Course Manual

Certificate course

AQUACULTURE WORKER

Agriculture Skill Council of India (ASCI)

PMKVY
प्रधानमंत्री कौशल विकास योजना

भाकृअनुप ICAR

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सी एम एफ आर आइ CMFRI

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PREFACE

Hon. Prime Minister Shri Narendra Modi Prime Minister of India said that “Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission”. In line with the Pradhan Mantri Kaushal Vikas Yojana (PMKVY) programme this ICAR- Kishi Vigyan Kendra (Ernakulam) of Central Marine Fisheries Research Institute organized one month skill development programme “Aquaculture worker” course in association with Agriculture Skill Council of India (ASCI) following the National Occupational Standards curriculum. Twenty numbers of selected youth were participated, majority of them are highly educated professionals. This is an indication of growing interest of youth towards Aquaculture. There is a ray of hope that Kerala Aquaculture has a bright future in the hands of younger generations which can be a trend setter for other states in the country. I wish all the very best and success for the all participants for their future endeavors.

(A. Gopalakrishnan)
Director

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Freshwater aquaculture Practices and prospects

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Major cultured/cultivable freshwater finfishes in India are Indian major carps (catla, rohu and mrigal), medium carps (fimbrius, gonius and gonionotus), Chinese carps (silver carp, grass carp and common carp), magur, pangas, murrel, anabas, pabda, and tilapia.

Indian major carps – Catla, rohu and mrigal

Medium carps – fimbriatus, gonius and gonionotus

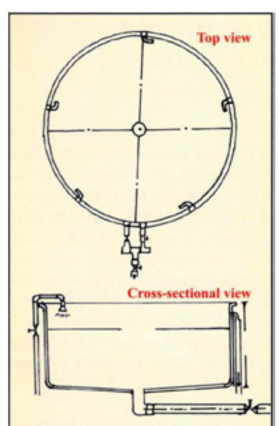
Silver carp **Grass carp** **Common carp**

MagurPangas **Murrel**

Anabas **Pabda**

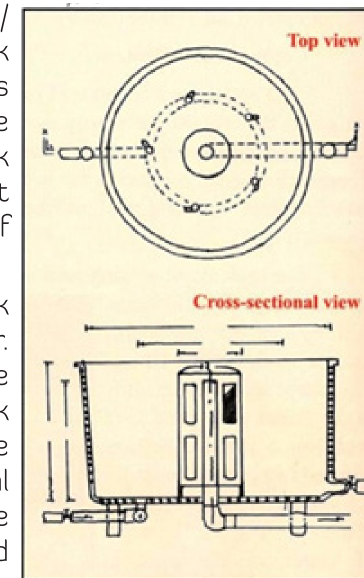
Breeding and Hatchery Management of Carps

Until late 50s riverine seeds were the exclusive source for carp culture. Major breakthrough was made in 1957 when induced breeding technique was successfully applied to freshwater fish, leading to hatchery production of seed. To start with it was pituitary gland extract as the inducing agent; later synthetic hormones like ovaprim, ovatide, WovaFH were developed and captive breeding becomes more consistent and easier.



In a carp hatchery there is (a)

Spawning tank and (b) hatching/incubation tank. Spawning tank is circular and the size depends on the number of eggs to be produced. The bottom of the tank is sloping towards a central outlet facilitating complete drainage of eggs.



Hatching/incubation tank is circular with 3-4 m diameter. Speed of water flow inside the tank can be adjusted duck beak type water inlets (ejectors) in the bottom connected to a central water supply ring built in the bottom. Depth of water is around 1-1.5 m. A cylinder type filter with around 1-1.5 m is fitted in the centre of the tank. Shell of the cylinder is made of concrete while the superficies are covered with fine mesh of 0.3-0.4 mm diameter to prevent hatchlings from escaping.

Carps mature at about 2-4 years of age. Healthy fish of 2-4 years of age are maintained in broodstock ponds for about 3-4 months before the spawning season at a density of 1500-2000 kg/ha. They are fed with balanced diet @1-2% body weight. Around 20-25% of water in broodstock ponds is replaced with fresh water in a month. Using canvas bags mature/oozing broodfish are transferred to spawning tanks and kept in separate hapas inside the tank @male:female::3:2. Inducing hormones such as ovaprim/Ovatide/Wova FH are administered @0.2-0.3 ml/L for males and 0.3-0.5ml/L for females by either intramuscular or intraperitoneal injections. Broodfish are kept in continuous shower post injection. The eggs are collected from the spawning tank and transferred to hatching tank. Hatching normally takes place within 14-18 h. Around 72 h after hatching the hatchlings are transferred to nursery tanks. The hatching tanks are cleaned with $KMnO_4$ before next operation. For long distances carp spawn can be transported in oxygen filled bags at density 25,000-50,000/bag with 6 L of water. For short distances carp spawn shall be transported in aluminium containers with good agitation of water. Table 1 depicts economics of carp spawn production in hatchery; there is potential to earn over 1 lakh rupees as net profit.

Table 1. Economics of carp spawn production in hatchery

Sl. No.	Items	Amount (in Rupees)
I.	**Expenditure**	
A.	**Fixed capital**	
1.	Breeding pool 6 m diameter (1 no), Incubation chambers (1.5 m dia, 6 nos) & egg collection chamber (2.5 X 1 X 0.75 m, 1 no) and shed	2,00,000
2.	Overhead tank (capacity 20,000 l) and accessories	1,00,000
3.	Broodstock and water Intake ponds (0.5 ha, 2 nos)	1,50,000
4.	Water pumps and accessories (Electric/diesel 5HP)	40,000
	Sub-total	**4,90,000**
B.	**Variable cost**	
1.	Prospective brood fish 1200 kg (raised from broodstock pond) @Rs 40/kg	48,000
2.	Fuel for diesel pump, electricity, etc.	20,000
3.	Disinfectant, inducing agents, etc.	15,000
4.	6 full time/part time workers @ Rs. 3000 per man-month for 3 months	54,000
5.	Miscellaneous expenditure	10,000
	Sub-total	**1,47,000**
C.	**Total Cost**	
1.	Total variable cost	1,47,000
2.	Depreciation cost on fixed capital @ 10% yearly	49,000
3.	Interest on fixed capital @12% per year	58,800
	Grand Total	**2,54,800**
II.	**Gross Income**	
1.	Sale of spent brood 1000 kg @ Rs. 55/kg	55,000
2.	Sale of spawn @ Rs 600/lakh for 50 million	3,00,000
	Total	**3,55,000**
III.	**Net Income** (Gross income - Total cost)	**1,00,200**

Fry and fingerling production

The 'nursery phase' in carp production is from 3-day old spawn to 15-20 days old fry, while the 'rearing phase' is from 20-day old fry to 2-3 months old fingerlings. It's highly recommended to use fingerling (100 mm/~10 g) to stock 'grow out' pond. Small

village ponds are ideal to use for fry rearing. Other than normal earthen ponds, cement tanks are also used for fry rearing. While the earthen ponds are 0.02-0.1 ha/1.0-1.5 m deep, cement tanks are 50-100 m2/1.0-1.2 m deep. The latter are ideal for high density rearing of fry. Aquatic weeds are undesirable in fish ponds; they absorb nutrients affecting productivity, harbor predatory/weed fishes, hinder fish movements and obstruct fishing activity. They can be removed by manual picking. Predatory and weed fishes are also undesirable since they resort to predation and competition. Examples are murrel, gobi, magur, singhi, pabda, Wallago, Puntius, Barbus, Anabas, Colisa, etc. Dewatering and sun-drying of pond are recommendedfor their eradication. Mahua oil cake shall be applied @2,500 kg/ha-mfor 3 weeks before stocking. Bleaching powder (350 kg/ha-m) and Urea (100 kg/ha-m) are also effective.

For fry production organic and inorganic fertilization are done to increase plankton in pond water. Lime is applied depending on the pH.Cowdung @5-6 t/ha or poultry droppings @2-3 t/ha are applied fortnight before stocking. This will improve natural productivity. Groundnut oilcake/mustard oilcake @750 kg, cowdung @200 kg and 50 kg single super phosphate per ha are applied in split doses, half 2-3 days prior to stocking and the rest depending on the plankton level in pond water in order to maintain desired plankton level.

Aquatic insects and their larvae are harmful to carp larvae by way of predation and competition. Examples are back swimmers, water stick insects, pond skater, water scorpion, water measurer, diving beetles, etc.Cheap vegetable oil @ 56kg/ha with 1/3 of any cheap soap is effective to control aquatic insects. Kerosene @100-200 l or diesel @75 l and liquid soap @ 560 ml or detergent powder @ 2-3 kg/ha are also effective.

For nursery rearing in earthen ponds optimum stocking density is 3-5 million spawn/ha, which are stocked during cool hours. For nursery rearing in concrete tank stocking density can be much higher, to the tune of 10-20 million spawn/ha. Either mono or multispecies can be stocked.

In nursery rearing supplementary feed in the form of finely powdered groundnut oil cake + rice bran @ 600 g/lakh spawn is given for first 5 days and 1,200 g/lakh spawn/day for the subsequent days in 2 equal instalments, during morning and evening hours. After about 15 days of nursery growth the average size is expected to reach 25 mm which is ideal size to transfer to rearing pond. Harvesting is done by dragnet of 1/8" mesh; quantity measured by perforated cups as below:

Number of cups X average number of fry = number harvested

Expected survival in nursery rearing is between 40 and 50%. During Jun-Sep 2-3 crops of fry in earthen ponds and 4-5 crops of fry in concrete tanks can be taken. Economics of carp fry production in 1 ha pond are furnished in table 2. Assuming that 2 crops can be reared the net profit will be Rs. 124,460/-.

Table 2. Economics of carp fry production in 1 ha pond

Sl. No.	Items	Amount (in Rupees)
I.	**Expenditure**	
A.	**Variable Cost**	
1.	Pond lease value	10,000
2.	Bleaching powder (10 ppm chloride)/other toxicants	2,500
3.	Manures and fertilizers	8,000
4.	Spawn (5 million @ Rs. 6,000/million)	30,000
5.	Supplementary feed (750 kg @ Rs. 12/kg)	9,000
6.	Labours for management and harvesting (100 man-days @ Rs. 125/man-day)	12,500
7.	Miscellaneous expenditure	5,000
	Sub-total	**77,000**
B.	**Total Cost**	
1.	Variable cost	77,000
2.	Interest on variable cost (@ 12% per year for one month)	770
	Grand total	**77,770**
II.	**Gross Income**	
1.	Sale of 17.5 lakhs fry @ Rs.8,000/lakh fry (35% survival)	**1,40,000**
III.	**Net Income** (Gross Return - Total Cost)	**62,230**

Earthen ponds of size 0.5- 2.0 ha are used to stock fry to produce fingerlings. Pond is fertilized using cowdung @3-4 t/ha for 1 week prior to stocking followed by fortnightly doses of 0.5 t/ha after stocking. Urea and SSP @ 10 and 15 kg/ha, respectively

are applied as fortnightly doses. Fry of size 25 mm is stocked either as mono species or multi species. Generally polyculture is adopted in rearing ponds – Indian major carps and exotic carps at combined density of 2-3 lakhs/ha. It's advisable to provide mixture of rice bran & groundnut oil cake (1:1). Soybean flour can also be used. Feeding schedule is @8-10% first month, @6-8% second and @4-6% third month. Water depth shall be maintained as 1.5 m. Fingerlings attain 80-100 mm (8-10 g) with a survival of 70-80% in 2-3 months. They are harvested using drag nets of suitable mesh sizes. Economics of fingerling production are furnished in table 3.

Table 3. Economics of carp fingerling production

Sl. No.	Items	Amount (in Rupees)
I.	**Expenditure**	
A.	**Variable Cost**	
1.	Pond lease value	10,000
2.	Bleaching powder (10 ppm chloride)/other toxicants	2,500
3.	Manures and fertilizers	3,500
4.	Fry (3 lakhs fry @ Rs.8,000/lakh)	24,000
5.	Supplementary feed (5 tonnes @ Rs. 11,000/tonne)	55,000
6.	Wages (100 man-days @ Rs. 125/man-day for management and harvesting)	12,500
7.	Miscellaneous expenditure	3,000
	Sub-total	**1,10,500**
B.	**Total Cost**	
1.	Variable cost	1,10,500
2.	Interest on recurring expenditure 12% per year for three months	3,315
	Grand Total	**1,13,815**
II.	**Gross Income**	
1.	From sale of 1.8 lakh fingerlings @ Re 1/fingerlings	**1,80,000**
III.	**Net Income** (Gross income - Total cost)	**66,185**

For long distance transport of fingerlingsoxygen-filled polythene bags are used. Density depends on size of fingerling, duration of transport, quality of water and environment temperature. Prior to transport the fingerlings are conditioned, e.g., by stopping feeding. It's desirable to support polythene bags by materials, such as paper cartons, to prevent damage during transportation.

Grow out culture

Usual production range in carp grow out culture is 3-5 t/ha/yr, though 6-8 t/ha/yr has been achieved by several farmers. Three critical inputs required are right kind of seed, feed and fertilizer. It's imperative to manage soil & water quality and monitor fish health. Normally grow out ponds are of 0.4-1.0 ha/2-3 m deep.

Drying of ponds is the best option, though it may not be always practical before stocking. It's essential to control aquatic weeds, predatory and weed fishes prior to stocking. Manuring with raw cowdung @3-4 t/ha, or poultry manure @1.5-2.0 t/ha is carried out. Liming is done 3-4 days before stocking - usually 200-300 kg lime for a pond with slightly acidic to neutral pH. The recommended proportion for polyculture is 30-40% surface feeders (catla, silver carp), 30-35% column feeders (rohu) and 30-40% bottom feeders (mrigal, common carp); if appropriate species of aquatic weeds are available aplenty grass carp @5-10% can also be stocked.

Stocking density depends on input use and levels of management. Stocking density is usually 80-100 mm (8-10 g) fingerlings @5000/ha after due acclimatization for a production target of 3-5 t/ha/year. If the target is 10-15 t/ha/yr fingerlings are stocked @8000-10000/ha, and @15,000-25,000/ha for production of 10-15 t/ha/yr.

Post-stocking fertilization includes providing cowdung @0.5t/ha, urea @10kg/ha and SSP @15kg/ha. Alternates are poultry litter, pig dung and duck droppings. Biofertilizer, Azollais provided @40t/ha/yr at weekly split doses can contribute to 100 kg N, 25 Kg P, 90 kg K and 1,500 kg organic matter. Biogas slurry @30-45 t/ha/yr or 80-100 L/day/ha is also recommended. It's advantageous because of lower oxygen consumption and faster rate of nutrient release. Mixture of ground nut oil cake and rice bran at 1:1 by wtis provided at 5% of the stocked biomass in first month followed by 3-2% in subsequent months.

Feed requirement/day = Estimated fish biomass in the pond x % feeding rate [biomass = average weight of fish x total number stocked x % survival].

Feed is normally given in dough form on feed trays or in gunny bags hung at uniform distance inside the pond. Feed in pellet form also given, which reduces wastage. Appropriate species of aquatic weeds are desirable for grass carp. If higher stocking density is envisaged aeration of ponds is a required using gadgets like paddle wheel, aspirator and submersible aerators. Approximately 4-6 aerators of 1 HP are required to aerate 1 ha pond. Water exchange is essential for intensive culture; no such issue with low stocking extensive culture. Skin, gill and fin of fish are carefully examined during sampling for parasites, lesion and haemorrhages. In case of Epizootic Ulcerative Symptom (EUS), CIFAX @1 L/ha-m is recommended. Lime @200 kg/ha is also effective; a second dose is preferredin case of severe infection. For other severe infections always consult the experts for proper treatment. Ivermectin is generally effective to treat parasitic infectionArgulosis.

During 10-12 months culture periodcatla attains around 1 kg and rohu 600-700 g. Multi stocking and multi harvesting is by far the best approach. Intermittent partial harvest of large fishes after 6 months of growth period would ensure continuous return, reduction of investments & risks, and congenial environment for remaining fish to grow. Catla and rohu fetch about 20% higher market price over other carp species. Silver carp is least preferred among the carps. It's advisable to transport the produce in insulated vans with ice to the distant markets of about 1000-2000 km. Live fish would fetch 30% higher price than dead (fresh) fish. Economics of grow out production of carp are provided in table 4.

Table 4. Economics of carp grow out production

Sl. No.	Items	Amount (in Rupees)
I.	**Expenditure**	
A.	**Variable Cost**	
1.	Pond lease value	20,000
2.	Bleaching powder (10 ppm chlorine)/other toxicants	5,000
3.	Fingerlings (8,000 nos)	8,000
4.	Manures, fertilizers and lime	10,000
5.	Supplementary feed (rice bran and groundnut oil cake, 8.0 tonnes @ Rs 9,000/tonne)	72,000
6.	Wages (150 man-days @ Rs.125/man-day for management and harvesting)	18,750
7.	Miscellaneous expenditure	5,000
	Sub-total	**1,38,750**
B.	**Total Cost**	
1.	Variable cost	1,38,750
2.	Interest on recurring expenditure 12% half yearly	8,325
	Grand Total	**1,47,075**
II.	**Gross Income**	
1.	From sale of 4 tonnes of fish @ Rs. 55/kg	**2,20,000**
III.	**Net Income** (Gross return - Total cost)	**72,925**

The specialized KVK of ICAR-CIFA at Bhubaneswar has been actively engaged in carp seed production on a demonstration and moderately practical scales. During 2014-16 it has used 2.4 Ha of ponds for fingerling production of catla and rohu. Many fish farmers were benefited by the quality seed produced in demonstration ponds of KVK.

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FISH FARM MANAGEMENT

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Steady increase in the demand of aquaculture has always led to more established farming practices. The success of any established farming practices mainly rely upon its management procedures. A viable yield from the aquaculture farming practice depends on proper management practices at all stages of growth of the cultured organisms. Increased survival and production from the farms is always the result of an increased effort applied during the various stages of farming practices.

CULTURE METHODS

Ponds

Ponds used for fish culture could either be drainable or non-drainable. A drainable pond is provided with an inlet for the entry of water from a water source and an outlet for its draining during the harvest. A non-drainable pond, however, does not contain an inlet or outlet and depends on either rains or pumped from some other water source. The ponds could be either embankment ponds or excavated ponds. A typical earthern pond consists of bunds, inlet and outlet. Bunds or dykes are the protecting structures of the fish ponds and farms. It protects the fish farm from the influx of high water from the inlet source and also acts as a wind breaker. Firm bunds are always constructed using a mixture of silt, sand and clay in the ratio of 1:3:2. Besides, the quality of the soil, the slope of the bund also affects the strength. For a normal fish pond of 0.5 ha, a slope of 1:1.5 is recommended for the wet-side and a slope of 1:1 for the dry-side slope. Ponds of more than 0.5 ha, are usually provided with a berm which is a platform-like area provided between the bund and the watery area.

Inlets and outlets are required for the ponds to ensure a smooth supply of water and drainage respectively. For smaller ponds, pipes are provided as inlet and outlet. The diameter of the pipes may vary with the water spread area of the ponds. The pipes are also screened using meshes to prevent the entry of wild fish into the ponds and the escape of the culture fish from the farm. For larger ponds, inlet structure is constructed using concrete and bricks along the feeder canal and is provided with grooves for the metal and the bamboo screens to control the entry of wild fish and control board to stop the movement of water. Monks are used in larger ponds as an outlet for water and to regulate the water level. The monks have got a horizontal pipe and a vertical tower, the height of which depends on the highest level of the water. The monks are also provided with grooves for the control boards to regulate the water.

Pens

Pens are structures used for confined aquaculture for growing of younger stages of fish / shellfish to a larger size within netting or screening which allows free circulation of water. Pen structures are made of split flat bamboo screen strips closely woven by interlacing with nylon or coconut twine. Fish pens are erected in areas of 0.3-0.5 ha. Readymade netting or bamboo screens are fixed to bamboo posts driven 0.5-1m deep into the bottom soil to form a circular or rectangular enclosure. Top of the fish pen has to remain 0.5-1 m above the expected maximum water level and the bottom portion to be inserted 20-30 cm into the soil. Net webbings for pens may either be single layered or double layered. Double layered pens are used in nurseries for polyculture.

Cages

Cages are culture structures where water is enclosed on all sides with cage netting material including the bottom while permitting the free circulation of water through the mesh of the cages. Cages are employed in cases where fishes are to be cultured at high stocking densities and protection to be offered from predators and competitors. Cage aquaculture has advantages of easier handling, maintenance, harvesting, less man power requirement and minimal supervision.Cages are grouped into two based on its design as fixed and floating cages. Fixed cages are used in water bodies with a depth of 1-5 meters and floating cages in waters of 5 meters or deeper. Cages are constructed using netting material of Polyamide, polyethylene, polypropylene or any other synthetic material. The top portion is laced to only one side of the body of the cage and the other three sides being free to facilitate its opening. Floatation of the cages is provided using inner tubes, barrels/ drums, bamboo etc. Sinkers are made of stones, ceramics, concrete blocks etc. fixed cages are fixed into the water bodies using anchors such as heavy concrete blocks and stones. Cages are suspended using frames provided with floats. The frames are made up of bamboo, wood, steel, aluminium or PVC. The frames are constructed in such a way as to provide a working platform.

BRACKISHWATER FARM SITE SELECTION

An economically viable farm always depends on the establishment of the farm at a suitable site. A successful farming site generally depends on the following conditions. Suitability of the soil texture for the establishment of the farm has to be considered thoroughly. The soil texture, porosity and compactness have to be examined before the construction process. Sandy clay to clayey loam soils are suitable for the construction of the dykes. Fine textured soils are preferred at the pond bottom as they are capable of absorbing and retaining the excess nutrients and later on releasing them for primary production. It is also recommended that areas of acid sulphate soils be avoided for the construction of fish farms. Such areas contain the presence of pyrite which when exposed to oxygen causes the formation of sulphuric acid. Leaching can also occur from the embankments making the pond water highly acidic and thereby leading to sudden mortality.

The availability of ample quantity of water and its quality plays a major role in deciding the growth and the well being of the cultured species. A thorough check on the water quality parameters and its proper management underlies the success of a farming practice. The water reaching the farm site should be free from any pollutants or organic load. The organic load in water deprives the dissolved oxygen content and sometimes causes the emission of toxic gases. The site chosen for the construction of the farm should be accessible to markets and processing plants. This can ease with the transportation of the input materials to the farm and the transport of the harvested goods out of the farm. Availability of electric supply and communication is also a need for the farm.The construction of the farm at a suitable site should be in accordance with the socio-economic aspects of the people around.

FARM DESIGN AND MANAGEMENT

A viable fish culture practice depends upon the successful selection of a suitable site for culture and the principles adopted to construct the farm. The four main constituents comprising the fish farm include: a peripheral dyke or the main dyke, secondary dykes, a master sluice and the main feeder channel.

The peripheral or the main dyke protects the farm from the strong tidal and wind action. The height, depth and width of the dyke has to be planned in such a way that the ponds are protected from the tidal influx. A freeboard is also allowed at a specified height of the dyke to prevent the overtopping of the dyke by the highest high wave. The strength of the dyke depends on the quality used for its construction. Normally, the soil digged out for the construction of the ponds serves the purpose. However, to gain extra strength, suitable soil is bottomed at the dyke. A generally recommended slope for the outer side of the dyke is

3:1 and towards the inner side, the slope is steeper varying from 1:1-1:2.

The secondary dykes inside the farm are constructed for partitioning the various individual ponds and are constructed in similar manner to that of the main dyke. However, the heights can be much smaller compared to the peripheral dyke.Master sluice would be the controlling centre for the water management of the farm. It controls the in-flow of the water from the main feeder into the farm. A master sluice of strong construction is recommended in areas of tide fed ponds. The master sluice is made of concrete structures with grooves which can hold the control boards(single or many) in grooves. This regulates the inflow and the outflow of the water from the farms. Secondary sluices mark the entry of the main feeder canal into different feeder canals or ponds. It controls the water flow inside the farms. Screens are also used at the sluices to prevent the entry of unwanted fish, eggs and larvae into the ponds and the escape of the species from the ponds. Screens are usually made of split bamboo of fine nylon mesh such that it does not interfere with the movement of the water.

