INTEGRATED FISH FARMING

1. Poultry-cum- Fish Farming.

Advantages of poultry-cum-fish farming:
1. At the same time from the same place chicken meat & eggs and fish can be produced.
2. Water needed for poultry husbandry practice can get from fish pond.
3. Fish also feed directly on the poultry excreta.
4. Raw poultry dung contains 1.6% nitrogen, 0.7% phosphorous and 0.7% potash. Again poultry dung in the form of fully built up dip litter contains: 3% nitrogen, 2% phosphate and 2% potash, therefore it act as a good fertilizer which helps in producing fish feed i.e. phytoplankton & zooplankton in fish pond. So application of extra fertilizer to fish pond for raising fish is not needed. This cuts the cost of fish production by 60%. In one year 25-30 birds can produce 1 ton dip litter and based on that it is found that 500- 600 birds are enough to fertilize 1 ha water spread area for good fish production. Daily at the rate of 50 kg/ ha water spread area poultry dung is applied to the fish pond. When phytoplanktonic bloom is seen over the surface water of fish pond then application of poultry dung to the pond should immediately be suspended.

This integrated farming of fish and poultry can be divided into 2 groups:
1. Fish culture practice.
2. Poultry husbandry practice.

1. Fish culture practice:
Fish culture practice followed in the integration of poultry-cum-fish farming is the “Composite fish culture system”. The detail of the composite fish culture system is discussed below:

Composite fish culture:
This is very popular in India and also in Assam in extensive and semi-intensive way. This type of fish culture practice is discussed below very briefly.
The whole management practices followed in case of composite fish culture system can be divided into-

1. Prestocking management.
   i. Construction of a fish farm.
      a. Site selection.
      b. Pond construction.
      c. Pond preparation for stocking with fish.
    ii. Renovation of an existing fish farm.

2. On stocking management.
   i. Selection of species.
   ii. Size, quality, number and composition of fish species to be stocked.
   iii. Stocking of fishpond with fish seed.
   iv. Cares to be taken during stocking.

3. Post stocking management.
   i. Liming.
   ii. Fertilization.
   iii. Feeding.
   iv. Water quality management.
   v. Fish health management.
   vi. Harvesting management.
1. Prestocking management.

I. Construction of a new fish farm/ Renovation measures of an existing fish farm:

i. Construction of a fish farm:

a. Site selection:
The availability of cheap land and plenty of unpolluted freshwater are the most important factors to be considered while selecting a site. The following are the important criteria in site selection for construction of a site-

1. **Water quality**: Biological and physico-chemical nature of water and their seasonal variations.
2. **Drainage**: There should be replacement and recycling facility.
3. **Soil quality**: Nature of soil with biological, chemical and physical properties. *Among the physical properties of the soil, water retention capacity, $P^h$ and productivity of the soil are very important. A selected site’s soil in its every 100 gm should contain 50- 75 mg nitrogen, 6-12 mg phosphorous and 1.5-2.5 gm organic carbon. For good production from cultured fish soil $P^h$ should be in between 7.5- 8.5.*
4. **Fish seed**: Availability of quality fish and prawn seed of required species with the transportation facilities to the site and assurance of supply in required time.
5. **Fish feed**: The local availability of fed ingredients as well as their cost is also very important as out of the total operational cost of fish farming 60% of the expenses goes for feed alone. But in the integration of fish farming with poultry farming practice supplementary feeding to the cultured fish is not required. This is because poultry excreta helps in fertilizing the pond water and produce the fish food organism like- phytoplankton and zooplankton. Apart from that some fish like- common carp take poultry dropping directly as their feed. But supply of feed to the herbivorous fishes like- grass carp, java puthi, etc is required. They need to be fed with grass like- para, napier, maize leaves, banana leaves, chopped green cattle fodder, etc.
6. **Climatic factors**: Rainfall, temperature, evaporation rate, flood, cyclones, etc are the important climatic factors. The growth of fish depends upon these factors. Sometimes flood, drought, etc. cause heavy loss to the fish farmers.
7. **Industrial and agricultural pollution**: The insecticides used in agriculture are toxic to fish. Beyond a certain level, heavy metals and various chemicals discarded from industries are also poisonous to fish.
8. **Infrastructural facilities**: For establishing a new farm various infrastructural facilities are required and they are- communication facility, electricity supply, cold storage facility, nearness to market, support from Government and local authorities, support of universities, research centres, extension centres, etc.
9. **Construction expenses**: The expenses for earth moving, RCC work, workshop, repair and spare parts, cost of construction materials, like- brick, rubble, steel, cement, etc. need to be surveyed. The major item of construction expenses goes for earth moving and RCC work. Earth moving can be done either manually or mechanically depending on the cost of labour.
10. **Availability of labour**: Skilled, unskilled, casual and construction labours are required for establishing a farm.
11. **Financial facilities**: Capital for the scheme can be raised either by loan from commercial banks or from equity participation. Availability of such facilities at a particular area should be studied well in advance. Availability of subsidies and other financial assistance from Government or other developmental organization for the proposed area also should be taken care of.
12. **Marketing facilities**: The farmed product can be sold either to internal market or to export market. In both cases the taste of consumer and the provision for supplying the product to the consumer should be observed.
13. **Availability of equipments and other inputs**: The equipments require for fish farming practices should be available at the site or they can be procured from a nearby place having transportation facilities at reasonable price.
b. Pond construction:

Scientifically constructed fish farm has 3 types of ponds and they are—

1. **Nursery pond:** Area of nursery pond ranges from 100- 500 m\(^2\) and the depth of water should be in between 1- 1.5 m. This pond covers 5% area of total productive area of the fish farm.

2. **Rearing pond:** Area of rearing pond varies between 500- 1000 m\(^2\) and the depth of water ranges from 1.5- 2.0 m. This type of pond covers 15% area of the total productive area of the fish farm. Sometimes it may be used as stocking pond also.

3. **Stocking pond:** Area of stocking pond varies between 1000- 20000 m\(^2\) and the depth of water ranges from 2- 2.5 m. This type of pond covers 60- 70% area of the total productive area of the fish farm.

4. **Bio pond:** Nowadays apart from the above mentioned fish pond in a fish farm a special type of pond- Bio pond is also seen in some farms. It acts as a large settling tank, where the water used for fish ponds of a farm is purified biologically. On need basis it may be used as stocking pond also. The area covered by this type of pond is 7- 10% of the total productive area of a fish farm.

The above mentioned pond of a fish farm is constructed in 2 ways and they are—

5. **Dug out pond:** This is constructed in a plain area by digging soil. This type of fish pond is more suitable for fish farming as they can be constructed by the fish farmer based on their requirements scientifically by maintaining the shape, size, depth, etc. Normally small size rectangular pond is preferred. But pond may be of any shape like- circular, square, rectangular, etc.

6. **Embankment pond:** This type of pond is constructed in undulating and hilly areas. This is constructed by erecting dyke on 2 sides or in 1 side of the selected place on need basis. This is economic to dig out pond from the construction side, but it is not good from the fish culture point of view. This is because the size, shape, depth, etc. can not be fixed as per the scientific fish culture specification, which are depends upon the site's configuration. Normally this type of pond is constructed in hilly places by erecting embankments to a suitable height for fish culture with provisions of inlet and outlet. Here in the inlets and outlets small mess size bamboo made or nylon made screen is tied. This prevents the entry of unwanted fish, aquatic insects, etc. into the culture system and also stops the escaping of cultured fishes from the culture system.

Pond digging: Based on the aim and the facility available with a fish farmer the aforesaid ponds are dug out on scientific basis. During digging of a pond along the side slope should maintained so that it is not eroded. This side slope depends upon the soil quality. For loamy or clay loam soil the side slope should be 1.5: 1. If the selected site contains more sand then this side slope should be little more. Constructed fish pond should have a slope towards a particular side or towards the centre, then dewatering become easier.

Construction of embankment: Fish pond embankment should be strong enough and their height should be 1 ft. more than the high flood level of the selected site. The bases of the embankments are constructed based on the height and slope required for it. Embankments width at the top and its side slope depends upon its height, nature (Peripheral dyke or internal dyke), purpose of use (for walking, for movement of small car, for movement of big vehicle, etc.), etc. Generally in case of clay loam or loamy soil the pond dyke’s external side slope should be 1: 1.5 and for internal side’s the side slope should be 1:2 (Fig. 1 & 2). Sandy soil is not good for construction of embankment as in this case the erosion will be more. Outlet and inlet may be constructed in the pond embankments at the desired height to maintain the water level in the pond at the required height, but in that case to prevent the entry of unwanted fish, insects & other organisms and also to prevent the escape of cultured fishes there should be some arrangement like- erection of net of bamboo made or nylon made. To prevent the soil erosion of pond embankments grasses should be grown over them. Fencing is essential along the boundary of fish farm to prevent the entry of domestic animals, like- cow, goat, etc. From time to time embankments should be check for any damage and repairing should be done. This helps in lasting the embankment for prolong period.
c. Pond preparation for stocking with fish:

i. Liming and fertilization:
Afterwards the pond is filled with water to a depth of 2-2.5 m water depth water inlet and out let may be constructed at the pond dyke with measures to prevent the entry of unwanted organisms and also to prevent the escape of cultured fishes. Then water pH is measured and based on the pH value liming is done as mentioned below. After 7-10 days of liming fertilization pond water is done. As fertilizer both organic and inorganic fertilizers are used. In our place easily available cow dung @ 670 Kg/bigha/year is applied as organic fertilizer. Inorganic fertilizer—urea @ 13 Kg/bigha/year, single super phosphate @ 3 Kg/bigha/year and murate of potash 12 kg/bigha/year is applied after 7-15 days of application organic fertilizer. 1/3rd of the required amount of lime and fertilizer is applied initially to the pond, and then the rest amounts is divided equally into 11 installments and are applied to the pond at monthly regular interval. Then by seeing the pond productivity after 7-15 days of application of inorganic fertilizer fish seed is released to the pond water.

