ICAR-CIBA Extension Series No. 74

Integrated Farming System in Brackishwater Aquaculture Ponds as a Livelihood Model for Tribal Communities of Gujarat

(Under Tribal Sub-Plan)

Pankaj Patil, Tanveer Hussain, Jose Antony, Babita Mandal,
Krishna Sukumaran R. Subburaj, Patel, N, P. Mahalakshmi, M. Kailasam,
C. P. Balasubramanian, K. Ambasankar, K. K. Vijayan

NAVSARI GUJARAT RESEARCH CENTRE OF CIBA
(Indian Council of Agricultural Research)
1st floor Animal Husbandry Polytechnic, Navsari Agricultural University,
Eru Char Rastha, Navsari 396 450, Gujarat, India

Integrated Farming System in Brackishwater Aquaculture Ponds as a Livelihood Model for Tribal Communities of Gujarat

(Under Tribal Sub-Plan)

Pankaj Patil, Tanveer Hussain, Jose Antony, Babita Mandal,
Krishna Sukumaran R. Subburaj, Patel, N, P. Mahalakshmi, M. Kailasam,
C. P. Balasubramanian, K. Ambasankar, K. K. Vijayan

NAVSARI GUJARAT RESEARCH CENTRE OF CIBA

(Indian Council of Agricultural Research)

1st floor Animal Husbandry Polytechnic, Navsari Agricultural University,
Eru Char Rastha, Navsari 396 450, Gujarat, India

February 2020

Published By
Dr. K. K. Vijayan
Director, ICAR-CIBA

Prepared by
Pankaj Patil
Tanveer Hussain
Jose Antony
Babita Mandal
Krishna Sukumaran
R. Subburaj
N. Patel
P. Mahalakshmi
M. Kailasam
C. P. Balasubramanian
K. Ambasankar
K. K. Vijayan

February 2020

ICAR-CIBA Extension Series No. 74

Citation
Patil, P. A., Hussain, T., Antony, J., Subburaj, R., Mandal, B., Sukumaran, K., Patel, N., Mahalakshmi, P., Kailasam., M., Balasubramanian, C. P., Ambasankar, K, and Vijayan, K. K, 2020. Integrated Farming System in Brackishwater Aquaculture Ponds as a Livelihood Model for Tribal Communities of Gujarat (Under Tribal Sub Plan). ICAR-CIBA Extension Series No. 74. pp24.

Introduction

India is bestowed with number of locally important cultivable brackishwater finfishes for Brackishwater aquaculture such as Asian seabass, Milkfish, Grey mullet, Pearlspot, Scat, Estuarine grouper and Cobia. Diversification assumes significant importance in coastal aquaculture in India as coastal aquaculture is limited to the shrimp aquaculture. Tidal amplitude of Gujarat coast is higher than other parts of West coast. This natural phenomenon had created vast stretches of marshy and saline lands all along the coast. The estimated brackishwater area in Gujarat is around 3,76,00 hectare with the potential brackishwater area suitable for brackishwater aquaculture is about 83340 hectares. Navsari District of Gujarat is blessed with plenty of potential open brackishwater water resources which can be utilized for brackishwater farming for livelihood of coastal communities of Gujarat.

Tribal communities are known to be the autochthonous folks of the land. After Africa, India has the second largest tribal population in the world and they are the integral segment of Indian culture and society. India, with a variety of ecosystems, presents a diverse tribal population throughout country depicting a complex cultural mosaic. India's population includes nearly one hundred million tribal people. However, still the most of the areas inhabited by the tribal is under developed.

Government of India has initiated a number of steps to develop socio economic conditions of tribal population in the country. Similarly ICAR-CIBA, Chennai have developed different brackishwater technologies model as an alternative livelihood for coastal tribal communities of India. In this background to provide employment and livelihood opportunities to tribals of Gujarat, CIBA-Navsari-Gujarat Research Centre, Navsari have initiated developing of different culture models for development of tribal community under Tribal Sub Plan (TSP) project. This initiative resulted in keen interest among the tribal community to adopt the technology for their livelihood support. This technologiesare customized to suit to the tribal farmers in Navsari area. Hence, an integrated farming system in brackishwater aquaculture pond with livestock culture on pond dyke is developed at NGRC Matwad Farm for tribals of Matwad Village, Navsari, Gujarat. The model comprises nursery rearing of

Asian seabass, *Lates calcarifer*; Pearl spot, *Etroplus suratensis*; Spotted scat, *Scatophagus argus* in hapas, farming of Asian seabass, *Lates calcarifer* in low volume cages, polyculture of Milkfish, *Chanos chanos* and Pearl spot, *Etroplus suratensis* in pond, and Surti goat farming on dyke. For maximum utilization of available pond resources, the poultry and horticultural on pond dyke can be also included in this kind of system for more productivity. The pond of around 2000 sq. m with depth of around 1.5-2.0 m has is ideal for integrated farming system in brackishwater aquaculture pond with goat farming shed of 16 x12 ft on the rear end of pond dyke.