The feeder channel is controlled by the master sluice and takes water into the farm and acts as a reservoir. The tide levels of the main water source are important in laying out the feeder channel. Other measures that are to be considered for the construction of the fish farm include:Use of a reservoir that could serve as a settlement or sedimentation pond to filter the water before its entry into the fish ponds.Use of screens or nettings before letting in the water to the main ponds from the reservoirs. Cement tanks or lined ponds are recommended at areas of high water seepage. Dykes may be supported using stone pitching to prevent the sliding of the dykes.

OPERATIONAL MANAGEMENT OF A FISH FARM

The management of fish farms could be broadly classified as pre-stocking, stocking and post stocking management.The pre-stocking management measures involve the proper preparation of the ponds for stocking. These include:

The use of fish toxicants to remove the unwanted (weed) and predatory fishes prior to stocking of the ponds. The weed fishes (Ambassis, Etroplus maculatus, Therapon sp.,Scatophagus sp.,) are known to compete for food and space with the cultured species, while the predatory fishes (Elops sp., Megalops sp.,Lates calcarifer) attack the stock.Repeated dragging and netting allows only the partial removal of the fish stock from the ponds. However, a complete eradication is achieved only through the use of fish toxicants (Table 1) at recommended doses. Farming has to be carried out only after the recommended period to nullify the toxic effect. Removal of aquatic insects which can pose a threat to the larvae of fish using soap oil emulsion (56 Kg vegetable oil + 18 Kg soap)

Table 1. Commonly used Fish Toxicants and their dosages

Sl.no.	Name of toxicant	Dosage (ppm)	Duration of toxicity (days)
1	Mahua Oil Cake(Basia latifolia)	250	7-10
2	Croton tiglium	3-5	3-5
3	Derris trifoliata	15-20	8-12
4	Tea seed cake (Camelia drupisera)	60-70	4-5
5	Ammonia (anhydrous)	10	7
6	Ammonium sulphate + slaked lime	60+60	7

Liming is one of the aquaculture management practices employed to improve the pond condition by means of application of liming materials capable of neutralizing the acidity of the soil. Ponds with alkaline waters are generally suitable for physiological process. In ponds with low alkalinity, acidity is found to be high which does not favour the growth of fish and shrimp. In addition to correcting the pH, liming has many added benefits such as

supplying the calcium needed for the organisms, precipitation of excess organic material present in the water body. Lime also destroys the parasites present in the pond water and bottom. The effectiveness of any liming material depends upon its neutralizing capacity. The neutralizing value refers to the amount of acid they will neutralize and is expressed as a percentage of the amount of acid neutralized by an equal amount of pure calcium carbonate. Thus neutralizing value of pure calcium carbonate is 100% and is used as astandard in referring to the liming rates. The efficiency of hydrated lime ($Ca(OH)2$) is 135% and that of quick lime (CaO) is 173%. Liming is carried out at least two weeks before fertilization and is easily broadcast over the pond.The amount of lime required for a particular pond based on its pH is determined using the formula:

$$\text{Lime needed (tons)} = \frac{\dfrac{\underline{(\text{DesiredpH}-\text{ActualpH})\times 0.5}}{\underline{0.1}}}{\text{Efficiency of lime}} \times \text{Area (ha)}$$

Fertilization is the management practice employed to enhance the natural fertility of the pond ecosystem, thereby stimulating the high phytoplankton production which in turn boosts the zooplankton production and thereby increasing the yields. Fertilizers used in fish ponds could be either chemical fertilizers or organic manures. Nitrogen, Phosphorous and Potassium are referred to as primary nutrients in fertilizers. A fertilizer which contains all the three primary nutrients are referred to as a complete fertilizer. Calcium, Magnesium and sulphur are referred to as secondary nutrients. In addition to the primary and secondary nutrients, certain elements are added in trace to the fertilizers and are referred to as the minor nutrients or trace elements. Some of the commonly used fertilizers include urea, ammonium sulphate, single superphosphate, double superphosphate and triple superphosphate, muriate of potash and ammonium phosphate. Fertilizers are usually applied at biweekly intervals alternatively with organic manures by broadcasting.

Both plant (green manure, compost) and animal (cow dung, poultry manure, pig dung etc.) manures are employed as organic manures and help in the slow release of nutrients into the water for a prolonged period. Organic materials may either be directly served as food for fish and fish food organisms or may decompose releasing the inorganic nutrients causing the plankton bloom. Organic manures are found to contain less N, P, K contents and hence application of large quantities is required. However, excess application of these fertilizers causes decaying in ponds and thereby leading to oxygen depletion. Thus, it is highly recommended that the fertilizers and manures be applied in split doses according to the requirement of the cultured stock.The stocking and the post stocking management measures involve the proper stocking of the species, feeding of the species, and periodic fertilization of the culture waters.

WATER QUALITY MANAGEMENT

The physicochemical parameters of the pond highly influencethe growth of the stocked organisms of the pond. Any organism that withstands the fluctuations in the water quality parameters would successfully thrive well in the system.A proper scientific management helps in maintaining the suitable ecology of the pond.

Dissolved Oxygen

The most critical and limiting factor in fish ponds which denote the amount of oxygen dissolved in a water body that is available for the cultured organisms. A level of 5 ppm is considered as optimum for the culture of fish. A concentration of 1-5 ppm is considered to have sub- lethal effects on the organism whereas a concentration of 0.3-0.8 ppm is shown to have lethal effects on fish. The amount of oxygen in a water body is primarily dependent on the dissolution rate of oxygen which in turn depends on the salinity of the water body. Photosynthesis by phytoplankton forms the major source of dissolved oxygen in a pond whereas the primary loss of dissolved oxygen is through respiration by phytoplankton and other cultured organisms. The

problem of low DO seldom affects the tide fed ponds as water gets continually exchanged through the sluices. Whereas ponds practising intensive culture, paddle wheel aerators are equipped for increased oxygen level.

pH

pH gives the measure of the hydrogen ion concentration. The more the hydrogen ions, the water is said to be more acidic. An increased level of hydroxyl ions indicates a more alkaline water. An increased amount of carbon dioxide in water increases the acidic reaction in water. Thus, pH is found to increase during the day time as Carbon dioxide is removed by means of photosynthesis and decreases during the night time as production of carbon dioxide increases through respiration by organisms. A pH of 6-9is considered best for growth of the organisms. A drop in pH to 4 indicates the acid death point and an increase in pH to 11 indicates the alkaline death point for fish and crustaceans. More alkaline waters can be controlled using alum while acidic water is rectified using lime, the dose of which depends on the pH of the water.

Turbidity

Turbidity denotes the amount of suspended matter present in a water body that interferes with the passage of light. Farm systems with phytoplankton turbidity are considered desirable whereas turbidity caused by suspended clay particles is undesirable as it reduces the magnitude of fluctuations in Dissolved Oxygen. The presence of clay particles in the pond limits the penetration of light which favours the growth of blue green algae in dim light and is known to drastically affect the growth of fish. Clay turbidity can be controlled through flocculation and coagulation process using coagulants like alum and gypsum. However, care has to be taken in using these coagulants as alum can cause the water to be acidic and gypsum is found to be ineffective in water saturated with calcium. Organic matter such as chopped hay/ cottonseed meal is also found to reduce the clay turbidity. It is recommended that fertilization be done after turbidity treatment as coagulants are known to remove phosphorous from water.

Ammonia

Ammonia in a water body is build up through the process of fish metabolism and the decomposition of the organic matter. The unionized form of ammonia is found to be more toxic than the ionized form. The toxicity is found to increase with an increase in pH and temperature as a higher percentage of total ammonia is present in unionized form. Ammonia concentration as low as 0.01ppm is found to have sub- lethal effects on fish and a concentration of 0.4- 2.5 ppm is known to pose lethal concentration in fish.Use of aeration and biological filters can bring down the ammonia to a lower level. The presence of phytoplankton can also make a control in the release of ammonia.

Total alkalinity

Total alkalinity represents the total amount of bases in water expressed as ppm of equivalent calcium carbonate. The bicarbonate and the carbonate ions present in water acts as buffer and absorb H+ ions when water is acidic and releases H+ ions when basic. Water of low alkalinity of less than 20 ppm gets poorly buffered due to the removal of CO2 resulting in a rapid rise in pH.

Total hardness

Total hardness represents the concentration of the metal ions (Calcium and Magnesium) in water expressed as mg/l of equivalent calcium carbonate. Alkalinity and hardness are similar in magnitude. If alkalinity is high and hardness low, pH rise to very high levels (>10.5) during photosynthesis. Most productive waters have a hardness and alkalinity of same magnitude. Hardness is responsible for osmoregulation. Water when hard causes less influx and therefore less stressed.

The optimal range of water quality parameters for a fish pond is listed out in Table 2.

Table 2. Optimal water quality parameters for pond culture

Sl.No.	Parameters	Acceptable range	Desirable range	Stress
1	Turbidity (cm)		30-80	<12, >80
2	DO (mg/l)	3-5	5	<5,>8
3	BOD (mg/l)	3-6	1-2	>10
4	CO2(mg/l)	0-10	<5, 5-8	>12
5	pH (mg/l)	7-9.5	6.5-9	<4, >11
6	Alkalinity (mg/l)	50-200	25-100	<20, >300
7	Hardness (mg/l)	>20	75-150	<20, >300
8	Ammonia (mg/l)	0-0.05	0-<0.025	>0.3
9	Nitrite (mg/l)	0.02-2	<0.02	>0.2
10	Nitrate (mg/l)	0-100	0.1-4.5	>100, <0.01
11	H2S (mg/l)	0-0.02	0.002	Any detectable levels

Bottom soil management

The underlying soil also maintains an important role in maintaining the water quality.In general, silty loam is considered highly suitable for the brackishwater aquaculture practices.Drying of the pond bottom 2-3 weeks prior to farming practices can be adopted as Better Management practices for aquaculture.The pH of the soil should be preferably in the range of 6.5-7.5 to favour the growth of benthic algae. In areas where pond bottom soils cannot be dried, application of nitrate fertilizers is found to be useful.

FEED AND FEED MANAGEMENT

Artificial feeding accounts for 60% of the input cost in a farming system. Optimal pond and feed management strategies can always increase the aquaculture production per unit area of the farm. Formulation of well balanced diets and their proper feeding are the important requirements to be considered during the feed management. The supplementary feeds used should be nutritionally adequate to meet the nutritional requirements of the cultured species.

There are 40 essential dietary nutrients required for the growth of the cultured organism, however, the major nutrients fall into six major groupsviz. Proteins and amino acids, lipids, carbohydrates, vitamins, minerals and water. Proteins are the major organic component in a fish and shrimp diet. It accounts for 65-75% of the total on a dry weight basis. Carnivorous fish and shrimp have high dietary requirements (50%) for protein whereas a protein of 25-30% is found optimum for the growth of herbivorous and omnivorous species. Protein serves as both a structural as well as an energy source. The gross protein requirement decreases with increase in age and size of fish. Proteins upon digestion break up into amino acidsthat get absorbed from the intestine and gets distributed in the circulatory system. Among the 20 amino acids, 10 amino acids are considered essential for the growth and the activities of fish and shrimp. These essential amino acids could not either be synthesized by the organisms or cannot be synthesized in sufficient quantities in the body of the organism.

Lipids are the source of essential fatty acids in aquaculture feeds providing a rich source of energy and serving as carriers for the absorption of other nutrients and pigments. The requirement of the essential fatty acids is found to vary with the species and the life stage of the species. The gross lipid requirement in general for fishes is 4-15%, with an optimum for 7-9% for prawns. The requirement of lipids for carnivorous fishes is 15-20%. Marine fish oil is a rich source of Poly unsaturated Fatty Acids(PUFA) and the aquaculture feeds are supplemented with marine fish oils. Cholesterol, a vital precursor of moulting hormone is required at levels of 0.5-1.25% of the total diet in shrimps. Attention has to be taken in the proper manufacturing and storage of the diets manufactured with fish oils as the PUFAs in marine oils readily undergo auto oxidation and become rancid.

Carbohydrates are the main sources of energy and its incorporation into the feed can spare part of the protein for growth. The requirement of carbohydrates is also found to vary with the species. Carbohydrates also serve as binding agents in the

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feed thereby increasing the water stability of the feeds and also help in improving the texture and palatability of the feeds. These are the organic compounds that are required in trace quantities in fish diet and contribute to the normal health and growth of the fish. Vitamins are broadly classified as water soluble vitamins (11) and fat soluble vitamins (4). The water soluble vitamins are used rapidly after absorption and either broken down or excreted. The fat soluble vitamins are stored in the fat reserves of the body. An excess amount above the required quantity is added to the feed to compensate for the vitamin losses during the manufacturing process as vitamins are subject to denaturation. There are about 20 inorganic minerals required by fish and shrimps for their proper growth and health. Minerals are obtained by the species both through the feed and through water and are absorbed across the gills and skin. Inclusions of vitamins are made to the feed in addition to the mineral content of other feed ingredients.

Starter feeds are the feeds used for the first feeding of the larvae of fish and shrimps. Fishes are weaned to diets once the yolk sac is absorbed and commence the exogenous feeding. The most suitable feeds during the initial feeding stage is live feed organisms, comprising of diatoms, flagellates, copepods and rotifers, followed by Artemia. These live feed organisms are enriched with vitamins, proteins and essential fatty acids to upgrade their nutritional quality.The feeds for these stages vary from crumbles to pellets based on their stages. The formulation of feeds during the early and the later rearing stages are one another the same but only differ in their protein content. Early stages of fish and shrimp require higher levels of protein that that at advanced stages. The higher levels of protein during the initial stages support the rapid development of body weight in their early growing stages. Broodstocks are to be fed with nutritionally adequate diets at satiation with high quality diet ingredients with a view to obtain high fecundity and larval survival. The broodstocks in addition to the formulated diets are also fed with wet feeds to provide a nutritionally balanced diet. The feeds are also supplemented with vitamins, pigments and other trace elements.

Feeding in farms can be done either manually or by mechanical means. Manual method or hand feeding is done by broadcasting the feed. This allows close observation on the feeding requirement of fish and their apetite. In case of shrimps, feeding trays are employed to check the feeding activity of the shrimp. A percentage of feed say 1-3% of the daily ration is spread in the feeding trays the same time when the feed is broadcasted over the ponds. The trays are lifted after several hours to make an observation on the feed intake. The next feeding ration is decided based on the amount of feed left over in the trays. Mechanical feeding is done either using demand feeders or automatic feeders. The demand feeders are response feeders, where the apetite of the fish demands the feed from the feeders. Demand feeders consist of a hopper with an aperture and is controlled by a movable gate to which is attached a pendulum. The movements of the fish cause the pendulum to move and thereby dispense the amount of feed as per the demand of fish. Automatic feeders are functioned using an electric motor and controlled using a timer that help in distributing the feed at fixed intervals for fixed time periods.

The daily feed ration can be administered as a single diet or divided into separate meals. Shrimps are usually fed 3-4 times as day by administering a said percentage of the total feed each time. The stability of feeds also play an important role in deciding the amount of feed to be administered. Less stable feeds are used at lower quantities to prevent the wastage of feed.The value of a particular feed employed is determined using the Food Conversion Ratio (FCR).A higher ratio of FCR represents a less efficient feed. Therefore, a feed to be more effective should have a lower FCR.

$$\text{FCR}= \frac{\text{totalweightoffeedconsumedduringthecultureperiod (Kg)}}{\text{totalweightoffeedconsumedduringthecultureperiod (Kg)}}$$

SUMMARY

With always a high demand for fish in the country, the business could definitely be turned into a profitable venture in a long run, though good management strategies adopted in the culture practice. The cost of production depends on the area used for the culture, and availability of seeds, labour force, physiochemical and climatic condition prevailing to that area. Though, aquaculture, one of the promising sectors of the present and the future era, but itis necessary to did an organize attempt to improve the yield of the organisms by deliberate manipulation of the rates of growth, survival and reproduction. A judicious and proper management during the culture practices remains as a base, to flourish the production and achieve remarkable profits.

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WATER QUALITY MANAGEMENT IN AQUACULTURE

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In aquaculture, water quality is one of the prime factors that determines the success of that particular culture. Primarily the water quality parameters are divided into three major categories, physical, chemical and biological. But a slight change in some of the parameters especially pH,temperature,DO will lead to stress in the organism and it may be of physiological or behavioral. Deteriorated or changed water quality will affect growth,reproductive capacity. Susceptibility to diseases is also more in such environment.Water qualitymanagement measures aim at improving water quality. Aquaculture entrepreneurs should know the basics of water quality management measures in aquaculture to reduce the problems related with water quality so as to utilize the of water body with viable profit as well as environmental sustainability.

Water Sampling

It is necessary to make sure that there is no contamination during sampling and all the samples are properly sub-sampled and preserved to avoid/minimize changes in the

How to collect samples?

Niskin bottle sampler is used for collecting water samples from specific depths (Fig. 1). Niskin samplers can be used for sampling surface water also. Samples of surface water can also be collected by merely dipping with open dip samplers. When Niskin bottles are not available, a weighted bottle sampler can be used to collect water atspecific depths (Fig. 2). Surface and bottom water samples are to be collected separately for the near shore and offshore.

Prior to sampling, the sampler and sampling bottles should be acid washed with 1N HCl in the laboratory.

Sample bottles should be rinsed twice with clean water

The desired samples should be collected from the place away from where the sampler and sample bottles were washed.

Care should also be taken to avoid the sewage flush out from the boats/ships at the time of sampling.

Fig. 1 NISKIN BOTTLE SAMPLER

Proper sampling is of utmost importance.

Take adequate number of samples to have representative sampling of the water body

Sampling should be contamination free to avoid erroneous results on analysis

Samples should be appropriately sub-sampled for the different types of analyses needed , such as

- for dissolved gases, alkalinity and pH

- for nutrients and physical parameters
- for trace metals
- for biological - Chlorophylls and plankton
- for bacteria etc.

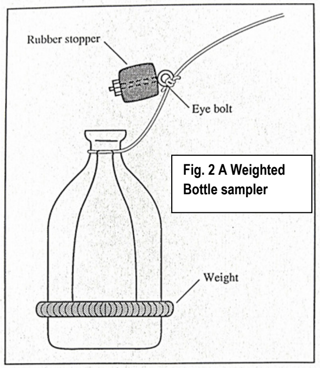


Fig. 2 A Weighted Bottle sampler

Preservation methods (Table 1) are to be adopted to avoid/minimize changes in the water composition during storage. The processing protocol should be meticulously followed for individual samples. For dissolved oxygen, the samples need to be fixed by employing Winkler's reagent on board vessel itself. Collection of samples for measurement of DO, other gases like CO2, pH and alkalinity must avoid atmospheric contamination during sampling and subsampling.

Table 1. Requirements for handling water samples for water quality assessment

Parameter	Preservation	Storage	Sample Holding (duration)	Sample volume	Type of container
Alkalinity		4oC	14 days	100 ml	Plastic / Glass
Ammonia	H2SO4 to pH <2	4oC	28 days	100 ml	Plastic / Glass
Chloride	None		28 days	50 ml	Plastic / Glass
Chlorophyll a		4oC	12 hrs	500 ml	Plastic / Glass
Colour		4oC	48 hrs	50 ml	Plastic / Glass
Conductivity		4oC	28 days	100ml	Plastic / Glass
Dissolved Oxygen	Fix immediately with Winkler A and B reagents	Away from sunlight	8 hrs	125ml	Glass
Nitrate		4oC	48 hrs	100 ml	Plastic / Glass
Nitrate-Nitrite	H2SO4 to pH<2	4oC	28 days	100 ml	Plastic / Glass
Odor		4oC	24 hrs	200ml	Glass
Orthophosphate	Filter immediately	4oC	48hrs	50ml	Plastic / Glass
Particulate organic matter		4oC	24hrs	200ml	Glass
pH	None		In situ	25ml	Plastic / Glass
Silicate		4oC	28 days	50ml	
Total Dissolved Solids (TDS)	None		7 days	100ml	Plastic / Glass
Temperature	None		In situ		Plastic / Glass

WATER QUALITY

Water Temperature

Water temperature is a physical property of water which expresses how hot or cold the water is. Air and water temperature is directly depends upon the solar radiation. Temperature can alter the physical and chemical properties of water (Fig. 3).

In water, light energy is absorbed exponentially with depth and so most heat is absorbed within upper layers of water, by dissolved organic matter and particulate matter. Water temperature influences density of water.

Water temperature affects the metabolism, growth and reproduction in aquatic animals. Many animals use temperature as a signal for when to reproduce and when to migrate. Generally, animals and plants grow faster at warmer temperatures, although all organisms have an upper temperature limit.

Congenial species are to be selected for aquaculture as per temperature preference for maximum growth rate.

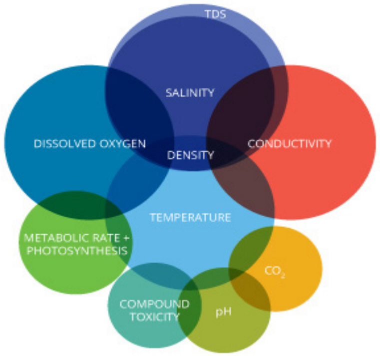


Fig. 3 Water quality paramters being influenced by water temperature

Temperature measurement of water samples collected should be done immediately using mercury / digital thermometer, by immersing the calibrated thermometer into the water

The atmospheric temperature is also measured in a well-ventilated area and in the shade, at 1.2 to 1.5 m above the ground, using a 50oC calibrated (liquid in glass) thermometer.

Turbidity

Turbidity refers to the decreased ability of water to transmit light caused by suspended particulate matter ranging in size from colloidal to coarse dispersions. Light penetration in to the water is measured by using a Secchi disc. The Secchi disk (Fig. 4) is a weighted disk, 20 cm in diameter and painted in alternate black and white quadrants, which easily measures turbidity in pond water. The average of depth at which the disk disappears and reappears is the Secchi disk visibility. Optimum Secchi disk visibility for shrimp ponds is 40 - 60 cm. It must be noted that the Secchi disk visibility isaffected by both types of turbidity ie (1) that resulting from phytoplankton blooms and (2)that caused by suspended soil particles. The individual taking Secchi disk reading

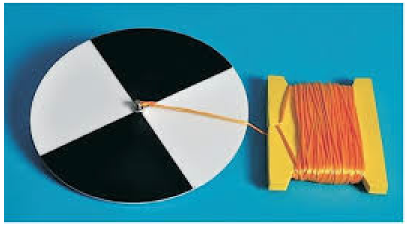


Fig. 4 Secchi Disk

must decide if the turbidity is from phytoplankton or suspended soil particles or both. The following guidelines may be used in evaluating Secchi disk visibilities for ponds (Table 2).

Table 2. Guidelines to evaluate Secchi disk visibilities for pond aquaculture

Secchi disk reading	Remarks
< 20 cm	Pond too turbid. If pond is turbid with phytoplankton, there will be problems with low dissolved oxygen concentrations. When, turbidity is from suspended soil particles productivity will be low.
20 - 30 cm	Turbidity becoming excessive
30-45 cm	If turbidity is from phytoplankton, pond in good condition
45 - 60 cm	Phytoplankton becoming scarce
>60 cm	Water is too clear. Inadequate productivity and danger of aquatic weed problems.

Salinity

Salinity is the concentration of total concentration of all ions in a given volume of water. Salinity is an important characteristic of natural waters. Salinity determines what species of aquatic animals to be present in that water body Salinity is expressed in parts per thousand by weight (ppt, or ‰) or in practical salinity units (PSU). For example, 1 gram of salt in1000 grams of water means its salinity is 1 g/kg, or 1 ppt. Salinity ranges from 0 ppt in fresh water to 35 ppt in the open ocean. For culture ponds of fresh water species the salinity should be in the range of 0.01 to 1 ppt and for brackish water species it is 20-35 ppt for optimum production.

