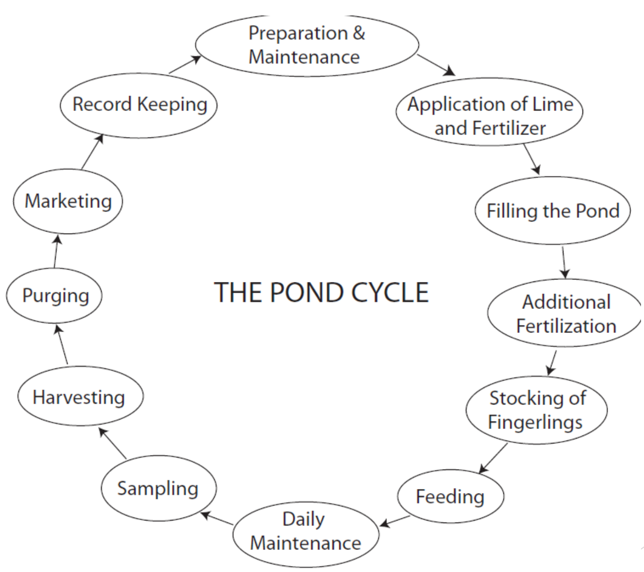
TILAPIA MANAGEMENT IN PONDS AND CAGES

AGA 4531

Dr J W NG'AMBI



Pond management activities – the pond cycle

Preparing Fishpond for Stocking

1. For an old pond, dry pond bottom for a period of fourteen days.

- Drying the pond bottom helps kill potentially harmful organisms in the soil and
- Speeds the breakdown of excessive organic

matter (a beneficial process) that remains after previous crops of fish

2. Apply lime to the pond bottom and dyke slopes.

Liming has the following benefits;

- Increases the pH.
- Acts as buffer and avoids fluctuations of pH.
- It increases the resistance of soil to parasites.
- Its toxic effect kills the parasites; and
- It hastens organic matter decomposition.

- Apply the amount of limestone depends on either the pH of the soil and water

Lime application rates

SOIL/WATER pH	pH GRADE	QUICK LIME (CaO) (g/m^2)	HYDRATED LIME $[Ca(OH)_2]$ (g/m^2)	AGRIC LIME (g/m^2)
4-5	Highly acidic	150	150	200
5-6	Acidic	100	100	150
6-6.5	Low acidity	60	60	100
6.5-7	Neutral	20	20	40
7-9	Basic	-	-	-

3. Apply organic fertilizer to the pond before filling it with water

- Chicken manure can be broadcast over the pond bottom at the rate of 1000–2000kg/ha.
- The fertilizer encourages the growth of plankton that will provide natural food for the tilapia.
- The pond can be filled to about 30–50cm depth initially, so that it can be easily warmed by the sun during the day, allowing good growth of plankton.
- Fertilizer can also be added, in a sack floated in the pond. The fertilizer rates may be increased or reduced depending on how well the plankton grows.
- The plankton should be maintained (by addition of more fertilizer) throughout the grow-out period.

4. Fill the pond with water

- After liming, addition of organic matter at pond bottom the pond can be filled with water.
- Screen the water through fine netting to ensure that no wild fish fry or eggs can get into the pond.

5. Apply inorganic fertilizer to the pond after it has been filled to create green water.

- chemical fertilizer will create better water quality than organic fertilizer, thus ensuring higher survival of the newly stocked fish.
- A week is normally sufficient for the water to turn green, after which time fish can be stocked.
- Apply fertilizer weekly

Type of fertilizer	Amount/hectare/week
16-20-0 (N-P-K)	175 kg
46-0-0 (urea) + 0-46-0 (phosphate)	61 kg + 40-70 kg
15-15-15	187 kg
Fresh chicken manure	1,875 kg
Chicken manure + 46-0-0 (urea)	1,100 kg + 26 kg
Fresh pig manure	5,000 kg
Cow/buffalo manure	6,000 + kg
Ami (MSG waste)	1,250 liters

Cribs ineffective for pond fertilization? Need for research needed

A women's cooperative operates fish ponds in Lundazi, Eastern Province of Zambia, and they rely on compost cribs for pond fertilization

Compost Cribs in Nsombo, Luwingu district
Lack of manure and ineffectivess of cribs for pond fertilization is a serious concern for rural aquaculture

Methods of applying inorganic fertilizers

- Dissolve the fertilizer in a bucket of water by stirring with a stick and then sprinkle the solution around pond.
- Place small mesh bags of fertilizer on platforms just under the water surface in the pond, where the material can slowly dissolve and become available to phytoplankton.
- Suspend small bags of fertilizer from stakes just under the water surface.
- Plan to continue applying fertilizers to your pond at the given rates on a weekly basis throughout the culture period.

Counting the fry

There are four commonly used techniques for counting fish fry, which are described below

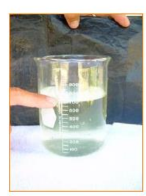
- a. **Individual count technique:** Using a small hand net or plastic spoon, proceed to count fry one by one to establish total fry per scope and the average of three scopes determined which is multiplied by the total number of scopes
- b. **Gravimetric technique**: Determine the average weight of a known number of fry without water. Then the rest of the fry are weighed in groups to estimate their numbers (Figure 23). For this technique it is indispensable to have a precision balance and fry of uniform size.
- c. **Water displacement technique:** Fry are transferred to a container (beaker or graduated cylinder) with a measured volume of water. The fry are then counted and their number is related to the increase in the volume observed in the container. Additional fry numbers are estimated by the water they displace in the container. Again it is important to use this method with fry of uniform size.
- d. **Visual comparison of fry population:** Several identical plastic trays or bowls are required for this technique. Each bowl is prepared with an equal amount of clean water (Figure 25). It is recommended to use bowls made of white, yellow or clear colored plastic. Fry are counted one by one into the first bowl. Then fry are added to additionalbowls until the populations appear equal thru visual comparison
- After a little practice and experience, this method provides a simple and quick way to enumerate large numbers of fry with sufficient precision (± 5%) for most farms.

