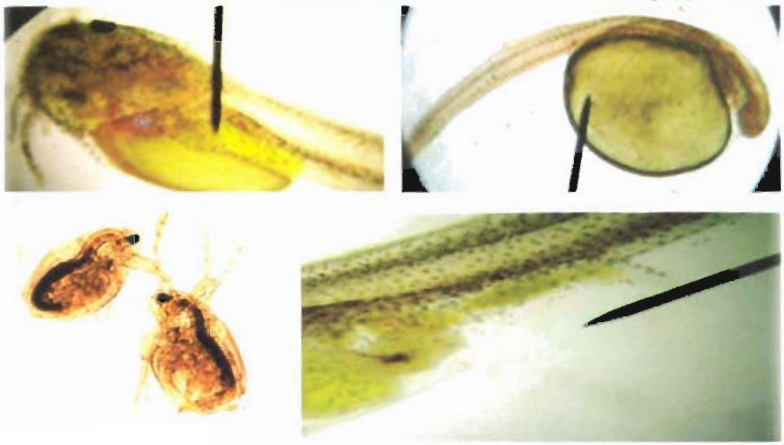
Manual for Production of Live Feed (*Moina*) for African Catfish Fry



FOR COMMERCIAL CATFISH HATCHERY OPERATORS



First Edition

National Fisheries Resources Research Institute (NaFIRRI)

A Centre of Excellence Spearheading Fisheries Innovations and Impact Creation in Collaboration with SMART Partnerships

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Preface

The Mandate of the National Fisheries Resources Research Institute (NaFIRRI) is to conduct basic and applied research of strategic and national importance in Aquaculture, Capture Fisheries, Water Environment, Socio-economics and Marketing, and any emerging issues in the fisheries sector. The research carried out is demand-driven by end-users, and it targets sustainable profitability and the natural resource base. NaFIRRI's research increasingly addresses technologies that will enhance aquaculture productivity and profitability in response to the looming fish gap of 300,000 tons of fish per year against a stagnated production of 450,000 tons per year from capture fisheries which also face other challenges.

The African catfish is a commercially farmed fish with great potential to contribute to reducing the fish gap in Uganda. However, high mortalities in catfish hatcheries are a major concern as less than 150,000 catfish fry are produced out of estimated 30m catfish fingerlings that are required annually. Therefore, this first Edition of the Manual is intended for use by Uganda's operators of the African catfish hatcheries. It provides basic facts about catfish developmental stages, the recommended live feed (i.e. *Moina*, a small microscopic water organism). The Manual also provides the hatchery operators with procedures and a stepwise process to produce and sustain large quantities of *Moina* for a commercial scale enterprise.

This Manual is a result of the work carried out by a team of NaFIRRI Scientists led by Dr. A.Owori-Wadunde and benefited immensely from inputs by various reviewers including hatchery operators. Other inputs into this Manual were contributed from a visit to hatchery operators in Nigeria. It is requested that Uganda hatchery operators provide feedback to NaFIRRI on aspects of catfish hatchery production that may require further research. This Manual is free and may be reproduced for use and not for sale or re-sale provided acknowledgement of the source.

Dr. John S. Balirwa
DIRECTOR OF RESEARCH

1.0 Introduction

The African catfish (*Clarias gariepinus*) is a commercially farmed fish in Uganda, second in importance after the Nile tilapia (*Oreochromis niloticus*). This catfish has gained rapid popularity in aquaculture because of its faster growth and higher pond yields attaining average weight of over one kg with pond yields as high as 3.0 kg/m^2 in six months compared to an average weight of 500g and pond yields of 1.2 kg.m^2 for the Nile tilapia (Fig.1).



Fig.1. The two most commonly farmed fish types in Uganda: (a) Nile tilapia, (b) African catfish, and their comparative sizes over the same period of growth

The estimated 20,000 t annual production of Uganda's catfish is mostly exported to the regional market. Production of this tonnage requires estimated 30m catfish fingerlings. Moreover, there already exists an unsatisfied annual demand for an estimated 170m catfish juveniles used as bait in the Nile perch fishery. This has led to invasion of the wetland fishery to capture juvenile catfish. The trade in catfish fingerlings and juveniles is estimated to be worth at least UGX 40b/= (at a unit price of UGX 200/= per fingerling/juvenile,1USD = UGX 2650).