Measurement of salinity

1. Using Refractometer (for in situ measurement)

Open the daylight plate (Fig. 5) and apply one or two drops of the water sample to the surface of the prism, using a glass rod. Hold the prism at an angle close to parallel with the floor so that the sample will not run off. Softly close the daylight plate. The sample should make a thin film over the entire surface of the prism. No bubbles should be there. Look through the eyepiece. Focus the scale until it is sharp to your eyes by gently turning the eyepiece either clockwise or counterclockwise. The upper field of view appears blue and the lower field will be white. The reading is taken at the line where the blue and white fields meet. For salinity, read the scale on the right side. It is marked as a "o/oo". This is read "parts per thousand". After taking a salinity reading, gently wipe the prism with a tissue paper and water. The refractometer needs to be calibrated periodically. To calibrate it, take a reading using distilled water. With distilled water on the prism, turn the calibration screw with the included screwdriver while looking through the eyepiece until the boundary line falls on "0".

2. Titrimetric method(for lab analysis)

In this method the dissolved halogen ions present in water

(chloride, bromide and iodide) are titrated with silver nitrate using potassium chromate as indicator. The halogen ions (other than fluoride) freely react with silver to precipitate silver halides. In this method silver will react with chromate only after all the halide ions, except fluoride, are precipitated and immediatelyas a slight excess of silver ion is present, red silver chromate is formed. A faint red colour of the solution point towards the end point of the titration.

Water pH

Water pH is the measure of hydrogen ion activity or a measure of acidity and alkalinity ranging from 0-14. The natural water pH ranges 5-10. The optimum water pH range in the aquaculture is 6.5-9. A pH of 7 is considered neutral. The lower the pH than 7, the more acidic the water is. The higher the pH than 7, the more basic or alkaline it is. The pH in ponds will rise during the day as phytoplankton and other aquatic plants remove CO2 from the water during photosynthesis. The pH decreases at night because of respiration and production of CO2 by all organisms. If high or low pH extends for a long time, it can cause stress, less survivals, poor growth, susceptibility to diseases and can to low production. Signs of less than optimal pH include increase mucus on the gill surfaces, black gill disease, damage to the eye lens, abnormal swimming behavior, loose shell, soft shell, irregularity in molt, poor phytoplankton and zooplankton growth.

Higher pH can increase the toxicity of ammonia, especially so when the water temperature is high. The acid and alkaline death points for pond fish are approximately pH 4 and pH 11 respectively.

The pH will vary in pond environment depending on a number of factors as follows

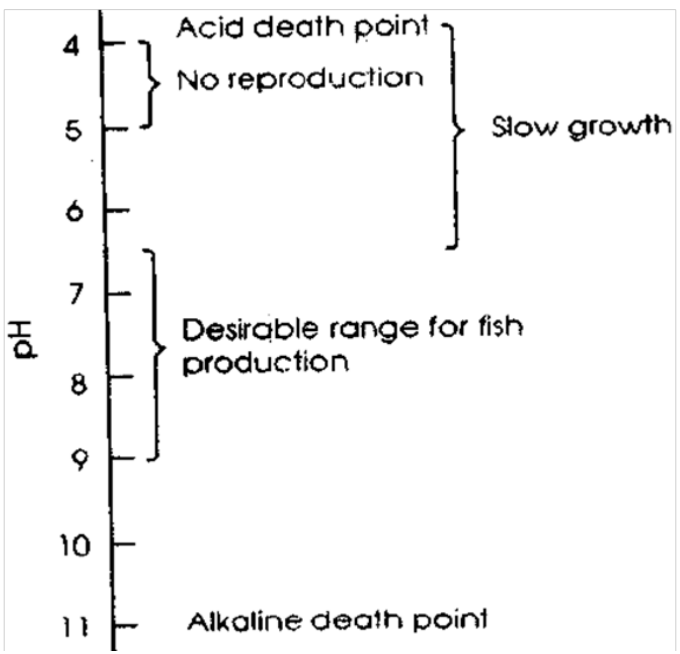
- Acid sulfate soil, acidic source of water
- Rate of rainfalls in pond areas
- Poorly buffered water

- Stocking density of resources
- Feeding and rate of sludge formation in pond bottom.
- Presence of micro/ macro organisms.
- Existence of phytoplankton in pond water.
- Rate of carbon dioxide production in pond water

How to measure pH

pH of water is measured with a pH meter. When the electrodes are dipped in two solutions of different pH levels and connected, a potential difference is set up between the two electrodes, which is measured by the potentiometer. This is directly related to the pH of the solution.

In the laboratory, a bench top pH meter is used to measure pH. For field measurement of water pH, portable pH meters can be used (Fig. 6).



Dissolved Oxygen (DO)

It is an important parameter in assessing water quality because of its prime impact on the living organisms living in the water. The dissolved oxygen level that is too low or too high can harm aquatic life and affect water quality.Free oxygen (O2), is oxygen that is not bonded to any other element. Dissolved oxygen is this free gaseous oxygen(O2) dissolved in the waterand remain within water.

In a water body, the source of DO is mainly the atmospheric diffusion and photosynthetic activity. When photosynthesis exceeds respiration DO is more. The solubilityof oxygen decreases with increased temperature and salinity. As depth increases DO will decrease. In shrimp farming, dissolved oxygen levels at the bottom is important, since shrimp spend a lot of time at the pond bottom. The desirable concentration of dissolved oxygen in water for fish is >5 mg per litre . As mentioned before, for dissolved oxygen analysis, the samples need to be fixed by adding Winkler's reagent on board vessel /site itself. Surface and bottom water samples are to be collected separately for the near shore and offshore. The processing protocol should be meticulously followed for individual samples.

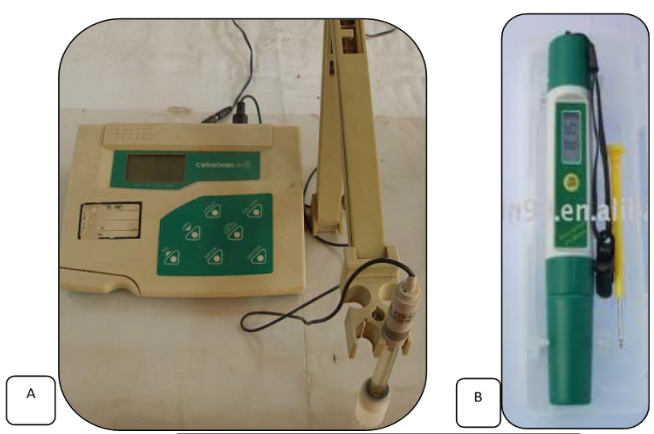
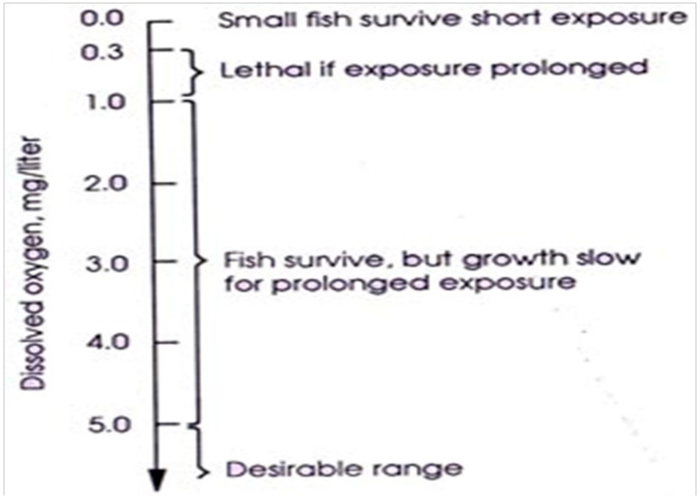


Fig.6 A. Bench top pH meter B. Portable pH meter

The commonly used method of estimation of dissolved oxygen is by Winkler titration method. In this methodology, the oxidation of manganous dioxide (bivalent manganese) by the oxygen dissolved in the sample results in the formation of a tetravalent compound. When the water containing the tetravalent compound is acidified free iodine is liberated from the oxidation of potassium iodide. The free iodine is chemically equivalent to the amount of dissolved oxygen present in the sample and is determined by titration with a standard solution of sodium thiosulphate.

Carbondioxide

The level of CO2 in the water varies with the respiratory and photosynthetic activity of animals and plants in the water body, the level of decomposition of organic material in that water (a significant supplier of CO2 in nutrient-rich waters), and the respiration of the fish themselves. Concentration of CO2 can rise to considerably high levels in systems with large numbers of fish and comparativelyslow water turnover.



How to measure CO2

Free CO2 in natural water is determined by titration with sodium carbonate Na2CO3 to form NaHCO3. Development of pink colour using phenolphthalein indicator in the natural water shows the absence of CO2 in the sample. The water sample is collected without allowance for bubbles.in a DO bottle and is tightly closed. In the laboratory, an amount of 50 ml of this sample water is transferred to a conical flask, carefully, without bubbling and 2-3 drops of phenolphthalein is added. If the water turns to pink then there is no free CO2 in water sample. If the sample remains colourless, it is titrated with standard Na2CO3 solution. The end point is the permanent appearance of the pink colour. Favorable range of CO2 in water is<5mg per litre.

Total Alkalinity and Hardness

Total alkalinityrepresents the quantity ofbasic anions present in water bicarbonates, carbonates, phosphates, hydroxides, etc. Alkalinity measures the total amount of base present in water and indicates the ability of a water body to resist large changes in pH. In other words alkalinity shows the buffering capacity of the water body. Alkalinity is expressed as mg per litre CaCO3. The total alkalinity concentration should not be lower than 20 mg per litre CaCO3 in production ponds.

The desired total alkalinity level for most aquaculture species lies between 50-150 mg per litre CaCO3 It can be estimated by titrating the water sample with strong H2SO4, first to pH 8.3 using phenolphthalein as indicator and then further to pH between 4.2 and 5.4 with methyl orange. Hardness is another significant water quality aspect foraquaculture management. Hardness represents the overall concentration of divalent salts (calcium, magnesium etc.). Calcium and magnesium are the most common sources of water hardness. Calcium and magnesium are essential in the biology (bone and scale formation in fish) of aquatic life.

Calcium is the critical component of total hardness is the calcium concentration, as environmental calcium is crucial for maintaining exact levels of internal salts for normal heart, muscle and nerve function. An appropriate range of hardness is between 75 and 200 mg per litre CaCO3. Alkalinity and hardness are reasonably stable but can change over time, usually during weeks to months, depending upon the pH or mineral content of bottom soils.

Decomposition of Organic matter

In aquaculture, different kinds of organic and inorganic compounds (e.g. formulated food, manures, and fertilizers) are added to the water body to increase fish production. But, a large part of these inputs are not utilized by the fish and are decomposed / disintegrated in the water. The microbiological decomposition of the organic matter is a critical factor for water quality control and nutrient recycle.

Aerobic decomposition of organic matter is an important drain of oxygen supplies in water. Many factors affect this decomposition. Aerobic decomposition of organic matter takes place with the help of aerobic microorganisms.

The temperature optima of microorganisms differ among microbial species, but the rateof decomposition generally increase over the range of 5 to 35°C. A temperature increase of10°C often doubles the rate of decomposition and oxygen consumption.

The pH preferences of different microorganisms also differ. Bacteria grow best inneutral to slightly alkaline habitats while fungi prefer acid environments.

Generally organic matter is degraded faster in neutral to alkaline systems than in acid systems.

Aerobic decomposition requires a continuous supply of oxygen and proceeds more rapidly whendissolved oxygen concentrations are near saturation.

Anaerobic decomposition of organicmatter takes place with the help of anaerobic microorganisms.

The rate of degradation oforganic matter is not as rapid under anaerobic conditions as under aerobic conditions.

The end products of anaerobic decomposition are alcohols, organic acids etc. whereas CO2 is the end product of aerobic decomposition.

The decomposition of organic matter varies with the type of carbonaceous material to be decomposed. Some organic compounds are more resistant to decay than others. For example sugar is decomposed faster than cellulose and cellulose faster than lignin.

The C/N ratio of organic matter has been widely used as an index of the rate at which organic matter will decompose. Organic matter with a wider C/N ratio will decompose much slower than organic matter with a narrow C/N ratio.

Oxidation Reduction Potential

Oxidation reduction potential (ORP) is a measure of the proportion of oxidized to reduced substances in water. It is also known as Eh.

It is measured with respect to Hydrogen electrode, using an ORP meter (Fig 7).

Eh range of natural waters 0.45 – 0.52 V

Appearance of Fe++ ion at 0.2 V coincides with depletion of oxygen

Total Ammonia Nitrogen

In aquatic system the ionized ammonia (ammonium ie., NH4+) is less toxic but unionized ammonia (NH3) is highly toxic to aquatic life. Together, ammonium and ammonia is known as total ammonia nitrogen (TAN).

Toxicity ofTAN increases with increased pH and temperature. The sources ofTAN are organic mineralization, fish feed and direct excretion from fishes. The oxidation of ammonia by nitrifying bacteria will provide the bioavailable forms NO2 and NO3 to the aquatic life.

Increased TAN will affect fish health and the major symptoms includeincreased oxygen consumption, damage of gills, histological changes, susceptibility to disease, reduced growth and the toxicity may lead to death.

Aquatic autotrophs rapidly utilize ammonium ions, thus naturally preventing it from increasing to toxic levels. The total ammoniacal N content of water is an index of the degree of pollution. Its concentration in unpolluted water should never be more than 0.1 mg per litre.

The TAN in water is measured making use of a spectrophotometer, using phenol hypochlorite method.

In this method phenol and hypochlorite react in an alkaline solution to form phenyl quinone-monoimine, which in turn, react with ammonia to form indophenol.

Indophenol gives the solution a blue colour, the intensity of which is proportional to the concentration of ammonia present in the sample.

Sodium nitroprusside is added to intensify the blue colour. Both ammonia and ammonium are measured, because in a strong alkaline solution all the ammonium is converted to ammonia. This procedure gives an estimate of total ammonia nitrogen.

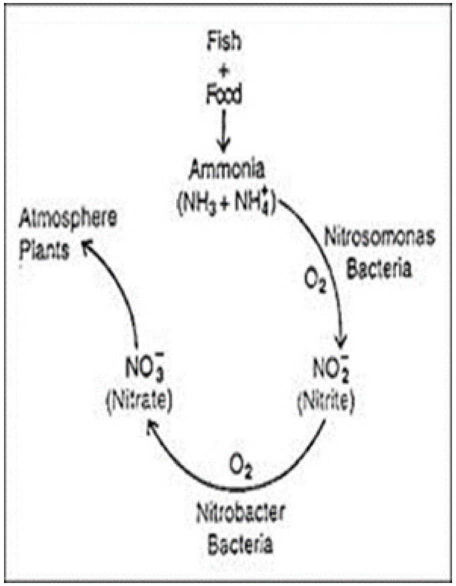
Fig. 7 Portable ORP meter

Nitrite N

Nitrite N originates as intermediary product of nitrification of ammoniacal N

The concentration of nitrite N in water should not exceed 0.5 mg per litre.

Nitrite N is toxic to fish and shrimp because it forms methemoglobin, affects immune and circulation systems, and reduces the transfer of oxygen to cells.



High chloride concentration reduces nitrite toxicity and so nitrite toxicity is less in brackish water.

To measure nitrite, the nitrite in water is allowed to react with sulphanilamide in an acid solution.

The resulting diazo compound further reacts with NNED and forms a highly colored azo dye, the absorbance of which is measured spectrophotometrically.

Nitrate N

It is the end product of nitritication of ammoniacal nitrogen by aerobic autotrophs. The favorable range of nitrate in culture waters is 0.1 mg/l to 4.5 mg/l. Its higher concentrations may lead to inability to swim and reduced movement.

The estimation of nitrate N in water is based on a method of reduction of nitrate to nitrite and then estimating the nitrite through spectrophotometrically.

Nitrate in water is reduced almost quantitatively to nitrite when the sample is passed through a column containing cadmium filings coated with metallic copper (Fig. 8).

Dissolved inorganic phosphorus

Phosphorous is a limiting nutrient needed for the growth of aquatic plants and algae alike. Excess concentrations of P can result in algal blooms.

An algal bloom is a rapid increase in the population of algae in an aquatic system. It can occur in green, yellow- brown or red in colour (Fig. 9).

Algal bloom is caused by an imbalance of nutrients in an aquatic system (P and N mainly)

For coastal waters the dissolved inorganic phosphorus (DIP) should not exceed 0.05 mg per litre and dissolved inorganic nitrogen (DIN) should not exceed 0.5 mg per litre.

Harmful Algal Blooms(HAB) causes negative impacts to aquatic organisms via production of natural toxins, mechanical damage etc.

Dissolved Orthophosphate can be determined by Ascorbic acid method. Ammonium molybdate and potassium antimony tartrate react in an acid medium with dilute solutions of orthophosphate to form phosphomolybdic acid that is reduced to the intensely coloured molybdenum blue by ascorbic acid.

The intensity of the blue colour increases in proportion

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to the amount of phosphorous present and can be measured spectrophotometrically.

Hydrogen sulfide (H_2S)

Hydrogen sulfideis a toxic, colorless gas with the distinctive foul smell of rotten eggs. It is formed in anaerobic situations (by transformation of sulfate to sulfide).

Its toxicity increases with decreasing dissolved oxygen and decrease in pH.

It is toxic above 0.1 µg per litre,that means detectable concentrations of hydrogen sulfide is undesirable for aquaculture.

H_2S can be eliminated from ponds by the use of aeration or $KMnO_4$ (potassium permanganate) to oxidizethe hydrogen sulfide into non-toxic sulfur compounds.

The occurrence of hydrogen sulfide can be identified by its stinking odor of rotten eggs.

For verification of presence of hydrogen sulfide, add 0.5 ml of

Fig. 9 Algal blooms

saturated solution of potassium antimony tartrate and 0.5 ml of 6N hydrochloric acid to 200 ml of water sample and shake well. The yellow colour of antimony sulfide is a positive test for sulfide.

Water quality sampling frequencies for various aquaculture systems

Sampling for water quality assessment in different aquaculture systems can be done at frequent intervals as shown in Table 2.

Table 2. Water quality sampling frequencies for various aquaculture systems

Type of system	Sampling frequency			Remaks
	Twice daily	Daily	Weekly	
Brackish water				
Low density		DO, salinity. Temperature	NH3, pH, Secchi disc	DO - early morning and next day late evening
High density	DO, pH, Temperature	Salinity, NH3, CO2, Secchi disc, Alkalinity	NO2, Hardness, H2S	DO - early morning and once in the late evening
Fresh water				
Low density		DO, Temperature	NH3, pH, CO2	DO - early morning and next day late evening
High density	DO, pH, Temperature	CO2, Secchi disc. Alkalinity	NO2, Hardness, H2S	DO - early morning and once in the late evening
Hatchery				
Brackish water	DO, NH3, pH, Temperature	NO2, Salinity, Alkalinity, Hardness	H2S	DO,pH - once in the morning and once in the evening
Fresh water	DO ,pH	NO2, NH3, Alkalinity, hardness	H2S	

Water Quality Parameters - Problems and Corrective Methods

Frequently encountered water quality problems and their corrective measures are given in Table 3.

Table 3 Water Quality Parameters - Problems and Corrective Methods

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Parameter	Problem	Cause	Effect	Optimal level	Corrective measure	Visible indication
Salinity	Fluctuations	Dilution & Evaporation	Stress	0.01-1 ppt for fresh water species and 20 - 35 ppt for euryhaline species	Water exchange	Hyper activity Mucous on body
Dissolved oxygen	Hypoxia	High organic matter load Plankton blooms Overstocking Overfeeding	Mortality Lethargy	4 -5 mg/1 for warm water fishes and 5-6 mg/1 for cold water fishes	Aeration Water exchange	Gasping at the surface Mucous accumulation on gills
CO2	Buildup of CO2 concentration in water	Over stocking Uptake of ground water rich in CO2 Plankton blooms	Prolonged exposure leads to mortality	<5 mgL-1	Water exchange/ Aeration	Gasping at the surface. Mucous on gills
Ammonia	Buildup of NH3 and NH4+- concentration in water	Overstocking Decomposition of excess feed Use of ground water rich in ammonia Agricultural runoff rich in ammoniacal fertilizers	Mass mortality			

Nitrite	Nitrite poison-ing	Over-stocking Poor nitri-fication Decom-position of excess feed Algal blooms Faulty biofilters	Methe-mo-glo-bine-mia	Methemo-glo-bine-mia	Aeration Water exchange	Hypoxia Lethargy
Nitrate	Nitrate poison-ing	Poor nitrogen recycling Decom-position of organic matter Use of ground water rich in NO3	Toxic only on pro-longed exposure	0.1 to 4.5 mg/l	Water exchange	Reduced move-ments
Hy-drogen sulfide	Hy-drogen sulphide toxicity	Decom-position of excess feed High organic load	Instant mortality	<0.1 µg/l	<0.1 µg/l	Gasping at the surface
pH	Acidosis and alka-losis	Acid sulphate soils Agricul-tural run off Excessive use of lime	Mass mortality	6.5 – 9.0	Use of lime or gypsum as the case may	

Water quality monitoring and management is essential for the smooth functioning of the aquaculture enterprises and a basic knowledge about all the above mentioned water quality parameters isa necessary pre requisite for its effective,

sustainable and profitable implementation.

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ACCELERATED SEED PRODUCTION OF PEARL SPOT USING MODIFIED HATCHERY METHOD

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Introduction

Pearl spot (Etroplus suratensis), popularly known in Malayalam as karimeen is an indigenous fish extensively found along the east and south-west coasts of Peninsular India (Jhingran and Natarajan, 1969,1973). Pearl spot is popular in Kerala for its taste and appearance. It is an elegant and exotic dish during the festivals of all occasions in Kerala. It is also inevitable in the non-vegetarian dishes of both foreign and native tourists in the house boats and resorts located along the coastal line of Kerala. Hence Pearl spot is an essential component contributing towards the sustainability of tourism (particularly back water tourism) industry in Kerala. In Kerala government declared Pearl spot as "State Fish of Kerala" and celebrated the year 2010-2011 as the "The Year of karimeen" for creating awareness about the need of Pearl spot conservation and its commercial production potential in the State. The annual landings of E. suratensis in the riverine zones of the lake, which constitute approximately 50 percent of the lake expanse has been reduced to 200t during 1999-2000

(Padmakumar et al., 2002) as compared to 1252 t reported during 1960s (Samuel, 1969). The consistent demand and price value motivated the farmers to initiate Pearl spot culture using wild caught seeds in different parts of the state. At present, the seeds (fry's/fingerlings) required for culture in backyard ponds, tanks, artisanal cages etc. are collected from the wild. The annual production of 2,000 MT is found to be insufficient to meet the ever increasing demands for "Kerala karimeen" in the country. It is estimated that annual production of 10,000 MT would be required to meet the present requirement. Pearl spot retail sale price ranges from Rs.250-350/- per kilogram in the domestic market.

Natural recruitment of the Pearl spot is adversely affected by the active and passive interventions by the humans in the ecosystem. Active interventions includes reclamation of natural water resources, sand mining, indiscriminate dredging for sub soil lime shell deposits, unscientific fishing practices, pollution, etc., This paved the way for the natural standing stock depletion of Pearl spot and price rise. In this context farmers initiated high density farming of pearl spots in cage systems and ponds. This has forced the local fisher folks for large scale collection of Pearl spot fry's and fingerlings from its natural breeding grounds to meet the ever increasing demand for its brackish water culture. Over exploitation through collection of indigenous Pearl spot fry's from wild resulted in the depletion of standing stock in recent times. Hence there is enormous potential for the production and supply of the Pearl spot seeds in the country. Institutions having skill and experience in imparting training on Pearl spot production technology are few in number in the State. It is estimated that per year requirement of Pearl spot seeds in Kerala is as high as 40 million, whereas the present availability is only 8 million. In this backdrop, Krishi Vigyan Kendra (Ernakulam) of CMFRI initiated mass scale Pearl seed production programme through modified hatchery method.

Pearl spot seed production scenario

Wild caught seeds are the widely marketed in the seed industry than the hatchery produced seeds and used for the culture. Recently efforts for promotion of seed production are getting virtuous momentum in the State. Pearl spot seed production is practiced mainly by two methods viz., traditional farmers practice and modified hatchery method. The major differences between these two methods are as follows.

