Fish Farming for Resilient Communities: Establishing the Enterprise

Information Tool

CGIAR | AICCRA
Accelerating Impacts of CGIAR Climate Research for Africa

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About AICCRA Reports

Titles in this series aim to disseminate interim research on the scaling of climate services and climate-smart agriculture in Africa, in order to stimulate feedback from the scientific community.

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ABBREVIATIONS

AICCRA	Accelerating Impacts of CGIAR Climate Research in Africa
AU	African Union
AUC	African Union Commission
AUDA	African Union Development Agency
BAU	business as usual
CA	conservation agriculture
CAADP	Comprehensive Africa Agriculture Development Programme
CBA	cost-benefit analysis
CCAFS	Climate Change Agriculture and Food Security
CGIAR	Consultative Group of International Agricultural Research Centres
CIS	climate information services
CSA	climate-smart agriculture
CSAIP	climate-smart agriculture investment plan
CSEP	Climate-Smart Agriculture Education and Policy Project
CSV	climate-smart village
FANRPAN	Food, Agriculture and Natural Resources Policy Analysis Network
FAO	Food and Agriculture Organization of the United Nations
FNS	food and nutrition security
GCCASP	Gender Climate Change and Agriculture Support Programme
ICT	information and communications technology
iNGO	international non-governmental organisation
IRR	internal rate of return
MoAMID	Ministries of Agriculture, Mechanisation and Irrigation Development
MSP	multi-stakeholder platform
NDE	National Designated Entity
NEPAD	New Partnership for Africa's Development
NGO	non-governmental organisation
NPV	net present value
PICZ	Professional Insurance Company of Zambia
REC	Regional Economic Community

1. CONTEXT OF FISH FARMING

Fish production has remained low in Africa and the Sub-Saharan Africa (SSA) region. Efforts have been ramped up to grow the fish industry. Aquaculture production in SSA has increased by an average of 11% annually since 2000. This is twice as fast compared with the rest of the world's trends. Despite the momentum seen in the last decade and all the financial and technical support, SSA continues to account for less than 1% of global aquaculture production. Fish farming in South Africa is an emerging industry that consists mainly of the culture of freshwater species such as crocodiles, trout, catfish, tilapia, and ornamental fish, as well as marine species such as abalone, prawns, oysters, and mussels.

In the recent past, climate variability and change have resulted in increased local temperatures that, in turn, have instigated evapotranspiration and negatively affected the breeding grounds of several essential fish species due to a reduction in the water levels of water bodies. The rise in local temperature also has influenced the physical-chemical properties of water, including temperature, pH, dissolved oxygen, salinity, and concentration of different ions in water bodies (El Morhit & Mouhir 2014). These changes negatively affect the physiological behavioral dynamics of fish as well as their natural feed resulting in lower production and productivity.

Today, about half the fish consumed globally are raised in these artificial environments. Commonly farmed species include salmon, tuna, cod, trout, and halibut. These "aquafarms" can be mesh cages submerged in natural bodies of water or concrete enclosures on land. Measures and interventions are required to support the increased production of fish. To meet the large fish supply demand, SSA's fish imports were 1.5 times higher in 2015-2019 than its aquaculture production. With the projected increase in demand for aquatic foods in SSA and the need to reduce dependence on imports, it is suggested that aquaculture produce an additional 5.0 million tons by 2030 and 10.6 million tons by 2050. Furthermore, this growth must be environmentally sustainable, accompanied by reduced production costs and competitive aquatic foods. Sustainable fish farming/aquaculture requires new thinking and strategies to increase productivity. This has become an important consideration to achieve accelerated effects of climate change, environmental risks, biosecurity and fish health concerns, and the need to apply new technologies that require a skilled workforce.

2. UNDERSTANDING FISHING FARMING

Fish farming (also known as aquaculture) relates to the 'raising of fish commercially in tanks, ponds or other enclosures to produce food.' Commercial fish farming has assumed a strategic agribusiness opportunity established as a profitable business venture. Fish is a great source of food and protein. The demand and price of fish and fish-related products continue to increase rapidly, driven by rapid population growth.