Already mentioned that the poultry excreta is rich in nitrogen, phosphorous and potash. Therefore, there is no need of using extra fertilizer as mentioned above in this type of integrated farming. Poultry-cum-fish culture is done through the integration of direct or indirect method. In case of direct integration poultry droppings are allowed to fall directly into the fish pond. In the indirect integration 10-15 days just before stocking the fish pond with fish seed poultry dropping is applied at the rate of 50 kg/ha/day and the same dose of poultry dropping is applied to the fish pond after stocking also. When phytoplanktonic bloom is seen over the surface water of fish pond then application of poultry dung to the pond should immediately be suspended.

ii. Renovation measures of fish ponds of an existing fish farm.

1. Renovation measures of a pond, which can be dried through dewatering:
Pond should be completely dried during dry season by pumping out the pond water and the pond bed is exposed to sunlight. After drying mud from the pond bed should remove. Here in this case pond water depth is need to be considered, in any case it should not go beyond 2.5 meters for good productivity. Then the pond bed is ploughed and dried. Then apply lime to the dry pond bed depending on the pond soil pH (Table-1.).

Liming.
Liming helps in maintaining the pH of fish pond water. This helps in increasing the natural productivity of the pond. Liming also helps in maintaining the cultured fish stock disease free. It is done based on the soil and water pH. Below liming dose based on soil and water pH is given—

**Liming schedule depending on soil and water pH:**

<table>
<thead>
<tr>
<th>Sl No.</th>
<th>Soil &amp; water pH (Kg./ha.)</th>
<th>Soil &amp; water type</th>
<th>Quick Lime required</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4.0-5.0</td>
<td>Highly acidic</td>
<td>2000</td>
</tr>
<tr>
<td>2.</td>
<td>5.0-6.0</td>
<td>Acidic</td>
<td>1200</td>
</tr>
<tr>
<td>3.</td>
<td>6.0-6.5</td>
<td>A little acidic</td>
<td>1000</td>
</tr>
<tr>
<td>4.</td>
<td>6.5-7.0</td>
<td>Neutral</td>
<td>400</td>
</tr>
</tbody>
</table>

Based on the pH of soil and water the required quantity of lime is determined. 1/3rd of the required amount of lime is applied initially to the pond, and then the rest amounts is divided equally into 11 installments and are applied to the pond at monthly regular interval.

Repairing of dykes:
During the drying period repairing of pond embankments (if required) are done. In repairing or constructing a pond dyke the following points are needs to be considered (in case of loamy or clay loam soil):
Out side slope: 1: 1.5  
Inside slope : 1: 2  
Height : 1 foot above the high flood level of the locality.

Base and top width of a dyke depends on its type (i.e. Peripheral dyke, internal dyke, dyke for moving vehicle or walking, etc.), height and slope.

Control of water seepage:
Water seepage which depends on soil quality is another hurdle need to control prior water filling in a pond. This can be control by using bentonite or using plastic sheet. Since bentonite is not easily available in all places and its high value in the market, therefore, a layer (15 cm thick) of muddy clay soil may be used. Some time a layer of cow dung and muddy soil mixture has shown promising result like that of bentonite.

Water filling, liming & fertilization:
Afterwards the pond is filled with water to a depth of 2- 2.5 meter. To maintain a desire 2-2.5 m water depth water inlet and out let may be constructed at the pond dyke with measures to prevent the entry of unwanted organisms and also to prevent the escape of cultured fishes. Then water PH is measured and based on the PH value liming is done as mentioned above. After 7- 10 days of liming fertilization pond water is done. As fertilizer both organic and inorganic fertilizers are used. In our place easily available cow dung @ 670 Kg/ bigha/ year is applied as organic fertilizer. Inorganic fertilizer- urea @ 13 Kg/ bigha/ year, single super phosphate @ 3 Kg/ bigha/ year and murate of potash 12 kg/ bigha/ year is applied after 7-15 days of application organic fertilizer. 1/3rd of the required amount of lime and fertilizer is applied initially to the pond, and then the rest amounts is divided equally into 11 installments and are applied to the pond at monthly regular interval. Then by seeing the pond productivity after 7- 15 days of application of inorganic fertilizer fish seed is released to the pond water.

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Fig: 1: Schematic diagram of a 0.4 ha stocking pond.