Table:

Traditional seed production	⟺	**Modified Hatchery method**
Not required	Scientific knowledge	Required
Pond	Infrastructure	Pond and indoor facility
Less	Operational Cost	High
Not required	Live feed facility	Required
Normal	Survival Percentage	High
Less	Labour input	High
Low	Production	High
Difficult	Harvesting	Easy
Not required	Feed	Required

2. Modified hatchery method for Seed Production

2.1 Brood stock pond preparation

Pearl spots are year round breeders but it breeds profusely during February to May and October to December periods. Visual differentiation of sex status during the juvenile stage is difficult in Pearl spot. But the sexes can be identified in matured adults, especially during the breeding period. Pearl spot produce eggs easily in natural pond conditions than in the artificial structures. Hence a well prepared pond is essential for facilitating egg production.

Small sized ponds are ideal for community breeding of pearl spots. Its size can vary from few cents to acre but preferably should be below 60 cents. The selected pond should possess well-built bunds and a suitable water exchange system. In ponds with tidal inflow sluice gates can regulate water intake while in the case of pump fed ponds a pumping system should be installed prior to stocking. Proper cleaning, desilting and weeding are required to facilitate egg laying process in a pond system. Weed fishes are the major menace in Pearl spot seed production ponds. Hence utmost should be taken to remove all the unwanted fishes from the breeding ponds. Weed fishes not only eat the eggs but also paved the way to reduce the hatching percentage. Complete drying of the ponds for few days till crack formation in the bottom is the worthy practice to reduce the weed fish problem than the other existing practices such as application of fish poisons, chemicals, etc.,

The flow chart of the pond preparation works is

Select a pond with minimum 3 feet water depth

↓

Select a pond with minimum 3 feet water depth

↓

Strengthen/ construct the surrounding bunds

↓

Dewater the ponds and dry the pond system for 3 days (if possible)

↓

Remove the weed plants and unwanted materials from the ponds

↓

Remove all the unwanted and weed fishes

↓

Apply lime @ 4 Kg/cent

↓

Fill the pond system using good quality water

↓

Install egg depositors (e.g. bamboo pole, tiles etc) in the pond system

↓

Stock brood fishes in the ponds

↓

Initiate feeding two times a day

↓

Observe and collect egg mass

↓

Transfer the egg mass to modified hatchery system for hatching

Lime application

Lime application is an essential practice to adjust the pH of the pond in the Pearl spot seed production ponds. Quantity of lime required for the pond will vary depending on the pH of the pond. Hence prior to initiate the lime application process pH of the pond need to be checked using tools such as pH pen or pH solution or pH paper.

Egg depositors

In general, Pearl spots attach eggs in hard substrates present in the brood stock ponds. Naturally they prefer bamboo poles, mud tiles, coconut husk and shell, submerged plants, submerged wood, rocks, stones, coconut leaves and other hard surface materials for depositing the eggs. Experiments using different egg depositors in ponds revealed that the bamboo poles and mud tiles are good egg depositing structures than the others. Hence to facilitate egg depositing bamboo poles or mud tiles with 1 to 1.5 m gap has to be fixed in the margins of the ponds prior to brood fish stocking.

Stocking of brood fishes

Pearlspot, E. suratensis is heterosexual and is gonochoristic exhibiting external fertilization. Fish is monogamous and identification of sexes is possible only during the breeding season. Pearl spot males attain sexual maturity at 125 – 140mm length and 80 – 100 gm size while females attain at 110 – 120 mm length and 75 - 90 gm size. Body coloration and iridescence of the matured males become more intense close to the spawning season. Females are generally small when compared to males of the same age. Females genital papillae become larger, broader, reddish, swollen and appear modified into an ovipositor close to breeding season Bindu et al., 2006. Fecundity in pearl spots varies individually depending on the size and condition of the brood fishes. In normal conditions its fecundity varies from 874- 7554 (2748) numbers. Healthy brood fishes either collected from wild or grown in ponds can be used as brood fishes for the breeding programme. Optimum stocking density of adult fishes in breeding

ponds ranges from 5 to 10 numbers per cent area of the pond.

Feeding

Supplementary feeding is essential for attaining maturation and initiating breeding of Pearl spots in the pond systems. Formulated floating feeds or farm made feeds can be used as the feed. Feeding should be carried out two times a day preferably during dawn and dusk.

Egg mass collection and hatching

Matured pearl spot start laying eggs after one to two months of stocking in the brood stock development ponds. Pearl spot prefer egg depositors sited near the margins of the ponds for laying the eggs hence its egg mass siting is a comparatively easier procedure in the ponds. Naturally, egg masses are protecting by the parents from other predatory fishes. These egg masses are the base material for the hatchery rearing works. The egg mass transporting is a vital process in the seed production phase. Special care should take to avoid exposure to air while transferring the egg mass from pond to hatching tanks. One egg mass or multiple egg masses sited on the same day can incubate in similar tanks for hatching. Preferable size of the hatching tank is 1 tonne with minimum 2.5 feet water depth. To replicate the fanning process of parent's in nature continuous aeration has to be provided in the hatching tanks. Any failure in aeration may reduce the hatching percentage of eggs in the tanks. Three to four days incubation is required to initiate the hatching process in the Pearl spots. Freshly hatched fry's lay as round groups in the tank bottom. Larvae reabsorb the yolk sac for the initial developmental process. Hence no feeding is requires for the freshly hatched larvae until free exhaustion of yolk. Generally this process will take two to three days period.

Larval feeding

Feeding can initiate after two to three days of hatching depending on the initial growth of larvae. Readiness of feed acceptance by the larvae can understand from its swimming behavior. Artemia nauplii are the best choice for starter diet in the tanks.

Live feed: Artemia

Artemia are available in cyst form in packaged air tight containers mainly imported from USA or China. These cysts need 24 hour incubation in saline condition to hatch out to nauplii which is the required form of feed for predatory larvae. Freshly hatched nauplii possess all the essential PUFAs (Vikas et al., 2012a). Keeping long time without harvesting from the hatching tanks may reduce the nutritional quality as well as will increase its length. Hence feeding using freshly hatched nauplii give good results (Vikas et al., 2012b).

Decapsulation and hatching Procedure of Artemia cysts are as follows.

Take 1 gm Artemia cysts

↓

Incubate at Room Temperature for 1 hour

↓

Hydrate in distilled water for 2 hours

↓

Wash the cyst

↓

Dewater the cyst using 100 μm filter

Treat hydrated cyst with 0.5gm active chlorine (sodium hypochlorite)

↓

Add 40% sodium hydroxide (0.33 ml)

↓

Make up the volume to 15 ml with seawater

↓

Keep the container in cool fresh water

↓

Shake vigorously for 20 minutes

↓

Observe the colour change and pour fresh water when the cyst

colour change to orange

↓

Add more water and decant

↓

Wash in 0.1 N Hcl

↓

Wash thoroughly using fresh water

Decapsulated cysts filter and wash thourougly using fresh water to remove all traces of hypochlorite. Incubate the decapsulated cyst (25 1.5oC) in seawater (35 ppt) under florescent light (1500 lux) for hatching.

Harvest the nauplii after 12 hours of incubation

Formulated diet

In place of Artemia nauplii dry formulated larvae diet also can be used for the freshly hatched larvae. In such case feed size should be preferably below 300 micron. As per the growth of the larvae feed size also has to be increased. Readily available formulated larvae feed size are 500 micron, 700 micron and 1mm. One and half months rearing is required to reach the larvae to fry stage (1.5 cm).

Nursery rearing

Nursery rearing is the process generally carries out to rear the fry to cultivable fingerling size (7 to 8cm). Nursery rearing can conduct both in open nursery ponds and in netlon happa systems. Nursery rearing in ponds: A well prepared pond is desirable to initiate nursery rearing in pond systems. Pond preparation includes the process such as dewatering, pond drying, weed fish removal, liming, etc., Stocking density of the fry's in the ponds may vary with the water quality parameters. Ideal stocking density in well prepared pond is ranges from 600 to 800 per cent area. Spot feeding till satiation is advised to carry five times a day in nursery rearing ponds.

Nursery rearing in Happa nets: Happa /encircled nets are widely used for nursery rearing of Pearl spot. Happa nets are fabricated using synthetic fabric of velon screen material. Stocking density vary depending on the size of fry, stocking density, water quality, depth of the pond, etc.,. Square shape happas are more convenient for handling when compared to round shape happas for Pearl spots. Ideal size of a happa net for nursery rearing in shallow ponds is 1.2m X 1.2m X 1.2 m size.

Advantages of happa nets in nursery rearing

- Controlled feeding can carry out which in turn reduce feed wastage
- Harvesting can be done easily without any injury to the frys
- Survival percentage will be high
- Management and monitoring will be easy in happa nets

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CAGE CULTURE: TECHNOLOGY OF THE MILLENNIUM FOR THE INCREASED PRODUCTION OF PURE ORGANIC FINFISHES

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1. INTRODUCTION

Fish can be cultured in any of the four prevailing culture systems like ponds, raceways, recirculating systems or cages. A cage or net pen is a system that confines the fish or shellfish in a meshed en¬closure and allows it to grow in its natural environment.The cage aquaculture initiated in Norway during 70s got developed into a high tech industry in many countries all over the world for high valued fishes. Cage culture is accessing and expanding into new untapped open-water culture areas like reservoirs, lakes,rivers and coastal brackish and marine inshore and offshore waters globally.Cage culture can be established in any suitable body of water, including lakes, ponds, mining pits, streams or rivers with proper water quality, access and legal authority. This flex¬ibility makes it possible to exploit un¬derused water resources to produce quality fish.The main advantage of fish culture in cages is the fast growth rate, effective utilization of feed, good water quality parameters of the natural systems and easy harvest on demand compared to the pond culture. Factors such as increasing consumption of fish, some declining wild fish stocks, and a poor farm economy have produced a strong interest in fish production in cages.

In India though the cage culture is in the initial phases due to the successful and easily operating technology and plenty of open water bodies it is expanding very rapidly.Cage aquaculture is an active mode of fish cultivation prevalent in many states of India including Kerala. Now it has been marked asone of the attractive and important means of livelihood as well as profit making ventures.Cage culture has gained great popularity not only among people who depend traditionally on fishing but also among those who do not even have any previous experience in fishing. There are some particular reasons why people are attracted towards cage aquaculture. The most important reasons are the durability of the cage, easy maintenance and high profit. The new cage design and efforts of Central Marine Fisheries Research Institute (CMFRI) during the last decade has considerably boomed the cage fish farming in Kerala especially in Ernakulum, Thrissur and Alleppey districts. Fish culture in Cage have several advantages over other methods of culture as it is done in existing open natural water bodies require comparatively low capital outlay and use simple technology, they are popular with farmers, extension workers and development programmes. Cages can be used not only for grow-out of fish to market size, but also for broad stock development of major marine finfishes.It is an aquaculture production system made of a floating frame, net materials and mooring system (with rope, buoy, anchor etc.) with a round or square shape floating net to hold and culture large number of fishes and can be cultured in reservoir, river, lake or sea.Of the estimated one million tons of marine fish cultured in Asia, probably 80-90 % is from cage farming. Cage culture is presently undergoing great innovations in response to globalization and the growing demand for aquatic products. It has been predicted that the fish consumption in developing and developed nations will increase by 57 % and 4 %, respectively over the coming years is expected to full fill through the increased production from cage aquaculture.

SIGNIFICANT ADVANTAGES OF CAGE CULTURE

- Many types of water bodies can be used (open sea, brackishwater, estuaries, reservoirs, lakes, rivers etc. which could otherwise not be harvested) for cage culture

- Good water quality parameters as the water is flowing
- Relatively low initial investment
- Easy operation and management
- Ideal for poor and landless people especially for fishers
- Effective utilization of Feed
- Fast growth and higher production of quality fish
- Production of fish in its natural conditions
- Reduced culture period (1-2 crops/ year)
- Production of high quality fish
- Easy and harvest

2. WHAT IS CAGE CULTURE?

Cage culture involves growing fishes in existing water resources while being enclosed in a net cage which allows free flow of water and with optimum feeding for fast growth and high production. It is an aquaculture production system made of a floating frame, net materials and proper mooring with anchor/ pole, rope, buoy etc.in an open water body. Economically speaking, cage culture is a low input farming practice with high economic returns. In view of the high production capacity in cage culture systems, it can play a significant role in fish production of the country and the income generation of the farmer.

3. CAGE STRUCTURE AND MOORING

Cage fabrication

1. CAGE FRAME

Indijenously fabricated high-density polyethylene (HDPE) cage

measuring 6 m diameter with catwalk and hand rail with provision for connecting different nets was used in the marine cages. Whereas GI frames can be of any measurement like 4 x 4, 6 x 6 or 9 x 4 according to the area or nature of the water body or our requirement; it can be square, rectangular or round (for sea)

Fig.1 HDPE round cage with blue inner and green outer nets 2. GI cage (4 m2) frame after welding and painting 3 GI cage (6 m2) in open water system in operation

Round GI pipes of 1 ¼– 1 ½inch diameter are usually using for cage fabrication; the required number of pipes (13 nos for 4 x 4, 18 nos for 6 x 6 and 22 nos for 9 x 4) has to be procured from the market cut according to the measurements as marked in the fig. It can be welded as a single unit or demandable types fitted with nuts and bolts and can be welded at the culture sites or any locations; while welding care has to take to do the welding without any holes to avoid water entering into the pipes. After welding the whole welding areas have to be covered with m-seal before painting.The whole structure has to be painted with marine epoxy primer & paint and allow dry properly before mooring.

3. 2. NETS

Two nets are required at a time for a cage to hold the fishes while doing grow out culture both in sea as well as open water systems. The design of net cage is as follows in marine cages:HDPE outer predator (braided 60 mm mesh) and inner grow-out (40 mm mesh) nets with a net depth of 6 m were used. A bird net (80 mm mesh) was used to protect the stock from birds. A 6 m diameter HDPE ballast pipe (63 mm diameter) at the bottom with holes for the free flow of the water was used to maintain proper shape of the nets.Where as in other open water systems no need of any braided nets which are usually costlyand the outer and inner net is made of twisted HDPE of 28 – 40 mm mesh and 18 – 24 mm mesh respectively based on the size of the fish seeds. Ballast pipe is according to the size of the inner net. It can be made with PVC or GI. Here also a bird net of 60 – 80 mm mesh is used to protect the fish from the attack of birds and ballast pipe to maintain the shape of the net is required. While making cage nets square mesh is a must instead of diagonal mesh to avoid escape and gilling of undersized fishes.

3.3. FLOATS

Drums for flotation: Minimum 8 numbers of 500 l plastic drums (used) are required for a single cage for floatation; and it has to be tightly sealed and tied to the frame as shown in the picture.

3. 4. MOORING SYSTEMS

Single mooring system:As the name implicates in single mooring systems the anchoring is only at one point. It is mainly used in the open sea conditions and the cage can rotate 360 o;resultant of the currents or wave actions and mooring is done either by anchor or gabion box with granite pieces.This reduces the stress of the mooring chains in sea conditions.

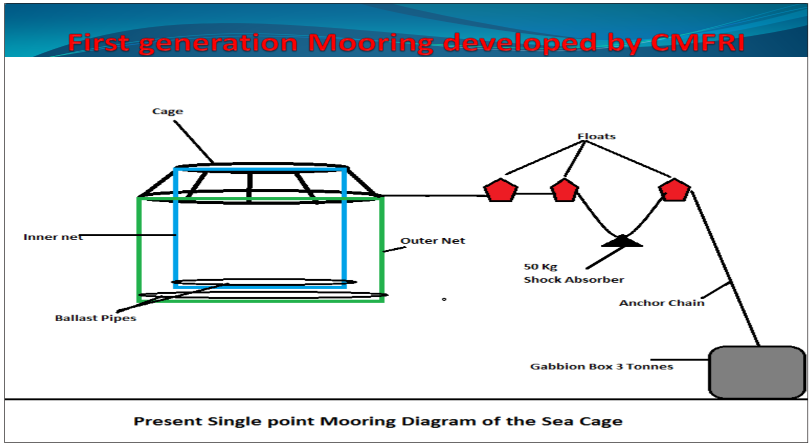

Fig. 2 Diagrammatic picture of the single mooring system

Double Mooring system: It is generally used in lakes, rivers or back waters where two directional water flows prevails. It uses poles in shallow areas; whereas anchors in deeper waters. Mooring will be on both the sides; so that cages will keep in place while the water flow in both the directions happens consequently mainly due to the tidal influx. Here the cages cannot move much except the vertical movements due the tides; a little side wise movement is also possible depending on the length of the ropes tied between the poles and the cages.

3. 5. SITE SELECTION

Selection of a suitable site is most important factor in the case of any culture especially in the open sea cage culture because it determines investment, running cost and mainly the ultimate success. A calm bay or inbound sea with good water flow and sandy or rocky bottoms should be selected as an ideal culture site. In the case of cage culture, most cage sites have been placed in relatively sheltered waters but there are a finite number of such suitable sites. But most of the times such an ideal area may not be available in most of the places. However, the future is in the open sea cage culture is likely to be further offshore, as the coastal waters limitations when the same develop as an industry and scarcity of water bodies. For site selection, a pilot survey has to be conducted prior to the commencement of cage farming. Different criteria must be addressed before site selection for cage culture The first is primarily concerned with the physicochemical conditions like temperature, salinity, oxygen, currents, pollution, algal blooms, water exchange etc. that determine whether a species can thrive in an environment. The water and sediment quality parameters of the proposed sites should be determined prior to the culture to meet the standard requirements. Other criteria that must be considered for site selection are weather conditions, shelter, depth, substrate etc. Finally legal aspects, access, proximity to hatcheries or fishing harbor, security, economic, social and market considerations etc. are to be taken care.So we can take the factors one by one and find out the most suitable area in our locality.

1. The depth should be sufficient to keep the nets clear off the sediment and allow water exchange beneath the nets. Otherwise we have to adjust the length of the nets according to the depth of the water column.
2. Good water exchange is also important in cage culture to replenish oxygen and flush away wastes.

3. Tidal amplitude is found to have great role in making daily water currents and pulling effects on the cages will be very high especially during the full and new moons. The ideal is 1 – 1.5 m or less than that.
4. Knowledge of the wave action at a potential site will help for the selection of a proper cage and mooring technology for the site.
5. The wind velocity of the site must be less than 30 km h-1 during culture period.
6. Water quality factors such as temperature, salinity, pH, suspended solids and the presence of algal blooms can potentially influence the growth and survival of the cultured fish.
7. Bottom characteristics also have some role in the site selection as sandy and rocky bottom is good than muddy.
8. Sources of pollution which can negatively impact on water quality.
9. Weather is also another important factor in determining the suitable site for cage culture as they can impact on both the cage structure and enclosed fish.

6. DIFFERENT SPECIES IN CAGE CULTURE

Candidate Species

Fast growing and high value species are the best suited species for marine as well as open water cage culture. A number of species are already grown commercially in cage culture overseas and notable examples are rainbow trout, brown trout and Atlantic salmon. Cobia Rachycentroncanadum, groupers and Asian sea bass Latescalcarifer and juvenile lobsters are the potential fish species for India due to its high market demand, better growth rate and seed availability. In brackishwater cages, common species used for culture include Sea bass, Snappers especially red snapper, Pearl spot, Etroplus surratensis, mullet (Mugil sp.), milkfish (Chanoschanos), and other carangids like T. blochii, T. mukalee,C. ignobilis, C. sexfaciatus etc. The major species used for culture in marine cages are Cobia, Pompano, Groupers, Sea bass, Sea bream, Rabbit fishes, and lobsters.

Hatchery technology is available for sea bass, cobia, pompanoand Groupers and in the case of lobsters the juvenile fishery is prevalent in the Indian coast as it fetches high price; and these fishes are the main candidate species used for the cage culture at present. The prospect of developing commercial interest in lobster farming in India seems bright due to the substantial increase in price consequent upon heavy demand from export market as well as due to the juvenile fishery. Fattening of lobster juveniles in the sea cages is very advantageous as the juveniles will get a chance to grow, mature and spawn in the cages. As its fishery is in live condition a better co-ordination can increase production and it helps in the conservation of the species at the same time. A variety of ornamental fishes, shrimps and mollusks can also form candidate species for cage aquaculture.

7. STOCKING

Grow out of the fish culture in cages starts as it transfers to the cages from the nurseries, usually the nursery reared juvenile fishes of 8 – 10 cm fishes with a minimum weight of 80 – 100 g are preferable for stocking in cages in case of sea bass. However, the size and stocking varies with the species and the major factor to be noted is that the seeds stocking in the cages has to be retained in the inner net, they

should not pass through its mesh. The stocking densities of species in cages are highly variable and the optimum density for many species is not known. Stocking in cages are usually two types i.e. high density/ low volume or low density/ high volume. Low density/ high volume stocking (2-20 fish/m3) are recommended for species like Cobia for which harvest size is several kilograms; high density/ low volume stocking (50-250 nos/m3) are good for those fishes target harvest is 1 kg or less. Stocking density depends on the size and type of the fish selected for mariculture, however generally depending on the production target of up to 25 – 30 kg per m3 stocking can be done.

Fish stocking in cages

The minimum recommended stocking density for common carp, tilapia, and catfish is 80 fish /m3. A recommended maximum stock density for beginning farmers is the number of fish that will collectively weigh 150 kg/m3 when the fish reach a predetermined harvest size (Schmittou, 1991). The smallest recommended fingerling size for stocking is 15 g. A 15-g fish will be retained by a 13-mm bar mesh net. Larger fish can also be stocked into cages. Survival rates in well-placed and well-managed cages are typically 98 to 100 %. Unless greater mortality is expected, no adjustment is needed to calculate stocking density.

An example of how to calculate the number of fish to stock per cage follows: Assume that a farmer wants harvest fish weighing 500 g from a 1-m3 cage.

Total fish weight at harvest	=	150 kg/m3
Number to stock	=	300 fish (300 x0.5kg)
Desired average fish weight	=	0.5 kg at harvest

Production = 150 kg/m3

For a harvest of fish averaging 200 g, the number of fish to stock would be:

Number to stock = 750 fish/m3

0.2 kg x 750 = 300 kg/m3

Juveniles of sea bass reared in the nurseries of size 10 - 15 cm in length (25 – 50 g) can be transferred to the cage for the grow-out. The stocking density in the cages varies from 20 – 25 kg/m3 in the final harvest time. So with a final weight of expectation of 1 kg fishes in harvest time after a period of 6 – 8 months; from the cages the stocking density varies from 25 – 30 fishes / m3 for the sea bass. Care must be taken to avoid handling stress and other physiological stresses as maximum as possible while transport and stocking.

8. GENERAL MANAGEMENT

The growth and thereafter production is the resultof proper management of the various culture activities. The various factors to be taken care in cage management are:

1. Feeding

In any aquaculture especially in cage aquaculture, the most important factor is feed and feeding as the fishes in the cages are totally depended on the feeds what we are feeding.A cost- effective feed of good quality and acceptance determines the production. The nutritional requirement is dependent on the species and its stage of development; juveniles usuallyrequirehigh protein good quality feeds. Feeding is also a vital function and includes many biological, water quality, and economic factors. The direct influence of growth rate in terms of feeding intensity, feeding time, food rations are important and the farmer has

to give more attention. The feeding characteristics of each species vary in feed intake, digestion, feeding frequency and conversion efficiency and these has to be addressed. Feed has to store properly if it is pelleted feed; if feeding with trash fish the chance of rapidspoil and has to be carefully managed. Feeding should be done throughout the culture period at varying levels depending on the growth rate and natural feed availability. Feeding trays or feeding rings can be used based on the type of feed used.Use of floating feed is vital for cage-farm operations.Feeding should be scheduled in such a way to ensure that feed wastage is kept to a minimum.

2. Net cleaning and net exchange

Cage nets may be checked weekly for cleaning, which is to be done more frequently if clogging is more during cage culture. Small tears may be repaired at the site itself, while major repairs should be done on shore only. Net exchange has to be done periodically to avoid fouling and for good water exchange. Mesh size should be carefully selected at each stage of growth the nest has to be changed according to the growth and size of the fishes cultured. The frequency of net change varies depending upon the site location,materials used, season and management of cage. Net cleaning can be done physically or by using mechanical pumps. Physical cleaning involves removing and scrubbing the net and drying. Similarly cage frames are also cleaned in situ using a hand brush both above and below the water line to dislodge weed and accumulated debris.

