Polyculture:

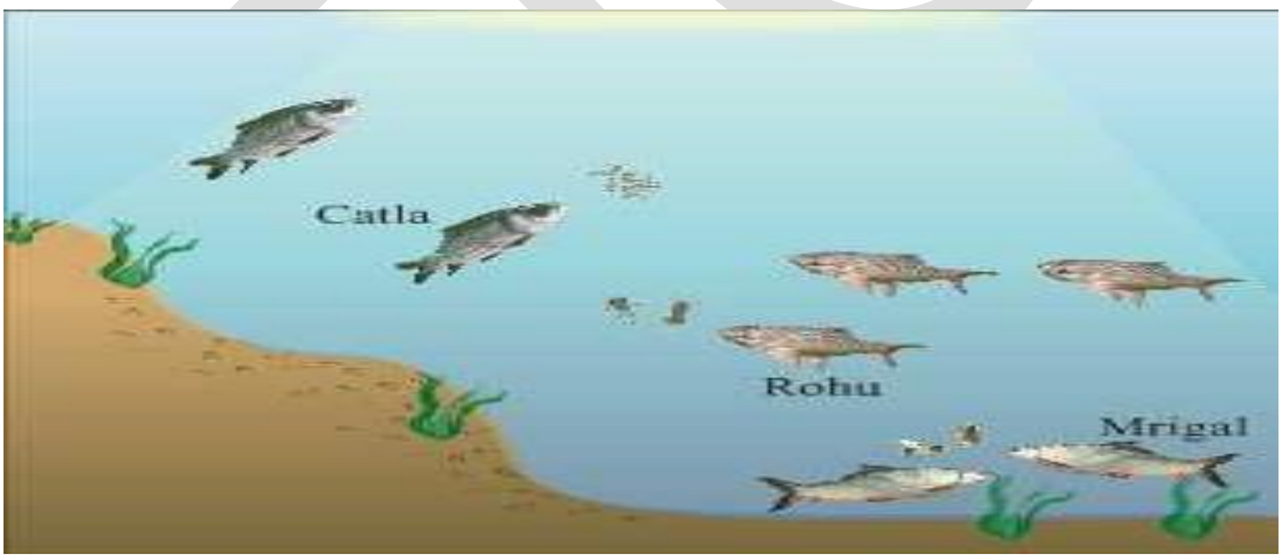
Polyculture or mixed fish farming or composite fish culture is the culture of fast growing compatible species of fishes of different feeding habits (or different weight classes of the same species) in the same pond so as to utilise the various available ecological niches in order to obtain high production per hactare of water body.

A pond according to its depth can be divided into three distinct zones — upper surface zone, middle column zone and bottom zone. A particular species exploits food of a particular zone. For example — Catla catla is a surface feeder, Labeo rohita a column feeder and Cirrhinus mrigala is a bottom feeder.

In case of single species or monospecies or monoculture only one zone will be utilised or exploited while the other zones would remain unutilised. As a result the entire ecological area would not be exploited and the yield or fish production would be less.

Principle of Polyculture:

When different species of fast growing compatible fishes, occupying different ecological niches of a pond or any water body, are cultured together, they most efficiently utilises all the food sources available in the pond for fish production without harming each other.



Objectives of Polyculture:

(1) To obtain maximum yield or fish production.

(2) To utilise all the available niches.

(3) The fishes cultured should not cause any ecological disbalance.

(4) The fish species cultured should not have any serious competition between them but each species may have a beneficial influence on growth and production of the other. For example, grass carp by consuming aquatic vegetation, converts plant tissue into fish flesh but its excreta fertilises the pond which benefits all other species.

(5) Some species of fishes are cultured which have specific roles to play in maintaining water quality in ponds by feeding on wastes accumulated in it. For example common carp and mrigal consume the faeces of grass carp and silver carp, which contain large amounts of undigested plant matter.

(6) Recent combination of fish species cultured are based on one or two species as the main ones and the others as subsidiary compatible species which would be utilising those parts of the food resources that would have been wasted.