Fig.: 2: Cross section of a 0.4 ha pond.
integrated farming. Poultry-cum-fish culture is done through the integration of direct or indirect method. In case of direct integration poultry droppings are allowed to fall directly into the fish pond. In the indirect integration 10-15 days just before stocking the fish pond with fish seed poultry dropping is applied at the rate of 50 kg/ha/day and the same dose of poultry dropping is applied to the fish pond after stocking also. When phytoplanktonic bloom is seen over the surface water of fish pond then application of poultry dung to the pond should immediately be suspended.

2. Renovation measures of a pond, which cannot be dried even by dewatering:
Renovation measures of an existing fish farm's ponds which can not be dried even by pumping out water are:

i) Removal of aquatic weed:
Unwanted aquatic weeds are needed to be removed from fish pond as it reduces the pond productivity. These unwanted aquatic weeds could be removed- manually, mechanically, chemically and biologically. If possible manual removal method is better. Grass carp, java puthi, tilapia, etc. are good biological agent in removing aquatic weed from fish pond. Chemicals used in the removal of aquatic weeds from fish pond are:

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Quantity to apply</th>
<th>Weed controlled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 2-4 D</td>
<td>4.5 - 6.5 kg/ha. Water spread area.</td>
<td>Floating weed like- Eichornia.</td>
</tr>
<tr>
<td>2- 4 D Ester</td>
<td>9-13 kg/ha.</td>
<td>-DO-</td>
</tr>
<tr>
<td>2- 4 D Sodium</td>
<td>10 - 12 kg/ha. (in solution form).</td>
<td>Small floating weed, like-duck weed.</td>
</tr>
<tr>
<td>2- 4 D Sodium</td>
<td>5 kg/ha. (in solution form).</td>
<td>Marginal weed, like- Colocasia, Ipomea, etc.</td>
</tr>
<tr>
<td>Simazine</td>
<td>5 kg/ha.</td>
<td>Floating weed like- Eichornia &amp; small floating weed, like-duck weed.</td>
</tr>
<tr>
<td>Simazine</td>
<td>0.5-1 mg/lit of water in pond.</td>
<td>Algae type.</td>
</tr>
<tr>
<td>Paraquat</td>
<td>0.02 kg/ha. (in solution form).</td>
<td>Small floating weed, like-duck weed.</td>
</tr>
<tr>
<td>Sodium arsenite</td>
<td>5-6 mg/lit. of water in pond.</td>
<td>Submerged rooted weed, like- hydrilla, valisnaria, etc.</td>
</tr>
<tr>
<td>Superphosphate</td>
<td>500 mg/lit. of water in pond.</td>
<td>-DO-</td>
</tr>
<tr>
<td>Urea</td>
<td>50-100 mg/lit. of water in pond. &amp; 250-300 mg/lit. of water in pond. (If urea is applied to the pond at the concentration of 50 mg/lit. or more then the fishes of the pond may die.)</td>
<td>Ottelia.</td>
</tr>
<tr>
<td>Hydrilla.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diuron</td>
<td>0.1 -0.3 mg/lit. of water in pond.</td>
<td>Algae type weed.</td>
</tr>
</tbody>
</table>
ii) Removal weed fishes, insects, unwanted organisms, etc.:
This is done by repeated netting or by using chemicals. Soap-oil emulsion (soap: oil :: 1: 3) over the pond water surface is most commonly used technique to kill the insects in fishponds. Mohua oil cake @ 200- 250 ppm or tea seed cake @ 750 –975 Kg/ha(100- 130 Kg/bigha) give encouraging result in controlling weed fishes of a pond and it also helps in reducing the quantity of organic fertilizer required by 50%. Commercially available bleaching powder @ 97- 113 Kg/ha (13- 15 Kg/bigha) can also be used as fish toxicant.

iii) Control of algal bloom:
Some time a thick layer of algal bloom of brown or green colour is seen over the water surface of pond. This can be removed from fish pond by using a piece of split bamboo followed by liming based on water pH as mentioned earlier. Chemicals like- coppersulphate @ 0.1- 0.5 mg/lit. of water or diuron @ 0.3- 0.5 mg/lit. of water also helps in controlling this bloom.

iv) Partial replenishment of water:
Since total dewatering is not possible, so depending on the feasibility some percentage of pond water may be pump out and the same is refilled with new water. But the water depth should be restricted to 2- 2.5 m for good production of fish.

v) Removal of noxious gases, etc.:
Noxious gases and the effect of other substances of pond bottom mud can be reduced by repeated netting or by moving a rope through the pond bottom mud.

vi) Repairing of pond dykes:
As mentioned earlier in case of renovation measures of fish pond which can be dried repairing of pond dykes are done.