A major obstacle to increasing farmed catfish production in Uganda is absence of starter feed in commercial catfish hatcheries. Three days after hatching, catfish larvae and fry feed on live feed in form of small (microscopic) water fleas (*Moina*). Catfish hatcheries generally lack technologies for producing live feed. This results in high mortalities of fry and fingerlings in catfish hatcheries.

1.1 Status of catfish fingerlings production in Uganda

Uganda's most recognized commercial catfish hatcheries (Hatchery 1 to 5) produce from 500 to 30,000 (average 10,900) fingerlings per female broodstock (Table 1). In comparison, Nigeria's production from an average hatchery operator yields 60,000 fingerlings per single broodstock. The average earning from one broodstock per year by a Nigerian is equivalent to UGX 12, 000,000/=. In comparison a Ugandan's commercial hatchery operator earns UGX 100,000 to UGX 6,000,000/= from each broodstock per year.

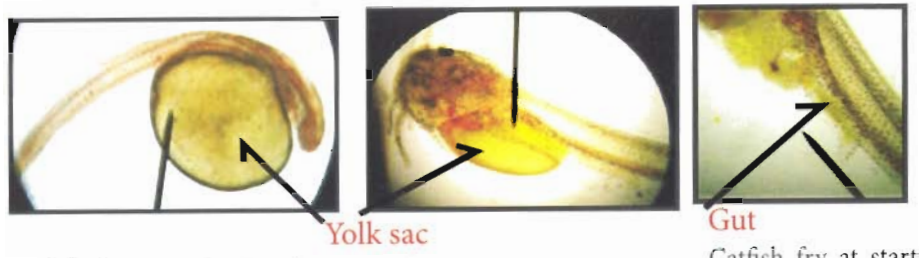
Table 1. The production of catfish fingerlings per female broodstock by various hatcheries (1USD = UGX 2650)

Hatchery	Total fingerlings sold per cycle	Number of female broodstocks used	Fingerlings farmer get per female broodstock	Total earnings from one broodstock (Ug.hs)	Efficiency ratio (with reference to Nigeria)
Hatchery 1 (U)	30,000	9	3,333	666,600/-	5.6%
Hatchery 2 (U)	5000	6	833	166,600/-	1.4%
Hatchery 3 (U)	2,000	4	500	100,000/-	0.8%
Hatchery 4 (U)	30,000	1	30,000	6,000,000/-	50%
Hatchery 5 (U)	20,000	1	20,000	4,000,000/-	33.3%
Average			10,933	1	8.2%
Nigeria	**60,000**	**1**	**60,000**	**12,000,000/-**	**100%**

High fry mortality from newly-hatched eggs through larval stages to the fingerling stage in Uganda is primarily due to poor feeding (e.g. on solid artificial feeds). These early catfish stages require live feed (i.e. small microscopic organisms) just as the young of other fish in the wild.

2.0 The embryology and early developmental stages of African catfish (*Clarias gariepinus*)

Fertilized eggs of African catfish hatch into fry at a size of 3.5 – 4.0mm in length (Fig. 2). They have no eyes, no mouth and no gut. Without a developed digestive system, catfish fry rely on the limited yolk before they develop a digestive system, hence, cannot feed on artificial complex diets.



Catfish fry soon after hatching (length 3.5 to 4.0 mm). The fry has no eye, no mouth, and no gut.

Catfish fry 1 day after hatching (length 4.0-4.5 mm). Gut not well developed and yet the yolk sac is running out

Catfish fry at start of feeding, 2 days from hatching (length 6.0 -7.0 mm), and very little yolk

Fig. 2 The different developmental stages of catfish fry from time of hatching to time of first feeding.

