Integrated FISH Farming System

Integrated farming may be defined as a sequential linkage between two or more farming activities. When the fish becomes a major commodity of this system it is known as integrated fish farming (IFF). Thus, the practice of Combining Fish Culture with Agriculture or livestock for full Utilization of resources and increased production is commonly known as Integrated Fish Farming. Integrated fish farming is based on the concept that 'there is no waste', and waste is only a misplaced resource which can become a valuable material for another product (FAO, 1977). In integrated farming, the basic principles involve the utilization of the synergetic effects of inter-related farm activities and the conservation, including the full utilization of farm wastes.

It is assumed that all the constituents of the system would benefit from such a combination. However, in most cases, the main beneficiary is the fishes which utilizes the animal and agricultural wastes directly or indirectly as food. As integrated farming involves the recycling of wastes, it has been considered an economic and efficient means of environmental management.

PROSPECTS /Advantages of IFF: They include efficiency in resource utilization, efficient utilization of wastes from other culture practices, reduction in risks by diversifying crops, recycling of wastes/ by products of one farming system as input for another system, efficient utilization of available farming space for maximum production, additional source of food and income, a reduction in additional cost for supplementary feeding & fertilization. In fact, IFF is an artificial balanced ecosystem without any waste. It generates more avenues for employment; it reduces the input and increases output and economic efficiency. IFF provides fish, meat, milk, vegetables, fruits, fodder, eggs, grains, & mushroom etc. Altogether, IFF has enough potential for rural livelihood & socio-economic status.

Integrated fish farming has received attention in recent years in the North East India. Among the different livestock based system, fish duck integration is one of the most popular farming practices among woman fishers.

Advantages of Fish -Duck Integration

- Duck dropping act as feed and fertilizer for cultured fish in the pond.
- Duck collect 50% of their food naturally from the pond.
- Ducks keep the water body clean and increase dissolved oxygen by doubling action.
- Duck house can be constructed at the embankment or over the water surface, hence no need of extra place for it.
- Left over feed of duck used as supplementary feed for fish.
- Production of duck eggs, meat, fish and horticulture from the same unit area.

1. **Selection of fish species**

- In this integration, fish species selection is one of the important point, where plankton feeder should be 60% and omnivorous should be 40%.
- A combination of six species viz, Catla (20%), Silver carp (20%), Rohu (20%), Mrigal (15%), Grass carp (10%) and Common carp (15%) should be stocked at density of 8000 to 8500 fingerlings/ha for the targeted production level of more than 3500 kg/ha. Such integration is suitable only for rearing and stocking ponds where fishes are above 12 gm.

2. Selection of duck and their maintenance

- Some important varieties of ducks are Nageswari, Sylhet Meat, Indian Runner, Serachameli and Khaki Campbell. Out of this varieties, Khaki Campbell crossed with local pati variety is the best in Assam condition.
- It should be collected from the Government Farm and then consult with the veterinary Doctor for treatment and preventive measure of some epidemic disease like Duck Plague, Cholera etc.
- Ducks are stocked @200-300 ducklings/ha of fish pond. From duck excreta annual manure production is 45-55 kg/duck/yr, which besides fertilizing the fishponds and can be directly utilized as fish food. Apart from this, 10-20% feed/day/duck is wasted which is utilized in ponds. Duck dropping contains 81% moisture and 0.91% N and 0.38% P2O5.

2.1 Duck-house

- Duck house should be made on the pond dyke or over the pond surface with the help of locally available material such as bamboo cane, thatches etc.
- In case of duck house over the pond surface, a small bamboo bridge is constructed from the duck house for feeding the ducks as well as for collecting eggs and duck from the house. Another bridge is constructed from the duck house to the pond surface for helping the ducks ascend or descend to pond water.
- Again duck house should be well ventilated for air circulation and exposed to direct sunlight. Periphery of the pond should be fenced for protection of ducks.
- Ducks are kept in duck house providing about 0.3-0.5 m^2/bird. Again one male duck should be kept in every 5-6 female ducks. Ducklet especially up to 3-4 weeks old are very susceptible to disease, hence, care should be taken within this period.

