

## Agriculture (Paddy) cum fish culture

### Advantages of paddy cum fish culture

1. Economical utilization of land
2. Little extra labour is required
3. Saving on labour cost towards weeding and supplemental feeding
4. Enhanced rice yield by 5 -15 %, which is due to the indirect organic fertilization through the fish excreta
5. Production of fish from paddy field
6. Additional income and diversified harvest such as fish and rice from water and onion, bean and sweet potato through cultivation on bunds
7. Fish control of unwanted filamentous algae which may otherwise compete for the nutrients
8. Tilapia and common carp control the unwanted aquatic weeds which may otherwise reduce rice yield up to 50 %
9. Insect pests of rice like stem borers are controlled by fish feeding on them mainly by murrels and catfishes
10. Fish feed on the aquatic intermediate host such as malaria causing mosquito larvae, thereby controlling water-borne diseases of human beings.
11. Rice fields may also serve as fish nurseries to grow fry into fingerlings. The fingerlings, if and when produced in large quantities, may either be sold or stocked in production ponds for obtaining better fish yield under composite fish culture.

### Site selection:

- About 80 cm rainfall is optimum for this integrated system.
- Fields having an almost uniform contour and high water retention capacity are preferred.
- Groundwater table and drainage system are important factors to be taken into consideration for selection of site.

### Types of paddy fields for integrated system:

Preparation of the paddy plot can vary according to the land contours and topography.

1. **Perimeter type:** The paddy growing area may be placed at the middle with moderate elevation and ground sloping on all sides into perimeter trenches to facilitate easy drainage.
2. **Central pond type:** Paddy growing area is on the fringe with slopes towards the middle.
3. **Lateral trench type:** Trenches are prepared on one or both lateral sides of the moderately sloping paddy field.

- Suppose the area of the integrated system is 100 m X 100 m i.e., 1 ha. The area to be utilized for paddy should be 82 m X 82 m i.e., 0.67 ha. The area to be utilized for fish culture should be 6m X 352 m i.e., 0.21 ha (4 sides).
- The embankment area should measure 3m X 388 m i.e 0.12 ha. and the area for fruit plants should be 1m X 388 m i.e., 0.04 ha. This is an ideal ratio for preparation of an integrated system.

## Paddy cultivation

### 1. Rice varieties used for integrated system:

- The most promising deep water varieties chosen for different states are PLA-2 ( Andhra Pradesh ) , IB-1, IB-2 , AR-1, 353-146 ( Assam ) , BR-14, Jisurya ( Punjab ) , AR 61-25B, PTB-16 ( Kerala ) , TNR-1, TNR (Tamil nadu), Jalamagan (Uttar Pradesh), Jaladhi-1, Jaladhi-2 (West Bengal) and Thoddabi (Manipur).
- Manoharsali rice variety seeds are used in rice fields where the fishes are reared.
- The paddy plot should be made ready by April - May. Having prepared the plot, deep water variety of paddy is selected for direct sowing in low lying areas after the first shower of monsoon rain.

### 2. Fertilization schedule:

- The paddy plots are enriched with farm yard manure or compost at 30 t / ha on a basal dose.
- The nutrient uptake of deep water paddy being very high, the rate of inorganic fertilizer recommended are nitrogen and potassium at 60 kg/ha.
- Nitrogen and posphorus are to be applied in three phases viz., at planting, tilling and flowering initiation.

### 3. Pesticide use:

- Paddy cum fish culture is not developed much due to the use of pesticides in rice fields for the eradication of different pest and these are toxic to fish.
- To overcome the pesticide problem, the integrated pest control system may be introduced and pesticides less toxic to fish may be used in low doses, if absolutely necessary.
- Pesticides like carbomates and selective organophosptes only should be used. Furadon when used 7 days prior to fish stocking proved to be safe.
- During the Kharif crop period, pesticides should be avoided. Harvesting of Kharif crop takes place in November - December. The yield in this crop is 800 - 1200 kg/ha.
- During the Rabi crop, the pesticides can be used according to the necessity. Before adding pesticides to paddy, the dyke of the trench should be increased so that the pesticide may not enter into the trenches. The yield in this rice crop is 4000 - 5000 kg/ha.

### Culturable species of fish in rice fields

- The fish species which could be cultured in rice fields must be capable of tolerating shallow water (>15 cm depth), high temperature (up to 35<sup>0</sup> C), low dissolved oxygen and high turbidity.
- Species such as *Labeo rohita*, *Catla catla*, *Oreochromis mossambicus*, *Anabas testudineus*, *Clarias batrachus*, *Clarias macrocephalus*, *Channa striatus*, *Channa punctatus*, *Channa marulius*, *Heteropneustes fossilis*, *Chanos chanos*, *Lates calcarifer* and *Mugil sp* have been widely cultured in rice fields. The minor carps such as *Labeo bata*, *Labeo calbasu*, *Puntius japonicus*, *P.sarana*, etc. can also be cultured in paddy fields.
- Culture of freshwater prawn *Macrobrachium rosenbergii* could be undertaken in the rice fields.
- The selection of species depends mainly on the depth and duration of water in the paddy field and also the nature of paddy varieties used.

### Major systems of paddy cum fish culture

Two major systems of paddy-cum-fish culture may be undertaken in the freshwater areas:

1. Paddy-cum-carp culture
2. Paddy-cum-air breathing fish culture

#### 1. Paddy-cum-carp culture:

- Major or minor carps are cultured in paddy fields.
- In the month of July when rain water starts accumulating in the paddy plot and the depth of water in the water way becomes sufficient, the fishes are stocked at the rate of 4000 - 6000 / ha .
- Species ratio may be 25% surface feeders, preferably catla, 30% column feeding, rohu and 45% bottom feeders mrigal or common carp.

#### 2. Paddy-cum-air breathing fish culture:

- Air breathing cat fish like singhi and magur are cultured in paddy fields in most rice grown areas.
- The water logged condition in paddy fields is very conducive for these fast growing air breathing cat fish.
- Equal number of magur and singhi fingerlings are to be stocked at one fish/m<sup>2</sup>. Channa species are also good for this integrated system.

### Fish culture in rice fields

Fish culture in rice fields may be attempted in two ways, viz. simultaneous culture and rotation culture.

#### Simultaneous culture:

- Rice and fish are cultivated together in rice plots, and this is known as simultaneous culture.
- Rice fields of 0.1ha area may be economical. Normally four rice plots of 250 m<sup>2</sup> (25 X 10 m) each may be formed in such an area. In each plot, a ditch of 0.75 m width and 0.5 m depth is dug.
- The dykes enclosing rice plots may be 0.3 m high and 0.3 m wide and strengthened by embedding straw.
- The water depth of the rice plot may vary from 5 - 25 cm depending on the type of rice and size and species of fish to be cultured.
- Five days after transplantation of rice, fish fry are stocked at the rate of 5000/ha or fingerlings at the rate of 2000/ha. The stocking density can be doubled if supplemental feed is given daily.



Releasing of fish seeds in paddy cum fish farm

The simultaneous fish - rice culture may have few limitations

1. Use of agrochemicals is often not feasible
2. Maintaining high water level may not be always possible, considering the size and growth of fish.
3. Fish like grass carp may feed on rice seedling, and
4. Fish like common carp and tilapia may uproot the rice seedlings. However, these constraints may be overcome through judicious management.



Simultaneous culture of paddy and fish

## 2. Rotational culture of rice and fish:

- In this system fish and rice are cultivated alternately. The rice field is converted into a temporary fish pond after the harvest.
- This practice is favoured over the simultaneous culture practice as it permits the use of insecticides and herbicides for rice production.
- A greater water depth up to 60 cm can be maintained throughout the fish culture period.
- One or two weeks after rice harvest, the field is prepared for fish culture.
- The stocking densities of fry or fingerlings for this practice could be 20,000/ha and 6,000/ha respectively.

### Fish culture:

- The weeds are removed manually in trenches or paddy fields.
- Predatory and weed fishes have to be removed either by netting or by dewatering.
- Mohua oil cake may be applied at 250 ppm to eradicate the predatory and weed fishes.
- After clearing the weeds and predators the fertilizers are to be applied. Cow dung at the rate of 5000 kg/ha, ammonium sulphate at 70kg/ha and single super phosphate at 50 kg/ha are applied in equal instalments during the rearing period.
- Stocking density is different in simultaneous and rotational culture practices.
- The fishes are provided with supplementary food consisting of rice bran and groundnut oil cake in the ratio 1:1 at 5% body weight of fishes in paddy cum carp culture.
- In paddy cum air breathing culture, a mixture of fish meal and rice bran in the ratio 1:2 is provided at the rate of 5% body weight of fishes.
- After harvesting paddy when plots get dried up gradually, the fishes take shelter in the water way. Partial harvesting by drag netting starts soon after the Kharif season and fishes that attain maximum size are taken out at fortnightly intervals.
- At the end of preparation when the water in the waterway is used up for irrigation of the Rabi paddy, the remaining fishes are hand picked.
- The fish yield varies from 700 - 1000 kg/ha in this integrated system.
- Survival rate of fish is less than 60 %. Survival rate is maximum in renovated paddy plots when compared to fish culture in ordinary paddy plots.
- The dykes constructed for this system may be used for growing vegetables and other fruit bearing plants like papaya and banana to generate high returns from this system.

## Composite fish culture

Fish ponds are a valuable source of protein and ready cash. Maximize production from your fish pond by raising combinations of between 3 and 6 complementary fish species which make best use of your pond's resources.

**Pond preparation** New ponds should be dug from clay loam soils. Avoid digging the pond on sandy soil.

- Narrow, rectangular ponds are easiest to manage. Allow for 0.2-0.4 ha in surface area and sloping in depth from 1.5 m to 2.5 m.
- Build the pond where it will be exposed to direct sunlight. Shade will reduce the pond's productivity.
- Apply lime to prevent fish diseases and parasites.

### Manuring

Use raw cow dung at the rate of 10-15 tonnes per ha per year.

Add about 2.5 tonnes to the pond 15 days before stocking and the remaining quantity in 10-11 monthly instalments. (If mahua has been applied to exterminate weed fish, forego the first application of cow dung.)

- Construct a bamboo crib to hold cow dung. Keep the crib filled with cow dung up to the water line.
- Defer application of cow dung for a few days if algal blooms appear and water becomes green.
- Add enough cow dung to make the water greenish-brown. This colour indicates there is plenty of natural food in the water.

Cow dung required (tonnes/ha/year)

Newly constructed pond	5.6 to 6.6
Pond which has been in use for some time	5.0 to 5.6
Old pond	0.7 to 0.5

### Lime dosage

Highly acidic	2,000 kg/ha
Near neutral	500 kg/ha
Mildly alkaline	200 kg/ha

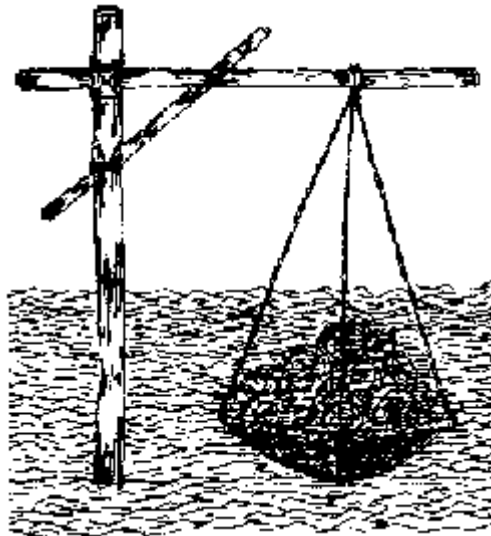
Highly alkaline no lime

Use litmus paper to test your pond's acidity.

Stocking

Note

Variation in pH is harmful to fish. Lime your pond one week before manuring.



Crib to hold cow dung

Fish fingerlings for stocking can be purchased from government fish farms or from private growers. Stock in October-November.

About 10-cm-long fingerlings should be used for stocking. A pond with 2-3 m depth should be stocked at 6,000-10,000 fingerlings per ha. Depending upon the availability of fingerlings, the pond can be stocked with 3, 4, or 6 species in the following ratios:

Note

Fingerlings should be transported in cool weather. In hot weather, transport in the early morning or evening.

