Manual for the Commercial Pond Production of the African Catfish in Uganda

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Cover Page Photo
Sampling a catfish monoculture grow-out pond under static water management, fed complete diet commercial sinking pellets at Naluvule Fish Farm, Wakiso District, Uganda.
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- Mr. Karim Waigulu Karim Fish Farm, Iganga District
- Mr. Matalib Musomerwa MUSO4 Fish Farm, Iganga District
- Mr. Emmanuel Mbulamberi Emma's Fish Farm, Pallisa District
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PREFACE

A fish pond is one of the several production units used in fish farming to grow fish. The purpose of commercial fish production is to grow fish FOR PROFIT. Therefore, a farmer using ponds to commercially produce fish must:

i. ensure optimal conditions within the pond that will enable fish to grow efficiently,
ii. provide the fish with the correct nutrition to grow within a stipulated production period, and
iii. have a production plan that matches the marketing strategy.

Consequently, this manual spells out guidelines for the commercial production of the African catfish in ponds for farmers in Uganda in consideration of the following:

Fish farming is not a traditional agricultural practice in Uganda. The majority of fish farmers in the country have not yet fully understood the fundamental principles of fish farming or how these should be applied to their production management. Their ability to interpret situations as well as other related information is therefore limited. Farmers have therefore found it difficult to sieve through what information is most appropriate for their circumstances and to adapt aquaculture production technology appropriately. This has resulted in the majority of fish farmers not being able to match management with realistic yields, thereby failing to achieve anticipated yields and returns from the technologies they adopt.

Therefore, the scientific principles upon which this technology package is based are explained so as to enable farmers to make appropriate adaptations based on their resources, opportunities and constraints. In addition, care has been taken to answer questions that were commonly asked by fish farmers during the USAID FISH Project’s interaction with them in its training sessions, trials, demonstrations and field visits.

It also attempts to address common mistakes and misconceptions found during the project’s interaction with farmers with a view of helping farmers get onto the right track and improve the production and management of their enterprises. Hence, the package and recommendations developed were in addition based on actual data obtained from the project’s demonstration and trial farms. The results of the package are therefore locally achievable. This means that farmers can make realistic business plans and projections.
This manual only covers catfish production from the fingerling stage to table size. It does not discuss any aspects of catfish hatchery management for seed production.

How to use this manual

It is intended that the manual be a handbook that farmers can easily refer to and use as a quick guide regularly during the course of their production. Therefore it has been written and set out in a manner that makes it easy for reading and cross-referencing. The chapters are ordered based in order of the activities (steps) one should follow if they are intending to establish and run a fish farm commercially. In some cases, details may be expressed differently in the various chapters.

The manual is set-out as follows:
• In Section I, the technology package is summarized so as to enable one do a quick overview.
• Section II explains and illustrates the principles upon which the recommendations are based and their application to the package. Results from the trials are also included to illustrate certain points.
• At the end of each chapter is a summary of the recommended guidelines - in the event that someone wants to quickly check certain procedures such as how to feed the fish. The summary guidelines are printed in light blue boxes.
• Section III focuses on running the fish farm as a business. It explains how the data obtained can be used to evaluate and plan production, business strategy and investment.
• New words are written in italics. The definitions of these words can be found in the List of Definitions.
• At the front of the of the book on red bordered paper are 'Reasons Why Farmers Frequently Fail' and at the back of the book, on green bordered paper are 'Reasons Why Some Fish Farmers Are Successful' based on farmers' own experiences as well as the projects' experiences working with farmers.
• Practices that help protect the environment and are part of the BMP's (best management practices) are highlighted in green oval boxes.
• In the event the reader is referred to more information about a certain issue, for example, see section 3.1.2. - the first number (3 in this case) refers to the chapter, the second number (1 in this case) refers to the major section within chapter three. All numbers fall in order and numbers thereof are sub-sections of the first, second sections respectively.
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DEFINITIONS

**Acclimate**
Allowing the animal to slowly adjust to new environmental conditions.

**Aeration**
Mechanically adding air into water with the objective of increasing the levels of dissolved oxygen in water.