Need for intervention

In order to achieve rapid progress in rural and tribal areas of the country, the policies and research strategies must focus on conserving natural resources, enhancing efficient use of available resources, increasing productivity, income and profitability. On the other hand, availability of fresh water for human use is emerging as national as well international challenge and its most efficient management as well as recycling is utmost requirement. Recycling of farm and crop residue as well as agricultural by products need to be focused to minimize the cost of production. Since animal waste makes good fertilizer for fish ponds, and since 50-60 percent of the cost of fish farming goes for feed, integrating livestock and fish farming is an ideal model for aquaculture and tribal communities. Integrated farming system in brackishwater aquaculture pond is one of the best examples of mixed farming. This type of farming practices involves a combination of fish polyculture integrated with crop or livestock production. On farm waste recycling, an important component of integrated farming system is highly advantageous to the farmers as it improves the economy of production and decrease the adverse environmental impact of farming. Fish culture can be integrated with several systems for efficient resource utilisation.

The integration of brackishwater aquaculture with livestock or crop farming provides quality protein food, resource utilisation, recycling of farm waste, employment generation and economic development.

Integrated farming system in brackishwater aquaculture pond also allows us to utilize unutilized brackishwater for farming of salt tolerant horticultural crops on aquaculture farm dykes and non-used land which in future support to reduce the pressure on freshwater resources for agricultural farming.

Components of integrated farming system in brackishwater aquaculture pond

A. Asian Seabass *Lates calcarifer* nursery rearing in hapa installed in pond
B. Milkfish *Chanos chanos* nursery rearing in hapa installed in pond
C. Pearlspot *Etroplus suratensis* nursery rearing in hapa installed in pond
D. Spotted Scat *Scatophagus argus* nursery nursery rearing in hapa installed in pond
E. Asian Seabass *Lates calcarifer* low volume pond based cage culture
F. Giant mud crab, *Scylla serrata*& Orange mud crab, *Scylla olivacea* Box Culture installed in Pond
G. Polyculture of Pearl spot *Etroplus suratensis* and Milkfish *Chanos chanos* in Pond Water
H. Goat farming in shed on pond dyke
I. Poultry farming in shed on Pond dyke
J. Horticulture farming of salt tolerant varieties on Pond dykes

Pond preparation

The brackishwater aquaculture pond with size range of 2000-2500 m^2 is suitable for integrated farming system in brackishwater aquaculture pond with provision of water to retain atleast 1.5-2.0 m. Suitable sized mesh screen nets (normally 1 mm) should be provided in the inlet side and outlet side to avoid entry of unwanted fishes, crabs and escape of the stocked fish respectively. Prior to stocking of the seed, the pond can disinfected by using organic or inorganic chemicals for removal of unwanted predatory fishes, crabs, etc. Catwalks from two sides, diagonally opposite to each other extending 3-5 metres in to the inner side of the pond may be erected for the ease of feeding to nursery cultured fishes in hapa and entry in to the pond. The livestock and poultry shed

Integrated farming system in brackishwater aquaculture pond

Livestock shed on pond dyke

The pond shall be filled using creek water or coastal saline groundwater that may be disinfected @ 10ppm active chlorine concentration prior to fertilisation and subsequent stocking. Depth of water in the pond shall be maintained at a level of not less than 120 cm and water depth shall not exceed 150 cm. Water level in the ponds may be topped up using filtered creek water. Water exchange may be carried out once in 30-45 days based on water quality analysis at the rate of 20-30 % of the total pond volume.

