

Basic information for aquaculture – helping farmers to develop their irrigation systems for fish production

The problem with current recommendations

Conventional approaches to the development of fish culture in rural Asia, and elsewhere, have focused on the development of semi-intensive pond systems. Based around stocking a polyculture of carps and or tilapias they have resulted in widespread adoption among well-resourced farmers and entrepreneurs in areas with suitable physical and market conditions. There has been less success promoting fish culture to resource-poor farmers, especially variations of these same recommendations. Although they are low input by comparison with developed country aquaculture they are still not adoptable by the resource-poor in less favourable environments. Promoting fish culture among poor people in arid areas with low and seasonal rainfall and a lack of traditional aquaculture is a particular challenge requiring a participatory approach with individual and groups of farmers towards field research resulting in appropriate systems.

What you need to grow fish

1. Water
2. Seed
3. Nutrients

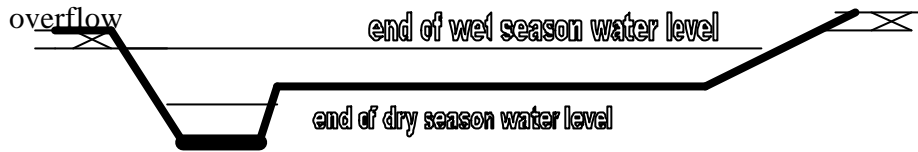
But you also need demand for the fish (consumed by farmers themselves or sold/exchanged) and you will need some basic information to build your own knowledge. Limited credit to modify your system and purchase some inputs may also be required.

Water

Modifying current irrigation systems to improve their use for fish culture should consider the following points;

The longer water can be maintained in a water body, the greater the fish production. A minimum depth is required which depends on the size of fish and ambient temperature. Generally smaller fish can grow in shallower water (fry/fingerlings 3-50cm; larger fish need 75cm or more). Deeper water (1-2m) is particularly good for larger fish and when fish are present at high density. When temperatures are very high (>32°C) or low (<15°C) deeper water is better as it moderates temperature fluctuations which are bad for fish. Some deeper irrigation structures are used for fish production (>3m) but do not result in more fish production per unit area.

The whole irrigation system doesn't have to be the same depth. In fact it is preferable if there are deeper and shallow areas.



This could be a

- crop field with a ditch at the lowest end
- a large community seasonal tank; the deeper area could be 'dead' storage
- a household-managed on-farm reservoir

Key features

The deeper area would be constructed to fill quickly and empty slowly; this allows fish to be stocked earlier and raised longer. It will also make harvest more efficient.

- Nutrients will accumulate in the deepest section-if this is relatively small it makes their removal easier.
- A low dike on the upper slope to control entry of water and silt may be worthwhile-but shouldn't prevent early filling of the system. Inlets and outlets should be screened to prevent loss of fish.
- Controlled access to the upper, shallow end of the system by cattle and other livestock will enhance fertility (see below) but this should be managed to prevent undue damage to the physical structure and excessive turbidity.

Seed

- Often there will be natural fish or fish seed in the water but stocking extra seed of the right species and size at the right time will increase productivity greatly over this natural production.
- The fish stocked should be species that **feed low in the food chain**, so that plant food produced in the water or added as a supplement will support growth. These include many species of carps, gouramis and tilapias. Many wild, indigenous fish present in surface waters are carnivorous or are mixed with carnivorous species.
- The larger the 'seed' stocked' the quicker they will grow, and the more valuable the harvest. Larger seed are also less likely to be eaten by predators. Stocking as soon as there is enough water to do so is also important to maximise production in seasonal water bodies.

Large seed can be made available to farmers by

1. Purchasing from conventional hatcheries as fry (<2cm length)/fingerlings (>2 cm length). Questions –are such seed available **as soon as farmers have water available? How can they be transported to where they are required? Cost implications?**

2. Purchasing hatchlings (up to 5 days old) and ‘nursing’ locally. **Can hatchlings be purchased? What species?**
3. Spawning fish and nursing locally. **Is there perennial water containing mature broodfish available?**

If fish seed is to be available for farmers as soon as they have water, then spawning and nursing should take place at hatcheries or locally **well before** the rains start.