2.2 Duck Feed

- Mostly fine rice bran and poultry feed (layers mash etc.) are used as duck feed at the rate of 100 gm feed/day/duck.
- Duck feed should be stored at cool and dry environment. If possible, manganese sulphate mixed with feed gives the better result at the rate of 10gms/100kg of feed. Apart from that Duck weeds (Lemna, Wolfia, Azolla etc.) are also fed to the ducks.
- Duck also consume tadpoles, juvenile of frogs and dragon fly larvae. Further protein content in natural food organisms of the ponds consumed by duck is high. Therefore, the duck reared in fishponds save the cost on protein substantially in duck feeds and gives more eggs in comparison to duck which are not allowed in fishponds. The left over feed

given to the ducks and duck dropping fulfill more than 59% of food requirements of farm fishes.

- Sometime algal bloom may increase, then duck dropping should be stopped periodically by using plastic at the bottom of the duck house and removed.

2.3 Lime application

In this integration except basal manure there is no need to apply inorganic and organic manure from the outside during the culture period. Only lime is applied at the rate of 250-300 kg/ha/year at suitable intervals.

Production

By this integration a production of 3500-4000 kg of fish, 18000-18500 eggs and 500-600 kg duck meat from 1 ha of pond area in 1 year without any supplementary feed and fertilizers can be obtained and the cost is turned down to 60% lesser than normal.

Source : A training manual on "Polyculture and integrated fish farming"

College of Fisheries, Assam Agricultural University,
Raha - 782103, Nagaon, Assam, India.

Fish-Cum-Poultry Farmings:

Integrated fish farming with poultry is generally cultured as the poultry manure is a very efficient fertilizer for fish ponds. The poultry droppings comprises 2% nitrogen, 1.25% phosphoric acid and 0.75% potash. The low feeding cost per individual bird makes poultry farming along with fish, a common investment for poor farmers.

(a) Poultry Raising:

Both 'broilers' and 'layers' variety of chicken can be raised for fish-poultry farming. One day old chick are raised up to the pullet stage after which they are put in layer cages.

Fish culture with both intensive and extensive poultry productions have been integrated successfully. The most intensive type of poultry production is the battery type of housing, which is installed by the side of the pond. The floor of the house is cemented and is set up at a slope so that the eggs may roll forward.

For layers, the floor area required is about 30 cm^2 while for broilers, 15-20 cm^2. The usual floor space allotted for each bird is 20 x 30 x 40 cm. The birds are confined to cages which are made up of standard, stout, galvanised wire. The cages are kept on trays for collection of droppings. For further on poultry refer chapter 5.

For manuring one hectare pond water, the droppings of about 250 layers and four batches of 200 broilers each are adequate in a year's time.

(b) Fish Raising:

For fish raising the ponds are stocked with fingerlings of catla, silver carp, common carp, murrels, tilapia, giant freshwater prawns, etc. The stocking density of fishes is related with that of poultry and also with the period of culture.

In one hectare pond area, when stocked with 5000 giant freshwater prawns (Macrobrachium rosenbergii) and 1500 silver carp, and cultured for a period of four months, one can harvest 600 kg of prawns and an equal amount of fish, along with 250 culled birds.

For culturing over a period of one year, ponds may be stocked with fingerlings of catla, common carp, silver carp and grass carp at a density of 5000-6000 fingerlings per hectare. At the end of twelve months of fish-cum-poultry culture, fish yield of over 3900 kg per hectare can be normally obtained along with 42,000 eggs and 200 culled birds.

(c) Advantages and disadvantages of fish-cum- poultry culture:

(i) Advantages:

(1) Chicken manure is a very efficient fertiliser, so no chemical fertiliser is needed for fertilising the pond water. This cuts down the expenditure of rearing fishes.

(2) No supplementary fish feed is required.

(3) The purchase and feeding cost per bird is low.

(4) Chicks are readily available and their productivity can be improved with simple and cheap management.

(ii) Disadvantages:

(1) Chicks should be examined from time to time and diseased one should be isolated, otherwise they will destroy the entire stock.