Origin of Polyculture:

Composite fish farming has its root in ancient China and India. In both these countries poly-culture was adopted in carp farming based on mixed seed stock, collected from natural sources. It was not possible to sort out stocks of different species in their early stages. The farmers, therefore, were forced to rear the different carp species together until they reached fingerling stage.

The farmers observed that there were differences in the feeding habits and different preferences for natural food organisms. This led to the thought of adjusting the stocking densities according to the occurrence of natural food and the niche occupied by each species in the ponds. Thus, it could be beneficial in traditional production systems by culturing appropriate species combinations.

Such a practice could effectively lead to the utilisation of a much larger quantity of food resources and developing a symbiotic relationship between the cultured species in the system. This would lead to higher production at a lower cost and the farm environment can be maintained at required levels.

The combination of species in polyculture system cultured in China consists of:

(1) Grass carp (Ctenopharyngodon idella) which feeds on macro-vegetation.

(2) Silver carp (Hypophthalmichthys molitrix) which feeds on plankton (mainly phytoplankton).

(3) Big head (Aristichthys nobilis) which feeds on microplankton.

(4) Black carp (Mylopharyngodon piceus) which feeds mainly on snails and other molluces at the bottom.

Fig: Composite Mixed culture(Indigenous & Exotic carp.)

(5) Mud carp (Cirrhinus molitorella) which feeds primarily on detritus.

(6) In addition sometimes the omnivorous common carp (Cyprinus carpio) is added that basically serves as a scavenger in farm ponds.

(7) Modern polyculture system has added a number of other species to the above traditional combination, such as tilapia, wuchang fish, crucian carp, red eye, white amur bream, snake head and mariadarin fish.

The combinations practised in Indian polyculture system comprises the following:

(1) The surface feeder, catla (Catla catla) which feeds on planktonic organisms particularly zooplankton. The larvae and young fry feed on planktonic unicellular algae.

(2) The column feeder, rohu (Labeo rohita) consuming vegetable matter including decaying aquatic plants, algae, etc. Larvae and fry feed on unicellular algae and zooplanktonic organisms.

(3) The bottom feeder, mrigal (Cirrhinus mrigala) preferring decayed plant and animal matter, algae,

detritus, organic matter, etc. The larvae and fry feed on planktonic unicellular algae and zooplankton.

(4) The bottom feeder, calbasu (Labeo calbasu), feeds selectively on benthic and epiphytic organisms and organic debris.

(5) Modern culturists and scientists have developed composite mixed carp culture by the addition of exotic carps such as grass carp, silver carp and common carp.

(6) New species combinations for polyculture have been developed through the introduction of benthic-feeding grey mullets (Mugil cephalus). The introduction of carnivorous fish, chital (Notopterus chitala), has been done for the control of weed fishes.

Drawbacks in Polyculture System:

1. It requires large tank.

2. The growth of exotic fish much faster than indigenous fishes. The taste and market price of the exotic fishes is inferior and much less respectively, than indigenous fish.

3. It is not very easy to adopt supplementary feeding in an economical way.

4. Special skilled knowledge and efforts are required by the farmers to produce or purchase the appropriate numbers of seed stocks of the different species selected to maintain optimum balance of the species.

5. Additional labour is required for sorting out the different species after harvest.

6. In many instances, consumer acceptance of the different species varies in most areas. Difficulties have also been experienced in finding markets for certain species like the silver carp.

Remark:

It has been found and proved that modern monoculture with proper feeding can be more productive than polyculture. Thus, it is opined that the value of polyculture depends very much on the situation and needs in a particular area. Polyculture probably is not widely applicable as was generally considered.

Methods of Polyculture:

The methods that are adopted in polyculture can be broadly divided into three phases: 1. Pre-Stocking Management 2. Stocking Management 3. Post-Stocking Management.

1. Pre-Stocking Management:

In pre-stocking management the pond or water body is prepared before the introduction of fry or fingerlings by the following way:

(A) Renovation of the Pond:

Generally due to rain and flood the edges or dykes of the ponds may get damaged and a lot of silt or mud may accumulate at the pond bottom, thereby decreasing the depth of water. In such cases the entire water of the pond is to be removed through the help of a pump.

