at a time; therefore sex ratios in breeding ponds can be as high as seven females to one male.
- Eggs hatch in the mouth of the female after about five to seven days (depending on temperature) and the hatchlings remain in the mouth while they absorb their yolk sacs.
- Tilapia fry start swimming out of the mouth to feed, but return to the mouth at any sign of danger. Once the fry have become too large to fit in the female's mouth, they become totally independent and move to warm, sheltered water such as near the edge of a pond.
- Tilapia eggs are relatively large, producing large fry.
- Removing the eggs or fry from a brooding female prematurely will increase the frequency at which the female will spawn.
- Eggs are stimulated to develop once the previous batch of offspring is released, so a female will return to spawn after a recovery period of four weeks or less.
- Typical brood sizes are 100-500 fry; larger females have bigger broods.

Husbandry techniques

- Earthen ponds are prepared for stocking in the standard manner for the semi-intensive culture of warmwater fish (see Section 4.1 of this manual).
- Fingerlings of 10-20 g are stocked and cultured for a full production cycle (five to six months with fertilization and feeding).
- Stocking rates range from two to six fingerlings/m^2, depending on the level of management.
- Male tilapia are known to grow almost twice as fast as females. It is therefore preferable to stock only males (monosex culture) to achieve the fastest growth and reach market size in the shortest possible period of time, resulting in more protein and profit for the farmer.
- When the fish have reached market size, ponds are partially drained and seines are used to remove the fish. The last fish are removed by fully draining the pond.

Production of all-male fingerlings

As mentioned above, male tilapia are known to grow more quickly than females, making it desirable to stock ponds only with males whenever possible. All-male populations can be produced by at least two practical methods, hand sexing and hormonal sex reversal. Each method has advantages and disadvantages. Hand sexing is cheaper and does not require special materials or technology, but it does require that farm workers be able to distinguish males from females without error at a fairly small size (approximately 20 g), so that no females will be accidentally stocked into a pond. Hormonal sex reversal, on the other hand, requires special training to prepare hormone-containing feeds and to administer these feeds on a precise schedule during the first few weeks after hatching. Additional details about these two methods are given in Section 5.2, "Tilapia seed production."

Tilapia rearing systems in ponds

- Extensive culture systems are the least productive. These are usually earthen ponds with low input and minimal management, uncontrolled breeding, and irregular harvesting; yields in this type of system are typically 500-2,000 kg/ha/yr of uneven-sized fish.
- The next system up is manured ponds with uncontrolled breeding and regular harvesting; yields are typically 3,000-5,000 kg/ha/yr of uneven-sized fish.
- Higher yields can be realized in semi-intensive systems, which require much greater investment in terms of management and stocking. If monosex fish are stocked and regular manuring and supplementary feeding is practiced, yields can be up to 8,000 kg/ha/yr of even-sized fish.
- It is quite common for tilapia to be grown in polyculture ponds with catfish or other predatory fish.

- The main advantage of growing tilapia in ponds is that they can be grown very cheaply through fertilization.
- Higher yields can be achieved by stocking monosex fish and using nutritionally complete feeds.

Figure 3.1-2. Young male and female tilapia (*Oreochromis niloticus*) can be distinguished when they reach about 20 g in weight. On males (left) the genital papilla is larger and more distinct than on the female (right).

Current issues of interest to tilapia farmers

A major management problem of pond-cultured tilapia is excessive reproduction and the subsequent stunting of fish due to overcrowding. Methods of controlling overpopulation include manual sexing of fish, use of sex-reversal hormones to produce all males, and use of predators. The success of these methods may rest with how well a fish farmer understands the techniques.

At the same time, another constraint in Kenya is the unavailability of sufficient quantities of high-quality fingerlings for pond stocking. There is need for fingerling production centres or hatcheries that can produce tilapia fingerlings in large numbers. Farmers should be encouraged to venture into the production of fingerlings as an enterprise and become fingerling suppliers for other farmers.

A third constraint is a lack of fish feeds, which are needed to increase fish growth rates, pond productivity, and income from the pond.

Moving on

This section has outlined some of the characteristics of Nile tilapia and provided some basic information about its culture. In the next section, the characteristics and culture of the African catfish will be considered.

3.2: African Catfish

Introduction

Demand for African catfish (*Clarias gariepinus),* both for food and as bait in capture fisheries, has been increasing substantially in Kenya in the last few years. The Fisheries Department estimates that for aquaculture activities, there is a demand of about 10 million catfish fingerlings per year, while the demand in the Lake Victoria capture fisheries is about 18 million fingerlings per year. This adds up to a total demand of about 28 million catfish fingerlings per year.

Catfish generally reach maturity at two years of age at a weight of 200-500 g. Females can produce between 10,000 and 150,000 eggs, depending on the size and age of the female. The yolk sac is almost completely absorbed two to three days after hatching and feeding begins at this time. The main first foods are zooplankton and small aquatic insect larvae. However, development is temperature dependent and some fry have been known to start feeding after their fourth day. By eight to ten days, they can be weaned onto a formulated diet consisting of fish meal and bran from cereals. Inadequate nutrition, poor water quality, and overcrowding are three major factors that often contribute to poor spawning results.

