Kenya Pioneers Intensive Tank Culture of Tilapia

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Tilapia culture in its crudest form began in Egypt almost 4,000 years ago, a thousand years before true fish farming—of carp—was first conceived in China. But other than biblical references, little of this early practice has been documented. Perhaps the first recorded, scientifically oriented culture of tilapia was conducted in Kenya, as recently as 1924. The practice soon became widespread and by 1965 it had become well established in Africa. During the 1940s, tilapia also became entrenched in the fish farming industry in the Far East and a decade later spread to the Americas.

Self-cleaning raceways at Baobab farm. Waterflow is critical.

Such has been the success of the tilapia that in the past 35 years it has risen from obscurity to be ranked as one of the most important of the farmed fish. There are approximately 3,500 documented works on the fish and they are reported to be cultured in over 110 countries.

Kenyan Developments

It seems natural that today Kenya should lead in the development of one of the most intensive techniques of tilapia culture. Sadly however, this is not so. A recent local symposium revealed that although there exist some 30,000 ponds covering 3,000 ha with a potential annual production of over 7,000 t, only 10% are functional, now producing 500 t/annum. The factors identified as responsible for the low yields are characteristic of the Third World, especially Africa, and have been emphasized at the World Aquaculture Conference held in Venice, September 1981:

- Lack of technical expertise and trained personnel for extension.
- Lack of good-quality seed.
- Inadequate financial support and credit facilities.
- A long history of poor achievement.

Determined efforts by the Kenyan Fisheries Department are underway to surmount these problems, particularly in view of the fact that inland and marine fisheries are reaching their maximum sustainable yield. Statistics suggest that construction of ponds to supply present fish requirements is a formidable task. Assuming that it is possible to raise present national fish productivity from 0.3 t/ha/year to 2.5 t/ha/year, the continued supply of fish at the present consumption rate would necessitate the construction of 1,000 ha of ponds per year. Similar statistics apply throughout Africa.

In the short term, intensification is essential. At least 16 other countries are undertaking experimental trials in tank systems. Small commercial units in the U.S.A. and Belgium have yielded 60 and 300 kg/m^3/year, respectively, while in China, experimental yields of a staggering 600 kg/m^3/year, equivalent to 6,000 t/ha/year have been obtained!

At the Baobab Farm

Baobab Farm was initially established to make use of coral scrubland owned by the Bamburi Portland Cement Company, Mombasa, Kenya. Today, alongside normal horticulture and livestock production, the Farm engages in game ranching and reafforestation of abandoned limestone quarry sites. One such quarry site had an abundance of subsurface water, a consequence of its near proximity to the ocean. Ponds were excavated and tilapia culture initiated in 1971. The general manager, Mr. Rene Haller, soon discovered the limitations of pond culture and began tank culture experiments. Eventually, Haller arrived at a system suited to the biology of the tilapia—circular, self-cleaning units with a unique siphon drain. Close collaboration with various scientific institutions, notably Stirling University, Scotland, led to the development of a 50-t production model tilapia farm, one of the largest of its kind in the world today.

Brackish water (15 ppt) is in abundant supply. Over 300 m^3/hr of water are lifted through a total head of 5 m requiring a low-kw motor. The use of highly efficient, low-pressure, high-volume pumps has reduced pumping costs to less than 10% of overall production cost.

By cascade aeration, 100% oxygen saturation is achieved and water is then dispensed by gravity through open channels. This reduces the capital cost of plumbing and fittings, especially valves. Water is effectively used three times—it passes through two raceways and one tank, with re-aeration taking place at each step. The use of gravity feed is designed with the ultimate consideration that this system could be 'plugged' into an irrigation line. Waste water would then be used for agriculture.

THE 50-T PRODUCTION UNIT

Two basic Baobab designs have been adopted:

- Shallow raceways for fry and fingerling rearing.
- Circular tanks for breeding, quarantine and fattening to marketable size.