Fig. Composite fish culture.

The pond bottom should be allowed to dry. The humus at the pond bottom should be removed through the help of manual labours. The dykes has to be repaired and plants to be planted on it so that its roots would prevent soil erosion. The pond is then filled with water.

(B) Clearance of Weeds:

One of the crucial problems encountered by Indian pisciculturists is the excessive growth of aquatic vegetation in water bodies and its control.

Weeds cause the following disasters in a water body:

(1) Severely restricts plankton production as it prevents sunlight from entering into the pond water.

(2) Limits the living space for fishes and obstructs their free movement.

(3) Provides shelter for predatory and weed fishes, molluscs, aquatic insects and fish parasites.

(4) It consumes nutrient from the pond which otherwise would have been utilised for the production of plankton.

(5) Upsets the equilibrium of physico-chemical qualities of water.

(6) Causes imbalance in dissolved oxygen budget, particularly during cloudy days.

(7) Promotes accumulation of deposits leading to siltation.

(8) Obstructs netting operations.

Due to the above hazards, the control of aquatic weeds is very much essential.

The control methods adopted are the following:

1. Manual and Mechanical Control:

If the weed infestation is scanty, then it can be easily removed manually with the help of a long bamboo. The entire weeds are swept with the bamboo to a side and then removed manually with the hand. As the weeds grow again, it is difficult to eradicate them completely. In case of denser infestation the weeds can be removed with the help of weed cutter.

2. Chemical Control:

In case of dense weed infestation suitable weedicides may be used. A large variety of chemical herbicides are used as weedicides.

(i) 2, 4-dichlorophenoxy acetic acid (2, 4-D) is very widely and effectively used. The usual rate of application is 4.5 to 6.7 kg/ha and its application has no harmful effects on fishes.

(ii) Submerged weeds can be kept under control by the application of ammonia at the rate of 15-20 ppm.

(iii) Diuron is effectively used at the rate of 0.1 to 0.3 ppm without affecting production of plankton and fishes.

(iv) Simazine is also used at a dose of 0.5 to 1.0 ppm.

3. Biological Control:

Weeds in a water body can be controlled by means of selected varieties of herbivorous fishes. The important herbivorous fishes used are: grass carp (Ctenopharyngodon idella), tawes (Puntius javanicus),common carp (Cyprinus carpio), Tilapia mosambica and gourami (Osphro- nemus goramy).

Thus, an ideal herbivorous fish:

(i) Is able to consume a wide variety of weeds as its food.

(ii) Is hardy.

(iii) Does not biologically interfere with other fishes.

(iv) Is economical to maintain.

(v) Adds to the fishery wealth.

In consideration of the above characters, grass carp has been found to be the idealist and has been used all over the world as the most effective in controlling weeds.

(C) Eradication of Weed and Predatory Fishes:

It is not desirable to have weed and predatory fishes in the cultural impoundment. Weed fishes by consuming the nutrients from water competes for food, space and oxygen with the fingerlings of culturable carps. They have high fecundity and ripen in summer and can breed even in the absence of rain.

The predatory fishes, on the other hand, directly prey on the culturable carp spawn, fingerlings and young fishes. Therefore, their eradication from the ponds before the stocking of fingerlings is of utmost importance.

One way of eradicating these unwanted fishes is by dewatering and drying the pond. However, where dewatering is not possible then these fishes have to be killed by the application of fish poison, generally of plant origin.

Although a number of organophosphatic compounds and chlorinated hydrocarbons such as aldrin, dieldrin, DDVP are tested as effective fish poisons, still the use of chemicals is not desirable as detoxification of these chemicals would require time and they would leave harmful residual effects in the pond.

The most widely used fish poison of plant origin is mohua oil cake. The application of Brassica latifolia (mohua oil cake) is of much significance in fish ponds because of its role as piscicide in the initial phase of treatment and as manure in later phase after its loss of toxicity.