**Anaerobic, Anoxic**
This is a situation when there is no oxygen available.

**Appetite**
The desire for food.

**Best Management Practices**
This term is used to describe a practice considered to be the most practical means of solving a resource management problem or reducing pollution levels to those compatible with water quality goals.

**Biomass or 'Standing Crop'**
The total weight (mass) of the fish in the pond at any one time. Critical standing crop is the biomass of fish in the pond when the growth rate begins to slow, meaning carrying capacity is near.

**Carrying Capacity**
The maximum biomass the pond can hold for production. Growth has ceased at this point, usually due to water quality problems.

**Catfish Highway**
Channel along the bottom of the pond levee that catfish dig out and tend to hide in.

**Condition(ed)(ing)**
Holding fish without feed for a minimum of 48 hours in good quality water at the hatchery or nursery prior to their collection and transportation to the grow-out farm. The major objective of doing so is to allow the fish empty their guts in order to reduce stress to the fish and maintain water quality during transit.

**Disease**
This is the manifestation of something gone wrong. Body functions become impaired as a consequence of stress, inherent weakness or infection.

**Dumping Feed**
This is placing feed into the pond without consideration of the fishes appetite, feeding response, appropriate feed distribution to the fish nor the consequences of the effect of the quantities fed on water quality. It is often wasteful and results into high Feed Conversion Ratios (FCRs) as well as reduced profitability.

**Feed Conversion Ratio (FCR)**
The Feed Conversion Ratio (FCR) is the amount of feed it takes to produce a unit weight of fish. It is a measure of the efficiency of feed utilization. It is a critical parameter to monitor as it determines the viability of the enterprise in feed-based production systems.

**Feeding Frequency**
This is the number of times in a day fish in a pond are given food.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fingerlings</td>
<td>Juvenile fish of 7 cm and above. Fingerlings of 10 g and above are suitable to stock into grow-out ponds directly. Fingerlings of 5 g or less should be stocked into a nursery pond first until they are above 10g.</td>
</tr>
<tr>
<td>Flushing</td>
<td>Replacing a large portion of the water in the pond within a day or less. The objective of flushing a pond is to get rid of excess suspended as well as soluble wastes and to dilute wastes. Think of flushing a toilet.</td>
</tr>
<tr>
<td>Flushing rate</td>
<td>Usually given as the % of the pond or tank volume per time period OR the volume of water per hour or day (e.g. liters per minute, $M^3$ per day)</td>
</tr>
<tr>
<td>Gasping</td>
<td>This is when fish come to the surface of the water to gulp in air in situations when dissolved oxygen levels low. For catfish adults, this gulping of air is normal and necessary for them to gain sufficient oxygen. For very small fry, this indicates stressful conditions.</td>
</tr>
<tr>
<td>Grow-out Pond</td>
<td>This is a pond in which fish are reared for table to a size the market requires.</td>
</tr>
<tr>
<td>Gutting</td>
<td>Removal of the intestines and other viscera from the abdomen of the fish.</td>
</tr>
<tr>
<td>Health</td>
<td>Is the standard or typical condition of the fish, whereby its bodily functions are normal. A healthy fish functions optimally, and is free of abnormalities of stress and disease.</td>
</tr>
<tr>
<td>Live Weight Equivalent</td>
<td>The weight of a whole live fish before it has been processed. Processing fish includes gutting it. Therefore, the term refers to the weight of the fish before gutting.</td>
</tr>
<tr>
<td>Nursery Pond</td>
<td>This is a pond in which young juveniles are reared to the stage when they become fingerlings or stockers. Fish at this stage are extremely fragile and susceptible to predation. Extra attention is consequently given to water quality management and predation control in nursery pond management.</td>
</tr>
<tr>
<td>Optimum Ration</td>
<td>The fish feed that gives the best growth and Food Conversion Ratio (FCR). There is minimum wastage and minimum deterioration of water quality when fish are fed optimum amounts of feed, which is usually 90% of satiation.</td>
</tr>
<tr>
<td>Phytoplankton</td>
<td>Microscopic plants that grow within water. These plants give water its bluish sometimes greenish colour. Because they are suspended within the water column, they also cause turbidity of the water and subsequently depending on the quantity reduce the depth through which sunlight can penetrate through the water column.</td>
</tr>
</tbody>
</table>
Pond, parts of

