Different Species Used for Coastal Pond Farming in India

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Commonly raised species in freshwater ponds are the carps, tilapia, catfish, snakehead, eel, trout, goldfish, gouramy, trout, pike, tench, salmonids, palaemonids, and the giant freshwater prawn *Macrobrachium*. In brackishwater ponds, common species include Pearl spot, *Etroplussurratensis*, mullet (*Mugil* sp.), milkfish (*Chanos chanos*), and the different penaeid shrimps (*Penaeusmonodon, P. orientalis, P. merguiensis, P. penicillatus, P. semisulcatus, P. japonicus,* and *M. ensis*). The more popular species for culture in marine cages and/or ponds are the Sea bass, Cobia, Pompano, Grouper, Red sea bream, Rabbitfish, and marine shrimps.

Traditional culture of grey mullets *Mugil cephalus* & milk fish *Chanos chanos*

In India two major cultivable fin fishes, namely, mullets and milk fish have been used in the traditional culture practices and also in the scientific culture of fin fishes in ponds and pens. Among mullets, the striped mullet *Mugil cephalus* is a fast growing species and is commonly available on the east and west coasts of India. It is also an important table fish and has a good market in the markets of our country.

Features of *Mugilcephalusas* as a candidate species

- Ability to live in varying genre of water resources.
- Ability to make their living together with a variety of fishes.
- Lively growth rate.
- High survival rate of young ones.
- Delicious taste and flavor.
- Ability to take food from natural sources as well as formulated feeds
- High demands in the markets and the attractive prices in the domestic markets

Seed

Most of the flathead grey mullet fry used in commercial aquaculture are collected from the wild. During the late summer months adults migrate to the sea in large aggregations to spawn. Fecundity is estimated as 0.5–2.0 million eggs per female, depending upon the adult size. Hatching occurs about 48 hours after fertilization, releasing larvae approximately 2.4 mm long. When the larvae are 16–20 mm, they migrate to inshore waters

and estuaries, where they can be collected for aquacultural purposes during late June to early September. Shoals of fry are collected by fine seine nets, transported in seawater to hapas or shore. They are then transported by trucks to separate nursery units, or nursery facilities in grow-out farms. They are then transported by trucks to separate nursery units, or nursery facilities in grow-out farms.

Pond preparation

Prior to culture ponds are to be prepared by drying, ploughing and manuring with 2.5 – 5.0 t/ha of cow dung.Ponds are then filled to a depth of 25 – 30 cm and kept for 7 -10 days – for natural feed build up. Increase water level to 1 -1.5 m and finger lings are stocked. Productivity has to be maintained at the required level – Chicken manure / chemical fertilizers.

Salinity	15-35 ppt
pH	6.5 – 9.0
Diss. Oxy	4 -5 mg/1
Nitrate	0.1 - 4.5 mg/1
Nitrite	<0.5 mg/1
Ammonia	Total ammonia <0.1 mg/1
Phosphate	> 60 ppm
Plankton	Good productivity

Nursery rearing

The nursery pond comprises about 1-10 % of the total area. The most suitable place is where it can be easily supplied with fresh unpolluted water at all times and at elevation where it can be readily drained even during ordinary low tides. Water depth should be 15 to 25 cm. A manageable area ranges from 0.01 to 0.25 ha. Feeding areas, corners and side ditches in the pond has to be properly tiled and dried to avoid the formation of black soil. The average water pH of 7.5-8.5 would be ideal for pompano farming. The level of lime application during pond preparation depends on the pH of the soil. Hence, the dosage has to be calculated accordingly. Water filling has to be initiated by covering the inlet pipe by using 2 layers of fine nets (100 micron) to avoid introducing other fishes and predators. A week before stocking, the pond must be fertilized with either organic or inorganic fertilizers to stimulate the plankton bloom.