Two to three days following hatching, catfish fry (6.0 - 7.0mm in length) will have virtually depleted the yolk but their digestive system and other organs will not be fully developed yet (Fig. 2). The fry could therefore start feeding on small (≈ 1.0mm size) soft protein-rich feeds such as the small *Moina* (0.5 – 1.0mm in size).

3.0 The *Moina*

3.1. What is *Moina*?

Moina is the scientific name given to a small (0.5 – 1.2mm) microscopic freshwater organism belonging to the group of similar forms known as Zooplankton. *Moina* is referred to by its common name of water fleas. These organisms may be seen with a naked eye when concentrated in a glass container with clear water.

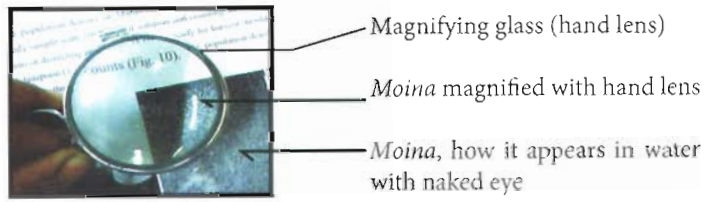


Fig.3. Use of hand lens to magnify microscopic organisms

Under the microscope (Fig.4) the body consists of a rounded head which has a conspicuous black compound eye that can be seen moving in all directions. The head which is connected directly to the rounded body without a neck also carries a pair of branched antennae. The gut runs from the mouth to the anal end along the dorsal side and is more visible when full of food. Usually mature *Moina* carry broods in a pouch on the dorsal side. These develop into new *Moina*.

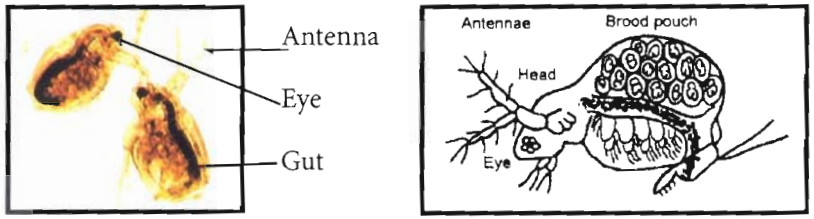


Fig.4. Magnified *Moina* showing its structure (adult size 0.7 to 1.0 mm)

Moina widely occurs in fresh water bodies in Uganda especially those high in organic manure such as sewage treatment lagoons. It also exists in pond waters that have been fertilized with, for example, organic manure. *Moina* appears in high concentrations in pools, ponds, lakes, ditches, slow-moving streams and in swamps where organic matter is decomposing. It is tolerant to poor water quality even where oxygen levels are low, such as in sewage treatment lagoons, but it is extremely sensitive to pollution by pesticides and heavy metals (e.g. copper and zinc). It prefers a temperature range of 24^{0C}– 31^{0C} but can withstand a wide temperature variation of 5^{0C}– 32^{0C} *Moina* does not tolerate dry conditions or high densities of its own population.

3.2 The Food for *Moina*

Moina feeds on various foods including bacteria, yeast, phytoplankton and detritus (decaying organic matter). Bacterial and fungal cells are the most preferred and rank high in food value. It grows most rapidly in presence of bacterial and yeast cells as well as phytoplankton (small water plants). They can even utilize the blue-green algae (e.g. *Microcystis aeruginosa*) that many animals find toxic. Both plant and animal detritus provide the energy for the growth and reproduction of *Moina*. Therefore, culturing *Moina* involves methods of availing these food items for its growth and reproduction.

3.3 Importance of *Moina*

Moina is suitable as starter food for catfish fry because of its small size and soft tissue. At the small size of 0.5 – 1.2 mm, the catfish fry of 4.0 – 4.5 mm can easily eat it and the soft tissue is also easily digested by the fry. The soft body of *Moina* does not require teeth to develop first before the fry can eat it. *Moina* contains enzymes that the catfish can rely on to digest other foods before it starts producing its own enzymes. In addition, *Moina's* slow movements allow the catfish fry to easily encounter it.