Individual counting of Fry to establish the total in a scope

Three scopes are counted and the average number of fry determined per scope. Then the rest of the scopes picked randomly

The gravimetric method

Water displacement method



Estimating fry numbers by the water displacement method. The volume of water displaced by a known number of fry is determined. From there on the number of fry is estimated by how much water each lot or group displaces.

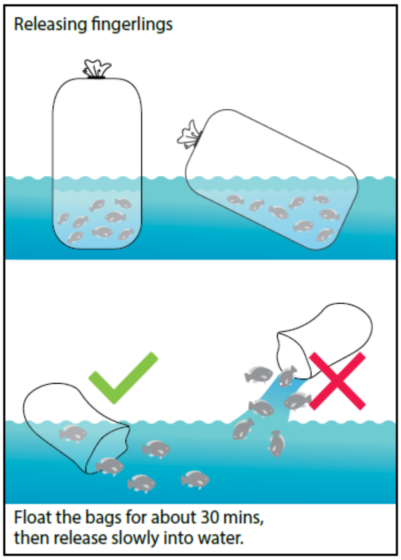
Visual comparison of populations

Estimating fry numbers by visual comparison of populations. After individually counting fry into a plastic dish with water, a second identical dish is prepared and fry added until the populations appear equal, as seen from above.

6. TRANSPORT FRY

- **Condition the fry first**
- Order and confirm in advance
- Arrange a time to pick up the fish and arrive on time
- Try and avoid travelling long distances during the day in extreme heat
- If moving during the day cover the bags with wet sacking to keep the temperature down
- Transport the fish in insulated tanks with aeration

Demonstration of packaging tech to farmers at Misamfu- Kasama



FRY RELEASE

- first unload the bags and float them in the pond for a period of 15 minutes.
- After this time the water temperature in the bags should have equilibrated with that in the pond and the fish can be released

7) NURSERY

- Very important process but not followed in Zambian aquaculture
- Small fry are very susceptible to predation and are less tolerant to poor water quality than older, larger fish
- Stocking small fry causes unpredictable yield of the pond
- The solution is to nurse small fry to a large size and then stock graded fingerlings (2-4”, 2-50g) in the grow-out pond.
- Not only will this ensure better control over fish density, but culture period and individual size variation of the harvest is reduced. The result is a much higher profit margin.

1) Nursing tilapia fry in hapas

- Hapas are very useful for nursing tilapia fry, as predation can be eliminated, they reduce the need for special nursery ponds (can be fitted in grow-out ponds and supply channels to save on space) and allow fish to be harvested quickly
-  

- Fish grow slower in hapas, however, due a combination of high stocking density and poor water exchange. It is important that the fry do not become too dense or mortality will be high. Below is the guidance

Size of tilapia		Recommended stocking density	
Inches	Grams	No. fish/m2	Grams/m2
1.0	0.2	750	150
1.5	0.5	440	220
2.0	1.0	255	255
2.5	2.0	143	285
3.0	5.0	63	315
3.5	10.0	35	350
4.0	20.0	20	395
4.5	50.0	10	480

The following guidelines should be followed when nursing fry in hapas:

- Only install hapas in **water of good quality, avoid using grow-out ponds with high organic matter input.**
- **Cover hapas with bird netting.**
- Ideally hapas should be about 1 m deep and fixed 60-70 cm underwater.
- Use **bamboo** for attaching hapas, as it is cheap, strong and flexible.
- Feed 20-25g of good quality powdered or pelleted feed (depending on size of fish) per m2 of hapa per day divided into 3 feeds.
- Growth is much faster and FCR lower in ponds that are green and have aeration.
- Change hapas once per month, grade the fish and thin them out.

Grading fry

- For optimum survival, it is recommended that fry nursed in hapas are size graded and thinned out once per month.
- Grading fry by size is achieved by **sieving fish** through netting, plastic mesh or parallel bars. Several sizes of grader will be necessary depending on the size of fish

Demonstration of grading tech to farmers at Misamfu- Kasama

2) Nursing fry in earthen ponds

- The main advantage of nursing fry in earth ponds is that growth is fast.
- Small ponds of 0.1 – 0.4 hectares are recommended, as they allow better protection against predatory birds and fish

Nursery ponds at a farm in Luapula Province

- **Use a good quality powdered feed** (30% crude protein or higher) and small size commercial pellets as the fish get bigger.
- Change water in the pond if it gets too green and/or fish begin to die.
- Installation of a **paddle wheel** or some other aeration device is not essential, but recommended for improving growth and survival. Aerate at night and longer on cloudy days.

GROW-OUT MANAGEMENT

- Fingerling, size graded tilapia (3-4 inch) (5 – 20 grams) should ideally be stocked in grow-out, as the fish will attain market size very quickly (grow-out ponds can produce multiple crops per year this way) and harvested fish will be very even in size.
- However, in Zambia 1 inch fry are commonly stocked but this leads to low harvested biomass
- Typically 3.5–7.5 tones of tilapia can be produced per hectare but in Zambia average production in ponds ranges from 1 to 2 tons per hectare (a lot of problems).
- With aeration and the use of good quality feed, this yield can be increased to 12-18 tones per hectare. However, frequent water exchange will be necessary to maintain water quality and running costs will increase significantly.

Low production from Zambia's rural aquaculture – Northern – Luapula province

Poor pond fertilization tech

Lack of organic fertiliser

Predators

Poor pond construction

Eastern Province

Possible solutions

AQUACULTURE

The novel tilapia–rabbit integrated culture: A means for poverty reduction for rural people

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Fig. 1. Rabbit in cages placed on experimental pond dike. (All photos by Prof. Dr. Mostafa A R Hossain)

Table 1. Growth and production performance of tilapia

Performance	On-farm		On-station	
	Tilapia-Rabit	Tilapia	Tilapia-Rabit	Tilapia
At Stock				
Mean weight (g/fish)	2.5	2.5	2.5	2.5
Harvest				
Mean weight (g/fish)	181	136	150	100
Weight gain (g/fish)	179	134	148	98
SGR (% bw/day)	3.13	3.57	3.20	2.93
Gross production (kg/ha)	3569	2535	3306	2156
Net production (kg/ha)	3494	2454	3270	2120
Survival (%)	66	62	73	72

Rabbitfish culture would definitely contribute to reducing protein deficiency among the people of Bangladesh. The initial investment is comparatively lower and affordable by resource poor farmers.