**Base of Dam**
The measure of the base of the dam depends on the slope.

**Dam:**

**Levee:**
These all refer to the same thing. The levee (dam or dyke) is the embankment that holds the water in the pond.

**Dike or dyke:**

**Freeboard:** Vertical distance from the maximum water line to the top of the dam.

**Height (h):** The height of the dam is the distance of the dyke from the base to the top (h).

**Toe:** The point where the slope of the levee reaches the pond bottom. The inside toe refers to this point within the pond and the outside toe outside the pond on the outer embankment.

**Top Width (TW):** The minimum top width of a dyke (between ponds) should be 1 meter. Usually, the main dyke at the deep end has greater top width than the divider dykes so as to facilitate transport.

**Production Cycle:** This is the period between stocking and draining when fish are being raised in the pond.

**Ration:** The amount of feed given to the fish (made available to the fish) per day. Often expressed as "% body weight per day".

**Sampling:** This is the removal of fish from the pond to assess their growth and health status. After the observations fish are returned to the pond.

**Satiation:** The fulfillment of the desire for food. When fish are satiated (full), they show no interest in taking in more feed.

**Shooters:** These are fish of the same age-group within the same population that grow much bigger than the rest. Often such fish cannibalize on the smaller ones.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standing Crop</td>
<td>The total weight (mass) of fish in the pond at any one time.</td>
</tr>
<tr>
<td>Static Water Pond Management</td>
<td>This is a system of pond management whereby no 'fresh' water is allowed into the pond during the course of production except to top up water lost by evaporation and seepage. There is no water exchange in static water pond management.</td>
</tr>
<tr>
<td>Stock</td>
<td>Generally refers to the fish in production within the pond or on the farm. Is also the action of putting fish into a pond.</td>
</tr>
<tr>
<td>Stocking</td>
<td>Putting fish seed into the pond. Stocking the pond marks the start of the production cycle.</td>
</tr>
<tr>
<td>Stress</td>
<td>Is an abnormal physiological condition of fish resulting when its collective adaptive responses of the fish to environmental factors approach the fish's limit of tolerance for that factor.</td>
</tr>
<tr>
<td>Thermal Stratification</td>
<td>This is when the temperature on the top layer of water is distinctly different from the lower layer as occurs in ponds deeper than 2 meters.</td>
</tr>
<tr>
<td>Turbidity</td>
<td>The degree to which light penetration through the water column is blocked. Turbidity in ponds is often caused by small particles of either clay or phytoplankton that are suspended within the water column.</td>
</tr>
<tr>
<td>Whole Fish</td>
<td>This refers to the fish before it has been gutted i.e. before any of it body parts have been removed for whatever reason.</td>
</tr>
<tr>
<td>Zooplankton</td>
<td>Microscopic animals that grow within the water, the smallest of which feed off phytoplankton.</td>
</tr>
</tbody>
</table>
### Description of the Different Categories of Catfish Size