Species combinations and their stocking ratios

	<b>3-species</b>	<b>4-species</b>	<b>6-species</b>
Catla	4	3	1.5
Rohu	3	3	2.0
Mrigal	3	2	1.5

Common carp	2	2.0
Silver carp		1.5
Grass carp		1.5

Introduction of fingerlings



Silver carp



Grass carp



Common carp



Catla



Rohu



Mrigal

Fish



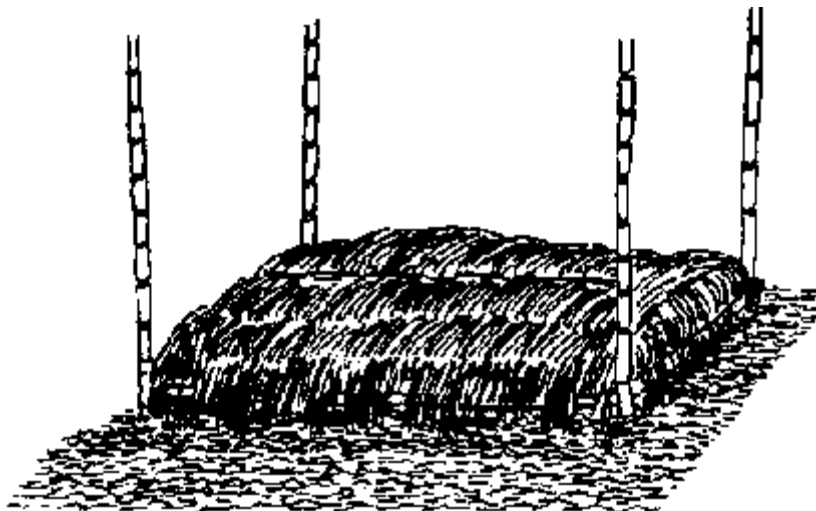
Right way-Release the fingerlings by gently tipping the plastic bag or container into the water.



Wrong way-Fingerlings should not be poured into the pond.

## Feeding

Fish eat tiny plants and animals zooplankton and phytoplankton-which float in the water. Your goal is to maximize the growth of this natural food through proper management, which includes fertilizing the pond. Your fish will also need food supplements of oil cake (e.g., mustard or groundnut oil cake)



Frame filled with aquatic weeds to feed grass carp and rice bran.

Grass-eating fish, such as grass carp, will need a regular supply of weeds.

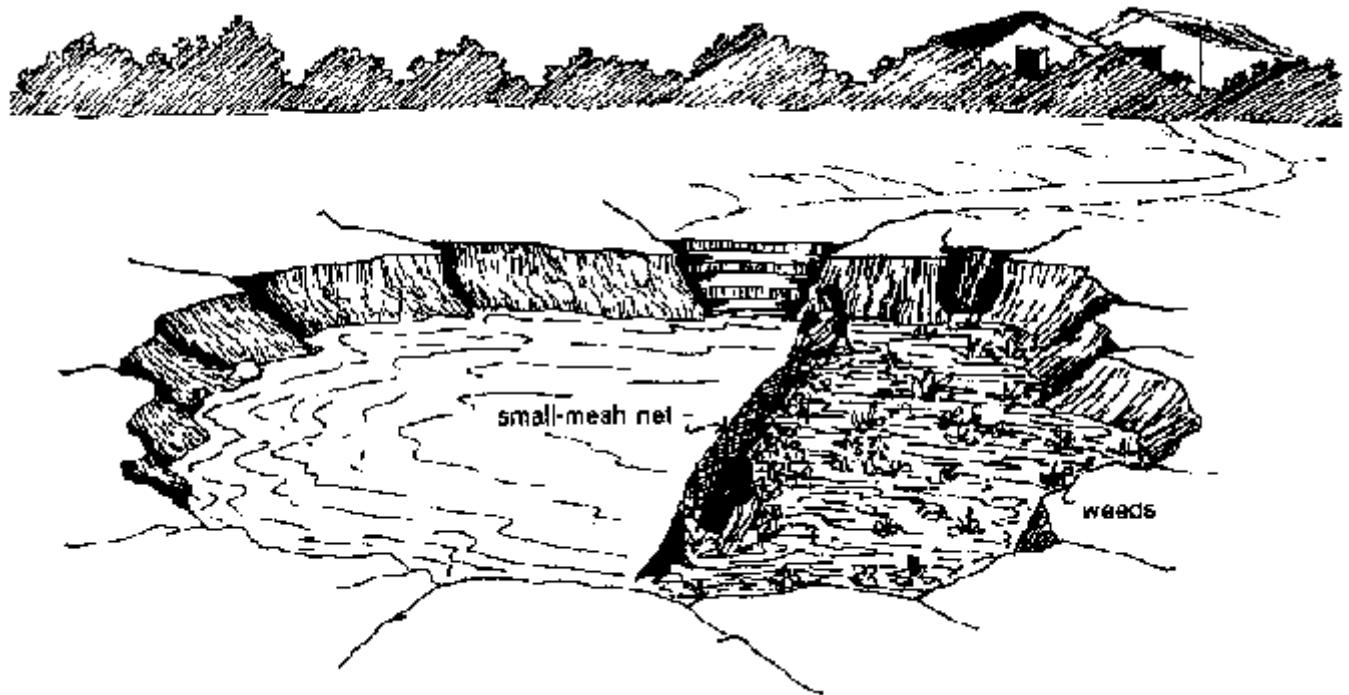
Part of the feed mixture can be broadcast at a fixed place. The rest of the feed can be made into a dough ball suspended in the water just below the surface.

To feed grass carp, suspend aquatic weeds on a frame made of bamboo and rope.

### Weed clearing

Weeds take up nutrients, harbour harmful insects, consume oxygen, and block sunlight. They must be removed from the pond.

- Floating weeds, such as water hyacinth and pistia, can be removed by hand.
- Lighter floating weeds, such as spirodella, lemna and wolfia, can be removed by dragging a rope or small-mesh net across the pond surface.

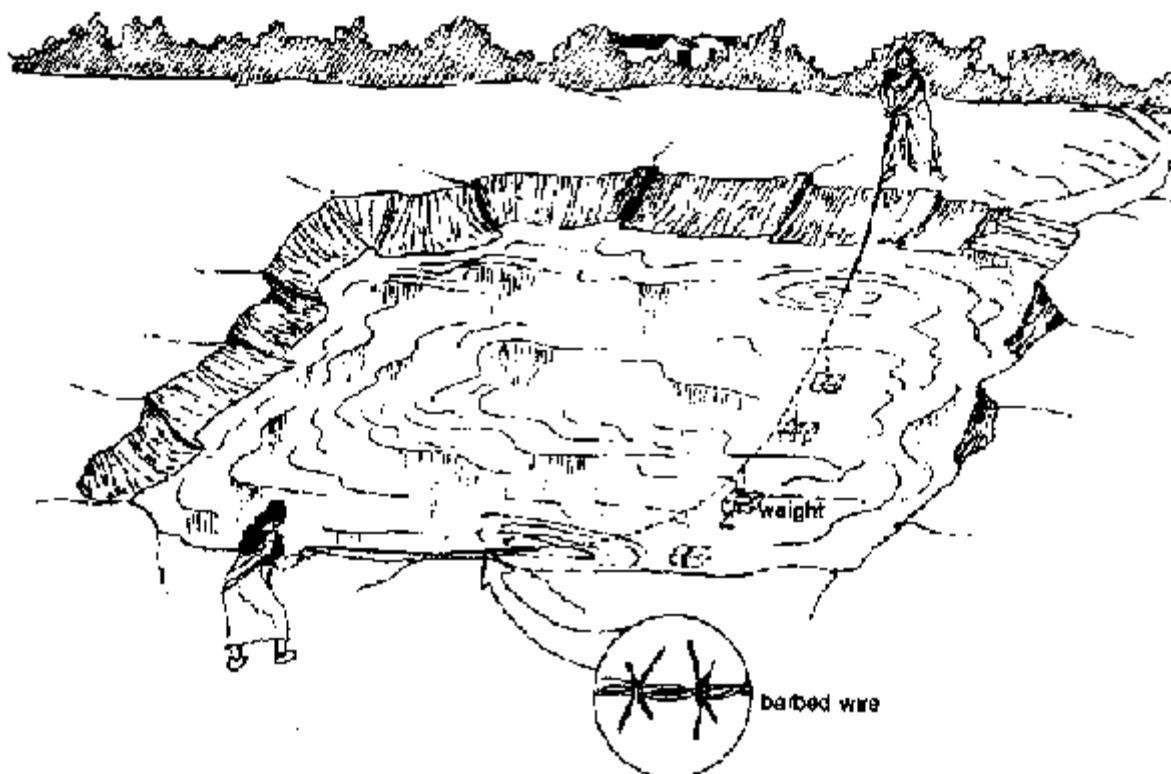


### Removing surface weeds

- Underwater weeds can be pulled up by dragging a length of weighted barbed wire or chain along the bottom of the pond

### Rake your pond

Rake the bottom of your pond periodically to release nutrients. This can be done by dragging bricks along the bottom.



Dragging weighted barbed wire to remove underwater weeds

#### Note

After applying mahua, wait before introducing your new species. Wait longer if a heavy dose of mahua cake is given. The minimum waiting period is 24 hours.

#### Undesirable fish

Eradicate predatory or "weed" fish with mahua oil cake. Broadcast soaked mahua oil cake uniformly over the pond at the rate of 2-2.5 tonnes per hectare of pond surface, with a pond depth of 1 metre. Mahua oil cake is available in the market. Fish killed by mahua oil cake can be eaten.

#### Problems and solutions

If water level drops due to excessive evaporation

- add water to the pond.

If fish come to the surface with their snouts protruding for air (most obvious

- stop applying manure and stop supplementary feeding.

- add fresh water to the pond. ing from the water, gulp

- beat the surface of the water with bamboo poles.

In the early morning)

- cut banana trunks into small bits and scatter

	<p>them on the hand surface to help reduce acidity.</p> <ul style="list-style-type: none"> <li>- pull a drag-net through the pond several times for aeration.</li> <li>- apply potassium permanganate at 1 to 2 mg per litre.</li> <li>- apply lime at 300 to 500 kg per ha of pond surface.</li> </ul>
If algal bloom forms	<ul style="list-style-type: none"> <li>- release silver carp yn the pond, 500 per ha of pond surface.</li> </ul> <p>(Average weight of silver carp should be 100 g.)</p>
If birds are eating your fish	<ul style="list-style-type: none"> <li>- install scarecrows or other bird-scaring devices.</li> </ul>
If your fish are being taken	<ul style="list-style-type: none"> <li>- watch your pond more closely.</li> <li>- float branches in the pond. This will prevent netting.</li> </ul>
If fish become diseased	<ul style="list-style-type: none"> <li>- net out the diseased fish and have them examined at the nearest government fisheries office for possible remedial measures.</li> </ul>

## Harvesting

Harvest the fish after one year when they have reached a marketable size of 0.6-1 kg If the pond is threatened by flood, drought, or disease, consider harvesting early When netting, start from the deep end of the pond and drag the net slowly toward the shallow end

## Cost and return from a one-hectare pond

Oil cake (3,000 kg @ Rs 5/kg)	15,000
Rice bran (3,500 kg @ Rs 2 50 /kg)	8,750
Labour (2 people) 360 person-days	7,200
	30,950
<b>Interest 15%</b>	4,642
	<b>Rs 35,592</b>
<b>Income</b>	
Sales of 4,000 kg of fish @ Rs 22/kg	Rs 88,000
<b>Net Profit</b>	
(Rs 88,000 - Rs 35,600)	<b>Rs 52,400</b>

## **Fish culture in cages**

Both fish pens and fish cages are confinement structures used for rearing fish. The pen, however, is larger; it ranges from 10,000 sq m to more than a square kilometer in contrast to the cage which ranges in size from one square meter to several hundreds of square meter. Also, cage culture is done in at least one-meter water depth or in deeper waters. Thus, this type can either be stationary or a floating cage which can then be established in the sea, lake, cove or river where biophysical factors are favorable.

Species of fish that are grown in fish cages are usually expensive and sold live for a certain group of consumers. Demand for live fish exports to Taiwan, Hongkong and China is fast-increasing. Seafoods that are popularly exported alive and grown in cages are grouper, humphead wrasse, lobster and seabass. These species, when cooked alive, command more than triple in prices. Wrasse and groupers are first-class fish species that are believed to also have medicinal properties for sick and recuperating people.