vii) Water filling, liming and fertilization:
Afterwards the pond is filled with water to a depth of 2- 2.5 meter. To maintain a desire 2- 2.5 m water depth water inlet and outlet may be constructed at the pond dyke with measures to prevent the entry of unwanted organisms and also to prevent the escape of cultured fishes. Then water pH is measured and based on the pH value liming is done as mentioned above. After 7- 10 days of liming fertilization pond water is done. As fertilizer both organic and inorganic fertilizers are used. In our place easily available cow dung @ 670 Kg/ bigha/ year is applied as organic fertilizer. Inorganic fertilizer- urea @ 13 Kg/ bigha/ year, single super phosphate @ 3 Kg/ bigha/ year and murate of potash 12 kg/ bigha/ year is applied after 7-15 days of application organic fertilizer. 1/3rd of the required amount of lime and fertilizer is applied initially to the pond, and then the rest amounts is divided equally into 11 installments and are applied to the pond at monthly regular interval. Then by seeing the pond productivity after 7- 15 days of application of inorganic fertilizer fish seed is released to the pond water.

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2. On stocking management.
i. Selection of species.
a) Species selection criteria.
Numbers of fish species are available for composite fish culture. But a species selected for culture should have the following characters-

1. Fast growth rate.
2. Good food conversion efficiency.
3. Acceptability of supplementary and natural food.
4. Adaptability to crowded conditions and resistance to diseases.
5. Ability to withstand changing physico-chemical and biological conditions of the pond water.
6. Good market value.

b) Fish species can be cultured.
Rohu (Labeo rohita), Catla or Bahu or Dhekera or Bhokua (Catla catla), Mrigal or Mirika (Cirrhinus mrigala), Silver carp (Hypophthalmichthys molitrix), Common carp (Cyprinus carpio), Grass carp (Ctenopharyngodon idella), Tilapia (Oreochromis mossambica), Magur (Clarias batrachus), Java puthi (Puntius javanicus) Kurhi (Labeo gonius), Freshwater prawn, etc.

ii. Size, quality, number and composition of fish species to be stocked.

a) Size of fish seed to be stocked.
It is seen that fish farmers of Assam are stocking their pond with fish seed of different sizes, starting from spawn, fry and fingerling to yearling. Considering the environmental condition which allow only a short period for growing of fish, stocking of pond with yearling is always best to get a good return. But it is not possible for farmers to get yearling in sufficient quantity as and when they required or it may not be possible for them to get it. Therefore, fish fingerling i.e. 10-15 cm size fish seed is the best stocking material in the stocking pond.

b) Quality of fish seed to be stocked.
Fish seed quality depends upon the quality of brooders. Therefore, farmers should collect the fish seed from a known source who is maintaining a good quality stock of brood fish for production of fish seed.

c) Number of fish seed to be stocked.
The stocking density depends on the species, culture period, desired individual size and intensity of management. In composite fish culture in stocking pond fish seed of 10-15 cm length (fingerling) is stocked at the rate of 7000-8000 nos./ha. (900-1000 nos./bigha).

d) Species composition.
Considering the seed availability; productivity, size & depth, etc. of pond; market demand; etc. 3, 4 or 6 species combination can be introduced into the cultured pond. Maintaining the stocking density at 1000 nos. of fingerlings/bigha the stocking percentage and number are given below-

<table>
<thead>
<tr>
<th>Fish species</th>
<th>% of species composition (numbers/bigha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3 species</td>
</tr>
<tr>
<td>1. Catla or bahu or dhekera or bhakua.</td>
<td>50 (500)</td>
</tr>
<tr>
<td>2. Rohu.</td>
<td>30 (300)</td>
</tr>
<tr>
<td>3. Mirika.</td>
<td>20 (200)</td>
</tr>
<tr>
<td>4. Common carp.</td>
<td>----</td>
</tr>
<tr>
<td>5. Silver carp.</td>
<td>----</td>
</tr>
<tr>
<td>6. Grass carp.</td>
<td>----</td>
</tr>
</tbody>
</table>

Note: 1. In the stocking pond apart from the above mentioned species Java puthi can also be cultured at the rate of 5-10%, but then the stocking density of Grass carp should be reduced by the stocking rate of Java puthi. Normally it is not suggested to introduce the Java puthi into the stocking pond as they are easily attacked by disease causing pathogens.

2. Common carp stocking percentage is kept less as they eroded the pond embankment and create turbidity problem in the culture system.