4.0 Culturing of *Moina*

4.1 Culture System

The system for production of *Moina* involves two stages: the stage of producing the food for *Moina* followed by the stage of culturing the *Moina* itself. This can be done in two ways. One way is to produce the micro-algae (food for *Moina*) and the *Moina* itself in the same system (the mixed culture). The second system is to have a culture for the food for *Moina* and a separate one for growing the *Moina* itself (the separate culture).

The most suitable green plants are those small plants with very small cells that look like fine dust particles to the naked eye, but they are green. They are not the large plants or the thread-like or fibre-like plants that we often see in wells and other water pools (Fig. 5).

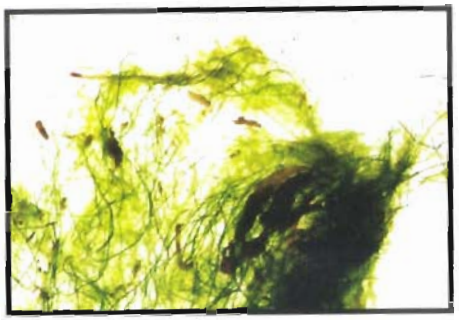


Fig. 5. The fibrous green plants (Spirogyra) to be avoided in culture for Moina

It is advisable to set the culture under a greenhouse with transparent cover to allow sunlight for the micro-algae but to protect the culture from weather (rain and excessive heat) (Fig.6).



Fig. 6. A greenhouse for protecting the culture from weather

4.2 The Procedure for culturing *Moina* in mixed culture

i. Fill the culture container (e.g. a 300-500L tank) with fresh water (e.g. well water, stream water, rainwater) of known volume and record the volume.

ii. Add about 15kg of dry decomposed grass (e.g. one wheel barrow full) to 200 litres of water and stir with a stick to mix.

iii. Add manure (chicken droppings, duck droppings, cow manure or pig manure), whichever is available (Table 2).

Table 2. The manure and other materials used to culture micro-algae and *Moina*

	Fertilizer type	Application rate per 200 litres of water
1	i. Poultry/pig manure ii. Bakers' yeast iii. Sunflower cake	95 g of dried manure 4.5 – 8 g 4.5 g (The yeast and sunflower cake are added after introducing *Moina*)
2	i. Cow manure ii. Sunflower cake iii. Bakers' yeast	314 g of dried manure 4.5 – 8 g 4.5 g (The yeast is added after introducing *Moina*)

iv. Stir the mixture gently 3 to 4 times a day to uniformly mix the nutrients

v. If available, use an aquarium aerator with air stones to improve the aeration of the system and run it continuously (some air pumps can be operated by solar power).

vi. Check the system for the production of micro-algae by the green colour of the water (Fig. 7). At this point the water is ready to be stocked with *Moina*.

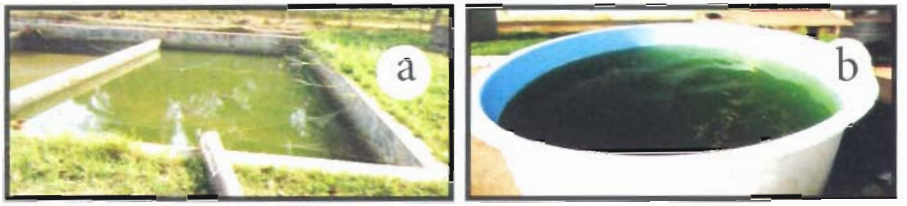


Fig. 7. Fertilized pond (a) and tank (b) ready for stocking with Moina

vii. Cover the culture tanks with nets ('coffee net, 'hapa' or mosquito net) immediately after setting to prevent contamination and/or frogs and insects from entering the culture systems.



Fig. 8. The coffee screen (a) and culture tanks protected with coffee mesh.



The 'hapa' material is usually sold in rolls of 30 running meter by Balton Company and other suppliers in Kampala.

Fig. 9. The 'hapa' material for covering the culture systems.

The commonest insects that may invade the culture tanks are mosquitoes that will breed in the water and the backswimmers, etc. (Fig.10).