According to Jhingran (1982), toxicity of mohua oil cake is due to its 4-6% saponin content. The toxic effect has been found to be most acute at 16 hours of mohua treatment (Jana et al, 1987). The effect of saponin lasts for 2-3 days. The recommended dose of mohua oil cake is 2500 kg/ha. After 19-25 days detoxification of mohua oil cake takes place and it takes up the role of manure.

(D) Addition of Lime:

The first step in fertilisation is the application of lime. The common form used is limestone.

Lime has a number of uses such as:

1) It corrects the acidity of soil and water.

2) It acts as a strong pH buffer.

3) Lime by its toxic and caustic action, kills bacteria as well as fish parasites and may render the fishes less liable to diseases.

4) Lime counteracts the poisonous effect of excess magnesium, potassium and sodium ions.

5) Liming is essential for successful pond manuring. A pond containing lime is found to be more fertile than the one without it.

The dose of lime depends upon the characteristics of the soil and water. A dose of 1,000 to 1,500 kg/ha is required for ponds with acid soil and water. If liming is done every year then a dose of 100 to 200 kg/ha is sufficient.

(E) Addition of Fertilisers:

The suitability of any fertiliser used in fish ponds is judged by the following:

1) increase in the production of plankton.

2) Should cheap.

3) it can be distributed over the pond.

4) Harmless to the fish under cultivation.

5) Good after-effects on the conditions of the pond.

The different types of fertilisers used in fish culture ponds fall under two categories:

(a) Inorganic and

(b) organic.

(a) Inorganic Fertilisers:

The major fertilising elements are nitrogen, phosphorous, potassium and calcium.

The different inorganic fertilisers used in fish ponds are grouped as under:

1. Phosphate fertiliser in the form of calcium superphosphate is used at a dose of 2000 kg/ha/yr to obtain best result. Single super phosphate is used at the rate of 40 kg/ha/month.

2. Nitrogen fertiliser in the form of urea is widely used in India. It contains about 45 to 46% pure nitrogen. Other nitrogenous fertilisers used are sodium nitrate, ammonium nitrate, calcium ammonium nitrate, liquid ammonia, etc.

3. Potassium fertiliser.

4. Magnesium fertiliser.

5. Trace element fertiliser.

(b) Organic Fertilisers:

Organic fertilisers are either of plant or animal origin. It contains almost all the nutrient elements required in the metabolic cycle. The nutrients locked in them are either made available directly or after decomposition and transformation by the microbes.

Organic fertilisers can be classified on the basis of the following:

1. Organic Manures with Little or No Carbohydrate:

The manures falling under this category are:

(i) Liquid Manure from Stable and Byres(cowshed):

This, when treated in ponds has been found to impart fertility for good fish yield. It is applied in small doses and simulates growth of phytoplankton, filamentous algae and zooplankton. Liquid manure when applied in large doses gives profuse growth of filamentous algae and may cause depletion of oxygen.

(ii) Guano (Avian Excreta), Dried Blood and Slaughterhouse Offal(animal Parts):

Through the use of dried blood and guano an increase in fish yield has also been reported. Slaughterhouse offal mixed with superphosphate (P2O5) when used as fertiliser in fish ponds has been found to enhance fish yield.

2. Organic Manure with Carbohydrate Content Only:

The organic manures in this category are:

(i) Oil Cakes:

Oil cakes such as mustard oil cake, mohua oil cake, cotton seed meal, soybean meal, etc. have been used for manuring fish ponds. Mustard oil cake is used either singly or in combination with cowdung.

(ii) Green Manuring:

Green manuring is used to fertilise fish ponds. In this method green plant tissues are decomposed and turned into soil. This is done by sowing a nitrogenous or other crop on dry pond bottom at the time of pond preparation or by dumping it in a heap at one end of the pond.

In West Bengal green grass along with dry cow-dung, stable refuse, poultry manure and oil cake are used as green manuring. In Orissa, green manuring is practised by growing a Leguminous plant (Sesbania sp.) on the pond bottom and then it is crushed after 10-15 days. Generally, a dose of 1,680 kg of green manure per hectare is reco-mmended at intervals of 3 months.