<table>
<thead>
<tr>
<th>Category</th>
<th>Length (cm)</th>
<th>Average Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fry</td>
<td>&lt;7</td>
<td>3</td>
</tr>
<tr>
<td>Small fingerlings</td>
<td>7 - 10</td>
<td>3 - 6</td>
</tr>
<tr>
<td>Medium fingerlings</td>
<td>10 - 12</td>
<td>6 - 9</td>
</tr>
<tr>
<td>Large fingerlings</td>
<td>12 - 15</td>
<td>9 - 20</td>
</tr>
<tr>
<td>Extra large fingerlings</td>
<td>&gt; 15</td>
<td>20</td>
</tr>
<tr>
<td>Stockers</td>
<td></td>
<td>21 - 100</td>
</tr>
<tr>
<td>Sub-Market</td>
<td></td>
<td>100 - 399</td>
</tr>
<tr>
<td>Table Size(^a)</td>
<td></td>
<td>+ 400</td>
</tr>
</tbody>
</table>

\(^a\) In the year 2008, the preferred 'table size' for catfish in the Project's area of operation was +600g. However this is coming down. The 'ideal' table size for a producer is about 400g because after the fish get to 400g the FCR increases and growth takes much longer. Some farmers currently are selling 500g catfish to their local markets. In other countries outside Uganda, 400g is the size of catfish sold for food. However, if larger sizes can fetch a higher price per kg, the farmer must evaluate the higher cost of production per kg and compare it with the higher price obtained.

Note that people can starve their fish or feed them poorly and the fish will become long and thin (see photo below). We sometimes refer to them as "pencil-fish". In this case, the weight/length relationship listed above will not be correct.
SECTION I

SUMMARY OF THE RECOMMENDED BEST MANAGEMENT PRACTICES (BMPs) FOR CATFISH GROW-OUT IN PONDS
Production of Table Size African Catfish in Static Earthen Pond without Aeration using Commercial, Nutritionally-Complete Sinking Pellets

A yield of 15 tons/ha to up to 20 tons/ha of table sized (400-800g) African catfish can be achieved from earthen ponds under static water management system in 6 to 10 months respectively; when the fish are fed commercial sinking pellets that are nutritionally complete (i.e. 32% crude protein level with stabilised vitamin C). Better results are to be expected with floating pellets.

In order to achieve this yield, the following management practices are recommended (Details on pages 3 to 5):

1. Proper pond construction in compliance with the recommended standards for commercial grow-out ponds. Depth of water is very important.
2. Pond preparation for stocking inclusive of water intake screening.
3. Use of quality seed and correct stocking procedures.
4. Stocking rates based on ponds carrying capacity in retrospect of the farmers desired harvest size.
5. Feed a quality nutritionally complete feed pellet and feed the fish by response.
7. Inventory control and regular sampling using the recommended techniques.
8. Proper record keeping and regular review of records during the production cycle.
9. Harvesting at “critical standing crop”, before the pond’s carrying capacity has been reached and fish growth slows or ceases.
<table>
<thead>
<tr>
<th>Activity/Item</th>
<th>Recommendations</th>
</tr>
</thead>
</table>
| **1. The Pond** | (i) Well compacted pond *levees* with a slope of at least 2:1 for commercial grow-out ponds.  
(ii) Average water depth in pond of 1 - 1.2 meters (0.8 - 1.0 m at shallow end to 1.0 - 1.5 m at the deep end).  
(iii) Inlet pipe at least 20 cm above the pond water level and screened with a properly fitted filter sock.  
(iv) Outlet pipe fitted with an anti-seep collar and screened correctly with cone mesh.  
(v) Freeboard of about 15-30 cm. Ponds less than 400 m² can have *freeboards* of 15 cm.  
(vi) Having a harvest basin within the pond is optional but can be quite useful at final harvest.  
(vii) The pond must be able to drain completely for complete harvesting and drying. |
| **2. Pond Preparation** | (i) Remove silt from pond. Soil removed from the bottom should be put back where it came from, i.e., used to repair pond *levees*. Excess should NOT be put at the top of the dam but rather away from the ponds.  
(ii) Ensure pond is not leaking.  
(iii) Correctly screen the inlet and outlet.  
(iv) Lime the bottom of the ponds, if needed, based upon alkalinity and hardness levels (especially of new ponds).  
(v) Fill pond. Ponds should be *stocked* within a week of filling with water. |
| **3. Stocking** | (i) *Stock* only fish in good condition. *Stock* fish with no obvious signs of injury, excessive stress or disease that have been packaged and transported in bags with adequate amounts of oxygen or in well aerated tanks.  
(ii) *Stock* based upon targeted harvest size and the pond’s *carrying capacity*.  
(iii) The minimum *stocking* size for grow-out ponds should be fish of not less than 10 cm in length or 5 grams average weight. An initial nursery phase of one (1) month, however, is recommended when
Fish come in straight from the hatchery before the fish are stocked into the grow-out pond. Having an initial nursery phase helps one have better control of the inventory and improves survival rates.