Fig. 10. Insects that commonly invade live food culture systems

viii. It may take from three to six days for the fertilized water to develop sufficient quantities of the micro-algae. However, this will depend on the quality of the water, the water temperatures and the fertilization method used.

ix. Do not allow the water to develop too much micro-algae and become very dark green. The excessive algae will consume all the fresh air from the tank at night and will choke the *Moina* to death.

x. Stocking (inoculation) of *Moina*
Stocking the *Moina* into the culture system is also known as inoculation. The suitable sources of *Moina* are listed in Sect. 3.1 above. Collect the *Moina* from any of these sources near you. Use plankton nets to collect *Moina*. For *Moina*, use nets of mesh size 300-500 µm for younger *Moina* and 500-1,200 µm for adult *Moina*. (Fig. 11).

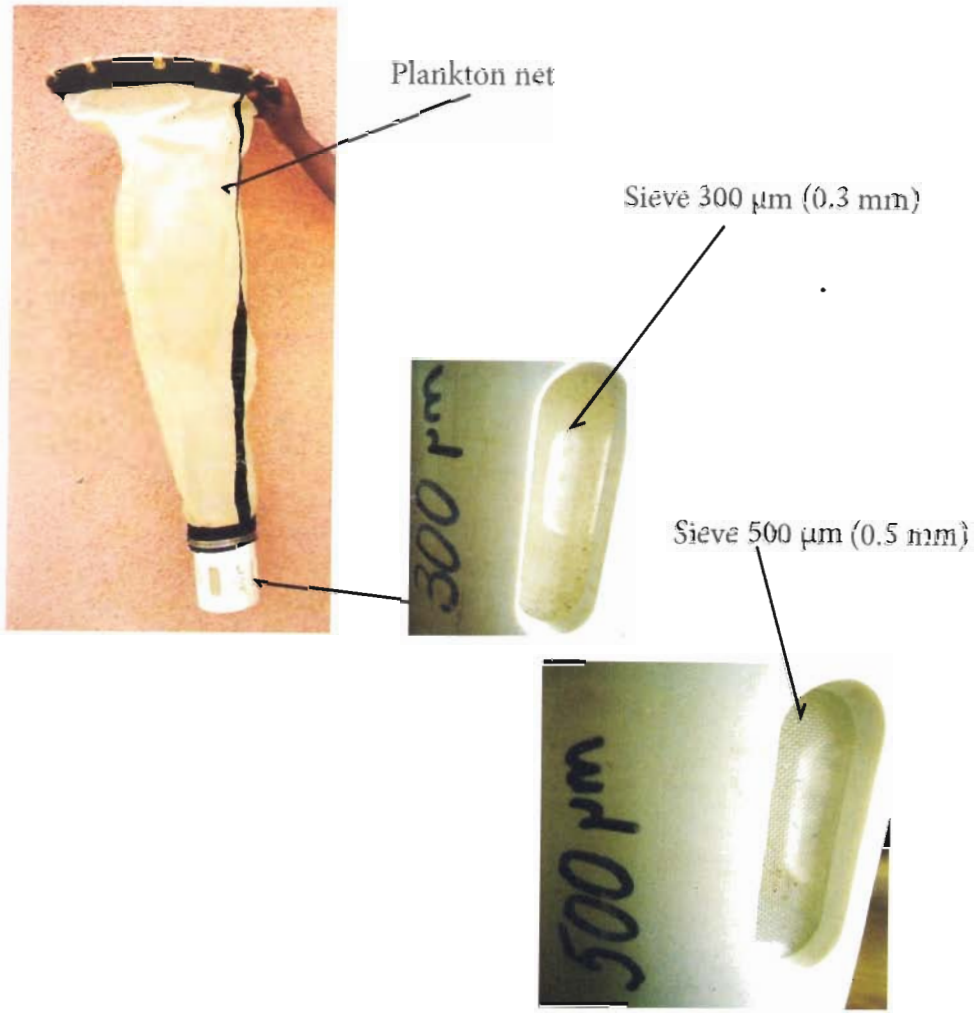


Fig. 11. The conventional plankton nets with screens of different mesh sizes

The conventional plankton nets are imported and expensive, but some cheaper improvised and fabricated nets can be made locally (Fig. 12).