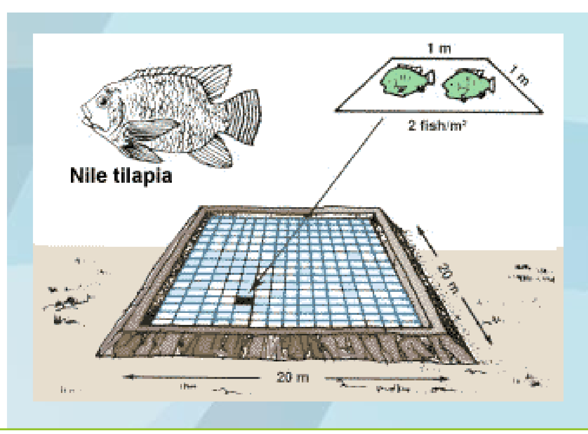
Rice-Fish Culture and its Potential in Rural Development: A Lesson from Apatani Farmers, Arunachal Pradesh, India

Abstract and Figures

Rice-based fish farming, though, inevitable as a mean of double crop production from the unit land, is often proves as cost-effective practice for marginal and poor farmers. The lack of adequate knowledge and support to farmers keep them away from the benefits of rice-based fish farming. The novel technique adopted by Apatani farmers in Lower Subansiri district of Arunachal Pradesh, India reduces the knowledge gap to achieve optimum benefit from such farming practice. The farmers enjoy a fish production of 500 kg per hactor per year without providing any supplementary feed to the fish stocked in their rice-fields. The economic return of the farmers was estimated up to 65.8% per annum from their rice-fish integrated fields. The system of rice-based fish farming by Apatani farmers has, therefore, bears immense potentiality to be recognized as low cost and sustainable farming practice and could be a significant breakthrough for poor and marginal farmers of the rest of the World.

Stocking density

- In order to maximize the profit from the fish farm, the stocking density needs to be as high as possible.
- Fish stocked at low density will grow faster than fish stocked at a high density infertilized ponds, but densely-stocked fish can also grow fast if they are given supplementary food and managed properly.



- For example stocking density of 2 fish/m2 of pond.
- If your pond is 20 by 20 metres, or 400 m2, you will need 400 x 2 = 800 fingerlings.

There are four kinds of culture systems based on stocking density, level of inputs and management.

- **Extensive culture;** natural food present in the pond, stimulated by fertilization. Stock 1-2 fingerlings/m^2 for extensive systems
- **Semi-intensive culture;** given supplementary feeds in addition to having the natural food present in the pond. Use 3-4 fingerlings/m^2
- **Intensive culture;** use 5-10 fingerlings/m^2 intensive feeding plus water movement and aeration. Ponds, tanks, raceways
- **Super-intensive:** >10 fingerlings/m^2 This system can use tanks or raceways as alternatives to ponds.

Culture intensity

System	Inputs & Equipment	Density (fish/m^2)	Harvest weight (g)	Days in culture	Yield (mt/ha/yr
Extensive	Ponds, fry, domestic waste, net, hook & line	0.1-0.2	<150	variable	<1
Semi-intensive	Ponds, fry, 1. Fertilizer, manure 2. Fertilizer, by-products, feeds, nets, water supply, drainage	0.5-2	<250	180-360	1. 1-3 2. 4-8
Intensive 1	Ponds, all-male fry, supplemental pelleted feed, emergency aeration, graders, catch-pit, water test kit	1-3	350-400	180-260	5-12
Intensive 2	Ponds, all-male fry, pelleted feed, partial water exchange, routine aeration, equipment as above	1-3	400-500	180-260	7-20
Intensive 3	Ponds or raceways, all-male fry, pelleted feed, partial water flow, full-time aeration, equipment as above, auto-feeders, feed blowers	5-10	500-700	350-450	22-50
Super-intensive	Tank, raceway, all-male fry, pelleted feed, continuous water flow, partial aeration, equipment as above	70-200/m^3	500-900	420-460	250-1200
Water reuse	Tank, greenhouse covering, all-male fry, pelleted feed, continuous low water flow, continuous aeration with monitoring, biofiltration, heating,	50-100/m^3	400-600	180-260	150-600
Cages	fry, pelleted feed boats, graders, auto-feeders	50-100/m^3	500-900	200-350	500-2000*

Source: Balarin and Haller (1983), Popma and Lovshin (1996), this author; * some experimental.

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Calculating stocking density

- Predetermine before calculation the target size at harvest as well as expected mortality rate — usually between 5-10%.
- Generally, according to the recommendation of the research, a static pond system has maximum stocking capacity of **1.8kg of fish per meter square**.

- Assuming your pond water is 600 m^2 and you intend to produce average size of 400 grams of tilapia at the end of culture season with an average mortality rate of 5%. Determine the stocking density of juveniles
- **Calculation (Method 1)**

Total final biomass = 600 x 1.8=1080 kg

No. of fingerlings = Total biomass/Final weight of each fish

= 1080/0.4 = 2700 fingerlings

Total No. Fingerlings = 2700 + 5% of 2700

= 2700 + 135

= 2835 fingerlings

Method 2:

- Recommended stocking density for semi-intensive culture is 3-4 fish /m^2.
- Stocking density (fish/m^2)

= Area of pond(m^2) x No. fish/m^2 +5% mortality

= (600 x 4) + (0.05 x 2400)= 2400 + 120

= 2520 fingerlings

- **Expected Total biomass = 2520 x 0.4 = 1008 kg**

3) Formula using mortality coefficient

- **No. of fish to stock = ((Y x A) / (S / 1,000)) x M**
- Where: Y = Yield per m^2 (kg)
- A = Area of pond (water only, m^2)
- S = Size of fish required (g)
- M = Mortality coefficient = (100 / estimated survival). The following estimated values could be used:

Size of fish	Mortality coefficient	
	Nile tilapia	Red tilapia
1" or 0.2g	1.67	1.92
2" or 2 g	1.39	1.52
3" or 10g	1.27	1.32
4" or 30g	1.18	1.20

From above example

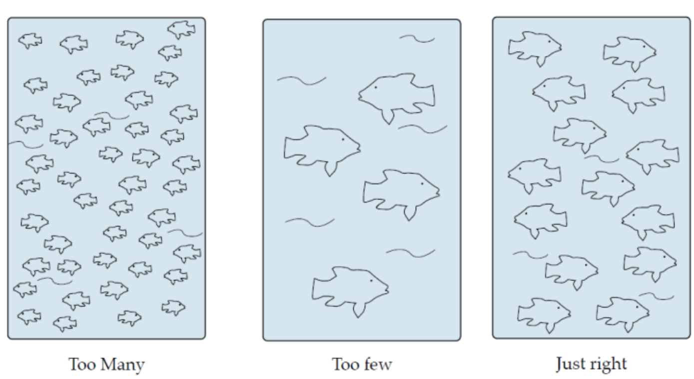
No. of fish to stock = ((Y x A) / (S / 1,000)) x M

= ((1.8 kg x 600 m2) /(400/1000)) x 1.67

= ((1080)/(0.4))x 1.67

= 2700 x 1.67 = 4509 fingerlings

- Stocking density affects the final market size of fish



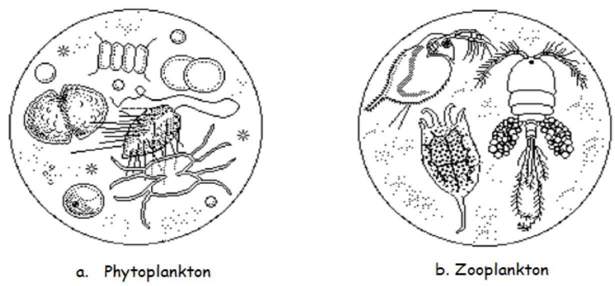
2) **Pond fertilization and "green water"**

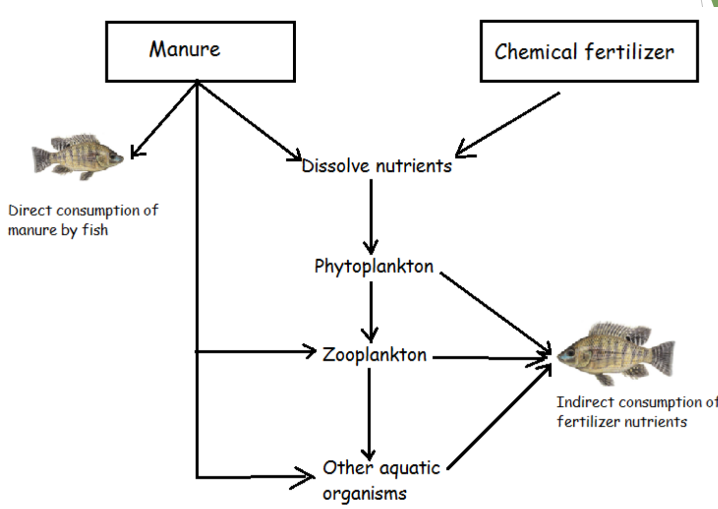
- Tilapia have the ability to filter microscopic plants (phytoplankton) and animals (zooplankton) from water. Farmers can use this ability to eliminate the need for expensive commercial feeds.
- Approximately 4 kg of N and 1-2 kg of P per hectare per day is required to maintain a green pond. These figures are for weights of N and P only so be careful when calculating amounts of fertilizer to add. The following table can be used as a guideline

Type of fertilizer	Amount/hectare/week
16-20-0 (N-P-K)	175 kg
46-0-0 (urea) + 0-46-0 (phosphate)	61 kg + 40-70 kg
15-15-15	187 kg
Fresh chicken manure	1,875 kg
Chicken manure + 46-0-0 (urea)	1,100 kg + 26 kg
Fresh pig manure	5,000 kg
Cow/buffalo manure	6,000 + kg
Ami (MSG waste)	1,250 liters

3) Types of feed use in fish culture

- **Natural food.** Living organisms in pond water; Phytoplankton (microscopic plants), zooplankton (microscopic animals), insects and certain other plants are all examples of natural foods. Fertilization increases their abundance





Utilization of natural food stimulated by fertilization

- **Supplementary feeds**
- These feeds supplement natural foods.
- They are **not nutritionally complete**, and will not adequately support fish growth in the absence of natural foods.
- Feedstuffs including Agric. by-products, cereal grain residues, brewery yeast, spoiled animal feeds, crop wastes, duck weed, mill sweepings, etc.
- Novatek (Fish Green pond (5mm extruded)

- **Complete feed diets**
- In the absence of natural foods, nutritionally complete manufactured feeds that contain all essential nutrients and vitamins must be fed to fish.
- These feeds are used in high technology, intensive culture systems
- For rural aquaculture development fertilization and supplementary feeding should be encouraged

Recommended feed sizes for different development stages

- Fry and larvae (0.01 - < 1 g): powdered feed;
- Fingerlings (1–5 g): Particle size, 0.5-2 mm (granules or crumbles);
- Juveniles (5–50 g): Particle size 2-3 mm;
- Adults (> 50 g): Particle size 3-6 mm.