A. Asian Seabass *Lates calcarifer* nursery rearing in hapa installed in pond

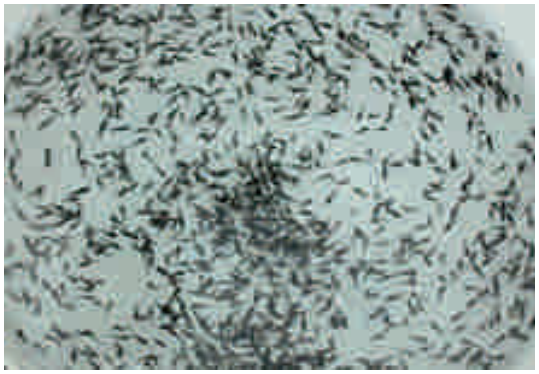
Asian Sea bass (*Lates Calcarifer*) known as Bhetki or *barramundi* in India is one of the commercially important finfish species caught from inshore areas, estuaries, backwaters, lagoons and fresh water ponds. Sea bass is a fast growing species with ability to tolerate wide fluctuations in environmental conditions and gaining rapid popularity as a candidate species for diversification in coastal aquaculture in India. Seabass is carnivorous in nature. However, juveniles are omnivores. Seabass is an opportunistic predator, whose diet changes at different ages of various size groups. It feeds mainly on zooplankton in early stages and as they grow changes to feeding on young fishes and shrimps. They show preference for pelagic fish rather than benthic crustaceans as the prey is large. However, juvenile seabass even consume smaller sizes of seabass of the same age group as whole and can cause reduction in the survival rate. It is one of the fastest growing fish, can grow to an average size of 1.5 kg in 10 to 12 months and fetches good price in domestic and international market. It is considered as a potential candidate species for farming in saline or freshwater environments in ponds and cages. The culture of seabass involves nursery rearing in happas, pre growout culture and growout culture in ponds and cages.

Asian Seabass *Lates calcarifer*

The HDPE knotless net hapa of 2 x 1 x 1 m with the mesh size of 2, 3 and 5 mm respectively are used over the seabass nursery culture. Hapa is fixed in earthen pond or open water bodies with the help of bamboo or casurina pole (6 feet height). Hatchery produced seabass fry (1.5-2.0 cm) can be procured and transported under optimal oxygen packing by air lifting or train up to 14-15 hrs without any mortality. On arrival, acclimatization has to be done to the prevailing local conditions. This is done by slowly adding the rearing pond water by sprinkling in order to bring to the prevailing temperature/salinity. The uniform size fry can be stocked @ 500-750 /m^2. The seabass fry can feed with slow sinking pellet feed of size ranging from 0.4-1.2 mm @ 8-10 % body weight daily in two rations (morning and evening). For small seed (1.5-4.0 cm) the feed ball can be kept in feeding tray which is tied inside the hapa while for fry size seed slow sinking pellet feed is sprayed slowly in hapa. Seabass is highly cannibalistic fish and if proper timely feeding, cleaning and management care is not taken then it affects the survival as well as sustainability of the culture. Hence, seed grading is one of the important steps in nursery rearing of seabass. This is very much essential to reduces the cannibalism and improve the percentage survival during the nursery rearing. Size grading is done at 4-5 days intervals. During the grading, all seed is removed from each happa and taken in grading containers where shooters are separated from the small size sed group and kept separately according to their sizes as smaller one, medium one and larger one (shooter) in different hapas. Generally seabass fry reaches the size of fingerlings (3-4 inch) in 60-75 days of nursery rearing depending upon the environmental conditions of the culture system, water quality parameters and management. The fingerlings can be harvested and sold for grow out culture in cages @ Rs. 25-30 per piece. In a year, on an average two-three cycles of seabass nursery can be undertaken in integrated farming system in brackishwater aquaculture pond with average stocking of 10000 seabass seed/ cycle.

Seabass nursery unit

Seabass seed grading



Stocked seabass seed

Harvested seabass fingerlings

B. Milkfish, *Chanos chanos* nursery rearing in hapa installed in pond

Among brackishwater finfishes, Milkfish *Chanos Chanos* is considered as one of the most potential candidate species for pond and pen based different aquaculture production systems, due to its fast growth rate (attains 500 g in 6 months), hardy nature, and low cost of production. Being a euryhaline and herbivore fish, it feeds on benthic algae lab-lab, phytoplankton and detritus and it accepts low protein pelleted feed in culture systems and tolerates salinities ranging from 0 to 50 ppt. Milkfish farming requires less investment and it forms a livelihood options for tribal communities in coastal regions. Milkfish fetches Rs. 150-180 /kg in the local market whereas the cost of production is only Rs. 50-60 /kg. The culture of milkfish involves nursery rearing in happas and growout culture in ponds as polyculture and monoculture.

Milkfish, *Chanoschanos*

Milkfish fry (21 days old) can be reared to fingerling size in hapas installed in ponds. Milkfish fry of 2.0-3.0 cm size can be stocked @ 500-700 nos. in 2 × 1 ×1 m hapas. Artificial feeds such as rice bran, corn bran or formulated feeds can be provided with natural food. Formulated farm made nursery feed (30-35 % protein) can be supplied to seed 2 times/day @ 8 to 10 % body weight daily. Cleaning of the debris from the Hapa has to be done on regular basis to facilitate the water flow in the hapa. To check the growth and survival of the seed, sampling need to be done at regular interval of 15 days. After 45-60 days rearing the fry will attain fingerling (10.0-15.0 cm) with the survival rate ranging from 90 - 95 %. The fingerlings can be harvested and sold for grow out culture in ponds @ Rs. 10-15 per piece. In a year, on an average two-three cycles of milkfish nursery can be undertaken in integrated farming system in brackishwater aquaculture pond with average stocking of 10000 milkfish seed/ cycle.

