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56 Economics of different production technologies in culture fisheries

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ABSTRACT

Fish production from the sea in India has almost reached the optimum level and aquaculture is fast emerging as an alternative avocation for many coastal rural fisherfolks. India is having about 2 million hectares of potential area suitable for the promotion of aquaculture. Hardly 10% of the potential area is presently used for various types of aquaculture practices, concentrating mostly on shrimp farming mainly due to its high export demand and lucrative price. But in recent years the demand for several other items such as clams, mussels, edible oysters, crabs, lobsters and a few finfishes is continuously increasing and commanding a premium price in the international market. Hence, there is immense scope to promote aquaculture of these varieties in our country by adopting appropriate location-specific farming practices. The economic viability and comparative profitability of different culture practices are the determining factors for the investors in their choice, selection and commercial adoption of various production systems in aquaculture.

Introduction

The Central Marine Fisheries Research Institute has conducted a number of studies about the economic viability of shrimp culture practices commercially adopted by fish farmers. Open sea mussel culture and pearl culture have been successfully demonstrated to the fishermen by the Institute for commercial adoptability. The successful demonstration and technology transfer of edible oyster farming and mud crab fattening led to their commerical adoption in many parts of our country. In this context, the present study attempts to bring out the economics of shrimp culture practices, cost structure

and potential earnings of small scale shrimp hatcheries and feed industries, the indicative economics of open sea mussel and pearl culture and brackishwater farming of edible oyster and mud crabs.

Materials and methods

Data on the costs and earnings of traditional and semi-intensive shrimp culture practices have been collected from 150 sample farms located in Ernakulam District of Kerala. Similarly primary data on the cost structure and revenue of practicing crab-fattening cum prawn-fish composite farming have been collected from 10 commercial farmers in Parur-Cherai region of Ernakulam District. The data on indicative economics of shrimp hatchery, feed mill, open sea mussel farming, pearl culture and brackishwater eible oyster farming have been collected from various publications of Central Marine Fisheries Research Institute.

Shrimp culture practices

In adjoining low lying areas of the brackishwater regions three types of prawn culture practices are followed. They are 1) seasonal prawn culture; 2) prawn farming in perennial fields and 3) semi-intensive prawn culture.

The practice of growing prawns in rice-fields on a commercial scale is an important part of prawn industry in Kerala. The *Pokkali* fields in Cochin area lie close to the backwater and at a slightly higher level than the lake. These fields are either connected with the estuary directly or linked by a number of tidal canals.

Paddy cultivation is done from June to September (southwest monsoon period). During this period, the salinity of brackishwater is reduced because of the rains, thus making the farms conducive for paddy cultivation. After the monsoon, the traditional prawn culture starts. After the paddy harvest, the saline water is allowed from the estuary to enter the fields freely. Most of the paddy fields are small holdings and a number of such fields lying together in an area is converted into a single block and leased out for prawn culture operations. Bunds are repaired and strengthened with clay and hay. Sluice gates are inserted to the primary bunds of the field to regulate in and out flow of water. A sluice gate is a rectangular hollow structure with one end opening into the pond and the other into the estuary or canal outside. The lateral

sides and the bottom are made of wooden planks. At the centre of the sluice, two vertical grooves are provided on the side walls into which planks are inserted to control the flow of water. On the inner side of the wooden sluice is a close meshed mosquito netting to prevent the escape of prawns. The number and size of sluice gate vary with the size of the farm. Kerosene lamps are hung above the sluice gate to attract the juvenile prawns into the pond. Harvesting of prawns and fishes are conducted during the new moon and full moon days using bag nets, drag nets and traps. The major prawn species such as *M. dobsoni*, *M. monoceros*, *P. monodon* and various types of fishes like tilapia, mullets and *Etroplus* besides small quantities of crabs are caught. Prawn culture is completed by mid April and the fields are dried and drained. The entry of water is prevented using wooden planks in the sluice gate. Once the pond is dried, it is raked up and heaped into small mounds, which is allowed to dry until the commencement of the monsoon rains which leach out the salt contents from the mounds into the surrounding water. With the advancement of southwest monsoon, the salinity decreases and the paddy seeds are sown on the top of the mounds and thus the cycle is repeated.

The perennial ponds are water impoundments which will have water throughout the year and the trapping and holding method is practiced round the year with periodic harvesting during the new moon and full moon days. It is basically on enclosed shallow estuarine areas, connected to the tidal creeks and estuaries by means of sluice gates. These farms are either owned by the government agencies or farmer's societies and are leased out to contractors for a period of 12 months. The culture method, harvesting and species composition are similar to that of seasonal farms, discussed above.

Semi-intensive prawn culture is done on Pokkali fields in Kerala. The fields are deepened with strong dykes. The farms are provided with one peripheral and two cross channels. The average depth of the pond is maintained between 0.5 to 1.0 m. A wooden sluice gate with a wooden shutter is fixed in each field. This is for regulation of water flow and to prevent the entry of unwanted fishes into the pond as well as to prevent escape of the stocked prawns. Proper exchange of water in the pond is maintained by the sluice gate operation during high tide and low tide. Pumps are used to drain the ponds during eradication of predators and also for harvesting. The ponds are prepared before stocking of seeds by removing the predators using ammonia @ 80 kg/ha and by application of lime. The hatchery produced seeds of the

desired species are used. The seeds, maintained in happas for 10-15 days are released into rearing ponds. Regular exchanging of water is essential during this period. Prawn feeds, containing mainly clam meat, are prepared locally and fed twice daily. The fields are harvested after 100-110 days of stocking, using bag nets, drag nets and cast nets. The harvested products are sold to the exporters who offer maximum price for the product.