Grow-out techniques

In many countries mullet fry and fingerlings are stocked in inland lakes and reservoirs as a form of fisheries enhancement (culture-based fisheries). Cultured flathead grey mullet are usually grown in polyculture in semi-intensive ponds and netted enclosures in shallow coastal waters. Mullet can be polycultured successfully with many other fish, including common carp, grass carp, silver carp, Nile tilapia and milkfish, and can be reared in freshwater, brackish water and marine water.Prior to stocking, aquaculture ponds are prepared by drying, ploughing and manuring with 2.5–5.0 t/ha of cow dung. Ponds are then filled to a depth of 25–30 cm and kept at that level for 7–10 days to build up a suitable level of natural feed. The water level is then increased to 1.5–1.75 m and fingerlings are stocked. Productivity is kept at the required level by adding chicken manure and/or chemical fertilizers. Optimal dissolved oxygen is maintained by the use of various types of aerators, especially after sunset. Extruded feed is supplied to semi-intensive ponds to cover the feeding requirements of both carps and tilapia grown in the same ponds.

The growing season is normally about 7–8 months. If mullet are monocultured, manuring may be sufficient to reach the required feed level. In many cases, mullet has been found to feed directly on chicken manure and good levels of production have been recorded. Growth is checked by sampling, and if growth rates are not as expected, rice and/or wheat bran is added daily in amounts of 0.5–1 percent of biomass to supplement the natural feed in ponds. When mullet are reared in polyculture, they are usually stocked with tilapia, common carp and silver carp. In this case, feeding and fertilization programmes are usually targeting the other cultured species and the mullet feed on the natural feed, detritus and feed leftovers.

Acclimatized to the appropriate salinity, and stocked as 10–15 g individuals at 6 200 –7 500/ha, a harvest of 4.3–5.6/tonnes/ha/crop can be obtained. In semi-intensive polyculture with tilapia and carp, mullet fingerlings are stocked at 2 500–3 750/ha together with 1 850–2 500/ha of 100 g common carp juveniles and 61 750–74 000/ha 10–15 g Nile tilapia fingerlings. Total harvests are typically 20–30 tonnes/ha/crop, of which 2–3 tonnes are mullet.After an on-growing season of 7– 8 months in either culture systems in the subtropical region, flathead grey mullet reach 0.75–1 kg; if kept for two on-growing seasons, they reach 1.5–1.75 kg each. Rearing for a second year depends on the market requirements; in some countries mullets are marketed at a size of 1.5 kg and larger. The two seasons are continuous until they reach that size. As usual, the choice of rearing technique depends on market demand and economics.

Feed: In monoculture, mullet feeds on natural food and on the by-products of grain mills and rice polishing plants. In polyculture, manufactured extruded pellets are produced either in feed mills specialized in the production of fish feed or, in many cases, in chicken feed mills that have a line for fish feed production. Feed is formulated according to the dietary requirements of the major cultured species (i.e. tilapia and common carp).

Harvesting: Harvesting of mullet is done usually partial or full according to the demand. Daily harvesting, according to market demand, can be carried out using gillnets of suitable mesh size. Nets are stretched in a zigzag line across ponds at sunset and collected at morning.In semi-intensive culture, total drain-harvesting is used. Fish usually move with the flow of water to a concrete catch pond at the pond outlet. A seine net can be used to collect those that do not reach the catch pond.

Handling and processing

Fish are collected from the catch ponds by scoop nets and transferred into plastic boxes, washed in running water, and then sorted according to species and sizes. Sorted fish are weighed and packed in plastic boxes with crushed ice or ice flakes.

Harvested mullet is marketed daily and consumed fresh and never kept on ice for more than one day. Older mullet is considered of inferior quality and does not usually gain a good price.

Attributes for aquaculture

- Milkfish is a warm water species. It prefers water temperatures 20–33°C.
- Unlike many other large saltwater fish it is herbivorous and feeds on cyanophyta, diatoms and other similar food items.
- Larvae eat zooplankton. Juveniles and adults eat cyanobacteria, soft algae, small benthic invertebrates, and even pelagic fish eggs and larvae.

- Can be grown in monoculture or in polyculture with other finfishes and crustaceans.
- Wild fry occurs in the tropical and sub-tropical seas.
- Technology for broodstock development and hatchery for large scale seed production is already established in many countries including India (CIBA).
- Technology for nursery and grow-out in ponds, pens and cages in fresh, brackish and marine environment is developed.
- Juveniles can be grown to maturity (broodstock size) in 5–7 years in ponds, tanks and cages under proper management.
- Artificial feeds for intensive farming have been developed.
- Fingerlings (25 g) can also be used as tuna bait.
- Recommended as bio-manipulators to produce green-water for environmentally friendly intensive shrimp farming.
- No known occurrence of disease outbreak in aquaculture.