(iv) The targeted harvest size will be intended market size if you are not following a split production plan.

(v) The critical standing crop for catfish ponds of an average water depth of one (1) meter fed commercial pellets is 15 to 18 tons/ha (i.e. 1.5 to 1.8 kg/m²). The maximum feed input in such a pond is 200 kg/ha/day (i.e. 20 g/m²/day).

4. Pond Water Management

(i) *Static water:* DO NOT FLUSH WATER THROUGH THE POND CONTINUOUSLY. Water should only be added to ponds:
   - A - to top up water levels, or
   - B - to correct water quality problems, such as low oxygen, high ammonia, etc.

Note that continuous water flow can be expensive and, in Uganda, the water is often cold, which will reduce growth rates. Continuous water flow would thus allow for higher *carrying capacity* but require more time.

5. Feeding

(i) Train fish to feed in the same area of the pond.

(ii) Training fish to feed enables a farmer to see his/her fish daily throughout the *production cycle*. This is of great value when it comes to assessing the number and size of fish in the pond in between *sampling* times as well as monitoring fish *health*.

(iii) Feed fish based upon their feeding response using the catfish feed chart as a guide to estimate daily feeding needs. Pay attention to the number of meals fish of a particular size should be given per day.

(iv) Keep recommended feeding records including both the amounts given and response at each feed.

(v) Use the records continuously to evaluate feeding performance in tandem with the pond records to adjust the feeding regime.
6. Sampling

(i) *Sample* monthly by seining a small portion of the pond to monitor for growth.
(ii) Calculate new feed amounts based upon the actual average fish weights obtained at *sampling*. This will help make adjustments from the predicted fish weights on the feeding chart and allow re-adjustment to the fish’s feeding requirements.
(iii) Record data in the pond records correctly at each *sampling*. Doing so will help with inventory control as well as monitor progression to the pond’s *critical standing crop*. Zero fish growth is an indicator of the pond having reached its *carrying capacity*.

7. Record Keeping

(i) Pond and feed records must be kept correctly as recommended.
(ii) Records of all inputs used for fish production (e.g. pond repairs, labour, fertilisers, etc.) as well as of all sales should be kept so as to calculate profit.

8. Harvesting

(i) In order to obtain the best returns, the pond should be harvested before it reaches its *carrying capacity*, at *critical standing crop*.
(ii) The best way to harvest the pond completely is:
   - First, check your records and know your estimated *standing crop*.
   - Second, seine the pond one or two times to remove the bulk of the fish when the pond is still full.
   - Third, reduce the water level about half-way then seine once or twice to remove the rest of the fish.
   - Fourth, drain the pond completely and pick up the rest of the fish. If the pond has a harvest basin that is correctly constructed, the remaining fish will collect in the harvest basin.
Why Some Fish Farmers Fail

1. Poor Farm Siting: Such as in a place with inadequate water supply, poor soils for pond construction (e.g. may be rocky), far away from markets and/or supplies, etc.

2. Poor farm and facility design: Ponds not compacted properly, leak a lot, may be too shallow, and consequently construction and maintenance costs become too high while optimum yields are not achieved. Poor accessibility to ponds, requiring workers to walk across difficult terrain to transfer fish from pond to vehicle or vice-versa.