Advantages of applying green manure:

1) Green manure induces microbial activity in the soil resulting in increased productivity.

2) After the decay of plant tissue, the humus compound thus produced increases the absorptive capacity of the soil.

3) The composition also provides inorganic nutrients directly to the soil.

4) The soil nitrogen is restored if leguminous plants are used.

5) Conserving effect of nutrients in the soil increases, which otherwise would have been lost through drainage and erosion.

6) Due to ploughing the nutrients carried by the roots are brought to the surface.

7) Green manuring increases the availability and solubility of lime and phosphoric acid.

8) Green manure provides a rich substratum for attached algae, zooplankton, insect larvae, worms, etc. which forms the food of fishes.

(iii) Compost:

Another good organic manure is compost. It is formed by dumping organic wastes, vegetable debris, cut grass, cow dung, aquatic weeds, etc. into a large pit and then the pit is covered with soil. The aerobic bacteria in the presence of nitrogen convert the above mentioned wastes into humus. A dose of 5000 kg of compost/ha of water body is recommended for rich growth of plankton.

3. Organic manures with carbohydrates and nitrogenous matter:

(i) Farm Yard Manure:

The farm yard manures denote refuse from all animals of the farm. The farm manures are most extensively used fertilisers in fish culture practice. Cow and pig dungs are very frequently applied, about 15-20 days before the introduction of fry and fingerlings. Ponds are manured with cow dung at the rate of 11,208 to 22,417 kg/ha. However, when applied in large quantities it may cause deoxygenation of water.

(ii) Poultry Manure:

Poultry manure is a very efficient fertiliser (Nitrogen 2%, phosphoric acid 1.25% and potash 0.75%) for fish ponds. This is why both intensive and extensive poultry production has been integrated successfully with fish culture.

(iii) Sewage:

Domestic sewage basically contains wastes from toilets, bathrooms, kitchens and other household washings. Sewage is rich in nutrients such as phosphorus, nitrogen, etc., which are available in huge quantities. It also directly promotes primary productivity. Raw sewage is inimical to the life of fishes due to high values of BOD, O2, NH3, H2S, bacterial load and negative oxygen value.

Thus, treatment of sewage is a pre-requisite for waste water aquaculture. Other than its manural capacity, the potentiality to serve as an additional source of water for maintaining the deserved depth of water in the pond, particularly during the dry summer season, is an added advantage of using such waste waters.

Sewage if not properly treated prior to its application in pond water may result in profuse growth of algae, and various kinds of fish diseases are encountered.

(iv) Sludge:

Sludge is the sediment deposited during the treatment of sewage. It is rich in total nitrogen (6.0%) and phosphorus (1.29%). Activated sludge is used as manure to fertilise pond water. It has been found to promote plankton growth and high fish yield.

2. Stocking Management:

In aquaculture practices only the common carp is cultured in monoculture system. While in poly-culture system either the Indian major carps or in combination with the exotic carps are cultured in various combinations. However, prior to the introduction of fry or fingerlings the cultured water has to be tested whether it is suitable for culture or not.

(A) Stocking Criteria:

For rearing of carp the main or basic objective is the production of an optimum quantity of the desired size of fish, at minimum cost. A number of interdependent factors are present that affect productivity and cost.

The factors that will influence the growth rate and production are stated below:

1. The quality and quantity of food produced by fertilisation.

2. The temperature of the water in the pond.

3. The availability of oxygen.

4. Build-up of metabolites in the pond.

5. Stocking rate.

6. The size of fish at stocking.

7. Artificial feed given to the fishes.

8. The duration of culture.

9. The size of the fish that are to be harvested.

10. The influence of productivity of natural fish food even when fertilisation and feeding are adopted in the pond.

11. The growth potential of the genetic strain used in culture.

There are two systems of stocking that the fish farmers generally adopt:

(i) Multi-size stocking, and

(ii) Multi-stage stocking.