### **Site selection**

Fish cages should be installed in suitable areas that are protected from strong waves and currents, free from pollution and accessible to the farmers and market. A minimum depth of one meter is required.

### **Fish cages**

There are two common types of floating fish cages: the bamboo frame cage and the nylon net cages with frames. They are both provided with anchors and floats. Fish cage rearing can be done in freshwater and brackishwater areas.

### **Bamboo frame fish cages**

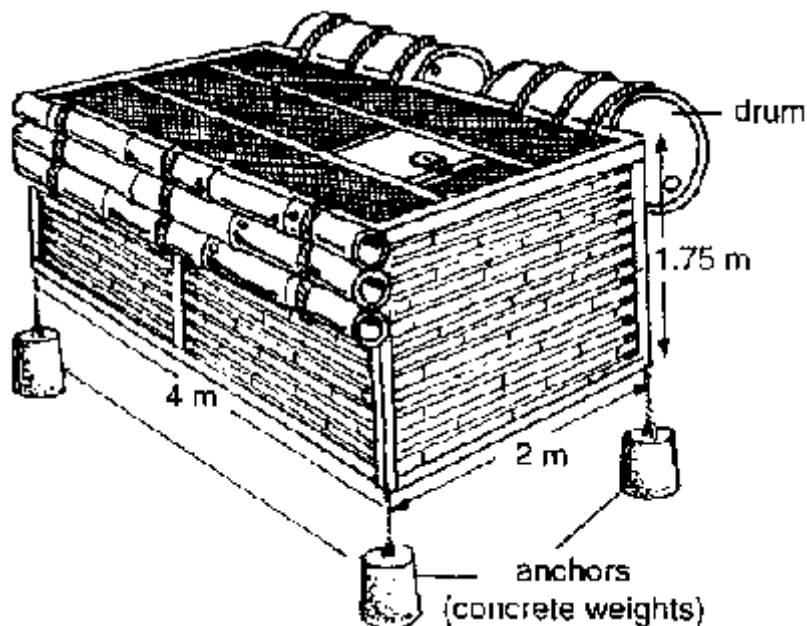
They are made of hard bamboo slats tied or nailed to wooden frames. The usual measurements are: 2 m long, 2 m wide and 2 m deep,  $3 \times 3 \times 2$  m and  $4 \times 2 \times 1.75$  m. They are provided with whole bamboo floats or empty drums at the top side. Net or bamboo top cover with door and lock is provided.

### **Advantages**

- Cages are easy and cheap to construct.
- Cages can be operated cooperatively.
- Cages are easy to stock and feed
- Fish grow fast in cages.
- Cages are easy to harvest.

## Net fish cages

They are made of fine-meshed (0.32-1.27 cm) nylon nets connected to a float frame of whole bamboo with empty drums of plastic or styrofoam to enhance buoyancy. The empty drum is optional for a small-sized net cage. The usual size is 8-10 sq m with 2 m-2.5 m depth. The net cages are provided with concrete weights that also serve as anchors. The cage is also provided with a mooring line to keep it in place, as well as reinforcement bamboo frames to spread the nets.

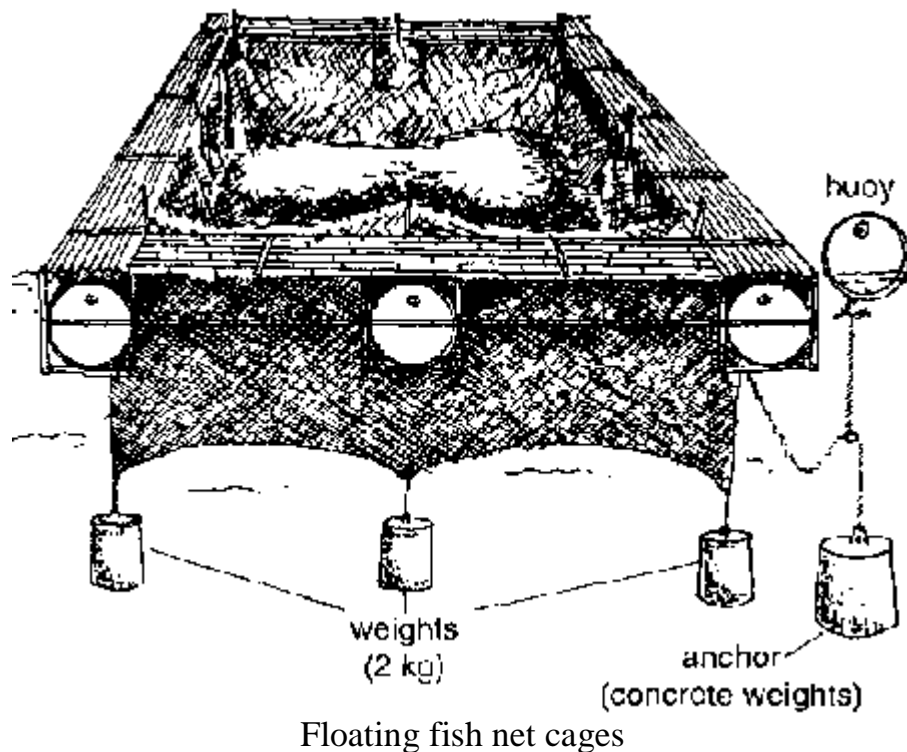


Floating bamboo fish cage

## Management

Fish cages can be used for fish fattening or growing. For growing purposes, use fingerlings. Before stocking, weigh and count the fish.

As a nursery for fingerlings, the cage should be made of fine mesh net. The size is appropriate for easy handling. There are two cages —the first is a brooder's cage with a 1.255.0 cm mesh size This is placed inside a bigger cage which functions as the confinement cage or as a conditioning cage for fishes, subject to transport. This is commonly used for rearing fingerlings to marketable-sized fish. The net's mesh size depends on the size of fish or fingerling that would be stocked initially. The cage area usually ranges from 1 sq m to 100 sq m or more and the depth ranges from 1.0-2.0 m or more. Cages are subject to fouling organisms. Clean heavily fouled nets as often as necessary to ensure efficient water change.



Check the net daily for possible damages to prevent escape of the stocks. Check also the structure (e.g., bamboo structures, ropes, sinkers, floats, etc.). Guarding the fish cages should be done at all times to prevent losses from poaching. Construct a caretaker's hut at the culture site to discourage poachers.

#### Rearing of the stock

Fish sampling is done at least every month to determine the growth rate and the proper quantity of feed to be given. Expose the fish to outside parameters that may affect their feeding performance which eventually affects their growth rate. During the wet season, water temperature usually drops; thus, decelerating growth rate. In summer, the growth rate is faster. Hence, feeding should be regulated. Practice an addition feeding to determine the actual food needs of the fish, especially before the sampling schedule. Do not feed fish subject for sampling.

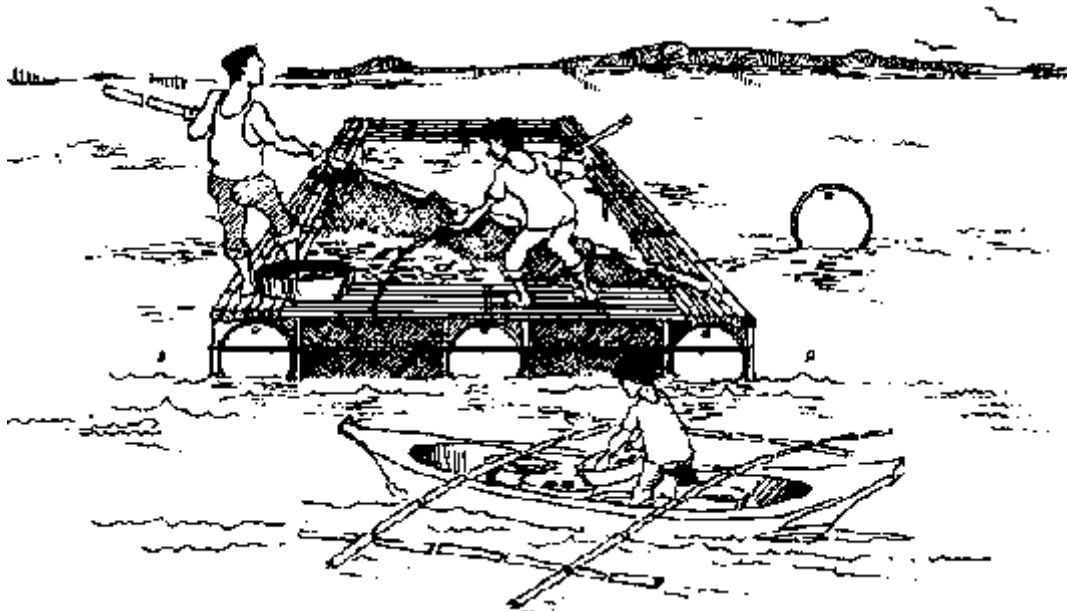
On the average, depending on the fish species and the kind of feeds, the feeding rate is three to five percent of the body weight. Give commercial feeds at three percent and trash fish at five percent. In the absence of commercial type, an alternative feed may be made at home, suited to fish requirement, e.g., a 70-percent rice bran, mixed with 30-percent fish meal or fine trash fish for *Tilapia mosambica* (hybrid). Feeding should be done early in the morning and late in the afternoon by equally dividing the feed needed. It is important that feeds are available at all times when using fish cages. Feeding trays may be used to minimize wastage of feeds.

Culture period ranges from three to five months. The stocking rate can be 5-20 pieces per square meter.

## Harvesting and marketing

Here is one way of harvesting fish: For the net cage, untie the bindings at the corners and sides of the net from the float frame. Insert a bamboo pole at the upper edge of the net cage and push the net along in order to corner the fish at one end. Scoop the fish with hand nets.

The fish, if sold live, fetches a higher price. It is, therefore, advisable to place the fish in double plastic bags containing well-oxygenated water. The bags are then placed in styrofoam or burl bag containers. Dead fishes to be sold should be packed in crushed ice at the rate of 1:4 by weight (1 kg ice to 4 kg fish) for nearer markets and 1:1 ratio for more distant markets at a temperature of 0° C which is good only for 24 hours or less.



Pull out the net for cleaning and repair after harvest.

## **Fish culture in pens**

The implementation of the Agrarian Reform Law covered fishponds which resulted the imposition of a ban on the issuance of new fishpond lease agreements and their renewal. The law prompted many businessmen to grow fishes in pens instead, because this is exempted.

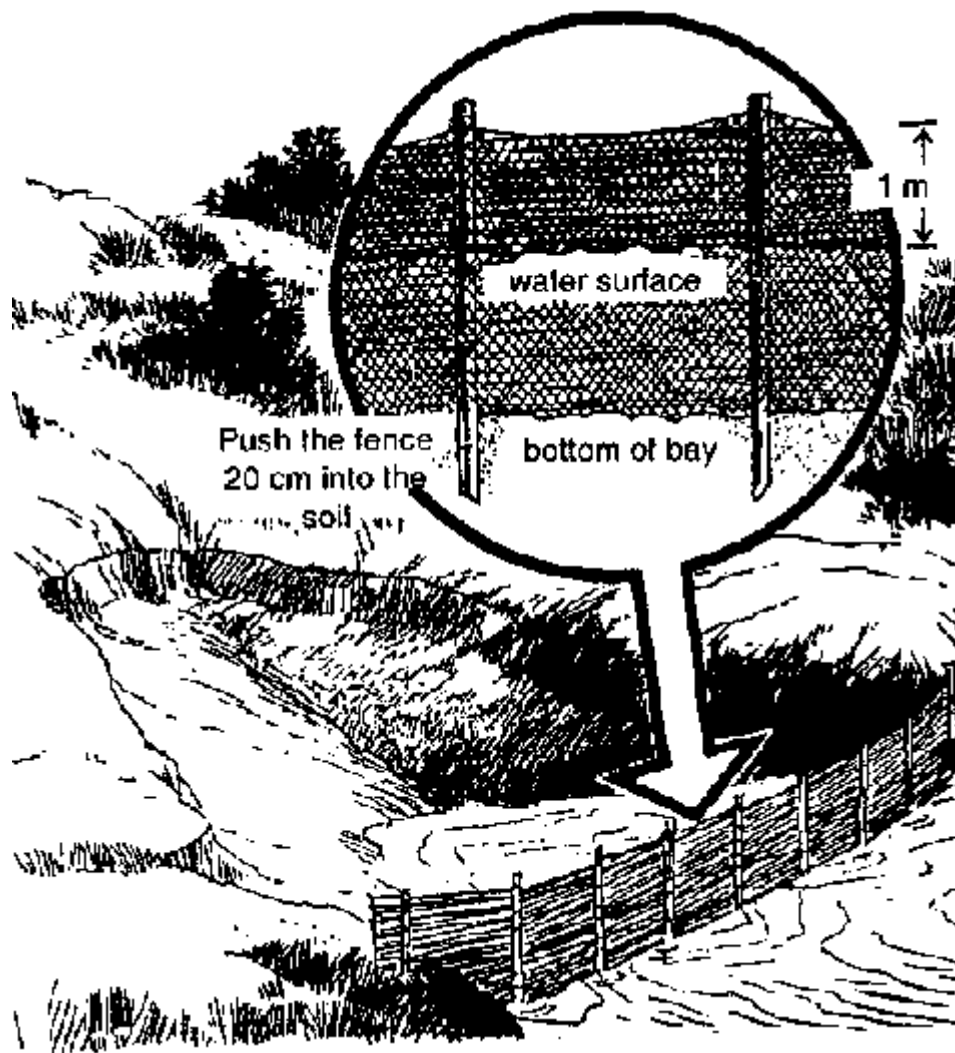
Fish-pen culture also became popular because of the fast-increasing demand for live fish both for export and domestic consumption. The price of exotic live fish is about triple to quadruple compared to the traditional chilled fish, such as groupers, seabass, lobsters, etc. Many Chinese and Japanese businessmen believed that eating live fish gives good fortune and luck. Studies also show that the prices of developing fishponds are quite prohibitive compared to establishing fishpens.