Harvested milkfish fingerlings

C. Pearl Spot *Etroplus suratensis* nursery rearing in hapa installed in pond

Pearlspot *Etroplus suratensis* (Bloch, 1790) is commonly called as green chromide and its popular vernacular names are Karimeen (Malayalam) and Kaalundri (Marathi). It is the state fish of Kerala having high market demand in the west coast. Pearlspot is an economically important food fish having a market value of Rs. 250-500 per kg. It is also an emerging ornamental fish. Pearlspot is adaptable to different culture systems like ponds pens and cages. Being omnivorous in nature (Bindu and Padmakumar, 2008), aquaculture of pearlspot is economical and highly suitable for supporting livelihood of small scale fish-farmers. A major bottleneck limiting the expansion of pearlspot aquaculture is inadequate availability of seed for stocking in growout systems. Pearl spot fish is an ideal fish for polyculture, integrated fish farming and cage culture.

Pearl Spot *Etroplus suratensis*

Pearl spot fry nursery rearing to fingerling size can be also carried in hapas installed in ponds. Pearl spot fry of 1.5-2.0 cm size can be stocked @ 750-1000 nos. in 2 × 1 ×1 m hapas. Formulated farm made nursery feed (30-35% protein) can be supplied to seed 2 times/day @ 8 to 10 % body weight daily. Cleaning of the debris from the Hapa has to be done on regular basis to facilitate the water flow in the hapa. To check the growth and survival of the seed, sampling need to be done at regular

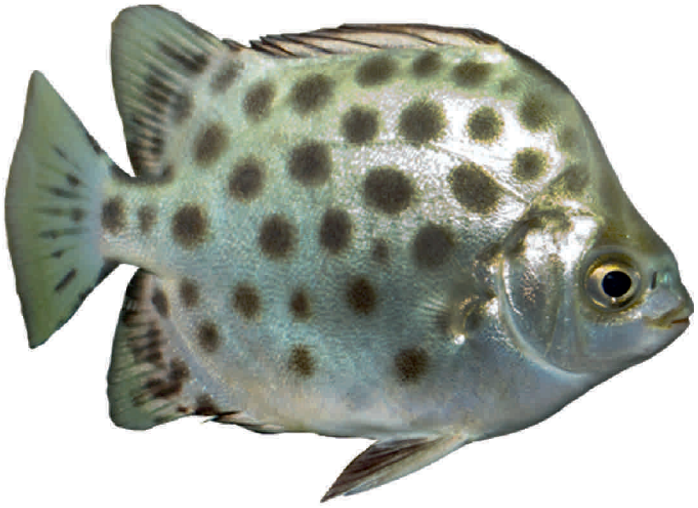
interval of 15 days. After 45-60 days rearing the fry will attain fingerling size of 3-4 inch with the survival rate ranging from 90 - 95 %. The fingerlings can be harvested and sold for grow out culture in ponds or cages@ Rs. 15-20 per piece. In a year, on an average two-three cycles of pearlspot nursery can be undertaken in integrated farming system in brackishwater aquaculture pond with average stocking of 10000 Pearl spot seed/ cycle.

Harvested pearlspot fingerlings

D. Spotted scat *Scatophagus argus* nursery rearing in hapa installed in pond

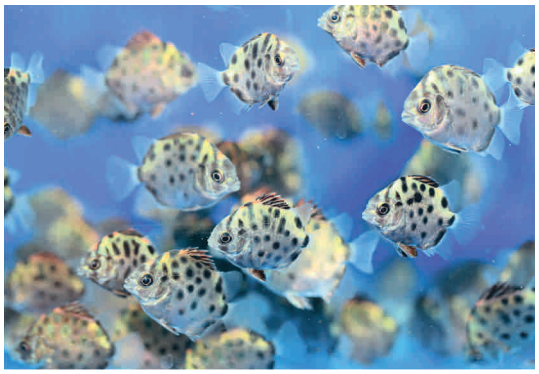
Spotted Scat (*Scatophagus argus*) belongs to scatophagidae family and distributed throughout Indo-Pacific ocean and easily caught from coastal and mangrove regions of southern India. It is also considered a food fish of delicacy in South East Asia. It is an algivore fish having omnivore feeding habit and accepts commercial feed readily in captivity. It is a group-synchronousspecies,and mature oocytes have reported from April to November months in captive conditions. Fishes of 40 – 60 g attains maturity which varies according to sexes. Spotted Scat can grow up to 1.5 – 2.0 kg body weight. Males and females of 100 – 150 g and 200 – 250 g body weight respectively are suitable for pair formation for breeding. Fecundity of female fish depends on body weight which ranges from 800 – 900 spawned eggs/g of body weight. Juveniles of 25 – 30 dph complete metamorphosis stage and ready to be reared in outdoor nursery systems. Each juvenile can be sold for @ Rs.10 –15 in the

retail ornamental market by traders. Acclimatization of juveniles to low saline waters is easy and simple due to euryhaline nature. Low input cost and simplified breeding technique of Spotted Scat juvenile production should be adopted as back-yard hatchery units by Women SHG's and small scale aqua farmers for revenue generation.