3. Water quality management

Cage-farm wastes are usually in the form of uneaten feed and fecal matters of the fishes. Mooring cages in deep waters, leaving 1-2 m bottom space and good current flow results in cage wastes being easily flushed away, thereby avoiding organic build up under the cages.Routine monitoring of water quality is essential; by this we can avoid losses caused by lethal changes in water quality. It is essential for estimation of optimum stocking and feeding requirements, to evaluate the general condition of stock, so that if stressed, can avoid handling. It is essential to evaluate site and configuration of cage. Information of long term changes in water quality at a site is very important for the sustainability of the industry and the variation in production may be properly evaluated.Health management is essential to maintain a good health status, assuring optimum production and the avoidance of diseases. In aquaculture, the economic risk associated with diseases is highand treatments are often initiated too late and are therefore rarely effective. Thus, aquatic animal health management must be aims to prevent diseases before they occur.

4. Periodic maintenance of the cages, moorings, anchors, and related accessories

Irrespective of the damage that can be caused by climatic changes, predators, drifting objects, poachers, all materials used in construction of cages have a definite life span. Cages, nets and moorings therefore must be checked at intervals for signs of damage and wear and tear and repaired or replaced if necessary is a must. Mooring must be checked regularly.

9. HARVEST

Harvesting in a cage culture system is a simple processand less labour intensive compared to that in ponds. Harvesting can be done in a single lot or in batches based on demand and market price. No sophisticated harvesting

technology is required cages can be towed to a convenient place and harvest can be carried out according to the needs. Also based on demand, partial or full harvest can be done.Preservation and processing of cultured fish will be an essential part of the culture industry when aquaculture is further developed.

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SEASONALITY CALENDAR FOR BRACKISH WATER CAGE AQUACULTURE IN KERALA

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Abstract

Aquaculture is one of the fastest growing food production systems in the world. Cage aquaculture is getting a good momentum in the country due to availability technology and resources as well. Brackish water bodies are potential resources for expanding cage aquaculture of high value fin fishes in Kerala. Presently, the local self-governments are regulating cage aquaculture and issuing necessary permission certificates to the needy farmers. Objective of the present study is to delineate the significance of Seasonality in brackish water cage aquaculture practices. Present study was conducted in Kadamakkudy, Nayarmabalam andEzhikkara brackish water creeks located in south west coast of Kerala, India during 2012-2016 periods.

Farmers are extensively practising Cage farming of fishes such as Pearl spot, Mullet, Tilapia and Seabass in backwater bodies. Culture seasonis completely relayed on the seed availability period rather than any other factors. This is mainly due to the constrains in getting seeds as and when required from hatcheries.

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Hence farmers initiate farming as and when they get seed this without observing season and leads. Seldom this will lead to massive mortality issues in February, March and April period. High temperature, high standing crop in cages associated with low inflow of fresh water cumulatively affect the entire water quality especialy during peak summer months. Study witnessed massive fish mortality in cages during March months in cosicutive years from 2013 to 2015.Water sample analysis results showed the presence of Heptachlor 0.47 µg/l and Aluminium0.10mg/l in in the water samples. Though the pesticide and heavy metal residues were within permissible limits, the increased water temperature and reduction in water flow from upstreams cumulatively would have created anoxic and toxic environment in and around the cage locations which might have led to the mortality stages. The study unraveled that cage culture in brackish water bodies require a seasonality calendar which possibly can mass mortality and related losses. Considering the outcomes of the present study a seasonality calendar suitable for brackishwater creaks of Ernakulam has been prepared to reduce the mortality risk in association with external factors.

Table 1. Seasonality chart for cage culture of fin fish in open brackish water resources

In order to sustain the cage farming sectorpolicy level interventions to ensure supply of healthy and sufficient quantities of fingerling

Month	Work	Remarks
April	Site selection	Moderate flow is ideal for floating cages
May	Cage Preparation for new ventures	Installation of cage anchors can also finish
June	Cage maintenance for running cage units	

July	Nursery Cage installation Seed collection and Nursery rearing	Nursery rearing of Pearl spot, Mullet, Tilapia
August	Grow out cage installation and stocking for grow out farming	Grow out farming of Pearl spot, Mullet, Tilapia
September	Routine management and feeding	Seed collection and nursery of Seabass
October	Routine management and feeding	Grow out farming of Asian Seabass
November	Routine management and feeding	
December	Partial harvest and marketing	Harvesting of Tilapia and sale to reduce standing stock in cages
January	Routine management and feeding	Complete harvesting of Tilapia
February	Partial harvest and marketing	Partial harvest of Asian Seabass
March	Partial harvest and marketing	Complete harvest of Asian Seabass, Pearl spot and Mullet

size fish seeds such as Pearl spot, Mullet and Asian Seabass supply should be ensured. Linkages with government and farmer consortiums for establishing seed banks also may be considered for the betterment of this system.

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RESPONSIBLE AQUACULTURE - MAKING FISH FARMING ECOLOGICALLY AND ECONOMICALLY SENSIBLE

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"Fish farming is a profitable enterprise today".

I don't think this statement needs any further elaboration. But we need to qualify this fact with another one. Yes , we need to be aware about the risks involved. There are many types of risks in fish farming. They occur not only in the farm but also in the entire value chain consisting of the fish we grow and harvest in our farm to the fish that ends up as a dish in the consumer's dining table.

Your success as an aquaculture entrepreneur depends on the extent to which you are able to anticipate and tackle the various risks at every step in the whole value chain. It means that your responsibilities as an entrepreneur go beyond your farm. This demands a certain level of preparedness about the ways in which various risks emerge and the knowledge about the means by which they can be resolved. The philosophy that guides this responsible behavior is based on the principle of precaution. It can be simply put as "Better safe than sorry". We can call this preparedness as responsible aquaculture. This is a behavior each one of us must nurture. But remember, it is something like a lock which needs to be opened from inside, not from outside.

Responsible aquaculture emphasizes the need for practicing aquaculture in a responsible way so as to ensure profitability as well as food safety with out causing negative environmental and social consequences. Promotion of Responsible fisheries including aquaculture is a concern shared by all nations in the world. And we have a number of guidelines in this regard. Food and Agriculture Organisation (FAO) under the United Nations has brought out a set of guidelines called Code of Conduct for Responsible Fisheries (CCRF). It is a voluntary code signed by the member countries including India in 1995 . The code has 12 articles and article 9 deals with aquaculture development. The Socio economic Evaluation and Technology Transfer division of ICAR-CMFRI has brought out the Malayalam version of the Code in 2002. You can access the pdf online. .

The meaning of being responsible

When do we feel responsible? Most often we feel responsible towards something or someone when you have a sense of ownership over that thing or person. We have a sense of responsibility towards our parents, relatives, children and pets. We feel responsible towards our assets like house, vehicle , land , and pond . But this sense of responsibility may get weaker when our sense of ownership is also weak. For example, if we are harvesting fish from a river or lake , which is anyway not owned by you , we have less concern towards the future. Your priority is to maximize your profit. You have least concern towards the well being of the ecosystem. This may not be the case if that lake belongs to you. Similar is the case, when you do aquaculture in a leased out pond. Since you are not the owner of the pond you may tend to ignore, for example, the bad consequences of the excessive chemicals you may apply there.

We must pay little more attention to this point. The pond or water body where you do the farming may be under your ownership. You can argue that because of the ownership vested with you, you can also be irresponsible in what you do there. " Any way it is my property, I will do whatever I want". But the

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consequences of your irresponsible action will not end in your pond. The water is linked with the other water bodies. If you wish to practice certain harmful practices , the harm will not be confined to your waterbody. It can have spill over effects on the nearby farms. If your neighboring farmers do unscientific practices you are also likely to get affected by those practices. This is more clear when you do your farming in a common water body like a river, lake or sea. So, our sense of responsibility will determine the kind of risks we may face in aquaculture. Thus individual sense of responsibility , the very awareness of the consequences of your actions, needs to be elevated to that of the wider community of the entrepreneurs as well as members of the society.

You may not have sufficient control over the members of your community. But as we have seen without the community taking equal responsibility, the right action of a single individual may not be of any use. Or bad action of a single individual will ruin the prospects of many other entrepreneurs depending the common water source or body. So what is the solution? Yes, the State must play its role. That is why we have rules and regulations. The rules and regulations in aquaculture ensure the collective responsibility which is very much essential for our individual success.

Principles of Responsible Aquaculture

A) Scientific farming is the first line of defense

As a farmer you have to face a number of risks while doing the fish culture. The most important one is the threat of diseases. When you start thinking about fish farming say shrimp farming, the first advice you might have received would be about the loss someone suffered in the past from a sudden outbreak of disease. There was a time when commercial shrimp farming was almost on the verge of extinction due to viral diseases. Today we have different kinds of scientific practices (biotic and abiotic controls) that reduce the risk of diseases.

This leads us to the first lesson in responsible aquaculture. Scientific aquaculture is the first line of your defense against risks.

Scientific aquaculture comes as a package of practices. Modern scientific aquaculture is knowledge intensive. You need to have sufficient knowledge on a number of aspects of the farming. This means that you can't claim to be scientific if you have merely adopted a new technology. The success of the new technology , for example hatchery produced fingerling, depends on many other scientific practices like stocking density, water quality, nutrient status etc. You need to be aware about what factors make your pond susceptible towards diseases. You need to have knowledge about the good feeding practices. The more you understand the science or the scientific rationale behind each recommended practice the more control you can exercise over the production process.

This is especially important when you are applying chemicals like antibiotics or pro- biotics. It is often seen that many farmers use anti biotics on false notions like the effect on growth or immunity. Irrational use of anti biotics leads to the very serious problem of anti biotic resistance. There is widespread and global concern towards the ill effects of anti biotic abuse not only among humans but also among animals. The consumer is well aware about this danger. Fish consumers , especially in developed countries are doubly cautious towards this threat. The technology for detection of anti biotic residues in such countries is highly sophisticated and chances of rejection of the whole consignment are high if you are careless in export oriented aquaculture. Consumers elsewhere prefer to take shrimp as raw unlike us. This makes them more vulnerable. In fact, a decision to avoid unscientific use of anti -biotics even if there is no rejection threat is a better testimony that you are practicing responsible aquaculture.

Another aspect of scientific farming is diversification and integrated farming technologies. Availability of good quality water in required quantity is becoming a constraint in aquaculture. So we need to think about ways by which available water can be put to the best use. The research institutes under ICAR have developed a number of fish farming technologies for increasing productivity

Breed improvement, Disease detection kits, Intercropping , poly culture, multiple stocking and multiple harvesting, waste water aquaculture systems, and low cost feeds are some of such technologies. You must make use of every opportunity to get training in such advanced technologies.

b) Value chain holds the key to success

Aquaculture today is a globalised trade. And as a modern fish farmer you can not remain as an isolated player . We live in a google world. Market is no longer a place where you physically meet the seller and buyer. Like any other commodity fish is also sold "on line" these days. There is wide spread awareness on the value of the fish protein and their health benefits. The consumer is equally aware about the bad effects of fish farming when done in an irresponsible manner. The domestic consumer herself is rich in consumer power. Money and mobile connectivity define purchasing power today. Mobile phone has enabled the consumer to be equally influential on the choices they make while purchasing the fish. The concerns for food safety used to be a major factor that influenced the purchasing decision. Social media plays a big role in spreading food safety issues . You may recall the recent case of the formalin scare that happened in Kerala. The public in general today is aware and concerned about the issue of unscientific use of chemicals especially antibiotics in fish farming. By establishing that you are following Good Aquaculture Practices in your farming you can take the consumer into confidence. Institutions like KVK can act as a "trust link" between the producer and consumer through suitable arrangements. Food safety is a value addition in aquaculture .

Today consumers, especially in developed countries, are nudged to exercise their purchasing power to buy products which are ecologically benign. This has come to fish also. This is mainly done through labeling schemes like organic fish farming. Ecological safety is an emerging option of value addition. Food safety and ecological safety are going to be market access conditions soon.

c) Be aware about the environmental and social consequences of aquaculture

Though Aquaculture is able to provide fish in a world where fish from the sea is becoming less abundant it is likely to bring certain negative consequences to the environment and society. We need to be aware about these impacts and take sufficient care to avoid or reduce the bad effects.

Some of the bad consequences are listed below

A) Destruction of mangroves, wetlands and other sensitive aquatic habitats.

B) Conversion of agricultural lands (like paddy lands) into ponds for fish farming

C) Excessive use of drugs and chemicals for aquatic disease control

D) Inefficient use of fish meal and other natural resources

E) Salinization of land and water by effluents, seepage and sediment from brackish water ponds

F) Excessive use of ground water and fresh water supplies for filling the ponds

G) Spread of aquaculture diseases and culture organisms into the native population

H) Loss of biodiversity (killing of birds, invasion of non native species through escape etc.,)

I) Conflicts with other resource users and disruption of nearby communities

In conclusion we can say that by practicing responsible aquaculture you are increasing the chances of your success as an aquaculture entrepreneur. The general public or the consumer is becoming well aware about the need to be sensitive towards the health of the individual as well as the ecosystem. As a producer we need to be sensitive towards this changing value system. If you are ecologically and socially sensitive you are economically sensible too. The producer is not a mere producer she needs to be a steward of the ecosystem too. Responsible aquaculture is the way foreward.

MARINE FISH NUTRITION

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Marine fish nutrition is unique in the sense that their nutritional requirements are highest grossly compared to any livestock. Ruminants have a protein requirement of approximately 15% in the compounded cattle feed and poultry feed varies from 20-22%. For pigs it varies from 24-26%. The same in aquatic animals varies from 25 – 40%. Marine fish is known to require not only high protein in their feeds but also fat to the tune of 10% in the tropics. Since shrimp and quality marine fish fetches high price in the market, with such costly inputs these enterprises are proven to be viable financially.

Fish nutrition like any other nutrition including human nutrition encompasses the major macro nutrients which are protein, fat and carbohydrate which includes fibre also. Generally fish cannot tolerate fibre content of more than 4% in its feeds because they are also monogastric (single stomached) animals. Exceptions like grass carp and rabbit fish are there to name which can handle more fibrous feed. Fish in nature has limited access to carbohydrate and utilizes protein to meet its energy requirement. That is why their protein requirements are higher compared to terrestrial livestock. Micronutrients like vitamins and minerals are also very vital in fish nutrition also. In general fat soluble vitamins like A, D and K are available to them through the fat they consume. They can be stored because fat is stored by all animals including fish. Water soluble vitamins are not so. Day-to-day requirement has to be obtained through feed and excess gets discarded through urine. In nature as fish lives in aquatic medium water soluble vitamins are obtained by them from the water where the microbes present synthesize almost all water soluble vitamins (B-complex). The only difficulty noticed is in the case of vitamin C which may fall short of the requirements in culture conditions. This is overcome by supplementing the feed apart from the dietary allowances through inclusion of vitamin and mineral premixes with a water stable form of vitamin – C (ascorbyl polyphosphate APP) available commercially.

The fish needs to be fed only when we culture them by restricting the water volume and increasing their number per unit area (stocking density). Feeding fish with fish is not appreciated now because it is pointed out that low value fish is a source of nutrition for human beings. Using it to feed fish which costs more deprives the section of the society which cannot afford to buy high quality fish costing higher.

In such a situation, if we examine evolution of fish feeding, it started with feeding by broadcasting feed material, mainly agro-industrial by-products like oil cakes, brans and grains. Further refinement happened when they were mixed and fed, which is the beginning of compounded supplementary feeding. All this involved feed wastage. To overcome this, farmers in Andhra Pradesh started hanging gunny bags containing feed material with perforations in the pond water so that wastage of feed can be minimized has wide acceptance.

The next development in fish feeding is the use of compounded feed pellets which began with a cold pellet. Better acceptance and digestibility was acquired through a steam cooked pellet and now most of the shrimp feeds available commercially are steamed pellets and crumbles.

Most crustaceans including shrimp and lobsters prefer a

sinking pellet which can be produced using kitchen utensils at farm site. Feeds produced closer to farm sites are called farm made feeds and simple formulations with locally available raw material will be very cost effective as shown below.

Ingredients	**Parts (%)**
An animal/ marine protein source Fish, shrimp, clam, poultry by product meal	30%
A vegetable protein source Soy, ground nut oil cake, cotton seed oil cake	30
A starch source Wheat flour, tapioca flour, maida	30
Oil Fish oil if available or a mixture of vegetable oils with fish oil	5
Mineral mixture	3
Vitamin mixture	2

The starchy ingredient (wheat or any other flour) when gelatinized with water becomes sticky. The remaining ingredients can be mixed with water to obtain a dough stiff enough to be pelletized. This pellet can be sun dried or oven dried to reduce its moisture content below 10% and stored and used. This is the simplest method of producing aquatic feed. Instead of a hand pelletizer if a motorized pelletizer is used the process gets mechanized gradually.

Having stated a simple method to produce feeds, it is appropriate to have knowledge of the feed stuff than can be used for making feeds. In today's world we need not carry information physically. It is available from a website www.feedipedia.org which is a very comprehensive database of all feed materials from where we can make out whether we can use the material we have as a fish feed ingredient.

Knowledge of the feed ingredients at your disposal is the initial step in scientific feed compounding, unlike resorting to an empirical mixture given above. After narrowing down the material to be used in making the feed, the next step knowing the nutritional requirements of fish. The most scientifically authentic information will be available in NRC (2011) and a summary of what is available there for some marine fish in which our interest lies is shown below.

Item	Asian seabass Latesclcarifer	Cobia Rachycentron-canadum	Grouper Epinephelus spp.
Protein %	38	38	42
Digestible energy (kcal/g diet)	4200	4000	4000

formulation the 'Excel' way Tips to farmers/farm managers. Fishing Chimes, 23 (5). pp. 17-23.

Item	White shrimp Litopenaeus-vannamei	Tiger shrimp Penaues monodon	Spiny lobsters*
Protein %	30	34	47-53
Digestible energy (kcal/g diet)	3000	3000	-Not available

*Smith et al. (2003)

Nutrient requirements of marine fish (modified from NRC, 2011)

The requirements reported being the above, we can find commercial products (mostly imported) with more than 40% protein and 10% fat. These products are imported because, as of now, the marine fish culture or mariculture has not become a fully commercial activity in India

Coming to formulation of feed per se, it is the technique of finding out how much of each ingredient should be mixed to obtain the right mixture of nutrients to meet the optimum nutritional requirements of the fish cultured. From a simple

scenario of mixing two ingredients and arriving at the required nutrient density in the mixture, it becomes more and more complicated when more than two ingredients are used with a variety of supplements and additives. The solutions are arrived at using mathematical calculations. With the extensive use of computers calculations can be done in Excel spread sheets as well as using linear programming tool-box in MS Excel known a Solver. Apart from the above, several software and data bases are available for use. For more information please read Vijayagopal (2003).

Technologies used in fish feed production are steam pelleting and extrusion. As mentioned earlier steamed pellets are suitable only for shrimp and lobsters (crustaceans) because sinking pellets can be only produced. Extrusion came into food industry from rubber and plastic industry, for the production of, ready to eat (RTE) snacks and cereal products like corn flakes and noodles. Aquatic feed production resorted to extrusion technology for the production of floating and slow sinking feed pellets depending upon the feeding habit of the fish. These properties are imparted to the feed pellet in extrusion by passing the feed mixture through a heated barrel in which one or two screws rotate and push the feed through dies. During this process gelling of both protein and carbohydrates takes place. With the puffing of starch as in popcorn and due to formation of air pockets in the pellet makes it float. By regulating the time, temperature and material composition, other properties like slow sinking and fully sinking pellets can be also produced through extrusion. It will not be out of place to mention here that extrusion is costlier than steam pelletization mainly because the initial investment in an extruder will be ten times more than a steam plelletizer.

Most of the cultured fin fish including the Indian major carps (IMC's) prefer floating pellets. Another major advantage of using floating pellets to feed fish is that, feed wastage can be minimized to such an extent that the higher price paid for procurement of floating pellets can be offset by the cost effectiveness attained by minimising feed wastage. This is possible mainly by observing feeding carefully and stopping feeding as soon as the fish stops feeding.

Feeding rate and feeding frequencies are other activities in fish culture requiring attention in the feeding management. The

Seabass

Size (mm)	Fish weight (g)	Feeding rate % body weight per day	Feeding frequency Meals per day
2.0	5 – 20	6 – 12	3 – 4
3.5	20 – 100	4 – 6	2 – 3
5.0	100 – 250	2 – 4	2 – 3
9.0	> 250	1 – 2	1 – 2

Cobia

Size (mm)	Fish weight (g)	Feeding rate % body weight per day	Feeding frequency Meals per day
2.0	15 - 100	5 - 10	3 - 4
3.5	100 - 350	4 - 5	2 - 3
5.0	350 - 750	3 - 4	1 - 2
9.0	> 750	1 - 3	1 - 2

indicative feeding Tables below for sebass and cobia illustrate that.

The thumb rule here is, generally adult vertebrates consume 2-3% of their body weight of dry matter (excluding the water content). As evident in the Table above, during early stages of growth the consumption rates would be higher and then stabilizes at 2-3% of the body weight. This quantity fed in divided portions over a period of 24 hours constitutes the feed ration technically.

Seed and feed are the most expensive inputs in aquaculture. Investment in seed stock has to be safeguarded using careful management of the stock and maximising survival of the stock

through good water management and prevention of diseases. In open systems like sea cages, thus site selection becomes extremely important. Feed being the recurring expenditure as well as the major input has to be sourced or produced without compromising quality. Careful storage of feed and its application based on knowledge of scientific feeding practices leads to maximization growth of fish and profits thereby.

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FARM BUSINESS PLANNING AND BUDGETING FOR SMALL FISHERY AND ALLIED ENTERPRISES

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Introduction

Fishery and allied enterprises have immense scope to support the livelihoods of small holders, especially the resource-poor coastal dwellers. There are wide variety of enterprises in the sector such as fresh water and brackish water fish farms, cage culture farms, ornamental fish farms, fish hatcheries and seed production units, mussel and oyster culture farms, clam processing units, pre-processing units andfish value added products units. Like any other small-holder enterprises, success of such units depends considerably on farm planning, budgeting, accounting as well as market analysis and business development. This chapter deals with the basic accounting and economic principles and practices based on which a successful fishery-based enterprise can be operated.

Farm business planning

Farm business planning is integral to farming as it involves adoption of business methods in every phase of farm activity. It is an integrated, co-ordinated and advance programme of actions

which seek to present and opportunity to farmers to improve their level of income. A detailed farm business plan should show the enterprises to be taken up and the various practices to be followed in production, use of labour, investments to be made and other details. It enables the farmer to achieve his objective (profit maximization or cost minimization) in a more organized manner. As in crop farming, farm business planning is an important activity in fishery related enterprises as well. The following are the major rationale of farm business planning:

- Farm business planning is a necessary pre-requisite for running a profitable enterprise.
- Helps in systematic assessment of the resources in hand and schedule farm production accordingly.
- Guide to better management and future decisions.
- Helps in mid-term corrections.
- Helps in assessing production and marketing decisions.
- Aids in inventory management.
- Helps in keeping track of income and expenditure thus ensuring profitability.

Types of farm plans

a. Simple farm plan: It is adopted either for a part of the farm or for one enterprise or to substitute one resource with another. It is relative easy to implement. Changes in farm activities are generally initiated with such simple farm plans.

b. Complete or whole farm planning: This involves planning for the whole farm. Such planning is adopted either at the beginning of farming or when major changes are contemplated in existing organization of farm business.

Main elements of farm business planning

The main elements of farm business planning are the following:

- Production analysis
- Resources at hand
- What is the scale of production and product mix?
- Quantity of inputs needed
- Source of inputs and supplies
- Technology available and source
- Where is the market?
- Harvest scheduling
- Marketing strategy
- Preparation of enterprise budget - costs and earnings estimates
- Record keeping
- Cash flow and accounting
- Farm inventory analysis
- Farm efficiency measures

Farm budgeting

Budget is essentially a presentation of costs and returns accompanied by a statement showing the physical quantities of inputs and output associated with each value figure. The objective of drawing up a budget is to measure the returns expected from the plan. Farm budgeting is a method of analyzing plans for the use of resources at the command of the decision maker. In nutshell, the expression of farm plan in monetary terms by estimation of receipts, expenses, and net income is called budgeting.

