Section II

HOW TO IMPLEMENT THE BEST MANAGEMENT PRACTICES
CHAPTER 1

INTRODUCTION

1.1. The Concept of Commercial Fish Production

The objective of commercial fish farming is to produce fish to supply markets at a competitive price and make a profit. The market is therefore, the driving force for commercial fish farming. The key parameters that determine the levels of production and success in fish farming are water quality, feed quality and seed quality. How one manages these parameters vis-à-vis the prevailing market demand and prices determines the viability of a commercial fish farm.

![Hand Illustration of the Five Basic Components of Commercial Fish Farming. (Adapted from Schmittou et al., 1998)](image)

**Figure 1.1:** Hand Illustration of the Five Basic Components of Commercial Fish Farming. (Adapted from Schmittou et al., 1998)

1.2. Sustainable Aquaculture Production

The catfish production technology discussed in this manual is feed based and built upon the principles of sustainable aquaculture. Sustainable
aquaculture as applied in this technology package is ‘an adaptable aquaculture production technology system whose ecological and economic viability persists indefinitely’ (Schmittou et al., 1998).

Fish are greatly affected by the environment in which they are grown. An aquatic ecosystem is extremely dynamic, changing with nutrient inputs, weather and season. The effects of the changes are even more pronounced in artificial systems like fish farms where man influences what organisms and other inputs are added to the culture environment. Fish growth and survival are closely related to water quality. Furthermore, fish are cold-blooded animals. All of their bodily functions are directly influenced by the temperature of the environment. So, while the markets determine aquaculture opportunity, the ecological and economical principles determine the choices for sustainable aquaculture practices and technology.

Therefore, users of the manual are encouraged to understand the principles upon which this catfish static water pond production technology is based. This is because, the specific environment where the farm is located defines what additional opportunities and constraints in production one is likely to encounter. Farmers and extension agents are therefore encouraged to be observant and continue to make adaptations, in order to enhance the productivity and profitability of their specific enterprises. Therefore, this book is but a guide to the commercial production of catfish in ponds.

1.3. General Biology of African Catfish

In nature, the African Catfish (Clarias gariepinus) tend to live in calm waters with vegetation. Living conditions in such an environment can be harsh. There is often a lot of organic matter in the water. In addition, in several of these locations (for example, in flood plains) the water levels fluctuate seasonally, going up during the rains and receding during the dry seasons. In several of the clarias catfish natural habitats, the water levels drop to the point whereby the water-way almost dries up. The relatively large amounts of organic matter in water coupled with the relatively slow water flows through such habitats result in low levels of dissolved oxygen in the water for prolonged periods and increased acidity of the water.

In order to overcome these environmental challenges, the fish have adapted in the following ways:
1. **Low Oxygen Levels** - Catfish have developed in addition to gills, an accessory cauliflower like organ (the arborescent organ) that enables the fish obtain oxygen from air when the oxygen levels are too low in water or the swamps have dried out. However, this organ is largely functional in adults. More than 90% of juvenile catfish oxygen consumption is from dissolved oxygen in water whereas in adults, 40% to 50% of the oxygen uptake is atmospheric (Hecht et al., 1997).

2. **Body Shape and Features** - The fish have no scales, but a relatively thin skin and protective layer of mucus over the skin. Their long cylindrical shape also allows them to easily burrow into the mud when water levels drop to keep themselves moist and cool. They can only survive in burrowing if there is an air-water interface. In addition, it has **barbels** that enable it sense its food even though visibility is poor in the swamp. Its flattened mouth is designed so that it can ingest food off the bottom.

3. **Feeding Habits** - The fish is also an omnivore, meaning it can literally eat almost anything although in the wild adults preferably eat other fish, insects or other forms of aquatic animals. Adults have a **diel** (twenty four hour cycle) feeding pattern, meaning that they need to hunt once a day, subject to food availability. Consequently they have a relatively large stomach capable of holding quite a bit of food, unlike the Nile tilapia whose stomach is relative small because it is naturally a browser and feeds several times a day.

4. **Social Behaviour** - Catfish are extremely social. They tend to live, hunt in tight groups. Hunting as a pack is among their natural feeding strategies (Hecht et al., 1997). They tend to dwell at the bottom.