The availability of fingerlings for growing in fishpens also promoted the rapid expansion of fish culture using pens. Southeast Asian Fisheries Development Center (SEAFDEC) and the private sector have made breakthroughs in breeding milkfish, seabass and grouper in captivity. Prawns, tilapia and shrimp (*Macrobrachium* spp.) were successfully produced earlier in hatcheries.

Also, although the fish pen is similar to fishponds, free-flowing water in the pen provides adequate supply of dissolved oxygen critical to fish culture. The use of aerators in fishponds is becoming expensive and risky because of erratic electricity. Fish pens will likewise put underutilized freshwater and brackishwater aquatic resources into productive use.

Fish pens can be set up in brackish and freshwaters, depending on the type of culture and kind of fish to be grown. Bays and coves, places with laminar and steady flow of water, optimum oxygen content and food are desirable places for establishing a fish pen. For small lakes and rivers, fish-pen management is relatively easier due to its proximity. However, seasonal patterns (e.g., seasonal overturn or oxygen cycle) should first be determined to ensure viability of this activity.

In freshwater bodies, polyculture may be done to maximize its use and efficiency, provided the species to be grown are compatible. An example of polyculture is a combination of carp, tilapia, shrimp and clams in the fish pen. Tilapia is a surface feeder while carp is a bottom eater, like the clam and shrimp. Tilapia *mosambica* can also exist in brackishwater and can be combined with seabass or grouper.



How to construct the fence

Polyculture can be practiced in both saline and freshwaters. For instance, *Tilapia mosambica* can co-exist with seabass or grouper. *Tilapia* fingerlings can, thus, serve as natural food since the grouper and seabass are carnivorous while the tilapia is planktonic. Milkfish can also be combined with mud crab and tiger prawn.

Freshwater fish pens should be shallow, ranging from 50.0 to 80.0 cm to allow rapid multiplication of food materials, such as phytoplankton, algae (lumot) and other plants. On the other hand, brackishwater fish pens should be 1.0 m to 1.5 m below zero tide level to allow effective photosynthesis. Ideal salinity conditions are usually from 10 to 25 ppt.

#### Methods of fish-pen construction

The type of construction depends on the configuration of water bodies and the desired species. Two common fish pen structures are the barricade and full-fence type. Both types can use either the slat or flattened bamboo fence or the combination of nylon nets and bamboo frames. Hang the net one meter from the

water surface to prevent fish from escaping while the bamboo posts should be higher than the highest high tide level by at least 30 cm to ensure confinement of the stocks inside even during the flooding period.

### Barricade Type

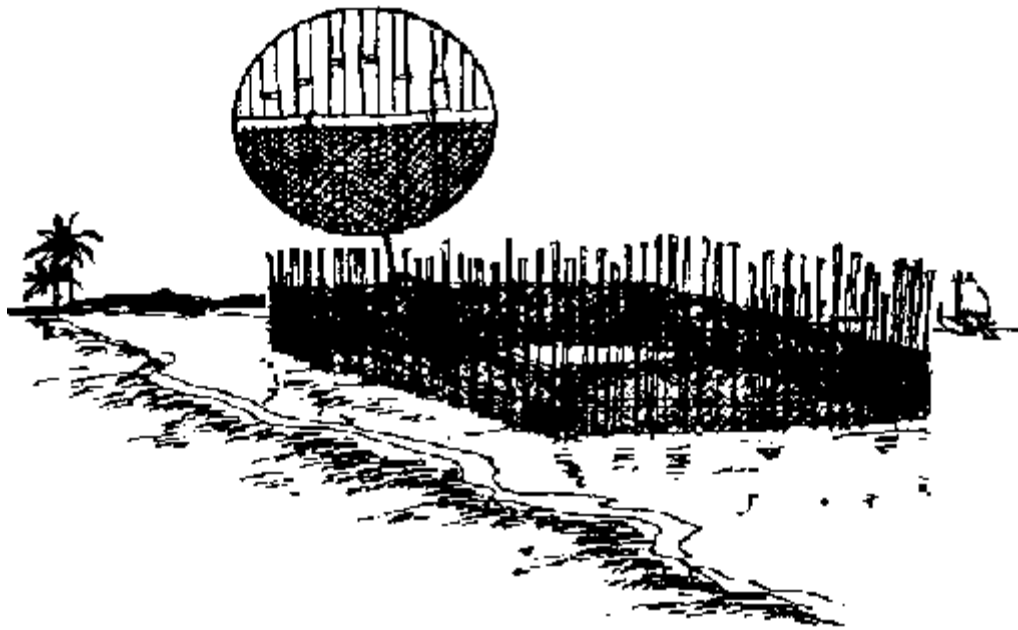
This type of fish pen is applicable in narrow shallow inlets, small coves or submerged protected bays or lakes. Barricade fish pen is more economical because you have to fence only one, two or three sides.



Barricade fish pen

### Conventional fish pen

This type is more common in big bodies of water, like bays and lakes where tidal fluctuation occurs and where waters rise and recede frequently. It is fully enclosed with a fence, using either flattened bamboo or bamboo slats and polyethylene or coralon nets framed with bamboo or wood.



Typical conventional fish pen

### Management of fish pens

Check the net enclosure daily for damages to prevent the escape of fish. A practical method of monitoring is by setting up a gill net in the four corners of the pen. A fish caught in any of these corners would indicate net damage in the enclosure net. Another is simply by finding out if those fishing (with gill net) near the pen have caught any of the species grown in the pen. This may, however, become a difficult way of monitoring net damages.

Supplemental or full feeding depends on the species of fish grown. Freshwater fish, like milkfish, tilapia or carp, need full feeding for the intensive method (20,000 to 30,000 fingerlings per 10,000 sq m) and supplemental feeding for semi-extensive (10,000 to 15,000 per 10,000 sq m). Selective feeding is done under extensive method of culture (3,000 to 7,000 per 10,000 sq m).

The amount of commercial feed given is normally computed at three percent of the body weight.

Monoculture of brackishwater fish species, like seabass and grouper, needs full feeding of trash fish, mussels or snails. Fresh trash fish is computed at five percent of the body weight of the fish population. Sampling of weight should be done at least every five days. Siganid or rabbitfish also needs supplemental feeding together with prawns.

Polyculture of tilapia with grouper or seabass needs supplemental and selective feeding. Stock the tilapia breeders at least one to 1½ months earlier to allow lead time for the production of fingerlings as feed.

Feeding should be done at least twice a day-one in the early morning and one in the late afternoon, equally dividing the amount of feeds required.

Monoculture stocking in fish pens can be done at two to five fingerlings per square meter.

### Harvesting

Selective harvesting can be done using pole and hook, cast net or gill net. Full harvesting is usually done with the use of seine nets during low tide. Tilapia cannot be fully harvested because about 20 - 30 percent burrow in the bottom during harvesting. At any rate, any volume can be harvested everyday, depending on the market (i.e., demand, price). The culture or growing period of different species ranges from three to five months.

Since live fish fetch higher price, transport harvested fish in double plastic bags with oxygenated water. Use styrofoam or burl bag containers.

### Profitability of fishpen culture

There is less initial capital needed in fish pen culture because, unlike with fishponds, purchase of land is not necessary. The economics of production varies, depending on the site, type of pen, kind of fish cultured and method of culture. Profits for brackishwater fish are usually higher than those from freshwater. It is more advantageous and profitable to grow expensive fish species in fish pens that are popularly sold alive. Growing in fishpens can be done two to three times a year.

## Integrated fish farming

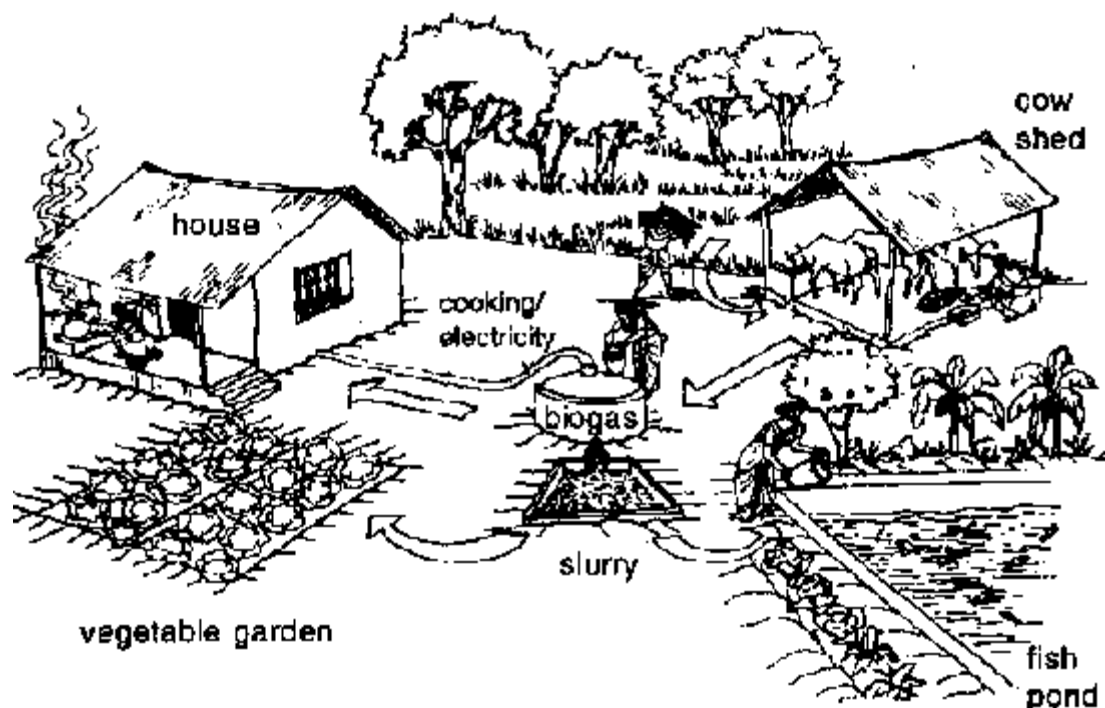
Raising fish in combination with pigs, poultry, cattle, or ducks can raise family income.

Since animal waste makes good fertilizer for fish ponds, and since 60 percent of the cost of fish farming goes for feed, integrating livestock and fish farming makes sense. Try a combination of different animals and crops that best suit your area. Grow vegetables and other crops on the pond dykes. Use animal waste to run a biogas plant and then feed the biogas slurry to fish—it is better than raw waste as fish-pond fertilizer. The goal is efficiency and higher profits.