The three common objectives of farm budgeting are:

a. To estimate the profitability of a particular pattern of organization.

b. To determine the change in profitsthat are likely to follow a particular change in organization, and

c. To compare different organizational patterns or alternative changes in organization on a profit basis.

Type of farm budgeting

a. Partial budgeting (Enterprise budgeting): It refers to estimating theoutcome or returns for a part of business i.e., one or few activities. In situation where relatively small modifications have to be made to existing organization, a partial budget will suffice.

b. Complete budgeting:This method is used to make out a plan for the whole farm. In situations involving extensive remodeling of the farm organization, a full budget is called for. This entails setting out all the individual costs and return items for the farm, so that overall net return is from the whole unit.

A typical example for an enterprise budget for small fishery unit is presented below.

A. Capital cost			
Cage 10m X 5m with GI frame	80,000	10	800000
Total A			800000
B. Operational Cost			
Asian Seabass seed	10000	40	400000
Pearl spot seed	2000	10	20000
Seabass feed	1344000		
Pearl spot feed	20000		
TOTAL B			1784000
C. COST-BENEFIT ANALYSIS			
C1. Annual fixed cost			
a. Depreciation on capital investment, @20%			160000
b. Insurance premium @ 2% of the capital investment			16000

c. Interest on 75% of the capital investment @12% per annum	72000
d. Administrative/Other expenses @ 1% of 75% capital investment	6000
Total Annual fixed cost C1 (a+b+c+d)	254000
C2. Annual Variable Cost	
a. Annual operational cost (B)	1784000
b. Interest on operational cost @ 12%	214080
TOTAL Annual variable cost C2 (a+b)	1998080
TOTAL OPERATIONAL COST (C1+C2)	2252080
D. INCOME	
a. Income from Sea bass production (6400 Kg @ Rs.500)	3200000
b. Income from Pearl spot production (240 Kg @ Rs.600)	144000
TOTAL INCOME	3200000
FINANCIAL ANALYSIS	
a. Operating cost	2252080
c. Total Cost	2534054
d. Gross Revenue	3200000
e. Net Operating income	947920
f. Net profit	693920
BC ratio	1.26

Estimation of depreciation

Depreciation is a method of reallocating the cost of a tangible asset over its useful life span. In other words, it re-estimates the value of a fixed asset every year taking account of its loss value due to wear and tear. It is worked as per the following example:

Cost of cage = Rs. 60,000/-
Scrap value = Rs. 5000/-
Life time of machine = 10 years
Depreciation = (60,000 – 5000)/10
= 55000/10
= Rs. 5500

Cost concepts

Cost concept approach to farm costing is used widely in India. The three cost concepts in brief, are Cost-A1; Cost-A2 and Cost C. The different cost items that are to be included under each cost concept are detailed below.

Cost A1

- Casual hired labour
- Hired machine labour
- Imputed value of own machine labour
- Feed
- Chemicals
- Seeds
- Maintenance charges
- Interest on working capital
- Depreciation

Cost A2 = Cost A1 + Rent paid for leased in land

Cost B = Cost A2 + Imputed value of owned land + Interest on owned fixed capital

Cost C = Cost B + Imputed value of family labour

Farm record keeping

Farm record keeping is a system of records written to furnish a history of business transactions with special reference to its financial side. The objective of farm records and accounts is to provide control over business and improve the management of farm.

Type of farm records

- Physical farm records
- Financial farm records
- Supplementary farm records

Physical records

- Farm map

- Land utilization records
- Production and disposal record for crops/livestock/fishery
- Labour records
- Machinery records
- Feed records
- Stock and store register

Financial records

- Farm inventory
- Cash flow statement
- Capital asset and sale register
- Cash sale register
- Credit register
- Purchase register
- Wage register

Supplementary records

- Auction register
- Hire register
- Stationary register

Cash flow statement

Cash flow statement provides the details of receipts and payments.It is prepared for a specific period. It reflects net changes in cash balance and helps to capture the progress of farm business systematically. A hypothetical example for a typical cash flow statement in a small fish farm is presented below:

Cash flow statement: An example

Balance sheet/ Inventory statement

Balance sheet is a statement of physical properties pertaining to a farm business in terms of assets and liabilities.Assets and

Date	Particulars	Expenditure	Income
1-1-2018	Purchase of seeds	10,000	
5-1-2018	Purchase of feed	15,000	
10-1-2018	Sales revenue on fish		26500
12-1-2018	Purchase of farm implements	21200	
15-1-2018	Wage payment	25,000	
25-1-2018	Rent on leased-in land	4,500	
28-1-2018	Proceeds from sale of seeds/ fingerlings		65,000
	Total for January, 2018	75700	91500
1-1-2018	Opening balance	24500	
31-1-2018	Closing balance	40,300	
	Net change in cash		15800

liabilities include fixed/ working/current. Contrary to cash flow statement, it is prepared for a point in time. Balance sheet essentially reflects net changes in inventory. It helps to capture the financial health and stability of the business. A hypothetical example for a typical balance sheet in the context of a small fish farm is presented below:

Balance sheet for a fish farm: An example

Farm efficiency measures

An important element in farm business management or decision making relates to the manner in which available resources are

Liabilities (Rs)	Value (Rs)	Assets (Rs)	Value (Rs)
Current liabilities		Current assets	
Fertilizers	5,500	Current assets	
Feeds	8,500	Cash in bank	25000
ST loan	45,000	Cash in hand	15,000
working liabilities		Grains stored	20,000
MT loan on equipment	75,000	working assets	

Insurance payments	25,000	Machinery & equipment	1,50000
Fixed liabilities		Standing fish stock	35,000
		Fixed assets	
		Land	10,00,000
Total liabilities	1,59,000	Farm sheds	2,50,000
		Total assets	14,95,000
Net worth			13,36,000

allocated. A measuring indicator is necessary to provide guides and standards for appraising accuracy of decisions regarding the use of resources. There are two broad types of efficiency measures, viz., physical efficiency measures and value efficiency measures. They can be further categorized into aggregate or absolute measures and ratio measures. Some of the farm efficiency measures widely used in the context of farm business planning are presented below:

Aggregate measures:

- Gross income = Value of main product + by-products
- Net operational income= Gross income – total operational cost
- Net profit = Gross income – (total fixed costs + total operational costs)
- Net worth = Total assets - total liabilities

Ratio measures:

- Cropping intensity = 100*(Gross cropped area / Net cropped area)
- Benefit-cost ratio (B:C Ratio) = (Present value of gross benefits)/(present value of total cost)
- Break-even point = The point where total costs equals total revenue = Fixed costs/(Price per unit- operational cost)

- Capital turnover rate = 100* (Gross income/Total value of farm assets)

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ENGINEERING TOOLS AND TECHNOLOGIES FOR FISH PROCESSING: A PROFITABLE VENTURE IN AGRI-BUSINESS

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Fisheries comprise a major economic activity within complex interactions between human beings and water - 'the first among equals' of the natural resources (Ahmed, 1992). Fisheries data assembled by the Food and Agriculture Organization (FAO) suggest that global marine fisheries catches increased to 86 million tonnes in 1996, then slightly declined. In the past three decades, employment in fisheries and aquaculture has grown at a higher rate than the growth of world population. The fishery engineering is evolving as an important domain in view of depleting stocks on both pre and post-harvest scenarios. It will also aid in fish processing technologies, optimizing energy and water use in seafood industries, mitigating climate change related issues and reducing carbon foot print. It is important to explore novel ways to obtain, quantify, and integrate industry responses to declining fishing stocks and increasing management regulations into fishery- and ecosystem-based management advice. The technological interventions help to reduce the wastage of fishes, which is otherwise a highly perishable commodity by preservation technologies and converting it into value added products with higher shelf life. Use of appropriate technologies along the fish value chain will help in producing better quality products and fetch more markets and higher price.

Major areas of technological interventions in the field of fishery engineering cover design and development of fish processing equipment and machineries, energy efficient and eco-friendly solar fish dryers, fuel efficient fishing vessels and fiberglass canoes, indigenous electronic instruments for application in harvest and post-harvest technology of fish, quality improvement of Indian fishing fleet and energy and water optimization techniques for fish processing industries. Focused areas include development of cost effective solar dryers with LPG, biomass, Infra-Red or electrical back-up heating systems, fish de-scaling machines, Fish freshness sensor etc.

1. Technologies for fish processing and value addition

Post-harvesting processing of fishes are important to reduce the wastage, increase shelf-life, add more value to the products and ensure higher returns. The major engineering interventions for fish post-harvest operations, processing and value addition are given below:

1.1 Solar dryers:Out of total catch 30-40 % of fish is dried or processed for export and local consumption. Sun drying (open air drying) is the traditional method employed in most parts of the state to dry fishery products. It denotes the exposure of a commodity to direct solar radiation and the convective power of the natural wind. This form of energy is free, renewable and abundant in any part of the world especially in tropical countries. Also it offers a cheap method of drying but often results in inferior quality of product due to its dependence of weather conditions and vulnerability to the attack of dust, dirts, rains, insects, pests, and microorganisms. Solar drying is an alternative which offers numerous advantages over the traditional method and environmentally friendly and economically viable in the developing countries. In solar drying, a structure, often of very simple construction, is used to enhance the effect of the solar radiation. Compared to the sun drying, solar dryers can generate higher air temperatures and consequential lower relative humidity, which are conducive to improved drying rates and lower final moisture content of the final products. However, there exist some problems associated with solar drying i.e. reliability of solar radiation during rainy period or cloudy days and its unavailability during night time. To overcome this limitation, an auxiliary heat source and forced convection system are recommended for assuring reliability and better control, respectively.

In a hybrid solar drying system, drying can be continued during off-sunshine hours by utilizing back up heat source and stored heat energy of daytime sunshine. In this way, drying becomes continuous process and the product is saved from possible deterioration by microbial infestation. These types of Hybrid solar dryers find useful applications in developing countries where the conventional energy sources are either scarce or expensive and the heat generating capacity of the solar system alone is not sufficient. Further, to assist the drying process (forced convection) in a hybrid dryer, a small blower is attached in between solar collector and drying chamber or inside the drying chamber which is powered by solar PV panels installed on drying chamber. Moreover, power from PV panels can be used for street lighting purpose. In addition, if the proposed setup is not used for drying purpose (kept idle), then the same can be used to draw hot water for domestic use. Therefore, in a single set up it is envisaged to have multiple utilities i.e. drying of fish, hot water and electricity generation.

Design of solar dryer varies from simple direct dryers to more complex hybrid designs. Hybrid model solar dryers are having LPG, biogas, biomass or electricity as alternate back up heating source for continuous hygienic drying of fish even under unfavourable weather conditions. ICAR-CIFT has developed different models and capacities of solar dryers for hygienic drying of fish. The capacity of these hybrid solar dryers varies from 6 to 110 m2 of tray spreading area for drying of various quantities of fish varying from 10 kg to 500 kg.

The labour requirement is considerably reduced compared to

open sun drying in beaches / coir mats because of the elimination of cleaning process due to sand and dust contamination. Re-handling process like spreading, sorting and storing because of non-drying or partial drying due to unfavourable weather conditions and spoilage due to rain is also not required. The drying time is reduced considerably with improved product quality. Improved shelf life and value addition of the product fetches higher income for the fisher folk. The eco-friendly solar drying system reduces fuel consumption and can have a significant impact in energy conservation.

ICAR-CIFT design includes small capacity dryers like solar tent dryers, natural convection dryers etc. which will be useful to dry fish hygienically during sunny days. Solar tunnel dryers, solar fish dryers with alternate electrical back up (SDE-10, SDE-20 and SDE-50) and solar fish dryers with fire wood or biomass alternate back up heating system (SDF-20, SDF-50) etc. can be efficiently used to dry fish using renewable solar energy which is abundantly and freely available. The details of solar dryers with different backup systems are given below:

(a) Solar Dryer with LPG back-up: ICAR-CIFT designed and developed a novel system for drying of fish using solar energy supported by environment friendly LPG back up (Fig.1). In this dryer during sunny days fish will be dried using solar energy and when solar radiation is not sufficient during cloudy/ rainy days, LPG back up heating system will be automatically actuated to supplement the heat requirement. In the solar fish drier with LPG back up heating system, water is heated with the help of solar vacuum tube collectors installed on the roof of the dryer and circulated through heat exchangers provided in the PUF insulated stainless steel drying chamber loaded with fish. Thus continuous drying is possible in this system without spoilage of the highly perishable commodity to obtain a good quality dried product.

This dryer is ideal for drying of fish, fruits, vegetables, spices and agro products without changing its colour and flavour. It helps to dry the products faster than open drying in the sun, by keeping the physico-chemical qualities like colour, taste and aroma of the dried food intact and with higher conservation of nutritional value. Programmable logical Controller (PLC) system can be incorporated for automatic control of temperature, humidity and drying time. Solar drying reduces fuel consumption and can have a significant impact in energy conservation.

Fig.1. CIFT Solar-LPG Dryer

(b) Solar dryer with Electrical back-up: Effective solar drying can be achieved by harnessing solar energy by specially designed solar air heating panels and proper circulation of the hot air across the SS trays loaded with fish (Fig.2). Food grade stainless steel is used for the fabrication of chamber and perforated trays which enable drying of fish in a hygienic manner. Since the drying chamber is closed, there is less chance of material spoilage by external factors. An alternate electrical back-up heating system under controlled temperature conditions enables the drying to continue even under unfavourable weather conditions like rain, cloud, non-sunny days and in night hours, so that the bacterial spoilage due to partial drying will not occur. Improved shelf life and value addition of the product fetches higher income for the fisher folk. The eco-frie ndly solar drying system reduces fuel consumption and can have a significant impact in energy conservation.

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Fig.2 CIFT Solar-Electric Dryer

(c) Solar-Biomass Hybrid dryer: A dryer working completely on renewable energy was designed and developed for eco- friendly operation. Solar Biomass Hybrid Dryer consists of well insulated and efficient solar air-heating panels, drying chamber, SS mesh trays, photo-voltaic cells, fans and biomass heating system (Fig.3). Hot air is generated by virtue of solar energy inside the heating panels and passed into the drying chamber. Continuous flow of hot air is maintained with the help of Photo Voltaic cells and fans to enable drying process. During cloudy days when sufficient solar energy is not available to maintain required temperature within the dryer, an alternate biomass heating system is manually actuated. Thus a fully green technology for fish drying is achieved by this.

Fig.3 CIFT Solar-Biomass Dryer

(d) Solar Tunnel dryer: Solar tunnel dryer utilizes solar energy as the only source of heat for drying of the products. Heat absorbing area of 8 m2 is made of polycarbonate sheet (Fig.4) . Products to be dried are placed on nylon trays of dimension 0.8X0.4 m. The dimensions of the whole drying unit is 2.21X2.10X0.60 m. The capacity of the dryer is 5 kg. Drying takes place by convection of hot air within the drying chamber. Apart from fishes, this dryer is also suitable for other agricultural products like fruits, vegetables and spices.

Fig.4 CIFT Solar-Tunnel Dryer

(e) Solar Cabinet dryer with electrical back-up: This offers a green technology supplemented by electrical back up in case of lacunae in solar radiation. The dryer consists of four drying chambers with nine trays in each chamber (Fig.5). The trays made of food grade stainless steel are stacked one over the other with spacing of 10 cm. The perforated trays accomplish a through flow drying pattern within the dryer which enhances drying rates. Solar flat plate collectors with an area of 7 m2 transmit solar energy to the air flowing through the collector which is then directed to the drying chamber. The capacity of the dryer is 40 kg. Electrical back up comes into role once the desired temperature is not attained for the drying process, particularly during rainy or cloudy days.

Fig.5. CIFT Solar-Cabinet Dryer with Electrical back-up

(f) Infrared drying – CIFT has recently developed an Infra Red (IR) dryer heat transfer is happening by radiation between a hot element (infrared lamps) and a material (to be dried). Thermal radiation is considered to be infrared in the electromagnetic spectrum between the wavelength of 0.78 μm and 1000 μm. Infrared emitters offer efficient heat and much more advantages compared to other conventional heat technologies:

- No direct contact with the product
- High drying/heating rate
- Infrared radiation can be focused where it is needed in a defined time,
- Cost savings thanks to high overall efficiency and optimal infrared heaters lifetime.

1.2 Fish Descaling Machines

(a) Fish descaling machine with variable drum speed: Fish de-scaling machine is designed and fabricated for removing the scales of fishes easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardine, Tilapia to Rohu. The machine is made of SS 304 and has 10 kg capacity. It contains a 1.5 HP induction motor and a Variable Frequency Drive (VFD) to vary the speed of the drum depending on the variety of the fish loaded. The drum is made of perforated SS 304 sheet fitted in a strong SS Frame. Water inlet facility is provided in the drum for easy removal of the scales from the drum so that area of contact to the surface will be more for removal of scales. The water outlet is also provided to remove scales and water from the machine. An Electronic RPM meter was attached with the de-scaling machine which directly displays the RPM of the drum. Speed of the drum is a factor influencing the efficiency. The machine takes only 3-5 minutes to clean 10 kg fish depending on the size.

Fig.6 Fish de-scaling machine with variable drum speed

(b) Fish de-scaling machine with fixed drum speed- table top: Fish de-scaling machine is designed and fabricated for removing the scales of fishes easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardine, Tilapia to Rohu. This machine is made of SS 304 and has 5 kg capacity. It contains a 0.5 HP AC motor with proper belt reduction mechanism to achieve required drum speed of 20-30 rpm. Body is fabricated in dismantling type one-inch square SS tube with a suitable covering in the electrical parts. The drum is made of perforated SS sheet fitted in a strong SS Frame having suitable projections to remove the scale and provided with a leak proof door with suitable lock.

(c) Fish de-scaling machine hand operated: Fish de-scaling machine is designed and fabricated for removing the scales of fishes easily. This equipment can remove scales from almost all types/sizes/ species of fishes ranging from marine to freshwater species like Sardine, Tilapia to Rohu (Fig.7). This machine is made of SS 304 and has 5 kg capacity. Body is fabricated in dismantling type 1 inch square SS tube. The drum of 255.5 mm diameter and 270 mm length is made of perforated SS sheet fitted in a strong SS Frame having suitable projections to remove the scale and provided with a leak proof door with suitable lock. A pedal is fitted in the side to rotate the drum manually.

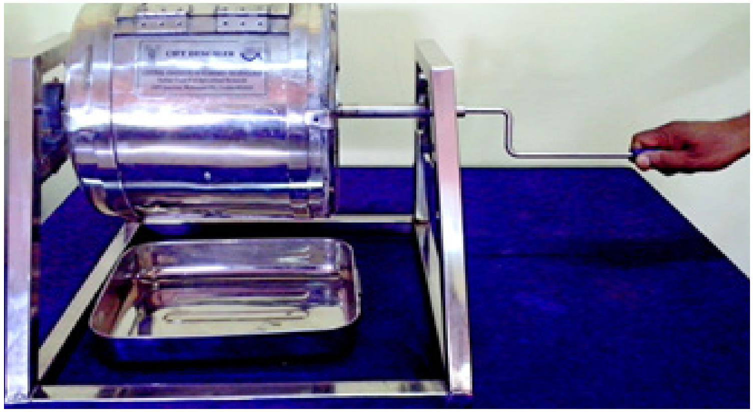

Fig.7 Fish de-scaling machine hand operated

1.3 Fish meat bone separator: A Fish Meat Bone Separator with variable frequency drive (VFD) to separate pin bones from freshwater fishes was designed and developed. This can be used at a range of 5-100 rpm. With a unique belt tighten system developed; the new machine can be easily adapted to any species and need not be customised for specimen during design stage. In existing imported models, only two speeds are possible which restricts the yield efficiency in a single span operation and also limits easy switching of the system for utilising specimen other than for which the yield has been originally customised. The meat yield of this machine was about 60% against 35% in imported models. Capacity of the machine is 100kg/hour.

1.4 Modern Hygienic Mobile fish vending kiosk: Most of the fisher folk across India sell fish in an open basket without any hygienic practices. The fish is kept in an open bag or container, it loses its freshness.They use ice purchased at high cost for temporary preservation and at the end of the day, if the fish is not sold, they give it at a low rate to customers with little or no profit. More over fish gets contaminated under unhygienic handling practices. The fish vending persons, especially women folk find it difficult to carry the fishes as head load and subsequently sell it in the local markets or consumer doorsteps. In this context, the ICAR-CIFT have designed and developed a mobile fish vending kiosk for selling fish in the closed chilled chamber under hygienic conditions at consumer doorstep.

The major advantages of the new Kiosk are as follows:

- The mobile kiosk was designed considering the maximum weight that a man pulls on rickshaw.
- The mobile unit is mounted on frame with wheels at the bottom. The kiosk can carry 100kg fish with 20kg under chilled storage display in glass chamber and remaining in insulated ice box (developed by CIFT).
- The main components of the kiosk are fish storage & display chilled glass chamber, hand operated descaling machine and fish dressing deck with wash basin, water tank, cutting tool,

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waste collection chamber and working space.

- The vending unit has been fabricated mainly using stainless steel (SS 304 Food Grade) and frame and supports are made with MS and GI sheets.
- The kiosk main part i.e chilling unit & display for fish storage which was envisaged to power by solar energy through solar PV cells,however presently powered by AC current.
- The stored fish is covered with transparent glass cover through which consumer can see the fishes and select according to their choice of purchase.
- Kiosk is attached with hand operated descaling machine for removal of scales. The fishes coming out of descaler is free of scales, dirt or slime.
- It also reduces human drudgery and avoids cross contamination, consumes lesser time. Fish dressing deck with wash basin also designed conveniently to prepare fresh clean fish under hygienic conditions.

Chilling of fish using electricity/PV cells or by adding large quantity of iceadds to cost to the selling price. Since this technology has well insulated storage space for fish with provisions for refrigeration, it reduces the ice melting rate and its cost, thereby reducing the selling price. The unit also extends the keeping quality of fish for 4- 5 days and increases marginal benefit to fish vendors. It also helps change the practice of unhygienic handling and marketing of fish.

1.5 Electronics and Instrumentation:

ICAR-CIFT identified the vast scope of electronics and instrumentation for fisheries technological investigations and started research and development activities. This resulted in a series of instruments for systematic monitoring, analysis and assessment of the marine environment including the performance of the machineries used for harvesting the resources and post-harvest technology. Basic technologies developed in ICAR-CIFT include more than five dozens of electronic instruments with fully indigenous technology and more than 50 sensors with novel features and designs. The notable achievement is the development of indigenous sensors, which are rugged to withstand hostile marine environment and enable us to monitor field data from remote areas. The total instrumentation is built up around these sensors, with required electronics, new signal processors and other peripherals for solid-state data storing, compatibility to PC, wireless transmission to distant points etc.

Some of the instruments, which has got great attention and acceptance are as follows: environmental data acquisition system, freezer temperature monitor, salinity temperature depth meter, hydro meteorological data acquisition system, warp load meter, solar radiation monitor and integrator, ship borne data acquisition system, water level recorder, ocean current meter, remote operated soil moisture meter, water activity meter, rheometer and micro algae concentration monitor. Since the instruments are designed to be compatible with computer and solid-state memory module, the information can be stored for long duration and retrieved at our convenience.

By effective use of efficient and appropriate engineering technologies which are cost-effective, adaptable and environment friendly, the fishermen community as well as seafood industry can reduce the harvest and post-harvest expenses and losses, add more value to the products, ensure better fish value chain dynamics and thereby obtain more income. The use of green and clean technologies also ensures less carbon and water foot prints.

2. Commercialization and Agri-Business Incubation

Agri-Business Incubators (ABI) open new entry points in the agricultural value chains, which in turn can use to access new markets. They afford leverage through these entry points to accelerate agricultural development and offer the unique potential to develop small and medium-sized enterprises (SME's) which can add value along these chains in ways which other development tools do not offer. There is no single "right

way" to perform agribusiness incubation. Rather the work of agribusiness incubation depends on the state of development of the agribusiness ecosystem and changes over time as that ecosystem matures and develops. In its earliest phases, incubators demonstrate the viability of new business models and look to create and capture additional value from primary agricultural products. In underdeveloped agricultural economies, incubators help by strengthening and facilitating linkages between enterprises and new commercial opportunities. They open new windows on technologies appropriate to agribusiness enterprises and help agricultural enterprises discover new, potentially more competitive ways of doing business. In subsequent phases of development, incubators operate as network facilitators: they link specialized service providers to agribusinesses and link separate agribusinesses to one another. Finally, in a more advanced state of business development, incubators operate as conduits for the exchange of technology, products, inputs and management methods across national borders.

