CRAB FARMING POTENTIAL IN INDIA

R. MARICHAMY

(Central Marine Fisheries Research Institute, Kochi)

INTRODUCTION

COMMERCIAL scale mud crab culture is fast developing in the coastal ponds of Andhra Pradesh, Tamil Nadu and Kerala. Countries bordering the Bay of Bengal Regions have given much importance for the development of crab farming in order to increase the production for export market. Fall of wild stock in resourceful grounds have stressed the need for proper management and stimulated mariculture ventures. The common mud crabs are *Scylla serrata* and *Scylla oceanica*, the later is widely preferred as it grows to a maximum size of 1.5 kg and will not cause any damage to bunds or fencing arrangements in the culture system. A pcakage of technology for field culturing of crab in coastal ponds as well as for production of seed in hatchery is available and envisage the scope for the large scale development of crab farming in the country. This paper deals with various potentials for the progress of farming, methods of culture, seed production, management techniques, constraints and indicative economic returns of the projects.

Pontentials : Extensive potential shallow coastal waters, lagoons, brackishwaters lakes, estuaries and intertidal swampy areas are available along the east and west coasts in the country.

Besides, this, the area already developed for shrimp farming in the coastal areas may become suitable for crab farming, as evidently seen in Tuticorin.

The prominent grounds identified in different States are given below :—

TABLE 1. *Brackishwater area Suitable for Crab Culture*

State	Estimated Brackish-water area (ha)	Area developed for shrimp culture (ha)	Prominent source and area in sq. m.
West Bengal	4,05,000	33,918	Sunderbans area
Orissa	31,600	7,417	Chilka Lake 906 Km^2
Andhra Pradesh	1,50,000	8,100	Godavary estuary 211 Km^2
Tamil Nadu	56,000	480	Pulicat Lake 461 Km^2 Ennore, Killai back water 13 Km^2 Punnakayal backwater 10 Km^2
Kerala	65,000	13,145	Vembanad Lake 300 Km^2
Pondicherry	800	50	Veerampatnam backwater Karaikal estuary
Karnataka	8,000	2,542	
Goa	18,500	525	
Maharashtra	80,000	1,869	
Gujarat	3,76,000	231	
Total	11,90,900	68,232	

It has been estimated that the potential resource of crabs particularly from the estuaries and backwaters, having a total area of 7,770 km^2 as 13,209 tonnes in the total potential resource of 43,816 tonnes in Indian coastal waters and apparently the southern part of the coasts are potentially richer than the northern part (Rao *et al*, 1973). Mud crabs support a year-round local fishery in coastal areas, estuaries, lagoons living both intertidally and subtidally. Babu

(1995) has reported on the potential grounds, season and culture techniques employed in Andhra Pradesh. There has been a noticeable decline in its population in the potential grounds such as Chika Lake, Pulicat Lake and coastal belt along Kakinada due to over exploitation by artisanal fishermen and now the catch consists of many undersized crabs. Indiscriminate fishing of juvenile crabs are going on in most of the commercial fishing grounds which can be trapped for further fattening in ponds. Moulted crabs of the commercial catches are preferred for fattening in cages/ponds. Available information on larval rearing and seed production have been enlisted by Marichamy and Rajapackiam (1991). A major limiting factor to the expansion of carb farming in number of countries are the non-availability of hatchery produced seed and farmers dependent on wild sources which are not reliable always. Production of crab seed supports the grow-out efforts and serves as a source of demand. The Central Marine Fisheries Research Institute has developed a viable technology for seed production and this will promote further for commercial scale production by private entrepreneurs in the country.

Maturation of ovary and spawning takes place normally in the sea. However, when the broodstock of matured size crabs in 9-11 cmcw are maintained in coastal ponds with salinity range of 34-36 ppt, observed gonadal maturation and obtained ovigerous females in healthy conditions. This study revealed the scope for the production of berried female or spawner crab in confined coastal waters/ponds itself. Similar observations on pond grown ovigerous females and successful uses in hatcheries has been reported by Liong (1995).

In India, shrimp ponds of high saline water media have been converted in many places for mud crab farming and such sites offer ample scope for the production of gravid female and spawners. Collection of such females of reproductive value from natural grounds any further will be potentially dangerous and the farming efforts as explained above will promote the sustainability of the fisheries.

Wild seed are available round the year in backwater zones of Chilka Lake, Sunderbans area, Kakdip, Namkhana, Kakinada coast, Dowleswaram, Rajamundry, Pulicat Lake, Killai backwaters, Muthupet saline swamps, Punnakayal estuarine complex, Colachel, Vypeen/Neendakara and Kozhikode for promoting the culture operations.