Spotted scat *Scatophagus argus*

For nursery rearing in hapas, Scat fry of 1.5-2.0 cm size can be stocked @ 500-750 nos. in 2 × 1 ×1 m hapas. Formulated farm made nursery feed (30-35 % protein) can be supplied to seed 2 times/day @ 8 to 10 % body weight daily. Cleaning of the debris from the Hapa has to be done on regular basis to facilitate the water flow in the hapa. To check the growth and survival of the seed, sampling need to be done at regular interval of 15 days. After 45-60 days rearing the fry will attain fingerling size of 3-4 inch with the survival rate ranging from 90-95 %. The fingerlings can be harvested and sold to ornamental shop @ Rs 40-50 per piece or for cage culture @ Rs. 15-20 per piece. In a year, on an average two-three cycles of scat nursery can be undertaken in integrated farming system in brackishwater aquaculture pond with average stocking of 5000 Scat seed/ cycle.



Harvested spotted scat fingerlings

E. Asian Seabass *Lates calcarifer* low volume pond based cage culture

For low volume pond based cage culture of seabass inintegrated farming system in brackishwater aquaculture pond, pond should have water depth of 2 m and must retain at least 1.5 m of water level throughout the culture. For culture two types of cage nets i.e. pre-grow out net and grow out nets are mostly used for good survival and higher production of the system. For Pre-grow out cage culture of small fish fingerlings (3-5 inch & 10-15 g), HDPE knotless cage nets of 4 x 4 x 1 m dimension made of 24/36 ply & 12-20 mm diamond /hexagonal shape mesh webbing mounted with 3-6 mm rope and 2000-3000 kg tensile strength are used for a period of 60-90 days. For grow out culture of 50-100 g above fish fingerlings HDPE knotless cage nets of 4 x 4 x 1 m dimension made of 45/60 ply & 25-30 mm diamond /hexagonal shape mesh webbing mounted with 6-12 mm rope and 3000-5000 kg tensile strength are suitable till harvest of the culture period. The Cage net can be made float with the use of PVC pipes (2-2.5 inch diameter) or Bamboo poles. Seabass is carnivorous fish in nature hence to avoid cannibalism and to improve survival during pre-grow out cage culture, net cages with internal partition to have two internal compartments of 2 x 2 x 1 m inside the cage nets which facilitate re-stocking of two size graded seabass fishes in each compartment. To protect cultured species from wild crabs and other predatory organisms each cages should have an outer protection cage net 4.25 x 4.25 x 1.75 m made of nylon knotted net of 36-40 mm mesh size.

Healthy, stress and disease free seed should be stocked. Seabass fingerlings (3-5 inch and 10-15 g) are suitable for low volume cage culture in pond. Seabass fingerlings in cage culture can be maintained @ 20-30 nos. /m^3 i.e. 320-480 nos. /cage.

Asian seabass low volume cage culture in Pond

Harvested seabass

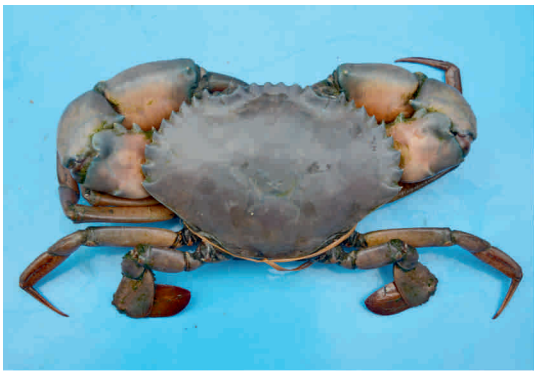
Fishes in the cage can be fed either with extruded/floating pellets or trash fishes. However, artificial feed have many advantages over trash fishes such as easy as procurement, storage and feeding. Seabass fish prefers slow sinking pellet feed (2-6 mm) having protein 40-45 % and FCR for pellet feed is claimed to be around 1.2 to 1.5. Feeding is done twice a day (morning and evening). The fish should be fed at the rate of 10 % and feeding rate vary from 3-10 % of total biomass over the culture period. The total biomass in the cage culture should be fortnightly estimated by random sampling of 15-20 fishes from each cage for adjusting the feed. Over feeding need to be avoided which leads to poor water quality of the culture system and resulting in reduced survival. Seabass is highly cannibalistic fish and if proper timely feeding, cleaning and management care is not taken then it affects the survival as well as sustainability of the culture. Hence, stocked fingerlings grading is one of the important step during pre-grow out cage culture of seabass. This is very much essential to reduces the cannibalism and improve the percentage survival during cage culture. Fingerlings size grading need to be done at 15-20 days intervals.

