



## *Saltmarshes for Aquaculture*

B.S. INGOLE, A. CHATTERJI, Z.A. ANSARI & A.R. PARULEKAR

The prospects of developing coastal aquaculture is considered to be an effective way for resource utilization and realistic land use policy. A major thrust is on the culture of economically important prawns and fish species in brackish water ponds.

Salt marshes or 'Khar' lands and extended estuarine wetlands have been considered as potential area for coastal aquaculture. They are unique tropical ecosystems deriving benefits from both terrestrial and aquatic production. They have high biological productivity potential and also serve as nursery for some of the commercially important fishes and prawns (Hamilton & Snedeker, 1984; Parulekar, 1986; Ingole et al, 1987).

The techniques for raising the productivity of such marshy lands and water bodies by fish farming are of recent origin. The real problem is to achieve the more widespread adoption of fish farming techniques which, while substantially increasing the sea food supply can also make a significant contribution to the rural development by creating more vocational opportunities.

The main necessity for such operation is to conduct a detailed feasibility survey of such potential areas. The general methods adopted for such survey along with the production

### *Coastal Zone Management*

The CICEF is now establishing the five pilot farms and hatcheries, in the five zones with the cooperation of the respective state governments. The operation of these pilot hatcheries and farms will be by CICEF with UNDP technical assistance. At the pilot farms, in five types of zones already identified, the appropriate technology of producing 4 to 5 T per hectare per year of prawn in 2 or 3 crops, under semi-intensive culture system (as applicable to the respective zones) will be evolved and the fishery officers will be trained to propagate the methods evolved to the fish-farmers to adopt and apply in their farms. At the pilot hatcheries the officials will be trained in production of prawn seed to assist the State Departments of Fisheries in replicating and operating hatcheries at other sites depending upon the seed requirement.

### **Conclusions.**

From the foregoing, the fact that large areas along the coast are available for development of aquaculture is clear. With the development of coastal aquaculture the devastating effects of rise in sea level on the coast could be delayed to some extent and a good harvest of fish/prawn can be reaped. Adopting extensive system of farming or avoiding usage of such primemovers or mechanical equipment which emit heat and carbon gases in the semi-intensive farms, would considerably help in reducing the heat and carbon dioxide levels in the atmosphere. Provision of green belt along the coast could increase the absorption of carbon dioxide and reduce the 'green house effect' and deter the sea level rise.

estimates and profitability to the proposed venture are described here.

#### Objectives

- (i) To demonstrate and evolve an ideal pattern of resource utilization and management of the untapped renewable resources of the 'Khar' lands.
- (ii) To start commercial fish farming of a variety of fin-fishes and shellfishes by using the indigenous techniques.
- (iii) To generate self-employment opportunities for coastal population.
- (iv) Establishing shrimp hatchery to fulfil the stocking requirement in shrimp farming.
- (v) The ultimate aim of such study is to develop or adapt appropriate aquaculture methods, that have minimal impact on the ecosystem through compatible use strategies.

#### Factors to be taken into Consideration

To undertake the pond culture as well as open water culture in marshy areas requires very careful consideration of many aspects to make it functionally efficient and economically viable. Therefore, the following points are needed for consideration :

- (i) Location of the site.
- (ii) Topography of the area.
- (iii) Tidal fluctuations.
- (iv) Vegetation in and around the area.
- (v) Resident biota - qualitative and quantitative assessment.
- (vi) Soil conditions obtained at the site.
- (vii) Magnitude of bio-geo-chemical interaction.
- (viii) Infrastructural facilities like accessibility, building freshwater resource and electricity.
- (ix) Marketing for the sale of farm products.