(2) Sufficient time should be given from one stocking of chicks to the next for renovation of the house and disinfectioning it.

Rice - Fish Integrated Farming System

Rice fish farming can contribute to household income, contribute to food security and nutrition and contribute to improved sustainability of rice production. Generally two production systems

have been recommended for culturing fish in the rice fields. They are, Simultaneous or Concurrent Method and Alternate or Rotational Method.

Selection criteria of rice field

- The field must hold water continuously for several months. The field should be hold water to a depth of 30 cm.
- The plot should be comparatively flat
- The land should be selected keeping in view that it will not be over flooded.
- The soil of the land should hold much water. Clay soil is better for this purpose and the soil pH should be around 6.5-7.5
- Those fields where water remains even after harvest of paddy that is, there should be water, which is sufficient to continue fish culture.
- Fishes can be grown unaffected by chemicals or pesticides used to protect paddy.
- In land with slopes, a high dyke on the uphill side at the field is usually not needed. The layout of the land will help to confine the fish, if the rice field is basin shaped. This can save a lot of work because middle of the field is deepest portion and a very little effort is required to raise the dykes.
- The paddy field should have strong dykes to prevent leakage and to retain water up to desired level /depth.
- The plot should be at the close vicinity of the farmer's house so that better care can be taken up.

Selection criteria of fish species

- The fish should be capable of tolerating very shallow water level.
- Should withstand higher temperature (up to $40^{O}C$) and variable temperature fluctuations
- Those species, which can withstand fairly high turbidity of water and poor oxygen concentration.
- The species, which have faster growth rate and should have desirable characteristics to grow to marketable size in short duration at the time of harvesting the rice.

Selection of rice varieties

- The variety of paddy should be high yielding
- The variety should be highly disease resistant and susceptible to less attack from pests.

- Local paddy varieties of medium to long duration with non lodging characteristics are suitable.

Preparation of fields and other considerations

1. Dyke construction :

Embankments should have a height of 40-50 cm. Since water level for rice does not exceed 20cm, such embankments will already have a free board of 20-30cm. This is sufficient to prevent fish from jumping over.

2. Provision of weirs and screens :

Three types of screens can be provided to prevent escape of fish and to prevent entry of predatory fishes to the plot: e.g. bamboo slats, a basket, and a piece of fish net materials even a well perforated piece of sheet metal.

3. Provisions of proper drains :

The common practice is to temporarily breach a portion of embankment for water to get in or out and once the purpose is finished the breach portion be repaired. Bamboo tubes, hollowed out logs, metal pipes or bamboo chutes are also used.

Depending upon the slope of the land three types of layout for construction of rice fish culture plot has been proposed :

- Perimeter trench model,
- Central pond model,
- Lateral trench model.

i. Perimeter trench model :

In this trenches are dug out in the periphery of the paddy field and the paddy cultivation area remains in the middle of the plot in zone of moderate elevation. In a plot of 1 ha, the area in the central part of the field for paddy cultivation is about 0.67 ha**.** The perimeter trenches may occupy about 0.2 ha and perimeter dykes may occupy another 0.12 ha. Design and construction is that the trench is about 6 meter at the top, 3.5 m at the base and depth is 1.2m. The perimeter may be 1 m in wide at the crest and 3 m at the base.

ii. Central pond model :

In this case fish culture area remains at the center or at the middle of the plot and the paddy growing areas lies surrounding the pond. In a plot of 1 ha area, part of the field for paddy cultivation is about 0.65 ha and the area for the fishpond is 0.35ha with peripheral dyke space of

0.002 ha. The dimensions of perimeter dyke may be 20cm in width, base is of 50 cm width and height is of 30 cm.

iii. Lateral trench model :

Trapezoidal trenches are dug at the sides of paddy plot of dimensions top width 18 m, base 15m and depth is of 1.5 m. There is also to be a peripheral dyke like other two previous cases. In a plot of 1 ha area; part of the field for paddy cultivation is about 0.61 ha and the area for the fishpond is 0.27ha with peripheral dyke space of 0.12 ha.