Grading must be done in early morning (07:00-11:00 am) and late evening (16:00-18:00 pm) hrs. At-least 2-3 people are essentially required on each cage for proper grading, cage net cleaning, cage management and to avoid handling stress to cultured fishes. Since cages are inside the pond water, algae may form on the cage nets and clog the mesh restricting the water exchange. Other animals like Crab may damage the nets. The cages should be regularly checked for clogs and leaks. Damaged nets should be repaired or replaced. Daily cages need to be cleaned with brushes to avoid clogging of the cage nets.

After 180 days rearing the seabass will attain size of 500-750 g with the survival rate ranging from 75 - 80 %. The seabass can be harvested from cages and sold @ Rs. 400-450 per kg. In a year, on an average two cycles of low volume seabass cage culture can be undertaken in integrated farming system in brackishwater aquaculture pond with two -four cages/Cycle.

F. Giant Mud Crab, *Scylla serrata* & Orange Mud Crab, *Scylla olivacea* box culture installed in pond

There are two species of mud crab available in the Indian coastal waters, under the genus *Scylla* i.e. giant mud crab, *Scylla serrata* and Orange mud crab, *Scylla olivacea* that can be reared under controlled conditions. *S. serrata* is characterised by polygonal markings on chelipeds, swimming, and walking legs and possess two spines on the outer margin of the wrist on the cheliped. Whereas, *S. olivacea* does not possess polygonal markings on its body and is characterised by a single blunt spine on the outer margin of the wrist on the cheliped.*S. serrata* grows to a maximum size of 1.5-2.0 Kg, whereas *S. olivacea* attains a maximum size of 0.5 to 0.7 Kg. Among the two species, *S. serrata* is the species of choice for culture, owing to its faster growth rate, larger size, higher price, greater suitability for pond culture, lesser aggression and ease of handling. *S. olivacea* demonstrates greater aggressive behaviour and intense burrowing habit that results in damage to the dyke structure, apart from being lower priced and attains a lower individual harvest size.



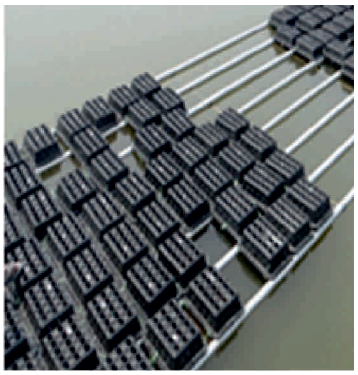
Giant Mud Crab, *Scylla serrata*

Orange Mud Crab, *Scylla olivacea*

Rearing of crabs directly in ponds under a polyculture system is not recommended due to its intense burrowing habit and aggressive behaviour which can affect dyke stability, harvesting and handling. Culture of crabs is therefore, recommended in a box culture system, wherein each crab juvenile is placed in individual HDPE boxes that are floated on a raft structure. The HDPE boxes come in various sizes, although larger sized boxes have shown to deliver better results. The boxes consist of holes on the top for feedings and smaller holes on the sides and bottom for water circulation and exchange of metabolites and faecal matter. Boxes consist of two parts, viz., upper lid and lower body that is immersed in water. The boxes are rigged on to a PVC floating raft and assembled in a battery structure such that about 3/4th volume of the box goes underwater, thus keeping the mud crab juveniles within water in the pond environment. Around 500-750 boxes may be installed in a 2000 m^2 integrated farming system in brackishwater aquaculture pond. Crabs may be individually fed using thrash fish at the rate of 5-8 % of BW on alternate days in a single feeding session.

Crab Juvenlies

Individual crab box



Crab Box Culture Unit

G. Polyculture of pearl spot *Etroplus suratensis* and *Milkfish Chanos chanos* in pond water

Polyculture is the culture of more than one species of aquatic organism in the same pond. The concept is that fish production in ponds may be increased by raising a combination of species having different food habits. The underlying goal of polyculture involves increasing productivity by more efficiently utilizing ecological resources within an aquatic environment. It is commonly believed that polyculture gives higher production than monoculture in extensive and semi-intensive systems and is considered more ecologically sound than monoculture. The mixture of fish gives better utilization of available natural food produced in a pond. The compatible fish species having complimentary feeding habits are stocked so that all the ecological niches of pond ecosystem are effectively utilised. Different species combination in polyculture system effectively contributes also to improve the pond environment.