Fish farming/culture is the growing of fish in a controlled environment (concrete or earthen ponds), vats (wooden or fibreglass), and plastics that have been practised for hundreds of years. It is a part of aquaculture, but sometimes the two are used interchangeably because most output from aqua cultural production comes from fish farming. Fish farming has a double responsibility of provision of fish for household consumption and sale for profit. The principles of resilience are core to ensuring fish stocks and communities dependent on water and land resources withstand climate change's effects. Resilience can help an ecosystem resist, recover or adapt to climate change and, when partnered with sustainability and adaptation practices, can strengthen fisheries and fishing communities for the future. Principles for achieving resilient fish farming should prioritise;

- Tackling the cumulative effects of climate change
- Practising sustainability in fisheries. Using sustainable practices in fisheries is equally important for a climate-resilient future. Yet, in the face of climate change, sustainability means making changes to how practices worked in the past, such as adjusting catch levels as conditions change, shifting management across space as species move, and more
- Implementing the principles of fishery resilience

Fish farming has several benefits/relevance starting from an individual family to the national levels that include:

A. Employment Opportunity

B. Economic

C. Nutritional (high-quality protein) and Food Security

D. Income generation

E. Earning foreign exchange

F. Health benefits

G. Ecotourism and leading to poverty relief

3. THE CODE OF CONDUCT FOR RESPONSIBLE FISHERIES

The Code of Conduct for Responsible Fisheries (1995), developed by FAO in collaboration with partners in fisheries established Code sets out principles for behaviour and practices toward responsible stewardship of marine resources and their environments. The principles are essential guides to all actors in all fisheries, from fishers to processors, exporters, biologists, and managers. The code provides a guide to achieving resilient fisheries as follows;

- proper management of marine resources,
- collection of data and provision of advice,
- exercising a precautionary approach to resource use and management,
- implementation and enforcement of management measures • Controls overfishing practices,
- development of aquaculture and caution to translocation of stocks,
- actions to ensure proper post-harvest processing of marine animals,
- monitoring and controlling of international trade of marine products, and
- support for all aspects of research needed to understand and manage stocks.

4. WHY RAISE FISH?

Raising fish enables society to use the available land and water better. At the household level, raising fish helps families have more protein to eat, directly supporting household members to gain strong and healthy status. Consuming fish provides a tasty experience like chicken, sheep, and goat. Surplus fish can be sold within the markets. You and your family can live a better life with enough food and more money.

Case 1: Guide on what is needed to raise fish.

There are several things that are required to support effective raising of fish that include:

- a piece of land where you can build a pond, or suitable water areas to build pens or keep cages
- time to build a pond and to care for it regularly
- access to extra extension advice
- capital purchase fingerings, foodstuff, extra labour when needed
- pond amendments (fertilizing agents - organic; inorganic etc.)

Caution: *Fish farming takes work. To raise fish, there is a need for hard work to raise anything else, such as maize, rice, cassava, or groundnuts. There is a need to learn to do many things.*

5. OPERATIONAL GUIDE

5.1. How to begin?

It is advisable for anyone considering venturing into rolling out the dream of fish farming activity, whether or not one is a farmer or extension personnel. Anyone intending to engage in fish farming must acquire the required tips and information to support effective implementation. Some of the key elements to be aware of and learn especially in the initial phase, include:

- the type of soil best for your pond, how to dig your pond
- what kind of fish to raise
- how to take care of the pond

5.2. Establishing a site for fish farming/aquaculture facility

To achieve a successful fish farming undertaking, site conditions must be fully considered as this is the critical determinant of whether or not the fish farm will competitively produce. Assessment that informs choices made on the site selection and the fish farm's design can make or break the undertaking. The site selection process considers the biological traits of the target fish, the intended production capacity, and the facilities required to achieve optimal and cost-effective production.

Thus, one must choose a suitable place where the pond is established. Specifically, one should remember that a pond for fish is the only one used for the land. Thus, care must be taken to avoid building a pond on land that could be better used for other uses besides fish farming. Generally, it is best to put a pond in a place with a gentle slope or on a hillside so one does not have to dig too much soil to build it. A pond built on a slope is also easier to drain.