Grow-out techniques

A review of literature shows that there have been a few efforts to culture the young ones to marketable size involving a variety of techniques in Philippines, Thailand, India, Sri Lanka, Malaysia and Indonesia. Mud crab culture depends to a large extent on wild seed supply in these countries. Culture and fattening are two distinct operations though it appears to be the same. Culture is a growout operation to raise the young seed to marketable size of 500 g whereas fattening refers to the holding of growers or water crabs for short duration to acquire maximum biological attributes to realise better economic returns. Large scale culture of mud crab is possible in fenced ponds, pen or floating cages. Techniques, employed in different types cages have been described by Marchamy (1980) and Marichamy *et al* (1986). This system is highly suitable for fattening the crabs. Fattening is an advanced technology widely followed in Thailand, Taiwan, Malaysia and Indonesia. Good number of potential grounds adjacent to productive brackishwater lakes exist for the expansion of this profitable venture. Gravid female mud

Fig. 1. *Gravid female showing the fatty gonad in the Centre when carapace is lifed.*

Fig. 2. *Fattened Mud crabs reared in pond.*

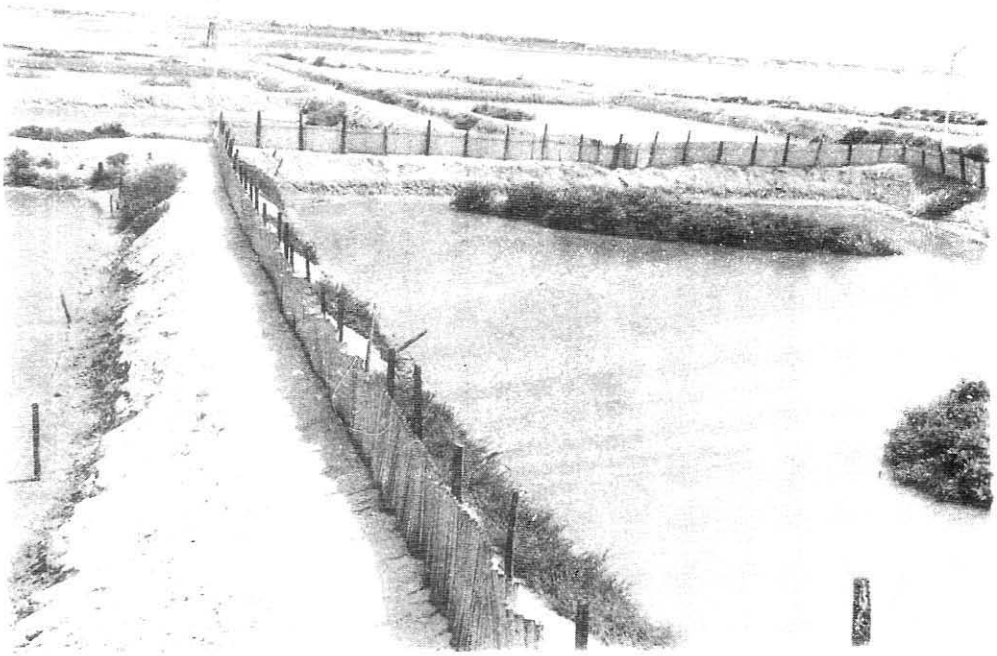

Fig. 3. View of Coastal crab culture pond with fencing.

Fig. 4. *Crab culture pond after harvesting.*

crabs as seen in Figure 1 with their internal orange-red egg masses filling the carapace are in good demand in fast-food resturants and because of the premium prices many farmers prefer this fattening. It is advantageous to develop this system in brackishwater area, wherein energy lost by frequent moulting are less and more gain in weight is realised.