Protein requirement for different sizes of tilapia

Fish Size	% CP Required
< 20 g	40 - 45%
20 - 100 g	38 - 40%
100 - 250 g	33 - 35%
250 - 450 g	32 - 30%
> 450 g	28 - 30%

Commercial feed from Novatek

Aquaculture (Extruded / Floating feeds)		Fish age, weight gain over period - Culture system	
181AQ002	Fish Broodstock (5mm Extruded)	>250gr Fish size	25
179AQ000	Fish Post Hatch 45% MT (0.2mm Powder)	0-3wks, 0 to 0.2gr - Cage/Pond	3
179AQ000	Fish Fry 45% (0.2 Powder / 0.5 Mash)	0 -1wks, 2-5gr - Cage/Pond	15
179AQ000	Fish Juvenile 45% (1mm Crumble)	2 - 4wks, 5-20gr - Cage/Pond	15
179AQ000	Fish Juvenile 45% (2mm Crumble)	5 - 7wks, 20-40gr - Cage/Pond	15
180AQ001	Fish Pre-Starter 40% (2mm Extruded)	5 - 8wks, 20-50gr - Cage/Pond	25
180AQ001	Fish Pre-Starter 40% (3mm Extruded)	8 - 12wks, 50-90gr - Cage/Pond	25
181AQ002	Fish Starter 38% (4mm Extruded)	13-18wks, 90-250gr - Cage/Pond	25
182AQ003	Fish Grower 32% (5mm Extruded)	19-24wks, 250-450gr - Cage/Pond	25
183AQ004	Fish Finisher 24% (5mm Extruded)	22-24wks, 350-500gr - Cage/Pond	25
184AQ005	Pond Fish 18% (5mm Extruded)	>180gram fish size - Clear Pond	25
185AQ006	Fish Green Pond (5mm Extruded)	>180gram fish size - Fertilised Ponds	25
187AQ280	Catfish Weaner 48%	Catfish Weaner 48%	15
188AQ300	Catfish Starter 42%	Catfish Starter 42%	15
189AQ310	Catfish Hatchery	Catfish Hatchery	15
190AQ310	Catfish Pre-Gower 36%	Catfish Pre-Gower 36%	25
191AQ320	Catfish Grower 32%	Catfish Grower 32%	25

FEEDING STRATEGIES

a) Daily feed ration

- The feeding rate is depends on the size and age of the fish. Table below provides a guide for feeding tilapia at 24–30°C using quality formulated feed.

Body weight of fish (g)	Number of fish per kilogram	Feeding rate	No. of feeds per day
1–5	1000–200	10–6%	4–6
5–25	200–40	5%	4
25–150	40–7	4–3%	4
150–250	7–4	3%	3-4
250–450	4–2	2–3%	2–3

- Daily Feed Ration (DFR) is calculated by multiplying the estimated total weight of fish in the pond (number of fish stocked into the pond at the beginning multiplied by the Average Body Weight of the fish sampled) by the feeding rate appropriate for the fish at their current size.
- DFR = Feeding rate per day x ABW x Total number of fish

Worked example of Daily Feed Ration

- What will be the total amount of feed needed each day by 1000 fish with average body weight (ABW) of 3g
- Total weight of fish in the pond = 1000 x 3g

  = 3000g
- DFR = 10% x 3000g= **300g** of food per day
- Fish of 3g size should be fed four times per day, so: Amount of feed = 300/4

  = 75g at each feeding time

b) Satiation feeding strategy

- Fertilizing ponds at 61 kg urea and 35 kg TSP/ha/week throughout the culture cycle;
- Supplementing feeds at 50% of satiation feeding level starting when tilapia reach 100 g in size; Harvest tilapia when reaching 500-600 g in size.

Determining satiation feeding level:

- Give feed to tilapia during 0800-1000 h and 1500-1700 h every Monday until tilapia stop feeding;
- Add all feed consumed in both sessions together, and the total feed amount is satiation feeding level; Feed tilapia 50% of the determined satiation feeding level from Tuesday through Sunday;
- Repeat the above process every Monday.

Food Conversion Ratio

- The Food Conversion Ratio (FCR) is the amount of food used to produce one kilogram of fish.
- FCR over one pond cycle is calculated from the Total Feed Requirement (TFR) and the Total Weight Gain (TWG) of fish.
- TWG = (Final ABW x Number of fish) – (Initial ABW x Number of fish)
- FCR = TFR/TWG
- An FCR value of 1.5 means that 1.5kg of supplementary feed was used to produce 1kg of fish.

Estimating Total Biomass and cost of feed from FCR

Example

From the above example 1000 kg fish biomass will be produced from 600m2 pond. What quantity of feed will be required ? And how much will it cost? Assume FCR of 1.5 for commercial fed

Quantity of feed = FCR X Fish biomass =1.5 x 1000 = **1500 kgs** feed is required.

Total Cost of feed = 1500 x Avg. fish feed price

= 1500 x ZMW 17/Kg

= **ZMW 25, 500**

4) Harvesting

- Tilapia can be harvested starting from about 3–4 months after the fingerlings have been stocked, provided water temperature remains suitable and good quality supplementary feed is provided
- There are two types of harvest: partial harvest, and complete harvest. A partial harvest can be done using a seine net or a cast net, but for a complete harvest the pond is seined 3–4 times and then drained to get all the remaining fish.

5) Fish flavor

- Most fish species reared in freshwater are notorious for picking up muddy or earthy off-flavours.
- This is caused by two chemicals, **geosmin** and **MIB (2-methyl-iso-borneol**), which can be produced by certain species of freshwater blue-green algae and actinomycetes bacteria.
- They are certainly more prevalent in the dry season than the wet season and the following factors are known to improve flavor:

- Reduce use of manures and other organic fertilizers, particularly towards harvest time
- Provide aeration
- Drain and dry ponds after every harvest
- Don't over-fertilize ponds
- Don't overfeed fish

Off-flavour of fish can be tested by smelling and tasting samples of fish cooked (without seasoning) by microwave or steaming.

- Meat nearest the head will have more off-flavour than that nearer the tail.

- If fish are found to have off-flavour, then reduce fertilization and exchange water.
- An alternative is to harvest the fish live and keep them in water free of geosmin and MIB for 3 days.
- There will be some weight loss, but meat quality will improve due to fat depletion.