These are the components of a 50-t production unit:

1 150-m^2 breeder arena	(300 breeders)
10 5-m^3 rearing raceways	(5,000 fry of 1-5 g)
4 2-m^3 quarantine tanks	(5,000 fry of 5 g)
24 7.5-m^3 fingerling rearing raceways	(5,000 to 10,000 fingerlings of 5-25 g)
12 20-m^3 circular fattening tanks	(5,000 fish up to 250 g)
1 50-m^3 circular holding unit	(20,000 fish)

The production cycle starts in the breeder arena. This unit, described by Haller and Parker in Fish Farming International, March 1981, is made up of three concentric zones. The inner circle is the male nesting area; females have access to it, but while brooding eggs can retreat to a second ring inaccessible to the males. When fry are released, they collect in the outermost ring and are regularly drained off to shallow rearing raceways. The shallow raceways provide marked diurnal fluctuations in temperature and encourage primary productivity resulting in improved growth. Stocked at 300 breeders with a 3:1 female to male ratio, a single unit can produce sufficient fry to sustain an annual output of 50 t of saleable fish.

Grading the fry at Baobab farm.

QUARANTINE

Fry at 5 g undergo a prophylactic treatment against parasites before being transferred to quarantine tanks and kept under observation for two weeks. Stress due to handling has resulted in up to 30% loss due to secondary infections, but the quarantine reduces this to a negligible less than 5%.

Once assessed as 'clean,' stocks enter a series of raceways, and are graded fortnightly, such that after three months, the larger 50% of fish weigh 50 g each at least, ready for stocking into fattening tanks. The shallow raceways facilitate handling of fish during the grading.

The stocks selected are 70 to 90% male and within 3 to 4 months most are a saleable 250 g. Undersized fish are used as feed in an adjacent crocodile farm. In this way, all farm wastes, including mortalities from other livestock sections, are turned into a valuable by-product: crocodile skin.

FEEDING

Feeding is done by hand, six times a day. This permits direct and frequent observation of the fish and any signs of distress can quickly be remedied. Feed is of a pelleted form. Two formulae are used, one of a 40% protein content, the other only 20% protein. These feeds are the starter and finisher diets respectively; intermediate requirements are achieved by mixing.

Currently, there are trials to evaluate various bulk ingredients as well as to find a substitute for fish meal, an important component. Since feed represents 40 to 60% of production costs, this is an important area of research. To date, cotton seed and pollard have shown promise as major dietary ingredients, but work has been hampered by aflatoxin and rancid fats which have caused fish mortalities. Both are consequences of feeds stored under humid, tropical conditions.

WATERFLOW AND QUALITY

Resting tilapia require a waterflow of about 0.5 l/min/kg; when they are active and feeding, the need can double, such that daytime requirements often exceed incoming supply. The resultant drop in tank oxygen level has a proportional effect on food intake, i.e., the ration size accepted by fish at 30% oxygen saturation is half that at 60%. A green, epilithic algal and diatom layer which lines the walls of the tanks produces oxygen by day in large quantities, such that tank concentrations are maintained above 40% saturation. Tilapia crop this algae, encouraging its growth while preventing autoshading due to overgrowth.

All tanks and raceways are self-cleaning, partly due to flow dynamics and in part due to the action of the tilapia. Careful attention is paid to keep current speeds between the settling velocity of large faecal particles (7-10 cm/s), and that beyond which fish are forced to swim (18-20 cm/s).

STOCKING RATE AND GROWTH

At the prescribed stocking rates, growth is good—from hatching to market takes nine months. Although by no means near the biological maximum, the stocking density is considered critical, in terms of the economics of feeding and water supply, while it is considered well below a density at which overcrowding or stress-induced diseases might occur.

Economics and Prospects of Intensive Culture

Tilapia are better at converting low-grade feeds into high-quality protein than are chickens, pigs, sheep or cattle. They also have a proportionally higher dress-out weight. However, in terms of intensification, tilapia culture requires greater technological understanding and a well-designed infrastructure.

Generally, the running costs of a fish farm can be attributed to three major items: seed, labor and feed. Intensive units, such as the Baobab Design, are self-sufficient in seed supply. Broodstock for a production cycle supplies several generations of fry. Labor requirement is low. Feed is the most expensive component. The use of farm wastes should reduce this cost; self-reliance on feed production is essential.

World population growth dictates a need for intensification in all aspects of agriculture. For tilapia culture, this trend is just around the corner.○