3. If 4-5 nos. of Kandhuli (Notopterus notopterus) is stocked in the stocking pond along with the cultured fishes then good yield is achieved. This is because the fish
Kandhuli helps in controlling the weed fishes in the pond thereby it minimizes the loss of feed to the cultured fish and also helps in maintaining the dissolved oxygen budget.

iii. Stocking of fish pond with fish seed.
In the integration of poultry-cum- fish farming 15- 20 days after bringing the birds to the poultry house fish pond are stocked with fish seed. This is because the poultry excreta during the period of 15- 20 days fertilize the pond water and produce the fish food organism like- phytoplankton and zooplankton for feeding the cultured fish. Production of fish food organism in the fish pond after application of poultry dropping can be judged by observing the water colour which becomes light greenish. And immediately after seeing that colour the pond should be stocked with fish seed.

iv. Cares to be taken during stocking.
Stocking of fish seed in the stocking pond should be done in the morning hours. Before stocking the fish seed is need to be conditioned. Through conditioning the fish seed are adjusted to the new environment. It may require from few minutes to hours time. First the container carries the fish seed are placed over the surface water of the fish pond for few times where the fishes will be stocked. This helps in bringing the temperature of the container water to the pond water temperature. Then slowly a little amount of water from the pond to be stocked is introduced into the container having the fish seed and acclimatized them. This process may be repeated for 2- 3 times on need basis. After conditioning fish seed from the container to the pond which is to be stocked is released slowly. This helps in minimizing the mortality of fish seed in the pond immediately after stocking.

1. Post stocking management.
i. Liming.
Liming helps in maintaining the P\text{H} of fish pond water. This helps in increasing the natural productivity of the pond. Liming also helps in maintaining the cultured fish stock disease free. It is done based on the soil and water P\text{H}. Liming dose and schedule are given above.

ii. Fertilization.
Fertilization increases the natural food availability in the pond. At the same time fertilization creates many environmental problems like- dissolved oxygen concentration depletion, phytoplankton bloom, higher NH\text{3} level, etc. But it is believed that manuring alone can increase the production of the pond by 75%.
Artificial fertilizer like- NPK, Superphosphate, etc. and organic manure like- cow dung, poultry dropping, etc are used commonly in fish pond. Generally Potash is not a limiting factor in our area. But Phosphorous is the limiting factor.

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iii. Feeding.
Apart from natural food most of the cultured fish species takes artificial feed. Feeding alone can increase the production from ponds by 4 times.
The exact nutrient requirements for all the species are not known. But in general the artificial feed should contain 30- 40% protein, 5- 10% fat, 50- 60% carbohydrates, less than 5% cellulose, 10% water, vitamins and minerals.

In the integration of fish farming with poultry farming practice supplementary feeding to the cultured fish is not required. This is because poultry excreta helps in fertilizing the pond water and produce the fish food organism like- phytoplankton and zooplankton. Apart from
that some fish like common carp take poultry dropping directly as their feed. But supply of feed to the herbivorous fishes like grass carp, java puthi, etc. is required. They need to be fed with grass like para, napier, maize leaves, banana leaves, chopped green cattle fodder, etc.

iv. Water quality management.
The success of fish culture largely depends upon the water quality of the stocking pond. Water quality is defined as suitability of water for the survival and optimum growth of cultured fish. The higher the intensity of culture the will be the water quality problem. In water quality management we regulate the environmental conditions so that are within the optimum range for the cultured stock. Some of the water quality problems encountered in fish farms are-

a) Depth of water: The depth of water in the fish cultured pond is important factor from the productivity point of view. The optimum depth of water in fish pond is 2-2.5 m. If there is any change in the depth of water in the fish pond is seen then it should be corrected. The excess water from pond can be removed through pumping or through the use of outlet in the embankment. If the water depth is reduced then from a nearby source it should be filling up.

b) Turbidity of pond water: This is occurring when there is more clay content in the soil of fish pond or it may cause due to overgrowth of phytoplankton. This reduce the primary production in pond, causes oxygen depletion in the pond water, reduce growth of cultured fish and also cause mortality of cultured fishes due to asphyxiation. Normally small fish and eggs are suffered from this water quality problem. To control this water quality problem apply aluminium (filter alum) sulphate i.e. $\text{Al}_2(\text{SO}_4)\_3 \times 14 \text{H}_2\text{O}$ at the rate of 10-40 mg/ lit. of water. Actual quantity can be determined by putting alum in a glass of turbid water. After applying alum liming should be done as per the water $\text{pH}$ as mentioned in the corrective measures of water $\text{pH}$.

c) Dissolved oxygen (DO): Dissolved oxygen range in the stocking pond should be in between 5-8 ppm. Dissolved oxygen depletion normally occurs in the morning or in the late night hours. If the depletion of DO occurs in the pond then the fishes will come to the surface of water and try to gasp air from the atmosphere. In that case feeding and fertilization in the pond should immediately be stopped. Supply water from a nearby source. Turbulent the water with the help of a split bamboo. Harvest the table size fish and reduce the density of fish in the pond. If the DO concentration is increase than its normal range then “Gas Bubble Disease” may occur. Normally it is seen in the noon and afternoon hours. Fish fry and fingerlings are mostly effected due to entry of gas bubble in the arteries of fish and finally fish may die. Supply of water from a nearby source having less DO concentration, transferring the affected fish to a nearby pond, etc are the remedial measures.