In fatterning system much care is given in feeding the stock intensively at 15-20% of body weight. Cuttle fish wastes and fresh bivalves meat facilitates fast development of the gonads. In neighbouring countries, brackishwater snail or meat of land snail is profusely used. Another important factor is the maintenance of salinity at a steady level. Brackishwater medium around 20-25 ppt in tidal areas are found most suitable for operations. Loss of energy by frequent moulting is minimised in such media and the system promotes to gain weight. Mud crab attains maturity at 90-110 cw. So females of 7-8 cm size with underdeveloped gonads are gathered from commercial catches and stocked in compartmental cages made out of dealwood boxes at 3-4 pieces/sq.m. for fattening. Depending upon the initial size and conditions of the crab, the fattened gravid female is attained in 3 or 5 weeks time. More than 90% survival is realised in cage culture system whereas in coastal ponds 30-40% is reported. Fattening is practiced in tidal ponds also (Fig. 2). Water crabs of both sexes in maturing sizes are also preferred for fattening. Commercial catches invariably contain newly moulted water crabs and they are discarded in export market and no local values also. Such crabs of advanced sizes may be selected periodically for fattening in cages. However, female crabs should not be stocked with males, if the aim is to produce gravid fattened crabs, that too, when reared in high saline media. Mating or copulation should be avoided and crop should be harvested before they spawn. In brackishwater ponds chances for maturation and spawning are less. So, wherever possible the water quality may be manipulated by maintaining the salinity according to the need. In such arrangements they energy is conserved for stomatic growth, leading to a maximum weight input.

Fattening of crab is profitable, because of the fast turnover, low operating cost, high survival rate due to control of cannibalism and short rearing period and good market demand for finish product. Crab fattening, could be carried out on part time avocation and needs relatively low capital. Viable technology is available for this small-scale operation and the scope for development is promising. Production potential of 2000 kg/ha was encountered in the trials made in cage culture.

Crab culture in ponds : Coastal, tidal ponds are developed for the large commercial scale culture of mud crab. The intertidal mud flat in the edge of Tuticorin Bay with advantages of tidal range for water movement and circulation was designed for the development of productive culture ponds of 0.1 and 0.3 ha extent for mass rearing of mud crab (Fig. 3 and 4). Overhanging fences with palmyrah rachis on dikes were provided to control the migration of crab from culture ponds. Soil mounds with mangrove were retained here and there to serve as natural shelter. In order to minimise the mortality of crabs particularly at the time of moulting by mighty predators, 'Refugee cages' made out of hollow bamboo pieces or stone were pipes were placed inside the ponds and this system improved the survival

rate. Feeding consists of low cost trash fishes/gutted wastes of fish market. Screened water is replenished by tidal exchange. Seeds in the size 3-7 mm cw were gathered from commercial catches and lifted in cool hours from Publicat Lake and Punnakayal to culture site at Tuticorin without any mortality. Transportation technology is simple. Seed are placed in tires, layered with soaked gunny sheets in cages or baskets. Seed are released at the rate of 10000/ha. Conducive environmental factors were determined. Temperature varied from 27-32°C and salinity between 26-49 ppt. Dissolved oxygen recorded in the range 3.7-6.0 ml/L. Depth was maintained at 0.8 mt.

The high salinity recorded in season in the range 35-45 ppt has never been a hinderance for the survival and growth of mud crab in coastal ponds at Tuticorin. The growth, survival and production rates differ according to the system of culture. Monoculture with single size stocking, monoculture with multiple size stocking, polyculture with milkfish and mullets, fattening of gravid female crabs are experimented and attained encouraging results in the range 2500-3500 kg/ha/crop. In polyculture system, the unconsumed organic feed materials are decomposed and finally enriched the algal bloom in the culture site. This green water with 'Lab Lab' and other algal matters become the natural food for milkfish and increased the production. The results envisaged scope for further improvement in production. Maximum weight input/75-100 gr/month was noticed in the size group of 9-13 cm(cw). This is the determining factor to select the size of seed for fattening. Viable technology was also evolved for raising the spanwer crab by environmental manipulation.

Large scale production of mud crab is possible only in ponds, whereas in cage culture system there are some limitations, though better survival and production are reported. Environmental manipulation such as regulation of water quality, maintenance of conducive conditions etc. enables farmer to produce gravid females or spawners in pond system.

Depending upon the availability of seed, the culture is designed. Monoculture with single size stocking becomes possible when uniform size of crab seed are available. Stocking operation is completed in short time and harvesting is arranged in single attempt after an interval of 6-8 months according to the size of seed stocked. Better survival was recorded in such experiments because the loss of stock due to cannibalism was less. Monoculture with multiple size stocking means the holding of different size groups ranging from 30-70 mm cw. Seed are gathered over a long period as and when available. Selective harvest of marketing size crabs of 400-500 g alone are lifted from culture ponds according to the demand inthe market. The crop is maintained like a wild stock.

Growth is encouraging but survival is recorded at 25% due to depletion of stock. Big size crabs predate the younger ones. Crab, needs privacy, particularly, at the time of moulting. Provision of artificial shelters or more 'refugee cages' has improved the survival of stock to a greater extent in later experiments.