#### Morphometric Conditions of a Salt Marsh

Salt marshes form on sheltered inner curves of estuaries, or they may have no physical barrier between themselves and the open sea. They are characterised by strong tidal currents and

In contrast to the preceding types by widely fluctuating salinities in the inundating tidal waters. The complex creek systems and numerous pans within a salt marsh increase the number of species able to survive, but there may be great changes in salinity from almost freshwater after heavy rain to hypersaline after a prolonged dry spell. As can be seen from Fig. 1, that the typical salt marsh is usually fed by a creek water and get flooded during the spring tide.

#### Description of a Saltmarsh at Saphala, West Coast of India

Saphala Salt Marsh (Lat. 19°41' N, Long 72°37' E) is about 110 km north of the metropolis of Bombay. It covers a total area of about 1907 hectares, out of which about 230 hectares is under salt production (Fig. 2). The saltmarsh falls under the backwaters of river Vaitarna and two bifurcating creeks, Sarwar and Mande.

The Southern and South-eastern part of the project area is flanked by paddy fields, whereas the area demarcating the northern limits are characterized by hilly tracks and wastelands. Both the Sarwar and Mande creeks have a gradual seaward slope and the maximum depth of water during the extreme high water of spring in either of the creeks rarely exceeds 1.5 meters.

The feasibility survey (Parulekar & Untawale, 1982; Anco, 1985) of this saltmarsh indicated that the magnitude of variations both seasonal and annual in water temperature, pH, salinity and dissolved oxygen in the backwaters and the open sea, not only depicts but fits into the broad pattern of variations in hydrology of estuaries, backwaters and the nearshore regions along the west coast of India.

As assessed from the survey (Table 1) the saltmarsh at Saphala provides environmentally and biologically suitable conditions for the rearing and commercial production of seafood species.

#### Brine Shrimp Culture

Brine shrimps are tiny phyllopod crustaceans and normally inhabit high saline waters even upto 310 ppm of salt. Most commonly occurring species is *Artemia salina*. The brine shrimps

are mainly used as a food in shrimp farming and it has substantial demand within the country besides good export market.

*Artemia salina* occurs in the condenser pans, especially in sector C (Fig. 2) of the Siphala salt marsh. If the inoculation at the rate of 50 gms of cyst per hectare is carried out in November, the harvesting can be undertaken in April-May, and the production of 30 kg cyst per hectare is expected from such operation. It will generate a revenue of Rs. 15,000/- per hectare.

#### Open Water Culture

This technique includes the floating cages or rafts and enclosures for culture of fishes and molluscs. Fish like sea bass '*Lates calcarifer*' can be grown in floating cages. The bivalve molluscs, because of their sedentary and gregarious habit, high physiological adaptability, short food chain, prolonged breeding behaviour and fast growth rate form the most ideal organisms for large scale aquaculture operations. These organisms have the most efficient and versatile way of converting the organic matters in the aquatic ecosystem, into palatable and nutritious human food.

Mass culture of mussels, *Perna viridis*; and oysters such as *Crassostrea graphoides* and *C. cucullata* can be started in the reservoir area during the salt production period (November-May) when there are less variations in the salinity. Mussel culture by long lines or raft culture and oyster culture on broken roof tiles can be initiated from November, when the spats (seeds) are available in natural beds.

The expenditure involved is estimated to be less than Rs. 2000/- per raft. The estimated yield will be 450 tons per hectare per year for green mussels and 100 tons per hectare per year for oysters. Time for attaining marketable size varies from 18-20 weeks in mussels to 44-48 weeks in oysters. In view of the fact there is a flourishing home and export market for edible bivalves, there exists good scope for starting the culture of shell fishes.

### Shrimp Hatchery

Although the backwaters and estuarine systems of India form nursery areas for the commercially important prawn and fish species (Gopal Krishna, 1988), they do not fulfil the stocking requirement of quality seeds for commercial fish farming.

Penaeid prawns such as *Penaeus monodon*, *P. indicus* and *P. merguensis* because of the fast growth rate and big size are preferred for commercial shrimp farming. However, one of the stumbling blocks in their farming is the non-availability of quality seeds. A sustained supply of seeds of penaeid prawns can be obtained by setting up shrimp hatchery in the unutilized area within the saltmarsh. The estimated investment for such an operation will be about Rs. 10 lakhs and will need about one hectare of land.