Water management

Continuous flooding up to the maximum tolerated by rice without affecting its rice production is recommended and it is generally 15-20 cm. At that depth, the effective water depth of 65-70 cm is available to the fish in refuge. This is sufficient to provide the fishes a cooler place when the shallow water over the rice warms up to as high as $40^{O}C$. The increased depth means a greater volume of water for rice –fish culture.

Fertilization

Application of fertilizers increases the nutrient concentration in water, which flourish the growth of phytoplankton, which are directly consumed by the fish or support good growth of zooplankton. Compost fertilizer for deep-water variety @30 tons per ha can be applied. In organic fertilizers for deep water variety Paddy as Nitrogen @120kg/ha, P_20_5 @ 60 kg/ha and K_20 @ 60 kg/ha can be applied.

Stocking patters

Rice fish culture may involve the stocking of young fry for the production of fingerlings (nursery operation) or the growing of fingerlings to marketable size (growing operation). Rice fish farming may either be the culture of only one species (monoculture) or a combination of two or more species of fish and crustaceans (polyculture). Generally, stocking density of fish depends on its size, species and the fertility of the land. It is best to wait until the rice is well established before releasing fish seed. Fish can be stocked once two or three tillers have appeared for which the usual waiting is 1- 3 weeks after transplanting or 4-6 weeks after seeding.

Feeding

To boost the growth of fish, rice bran and mustard oil cake in the ratio of 70:30 @2-3% of the body weight of fishes can be provided.

Source : Training manual on "Polyculture and integrated fish farming" publihed by : College of Fisheries, Assam Agricultural University, Raha - 782103, Nagaon, Assam

4. Fish-Cum-Pig Culture:

In integrated fish farming with pig, the 'pig dung' is useful for conditioning the soil and providing the necessary nutrients required for fertilising the pond water. Fish-cum-pig culture is practised at large in China where pigs are considered as **"costless fertiliser factories".**

Pig dung contains about 70 percent digestible feed for fishes. The feed while passing down the pig's alimentary canal, gets mixed up with enzymes which continue to act even after defecation. Such undigested solids serve as direct food source for tilapia and common carp.

In tropical fish ponds, weeds are a major problem in fish culture. Such vegetation's are considered as valuable food resource for pigs.

Thus, pigs aptly play a role in biological control of weeds:

(a) Pig Rearing:

In fish-cum-pig culture the embankments of fish ponds are made wider (over 10 m in China) to facilitate the building of pig sites and also for growing vegetables, fruit trees or other crops. In the slopes, grasses can also be grown which is used as fodder for grass carp and for other farm animals.

Various aquatic plants, such as azolla, duck weed, Pistia, Wolffia, Lemna, and water hyacinth (Eichhornia) are grown in feeder channels and irrigation ditches associated with the pond farms. These and the foliage of other terrestrial plants (vegetables, rice, corn, etc.) are used for feeding the pigs.

In the water area of the pond, about 10 tons of aquatic plants can be produced, which are sufficient to feed 10 pigs. These plant materials are generally mixed with bananas, coconut meal, rice bran, soybean wastes, groundnut cakes, fish meal, etc.

Pig sites or pen or sty are generally built on nearby land or on the pond embankment. The pen enclosure is built not only for pig raising but also special consideration is given to the needs for breeding, nursing and fattening activities. Pig pen generally have a system of channels for transferring the organic matter into the pond water.

Alternatively, the sty or pen may be constructed above the pond water. The structure is made of wood and provided with a lattice type of floor which permits the excreta and uneaten food to fall directly into the pond water.

Modern practices are to avoid direct washing of the wastes into the pond. The urine and dung of pigs are first allowed to the oxidation tanks (digestion chambers) where sedimentation and fermentation of the manure take place. The supernatant liquid, at regular intervals, are then discharged into the fish ponds.

The sludge that remains is utilised as fertilisers in agriculture. Alternatively the pig manure may be kept in a heap on the pond embankment for later use. The chemical composition of pig wastes is depicted in Table 6.13.