Possible combinations include:

- Fish-cattle
- Fish-duck
- Fish-poultry
- Fish-pig
- Fish-goat or -sheep
- A combination of fish with two or more types of livestock (e.g., poultry pigfish)

Poultry- fish culture

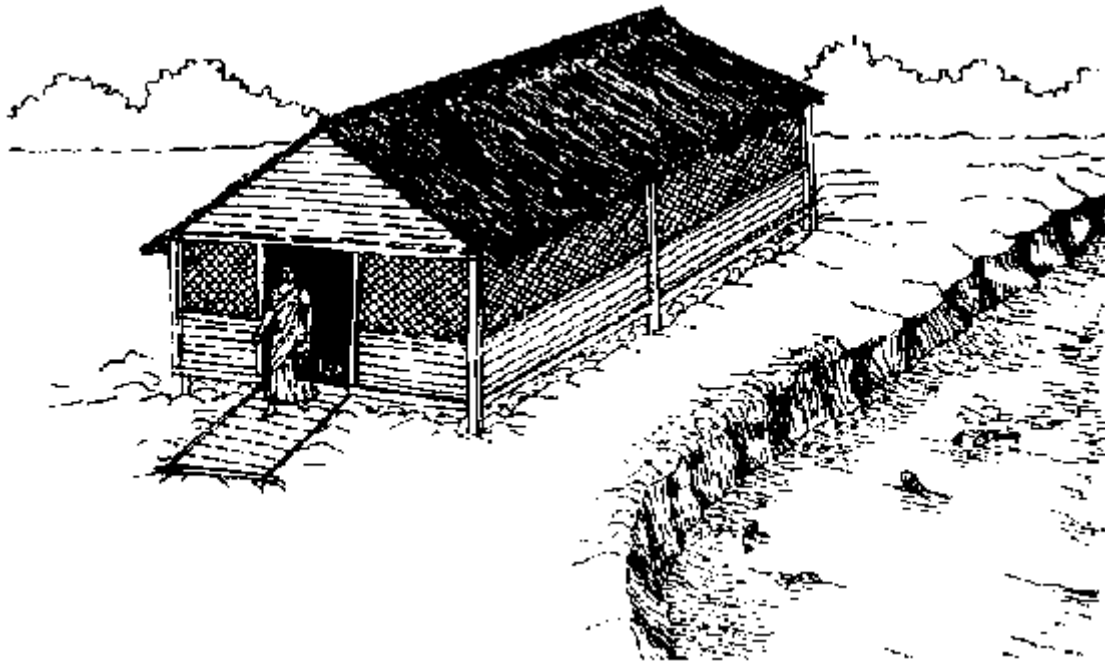


Poultry- fish culture

Deep litter system

Between 500 and 600 birds will produce enough litter for a 1 ha fish pond. Using this system, 4,000-5,000 kg of fish 60,000 eggs and 1,200 kg of chicken can be produced annually.

- Locate the poultry house near the fish pond.
- Construct the poultry house floor out of brick, concrete, or hard soil.



Deep litter system

Cover the floor to a depth of 15 cm with chopped straw, dry leaves, hay, groundnut shells, broken maize stocks, or sawdust.

Provide 0.3 to 0.4 sq m per bird.

Keep the birds on the litter to collect their droppings.

Stir the bed regularly.

Keep adding more organic matter to maintain the required depth of 15 cm.

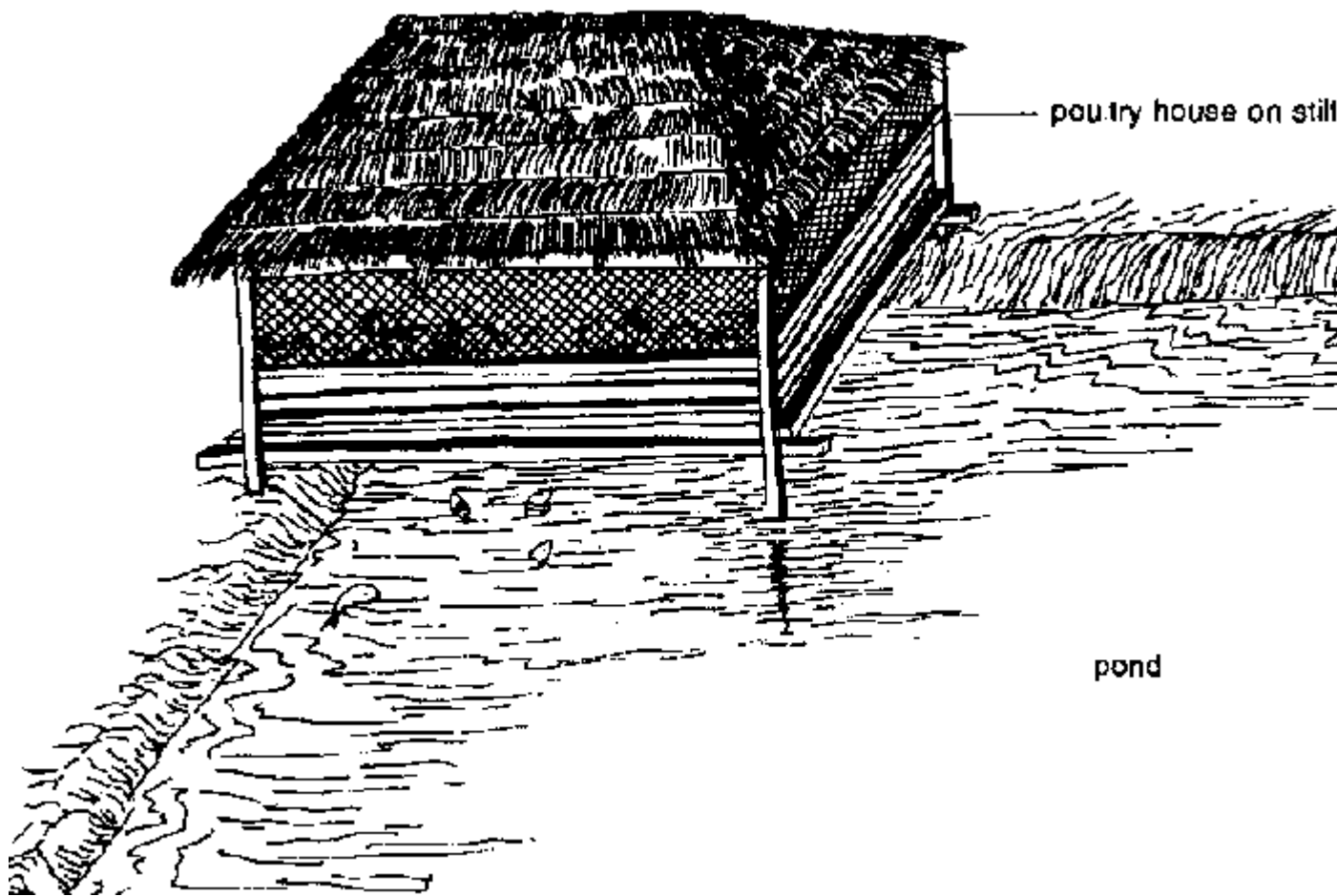
If the litter becomes damp, add superphosphate or lime to keep it dry.

After 10-12 months, the litter is fully built up and its nitrogen content has reached about 3 percent. This litter can be used as fertilizer for your fish pond.

Store the litter in a dry place and apply it to the pond at the rate of 15-20 kg/ha per day.

Slatted floor system

Build a poultry house on stilts over the pond. Build the floor out of slatted bamboo or slatted wood so that the bird droppings fall directly into the pond. The birds can be kept in cages or allowed to move freely inside the poultry house. pond



Pond

Note

Do not apply litter when algal blooms appear at the surface of the pond.

### **Composite fish culture**

Fish ponds are a valuable source of protein and ready cash. Maximize production from your fish pond by raising combinations of between 3 and 6 complementary fish species which make best use of your pond's resources.

**Pond preparation** New ponds should be dug from clay loam soils. Avoid digging the pond on sandy soil.

- Narrow, rectangular ponds are easiest to manage. Allow for 0.2-0.4 ha in surface area and sloping in depth from 1.5 m to 2.5 m.

- Build the pond where it will be exposed to direct sunlight. Shade will reduce the pond's productivity.

- Apply lime to prevent fish diseases and parasites.

### Manuring

Use raw cow dung at the rate of 10-15 tonnes per ha per year.

Add about 2.5 tonnes to the pond 15 days before stocking and the remaining quantity in 10-11 monthly instalments. (If mahua has been applied to exterminate weed fish, forego the first application of cow dung.)

- Construct a bamboo crib to hold cow dung. Keep the crib filled with cow dung up to the water line.

- Defer application of cow dung for a few days if algal blooms appear and water becomes green.

- Add enough cow dung to make the water greenish-brown. This colour indicates there is plenty of natural food in the water.

### Cow dung required (tonnes/ha/year)

Newly constructed pond	5.6 to 6.6
Pond which has been in use for some time	5.0 to 5.6
Old pond	0.7 to 0.5

### Lime dosage

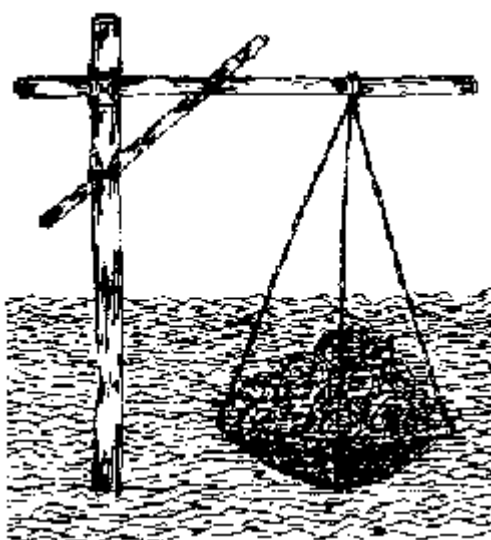
Highly acidic	2,000 kg/ha
Near neutral	500 kg/ha
Mildly alkaline	200 kg/ha
Highly alkaline	no lime

Use litmus paper to test your pond's acidity.

### Stocking

### Note

Variation in pH is harmful to fish. Lime your pond one week before manuring.



Crib to hold cow dung

Fish fingerlings for stocking can be purchased from government fish farms or from private growers. Stock in October-November.

About 10-cm-long fingerlings should be used for stocking. A pond with 2-3 m depth should be stocked at 6,000-10,000 fingerlings per ha. Depending upon the availability of fingerlings, the pond can be stocked with 3, 4, or 6 species in the following ratios:

Note

Fingerlings should be transported in cool weather. In hot weather, transport in the early morning or evening.

Species combinations and their stocking ratios

	<b>3-species</b>	<b>4-species</b>	<b>6-species</b>
Catla	4	3	1.5
Rohu	3	3	2.0
Mrigal	3	2	1.5
Common carp		2	2.0
Silver carp			1.5
Grass carp			1.5

Introduction of fingerlings



Silver carp



Grass carp



Common carp



Catla



Rohu



Mrigal

Fish



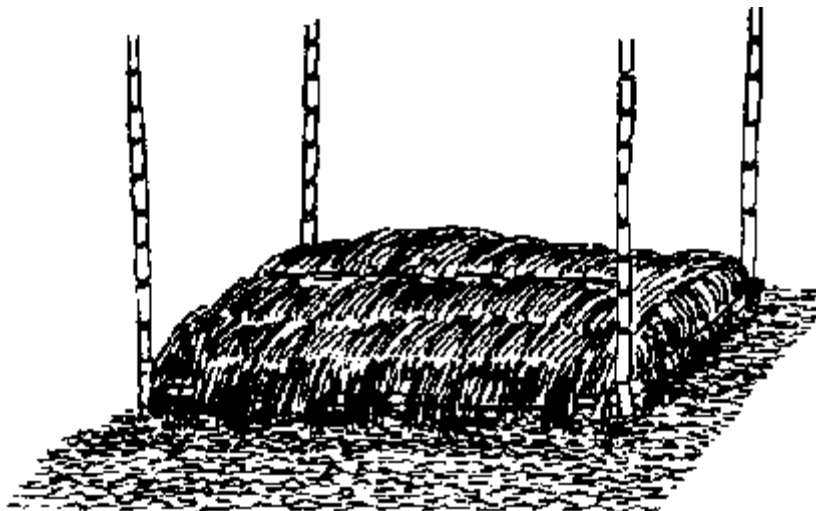
Right way-Release the fingerlings by gently tipping the plastic bag or container into the water.



Wrong way-Fingerlings should not be poured into the pond.