Key points

- Conventional hatcheries, especially when managed by the Government, often begin producing fish seed **after** the rains start
- Some fish are easier to spawn and nurse than others; common carp and other small carps are easier to spawn and nurse than larger, riverine carps. If they are available, tilapias and gouramis are the easiest to produce.
- Conventional, commercial nursing in managed earthen ponds is not easy for resource-poor farmers to do. Stocking of hatchlings or fry in less intensively managed seasonal water bodies can often meet the needs for local stocking.
- Nursing fry to larger, more predator-resistant fingerlings in hapas has worked well in many situations. It can be managed by suspending hapas in small or large perennial waterbodies. Landless people can participate as hapas can be used in community water bodies etc. Hapas allow fish to be held at high density and for farmers to follow their development closely.
- Sometimes fry produced in one season can be held over in perennial water to the next season. Nursing and holding fish for prolonged periods of time (‘stunting’) can allow later ‘compensatory growth’ when later stocked out in favourable conditions.

Nutrients

Nutrients are scarce on most resource-poor farms and using them to produce fish may mean shortages elsewhere in the system. Resource-flow diagrams with farmers may identify under-utilised or wasted nutrients that can be used to increase fish yields. Fish need to feed and their individual growth, and production from any system stocked with many individuals, depends on the quantity and quality of feed available.

The culture unit-be it a farm dam, nala bund or community tank is both the place where this feed can be produced and where the fish is raised. Feed is produced in the system through additions of nutrients or **fertilisation** that stimulate phytoplankton and other minute feed organisms.

- Fertilisers include chemical, inorganic fertilisers, manures and plant residues. The most valuable organic wastes are those with a low C:N ratio-such wastes are more nutrient-dense. This means they are more cost effective to transport and use in fish culture systems.
- Organic wastes may have a high opportunity value for fuel or field fertilisers. Solid wastes may be utilised for these purposes but urine should be considered, since this is high in soluble nitrogen.

- Organic wastes quickly lose their quality especially nitrogen, which is lost as ammonia. If you can smell the wastes- you are losing nitrogen (*brainstorm methods to ensure as much fresh waste is used in the system as frequently as possible*).
- Fertilisation based on the 'little and often' is much better than large additions irregularly
- All inorganic fertilisers should be dissolved in a bucket of water before adding to the pond.
- Generally the closer the source of the nutrients to where they will be used the better- more handling and moving means more time spent by the farming household
- As with growing crops- some plants will grow without extra nutrients added- the soil and water contain nutrients –especially nitrogen and phosphorous- but plant growth, and fish production, will be lower. If fertilisation is impractical, as with planting field crops, **reduce the density of seed stocked.**

Table 1

The best density of fish to stock depends on the amount of nutrients in the culture system

• System	• Fish Density (No/ m ²)
• unfertilised	• <0.2
• fertilised	• <1-5
• fertilised & fed local feed	• 2-10

In larger systems it will not be practical to add nutrients – but

- Can we improve and concentrate the run-off of nutrients from where people and livestock live, crops are processed etc?
- Promoting fertilisation of multi-purpose water resources- especially those in which the water is used for drinking or bathing is not advisable. Can alternative, hygienic sources of water be developed for these purposes?
- Fertilisation promotes feed suitable for filter-feeding fish, that extract the phytoplankton and other minute feed organisms and a range of other food for fish feeding in the sediments. (*Use a piece of fine woven cloth and jam jar to show farmers what zooplankton look like*)

Nutrients can also be added as **supplementary feeds**. These can be used strategically depending on their availability.