5.3. Factors to be considered in the selection of the Fishpond site

Careful zoning and selection should take into account site suitability to support fish farming/aquaculture and improvements, particularly in resource-use efficiency, energy-efficient pond aeration, and others can enable small-scale and medium-scale farmers to intensify and increase pond productivity. The following factors are essential considerations during the site selection process:

- Water availability (adequate quantity and good quality)
- Land topography
- Accessibility
- Soil type
- Vegetation cover
- Proximity and size of the market
- Availability of inputs
- Bio-security

5.4. A simple test of the suitability of soil for pond construction

Soil type is one of the critical factors one should be aware of, as the effectiveness of sitting and sinking a fish pond rests on its suitability. Simple tests can be carried out that follow the under-listed guide:

1) Dampen a handful of soil with water. Use only enough water to dampen the sample. Do not saturate it
2) Squeeze the sample tightly in your hand
3) Open your hand:
    a. If the sample keeps its shape, it is probably good enough for building a pond (i.e., sufficient clay present)
    b. If the sample collapses and does not keep its shape, it is probably not good enough for building a pond (i.e., too much sand present)
4) The site should be in a region or area that is suitable and allowed for aquaculture production.
5) Well-drained and away from flood-prone areas or at least having flood potential.
    a. Control
6) Allow for acceptable effluent disposal as required by Environmental Management
    a. Authorities
7) Have a climate suitable for the production of the intended species.
8) Have accessibility to a good and all-weather market.
9) Have easy access to services and technical assistance.
10) Have adequate room for intended investment and possible future expansion.
11) Not in a pollution-prone area.

5.5. Determination of the final size of a fish farm

The final size of the fish farm is determined by several factors, including the following:

a) Amount of water available for fish culture.

b) The technology to be employed; Intensive systems require less land than semi-intensive systems to produce the same quantity of fish.

c) The target production.

d) Capital available for investment.

5.6. Determination of the number, size, and shape of the pond?

The number, size, and shape of ponds depend on several factors, including the following:

(a) Land size

(b) Topography of the land

(c) Intended use of the Pond

(d) The Species to be produced

(e) Frequency of Harvest

(f) Target quantity per harvest

(g) Whether juvenile production is intended etc.

5.7. Steps of Fishpond Construction

Fish pond construction is a stepwise process. In summary, one should follow the provided chronology of the activities to establish a fish pond enlisted below:

a) Reconnaissance survey: Visit the project site to get first-hand information.

b) Land clearing: The removal of the vegetation on the site.

c) Land mapping: It is the marking of the specific area for a specific structure.

d) Excavation: It is the earth removal for specified structures, e.g., ponds, channels, etc.

e) Construction of associated structures, e.g., monk, slice gate, etc.

f) Pond dressing: It is the smoothening of the dykes to look good.

g) Grassing: It is the planting of grass on the dykes to prevent soil erosion.

h) Pond impoundment: It introduces water into the pond.

Case 2: Design calculation

Dyke slope: 50% (0.5)

Bottom slope: 1% (0.01)

5.8. Implementation of the steps in the Construction processes

a) Mark out the area that the pond will occupy using wooden pegs and strings and then remove all the vegetation.

b) Remove the topsoil and keep it in a good location close to the site. It will be used to cover the pond bottom and the dyke tops to enhance fertility.

c) Clear the area within the pond limit of all vegetation, including the area within 10m of dykes and pond structures and any access, water supply, or drainage area.

d) Establish a Temporary Benchmark (TBM). A benchmark is a mark on the ground that establishes the elevation of a place and is used as a reference point for all other elevations.

e) Using spirit level, measuring tape, pegs, and strings, mark out:

   a. The dykes

   b. Dyke slopes

c. Inner and outer toes

d. The pond bottoms

f) Using the determined pond depths and the actual elevations of the site, determine which areas need digging and which need filling. This is very important because it eliminates unnecessary soil movements and thus minimizes construction costs.

g) Dig out the soil at the 'dig' areas and place it in the 'fill' spaces. Most of the fill areas will be in the dyke position. Make sure to remove boulders and tree stumps from the pond area.

h) Once the soil is placed on the fill area, make sure that this soil is properly compacted. To achieve good compaction, place soil in layers not exceeding 15 cm in height and compact back to at least 10 cm. When constructing dykes, soil layers are placed 20 cm inside on top of each other to reduce the amount of work during dyke cutting.