In Taiwan and Philippines most mud crab growout operations are part of polyculture systems in which milkfish, penaeid prawns and seaweeds are also produced. In polyculture trials the ponds are manured for the growth of Lab Lab and other micro algae well in advance. *Chanos chanos* is a compatible species and without any hinderance to the other they

grow well. Seed of milkfish are collected in May-June and September-October in intertidal lagoons in Gulf of Mannar coast and stocked at the rate of 5000/ha.

In such ponds, crab seed in the size range 5-7 cm which do not fetch an market value are gathered from commercial catches and stocked at 5000/ha. In polyculture system the unconsumed organic feed materials are decomposed and finally enriches the algal bloom in the culture site. The 'green water' and other algal matters became the natural feed for milkfish and increased the production.

Results of the culture experiments are encouraging. Crab seed with an average of 35 mm and 7 g have grown to 153mm/617g in monoculture with stocking of uniform size. Monthly average growth is recorded as 14mm/70 g with production at 1700 kg/ha. In polyculture trials the same yield is attained in addition to the product of milkfish. *Chanos chanons* released at 20 mm/0.1 g have grown to 346 mm/300 g. With the survival of 50% the rate of production recorded as 800-1000 kg/ha/crop.

The growth pattern of mud crab reared in monoculture in coastal pond is presented in Table 2. It may be seen that marketing size is attained 5-6 months. The rate of growth shows variations (12-17 mm/23-75 g per month) according to the size of crab.

Maximum growth of 17.2 mm/67.5 g was noticed in male crab than the females and this difference is prominent in crabs measured in the size 130 mm and above. A fall in the rate of growth (12mm/53-63g) was noticed subsequently both in male and female and the study indicate that culture has to be terminated soon after this size is attained so as to realise better economic returns. In the present export trade, a maximum of price of Rs. 250/- is offered per kilogram of crab (2 pieces). So further rearing of crab beyond this size in the same pond may not be economically feasible.

Farm management : Preparation of mud crab culture ponds is more or less similar to the shrimp farm development. Soil should be soft and clay mixed sand with pH around 8.00. 20% water exchange promotes the maintenance of water quality. Conducive environment and salinity of the culture media is 15-28 ppt with temperature in the range 25-31°C. However, slightly higher salinity zones have also been found to be productive. Spawner crabs could be produced by stocking both male and female of maturing sizes in the impoundments of ponds by environmental manipulation. Sampling of the stock is made by periodical cast-net operations to assess the growth, survival, biomass, feeding requirement etc. similar to

TABLE 2. *Growth pattern of mud crab reared in monoculture system.*

No. of days after stocking	MALE						FEMALE					
	Mean size		Growth increase		Growth rate/m		Mean size		Growth increase		Growth rate/m	
	cw mm	wt gm	mm	gm	mm	gm	cw mm	wt gm	mm	gm	mm	gm
0	36	7	—	—	—	—	36	7	—	—	—	—
76	72	65	36	58	14.2	23.0	72	66	36	59	14.2	23.3
169	133	387	97	380	17.2	67.5	132	344	96	337	17.0	60.0
258	145	552	109	545	12.7	63.4	143	463	107	456	12.4	53.0
285	154	720	118	713	12.4	75.0	153	591	117	584	12.3	61.5

shrimp farming practices. Maximum water exchange to a level of 80% is arranged particularly during lunar days to stimulate the stock for moulting and growth. In polyculture trials, supplementary feed with rice bran and groundnut oil cake mixture with a binding substance like tapioca is added on alternate days. Harvesting is arranged during morning hours and care is given to handle the grown crabs. Loss of appendages, particularly the chaelate legs is avoided, and tied before lifting to the market.

Hatchery management : Marichamy and Rajapackiam (1991) have succeeded in designing a promising system for rearing the zoeae larvae and seed production. The influence of temperature and salinity on the incubation of berried female for successful hatching of larvae has been well recognised. Low salinity and low temperature may take more days and hatched out larvae may not be viable. Best result is attained at salinity of 31 ± 2 ppt, oxygen at 5 ppm, temperature in the range 28-31°C and pH 8.00-8.50. Once the larval stock reaches megalopan stage on 17th or 18th day, the salinity of the rearing medium should be brought down around 25 ppt to promote them for quick metamorphosis into crab stage in 7-8 days time. Intermoult period are shorter for young crabs reared in reduced salinity at 21-25 ppt. Besides this management, artificial seed weeds (bunches of nylon fibre) are suspended in the rearing tank to increase the survival of megalopa since cannibalism is manifest from this stage onwards. The feed for early zoeal larvae consists of skeletonema, testraselmis, chlorella mixed with rotifer and yolk. Zoeal III and IV prefers rotifers at 30-40/ml and artemia Nauplii at 10-15/ml, egg custard, fertilized bivalve eggs and BMC pellets (Japan). Minced clam meet and higher concentration of artemia nauplii, SUTIMAL pellets of 150-300 micron size constitute the feed for zoea V and above. Artemia biomass, macerated shrimp and live copepods are supplied to megalopa and early crab stages. The success of mud crab seed production largely depend upon the availability of technology in larval nutrition and microencapsulated diets. Next to Japan and Taiwan, Indian will soon evolve a viable technology for large scale commercial production of crab seed through hatcheries.