## Feeding

Fish eat tiny plants and animals zooplankton and phytopinkton-which float in the water. Your goal is to maximize the growth of this natural food through proper management, which includes fertilizing the pond. Your fish will also need food supplements of oil cake (e.g., mustard or groundnut oil cake)



Frame filled with aquatic weeds to feed grass carp and rice bran.

Grass-eating fish, such as grass carp, will need a regular supply of weeds.

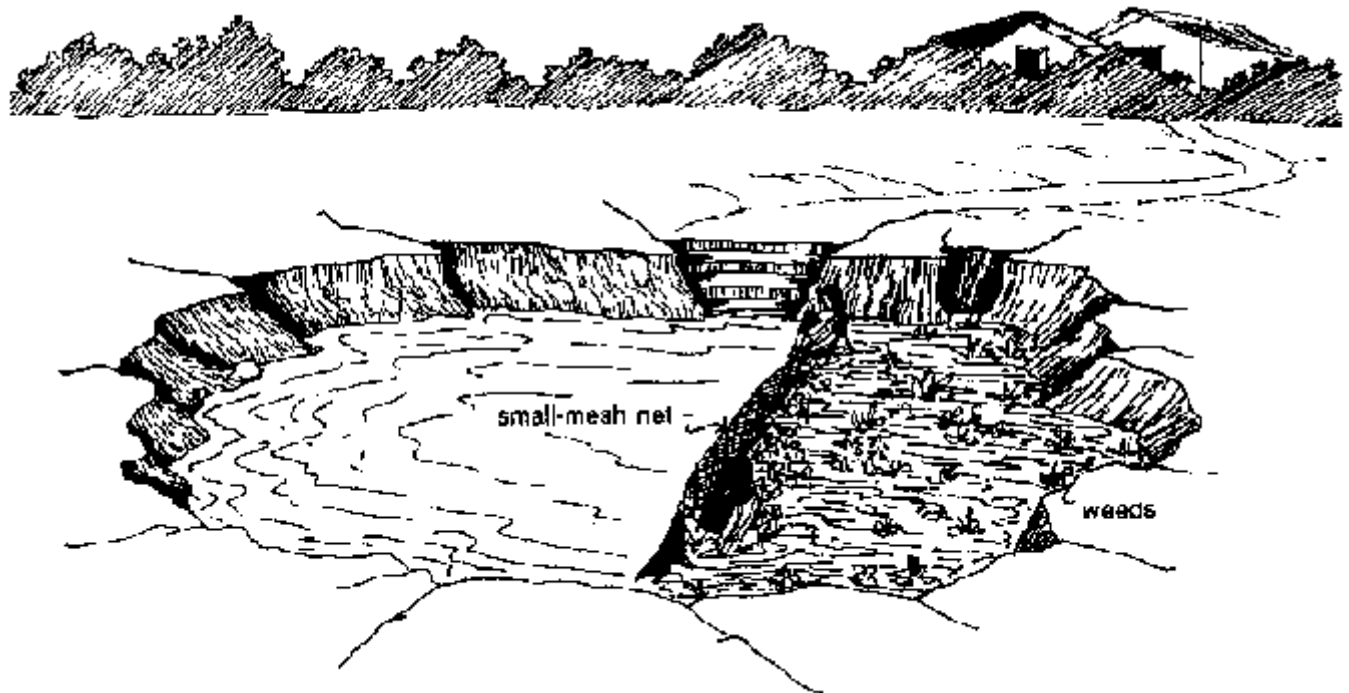
Part of the feed mixture can be broadcast at a fixed place. The rest of the feed can be made into a dough ball suspended in the water just below the surface.

To feed grass carp, suspend aquatic weeds on a frame made of bamboo and rope.

### Weed clearing

Weeds take up nutrients, harbour harmful insects, consume oxygen, and block sunlight. They must be removed from the pond.

- Floating weeds, such as water hyacinth and pistia, can be removed by hand.
- Lighter floating weeds, such as spirodella, lemna and wolfia, can be removed by dragging a rope or small-mesh net across the pond surface.

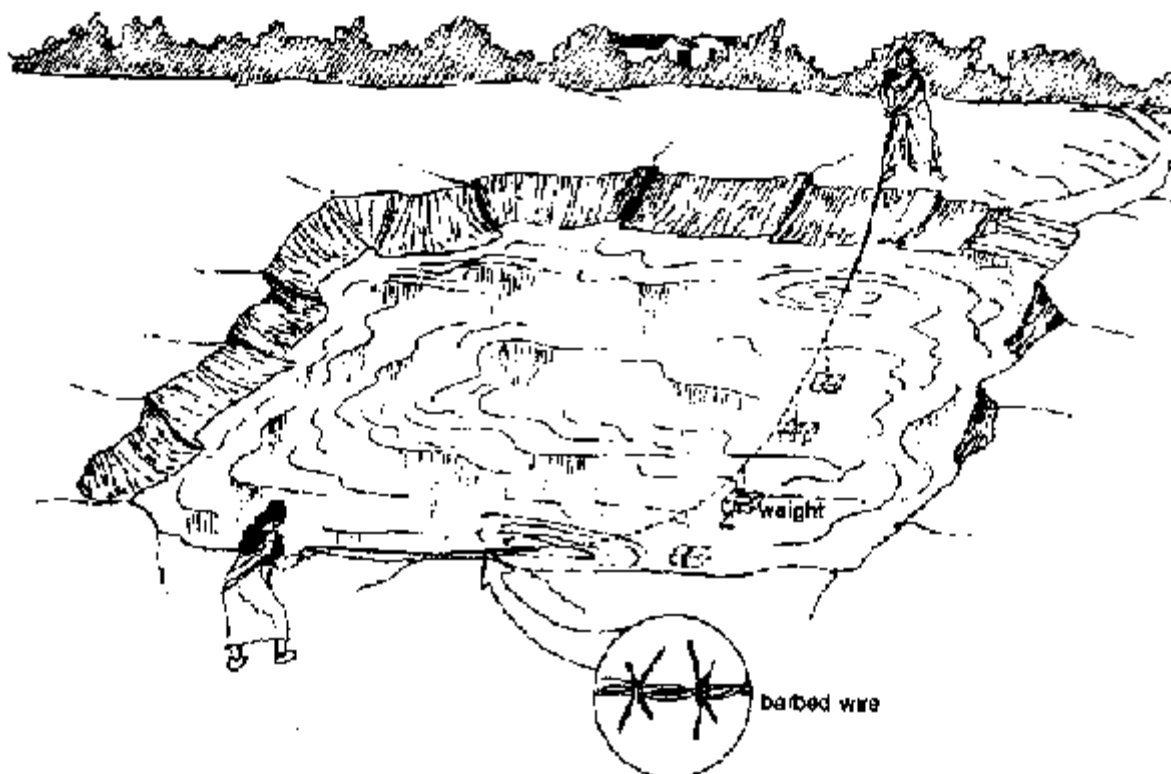


### Removing surface weeds

- Underwater weeds can be pulled up by dragging a length of weighted barbed wire or chain along the bottom of the pond

### Rake your pond

Rake the bottom of your pond periodically to release nutrients. This can be done by dragging bricks along the bottom.



Dragging weighted barbed wire to remove underwater weeds

#### Note

After applying mahua, wait before introducing your new species. Wait longer if a heavy dose of mahua cake is given. The minimum waiting period is 24 hours.

#### Undesirable fish

Eradicate predatory or "weed" fish with mahua oil cake. Broadcast soaked mahua oil cake uniformly over the pond at the rate of 2-2.5 tonnes per hectare of pond surface, with a pond depth of 1 metre. Mahua oil cake is available in the market. Fish killed by mahua oil cake can be eaten.

#### Problems and solutions

If water level drops due to excessive evaporation

- add water to the pond.

If fish come to the surface with their snouts protruding for air (most obvious

- stop applying manure and stop supplementary feeding.

- add fresh water to the pond. ing from the water, gulp

- beat the surface of the water with bamboo poles.

In the early morning)

- cut banana trunks into small bits and scatter

	<p>them on the hand surface to help reduce acidity.</p> <ul style="list-style-type: none"> <li>- pull a drag-net through the pond several times for aeration.</li> <li>- apply potassium permanganate at 1 to 2 mg per litre.</li> <li>- apply lime at 300 to 500 kg per ha of pond surface.</li> </ul>
If algal bloom forms	<ul style="list-style-type: none"> <li>- release silver carp yn the pond, 500 per ha of pond surface.</li> </ul> <p>(Average weight of silver carp should be 100 g.)</p>
If birds are eating your fish	<ul style="list-style-type: none"> <li>- install scarecrows or other bird-scaring devices.</li> </ul>
If your fish are being taken	<ul style="list-style-type: none"> <li>- watch your pond more closely.</li> <li>- float branches in the pond. This will prevent netting.</li> </ul>
If fish become diseased	<ul style="list-style-type: none"> <li>- net out the diseased fish and have them examined at the nearest government fisheries office for possible remedial measures.</li> </ul>

## Harvesting

Harvest the fish after one year when they have reached a marketable size of 0.6-1 kg If the pond is threatened by flood, drought, or disease, consider harvesting early When netting, start from the deep end of the pond and drag the net slowly toward the shallow end

## Cost and return from a one-hectare pond

Oil cake (3,000 kg @ Rs 5/kg)	15,000
Rice bran (3,500 kg @ Rs 2 50 /kg)	8,750
Labour (2 people) 360 person-days	7,200
	30,950
<b>Interest 15%</b>	4,642
	<b>Rs 35,592</b>

## Income

Sales of 4,000 kg of fish @ Rs 22/kg Rs 88,000

## Net Profit

(Rs 88,000 - Rs 35,600) Rs 52,400

Sources: Central Institute of Fisheries Education, Bombay and Dr. V. R. P. Sinha and Nirmal K Thakur

## Paddy - fish culture

Fish raising and paddy growing make a profitable on-farm combination. The system described here produces two crops of paddy tall variety in the wet season and a higher yielding variety in the dry season and a single crop of fish.

### Fish species mix and stocking rate

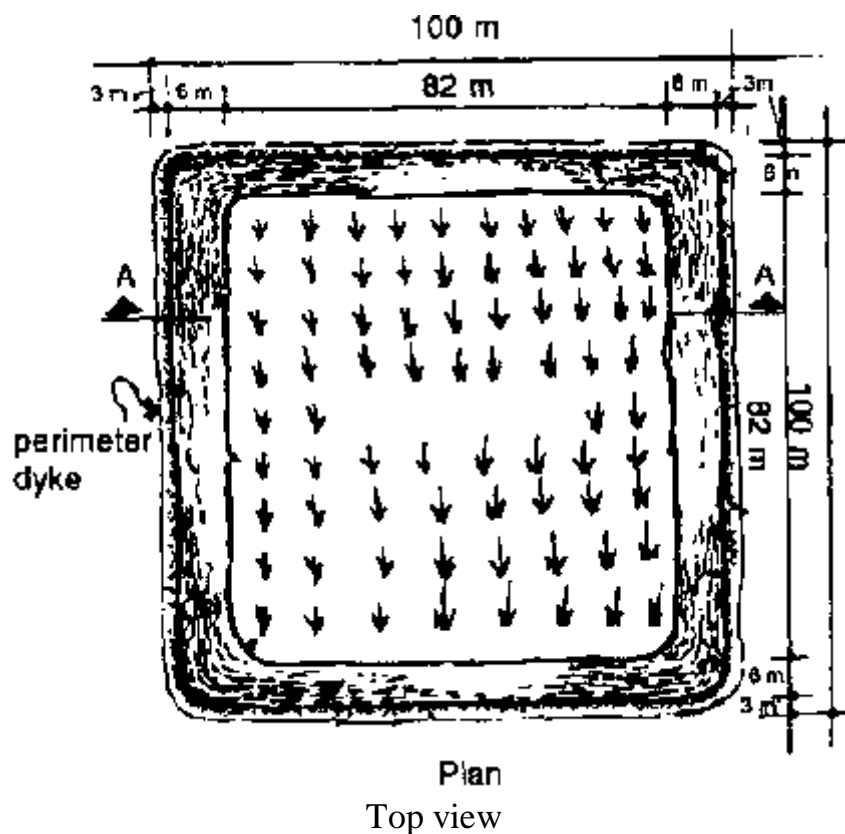
Stock rohu, catla, mrigal, or minor carp at the rate of 4,000/6,000 per ha. The species mix should include 25 percent surface feeders, preferably catla, which are readily available; 30 percent column feeders, such as rohu; and 45 percent bottom feeders, such as mrigal or beta. Prawns also grow well in paddy-fish culture plots.