- Control predators

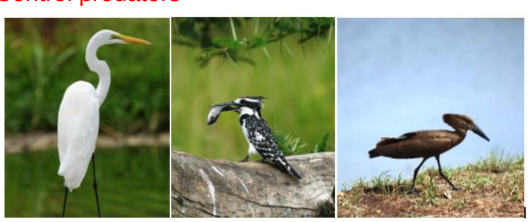


Plate 9-1: Common predatory birds of fish; from the left Egret, King fisher and Hammercop (Source: Isyagi et al., 2009)

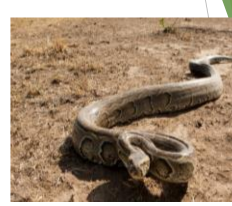


Plate 9-2: African fish eagle on the left and Monitor lizard on the right

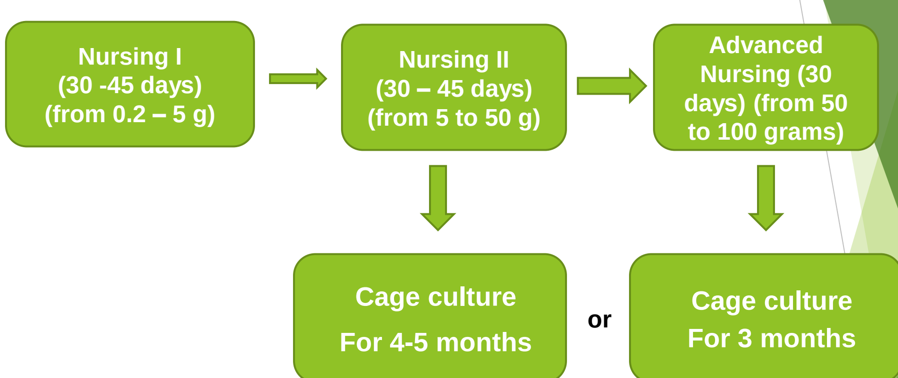
Management of Cages

Cage maintenance

- Cleaning during grading of the fish, which is set for every after six (06) weeks period.
- prevents excessive fouling that may cause net breakages and heavy fish losses due to fish stress and disease outbreaks.
- The smaller the mesh size, the heavier the rate of fouling (advanced nursing encouraged)
- cages can be cleaned using brushes with long handles to allow cleaning from the upper surface to the lower sections of the cages.
- After harvesting cages will be pulled out of the lake, and will be placed in a special container and washed with copper sulphate solution to remove the attached algae and other fouling materials.

Fry Nursing for cage culture

- raise fry to the 50 g juvenile stage within ponds set up close to the lake prior to transfer to the cages.
- During secondary nursing in the lake, the juveniles will be raised from 50 g to 100 g in specially designed juvenile cage nets (before being released into the grow-out cage nets



Farmers can adopted any of these options as a business and earn income in the shortest time possible

- Advanced Nursing of fry is encouraged
- The larger the fish at stocking, the larger the net that can be used to make the cages
- This means better;
  - water circulation
  - better survival
  - faster growth
  - a shortened grow-out period.

Stocking density

- The stocking density is rather expressed as number of fish per unit volume or the total expected biomass per unit volume at harvest time.
- The minimum recommended stocking density for, Tilapia is **100 fish /m^3** at stocking or **50 kg/m3** of collective biomass at harvest.

- Stocking density will depend on the expected yield of fish per cubic meter of water. This is dependent on a number of factors:
- **Water quality** – a higher density of fish can be raised per cage at sites with good water quality.
- **Water flow** – Higher densities of fish are possible at sites with good water flow such as rivers.
- **Cage size** – Smaller cages can hold a higher density of fish, as water exchange is more frequent

How to calculate a stocking density:

- The total weight of fish that can be cultured is limited by the carrying capacity of the water body.
- High stocking density of reached carrying capacity will result in increased fish stress, disease and mortality, and reduced feed conversion efficiency, growth rate and profit

Example

- To work out the number of fish to be stocked per cage of 8 m^3 :
- **Final biomass at harvest** = final stocking density times volume of cage (e.g. 50 x 8 = 400 kg)
- **Stocking number = final biomass ÷Target ABW at harvest + Mortality 20%**

=(400/0.500) + Mortality 20%

= **800**+ 160 = **960 fingerlings**

Quality feeds

- The feed should be nutritionally complete with all essential nutrients including proteins, lipids, vitamins, minerals and carbohydrates.
- A correct amount of feed should be weighed and provided to the fish daily. Feeding rate tables are used to adjust daily ration.
- The fish should be sampled every four weeks to determine their average body weight and to facilitate calculation and adjustments of the daily ration
- Give much feed as the fish can eat in 10 minutes.

Feeding Management

- The fry to subjuvenile (fingerlings) fish will be raised on high protein (35% CP) diet.
- Table 5-1 provides the guidelines for the feed protein content for the various stages of the culture fish.

Relation between weight of fish, crude protein requirement, pellet size and feeding rates of farmed fish.

Fish Weight	Crude Protein	Pellet Size	Feeding Rate
< 0.1-5.0 g	40-45 per cent	< 1 mm	10.0-18.0 per cent
5.0-30.0 g	40-45 per cent	1-2 mm	6.0-10.0 per cent
30.0-100.0 g	35-40 per cent	2-4 mm	3.0-6.0 per cent
100.0-200.0 g	30-35 per cent	4-6 mm	2.5-3.0 per cent
200.0-500.0 g	30-32 per cent	6-8 mm	2.0-2.5 per cent
500.0 g-1.2 kg	28-32 per cent	6-8 mm	1.5-2.0 per cent

FCR

- Feed Conversion Ratio (FCR): Feed Conversion

Ratios (FCR) should be calculated as:

$$FCR = \frac{Weight\ of\ feed\ used\ (kg)}{Final\ weight\ of\ fish\ (kg) - Initial\ weight\ of\ fish\ (kg)}$$

- It should normally vary between 1.2-2.0 depending on feed quality, growing conditions and management.