5. The fish are able to withstand slightly acidic water.

6. The catfish also grows fast and does not become sexually mature until it is about a year old (about 600g) depending on feeding. Females become mature earlier than males.
The above mentioned attributes, make the catfish a good candidate for aquaculture. However, these biological characteristics affect the fish’s production requirements and potential in the following manner:

1. **Low Dissolved Oxygen Levels** – Where the water has adequate levels of dissolved oxygen, catfish obtain their oxygen from the water through their gills. Aerial respiration in catfish is largely a compensatory mechanism for the periods when the dissolved levels of oxygen in the pond are low (Lévêque, 1997). However, in order to survive the periods of low dissolved oxygen, the fish must have access to the air otherwise they will die. In addition, the fish spend more energy obtaining oxygen from the air than they would do, when they can obtain it from the water.

In fish farming, the initial limiting factor to production as far as water quality is concerned is oxygen. Because adult catfish have the ability to overcome this by breathing air, higher carrying capacities and feed input level can be accommodated in catfish grow-out ponds as long as the build up of metabolic wastes (ammonia) in the water are kept under control and the fish can access the water surface. However, because more energy is spent when the fish obtain air from the atmosphere, *Feed Conversion Ratios* (*FCRs*) tend to increase, which in turn affects the profitability of the enterprise. Therefore, just because clarias catfish have the ability to withstand situations of low dissolved oxygen, for profitable production, the water quality parameters should as much as possible be maintained within the recommended ranges (see section 5.1. for more details). A minimum amount of oxygen within the water is required for the breakdown of metabolic wastes. Having more oxygen dissolved in water improves the efficiency with which the gills function which is more energy efficient for the fish and results in better growth rates.

2. **Body Shape and Features** - Because the catfish have no scales, the thin layer of mucus is the only first line of defense against infections whose port of entry into the fish is the skin. Consequently, removal of this layer of mucus through poor handling predisposes the fish to infection and illness. Catfish, should therefore, be handled with care during routine production operations.

Because catfish are bottom dwellers, most of the time within the pond they will be at the bottom unless there is a reason for them to
come up, for example, to feed or gulp air to obtain oxygen. Consequently, they tend to stir up the pond bottom which makes the water in catfish grow-out ponds muddy (i.e. turbid). Coupled with their burrowing behavior, they also dig into the sides of the pond, creating what is termed as the 'catfish highway'. This results in breakdown of pond levees, especially when they are not constructed as recommended and in addition increase levels of pond turbidity (see sections 3.1.1, 3.1.2. and 5.2.5. for more details respectively). Their body shape and the catfish highway they create in the pond enable them to easily escape seining when nets and techniques are poor. They are able to pass under and around the nets. When there is a hole at the bottom of the seine net, and one catfish finds it, because they move in hordes like sheep unlike tilapia, all the others shall be informed and they will all escape in a stream through the hole. Therefore, seine net specifications and seining technique are important; otherwise one can easily come out with an empty net.

3. Feeding Habits – The clarias catfish is omnivorous. This means it can consume a wide selection of food items that allows for a range of options in culture to provide for its nutritional needs. Because of their social hunting behaviour, it is preferable to feed them in ponds from a single place as doing so induces a feeding frenzy that results in the complete consumption of the feed, improved FCRs and reduced feed wastage. This is an important fact as above 60% of production costs are the feed cost (Hecht et al., 1997).

4. Social Behaviour – Pack hunting is a natural feeding strategy in Clarias catfish. Keeping the fish at high densities, consequently results in reduced stress and aggression while stocking at low densities results in the establishment of territories and aggression. Stocking densities in the pond should be such that:
   (i) They are high enough to the point whereby territories are not established, aggressive behaviour is reduced, feeding response is high and feed consumption time is reduced.
   (ii) Management requirements to sustain the biomass in the pond do not reach the pond’s carrying capacity limits for the specified management level (see sections 5.3. and 6.2.6. for more details).

5. Most healthy fish tend to swim against a current. Therefore, they will tend to aggregate and swim out of the inlet if water is flowing
into the pond during the production cycle. Thus, most escapes of catfish from ponds actually occur through the inlet (Plate 3.3). Inlets should therefore be set above the water level and well screened (see section 3.1.4. for more details).

1.4. Current Market Factors and Opportunities in Uganda and Region favouring African Catfish Grow-out Production

In addition to the favorable biological characteristics, there is both a local and regional market for the catfish which makes it also a good candidate for commercial farming.

Currently, there is a shortfall in the local supply of fish in Uganda. Catches from the country’s lakes have declined largely due to the negative effects of using under-sized fishing gear and over-fishing (Figure 1.2).