Milkfish *Chanos chanos* and Pearlspot *Etroplus suratensis* are herbivorous fish species with good growth and survival rate which suits for the polyculture in the brackishwater aquaculture integrated fish farming system. It is reported that Milkfish can consume organic matter deposits at bottom sediment and thereby clean the waste accumulation and maintain water ecosystem of the pond. For polyculture integrated farming system in brackishwater aquaculture pond around 3-4 inches of

Milkfish and Pearlspot fingerlings can be stocked at the density of 1000-1500 nos respectively. The stocking density varies with the quantum of availability of seed and area of culture. Natural pond productivity is maintained by fertilization through goat and poultry dropping and manure. In addition, supplementary feed (20-25 % crude protein) prepared from locally available ingredients can be used at 2-5 % body weight daily. Monitoring of the important water quality parameters need to be done at regular interval to ascertain the growth and survival of the fishes. After a period of 150-180 days, the culture can be harvested when Milkfish and Pearlspot reaches to size of 300-500 g and 250-300 g respectively. This kind of culture system provides maximum survival (90-95 %). The production of milkfish ranges from 600-700 kg/crop while pearl spot production is from 400-450 kg/crop. The harvested Milkfish and Pearlspot can be sold in market at rate of Rs. 120-150/kg and Rs. 250-300/kg respectively. In one year, on an average two polyculture crops of Milkfish and Pearlspot can be undertaken in integrated farming system in brackishwater aquaculture pond.

Harvested polycultured Milkfish and Pearlspot from integrated farming system in brackishwater aquaculture pond

H. Surti goat farming in shed installed on pond dyke

Goat is considered as poor man's cow and a goat's excreta is considered as a very good organic fertilizer. The goat excreta contains organic carbon-60 %, N-2.7 %, P-1.78 %, K-2.88 % and its urine is also equally rich in both N & P. At least 50-60 goats are essential to fertilize 1 ha pond.

The Surti goat is an important breed of domestic goats in India. It is a dairy goat breed and mainly raised for milk production. Surti goat is one of the best dairy goat breeds in India. The Surti goat is distributed in surrounding areas of Surat, Baroda and Nasik of Maharashtra. The breed is very popular in it's native areas, and they are raised and maintained in small flocks ranging from 3 to 15 goats. Most of the flocks are raised on extensive grazing system. Surti goats are small to medium sized animal with compact body. Their coat is predominantly white in color with short and lustrous hairs. They have medium sized dropping ears. Their forehead is prominent and face profile is slightly raised. Both bucks and does usually have medium sized horns. Their horns are directed upward and backward. Udder of the does is well developed with large conical teats. They have relatively short legs, and they usually unable to walk long distances. The Surti does are pretty large than the bucks. The does on average weight about 32 kg, and average body weight of the bucks is about 30 kg system in pond

Surti Goat

Low cost goat rearing shed on pond dyke

In case of commercial production of Surti goats, they need a good housing shed with clean water facility. A shed of 10 X 10 sq.ft will accommodate about 15 to 16 goats. Goat house on the pond dyke can be made from the ground with wooden, bamboo or concrete poles. The shed must floor dry, perforated and should have proper ventilation system. The goat waste (uneaten feed & faecal matter) through perforated base of shed falls into pond water and acts as a natural fertilizer which helps to augment the natural productivity of the culture.

Goat Feeding: Concentrate feed and Green Grass of pond dyke

For the livestock rising and production purpose, management of feeding should be carried out appropriately. Best feed for livestock is green grass. Grasses from grounds obtained from pastures, edges of farmlands, forage and fodder plants are the major sources of feeding for Goat. For each goat there is different requirement of necessary forage and fodder based on its body weight and about 2-6 kg of forage and fodder need to be fed per day to each goat ranging from 10-30 kg. About 5 liter of fresh water is necessary for goat per day. Goats can also fed with eat bitter grasses.

Goats can fed with dry matter equivalent of 4 % of its own body weight. To make the balance in the diet of goat and for obtaining good growth, concentrate feed (mixture of maize, wheat, rice bran, wheat bran, barley, millet, soyabean, bi-products of oilseeds) consisting of 20-25 % crude protein need to fed @ 300-500 g per day to each goat For easy feeding to goats, forage and fodder are always given in stall-fed, and if stall-fed remains empty, it shows inadequacy of forage and fodder to goat. Goats should be fed twice in a day, in the morning and evening; and changing of water and feeding time table should be maintained at the same time. Unnecessarily, feed should not be over fed to goat. Over feeding may cause bloat out stomach and sometimes goat can die.