The demand for milkfish has been growing as population rapidly increases. Scientifically speaking, milkfish is known as *Chanos chanos* and is considered as one of the cheapest source of animal protein in the region. Semi-intensive culture in brackishwater ponds is only one of the major growth areas in milkfish farming. Semi-intensive Milkfish Culture Sites recommended for the milkfish culture are those existing brackish water fishponds which are susceptible to have constant salinity and temperature throughout the year. Soils like sandy clay, loam or silty are best.

Seed

Under natural conditions, larvae and fry migrate inland, seeking tidal pools. They settle in them for 1 month until they become juveniles, then migrate into lagoons, lakes and shallow waters. Larvae for aquaculture can be collected from brackish waters such as shallow sandy areas, mouths of rivers, and lagoons. Intensive milkfish farming depends heavily on hatchery bred fry.

Nursery

Nursery ponds are prepared by sun drying, liming and application of organic and inorganic fertilizer to enhance growth of benthic algae (lab-lab). Supplemental feeding with rice bran and other feedstuff is often done. Fry are stocked in 1–5 hectare nursery ponds, at the rate of 30–40 fry /m^2, for 30–45 days. Densities are reduced as the fish grow. Some are directly stocked in grow-out ponds and the rest go to transition or stunting ponds at 15 fingerlings /m^2 for 6 months to about a year.

Grow-out

A grow-out can be square or rectangular in shape constructed in series design with independent water supply / drain gate / canal system. Sluice gates can be made up wood or concrete. The pond bottom must be leveled flat but inclined towards the gate for convenient water management and easy harvesting stocks. Comparatively, lab-lab excels over other food types in milk fish culture. When it comes to raising milkfish Lab-lab is local term benthic algal communities which consist of yellowish – greenish minute plants and animals that

form a mat on the pond bottom. They are sometimes detached and float in clumps or patches. There are different types of grow out systems are practicing in different parts of the world.

***Shallow water culture*:** In the traditional culture method, milkfish are cultured in shallow (40–60 cm) brackish water ponds of 2–50 hectares. Water exchange is tidal. The growth of benthic algae is encouraged through photosynthesis and fertilization. Other natural foods like filamentous algae (lab-lab) may be resorted to, but yield is less compared with lab-lab. Usually stocking; 2,000–3,000 fingerlings (5–10 g)/ ha; 1–2 crop/ year; and yield 1.5–2.0 t/ha/yr.

Deep water culture: Milkfish are cultured in ponds, with a depth 80–110 cm and area 1–10 hectares; usually stocking; 2,000–3,000 (5–10 g)/ha.water exchange is tidal. Production: 1–2 t/ha/yr.

The modular system: Allows 6–8 crops/yr. with yield of 2–4 t/ha/yr. The growing fish are moved through three adjoining ponds of increasing sizes, at the ratio of 1:2:4 or 1:3:9. Ponds are prepared by the lab-lab method of growing natural food. Water exchange is tidal. The program involves pond preparation, stocking, transfer & harvest in regular intervals. To sustain year-round production, an inventory of fingerlings, organic and inorganic fertilizers, and organic pesticides needs to be maintained.Aerated ponds: Increased productivity can be gained through culture in deep ponds (0.1–1.5 m) using paddle wheel aerators, feeding machine and water pump to increase primary productivity. At the minimum stocking density of 8,000–12,000 fingerlings per hectare, production of 4–6 t/ha/yr can be attained. At the highest density of 30,000 fingerlings per hectare, yield is 12–15 t/ha.