d) Ammonia: Ammonia occurs in pond water in 2 forms i.e. ionized and unionized. Unionized ammonia toxic to fish. Ammonium ($\text{NH}_4$) is lethal to fishes only at a level above 16 ppm while ammonia ($\text{NH}_3$) is lethal at a level above 0.02 ppm. If the unionized ammonia concentration is increased then the fish may die. Control the water temperature, $\text{pH}$ and also the concentration of phytoplankton in the pond and for that purpose take the renovative measures given in case of changes of water $\text{pH}$ & temperature.

e) $\text{pH}$ of water: $\text{pH}$ is defined as the negative logarithm of hydrogen ion concentration. $\text{pH}$ value 7 is neutral, below 7 is acidic and above 7 is alkaline. For fish culture soil and water $\text{pH}$ should be in the range of 7.5-8.5. Acidic $\text{pH}$ is due to chemical nature of soil and water and it can be controlled through liming as mentioned above in liming. Alkaline $\text{pH}$ is seen with alkaline soil and with phytoplankton bloom and this can be controlled by water replenishment and through the application of gypsum.

f) Phytoplankton bloom: The sudden increase of population of certain planktonic algal group as thick mass in water is called phytoplankton bloom. It is identified by the deep green or blue green or reddish green colour of the pond water. During the day time phytoplankton produces excess oxygen and during night and cloudy days they absorb dissolved oxygen
from water for their respiration resulting dissolved oxygen depletion and fish mortality. The death and decay of algae also cause dissolved oxygen depletion. The reason for this algal bloom in pond water is the presence of excess nutrients in water. Therefore if this problem encountered in the fish culture pond then supply poultry manure to the pond should immediately be cut off and the remedial measures should be taken as mentioned in the case of algal bloom cited in the renovation measures of a pond which can not be dried.

g) Changes in water temperature: It leads to loss of appetite of cultured fish. Fish will also shows poor growth and they become susceptible to diseases. If the water temperature changes to a markable level then supplying feed and fertilizer to the pond should immediately be stopped. Replenishment of water from a nearby source, harvesting the table size fish, etc. are some of the corrective measures to be taken for it.

Note: Apart from the above cited water quality parameters the other water quality parameters to be noted are- total alkalinity, turbidity, micronutrients, chemical pollutants, insecticide, organic matter, presence of aquatic vegetation, etc. are to be checked regularly for good production from a fish pond.

i. Fish health management.
Cultured fish should check regularly for their health. If any deviation in their normal behaviour is seen then they should be treated with the advice of an expert.

ii. Harvesting management.
After 7-8 months of growing cultured fishes reaches marketable size. The grass carp and silver carp becomes 1 kg size in 7-8 months cultured period. To reach 750 gm to 1 kg rohu, catla, mirika, etc needs about 1 year growing period. When the cultured fish reaches 750 gm to 1 kg, in weight then they are harvested from the pond. The harvesting may be done by removing the complete stocks of cultured fishes or by removing the only table size (750 gm to 1 kg) fishes partially based on market demand. In case of partial harvesting the numbers of fish harvested from a pond is replenished with equal numbers of small fishes from nursery ponds of the farm. This helps in getting more money.

2. Poultry husbandry practices.
Integration of poultry and fish farming is done through 2 ways –

A. Direct.
In this direct integration of poultry-cum-fish farming poultry house are constructed on the water surface of the pond and the poultry droppings are allowed to fall directly to the fish pond.

B. Indirect.
In indirect integration of poultry-fish farming poultry house are constructed at any convenient places of the fish farm and poultry droppings are stored and allowed to decompose to form dip litter and to form fully built up dip litter and this dip litter or raw poultry dung are applied to the fish pond in required quantity as and when necessary.

In poultry farming along with fish the following management practices are followed:

1. Poultry farming systems.
2. Construction of poultry house.
3. Selection of poultry birds.
4. Housing of birds.
5. Feeding of birds.
7. Health care.
8. Production.

1. Poultry farming systems:
There are 3 systems of farming of poultry birds along with fish farming-

1. Extensive system (free range).
2. Semi-intensive.
3. Intensive.
In the poultry-cum-fish farming system poultry birds are raised under intensive system. They are not allowed to go out side of their house. This intensive system of raising of poultry bird is of 2 types-

1. **Battery system (cage system):** In the cage system of poultry farming the poultry house are constructed over the pond water surface in a row manner and the poultry dropping are allowed to fall to the pond water directly. However, if the poultry house are constructed on the embankment of a pond below the cage some pots are placed to collect the poultry droppings and from these pots the poultry droppings are applied to the fish pond.