(i) Multi-Size Stocking:

This involves stocking, in the same pond different sizes (fry, fingerlings and young adults) of fishes in order to utilise the food resources more efficiently. In this system additional stocking of fishes and periodic harvesting of marketable fishes are undertaken.

(ii) Multi-Stage Stocking:

In this system fishes are stocked in progressively larger ponds (nursery, rearing and stocking) as they grow in size. Here, the stocking rates are reduced and harvesting of marketable fishes are done after a period of approximately one year culture.

It is, thus, clear that the number of fishes to be stocked should be determined through a formula:

$$\text{No. of fishes to be stocked} = \frac{\text{Expected total production}}{\text{Expected individual growth}} + \text{Expected loss due to mortality}$$

(B) Species Combination:

Three broad combinations are practised in India, i.e.

(1) Culture of Indian major carps alone,

(2) Culture of exotic carps alone and

(3) Culture of Indian and exotic carps together(composite mixed culture).

In cases where silver carp is cultured along with catla, the silver carps introduced should be smaller in size and lesser in number.

As silver carp feeds on phytoplankton, the density of phytoplankton would fall if silver carp is introduced in large numbers. This would hamper the quantity of zooplankton and ultimately the growth rate of catla that feeds predominantly on zooplankton.

Besides the above, a number of other species are also stocked in polyculture system. The more common ones being tilapia (Tilapia mosambica), gouramy (Osphronemus goramy), grey mullet (Mugil parsia), tawes (Puntius javanicus) and a small number of carp hybrids (calbasu male x catla female).

Sometimes a carnivore, chital (Notopterus chitala), is added to control weed-fishes. However, this carnivore should be smaller in size (2 inches to 3 inches) so that they do not prey on carp fingerlings.

Although polyculture envisages compatible combinations of species or age groups that do not compete in feeding habits, but there is often considerable overlap of the feeding habits and preferred food items. When several species are added in ponds, the concept of exclusive ecological niches and special separation are not always applied.

Recent combinations are generally based on one or two species as the main ones (depending upon the market demand) and the others as subsidiary compatible species that will utilise the unutilised food resources or would help in reducing the deterioration of water quality by feeding on the wastes.

(C) Stocking Density and Ratio:

Several stocking rates in different combinations is practised in different areas depending upon the market demand and the size to which it is grown. Under normal management, a stocking rate per ha of 5000-6000 fingerlings of 2.5-5 cm length is grown to a size of 600-1000 g or more in one year or less. A lower stocking density 4000-5000 is recommended if the fishes are to be grown to marketable size in a short time.

Different species of fishes are stocked in varying ratios. The commonly stocked ratio of catla, rohu and mrigal in the ponds of Bengal are 3: 3: 4 (Alikunhi, 1957). Recently, the most commonly stocking ratio is catla 30 per cent, rohu 60 per cent, and mrigal 10 per cent. If calbasu is included, then the percentage of catla is reduced to 50 per cent to accommodate calbasu at 10 per cent.

These ratios are altered to achieve higher rates of production:

(i) Depending on the market demand of the species cultured,

(ii) In accordance to the primary production in the ponds,

(iii) Through more intensive stocking and supplemental feeding with locally available foodstuffs (oil cake, rice bran, etc.) and

(iv) Through introduction of fast growing exotic carps (grass carp, silver carp and common carp).

3. Post-Stocking Management:

Culture of carps in pond is mainly based on fertilisation and supplementary feeding.

A. Pond Fertilisation:

Fertilisation with inorganic and organic manure helps to meet the requirement of carbon, nitrogen, phosphorous and other nutrients. It is a known fact that manure increases plankton and chironomid(flies) production in fish ponds, probably due to high production of bacteria and protozoa developing on the organic matter of the manure. Detritus or the decomposing organic matter has a high protein content.

The stocking density and the environmental conditions of the pond determine the rate of application of fertilisers. Moreover, the dosage and mode of application is also important, whether the entire quantity has to be applied in one lot or sporadically.

Too much of nutrients, resulting from manuring may lead to the development of algal bloom, particularly under Indian conditions. It may cause clogging of the gills and also depletion of the oxygen concentration in the ponds. Manuring, thus, should not be done during persistent cloudy weather or when algal bloom appears.