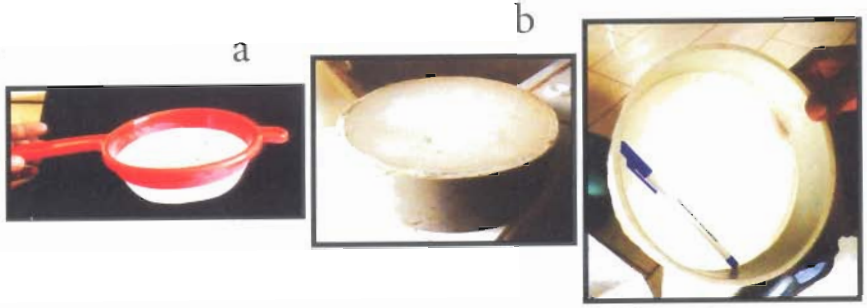


Fig. 12. A variety of locally fabricated screens /sieves (a) tea sieve, (b) plankton net mounted at end of a plastic pipe

xi. First stock the collected *Moina* in a separate culture tank ('mother' tank). Because the natural sources of *Moina* are not pure but may be mixed with other zooplankton (e.g. rotifers, copepods,), the populations of the different organisms will build up and then come down at different times. The pure *Moina* can then be collected when only its population is present and then stocked (inoculated) into the prepared culture tank.

xii. Start with a small but pure population of *Moina* which will multiply with time.

xiii. After inoculating the *Moina* into the culture tank, start adding Baker's yeast and sunflower cakes every day in the proportions given in Table 2. Add the sunflower cake directly into the culture tank. For the yeast, dissolve one table spoon of yeast in hot water, stir and sprinkle into the culture tank.

xiv. Continue aerating and stirring/mixing the culture system gently.

xv. Inspect the population of the *Moina* using a magnifying hand lens or a clear glass by getting a little of the culture water in a glass and examining the sample against light.

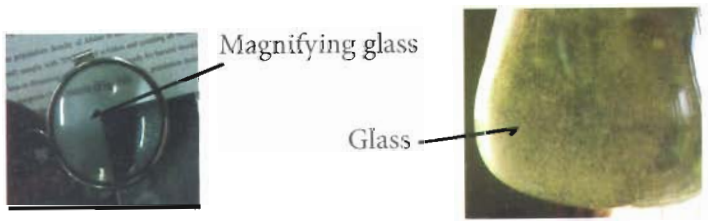


Fig. 13. Inspecting population of *Moina* in the culture using hand magnifying lens and a glass flask

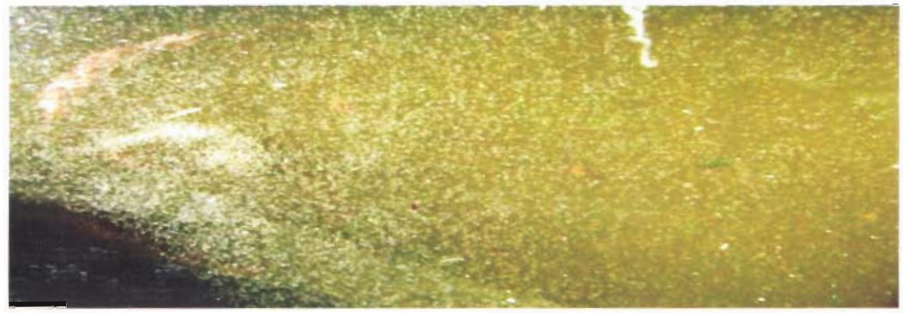


Fig. 14. Appearance of the optimum population density of *Moina* in the culture tank when it should be harvested

4.3 Harvesting *Moina*

Under conditions outlined in this Manual, *Moina* reproduces rapidly doubling in density in two days. Once the *Moina* population has grown to appear as in Figures 13 and 14 above, start harvesting it immediately for feeding it to Catfish larvae. Any further delay beyond such densities will result into *Moina* dying and the culture will crush.