Pond Preparation and growth of Lab-lab

Drain the pond completely and allow it to dry for about 1-2 weeks until the soil cracks. Do not over dry because prolong drying is not advisable as it makes the soil hard and powdery. Eradicate unwanted species using organic pesticides such as combination of ammonium sulfate fertilizer and agricultural lime. Prepare a mixture of hydrated lime and ammonium sulfate fertilizer (21-0-0) at a ratio of 3:1 at a rate of 100-grams/1000 m^2 and broadcast it in wet waters of pond bottom during sunny days. The mixture releases heat and ammonia, which effectively kills unwanted species in the pond. Fertilize the pond by applying chicken manure at 2 tons per hectare. Fill the water to depth barely covering the pond bottom and broadcast urea (45-0-0) at 15 kg/ha, 2-3 days later to speed up the breakdown of chicken manure. Increase the water depth gradually over a period of half – one month at 3-5 cm from time to time until the stocking depth of 0.8-1.0 meter. An abrupt increase in water depth will cause the lab-lab to detach and float. Install fine-mesh screens at the water gates to prevent re-entry of unwanted species and the possible escape of cultured species. The common practice to get rid of the snails is by collecting them by sweeping or hand picking and burn them. Eradication of Snails Ready the ponds for stocking. Initial size of stocking is being done with average weight of 80-100 grams from reliable source.

Stocking and management

Fingerlings are normally held in hapa nets a few hours before stocking. Stocking should be done during the cooler part of the day. Slowly release the fingerlings to the pond at the density of 50,000 fingerlings/ha per cropping. Count the fingerlings to prevent under or over stocking. When lab-lab starts to get overgrazed, apply inorganic fertilizer (16-20-0) at 50kgs. / ha every 1-2 weeks. Provide formulated diets daily at 5 percent (5%) of the body weight per day. In designated area, broadcast or use feeding tray to condition the fish to eat pellets

for about a week. Water management can be either tidal or with the aid of water pump. Tidal management were mainly following the lunar periodicity after stocking, maintain the optimum water condition for both the fish and natural food. When using lab-lab food base, apply fertilizer (16-20-0) at the rate of 50 kg /ha, divide into small doses and apply every 12-15 days. As much as possible coincide the fertilization during the spring tide cycles. Replenish about one-third of the pond water before any fertilizer application. During hot months, increase the frequency application. During rainy months, drain the uppermost freshwater layer in the column to prevent the occurrence of salinity fluctuations. In the middle or towards the end of the culture period, lab-lab may be prematurely depleted because of overgrazing, poor water conditions. Provide supplemental feeds at a rate of about (5%) percent of the average body weight of the fish per day using commercial feeds. Unusual fish behavior may sometimes be experienced when the stocks are exposed to stress. This phenomenon is characterized by the presence of fish at the water surface gasping or swimming in circles. These are indications of stress associated with sufficient dissolve oxygen (DO) concentration. Replenish water at the first opportunity stress associated behavior of the fish. The water may be splashed-on to a piece of wood to increase oxygen concentration in the pond. To attain the highest possible profit, culture period should be about 60 days for cost efficiency. Yield is up to 2.0-2.5 tons/ha./crop which is equivalent to 6.0-7.5 tons/ha/ year for 3 cropping.

Harvest

Milkfish are normally harvested at sizes of 20-40 cm (about 250-500 g). There are three known methods used for harvesting milkfish:

- Partial harvest. Selective harvest of uniformly grown milkfish from grow-out facilities (i.e. cages, pens, ponds, tanks) using seine or gillnets, retaining the undersize fish and harvesting only the commercial sized stocks, with an average body weight of 250 g or larger. Partial harvesting is done by using bigger meshed nets so that small fishes could pass through the net trapping only the bigger and harvestable stocks.
- Total harvest. Complete harvest in one crop period from grow-out facilities (i.e. total draining of ponds by gravity or pump, hauling of the entire net cage structure, seining or the use of gillnets in pens). The harvest size at this stage may vary from 250-500 g.
- Forced harvest. Emergency harvesting, regardless of fish size or grow-out stage, which is carried out during 'fish kills' due to oxygen depletions that are attributed to algal blooms, red tide occurrence, pollution or other environmental causes.

Traditional cultureof Asian Sea bass

Extensive culture of sea bass as a traditional activity is followed in the Indo-pacific region. In low lying coastal ponds, juveniles of assorted sizes collected from estuarine areas are introduced and fed with the forage fishes like tilapia, shrimps and prawns available in these ponds. These ponds receive water from adjoining brackish water or freshwater canals or from monsoon flood. Harvesting is done after 6-8 months of culture. Since sea bass exhibit differential growth, the size of the harvested fishes varies from 0.5 to 5.0 kg. Production up to 2 ton/ha/7-8 months has been obtained.