5.9. Characteristics of Pond Dykes

Any pond dike should have three essential qualities:

a) It should be able to resist the water pressure resulting from the pond water depth.

b) It should be impervious, with minimal water seepage through the dike.

c) It should be high enough to keep the pond water from ever running over its top, which would rapidly destroy the dike.

5.10. Determining Dyke Slopes

Dyke slopes are critical to the longevity and survival of the ponds. The slope of the dyke should be determined bearing in mind that:

a) Steeper slopes erode quickly.

b) The more the soil becomes sandy, its strength decreases, and slopes should be gentler.

c) The bigger the pond size, the stronger the erosive power of the water waves.

d) As the slope ratio increases, the volume of earthwork increases, and the overall construction cost and the land area required for the ponds increase.

e) There are two common types of inlet structures pipe inlets and open inlets

Inlets and outlets are an integral part of the fishpond structure. These should be taken into consideration when designing the pond structure. Several points are considered when placing these two structures of the fishponds.

5.11. When designing and constructing an inlet

a) Place the inlet at the shallow end of the pond.

b) Make sure that the bottom level of the inlet is at the same level as the bottom of the water feeder canal and at least 10 cm above the maximum water level in the pond.

c) Design the inlet structure to be horizontal without a slope.

d) Make it wide enough to fill the pond in a reasonable time.

e) Make it such that water splashes and mixes as much as possible when entering the pond.

f) Provide a screen to keep unwanted fish and other organisms out.

g) Control mechanism e.g., gate valves.

5.12. Pond Outlets are built

a) To keep the water in the pond at its optimum level, which should be the maximum water level designed for the pond.

b) To allow for the complete draining of the pond and harvesting of the fish when necessary

c) A good Outlet should ensure that:

   a. The time needed to drain the pond entirely is reasonable.

   b. The draining water flow is as uniform as possible to avoid disturbing the fish excessively.

   c. Fish are not lost even during the draining period.

   d. Water can be drained from any pond level.

   e. Allowance is made for overflow of excess water.

   f. It can be cleaned and serviced quickly.

   g. Construction and maintenance costs are kept at a minimum.

d) In most cases, outlets have three main elements:

   a. Water control plugs, valves, control boards, screens or gates

   b. A collecting sump inside the pond, from which the water drains and into which the fish is harvested

   c. A Conduit through the dyke through which the water flows out without damaging the

e) To dykes or the drainage canal

   a. Materials that can be used to construct pond outlets and inlets include

   b. Bamboo poles,

   c. PVC pipes,

d. Wood,

e. Bricks,

f. Cement blocks or

g. Concrete

5.13. Pond Stocking & Management (Practices)

Stocking is the introduction of fish (fingerlings or juveniles) into the new pond environment. Fish seeds can be collected from the wild (rivers, streams, lakes, etc.) or from hatcheries/existing fishponds where fish are adapted to cultural conditions. The right type and the correct number of fish are placed in a pond at the right time (cool hours of the day).

Test stocking (pre-stocking) should be practised by introducing a few fish into the new environment. The test stocking period ranges from two days to one week. If the fish survive well, then the pond can be fully stocked. The type of aquaculture influences the kind of fish stored. Acclimatization allows fish to swim out into the pond. A recommended stocking rate of fish (ratio of one species to another or male to female) and stocking density (number of fish per square metre of pond water) to avoid overcrowding, should be practised. This will ease management problems and enhance the success of the fish culture.