3. Poor Investment Plan: Several farmers assume that to be a commercial fish farmer one must have several large ponds. Hence, they construct many ponds at once, which constrains their cash flow. Because of this, some farmers take a while to start production or may only afford to start production in one pond after all the investment.

4. Start production before knowing what management options are available or how to farm fish.

5. Start looking for the market for fish when the fish is ready for sale. Meanwhile, because they are still feeding, the pond attains its maximum loading and fish stop growing. The longer the fish stay in the pond after they have stopped growing, the smaller the profit margin.

6. Do not employ the right people. Entrepreneurs use other peoples time, i.e. employ the right people. Hiring family members who have little or no desire to learn proper fish farming techniques is a liability because most people find it difficult to dismiss them even after it has become apparent that they are the reason for the poor performance of the fish farm.

7. Manage farms by remote control or telephone. No direct involvement in production and management activities of the farm.

8. Irregular and improper feeding. This ranges from complete lack of knowledge about the nutritional requirements and feeding of
catfish to attempts at saving money by using cheap feeds. Some farmers just do not feed their fish because they think fish will grow as long as they are in water. They do not realize that like all animals, best performance would be obtained if the fish have a balanced diet and that the feed needs to be palatable, easily digestible and does not disintegrate into the water before the fish can consume it. For the same reasons that the majority of poultry farmers would not think it wise to feed layers maize bran, a commercial fish farmer should not believe they can get the best production results by feeding catfish maize bran only. If one intends to increase production and profit margins from producing eggs, then it is well known that the best way would be to feed the layers with quality layers mash and not growers mash. Likewise, fish should be fed with the correct feed of the right quality.

9. Do not appreciate that different management levels have different requirements which consequently affects *stocking* rates. As in cattle, for example, the management requirements and *stocking* rates for ranching are different from zero grazing because of the limits to which the animals reared under the different systems can get access to adequate feed to cater for their maintenance and production needs. The same applies in fish farming. *Stocking* rates are a function of the specific management regime.

10. Being more impressed with harvesting the few large fish rather than looking at the overall picture and appreciating total tonnage at harvest. If you had a sow that ate all its piglets and grew nice and fat; would you be happy? Or would you rather have several but smaller animals of a reasonable size for sale rather than one giant? Survival rates and average fish size matter when raising table-fish, because profit margins above operational costs generally range between 10 to 30% depending on one’s market. The net income is therefore largely a function of turnover.

11. Do not keep records and do not assess performance to re-adjust management practices accordingly after each cycle. A farmer is therefore unable to tell whether a profit or loss will have been made. Having money in one’s pocket after a sale does not imply one has made a profit. Some farmers do not want to keep records because they are scared of facing the harsh realities of a loss. Unless one is able to face the bitter truth and correct his/her
management practices, there won’t be any improvements and the business will eventually collapse.

12. Hobby farmers who keep fish in ponds forever as though they are taking care of wild-life in a game park.

13. Wrong objectives for investing in aquaculture. Some do it simply because their friends are doing it or because they are targeting ‘free’ funds from donors or government. Nothing in this world is free. Always watch out for the hidden costs before making a final decision. Furthermore, pond construction is costly and is not something one should undertake for the sake of it. Changing one’s mind and having to fill in ponds because you have changed your mind is even more costly. Think objectively before you embark on fish farming. Farm fish as a business; as a source of employment and income for yourself and others. Invest in fish farming only if you have identified it as a serious opportunity that can work out into a successful enterprise.

14. Expand the farm as a solution to low profit and yields. It is a bad business decision to expand a failing business without first finding out what the causes of the failure are and correcting them.

15. Buy high quality expensive feed but use the laziest and least conscientious person on the farm as the feeder. This is like throwing money down a drain.

16. Believe consultants and newspaper reports that indicate fish farming requires little investment and results in huge profits. If it were that easy, everyone would be doing it. And the so-called consultants would be busy making money from growing fish; not from advertising their expensive training programs.
   - Yes a person can grow fish with little investment but there will be little production in return. You can’t get something from nothing.