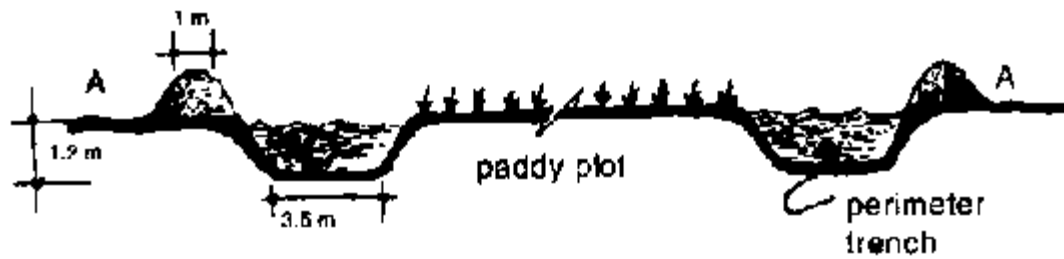
Fingerlings can be obtained from government fish centres or from local private dealers. Stock the fish when the water level rises over the paddy growing area (July-August).

### Selection of site

Low-lying areas with high rainfall (above 800 mm) are well suited to paddy-fish culture.

### Trench design and construction





Cross-section view

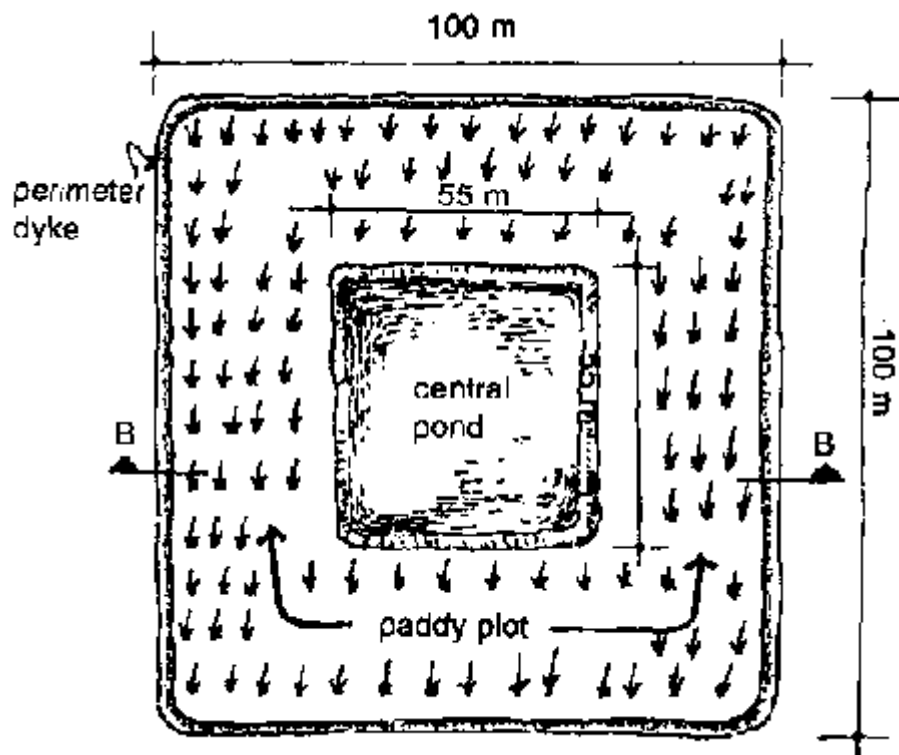
### Perimeter type

Place the paddy growing area in the centre. The paddy growing area should slightly slope on all sides toward a perimeter trench.

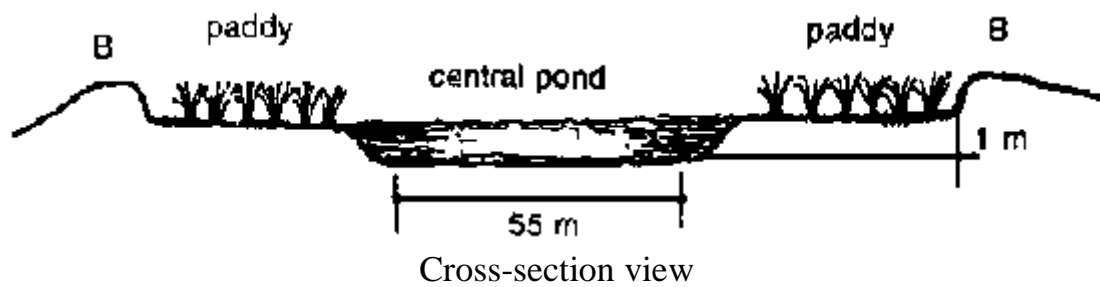
### Central pond type

In this design, the paddy growing area drains into a central pond.

### Lateral trench type

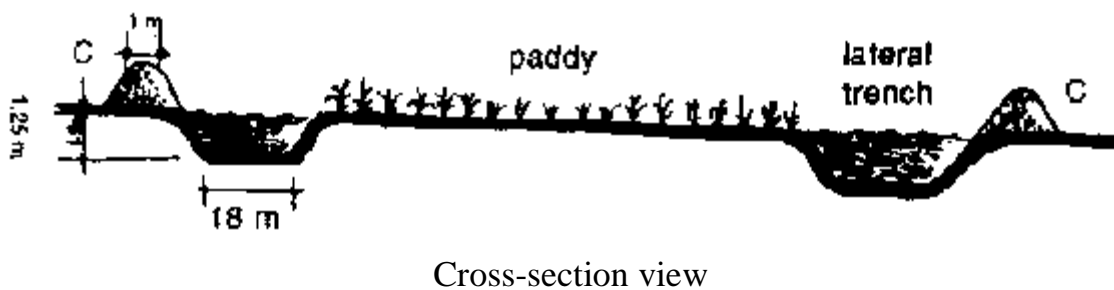
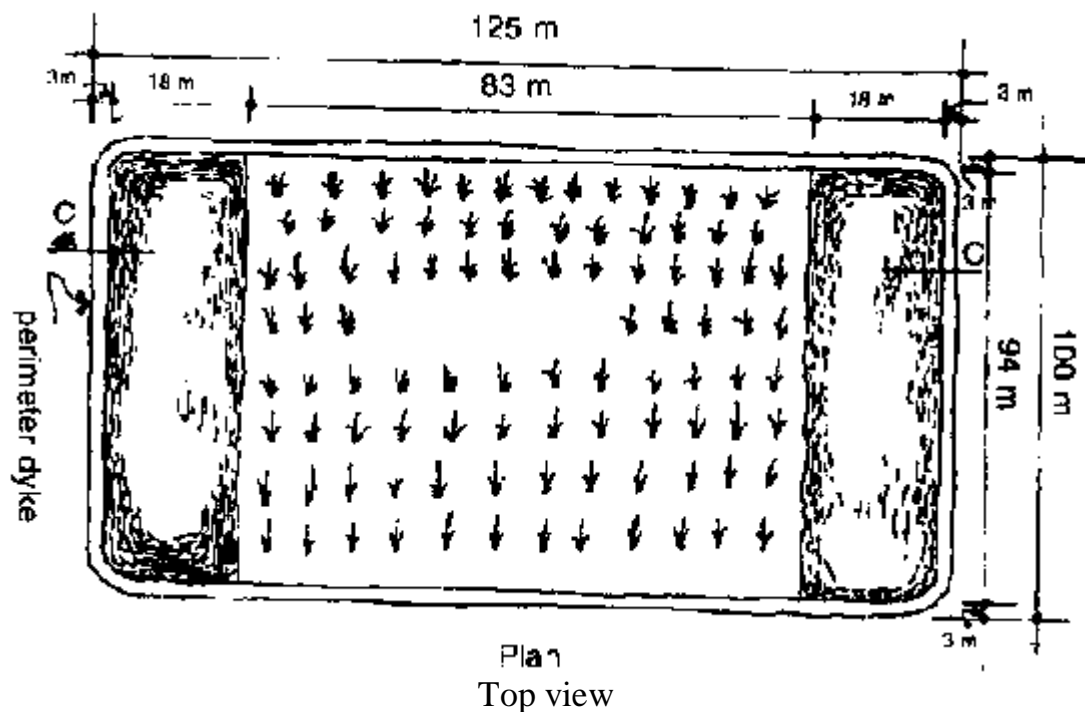


Plan  
Top view



Dig a trench at one end of a moderately sloping paddy field. Or dig two trenches or ponds at opposing ends of the paddy growing area. The total water area should be about one-third the land area.

The actual shape of plots can vary according to land contours and topography.



Note

High yielding varieties should not be grown in the wet season. The water level maintained for the high yielding varieties is too low for fish cultivation (2.5-3.0 cm).

## Note

To protect your new rice plants, use bamboo traps to remove crabs.

## Fish feeding and management

For better growth, feed the fish mustard oil cake and rice bran (one part oil cake to one part rice bran) at the rate of 2-3 per cent of fish body weight.

- Feed from bamboo trays each day.
- If available, feed shelled mollusc meat to your prawns.
- Periodically catch fish to monitor their health and growth.
- Test the pond water with litmus paper. If it is acidic, add lime at the rate of 100 kg per hectare to the trenches or ponds only (not to the paddy growing area).

Fish weigh 2-3 g at the time of stocking and 200-500 g at harvest.

## Paddy varieties

- Choose a deep-water paddy variety for the wet season.
- Choose a short-duration, higher-yielding variety for the dry season crop.

## Paddy preparation

### Wet season crop

- Clean the plot.
- Add cow-dung (4,000-5,000 kg/ha). Use sewage water if available.
- Plough the plot thoroughly.
- After first rain (May-June), sow deep-water paddy seed.

### Dry season crop

- After harvest (December-January), clean the plot once again for the second crop.
- Plough the plot repeatedly.
- Apply basal fertilizer during final harrowing at the rate of 10 kg N, 30 kg P<sub>2</sub>O<sub>5</sub>, and 30 kg K<sub>2</sub>O per ha. If available, apply sewage water in place of NPK.
- Transplant 2-3 seedlings per hill. Keep 20-30 cm space between hills and 20 cm space between the rows.

- Irrigate with freshwater from adjacent ponds or trenches or with sewage water.
- Keep 5-7 cm of water in the paddy plot.
- Remove weeds at the time of tillering.
- Apply the second dose of fertilizer at tillering stage (30 kg N/ha) and the third dose before panicle initiation (development) stage (15 kg N/ha) or add sewage water, if available, from tillering to panicle development (booting) stage.
- Irrigate the plot as needed.

### Fish harvesting

Around the time of the deep-water paddy harvest, when the plot gradually dries up (December-January), the fish take shelter in the trench or pond. Fish harvesting should start shortly after the first paddy harvest. Fish that have reached 200-500 g should be taken out at fortnightly intervals by drag netting. In time, the water in the trenches and ponds will be used up to irrigate the second paddy crop. Remove the remaining fish by hand.

### Note

Build an earthen ridge between the pond and paddy growing area to prevent pesticide from getting into the pond water.

### **Cattle fish culture**

#### Two for one

A one-hectare fish pond needs about 10-15 tonnes of dung and urine per year to maintain its fertility. New ponds need higher doses of dung and urine. In general, the dung and urine of two cattle are sufficient to maintain a one-hectare pond.

#### Caution

Your pond water should be brown. If the water suddenly turns dark green because of algal growth, stop the inflow of dung and urine until the water turns brown again. Stop the flow of dung and urine during persistent cloudy weather (2-3 days of continuous cloudiness). You do not have to stop the flow of dung and urine during rain.

Raising fish and cattle together is quite profitable. Although wastes from cattle are not as rich as wastes from poultry and pigs, cattle farmers can still use cattle dung and urine to maintain a fish pond.

Cattle waste as pond fertilizer If you own cattle, construct a shed close to your pond. The shed should have a bricklined floor with good drainage toward the

### Dung and urine slurry

As a better alternative, mix dung and urine thoroughly, dilute with water and, using a bucket, evenly broadcast the mixture into your fish pond. Dung in the form of biogas slurry is even better. Apply 80-120 kg of fresh slurry per hectare of pond each day. (See Biogas as a rural energy source.)