Generally, goat meat price varies from region to region and it will be more on special occasions. On an average, live weight of 1 kg Surti goat meat costs about 225 to 350 Indian rupees for bucks (males), 210 to 325 Indian Rupees for does (females). However, the price depends on negotiation skills and will get for cheaper when you buy in flock.

I. Poultry farming in shed on pond dyke

This type of integration utilises poultry droppings as a fertilizer for fish culture in the pond. Approximately 50-60 nos. of birds can be reared in a 2000 sq.m integrated farming system in brackishwater aquaculture pond. Poultry birds of Rhode Island or Leghorn variety are mostly preferred and require only 0.3-0.4 square meter space/bird. Hoppers can be used to feed birds and to minimise feed wastage. The poultry birds (layers) are mostly fed with starter, grower, and brooder feed as per their age and body weight. Small poultry house of 10 x 10 ft can be built over the pond. The poultry house floor can be constructed by using slatted bamboo or slatted wood so that the bird droppings fall directly into the pond. The birds can be kept in cages or allowed to move freely inside the poultry house or pond dyke.

J. Horticulture farming of salt tolerant varieties on pond dykes

In integrated farming system in brackishwater aquaculture pond, pond dykes cover a large area on many farms. However having a huge potential for increasing production, still pond dyke land is most often underutilized in aquaculture.

The brackishwater aquaculture and horticulture farming system includes the culture of salt tolerant fruits, vegetables and flowers on the dykes and peripheral area of the pond. For horticulture crop production the inner and outer dykes of the pond and adjoining areas are used without affecting the culture. The choice of plant is the main important criteria for the success of this system. The salt tolerant plant must be dwarf, seasonal, evergreen, remunerative and less shady. The salt tolerant fruit crops like pomegranate, sapota, aonla, bael, jamun, karonda, tamarind and date palms are relatively tolerant to salinity can be used for integrated farming system in brackishwater aquaculture pond. Most of the major cereal crops also exhibit high tolerance to soil salinity such as wheat oats and barley. The salt tolerant vegetables like brinjal, cucumber, cabbage, cauliflower, ladies finger can be grown according to their season throughout the year. The flower plantation on the embankment is also useful. The waste leaves of horticultural crops can also be used as for preparation of manure with mixture of goat and bird wastes. Manure from livestock and pond culture water can be used for the crop. Such integration provides additional income to farmer and beauty to the farm with 20-25 % more return in comparison to aquaculture alone.

Water quality management

The water quality of the pond plays an important role in culture production. The optimum water quality required for integrated farming system in brackishwater aquaculture pond is Salinity: 5-35 ppt, pH: 7.5-8.5, Temperature: 28-32 ^{0}c, Dissolved oxygen (DO): > 5 mg/l; Ammonia: <0.25 ppm, Nitrite: <0.05 ppm and Nitrate: < 1 ppm.

Economics

Integrated farming system in brackishwater aquaculture pond with livestock and horticulture is a sustainable business model. For a 2000-2500 m^2 pond, a revenue of about Rs. 7.0-7.5 lakhs per unit area (2000-2500m^2) against an operational cost of approximately Rs. 3.0-3.5 lakhs/crop with estimated net benefit of Rs. 3.5 4.0 lakhs per crop can be achieved. However, the revenue and income from integrated farming system in brackishwater aquaculture pond depends mainly on availabilityof culture area, species to be cultured and management of the system.

Advantages of integrated farming system in brackishwater aquaculture pond

- This kind of system allows efficient waste utilisation from different culture practice and recycling of wastes for fish production.
- It reduces the additional cost for supplementary feeding as well as fertilisation
- It reduces the effort and increases output with higher production and economic efficiency.
- Provides more employment opportunities to the farmers and
- Utilization of non-utilized untapped brackishwater and salt land for horticultural and agricultural uses.

Inference

The concept of the developing an integrated farming system in brackishwater aquaculture pond is to provide employment generation and livelihood opportunities to tribal communities throughout the year through integrated culture of different candidate brackishwater aquaculture species and important livestock varieties in one pond. Integrated fish farming serves as a model of sustainable food production

Revenue generation by tribals through integrated farming system in brackishwater aquaculture pond

Brackishwater aquaculture for
food employment and prosperity

For more information:
Director,
ICAR-Central Institute of Brackishwater Aquaculture
(Indian Council of Agricultural Research)
#75, Santhome High Road, MRC Nagar,
Chennai, Tamil Nadu. 600 028

Phone : +91 44 24618817, 24616948, 24610565
Fax : +91 44 24610311
Web : www.ciba.res.in
Email : director@ciba.res.in