Once operational, the hatchery can produce about five million post larvae and juvenile of quality penaeid prawns per year. Thus, besides providing stocking material for shrimp farming in the salt works the hatchery can also generate additional revenue from marketing.

### Polyculture or Mixed Culture of Shrimps and Finfishes from Wild Stocking

Most of the saltmarsh areas abound in the occurrence of different life-history stages of finfishes and shell-fishes (Table 2). During the rainy season i.e. June-Sept, when the salt production activities are at a standstill and most of the saltwork area gets inundated with rainwater, the stocking of wild stocks comprising of mullets, pearl spot, milk fish along with naturally occurring penaeid and metapenaeid prawns can be practised. For maintaining the salinity between 18 ppt and 30 ppt the "bittern" from the salt work can be diverted into the reservoirs.

The stocking can be undertaken in late May or early June, when post larvae and juveniles of a variety of commercially important finfishes and shrimps, occur in the natural waters. This will have to be done by regulating the high tide seawater flow through the sluice gate. Once a week the flushing of water has to be carried out for achieving good renewal of water.

within the impounded area. The species grown under such wild stocking, attain marketable size within 15-20 weeks and accordingly harvesting may be done in October.

#### Brackishwater Culture

Development of brackishwater culture depends upon the application of techno-economically viable methods, which are generally site specific. As shrimps fetch highly lucrative returns, emphasis in recent times has often been placed on shrimp farming.

This phase of development, comprising of clearing and deepening of creeks, erection of barrage and sluice gates, contouring and bunding of low lying lands and construction of embankments, is timed to be initiated after reviewing the progress of operation under the polyculture phase of development. The implementation of this particular phase besides generating newer seafood resources including seaweed, finfishes, bivalves and shrimps will also help in evolving a realistic pattern for "Khar" land utilization along the Indian coastline.

#### Aquaculture Production and Revenue Generation from a Saltmarsh

Development of a saltmarsh for aquaculture may be taken up in three phases. The farming of brine shrimp in condenser areas should be started in the first phase. This involves less investment and manpower with high return. The reported yield is 30 kg cyst/ha/season and the present selling price for Artemia cyst is Rs. 600-700/kg. Therefore the income of Rs. 18,000/ha/season is expected. (Table 3).

Polyculture or mixculture of commercially important finfishes such as mullets, milkfish and pearly spot alongwith the naturally occurring penaeid and metapenaeid prawns can be practised during the second phase. This will give the production of around 2-3 tonnes/ha. The value of this produce, at prevailing market rate will be Rs. 10,000 per hectare. Raft culture of mussels and oysters can also be started during the salt production period. The production of 15 tonnes of mussels and 3 tonnes of oysters per season is expected from such operation with the

income of Rs. 1,00,000/ha/season.

After assessing the feasibility of shrimp production, the setting up of shrimp hatchery can be taken up. This can produce about five million post larvae and juveniles of one and two prawns per year and will give the additional revenue of Rs. 40,000 per year.

After having the necessary infrastructure facilities at farm site, the shrimp farming can be started in the second phase. The time for commercial production, from the time of stocking to harvesting will be 20-21 weeks and with the sustained supply of quality seeds from the hatchery, two crops a year can well be raised. Therefore, the shrimp production will start in the third phase. The estimated production is about 500 kg/ha/ harvest, which at the current market price will fetch about Rs. 70,000/ha/year, against the production cost of Rs. 15,000/ha/year.

To supplement the income and also to make the shrimp farming more lucrative, shrimp-cum-fish culture of mixed culture can be practised by adopting a realistic stocking strategy. This will generate additional income, as besides the shrimps, 700-800 kg/ha/yr of fish can also be harvested.