![Graph showing Uganda's total fish production over the years]

Source: FIGIS: 2008

**Figure 1.2:** Uganda's total fish production over the years.

The demand for fish on the other hand has continued to rise from Uganda’s rising population as well as the increased demand from export markets. This demand is unlikely to be met by the lake fisheries because fish production from the lakes cannot sustainably be increased beyond the lakes 'sustainable yield' otherwise the fishery resources will be depleted. (Plate 1.1 shows a photo of mugongo wazi sold in local markets). The only feasible option of increasing fish supply to meet the
rising demand is through fish farming as it is increasingly becoming a major source of fish for the market.

As a result of the low supply, local fish prices are rising (Figure 1.3). Whereas ten years ago fish was the cheapest source of animal protein in the country, it is now as expensive as beef. The current price trends are making farming fish more economically viable than it was five to ten years ago. However, the cost of inputs is also rising so the commercial farmer must closely follow prices and have contingency plans for times when input costs rise faster than market price.

![Figure 1.3: Trends in price (USh) per kilo of table size tilapia, catfish and pelleted fish feed (30% crude protein) for the period 2005-2008. (Data from USAID Fish Project; 2005 and 2006 data based upon farmer interviews; 2007 and 2008 data from sales reports)](image)

The diversity of fishes harvested from the lakes has also declined. Whereas the catfish were among the fish commonly caught, these days it is largely Tilapia, *Rastrineobola* sp. (mukene) and Nile perch and found in the local markets. The only source for large volumes of catfish now farmed catfish. Fish farms are now the major source of catfish to the processing plants in the country. Regional and International Markets for the Catfish have also been identified by processors who have started exporting farmed catfish, smoked and frozen. See Plate 1.2 that shows the various farmed catfish products now on market.

The Nile perch was previously the main source of filleted fish on the local market. Because it was cheap, most consumers purchased Nile perch fillet for their children. However, it is mostly the Nile perch that is exported as fillet out of the country and alternatives have to be sought. Farmed
Chapter 1 - Introduction

catfish fillets are now beginning to find their way into the local market where they offer a good substitute. In addition, catches of the Bagrus dogmac (Ssemutundu), a delicacy in Buganda, have declined so much that one hardly finds these fish in the local markets anymore. More people are now buying the high quality smoked catfish from farms as an alternative. This African catfish is also a delicacy in the Eastern and Northern parts of the country. Consequently, by 2007/2008, about 33 tonnes of catfish were sold from 20 farms that reported to the USAID FISH Project. The forms in which table catfish is sold are:

1. Whole fresh catfish
2. Whole smoked catfish (*gutted*)
3. Catfish frozen fillets
4. Catfish smoked fillets

1.5. Are You a Commercial Farmer or Intend to be One?

In order to classify oneself as a commercial fish farmer, one must undertake to do the following:

**Table 1.1: Characteristics of a Commercial Fish Farmer**

<table>
<thead>
<tr>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plans production around targeted markets.</td>
<td>Production without any strategy.</td>
</tr>
<tr>
<td>Employs technically-trained and knowledgeable personnel.</td>
<td>Source of employment for friends and relatives.</td>
</tr>
<tr>
<td>Management approach is performance oriented - yields, productivity (efficiency of production) and profits.</td>
<td>Management approach simply to keep fish, not bothered about yields or profit as long as units are full of fish.</td>
</tr>
<tr>
<td>Harvests and sells fish based upon a plan.</td>
<td>Irregular harvesting and sales of fish.</td>
</tr>
<tr>
<td>Produces for profit.</td>
<td>Not bothered about returns or length of production cycle.</td>
</tr>
<tr>
<td>Costs all inputs inclusive of own labor.</td>
<td>Does not cost all inputs especially labor.</td>
</tr>
<tr>
<td>Keeps and analyses written records of production, costs and returns.</td>
<td>Does not keep any written records.</td>
</tr>
<tr>
<td>Information from farm’s records form the basis for making management decisions. The farm’s records are the key management tool.</td>
<td>Information from records, even if kept, are not analyzed nor used to improve efficiency of the farm’s management and operations.</td>
</tr>
</tbody>
</table>
Plate 1.1: Nile Perch Frames
Nile perch frames have increasingly taken more of the retail market share in city suburbs and upcountry due to the reduced supply of affordable whole fish to these markets. They would be your main "competition" if your farm is in a rural area.

Can you produce a better product at an affordable price and still make a profit? This manual can show you how.
a. Whole Catfish, also sold live at live fish markets.

b. Smoked Filleted Catfish.

c. Whole Smoked Catfish.

d. Frozen Catfish Fillets sold at supermarket.

e. Restaurants can be convinced to carry catfish dishes. Ask for catfish masala at Faze 2 in Kampala.

Plate 1.2: Products from Farmed Catfish Available in the Ugandan Market