- From the above example, a farmer stocks 2,381 of 30g tilapia in a 5 x 5 x 2 m cage. He harvests 1,027 kg of tilapia at harvest and uses 1,250 kg of feed in total:
- FCR = 1,250

  1,027- (2,381 x 30 / 1,000)

  = 1,250

  879

  = 1.31

Survival of cage farmed fish

- Survival rates of the fish in cages should be monitored. This is expressed as a percentage of the number of fish stocked to the number harvested.

This is obtained from the record of mortalities throughout the production cycle at harvest. Survival rate can be 80% to 95% depending on cage management.

Cages fish health management

- Infectious diseases are mainly due to waste accumulation, crowding, poor handling, variations in water quality parameters and bio fouling.
- The most common diseases that occur in cages are from bacterial infections.
- Cage abrasion can also cause fin and skin damage to farmed fish.
- Occurrence of infections/ diseases can be minimized by selecting good site, optimal stocking density and careful handling of fish stock.

- Fish farmers should maintain a record of weather, water quality parameters, feeding rate, length and weight of fish sampled, fish behavioral changes, net cage exchange details, etc..
- Records provide useful information for analysis of health status.

Best management practices

a) Avoiding over-stocking of fish fingerlings.
b) Monitoring growth rate at appropriate time intervals.
c) Feeding fish with pellets of good quality and right quantity.
d) Regular cleaning and exchange of net cages for effective water exchange.
e) Avoiding use of antifouling paints/ chemicals.
f) Timely removal and proper disposal of dead fishes.
g) Periodic monitoring of water temperature, dissolved oxygen, pH, etc..
h) Close observation of fish behavior while feeding them, to assess health status.

Performance, yield and marketing

- Fish in the cages should be sampled every four to six weeks to monitor growth performance to guide adjustment of the feeds
- Fish should be starved for about 24 hours before sampling in order to reduce stress
- Fish should be weighed regularly to monitor growth rates, FCR and facilitate adjustments of the amount of feed.

Main problems

1) Ripping of cage nets

- It is not uncommon for tilapia to escape from cages due to ripping of the net. The most common reason for this is aquatic predators learn that the cage contains food and they can make short work of netting with their sharp teeth. Once they have learned this ability, then they can cause huge destruction going from one cage to another.
- **Anti-predator netting-**thick-meshed netting is the only guaranteed method backed up with control of the predators in question.

2) Theft

- Site selection is important and many cage farmers locate alongside land they either own or rent.
- Electricity for security lighting is then easily installed and staff can live in close proximity to the cages.
- An alternative solution used on very large rivers is to build a light weight, floating house for staff.

3) Disease

- There is absolutely no biosecurity associated with cage farming. The fish are suspended in a natural water body that will contain many fish species, often including tilapia. Any diseases present in the wild fish population will be passed on to the farmed fish.
- Fortunately, tilapia are a very disease resistant fish, but they are not immune.

RECORD KEEPING

Importance of record keeping

- Maintaining good records helps you with the following:
- Provide a basis for farm credit and financing
- Control the business and improve the management and efficiency of the farm
- Provide information to competent authorities for policy formulation
- Determine the relative profitability of the various production techniques and /or systems
- Provide information for tax purposes
- Provide basis for deciding future plans of the farm

Types of aquaculture records

- **Pond management record**, for example
- Pond utilization table schedule
- Sampling record sheet
- Fertilization and liming
- Fish health records
- Water quality records
- Feeding records
- Harvesting records

a. Pond utilization table

Pond number	Date stocked	Pond size	Species stocked	Number of fish stocked	Expected harvest date	Expected harvest (kg)	Actual harvest (kg)

b. Sampling record sheet

Date of sampling	Date of stocking	Pond No.	Number of fish examined	Fish Species	Average fish weight (g)	Remarks

c. Fertilization and liming

Date	Species	Pond number	Pond Size (m^2)	Name of fertilizer/lime		Amount of fertilizer/lime (kg)		Cost of fertilizer/Lime		Remarks
				Fertilizer	Lime	Fertilizer	Lime	Fertilizer	Lime	

d. Fish health records

Date	Pond/tank number	Pond/tank size	Species	Age or size of fish	Usual responses	No. dead	Symptoms	Action taken

Breeding and larval rearing records

- Spawning and hatching records
- Data sheet template for tilapia seed harvest records.
- Data sheet template for sex-reversal survival records.

a) Records on breeders

	POND /HAPA NO.)	NUMBER OF FISH		BATCH WEIGHTS (KG)		REMARKS
Date of stocking:		Females	Males	Females	Males	

b) Data sheet template for sex-reversal survival records.

	Sex-reversal hapa	Number of swim-up fry in (A)	No. Of fry	% output = (B/A *100)	Remarks
Date of seed out from the sex-reversal hapa					

c) Data sheet template for tilapia seed harvest records.

	POND /HAPA NO.)	NO. OF SEED COLLECTED					REMARKS
Egg harvest dates:		Stage I (just laid eggs)	Stage II (with eye spots)	Stage III (with small tail)	Stage IV (With yolk- sac)	Stage V (Swim-up larvae)	