Harvest about 20% of the volume of the culture containing the *Moina* every day for feeding fish larvae and replace the culture volume with the same quantity of water removed. For example, if your culture volume is 200 litres, harvest 40 litres every day and replace the culture with 40 litres of fresh water. Follow the same routine daily until the fish fry start feeding on dry larval feed (usually four to eight weeks).

4.4 Procedures for the separate micro-algae and *Moina* cultures.

The procedure for the separately micro-algae and *Moina* cultures is similar to the procedure for preparation of the mixed micro-algae and *Moina* culture. The only difference is that the micro-algae are cultured in different tanks and harvested and fed to the *Moina* in separate *Moina* culture tanks (Fig. 15).

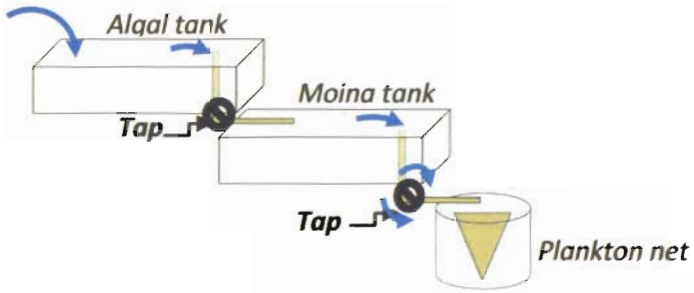


Fig.15. Schematic arrangement of tanks for the separate Micro-algae and *Moina* culture system

5.0 How long should Catfish fry be fed on *Moina* in catfish hatcheries?

Catfish fry start feeding on *Moina* from day three after hatching. However, nursing the fry up to fingerling stage for sale (usually at 5 - 10 cm in length) takes four to eight weeks (1 – 2 months). The fry starts feeding on *Moina* but will switch to dry artificial larval feed in powder form from about the fifth week onwards when its digestive system has developed sufficiently. Therefore, it is recommended to change the fry from live feed (*Moina*) to the dry feed gradually rather than suddenly.

6.0 Summary of Procedures for preparing a *Moina* culture

6.1 Set up the micro algae tank and following the steps in Sections 3 and 4.
6.2 Set up the tank for culturing the *Moina*.
6.3 Release some culture water from the micro-algae tank (about 20% to 30% by volume) into the tank for culturing the *Moina* and inoculate (stock) this tank with *Moina* from a good *Moina* source i.e. from the 'mother' culture.
6.4 Allow the population of *Moina* to grow to harvesting level; meanwhile add bakers' yeast as in section 3 and 4 to feed the *Moina*.
6.5 When ready, start to harvest the *Moina* from its own culture tank while replacing the same volume of fresh water into the micro-algae tank daily.

7.0 Summary of the steps in weaning catfish fry from *Moina*

7.1 Start feeding the fry on *Moina* only from day three.
7.2 From Week two, start adding little amounts of dry artificial larval feed (protein 45% and above, in powder form) – just a sprinkle while you watch the feeding response.
7.3 Gradually increase the amounts of the dry feed while reducing the quantity of *Moina* from the fifth week (Fig. 16).
7.4 Add enough feed that the catfish fry can consume. No excess feed should be allowed to accumulate at the bottom of the fry nursing tanks.

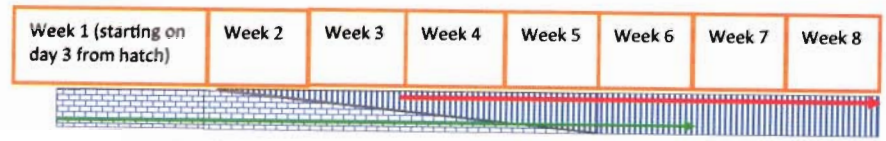


Fig. 16 **Diagram showing schedule of changing from feeding catfish fry on *Moina* to dry artificial feed**

Key:

= feeding on *Moina*
= feeding on artificial dry larval feed

Do not add excess dry feed to avoid polluting the water and risk killing catfish fry.

8.0 Acknowledgements

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