Pond culture

The two-week nursery reared fingerlings are suitable for pond culture. The production pond can have concrete walls and a soft bottom, ranging in area from 0.1 ha to a few ha, water depth of up to 2 m and salinity of 5-10 ppt is suitable. Seabass culture in ponds can be carried out either by poly-culture method or by feeding

with low cost fishes like tilapia/oil sardines or with extruded floating pellets. The pond is at first dried, tilled, leveled and manured with raw cow dung @ 1000 kg/ha. If required, lime is added @ 50-200 kg/ha to maintain soil pH above 7. Urea @ 100kg/ha and super phosphate @ 50 kg/ha can also be added to enhance the algal bloom. Sea water/fresh water is then filled to a depth of 60 – 70 cm in the pond. When the pond water becomes light green in colour indicating sufficient development of algae in the pond, forage fishes are introduced.

In pond culture, stocking with seed of uniform size (5-10 g), @ 3000-5000 nos./ha is desirable. Feeding of fish is carried out following two methods. In the first method, the fish are fed exclusively with chopped trash fish @ 10% of biomass twice daily (08.00 & 17.00 hrs) and reduced to 5% subsequently. In the other, the food is made available in the pond in the form of forage fish like Tilapia *(Tilapia mossambicus)*. Pelletized feed can also be given. In a well-prepared pond, manured/fertilized with raw cow dung @ 1000-1500 kg/ha and urea @ 100-150 kg/ha, Tilapia adults (male and female in the ratio 1:3) are introduced and reared for 1-2 months prior to stocking with seabass. To maintain natural food production for the forage fish, periodic manuring at fortnightly interval is done @ half the initial dose. 20% of pond water is exchanged on alternate days. Harvesting is done by draining the ponds or by using seine nets. Grow-out pond culture of seabass can yield a production of 2-3 tons/ha within a rearing period of 7-8 months.

Harvesting

For sea bass farmed in cages, harvesting is relatively straightforward, with the fish being concentrated into part of the cage (usually by lifting the net material) and removed using a dip net. Harvesting sea bass 'free-ranging' in ponds is more difficult, and requires seine-netting the pond or drain harvesting. After harvesting, the barramundi are placed in ice slurry to kill them humanely and preserve flesh quality. Fresh barramundi is generally transported packed in plastic bags inside styrofoam containers with ice. There is a limited market for live barramundi in Kerala. Fish are usually transported live in tanks by truck.

Pompano culture

The aquaculture of pompano has been successfully established in many Asia-Pacific countries like Taiwan and Indonesia. The farming can be successfully carried out in ponds, tanks and floating sea cages. The species is pelagic, very active and is able to acclimatize and grow well even at a lower salinity of about 10 ppt and hence is suitable for farming in the vast low saline waters of our country besides its potential for sea cage farming. The shape, colouration and meat quality of this fish is comparable with silver pomfret. In the international market, the dockside price of Florida pompano averaged to $ 8 /kg and in India, the current price of silver pompano is about Rs.200/ kg at the fish landing centres and around Rs.250/ kg in the retail markets.

Pond preparation

The pond has to be dried properly until the cracks appear on the surface. The top layer of the soil containing waste accumulated through previous crop of fish or shrimp has to be removed. Ploughing has to be done to tilt the soil below 30 cm. Feeding areas, corners and side ditches in the pond has to be properly tiled and dried to avoid formation of black soil. The average water pH of 7.5-8.5 would be ideal for pompano farming. The level of lime application during pond preparation depends on the pH of the soil. Hence, the dosage has to be calculated accordingly. Water filling has to be initiated by covering the inlet pipe by using 2 layers of fine nets (100 micron) to avoid introducing other fishes and predators. A week before stocking, the pond must be fertilized with either organic or inorganic fertilizers to stimulate the plankton bloom.