Financial management records

- Purchase of inputs, including quantities and costs
- Records of input usage, e.g., feeds and labor
- Costs of labor, including the type and duration
- Costs of new construction or repairs
- Salaries, both in cash and in kind
- Sales records, including what was sold, quantities, and prices
- Inventory of equipment
- Costs of renting or hiring equipment, machinery, services, etc.
- Records of significant events at the farm, including
- Visits by extension officers and recommendations given
- Unusual weather that may affect pond productivity or farm operations

a. Data sheet template for fry/fingerling sales records

	Customer details (name, address and tel)	Date of sex-reversal	Number of fry sold (A)	Price of fry (B)	Total revenue =(B x A)	Remarks
Date of seed sale						

b. Data sheet template for table fish sales records

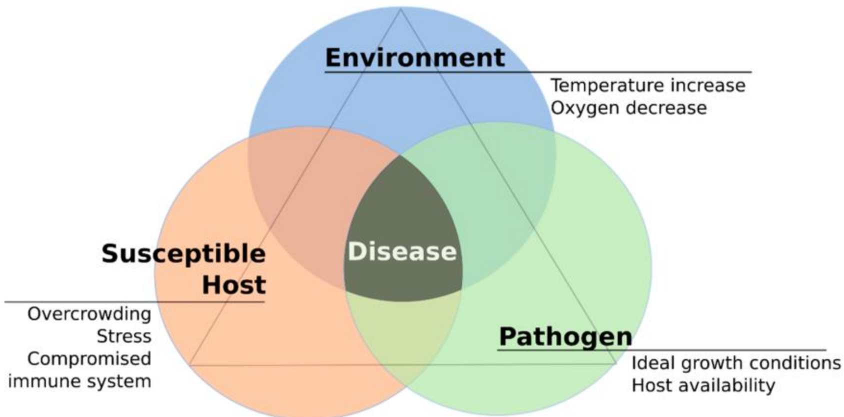
	Customer details (name, address and tel)	Kg of fish sold (A)	Price of fish per kg (B)	Total revenue = (B x A)	Remarks
Date of sale					

Disease management in tilapia

Disease factors

- Although the presence of a pathogen is a necessary factor for disease to develop, that alone is in most cases not sufficient to induce a disease outbreak
- In practice, diseases develop when a certain combination of suboptimal environmental factors meet and the stress level of the culture population reaches a point that is detrimental to the animals' immune systems. For example, water temperature might increase or decrease depending on the season and induce fish stress.
- Pathogens have different optimal temperature ranges at which they induce disease. For instance *Francisella* species outbreaks tend to develop after a drop in temperature under 28 degrees-C, whereas *Streptococcus agalactiae* outbreaks usually occur after temperature increases above 32 degrees-C.

The disease triangle



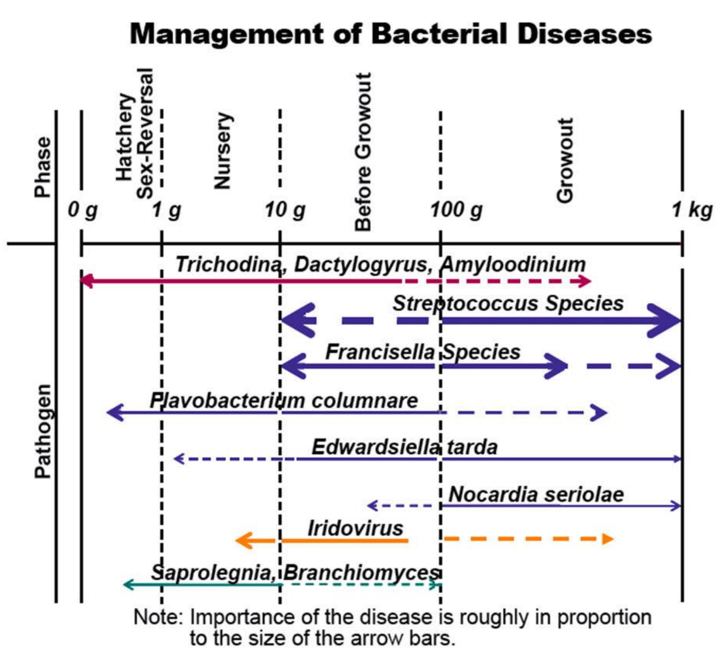
The disease triangle in the context of the increase of water temperature: Interplay of host, pathogen and environment and the main underlying factors that lead to disease development.

Disease epidemiology, monitoring crucial

- Prerequisites for disease prevention are the identification of the etiological agents responsible for diseases and understanding of the epidemiological factors that trigger and aggravate the diseases at farms.
- It is also critical to understand the delicate balance between farming intensity and the well-being of fish.
- To fully identify pathogens, disease sampling and epidemiology should be carried out for several farming cycles over a one- or two-year period
- Depending on the level of acceptable mortality at the end of the production cycle, each farm should decide on the level of percentage daily mortality that will trigger a full disease investigation in a given unit

Major diseases

- Experience has shown that most intensive fish-farming systems suffer from six to eight major infectious diseases, which must be prevented before the industry can truly become sustainable.
- After more than five years of sampling and disease epidemiological surveys across the Asia-Pacific region, Africa and Latin America, Intervet Norbio Singapore has identified four major bacterial disease pathogens
- *Streptococcus agalactiae, S. iniae,*
- *Flavobacterium columnare*
- *Francisella* species
- iridovirus viral agents
- several major external parasites, including *Trichodina* and *Amyloodinium*



Tilapia major clinical signs

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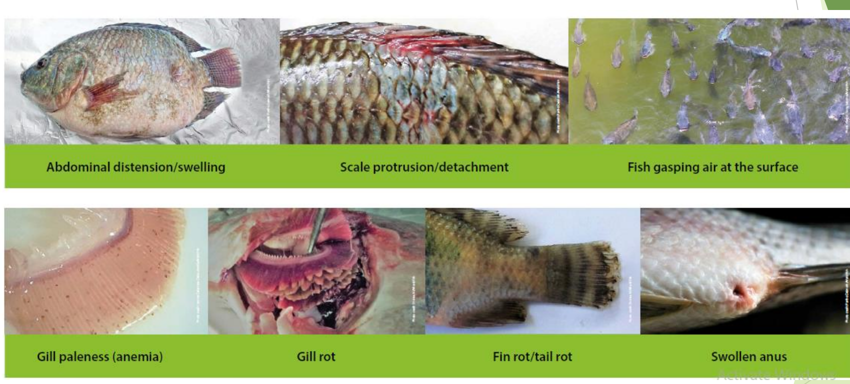

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- Prevention, early recognition, diagnosis and rapid intervention are the best steps to manage aquatic animal diseases.
- If you observe clinical signs, abnormal behaviour and unusual mortality, contact your local aquaculture health professionals to report and ask for support.