### Production

About 2,500-3,000 kg of fish can be produced from one hectare of pond each year. The cattle provide milk and labour. Buffaloes can also be raised instead of cattle.

## **Duck - fish culture**

### Benefits of ducks

- Ducks contribute to high fish production while producing valuable eggs and meat.
- Ducks loosen the pond bottom, releasing nutrients which increase pond productivity.
- No additional land is required to raise ducks.
- Ducks get 50 to 75 percent of their feed from the pond in the form of aquatic weeds, insects, and molluscs.
- Ducks spread their droppings over the whole pond. This reduces the labour associated with pond manuring.

Ducks and fish make a great combination. Just build a simple duck shelter next to the fish pond and reap the results. Your fish will grow large on duck manure, spilled duck feed, and microscopic animals and plants made plentiful by the presence of the ducks. You will harvest fish, duck eggs, and meat while saving on pond fertilizers and supplementary fish feed.

### Pond management

- Six- to eight-week-old ducklings should be stocked on the pond.
- Vaccinate them prior to stocking.

- The ducks are likely to prey on small fingerlings. To avoid this, stock the pond with fingerlings more than 10 cm in length.

#### Selection of ducks

Indian runner, styles, mete, and megaswari are suitable breeds.

#### Construction of duck house

- Construct a house on the pond embankment to shelter the ducks at night and during egg laying.
- Allow the ducks free access to the pond during the day. It is not necessary to build a fence around the pond.
- Provide about 0.3 0. 5 sq m of floor space per bird.

#### Duck droppings as manure

- Droppings should be collected from the duck house at night and applied to the pond every morning.
- 200-300 ducks are sufficient to manure a 1 ha fish pond.

#### Feed supplements for ducks.

Supplementary food at the rate of 100 g per bird per day can come from household wastes such as kitchen leftovers, rice bran, and broken rice. Put this feed inside the duck house. Do not give ducks spoiled food.

#### Fish, eggs, and meat

Ducks start layers eggs at the age of 24 weeks and continue to lay until the age of two years. After this, sell them.

About 3,000 kg of fish, 12,000 eggs, and 500 kg of duck meat can be produced per hectare of pond each year.

### **Pig - fish culture**

#### Productive combination

A pig attains slaughter size after 5-6 months. Fish culture is normally done for 10-12 months. Therefore, two lots of piglets can be raised along with one harvest of fish.

A total of 4,200 kg of pig meat and 5,000-6,000 kg of fish per hectare of pond can be produced each year. Pigs are fed grasses and other green fodder and kitchen wastes at the rate of 1.5 kg per pig per day.

Pigs efficiently convert farm and kitchen refuse into manure which can be used to fertilize fish ponds. Indigenous breeds are hardy and well adapted to local conditions. Exotic breeds are more productive and gain weight faster, but require more care than indigenous breeds.

### Housing

Build a pig pen with 1 to 1.5 sq m of floor space per animal on the pond embankment. The floor should be cemented with drainage toward the pond. About 30-40 pigs should be raised per hectare of pond area.

### Selection of breeds

Quick growers and prolific exotic breeds, such as Large White, Yorkshire, Landrace, etc., are preferred. Do not allow exotic breeds outside their pen. Indigenous breeds can be allowed to forage outside, around the pond during the day. If pig rearing begins before fish stocking, it is not necessary to apply basal manure to the pond. (See Composite fish culture.)

### Note

Do not allow the pig excrete into the pond if the water turns dark green.

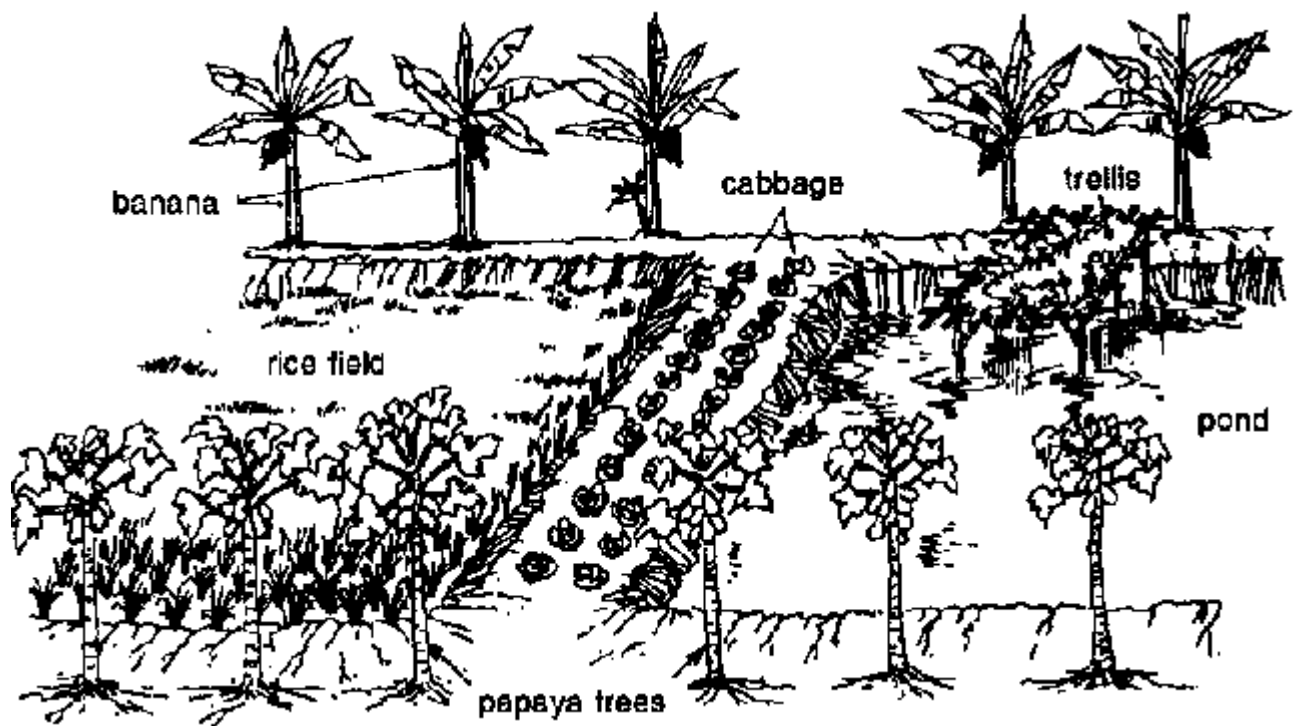
### Poultry, pigs, and fish

You can combine poultry and pig raising by housing poultry above the pig pens. The poultry droppings and spilled feed fall through a slatted floor into the pig pen. The pig droppings can be washed into the pond.

Sources: Dr. S. D. Tripathi, Dr. B.K. Sharma and Dr. Manak K. Das

### **Horticulture on dykes**

Dykes cover a large area on many farms. Despite its potential for production, dyke land is most often underutilized. The following are some suggestions for making use of dykes.



Dyke planted with cabbage

#### Fruit trees

Dig pits (50 cm in diameter x 30 cm deep) and fill them with compost and soil. Plant papaya saplings (April-May) and banana and citrus (June-July). Water regularly. Maintain 3 banana plants in one pit. Harvest papaya after 6 months.

#### Creeper plants

Dig small pits (25 cm in diameter x 10-15 cm deep) and add compost. Plant gourd seeds (2-3 in each pit) in March. Build a bamboo trellis for creepers over your pond. Harvest from May onwards.

#### Leafy vegetables

Cultivate leafy vegetables like amaranthus, water bindweed, and Indian spinach during summer.

#### Winter crops

Cultivate and dress the top soil with compost. Build small mounds spaced 40-cm apart. Transplant early varieties of cabbage and cauliflower in late August or early September. Add water as needed. When plants reach 15-20 cm, apply fertilizer (Sufala, 20-25 g to each plant). Repeat 25-30 days after transplanting. Begin harvesting 65-70 days after transplanting.

Part way through harvesting the first crop, transplant cabbage and cauliflower on the intermediate harvested space. Manure and water the same as for the first crop. The second crop will be ready by February. Intercrop with spinach and tomato.

Fish culture with waste leaves

Use waste leaves of horticultural crops and banana leaves as feed for grass carp. (See related topics in this manual.)

Contributor. Dr. A. K Dutta

### **Solar drying of fish**

Village used to sun-drying clothes, fruit, vegetables, or cow dung cakes, can easily learn to dry fish for home consumption and sale.

Fish are more difficult to dry than fruits and vegetables. However, with the proper technique and some practice, fish can be dried with little effort and at low cost. Dried fish usually fetch a good price in the market.

Preparation Fish can be divided into two categories:

Small fish white baits, silver bellies, small sardines, prawns, soles, etc.

Medium and large fish mackerels, jew fish, croaker fish, pomfrets, seer, catfish, tuna, shark, etc. The process for drying small fish is different from drying medium- and large-size fish. However, all sizes of fish must be fresh and odour-free. Sundrying takes two to three days for an average 8 to 10 hours a day, with a maximum temperature of 38°C. Properly dried fish should contain 12 to 15 percent moisture.

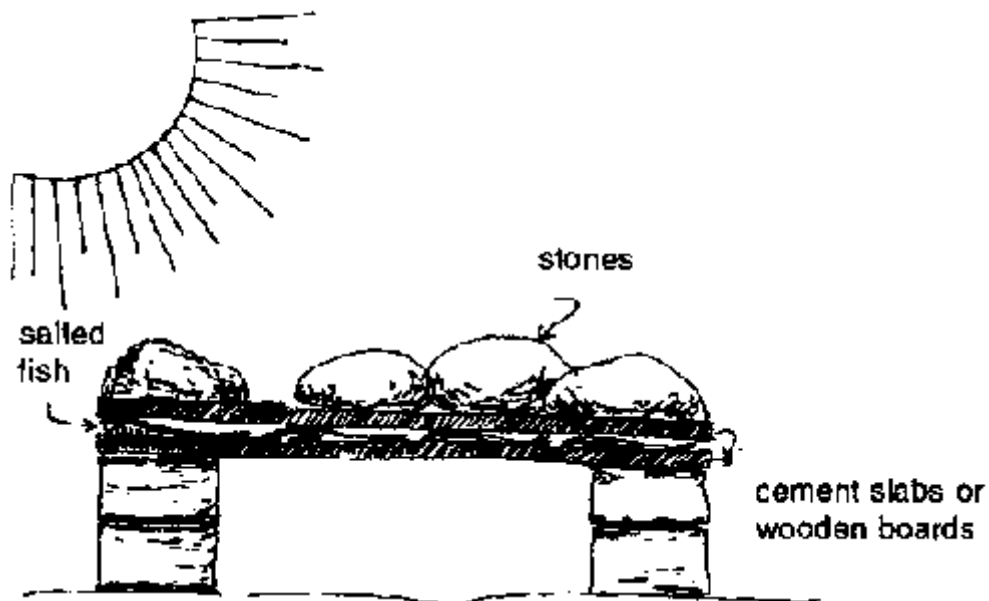
Small fish

- 1 Wash in clean water to remove dirt and sand.
- 2 Allow excess water to drain out for 30 minutes.
- 3 Spread washed fish on mats, split bamboo, or gunny bags, hang them from a line to dry.
- 4 Allow the fish to dry in the sun.
- 5 Occasionally, turn the fish so that both sides dry.
- 6 Pack the dried fish in polythene bags.
- 7 Put the bags in plastic or wooden containers.
- 8 Store dried fish in a cool, dry place.

Medium and large fish

- 1 Cut off the head.

- 2 Slit open the belly and remove the guts.
- 3 Wash the fish in water and remove the blood.
- 4 Make a mixture of common salt using  $\frac{1}{3}$  fine salt and  $\frac{2}{3}$  coarse salt.
- 5 Salt the fish-one part salt to four parts fish (1:4) for large fish and one Part salt large fish and one part salt to eight parts fish (1:8) for medium fish.
- 6 Leave the fish to absorb the salt for about on hours.



Solar drying of fish

- 7 Sandwich the fish between slabs of cement or wooden boards piled with weights.
- 8 After one day, turn the fish.
- 9 Wash the salted fish in 3.5 percent salt solution.
- 10 Dry the fish by spreading them on mats.
- 11 Pack the dried fish in polythene bags and store them in a cool, dry place.