(i) Application of Organic Manure:

Raw cow dung is generally used as an organic manure. Under most situations a dose of 100-120 kg (dry matter) per day can be safely used under most situations. Generally in India, the application of organic manure is 10,000- 20,000 kg (wet weight/ha/year).

(ii) Application of Inorganic Manure:

Using chemical fertilisers is advantageous since the nutrient contents are generally of standard which would facilitate the selection of required dosage. In intensive culture, where fishes are stocked in higher densities, fertilisation at a dose of 60 kg/ha of single superphosphate and 60 kg/ha ammonium sulphate, every two weeks is considered to be beneficial.

In polyculture carp ponds where supplementary feeding is adopted, nitrogen, phosphorous and potassium fertilisers are applied at a ratio of 18: 8:4 at the rate of 500 kg/ha/year.

(iii) Liming:

Liming should be done monthly, 1 -2 days after the application of organic manure at the rate of 25 kg/ha (i.e., 300 kg/ha/year).

(iv) Raking(scratch at the bottom):

One day after liming, raking of pond bottom should be done (if possible) for proper mixing of lime and also for the release of abnoxious gases formed in the bottom soil.

B. Supplementary Feed:

The spawns after being stocked, start feeding voraciously on zooplankton. Within 2-3 days of stocking, the natural food available in the pond gets depleted. At this time artificial feed along with natural food enhances the growth and survival of spawns. Farmers in India use processed feed mixture of pellets along with fertilisers in carp ponds.

For Indian carps the commonly given feed are rice/ wheat bran and oil cakes of ground-nut, coconut, mustard, etc. The husk of the rice/wheat bran are first removed by passing it through a fine-meshed sieve and also to ensure uniformity of particle sizes. Powdered oil cakes and rice/wheat bran, comprising 1 : 1 mixture are given at the rate of 3% of the body weight from the second day of stocking (Mahapatra et. al, 2006).

In combination of the above, feed may also comprise powdered algae and aquatic weeds, fish meal, poultry droplets, vitamins, etc. Tripathi et al. (1979) recommended a diet of 1: 1: 1 mixture of groundnut oil cake, rice bran and fish meal containing 26.7% protein and 32.5% carbohydrate.

Artificial feed may either be sprayed at a fixed place on the water surface, during specified hours or fed as a thick paste or dough in small shallow earthen vessels or bamboo tray, kept suspended in water.

C. Periodic Netting for Growth and Health Care:

Netting operations should be undertaken regularly at least once or twice a month to enhance fish growth and at the same time to see whether they are affected with any disease or not. Healthy pond environment ensures good fish growth.

If it is seen that the supplementary feed provided is not being consumed, then either the fishes are suffering from some disease or the water quality has deteriorated. The water quality should be checked and remedial measures should be undertaken.

Carps are generally affected with a number of diseases. The major diseases encountered in polyculture ponds in India are fin and tail rot, saprolegniasis (it is a fungal disease caused by Saprolegnia, affecting the skin and gills), Ichthyophthiriasis (it is caused by the protozoan parasite Ichthyophthirius multifiliis), etc.

Fishes may also be infested by Argulus, Lernaea and Ergasilus. Affected fishes are sorted out and proper treatment is given to them.

As carp culture is done in intensively manured ponds with dense stocking of fishes, it often results in deficiency of oxygen. Oxygen deficiency in carp ponds is one of the major causes of large scale mortality, particularly in tropical regions.

The problem of anoxia generally occurs during night when photosynthesis and oxygen production ceases and the only source of dissolved oxygen is the atmospheric oxygen which gets dissolved in the water due to wind and water movements. So, proper monitoring and necessary action should be taken to rectify it. The two most common measures adopted are aeration and addition or exchange of water.

D. Control of Diseases:

Prophylactic treatments with dip or bath in 0.38% potassium permanganate are given to fishes as a precautionary measure. Therapeutic treatments are given to cure parasitic infections and bacterial diseases. In case of frequent infections by the copepod parasite (Argulus sp.), treatment with three consecutive applications of malathion at the rate of 0.1 mgl-1 is given at ten days interval.