A more pragmatic system for business incubation and promoting start-up companies with respect to agricultural technologies have been evolved in recent times within the ICAR-CIFT.The Agri-Business Incubation (ABI) center along with Institute Technology Management Unit (ITMU) seeks to provide business consulting services to agriculture-related businesses and helps to develop a strategic business plan. ABIs facilities for incubation of new business ideas based on new agricultural technologies by providing cheap space, facilities and required information and research inputs. The Agribusiness Incubator Program also seeks to provide business consulting services to agriculture-related businesses and helps to develop a strategic business plan.

The Engineering Division of ICAR-CIFT has commercialized its technologies like solar fish dryers, fish descaling machines, refrigeration enabled fish vending machines etc through the ABI. In the financial year 207-18 itself, two entrepreneurs have taken up Solar fish drying technology and three start-ups came up by establishing CIFT designed fish vending kiosks. Three firms fish descaling machines were also successfully handed over to sea-food industries located both in Andhra Pradesh and Kerala. Apart from these, 10 numbers of fish dryers of 10 kg capacity were distributed among women SHG groups located in Kerala, Manipur and Assam for demonstration purposes. Furthermore, 3 incubatees(one physical and two virtual) have already registered under ABI in the current year for using engineering technologies.

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EDIBLE OYSTERS - BASICS OF FARMING AND ITS WEALTH IN HEALTH BENEFITS

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Overview

Oysters, "Janitors" in the aquatic ecosystem is also a palatine food. This bivalve mollusc is protected by two calcareous shells,rich in calcium carbonate and strontium. The animal is attached to the hard substratum with the cementing material produced by the animal itself.

Globally, China the lead producer of oysters (Crassostrea spp. 3948817 metric tonnes, FAO 2014).In India its popularity is so limited but in the beginning of 20thcentury the scenario has changed due to the implementation and commercialization of oyster farming in the country by Central Marine Fisheries Research Institute (CMFRI) through a World Bank aided NAIP project. Its collateral efforts with State Fisheries make this farming a popular and profitable aquaculture practice along the coastal States of India especially in Kerala and Maharashtra.

In India Crassostreamadrasensis, the major species contributing to the fisheries and its commercial production was started in Ashtamudi Lake in Kerala (1995). The initial production was 2 tonnes but now the production has reached 4045 tonnes (2016).

Farming methods

They are broadly grouped as bottom (on bottom) culture and off-bottom culture. Raft, rack, long-line and stake are used in the various off-bottom culture practices. In India, rack and ren method is the popularized technology in estuaries. The off-bottom culture methods are advantageous over the bottom culture in the following respects.

1. Relatively rapid growth and good meat yield
2. Facilitate three-dimensional utilization of the culture area
3. The biological functions of the oyster such as filtration feeding etc. are carried out independent of the tidal flow
4. Silting and predatory problems are negligible
5. Metal and bacterial accumulation is less

Culture technology and economics

Edible oyster culture is a very simple technology, which can be easily practiced. There are a few critical factors (such as seed collection and harvesting period) which are governed by the biology of the species which affect the profit of the farming operations. The farmer can easily understand these aspects by observation and practice. In India the proved oyster farming is rack and ren method in estuaries and backwaters. The investment details are given in Table 1.

Table 1: Economics for a model oyster farm

Economics for a model oyster farm for 3 years

Farming method	- Rack	Oyster farm	- 5 m X 5 m
Water body	- Estuary	No. of ren	- 300
		Duration	- 7 months

I. Fixed cost (Material cost)				
Sl.no	Item	Qty	Rate	Total
		Kg / nos	(Rs)	(Rs)
1	Bamboo poles	19	350	6650
2	Rope (for farm construction) 3mm	2	280	560
3	Rope (for ren making) 3mm	6	280	1680
	Total			8890
	Depreciation 33%			2934
II. Recurring cost				
1	Cost of shells for ren making	1500	1	1500
2	Ren making charges	300	5	1500
3	Farm construction charges	3	1250	3750
4	Installation of spat settler	300	5	1500
5	Labour charges for harvest	6	1000	6000
6	Cannoe hire charge	5	300	1500
7	Depuration charge	1440	10	14400
8	Shell on (Single oyster de-clumping)	1500	1	1500
	Total			31650
III. Marketing expense (shucked meat)				
1	Shucking charge	67	75	5025
2	Marketing charges for shucked meat	67	25	1675
3	Fuel charge (LPG)	1	2700	2700
	Total			9400
	Total input cost =I + II + III =2934 + 33150 + 9540 = 45624			
IV. Total yield				
	Shell on	4.8 kg / ren	300 ren	1440kg
	Single oyster	5nos/ ren	300 ren	1500 nos
	Meat * 5.2% of 1290 kg**(67kg)			
V. Gross revenue				
	Single oyster	1500	30	45000
	Heat shucked meat	67	500	33500
	Total			78500

NET PROFIT 78,500 - 45,624 = 32,876

* Meat percentage may vary according to the waterbody and climatic variations
* *After deducting single oyster weight

Seed Collection

Oyster seed are collected from estuaries by placing suitable collectors called cultch in the water column at appropriate period. During spawning seasons the spat collectors are suspended from racks.

How to prepare a cultch?

Cultch is the term used for spat / seed collector. For suspended method of oyster culture cutch made of oyster shells have been found to be ideal. Empty oyster shells are cleaned manually to remove the foulers and then washed to remove silt. A small hole is made on the shell and these are strung on 3mm dia nylon rope with a spacing of 15 to 20 cm between each shell (5 shells per meter rope). Such strings are called ren. The spaced rens can be used as such for grow out system. For seed collection purposes the shells are strung continuously without spacers (10 to 15 shells per meter) and after the attachment of seed they shells can be removed and restrung at the rate of 5 shells per meter which is the ideal density for grow out.

If the oysters are to be grown by the tray method then empty shells or lime coated tiles can be placed in the trays for seed collection. Lime coated tiles gave encouraging results and on a single tile, as many as 120 larvae are known to settle.

When to place the cultch for seed collection?

One of the main factors that determine the success of the farming operation is the period when the clutches are placed for seed collection. If they are laid in advance of spatfall, they may be covered with silt or settlement of foulers , making them unsuitable for the oyster larvae to settle. The larval period in C. madrasensis is 15-20 days. The ideal time for laying the spat collectors in the

water is about 7 -10 days after peak spawning (as determined by gonad examination and abundance of early larval stages in the plankton). Strong currents interfere with larval settlement and may result in poor spat collection. The water quality parameters for oyster farming are given in the following table (Table 2).

Live consumption

As an excellent appetizer and to know the salty taste of oysters—you'll need to open them up by shucking the "depurated" oysters (use a thick towel and oyster shucking knife).

Depuration

The process of expelling contaminants from gills and guts

Water quality indices	Desired level
Physical	
Temperature	25-34°C
Transparency	50 -150 cm
Chemical	
Salinity	15 -38 psu
pH	6.5 - 8.5
DO	5-10 mgL-1
Total ammonia	0.01 – 0.1 mgL-1
Nitrite	<0.5 mgL-1
Nitrate	0.1 – 3 mgL-1
Phosphate	0.05 – 0.5 mgL-1
Biological	
GPP	0.5 - 3mgCL-1
NPP	1 – 2.5 mgL-1
BOD	2 -5 mgL-1
Chlorophyll	10 – 15 mgL-1
Seston / TPM	25- 30 mgL-1

Table 2: Criteria for site selection

of oysters by providing them with good purified seawater before they are used for consumption is called depuration.

Why oysters are so good for US ?

"Milk of the Ocean"

Oystersare rich in protein, lipids, carbohydrates, minerals (calcium, **iron**,copper,zinc, phosphorus) and vitamins (A,D,C,D&K) (Table 3). Oyster diet will increase your intelligence and learning abilities if introduced in childhood.

Brain food and Happy mood

They are good sources of Vitamin B 12, Omega 3 fats, iron and zinc, which boost memory and brain functioning. Proteins in oysters are high in tyrosine, an amino acid that is used by the brain to help in regulating mood and adapting to stress.

Dementia or alzheimers

Zn reduce age related mascular degeneration, and increase immunity (more in oysters)

Bone Health

The high level of calcium, phosphorus, **zinc**, iron, copper and **selenium** all contribute in their own way to increasing bone mineral density and durability, thereby protecting from developing conditions like osteoporosis.

Wound Healing and Immunity

High levels of zinc in oysters can give us quick **wound healing** and a **strong immune system**

Heart Health

Omega-3 fatty acids reduce the chances of plaque accumulation thereby reducing the risk of arteriosclerosis. The **potassium and magnesium** content of oysters help in **lowering blood pressure** by relaxing the blood vessels. A rich natural source of zinc, maintaining sense of taste and smell and inhibiting the abnormal clotting that contributes to cardiovascular disease.

Blood Circulation

Rich in **iron,** which is a key component of haemoglobin that carries oxygen to the cells. A steady supply of oxygen makes the various organ systems function efficiently and **boosts the overall metabolic rate** of the body.

Do you want to become a Casanova / Cleopatra

Oysters are rich in amino acid and zinc they are known as aphrodisiacs for triggering increased level of sex hormones, testosterone and estrogen.

Glowing skin

Including oysters in your diet helps maintaining collagen levels in the skin. This enables the skin to retain its elasticity and firmness and delay the onset of wrinkles.

Food for all

Oysters are low in fat, cholesterol and calories and can thus be enjoyed by everyone, if consumed in moderation.

Table 3.Nutritional facts(Source:http;//nutritiondata.self.com)

Serving size 25g	
Calories	40.8
Nutrition facts	
Carbohydrates	
Total Carbohydrates	2.5 g
Fats and fatty acids	
Total Fat	1.1 g
Saturated fat	0.3 g
Monounsaturated fat	0.2 g
Polyunsaturated fat	0.4 g
Omega -3- fatty acids	370mg
Omega -6- fatty acids	16.0 mg
Protein and aminoacids	

Protein	4.7
Vitamins	
Vitamin A	122 IU
Vitamin C	3.2 mg
Vitamin E	0.2 mg
Riboflavin	0.1 mg
Niacin	0.9 mg
Folate	3.7 mcg
Vitamin B12	7.2 mcg
Pantothenic acid	0.2 mg
Minerals	
Calcium	4.0 mg
Iron	2.3 mg
Magnesium	11.0 mg
Manganese	0.3 mg
Phosphorus	60.8 mg
Potassium	75.5 mg
Sodium	53.0 mg
Zinc	8.3 mg
Selenium	38.5 mcg
Sterols	
Cholesterol	25 mg
Others	
Water	16.0 g
Ash	0.6 g

"Let your food be your medicine" — Hippocrates

FISH WASTE MANAGEMENT: TURNING FISH WASTE INTO HEALTHY FERTILIZER

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Introduction

In recent decades there has been a constant increase in global populationwhich generates the gigantic challenge of providing food and livelihoods to a population well of greater than 9 billion people by the middle of twenty-first century (FAO, 2018). Fisheries sector plays a key role in providingfoodsafety and employment formany people. Global fish production has touched about 171 million tonnesby 2016 (FAO, 2018) and further increase in fish production through growing aquaculture industry is expected in coming decades. On contrast, of the overall worldwide fish production, almost 75% is only used for human consumption (FAO, 2007).The abandons from the world's fisheries exceed 20 million tons annually(equivalent to 25% of total production) which include "non-target" species, fish processing wastes and by-products. Most of these are simply disposed off in landfills, by incineration, or dumping at sea or lands.Considering the high organic content fish waste is categorized as "certified waste" that is even more costly to dispose. Management of fish waste is coming under increased scrutiny to environmental issues

(Jesperson et al., 2000) and is an emergingalarm and cost burden to whole fish industry (Anon, 2002).Considering the present and future intensity of fish production, the ultimate disposal of fish waste willturn out to be a serious problem for environment. Utilization of fish wastes help to eliminate harmful environmental aspects and improve the income for fish farmers, demanding the criticalnecessity to find ecologically acceptable means for reutilization of these wastes.

The burden of fish waste in India

Fisheries is an important economic activity in India and presently, the country occupies the second position globally in whole fish production with annual production of about 11.41 million tonnesduring 2016-17.Fishery sector funds about 0.9% to National GDP and 5.17% to agriculture GDP (DADF, 2016). Theimpactmight have been much improved if fish wastes and byproducts had been effectively utilized (Jayathilakan et al., 2012). Fish markets and fish processing industries of India generates enormous quantities of discarded fish waste which are presently considered as loss and discarded without recovery of any useful product (Nurdiyana and Mazlina, 2009). It is estimated that India generates >2 metric million tons of waste from fish processing plants only (Mahendrakar, 2000).Among various maritime states, the largest amount of fish wastes were found to be produced from Gujarat (30.51%) followed by Maharashtra (23%) and Kerala (17.5%) (Zynudheen, 2008). As these wastes are rich in nutrients, unless efficientlymanaged, are likely to be dumped in environment making pollution and health related complications (Selvi et al., 2014). Adverse environmental effects associated with fish waste include, accumulations of waste sludge and whole fish parts in near-shore locations, generation of toxic hydrogen sulfide, ammoniaand greenhouse gases such as carbon dioxide and methane (Tchoukanova et al., 2012), increased gathering of scavengers in discharge locations and noxious conditions caused by odours, bacteria and waste decomposition (U.S. Environmental Protection Agency Report, 2010). Similarly, if fish wastes are discarded in ocean itself, aerobic bacteria of water decompose

these organic matter using oxygen so that a considerable reduction of oxygen in water occurs. Apart from the release of toxic gases, the waste also overloads nitrogen, phosphorous and ammonia, leading to pH variation increased turbidity of water resulting in low productivity. Apart from increased phytoplankton production, eutrophication can cause many other effects such aschanges in energy and nutrient fluxes, pelagic and benthic biomass and community structure, fish stocks, sedimentation and nutrient cycling (Fang et al., 2004). Besides, inadequate handling of fish waste can have serious consequences to human health such as contamination of water supply, increasedincidences and spread of many infectiousdiseases, deterioration groundwater and other local ecosystemsetc.

Fish waste management and utilization for by-products

An important waste reduction strategy is the recovery of marketable byproducts and value-added products through bioconversion from fish wastes. The common methods for fish waste utilization include production of organic fertilizers, animal feeds (especially fish, swine and poultry feed) and feed supplements (fish oil, fishmeal, fish silage, calcium supplements), source of biodiesel and biogas, extraction of natural pigments, industrial enzymes (proteases, alkaline phosphatase, hyaluronidase, acetylglucosaminidase and chitinase), cosmetics, pharmaceutical products such as collagen, fish bone extracts, and polyunsaturated fatty acids. Fish protein hydrolysate can be used as a milk replacer and food flavoring agent. Other options includes production of short-chain organic fatty acids, substrates for microbial culture media, production of attractants for economically important flies, production of surgical sutures from fish gutand use of fish scales as natural adsorbents, in ornamental uses and organic wastewater coagulant for sedimentation of small particles, fish glue production from fish skin and heads (Gumisiriza et al., 2009).

Bioconversion into plant fertilizer by composting

High concentration of nitrogen, phosphorus and sulphur in fish waste marks its potential to be used as a plant fertilizer.

However, its sensory characteristics, especially due to odoriferous nitrogen and sulphurcompounds work against this use. Biological management known as composting can be the most cost effective, environment friendly method for bioconversion of fish waste into valuable organic fertilizers (Coker, 2006). Composting is the biological conversion of waste materials, under controlled conditions, into a hygienic, humus rich, relatively biostable product that conditions soils and nourishes plants (Mathur, 1991) Fish wastes have some specific characteristics that could affect the success of a composting operation and if these relevant features are considered during composting process, it may result in a unique composting performance and superior quality organic fertilizer that are different from other waste materials.

General characteristics of fish wastes

Fish frames, guts, heads and fins generally constitute the largest quantity of seafood wastes from finfish. The only difference in shell fish waste from fin fish waste is that it contains large amount of chitin due to the presence of shell residues. Compared to other organic wastes, fish waste contains a large amount of readily digestible protein and release ammonia and H2S during composting process (Selvi et al., 2014). Moreover, release of ammonia and other nitrogen-containing gases will make the process meaningless as the main element contributed by protein i.e. nitrogen, will be lost in the gas. Therefore, conversion of ammonia and sulphur compounds into plant utilizable forms the major target during composting of fish waste. The high salinity of sea food waste and high chitin content due to shell residues of shell fish (Hu et al., 2009) also have to be taken consideration during composting process. Another characteristic of protein rich composting mixtures is that, it tends to have a low C/N ratio. Hence, another main ingredient known as "bulking agent" is required for an adequate carbon to nitrogen ratio (Frederick et al., 1989; Imbeah, 1998). Examples for bulking agents include forestry and wood processing wastes (such as size-reduced or shredded brush, bark, wood chips, sawdust), agricultural wastes, and peat. Rapid release of ammonia from protein degradation of

seafood wastes and of calcium from fish bones, tends to shift the pH of the compost mixture towards the alkaline range. Therefore, if the bulking agent employed has some acidic characteristics, it can contribute to decrease its pH.Another requisite for the bulk agent is water absorbing character, as seafood wastes generally tend to have high moisture contents (Mathur et al., 1986).

Operational parameters in composting process

1. Aeration: Presence of air as a supplier of oxygen is needed for the multiplication and other metabolic activities of many aerobic microbes responsible for bioconversion. An insufficient supply of oxygen will lead to the adoption of anaerobic degradation processes ultimately leading to the release of malodorous gases. Aeration also helps to preserve an adequate moisture level and to control temperature by dissipating the heat generated in degradation reactions. On contrast, excessive aeration result in low temperatures unsuitable for the composting process and, also will dry out the mixture. It is recommended to turn the compost pile weekly during the first two months and every 15 days during the last two months if total composting period is 4 months.

2. Carbon to nitrogen ratio (C: N): To maintain an active microbial population in a composting process, available carbon to nitrogen ratio should be kept at appropriate levels. Lower ratios will result in losses of nitrogenous compounds, Whereas, higher ratios will delay the composting process (Inbar et al., 1991)

3. Moisture level: Hobson and Wheatley (1993) indicated that optimum moisture range for composting operations is 40-60% to 20% oxygen. Water is essential to the viability of microbial populations and is a medium for the bioconversion reactions in compost mixture. While low moisture levels will affect the speed of degradation in compost, flooding of compost site will interfere with the gas exchange required in aerobic processes.

4. Temperature: Influences type of microbial population and bioconversion rates in composting process. It also sanitizes the compost. A temperature of 130-150° F or 54-65° C for three successive days is generally recommended.
5. pH:A pH of 6-8.5 is generally recommended for good composting performance. Release of carbon dioxide and ammonia during degradation of protein rich wastes such as fish waste will impart acidic and alkaline characteristics respectively, which tend to neutralize pH value of compost without the need for external modification (Haug, 1993).

Major processes that occur during composting process of fish waste include

Process	Requirement	Impact
Carbon dioxide production	Appropriate carbon to nitrogen ratio	Able to enhance soil conditions
Heat generation	Appropriate moisture content. Raise in temperature stops when the composting process is finalized	Improve nutrient content. Pasteurize the compost
Microbial degradation of organic matter	Appropriate pH and microbes	Improve nutrient content
Oxidation reactions a. Ammonia oxidation b. Nitrite oxidation c. Suplhur oxidation d. Phosphate solubilization	Solid state and specific microbes	Improve nutrient quality and removes bad odour

A glance on reactions during composting process

Settingup a composting facility: The composting facility should be located a sufficient distance from residential areas to ensure protection from odours (EPA, 1996) and at least 100 metres from surface waters. The compost area must be placed on an impermeable base (such as concrete) that is graded to ensure runoff and leachate drains to a collection tank or pit of sufficient size to prevent overflow.

Minimization of odour: Anaerobic conditions settled within the compost piles are the major reason for odourformation from fish waste composting facilities. Under aerobic conditions, the main gas generated from composting is odourless carbon dioxide, while under anaerobiasis, odorous gases (ammonia, methane and hydrogen sulphide), organic sulphides and volatile fatty acids are produced. Odours can be reduced by includingfish wastes into composting method on the similar day of their production.Together, odour management needspreservation of aerobic conditions by regular turning of compost pile or using any ventilation facilities. Odour can be further minimized by keepingthe appropriate carbon to nitrogen ratio in compost.

Minimization of dust formation: Dust is generallyproduced by the movements of dry materials by machinery, wind, trucks and other equipment which can be effectively managed by light water spraying. Although dust production is improbable due to high water content of compost, its occurrence can be taken as a sign of inadequate moisture in compost.

Assembly of compost windrows: Two simple requirements for composting fish waste are a source of carbon (wood chips, bark, sawdust, leaves etc.) and a source of nitrogen (from fish waste). A simple formula is adding three or two parts carbon to one part of nitrogen. In simpler words, while composting, the fish waste is mixed with plant waste and after complete composting process, a nutrient wealthy fertilizer for soil amendment will be formed. The compost pile may vary in size according to available space; the minimum recommendation for productive degradation is approximately, 10 cubic feet, or 3 feet × 3 feet × 3 feet. For very small volumes of waste, an ordinary compost bin can be used for composting. The base of compost windrow is formed by establishing a 200 mm thick base layer of any source of absorbent material (such as sawdust). Upon this base, alternating layers of fish waste and sawdust are added in a volume ratio of 1:2 of fish waste to sawdust. Such windrows can be up to 3 mwidth and 1.5 mheight. When the full height of the windrow is reached, it may be extended lengthwise. Compost pile must be capped with a 150 mm deep layer of new sawdust or mature compostas the thick outer-covering layer will reduce odours, flies and birds. It is essential that all fish wastes are completely covered with sawdust and kept within the pile. Approximately 2 tonnes of fish waste will create a compost windrow measuring 3 m wide by 10 m long containing four layers of waste.If abundant sawdust is available, using additional sawdust results in compost that is highly absorbent and can be re-used along with new sawdust in subsequent piles. Seasonal effects can influence the relative amounts of fish wastes and sawdust required. In rainy periods, extra sawdust should be added to increase absorbency while slightly less sawdust may be necessary during dry periods.

Compost windrows should be left uncovered to maintain aeration and suitable moisture levels within the pile. Depending on the structure of the pile and the type of materials used, unturned compost will sufficiently mature to spread over pasture or gardens in about one year. Turning the compost windrow three to four times will help maintain an even temperature throughout and will hasten the decomposition process. To reduce the spread of odours downwind from the composting site, avoid turning windrows on windy days. A temperature greater than 55oC should be maintained throughout the windrow for at least three consecutive days to prevent proliferation of pathogens (EPA, 1996).Once the compost was considered mature, it is sieved using a 20- mm mesh screen.

Role of microorganisms in composting

The biological phase of the operationcomprises microbes

involved in various reactions and hydrolytic enzymes present in plant materials and animal tissues. It is the biological phase thatregulates the outcome of whole process. Even though the degrading enzymes present in fish viscera are significant, theycan work only at the beginning of composting process, as enzymes will be inhibited and damaged as biological degradation process. Consequently, microbes remain as the main contributor to the composting method. Therefore, utilization of metabolic versatility of beneficial microbes is valuable in fish waste composting, as the actual number of degraders in natural composting process denotes only 5-10% of whole microbial community (Sayler et al., 1984). Therefore, conventional composting without using competent microbial consortium tends to very tiresome, less efficient and may result in less valuable soil amendment. An easier mode to achieve beneficial microbes is addition of small amount of not totally matured compost from a different composting process.