Figure 3.2-1. African Catfish, *Clarias gariepinus*

Temperature tolerances

- Temperature is the most important variable affecting the growth of larvae and early juveniles.
- The optimal temperature for growth appears to be 30°C; however, temperatures in the range of 26-33°C are known to yield acceptable growth performance.
- At temperatures below this range, growth rates decrease but survival is still good. However, 28°C is the optimal temperature for both yolk sac absorption and maximum growth rate.
- High temperatures can encourage the growth of harmful bacteria and fungi, however.

Tolerance of low dissolved oxygen (DO) concentrations

Catfish can withstand very low dissolved oxygen levels, but well-oxygenated water is recommended. This is easily achieved by means of aeration or good flow rates.

Salinity tolerance

- A salinity range of 0-2.5 parts per thousand (ppt) appears to be optimal for young catfish.
- Larval growth is acceptable in up to 5 ppt salinity, and survival is good up to 7.5 ppt.

Light (Photoperiod)

- Optimal survival is achieved when larvae are reared in continual darkness, and larval growth decreases with longer periods of light.
- The free-swimming embryos (hatchlings) shy away from light and are said to be photophobic. They form aggregations on the bottom of the incubation tank.
- Taking advantage of their photophobic behaviour, it is possible to concentrate them in a dark corner of the tank and to remove both deformed and weak hatchlings using a siphon.

Reproduction in the natural environment

- In nature, African catfish are known to exhibit a seasonal maturation of gonads usually associated with the rainy season.
- The onset of maturation is influenced by changes in temperature and photoperiodicity.
- Final maturation and spawning are triggered by a rise in water level and flooding of marginal areas resulting from rainfall.
- In eastern Africa, reproduction usually begins in March, with the start of the long rains, and ends in July.
- Spawning usually takes place at night in shallow areas of lakes, streams, or rivers. Courtship and mating between male and female pairs is aggressive.
- The pair usually mates, then rests for a few minutes, and then resumes mating again.
- Catfish do not exhibit parental care except for the careful selection of mating site.

Nutrition and growth

- Catfish are omnivorous or predatory, feeding mainly on aquatic insects, fish, crustaceans, worms, molluscs, aquatic plants, and algae.
- They find food by probing through the mud on the bottom of the ponds.
- Their nutritional requirements in fish ponds (particularly for protein and lipids) are highly variable, and are influenced by factors such as management practices, stocking densities, availability of natural foods, temperature, fish size, daily feed ration, and feeding frequency.

- Zooplankton become more important as a diet item with increasing fish size and predominate in the diets of larger fish.
- At hatching, catfish larvae measure 5 to 7 mm in length and weigh between 1.2 and 3.0 mg.
- The larvae begin feeding two to four days after hatching, depending on the temperature, before the yolk sac is completely absorbed, and food must be offered to them at this time.
- Food given to catfish larvae should have 50% protein and 10-15% lipid content.
- The stomach is completely functional after five days of feeding, marking the end of the larval period.

Spawning and fingerling production

- For catfish culture, spawning is usually done artificially, by hormone injection.
- Seed production therefore usually requires maintenance of a broodfish conditioning pond and the use of a small hatchery for spawning and nursing the young fish.
- For further details on spawning and early rearing of larval catfish, refer to section Section 5.3, "Catfish seed production."

Pond culture of catfish

1. Pond preparation

- Ponds should be properly prepared prior to stocking so that natural foods are abundant and the presence of predators is minimized. See Section 4.1 ("Preparing your fishpond for stocking") to see how to best fertilize ponds prior to stocking.
- In general, the use of organic fertilizers (manures and composts) results in the fastest development of zooplankton blooms in ponds.
- See also the section on "Preventing fish diseases and controlling predators."

2. Stocking levels

- When stocking hatchery-started fry into nursery ponds, stock at a rate of 100-450 fry per m^3.
- When stocking fry into hapas in ponds, stock at a rate of 100 fry per m^3.
- When stocking catfish in tilapia ponds as a way to control unwanted tilapia reproduction, stock approximately 10% of the number of tilapia stocked, i.e., for every 100 tilapia stocked, add about 10 catfish. Note that the difference in the sizes of tilapia and catfish stocked is critical; refer to Section 4.2 for further details.
- When stocking catfish fingerlings to rear them for the market, increase the stocking rate to about 2 to 10 per m^2. For a 6- to 9-month growing period, these rates will produce fish of about 500 g and 200-250 g, respectively, depending on water temperatures.

3. Pond management through the culture period

Manage the pond as discussed in the sections on "Preparing your fishpond for stocking," "Feeding your fish," and "Managing pond water quality."

Current issues of interest to catfish farmers

A major challenge to catfish producers is high mortality rates of fry resulting from starvation, cannibalism, disease, and predation during the hatchery and nursery phases of production. Provision of an acceptable feed during this critical period is the most important factor affecting the survival of catfish fry.

Moving on

This chapter has provided some basic information about the characteristics and culture of the two most popular pond fish in Kenya, the Nile tilapia and the African catfish. The next chapter provides a step-by-step overview of the management practices needed for the efficient production of these two species in earthen ponds.