E. Final Netting for Harvesting and Marketing:

Polyculture is generally practised for a period of 10 to 12 months, after which the entire stock is harvested in case of multi-stage stocking. During this period catla attains a weight of 800 gm-1 kg, Rohu 600-800 gm, Mrigal 400-600 gm, Silver carp 1.0-1.2 kg.

Grass carp 1.0-1.5 kg and common carp 800 gm-1.0 kg. If all the above mentioned polyculture techniques are followed the yield may vary between 2000 kg/ha/year and 5000 kg/ha/year, depending upon the stocking composition and density.

In case of ponds that are undrainable, the most common means of harvesting is done by seine net (Fig. 1). This net is suitable for harvesting most species of fish except for common carp that may escape by burrowing into the mud bottom.

Species like silver carp, mullet and milkfish can escape by jumping over the net. In case of drainable ponds with proper harvesting sump or similar device, harvesting is done by draining.

This is generally done when the fishes are to be sold in live condition. Some farms have marketing ponds where the live fishes are temporarily kept till they are marketed. After harvesting, the catches are sorted out species-wise and size-wise before marketing.

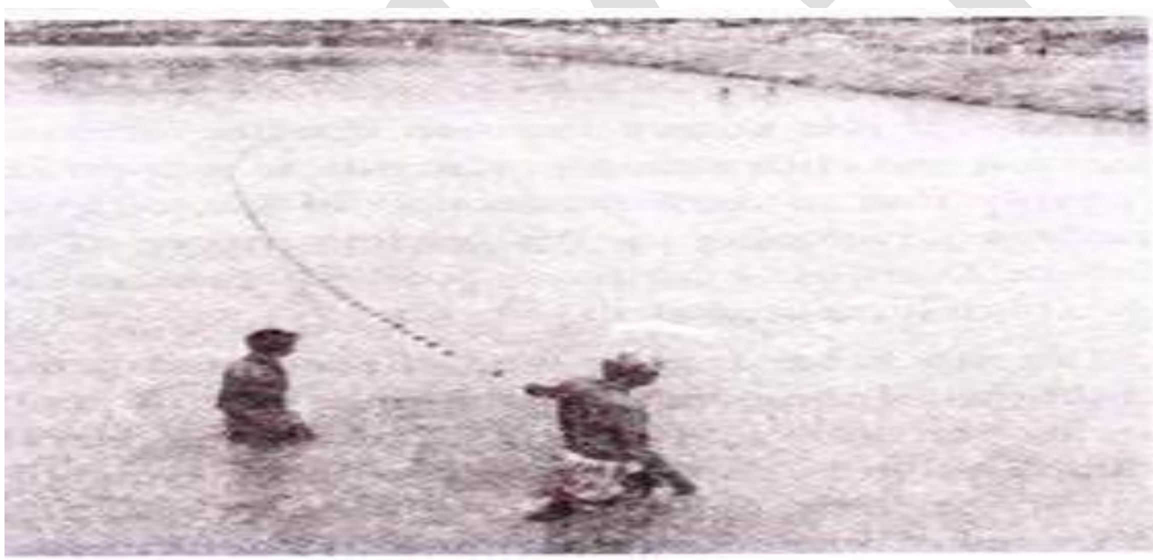


Fig.1 Harvesting a small sized pond by seine net.

F. Economics of Polyculture:

Carp culture is undoubtedly economically viable in places where there is a market for carp.

The two major factors that determine economic viability are:

(1) consumer acceptance, and

(2) price levels in the market.

The initial cost of farm construction and equipment is high but with proper maintenance, ponds can be used almost indefinitely. Moreover, the food requirement for the fishes can be met partly or fully through pond fertilisation and the supplementary feed given is of low cost, this helps to cut down considerably one of the major costs of production.

Further the cost of producing fry or fingerlings can be kept down through adoption of less expensive techniques. All these factors undoubtedly keep down the expenditure at a minimum and help to get a good profitable return.