#### **Development of Manpower**

Aquaculture is a labour intensive activity. However a large part of the manpower required will be unskilled. For the managerial and supervisory functions, only 10% of the total manpower will be needed.

With the idle capacity of the existing staff on the salt works especially during monsoon season a certain amount of diversion for utilizing the manpower-needs to be explored. This will considerably help in infusing new manpower, at a lower level.

#### **Recommendations**

- (i) The floating cages and rafts culture or on bottom culture in reservoir have minimal or no ecological impact on the ecosystem.
- (ii) Brackish water culture in saltmarsh has no adverse effect on the environment.



- (iii) Brine shrimp culture in condenser and reservoir area will give additional revenue with minimum investment.
- (iv) Mariculture practices should be encouraged in salt-marshes in preference to pond culture with maximum utilization of land, manpower and natural environment.
- (v) If the more suitable land is available the shrimp hatchery can be set up which will provide stocking material for shrimp farming and also generate additional revenue.

TABLE—1  
Environmental Parameters

Months	Sta- tion	Air Temp. °C	Surface Water Temp. (°C)	Sal- inity (‰)	Dissolved Oxygen (ppm)	pH
August	1	29.0	24.5	3.1	2.2	7.50
	2	29.0	23.2	3.4	2.0	7.30
	3	29.3	23.5	3.7	2.4	7.30
	4	29.3	23.0	3.0	1.6	7.50
	5	29.0	24.2	3.4	4.8	8.00
Average		29.00	27.18	4.70	2.56	7.50
September	1	27.5	23.0	4.3	2.9	7.75
	2	29.0	29.0	3.4	3.0	7.75
	3	29.0	30.0	4.6	3.3	7.00
	4	29.0	30.0	12.1	2.9	7.30
	5	30.0	32.0	4.8	2.8	7.50
Average		29.70	29.80	7.94	2.98	7.50
October	1	31.2	29.9	29.5	3.0	7.50
	2	29.3	31.0	29.7	2.5	7.30
	3	30.5	30.0	29.7	3.5	7.50
	4	31.0	30.3	30.8	4.0	7.50
	5	30.0	31.0	29.6	3.7	7.00
Average		30.44	30.54	29.32	3.42	7.40

TABLE 2

Availability of Life Stages of Commercially Important Species of  
Infauna and Shallowwater Salt Marsh

## Notes

1. *Mugil cephalus*
2. *Micropogonias*
3. *M. undulatus*
4. *M. undulatus*
5. *Stenotomus*
6. *Stenotomus*
7. *Leiostomus*
8. *Etroplus suratensis*
9. *Tilapia mosambica*
10. Prawns
11. *Paraneuhaus induta*
12. *P. monodon*
13. *P. pergamus*
14. *Metapenaeus brevicornis*
15. *M. affinis*
16. *M. edmonsi*
17. *M. monodon*
18. *Parapenaeopsis setiferus*
19. *P. setiferus*

## Invertebrates

20. *Berita viridis*
21. *Grasshopper*
22. *C. succinea*

TABLE-3

Year-wise Production and Income Generation Trends from Aquaculture

Year	Activity	Area under cultivation (ha)	Estimated production (tonnes)	Subsidy (in Rs. in the month)
First year	Bride shrimp culture in condenser area	1	30 kg.	18,000
Second year	Salmon hatchery	1	9 million post larvae	20,000
	Bullfrogs in reservoir area during monsoon season	1	3 tonnes	10,000
	Mussel and oyster culture in reservoir area during November-May	1	17 tonnes	1,05,000
	Bride shrimp culture in condenser area	1	30 kg.	15,000
Third year	Mussel and oyster culture in reservoir	1	17 tonnes	1,05,000
	Bride shrimp culture in condenser area	1	30 kg.	15,000
	Shrimp farming	1	500 kg.	20,000
	Sale of hatchery products	1	1 million post larvae	6,000

\* Production estimates are based on the results of relevant technology.