Constraints : Crab farming will remain small-scale until hatchery techniques to rear large number of larval and seed are researched and improved. Nutritionally balanced diet has to be prepared. Low survival and heavy cannibalism are the problems in larviculture. The inadequate supply of seed at desired time has been considered as limiting factor in crab farming. Destruction of nursery grounds and increased fishing activity with the support of excellent demand may damage the resource potentials still further in due course. Technology for crab farming is a proven one. Development of pond culture system of fattening in cages or ponds involve merely a transfer of appropriate technology already practiced in the bordering countries of Bay of Bengal region with necessary changes to suit local conditions.

Survival or recovery is poor in large scale operations in coastal ponds owing to loss of stock by cannibalism. Effective measures should be evolved by continuous field experiments to

minimize this in pond culture system. Crab fishery is well developed in the recent years in India and as such scopes are bright to develop fattening of crab in cages and ponds in brackish water area. The rejected sizes may be preferred for fattening for a short period to increase their market value.

Scope for development :

Larviculture studies indicated that tropical waters with high salinity and temperature are conducive for successful production of crab seed in hatcheries. India will take this advantage soon. In addition to the present efforts in farming and seed production, research programmes for seed survey, protection of nursery grounds, study on environmental condition for farming and development of extension by training to popularise culture and fattening are a few aspects invite our attention for promoting mud crab culture. Intensive fishing efforts and lucrative market in export trade necessitated careful planning and implement the advance techniques to promote this little known profitable venture. The available technolcogy both in farming and seed production envisage the scope for further investment in this part of mariculture industry. The present rate of production can be freely aimed to 2.4 tonnes/ha/crop of 5-6 months with proper management to increase the survival rate at 60%. Suseelan *et al* (1995) have worked out the economics of mud crab farming and derived a net profit of Rs. 1,11,550/0.1 ha. Based on several trials of mud crab culture made in coastal ponds at Tuticorin, the cost economics have been worked out and an indicative cash flow statement is prepared and given in Table 3. Crab culture is more remunerative than shrimp farming, particularly in fattening projects.

TABLE 3. NON-RECURRING (Other than the cost of land, pond construction etc.)

PARTICULARS	Amount Rs.
1. Renovation of ponds, fishing of sluice gates	7,000.00
2. Fencing arrangements and maintenance (4 ponds x 0.2 ha)	45,000.00
3. Manure and pond preparation	4,000.00
4. Refugee cages and holloq blocks (concrete) 500 x 4 ponds = 2000 nos.	20,000.00
5. Farm accessories	2,000.00
6. Refractometer	9,000.00
Total	87,000.00
RECURRING Expenditure for 3 crops	
1. Cost of crab seed for stocking	1,80,000.00
2. Feed	1,10,000.00
3. Nets (RINGS) etc.	3,000.00
4. Cost of milkfish seed	1,500.00
5. Farm materials	2,000.00
6. Transportation and fuel cost	10,000.00
7. Travelling allowances 4	20,000.00
8. Stationery, Photography etc.	2,000.00
9. Remuneration for admn. staff 4	6,000.00
10. Wages for labourer	9,600.00
11. Contingent expenditure	1,900.00
	3,46,000.00
Grand Total	4,33,000.00

INCOME

At the survival rate of 60% estimated production is	=	2400 kg/ha/5-6 months
Harvestable size	=	400 — 550 gr.
Present market rate for exportable quality	=	Rs. 180-250/-
Expected income	=	Rs. 4.8 to 5.4 lakh/crop
Income in 3 crops	=	Rs. 14.4 to 16.2 lakhs/"
Expenditure in 3 crops	=	Rs. 4,33,000-00
Net profit in 3 crops	=	Rs. 10.1 to 11.9 lakhs/ha.

Additional income expected in milkfish production is Rs. 20,000/ha/crop. Besides this, market rate for the sale of selective harvested crabs are likely to go up in the export trade.

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