- If they are relatively expensive such feeds should be fed at rates that the fish are observed to eat them all. If they are very cheap, left over feeds will decompose, releasing nutrients that act as fertilisers. Generally more nutrient-dense feeds, which are most **digestible**, are also more expensive and have alternative uses as feeds for **livestock (e.g. brans, oilcakes)**.
- Decomposition of feeds and fertilisers such as manures is a desirable process but care should be taken that not too much is added at one time. During decomposition,

oxygen is used up and if too much is used levels drop and become dangerous for fish survival and growth. Appropriate levels are given in **Table 2**. liming is not essential, many people grow fish without using it. Wood ash is a good alternative.

Table 2: Maximum recommended dose of commonly used fertilisers.

Type of fertiliser	Max. dose recommended (kg acre ⁻¹ day ⁻¹).
TSP	3.5
Urea	4.2
DAP	8.7
AP	7.4
Manure	26
Maize compost	125 (dry weight)
Maize or rice wastes	2.1
Cassava roots	3.6-7.1
Dried beer waste	1.4
Biomass-vegetation*	41.7

* vegetation can also be composted in the corner of the pond, from where nutrients will be released slowly. If vegetation is piled up in heap, the feeding activity of the fish is easy to observe and fibrous remnants of green manures can be removed.

Problemsolving

Common problems of farmers stocking fish are;

‘Our fish don’t grow’

‘Our fish disappear’

‘It is difficult to sell our fish’

Suggestions:

Our fish don’t grow’

- Sometimes farmers’ expectations are difficult to meet and these should be clarified before promoting fish culture. What are they expecting in terms of individual fish growth ? Large fish caught in natural waters may have been growing over long periods and, because the density is low, have access to large amounts of food each.
- We must be realistic about both individual fish growth and yield under most resource-poor conditions. However, the more nutrients that can be used, and the ‘greener’ the pond water-the better the fish yield.
- Some fish species have inherently faster growth than others, some tolerate higher densities better than others. Fish like silver carp can produce high yields of small fish quite quickly. Common carp can grow to a large individual size in many systems, but only if densities are low
- Individual fish growth can be increased if densities are low and the types of fish stocked have **complementary feeding habits** . Stocking the same number of several species will generally result in better results than using a single species.
- When it is not possible to maintain green water continuously, still use fertilisers and feeds regularly.
- Fish with small bodies and large heads suggest overstocking, a lack of food , or both.

·Our fish disappear·

- Did the farmers stock as many fish as they thought. Checking the number and quality of fish seed stocked is important.
- A major reason for feeding fish regularly, even if in very small amounts, is that the farmer keeps contact with them and can constantly reconfirm that they are still in the water. Children are keen observers of fish eating habits and their interest can be stimulated if they have some involvement in their culture.
- Fish may die in the pond as a result of **predation** or **pathogens**. Predators are very situation specific but can include other fish, frogs, snakes, birds and some mammals.
- Barriers to entry through screening inlet water can help; physical removal of eggs and juveniles of frogs and predatory fish can help. Trapping of adults can also control predator numbers and local people will usually know the best way to do this.
- Removing habitat that helps predators e.g. perches for birds, holes for snakes and frogs close to the fish culture system, is also useful.
- Humans are often the most important predators. It is best if the household/community can guard their fish as they look after other valuable possessions. If left alone thorn bush in the water that tangle nets and lines can give fish cover from thieves.
- Pathogens, including parasites may occur and usually present but rarely cause significant mortalities in seasonal water bodies, which are usually very healthy environments.

·It is difficult to sell our fish·

- Is there demand for seed fish, food fish or both ?
- Fresh fish deteriorate in quality very quickly once they are harvested so understanding opportunities to sell, barter or trade them is important.
- If trading fish is new we need to understand seasonal trends and cultural norms. When cultured fish becomes available for the first time, informal markets may provide the least risk approach.
- Keeping live fish ready to sell in small enclosures can improve the marketing power of the producer
- Can fish be processed-drying, salting, fermenting?