Nursery Rearing and Seed Stocking

Hatchery produced pompano fingerlings of 1 inch size can be stocked in happas/ pens of 2 meter length, 2.0 meter width and 1.5 meter depth. In each happa about 200 fingerlings can be stocked. While stocking care should be taken to avoid agitation of the pond bottom and too many persons getting into the pond may increase the suspended solid load in the water, which may cause gill chocking of the fish fingerlings leading to mortality. Initially the fishes have to be reared in happas for 60 days or until they attain 10 – 15 grams size and thereafter it can be released into the pond. The mesh size of the happa could be initially at 4 mm size and it can be changed with 8mm mesh size happas after 30 days. The stocking density in happa could be maintained as 200 nos/ happa. After attaining 30 grams size ideally 5,000 Nos. can be stocked in a one acre pond.

Pompano is a fast moving marine fish and it requires highly nutritive feed to meet the energy requirements. During nursery rearing Pompano can be weaned to any type of feeds viz., extrudedfloating pellet, sinking pellet feed and chopped trash fishes. Ideally pompano can be weaned to extruded floating pellet feed to avoid feed wastage and spoilage of pond bottom. The CMFRI has conducted pompano farming demonstration by using the extruded floating pellet feed manufactured by M/s. Rudhra Techno Feeds, Bhimavaram, Andhra Pradesh. During the happa rearing phase, feeding has to be done 4 times a day and in pond culture phase it could be 3 times a day. The feed size should be lesser than the mouth size of the fish and hence, suitable sized feed has to be selected for feeding the fishes. The details of feed and feeding schedule of pompano are as follows:-

Water Quality Management

Plankton bloom is essential for early stages of pompano (until 100 grams) culture. If the colour of the pond water is clear a mixture of organic (10-30 kg/ha.) and inorganic fertilizers (1-3 kg/ha) can be applied to obtain algal bloom. Sufficient water level must be maintained in the ponds to reduce risks of the growth of benthic algae. The water depth in the shallowest part of the pond should be at least 100 cm. Water quality can be maintained by exchanging 10% of the water once in a week; 20% per week after 3 months and 30% per week after 6 months. If water colour is too dark, the quantum of water exchange can be proportionately increased. To maintain water pH within an optimum range of 7.5 - 8.5, agri-lime has to be applied regularly. Dissolved oxygen (D.O) level should be maintained above 5 ppm at all times. During the entire culture period the growth pattern of pompano was monitored through regular sampling of fishes at fortnightly intervals. The length and weight measurements taken are presented below:-

Growth Pattern

DOC	Growth (mm)	Weight (g)
1	30.59 ± 0.24	2.00 ± 0.04
30	73.42 ± 0.53	15.08 ± 0.16
60	102.88 ± 1.91	34.60 ± 0.41
90	158.39 ± 2.42	72.54 ± 1.95
120	182.30 ± 2.03	101.82 ± 3.11
150	203.71 ± 3.73	172.39 ± 4.55
180	226.51 ± 2.90	258.31 ± 5.76
210	273.07 ± 3.62	375.32 ± 8.07
240	296.88 ± 6.27	464.65 ± 10.25

Health management

Pompano is a much hardier species and does not get much disease problems. When it is reared 2 in high salinities parasitic infection of copepods may occur. Periodical application of commercially available pond management chemicals like Iodine solution would help to keep the fishes healthier. Feed supplements like LIV-52 syrup can be given by mixing with the feed to improve the immunity levels.

Harvesting: Harvesting of pompano is normally carried out using drag net. To maintain the freshness and quality of harvested fish, washing in clean water and chill killing can be done. Harvested fishes can be stocked in plastic crates by adding layers of ice in equal quantities at the bottom and top of the fish. It is suggested that harvesting of fish can be carried out during the off season period of April to June to get a better price. It is well recognized that for sustainable production in aquaculture, diversification of species is a vital requirement and from the lessons learnt from the shrimp farming scenario in India, it is very much needed to diversify the marine and brackish water aquaculture with high value fin fish species. Generally, high value marine fishes are in good demand in the Indian market and often there is a scarcity of the same. In the domestic market, silver pompano has demand starting from 250 grams size onwards. Hence, it is felt that pompano aquaculture can prove to be much lucrative and can emerge as a major aquaculture enterprise in the coming years.