Table 6.13 : Chemical composition of pig wastes

Source	Organic matter (%)	N (%)	P_2O_5 (%)	P (%)	K_2O (%)	K (%)
Fresh manure	15.00	0.60	0.40	0.18	0.44	0.37
Urine	2.00	0.30	0.12	0.05	1.00	0.83
Air-dried manure	34.32	2.12	0.98	0.43	2.45	2.03
Litter manure	34.00	0.48	0.24	0.11	0.63	0.52

The number of pigs to be raised per hectare and the manuring rates to be applied are based on years of experience. The production of manure depends upon the age and size of the pig. A piglet produces about 3.4 kg manure a day, while a one-year-old pig gives about 12.5 kg a day.

The average production of faeces and urine per pig is about 7.8-8 tons per annum. A density of 60-100 pigs has been found to be sufficient to fertilise a one hectare fish pond.

(b) Fish Rearing:

Polyculture is commonly practised in such integrated farming due to the variety of food that becomes available in the pond. Herbivorous and omnivorous fishes are used for culture; generally common and Chinese carps and less frequently catfishes (Pangasius), Indian carps and tilapia.

Due to high productivity of the ponds, fairly high rates of stocking are generally practised — 60,000 fingerlings of different species (weighing 20-30 gm) per hectare.

(c) Production and Duration of Culture:

The duration of culture of fishes and pigs varies. Generally it is about one year, but culture for 6 months duration is also practised. The overall economics of combined fish and pig rearing depends on the local

conditions. However, the pigs are generally sold when they have attained a weight of 90-100 kg. The production of fish generally varies between 2 and 18 tons per hectare per annum.

(d) Advantages and Disadvantages of Fish-Cum- Pig Culture:

(i) Advantages:

(1) Such integrated farming increases the productivity per area and thus, the farmers income becomes doubled or more.

(2) Pig dung conditions the soil of a new pond and provides ready-made organic matter, containing the necessary nutrients.

(3) Pig dung contains about 70 per cent digestible feed for fishes. The undigested solids present in the faeces of pig serves as direct feed source for tilapia and common carp.

(4) Pigs aptly plays a role in biological control of weeds, as weeds are considered as valuable food source for pigs.

(ii) Disadvantages:

(1) Addition of too much pig manure may lead to increased nutrient load resulting in pollution of the water body and mortality of the fishes.

(2) Considerable care and management skills are required to prevent pollution. It has been found that satisfactory fish production can be obtained with much lower manuring.

5. Other Animals in Fish Systems of Integrated Farming:

(a) Fish-Cum-Cattle Farming:

Cattle wastes and washings from the cattle sheds are conveyed through pipes into the ponds which acts as good fertiliser. Cattle wastes are generally collected in a pit for later use. In addition to fish yield, production of milk from cattle and beef adds to the economy.

(b) Fish-Cum-Rabbit Farming:

Rabbit farming has been found to be ideal for integration with small- scale fish culture. Rabbit manure have greater value as a direct food for fish compared to other livestock wastes.

(c) Fish-Cum-Mulberry Farming:

Mulberry plants are raised on the dikes of the fish farm and in the neighbouring fields for silkworm production. The mulberry wastes and silkworm larvae and pupae (after removal of silk) are used as feed for the fishes. It also fertilises the pond water.

Advantages of Integrated Fish Farming:

The advantages of integrated fish farming are as follows:

(1) Full utilisation of farm wastes.

(2) Utilisation of the cooperative effects of interrelated farm activities.

(3) It increases employment opportunities.

(4) It increases nutritional source for the farmer's family.

(5) It gives higher and stable farm productivity and there is less risk (biologically and economically).

(6) It increases the income of rural population.

(7) It is a means of land reclamation in certain areas.

(8) It is an efficient and economic means of environmental management.

Disadvantages of Integrated Fish Farming:

Recently, controversy has arisen among scientists on the public health aspects of integrated farming. Speculations are ripe that integrated fish farming with pigs and poultry may be a cause of influenza pandemic. This may be, as the pigs would act as 'mixing vessels' for avian and human influenza viruses, it can create new lethal strains of viruses by mutation.

In such an act, fishes themselves do not play any role. However, there is no conclusive evidence that integrated farming can become a public health hazard. For safety measures, pig-poultry combinations in integrated fish culture should thus be avoided.