2. **Deep litter system:** In the dip litter system the poultry houses are constructed on the pond embankment or any convenient places of the fish farm. In this system the floor of the pen is covered with 10- 15 cm thick easily available dry organic matter like- dry leaves of tree, chopped straw, hay, saw dust, lime, etc. The dropping of the birds which fall gradually combined with the materials used and bacterial action started. When the depth of litter becomes less, more organic matter is added to maintain the sufficient depth of litter. The litter is regularly stirred and after 2 months it becomes dip litter and in about 10- 12 months it becomes fully built up litter In case of litter becomes damp lime is applied to make it dry. This is preferred over the battery or cage system because of higher manorial value of dip litter or fully built up litter.

2. **Construction of Poultry House:**
Production of good number of chicken eggs and meat can get if the farmed poultry stock remains comfortably in the poultry house. Poultry house must provide adequate space, cool during summer, warm during winter and provide adequate supply of sunshine, good aeration and dry environment. In construction of a poultry house it should be noted that the house should always remain clean and dry. In direct integration the house is constructed above pond water surface and in case of indirect integration it is constructed either on the pond embankment or in any convenient places of the fish farm. The height of the house from floor to the roof should be 3.6 m and the height of walls should be 2.72 m. Through the control of light and air the house should made air-conditioned. The ceiling of the house is needed to be covered with a screen. In direct integration the house floor is constructed with small holes. This poultry house may be constructed at cheaper rate with locally available materials like- bamboo, thatch, wood, etc. But this house may also be a concrete structure. In case of direct integration the floor of the house should remain at least 1.2- 1.5 m above the pond water surface. The space of the house required is calculated based on the number of birds going to stock. Normally for every bird 0.3- 0.4 m² space per bird is required. In intensive farming of poultry in 1 house up to 250 birds can be farmed.

3. **Selection of Poultry Birds:**
Depending on the utility, economic value and fancy purpose, etc. the poultry birds are classified as-
1. Meat type (Broilers)
2. Egg type (Layers).
3. Game.
4. Ornamental.
5. Bantam (Fighter).
In the integration of fish and poultry farming both egg type and meat type are farmed. In the cage and dip litter system both egg type and meat type are grown. But in storied house (chang ghar) egg type birds are farmed. In the dip litter and cage system any of the high yield (egg and meat) variety of poultry birds like- Rhode island, Leg horn, etc. are suitable, but in storied house Kisten golden breed is only preferred.

4. **Housing of Birds:**
Just 1 month prior to stocking of fish pond with fish seed after vaccination against viral diseases and after providing all prophylactic measures about 8 week aged poultry birds are brought to the house for farming. Before introduction of birds into the house the house and
the utensils to be used in the poultry raising practice should be disinfected with disinfectant like- potash. When the poultry birds becomes 18 months aged then their egg laying capacity will be reduced and the old stock should sale out and a new stock should introduced to the house after cleaning the house with disinfectant. For every 1 hector water spread area 500-600 (67- 80 birds/ bigha water spread area) birds are sufficient for poultry-cum- fish culture practice.

5. Feeding of Birds:
Poultry are fed with balanced poultry feed available in the market in different trade names. Under litter system the poultry birds are fed according to their age. The normal feeding practices followed-
1. Skik mash- 40- 45 gm/ day in 3- 4 times a day up to the age of 8 week of birds.
2. Grower mash- 50- 70 gm/ day in 5- 6 times a day from 8- 18 weeks age of birds.
3. Layers mash- 80- 120 gm/ day in 3- 4 times a day from 18 weeks age of birds.
Along with feed there should be sufficient supply of drinking water to the farmed poultry birds is required. For dust bath of birds an earthen pot of about 2 feet diameter filled with clean and dry earth are place in the house. Roosting starts from 8 weeks age of the chicken and so perches are provided in the pen for roosting of birds at the rate of 8 inch/ perch/ bird.

6. Egg Laying management:
Chicken starts laying eggs from 22 weeks onwards and they lay eggs from 22 weeks to 18 months. When their egg laying stopped then the old stock of chicken is replaced with a new stock of poultry birds. For egg laying they need nest. This nest may be of wood or bamboo or tin made. For every 5-6 birds 1 nest is required. Therefore, based on the numbers of chicken the required numbers of nests are kept in the house.

7. Health Care:
Poultry birds are suffered from viral, bacterial, parasitic, fungal and nutritional diseases. Keeping the poultry house clean and dry and vaccinating the farmed stock of the poultry birds against all the viral diseases can help in maintaining a healthy stock of chicken. Before bringing the poultry birds into the house the house and utensils to be used in the farming practices should be disinfected. The farmed chicken should be fed with balanced feed. The poultry birds should fed the medicine for worms at least once in a month. The veterinary expert is needed to be communicated for any type of poultry diseases and accordingly advice may be taken up.

8. Production.
In this poultry-cum- fish farming from a hector of water spread area pond in 1 year 3500-4000 kg fish, 650 kg chicken meat and 120000 nos. of chicken eggs can be produced.

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(Source : College of Fishery, Raha, Nagaon)