Microbes for turning fish waste to fertilizer

Microbes play a crucial role by acting as a bridge that connects fish waste to fertilizers. Numerous studies have shown that insufficient quantity or biological activities of the indigenous microbes might lead to undesirable composting proficiency, while strengthening indigenous microbes through application of beneficial microbes can improve the composting process (Wei et al., 2016a; Xi et al., 2015). Microbial consortiathat are essential for transformation of fish waste to fertilizer should include

1. Ammonia oxidizing bacteria
2. Nitrite oxidizing bacteria
3. Sulphur oxidizing bacteria
4. Proteolytic bacteria
5. Chitinolytic bacteria
6. Lipolytic bacteria
7. Phosphate solubilizing bacteria

Altogether, these bacteria degrades the organic matter in fish waste, removes toxic components and transform various components in to accessible plant nutrients. As fishwaste contains huge quantities of ammonia that is toxic to plants, conversion of ammonia to nitrite by ammonia-oxidizing bacteria is an essential step in composting. Further oxidation of nitrite to nitrate, the form of nitrogen mainly assimilated by plants through nitrite oxidizing bacteria is also another essential step. As ammonia oxidation is often the rate-limiting step during composting process, addition of AOB and NOB, as well as providing favorable conditions for the activity of ammonia-oxidizing bacteria can improve the quality of the compost product. Sulphur is now being recognized as the fourth major nutrient for plants in addition to nitrogen, phosphorus and potassium. The action of sulphur oxidizing bacteria in compost results in the formation of sulphate, which can be used by the plants, while the acidity produced by oxidation helps to solubilize plant nutrients and improves alkali soils (Vidyalakshmi et al., 2009). Thus addition of SOB during composting also have the potential to improve the quality of final product as a soil ammendment. Similarly, many bacteria and fungi are able to improve plant growth by solubilizing sparingly soluble inorganic and organic phosphates and these are named as Phosphate-solubilizing bacteria (Delvasto et al., 2006). Therefore, the use of phosphate-solubilizing microbial inoculants in agricultural practice would not only offset the high cost of manufacturing phosphatic fertilizers but would also mobilize insoluble phosphorus in the fertilizers and soils to which they are applied. Additionally, use of microbes that can degrade the organic components of fish waste namely, protein, lipid, chitin and cellulose of bulking materials may be the best option for the efficient conversion of fish waste to a valuable fertilizer in near future.

FARM DATA RECORDING, READING AND UNDERSTANDING MANUALS

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Introduction

The modern day farming is considered as an enterprise. If it is considered as an enterprise , the modern day farmer is an entrepreneur or a business man. Farmer entrepreneur has tasks such as monitoring farm income , making outside transactions and keeping track of the farm supplies. Farmer must employ Key tools and methods in order to keep track of and manage his business.

The need for farm records and accounting

Farm management is concerned with the process of decision making by the farmers. It also embraces the application of physical and biological sciences in keeping with the economics of profitable resource allocation and maximization of farmers net income and welfare goals. Farm records and account keeping are the pre requisites for effective farm management and the back bone of farm enterprises aiming at profit maximization or any other goals. Farm records and accounts are not usually written down by small or peasant farmers , but some kind of mental record keeping and accounting is done.

Hence there is a need to encourage the documentation , even at the small farm level , of activities on the farm as well as the expenses and returns in physical as well as monetary terms in which the framework of a general farmer education programme.

Types of farm records and accounts

The farm records which a good farmer should keep are

i. Income and expenditure or Receipts and payments or cash returns– Which gives a clear picture of financial performance of the enterprise. Interim corrective measures are possible and further upscaling , downsizing of the enterprises are possible only if the farmer has clear cut income and expenditure records. A cash book should be maintained ideally in all farms.

ii. Yield or production records– Yield or production records will always help to analyse the response of plants w.r.t biotic and abiotic factors, responses to fertilization, Irrigation, feeding practices in case of animal husbandry and fisheries which can be of great help in planning the management of the enterprise in a profitable way.

iii. Farm inventory of tools and properties – An inventory of tools and properties should be maintained and periodic stock verification also needs to be done.

iv. Annual valuations– Annual valuation of immovable properties and other factors of production should be carried out.

v. Farm diary– Farm diary should contain records of all the farm operations. Purchase of items, input management, farm out put etc.

vi. Profit and loss account– This is one of the key financial document all the farms should maintain.

vii. Labour records– Labour records will help to assess the labour requirement in the successive years. This also will help to judge any alterations in the labour allotment, enhancing the labour efficiency and also provides an insight about the labour requirement for particular operations.

viii. Farm input utilization record– Input utilization records will help to assess the requirement in the successive years which can provide a projected figure of operational expenses of the farm which ultimately help the farmer to manage the financial resources effectively.

ix. Sales record- Sales record will provide information on sales like peak months of sale for a particular commodity, demand of a particular commodity and also profit and loss of particular commodities which can help in future planning and upscaling.

x. Purchase record- Purchase records is also a must in all farms. Which helps in quantifying the input usage in the farm

xi. Special or supplementary records- every activity in the farm should be ideally recorded like water usage per month, electricity usage per month, monthly wastage of resources, reasons for mortality of plants, animals or fishes etc.. Which always help in future activities.

Classification of aquaculture records

Aquaculture records can be classified into:

- **Daily recordskept** for input usage like feeds, fertilisers, labour and daily occurrence

- **Occasional record** which are kept for events that do not happen on daily basis. Such records would include:

i. Specific pond production (Quantity and values) by species

ii. Costs of acquisition of inputs

iii. Cost incurred in new constructions or repairs

iv. Salaries (both in cash and in kind)

Some important aquaculture records parameters include:

- Capital investment costs e.g. cost of constructing ponds, hatchery etc.
- Total area under culture
- Individual pond identity
- Individual pond treatments

- Stocking densities and time of stocking
- Species stocked
- Kinds, quantities and cost of inputs used
- Pond productions in amounts and values
- Other productions and values
- Daily occurrences

Other records to consider include:

1. Salary / wages records
2. Farm inventory records
3. Records on payment of rents and hire of equipment, machinery, services etc
4. Pond sampling records

Advanatages of farm record keeping

1. Be used in Determining profitability of various techniques of production or systems
2. Be used to compare the efficiency of use of inputs, such as land, labour and capital, with that of alternative production activities
3. Help the investor in improving the efficiency of farm's operations
4. Be used to preserve institutional memory of the enterprise for future reference.

Net farm income statement (Profit and loss statement)

Total income- Total expenses= Net farm income

Three key financial documents

1. Profit and loss statement

The second important financial statement which contains the summary of receipts and expenses and the resulting profit or loss during an accounting period , usually a year. This profit and loss statement presents a much better estimate of the business performance.

2. Balance sheet

Balance sheet is a statement of the assets, liabilities, and capital of a business or other organization at a particular point in time, detailing the balance of income and expenditure over the preceding period.

3. Cash flow statement

Cash flow statement contain the daily cash inflow and outflow statement. It helps the entrepreneur to plan his present and future actions.

Reading and understanding manuals

Here are some guidelines to help make instructions easy on the user.

- Provide step-by-step sequences in the correct order.
- Follow the timing and sequencing of the actual operations
- Provide visual stepping stones (e.g. Step 1, Step 2 etc.)
- Avoid lengthy paragraphs.
- Use everyday words and terms: avoid jargon.

Things to be remembered while understanding manuals

- Usually all the instuctions in a manual will be printed in very small font . A farmer should keep a reading lens to enlarge it and follow all those instuctions.
- There would be few mandatory labels in all wrappers of all produts related to farming. These are Manufacturing date or packed on , expiry date or best fore , Batch code, QR code etc. selection of products should be based on these labels.
- In few products the ingredients or contents of the product will given in proportion . That will be help the consumer to select or avoid the product based on his or her preference. For eg. Certain contents in a product may cause some allergy to a consumer or certain content in a product are known to

be cancer causing agents which the consumer would like to avoid. In such cases, the contents or the ingredients given in the label would be of great help to the end users.

- A farmer should be able to follow the methods of use given in the label or manual. The instructions would be in a sequence. One should learn to follow the instructions in a sequential manner.
- Knowing simple calculations is also must while using farming related products. For eg. If something is to be sprayed in a crop or some medicine needs to be diluted and administered to animals or fishes in the pond, one should know the basic calculations. 0.2% dilution of something to be spayed or provided to animals means, 2 g or 2ml of that particular product is diluted in 1 litre of water before usage.
- In case of pesticides there will be statutory warning in products with colour codes. If the colour code of pesticides is Green, it is safe to use. If it is blue is it is slightly toxic but can be used with precaution. Yellow labelled is moderately toxic and should be used with due precautions. Red labelled pesticides are highly toxic and should be used cautiously as per the instructions and recommended doses. All the pesticides should be used as per the recommended dosages only.

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TEAM WORK, TIME MANAGEMENT AND PLANNING

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Even though collaborative work among individuals is very prominent today, that was not the case over half a century ago. The shift from the typical assembly line to more contemporary organizational models that contain increasing amounts of teamwork first came about during World War I and World War II, in an effort for countries to unite their people. The movement towards teamwork was mostly due to the Hawthorne studies, a set of studies conducted in the 1920s and 1930s that highlighted the positive aspects of teamwork in an organizational setting.

Teamwork is nothing but the collaborative effort of a group to achieve a common goal or to complete a task in the most effective and efficient way. This concept is seen within the greater framework of a team, which is a group of interdependent individuals who work together towards a common goal. It truly conveys Together Everyone Achieves More. Basic requirement for effective teamwork is an adequate team size. The context is important, and team sizes can vary depending upon the objective. A team must include at least 2 or more members, and most teams range in size from 2 to 100. Most innovative ideas often come from small teams, possibly because larger teams argue more, which can get in the way of coming up with those big ideas.

Teamwork is mainly about situational leadership, letting the person with the relevant core competency for a situation take leadership

Four key behavioral characteristics that compose teamwork are:

(a) Performance monitoring :

The first requirement of teamwork is that team members monitor the performance of others while carrying out their own task. Monitoring ensures that members are following procedures correctly and in a timely manner, while also ensuring that operations are working as expected.

(b) Feedback :

Next as a follow-up activity to monitoring, feedback on the effectiveness or ineffectiveness of performance is passed along to members being monitored.

(c) Closed-loop communication:

Closed-loop communication describes the information exchange that occurs in successful communication between a sender and receiver.

(d) Back-up behaviours:

Finally, back-up behaviors (i.e., willingness to back team members during operations) are required for effective teamwork. Team members must be willing to help when they are needed and must accept help when needed without feeling they are being perceived as weak. A failure of one of these behavioral characteristics aspects could result in ineffective team performance.

Basic Elements for effective team work:

- Good Communication & Social Skills
- Positive Interdependence: We instead of me
- Individual Accountability/ Personal Responsibility
- Shared goals among all members

- Processes for Conflict Resolution whenever dispute arises.

Stages of Team Development:

1. Forming:

This stage is described by approach/avoidance issues, as well as internal conflicts about being independent vs. wanting to be a part of the team. Teamwork is at its lowest levels which happens during initial stage of team formation.

2. Storming

The second stage is characterized by a competition for power and authority, which is the source of most of the conflicts and doubts about the success of the team. If teamwork is low in this stage, it is very unlikely that the team will get past their conflicts. If there is a high degree of teamwork and willingness to collaborate, then the team might have a brighter future.

3. Norming

The third stage is characterized by increasing levels of solidarity, interdependence, and cohesiveness, while simultaneously making an effort to adjust to the team environment. This stage shows much higher levels of teamwork that make it easier for the above characteristics to occur.

4. Performing

This final stage of team development includes a comfortable environment in which team members are effectively completing tasks in an interdependent and cohesive manner. This stage is characterized by the highest levels of comfort, success, interdependence, and maturity, and therefore includes the highest levels of teamwork as team starts to perform collectively towards common goal.

In short, team work boosts creativity and productivity among team members, helps discover new concepts from colleagues with different experiences and also they tend to take more risks as a team and finish work effectively. For every work, whether done individually or as a team, it requires accurate planning and proper implementation for getting expected outcome.

Planning, prioritization and time management go hand in hand. If we can prioritize our works effectively through proper planning, we can manage our time to produce required outputsSince childhood, our parents and teachers have rightly advised us to spend time and money wisely. Time once gone is gone forever. So time management is of utmost importance in every aspect of life.

Time management is the process of planning and exercising conscious control of the time spent on specific activities to work smarter than harder. It seems that there is never enough time in the day. But, since we all get the same 24 hours, why is it that some people achieve so much more with their time than others? The answer lies in good time management. The highest achievers manage their time exceptionally well.

Benefits of Effective time management are enormous viz;

- Greater productivity and efficiency.
- A better professional reputation and increased career opportunities.
- Less stress.

Failing to manage your time effectively can have some very undesirable consequences like;

- Missed deadlines and appointments
- Procrastination and lack of focus
- Lack of professionalism and poor professional reputation
- Inefficient workflow and low work quality
- Unwanted stress

Steps for better time management

1. Planning:

Planning is the most important part of the formula we call

time management. Research shows that for every 1 minute we spend in planning, we will gain 10 in execution. Planning will keep us on course in achieving our goals and objectives. When we don't plan, we end up responding to the day's events as they occur. We put forth considerable effort, but at the end of the day, we haven't accomplished anything significant. If we don't determine what we want to achieve, we will experience frequent changes in our plans. Planning includes adding meetings or works to be done using a calendar or reminders, preparing a To Do List or a "TASK PLAN", completing pending tasks one by one avoid multitasking so as to ensure completion of tasks within the stipulated time frame. We can set both long term goals (to be achieved in a year or month, etc) and short term goals (to be achieved in a week, a day, etc).

2. Prioritization:

Prioritizing your daily tasks is the key to successful time management. High Priority work should come on top followed by those which do not need much of your importance at the moment. There are few methods which help us sort between various tasks based on their importance and urgency sa as to facilitate priotization, delegation to capable members or deletion from our schedule.

The 80/20 Rule-Pareto Principle is one such method. Of all the work we have to do within a week, 80 percent of the tasks take up 20 percent of our time. The remaining 20 percent of our tasks however, account for 80 percent of our work effort. This principle is known as the Pareto Principle, named after its inventor Italian economist Vilfredo Pareto. The core lesson to take away from the 80/20 ratio is: There are activities that have greater results than others. Even though the ratio is more of an average estimate than an exact number, we should identify the 20 percent tasks that have the 80 percent results and make them our priority.

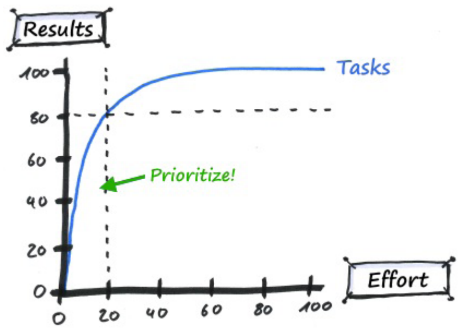

Fig 1 Maximum results with little effort.

Another method is Eisenhower Matrix which helps prioritize work according to their urgency and importance. (Fig.2)

1. Start with completing the most important and urgent tasks and schedule deadlines for the least urgent tasks on your list.
2. Tasks that are important but not urgent can be planned and scheduled for doing after completing above tasks.
3. Tasks that are of secondary importance and should be completed soon are best delegated to team members who are better skilled and have more capacity.
4. Eliminate the tasks that are neither important nor urgent. This saves our time and effort.

URGENCY/ IM-PORTANCE	URGENT	NOT URGENT
IMPORTANT	1	2
NOT IMPORTANT	3	4

Fig 2 Identify Urgent vs Important using Eisenhower matrix

3. Complete the most important work first - First complete the most important work in our list. If it is a difficult task, it is human tendency to postpone. If we finish that work instead of postponing, it saves time as well as gives a sense of accomplishment also.
4. Plan realistically; Plan for work that can be completed within a day. Make sure we don't have an end-to-end schedule for every work day and instead include buffer times. So that in case of some unforeseen work we would not be stressed.
5. Avoid cluttering; Avoid keeping stacks of file and heaps of paper at your workstation. Put important documents in folders. Keep the files in their respective drawers with labels on top of each fileto avoid unnecessary searching.
6. Avoid distractions; In our everyday life, distractions cost us many valuable hours in a day. Mobile phones, chatty coworkers, social media are some of the common distractions at work which should be avoided.
7. Taking regular breaks while working , making sure it does not exceed limits, is an effective way to stay productive all day.
8. Identifying productive hours-We may be at our highest brain capacity, with best focus and attention, before lunch hour, and slow down significantly in the evening. So, if we have a project that involves critical decisions and complex thoughts, the best way is to manage it in our "golden energetic hours".

Effective time management skills can have a positive impact on your work and life in general.

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TAKING OFF A BUSINESS VENTURE

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What is a business?

An organization or economic system where goods and services are exchanged for one another or for money. A business can be privately owned, not-for- profit, or state owned.

Prerequisites for starting a business

In order to successfully run a business the entrepreneur has to keep in mind the following prerequisites before entering into a business;

1. Select a product / service:

The primary requisite of starting a business is about choosing or selecting a product/service. Initially it is better to have a basket of ideas from which we can zero in on a better one which suits the demand pattern of the market and consumers, considering the life cycle of the product, shelf life of the product, ease in availability of raw materials, man power, technologies available for production etc.,

2. Investment:

Each and every business requires some form of investment. Investment in the sense time, energy or matter spent in the

hope of future benefits. The investment may be required for fixed expenses, recurring expenses and inventory expenses. The quantum of investment in terms of money is determined by amount required for reinvestment in working capital and capital expenditure.

a) Fixed investment: Expenditure required for physical assets viz., machinery, land, buildings, installations, vehicles or technology.

b) Recurring expenses: The expenses which are incurred by a business on a regular basis. These expenses are essential for day to day running of the business ie., charges on rent, electricity, salaries, etc.,

c) Inventory expenses: Some goods produced or purchased in a season/ year may be stocked for selling in a later year/ season, the expenditure incurred in this item is known as inventory expenditure.

3. Fix your customers:

Every business need enough customers to whom its output can be sold on a consistent basis. Inorder to make it viable and to make profit out of it.

4. Market Survey:

A thorough investigation into the state of the market about the product/ service we are planning to deal including an analysis of consumer needs and preferences is needed before venturing. Market survey/ research provides vital information which helps to identify and analyze the needs of the consumer, market size and the quantum of competition the service / product is expected to be facing in the existing market. Market survey is a very important component of business strategy and also it helps us to expedite how our product/ service fit into the market. Be brutally honest while conducting market survey in essential to succeed.

5. Business plan:

A business plan is a written description of your business's future, a document that tells what you plan to do and how you plan to do it. In simple, a business plan is a document that outlines the basics about your business, products and services, the market you are targeting, the goals you have for your business and how you will achieve the goals.

6. Marketing plan:

It's an operational document that outlines an advertising strategy that a business entity will implement to generate leads and make the product/ service hits its target market and reaches our consumers. The marketing plan helps in pricing decisions, new market entries, tailored messaging targeting our consumer type and plat form selection for the product promotion. Moreover the plan outlines the marketing activities on a monthly, quarterly or annually.

7. Naming and registering a business:

What's in a name? a lot, when it comes to small business success. The right name can make your entity talk of the town and the wrong one can doom it to failure. Ideally, our name should convey the expertise, value and uniqueness of the product you have developed. The firm should be registered with the competent authorities.

8. Create an office space:

We all know that productivity level drops when we feel uncomfortable. Whit this in mind it's important that our office space is setup to be the best possible working environment it can make your employees comfortable, relaxed and productive. But utmost care should be taken to make the investment in this regard to be at best possible lowest level. The office space should have a building number Allocated by the local self-government.

9. Make the best possible core team:

In general everyone is ready to work; but a very few would love to be part of building a venture from scratch. Select persons who have guts to make concrete decisions and ability to advise

you and debate you. Don't be surrounded by individuals who nod their head for every decision you make. At least find a guy who is matured enough to understand your venture, capable of running the show in your absence. Be careful not to choose a person who works for a smaller duration though is very talented.

Legal form of a business

Select a legal form for your business, whether it is a sole proprietorship or a partnership venture, public limited company, private limited company or society etc., the right choice of the form of business is very crucial because it determines the power, control, rights and responsibilities as well as division of profits and loss.

1. Sole proprietorship: it's an one man organization where a single individual owns, manages and controls the business,
2. Partnership venture: A partnership is formed by an agreement which may be either written or oral. When the written agreement is duly stamped and registered it is known as partnership deed. The rights, duties and liabilities of partners are laid down in the deed.
3. Cooperatives: Its's a society with voluntary association of 10 or more members residing or working in the same locality who join together with the objective for promotion of their common interests in accordance with the principle of cooperation.
4. Private Limited Company: A private limited company is a voluntary association of not less than 2 members whose liabilities are limited, the transfer of shares is limited to its members and which is not allowed to invite the general public subscribe to its shares.
5. Public Limited Company: A public limited company is the legal destination of a limited liability company that has offered shares to the general public and had limited liability.

Mandatory licenses and registrations

The process of obtaining license changes from one type of business to the other based on No. of employees, sector, type of business and place of business.

1. Local Self Government registration: It is mandatory to get the local self government license for starting a business venture irrespective of its type. It is a basic necessity for applying all other licenses.

2. Company or Partnership registration: It is advisable for entrepreneurs who have plans for operating a business with an annual turnover of 20 lakhs or above to obtain a Limited liability partnership or company registration. The ministry of corporate affairs regulates the registration of a company and Limited liability partnership

3. GST Registration: All types of entities and individuals who have an aggregate annual turnover of more than 20 lakhs are required to obtain GST registration. Further any firm/ individuals in interstate supply is required to obtain GST registration irrespective of turnover. It is mandatory to obtain GST registration within 30 days of starting a business.

4. Udyog Aadhar registration: This is a registration available for entrepreneurs who want to start and operate a small business ie., micro, small and medium enterprises. The eligibility criteria for obtaining Udyog Aadhar registration is based on the investment in the plant and machinery made by a manufacturing concern or investment in equipments made by a service provider. Only firms having this registration are eligible for availing various subsidies and schemes specially provided by the government for helping small businesses in India.

5. FSSAI license or registration: Food Safety Standards Authority of India (FSSAI) is responsible for verification of the safety and standardization of food products nationwide. Retail stores, restaurants, modern trade outlets and kiosks needs to get registered under FSSAI. Consumers look for

this five letter word in the food packets or containers. Under FSSAI the license or registration is divided into 3 categories based on quantum of annual turnover, installed capacity and locality.

a. FSSAI central registration: Generally large manufacturers, imported and exporters dealing in large scale food business need to obtain FSSAI central registration.

b. FSSAI state license: Food business operators with small to medium sized manufacturing units, transporters, marketers, traders etc., need to take FSSAI registration from the state government.

c. FSSAI registration: Any food business operator with annual turnover less than 12 lakhs needs to get FSSAI registration.

6. Shop and Establishment Act License: The shop and establishment was created for regulating the conduct of business like the hours of works, child labour, payment of wages, safety and general health of the employees, shop and establishment act license or registration is issued by the state governments.

7. Other licenses and registrations: Certain types of business viz., insurance providers, financial service providers, broadcasting service providers, defence related service providers would require approval from regulatory bodies like RBI, IRDAI etc., further certain businesses may also have to obtain permits from the fire department, pollution control board, local health care system, legal metrology department etc., to name a few.

Accounting and record keeping system

Your success in business will rest on good record keeping practices and solid cash flow, without good records it is impossible to determine the financial condition or profitability of your business. Your record keeping system whether on paper or on a computer should be simple to use, easy to understand, reliable, accurate, consistent and designed to provide information on a timely basis. The following are a list of basic requirements for any accounting system.

1. Cheques Journal: This is a list of all payments made from your bank account. Separate journals are required for all accounts operated by the firm.
2. Cash receipts book: This is a list of all purchase invoices. In addition the GST component must be shown separately.
3. Debtors record: This book will show at any time what you are owed from your customers.
4. Creditors record: This records shows what money is owed to your suppliers at nay given time.
5. Payroll: Records regarding the salaries you are paying to your staff. Separate expenses claim forms must be retained for payment if any additional refunds are made to the employees.
6. Sales Invoices: A copy of all sales invoices must be maintained.
7. Purchase Invoices: A copy of all purchase invoices listed in your day books must be retained.
8. Stock register: A stock register is a record of goods purchased and is stored. The register shall be updated on the receipts on the receipts Colum as and when fresh stock is received and issues done immediately. It is important that the person responsible for the stocks initials the quantity in the stock books.
9. Bank statements: All bank statements from all your bank accounts should be maintained.

All of the above records must be kept for seven years and be available for inspection by the notified authorities.

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