5.14. Practicing stocking

In implementing the stocking of the fish ponds, some guidelines should be followed to avoid shocking the system. The following constitute essential elements to follow in stocking the ponds:

a) In any fish enclosure, healthy fingerlings of 5 – 7 cm should be stocked. Juveniles of 7-10 cm are most advisable;

b) Stocking densities should range between 10 - 50 fish/ depending on water conditions, size of fish seed, culture system and management, and specific specialist research-extension advice;

c) Procure your fish seeds from reputable sources and make allowance for mortalities (at least 10%);

d) Fish seeds should not be fed for 24 - 48 hours before transportation as they survive better on an empty stomach when in transit;

e) Stocking of fish should be done early morning or late evening in moderately cool weather & and when fish are less active;

f) Fish seeds should be transported and packed in water-filled oxygenated polythene bags or various containers used;

g) Release fish fingerlings to their new home surroundings slowly to avoid shock due to temperature changes;

h) Introduce feed into the fish tank/pond 6 - 12 hours after stocking;

i) Stocked fingerlings should be sorted after 15 days (2 weeks) of the initial stocking to remove shooters (jumpers) to reduce cannibalism and ensure even growth of fish;

j) Sorting could be done as advisable, preferably in the morning (8 – 10 am); and

k) Sorted fish should not be fed for 2 hours minimum or 3 hours maximum. This will help to relieve the fish of handling stress and regain lost energy.

Guide in Taking Care of the fish

Take very good care of your fish.
Keep the water green and feed the fish regularly,
While feeding, watch them carefully to see that they are healthy and swimming strongly.

5.15. Feeding your growing fish

The big fish in the pond will get much of their food from tiny plants and animals that grow in the green water. To keep the water green, fertilize your pond each week. When using plant compost or plant material, ensure that the pond is filled to the water line.

To make your fish grow more quickly, you must feed them food produced from the natural pond environment and feed given as supplements to the pond. You can feed them a variety of food sources as detailed below:

a) termites

b) tender leaves and waste of banana and cassava

c) grain mill sweepings

d) rice bran

e) beer wastes

f) cottonseed or groundnut cake

g) slaughterhouse wastes

h) animal wastes

i) kitchen wastes

j) spoiled fruit and vegetables

k) left-over food

l) chopped grass.

m) Some of the tips for feeding the fish constitute of the following husbandry practices:

n) feed your fish at least once a day. Fish will grow better if you provide them more often.

o) ensure that feeding of the fish is done at the same time consistently (every day), preferably early in the morning and late in the afternoon when it is cooler.

p) The bigger your fish grow, the more food they will need.

q) It is difficult to know exactly how much food to feed your fish. It would be best if you watched them when they eat to learn how much food they need.

r) Feed your fish in the shallow part of the pond so that you can see them eat.

s) If the fish does not eat all their food, reduce the amount provided the next day.

t) when the amount of feed eaten by the fish increases, provide a little more the next day.

Note: If you feed your fish at the same place every day, you will see whether the fish are eating well. If you give them too much, the food that is not eaten will stay on the bottom.

Too much uneaten food on the bottom of the pond will make the water bad. Do not overfeed your fish.

Feed example for Tilapia

Feed tilapia with rice or wheat bran in the following quantity on daily basis for each 100 square metres of pond:

- first month, 360 grams
- second month, 480 grams
- third month, 720 grams
- fourth month, 960 grams
- fifth month, 1 200 grams
- sixth month, 1 440 grams.

Measure first how much bran a given container, such as a milk powder tin, can hold, for example, 240 grams. From this, determine how many food containers should be distributed daily in each pond.

- To make it easier to see if your fish are eating well, mark several places in your pond to feed them.
- Mark each place by making a square light wood or bamboo ring. Drive a pole into the pond bottom and attach the square or ring.
- When you feed the fish, put the food inside the square or ring. You may be able to see any uneaten food on the bottom under the square or ring. If you cannot see the bottom, feel with your hands to find any uneaten food that may be there.

5.16. Harvesting the pond

1. Harvesting is one of the essential practices for fish farming/aquaculture undertaking. Some tips are provided which can help in the proper handling of the harvesting process of the pond fish as follows:
2. Do not take any fish out of your pond during the first five months. After five months, you may catch a few big fish to eat with your family each week.
3. When most of the fish are big enough, it is time to harvest all of them. Usually, they will be big enough to harvest in about six months.

4. Harvest the fish early in the morning when it is cool.
5. Have some watertight containers ready to store live fish.
6. The easiest way to harvest is by draining the water out of the pond.
7. But there are several ways to harvest your fish. You can harvest them.
    a. Without draining the water
    b. By draining part of the water
    c. By draining all of the water

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