Economics of shrimp farming

The economics of semi-intensive shrimp farimg based on data collected from 150 selected farms in Kerala is given in Table 1. and that of a 5 ha farm under more intensive use of inputs and seeds of *P.monodon* is given Table 2. As may be seen from these Tables, the cost structure, revenue and profitability are different in the two systems for which economics are worked out on the basis of the variations in the intensity of input-use. The average net profit per ha per crop for the selected shrimp farms, doing semi-intensive farming and using selective stocking of both *P. indicus* and *P. monodon* along with auto stocking and locally prepared feed is worked out Rs. 11,400 (Table 1) whereas in more intensive farming using seeds of *P.monodon* with high density and imported feed, the annual net profit worked out to Rs. 3. 96 lakhs per ha (Table 2.) In both the cases net profit is worked out by deducting the entire cost including depreciation and interest on initial investment from the sales value of total product. However, the investment requirement in those two cases varies very widely. In the first case, the investment requirement per ha is only less than Rs. 1 lakh whereas in the other it is about Rs.11 lakhs.

Table 1. **The annual cost and earning per ha of shrimp farming in Kerala**

A.	**Investment**	**Rupees**
	Construction of ponds	50,000
	Pump	16,000
	Sluicegate	18,000
	Miscellaneous	6,000
	Total	**90,000**

B.	**Fixed cost**	
	Depreciation	9,000
	Interest @ 18% P.A.	16,200
	Opportunity cost of the land (lease value)	35,200
	Total	**32,500**
C.	**Operating cost**	
	Eradication of predators	800
	Seed @ Rs.120/ thousand	7,200
	Feed @ Rs.15/Kg	30,000
	Labour @ Rs.50/day	12,000
	Diesel	1,600
	Miscellaneous	800
	Total	**52,400**
D.	**Total Cost** (B+C)	87,600
E.	**Yield**	900 kg
F.	**Revenue** (@ Rs.110 per kg)	99,000
G.	**Net profit** (F-D)	11,400
H.	**Rate of return**	31%

Table 2. **Cost and earnings of shrimp culture in a 5 ha farm with comparatively higher levels of input use**

A.	**Investment**	**(Rs.in Lakhs)**
	Construction of ponds including land value	24.00
	Lab and farm equipments	30.00
	Miscellaneous items	1.00
	Total	**55.00**
B.	**Fixed coast**	
	Depreciation for one crop (half year)	2.75

	Permanent staff salary (half year)	0.74
	Interest 18% P.A. (half year)	9.90
	Total	**13.39**
C.	**Operating cost**	
	Seed	9.00
	Feed	11.25
	Chemicals and manure for pond preparation	1.75
	Fuel and current charges	1.50
	Maintenance and repair	1.70
	Harvesting	0.60
	Labour for stocking and pond preparation	0.40
	Office expenses and miscellaneous	0.50
	Total	**26.70**
D.	**Total Coast (B+C)** (one crop)	Rs.40.09
E.	**Cost for 2 crop in a year**	Rs.80.18
F.	**Yield in Kg**	40,000
	(two crops)	
G.	**Revenue @ Rs.250.Kg**	Rs.100.00 per year
H.	**Annual profit for 5 ha. (G-E)**	Rs.19.82
I.	**Annual profit per ha.**	Rs.3.96
J.	**Rate of return**	54%

The operating cost per kg of shrimp production amounted only Rs.58 in the first case as against Rs.133 per kg in the second case which indicates the high intensity of input use. However, this variation in cost is also reflected in the revenue to a certain extent as the value realised per kg of shrimp in the latter is about two times that of the former.

A reasonable level of profit between these two, say about Rs.1.5 lakhs per ha can be achieved with a moderate investment of about Rs.5-6 lakhs

which a small scale entrepreneur can afford with supplementary feeding and using selective stocking of seed of *P.monodon* or *P.indicus* which can be either hatchery produced or collected from the wild.

From the experience of Taiwan it has already been proved that higher the level of intensive system of culture, greater will be the levels of pollution leading to complete destruction of the culture system as a whole. Now Taiwan has gone back to white shrimp which is more disease resistant in comparison of tiger shrimp. In Andhra Pradesh many farms are adopting very high density in stocking and over feeding and thus resorting to killing the proverbial goose for golden eggs. Hence, to avoid such a situation small scale sector should be given special preference to dominate this industry so as to keep away the large scale industrial units from polluting the system.

Economics of hatchery production

Other than shrimp farming the major avenues available for small scale investors in aquaculture sector are the hatcheries to produce seeds of *P.monodon* or *P.indicus*. For instance, even if half of potential area of 65,000 ha in Kerala is to be brought under shrimp farming there will be an average annual demand of about 5,000 million seeds. To produce so much quantity there is a scope for setting up more than 100 small scale hatcheries in Kerala State.

At present most of the shrimp farmers depend on collection of seeds from the wild for their requirements. This practice cannot be continued indefinitely as the availability of the seed from the wild will be gradually reduced and the collection will be restricted or banned. Ultimately, the hatcheries will be the only source to get the seeds of the desired species of shrimp. Economics of a hatchery with a production capacity of 1.65 million seeds of *P.indicus* in a year is presented in *Table 3*. The technology of such a hatchery is developed by CMFRI and it is considered as the cheapest technology available throughout the world. Moreover it can be in the frame work of a small scale industry. Its initial investment is only about Rs. 2.2 lakhs and the total operating costs worked out at Rs.51,000 per year to produce 1.6 million seeds of *P.indicus* which can be sold at a minimum price of Rs.100 per thousand. The net profit after deducting all costs including interest and depreciation worked out at about Rs.34,708, registering a rate of return of 34%. The hatchery, though designed for *P. indicus* can be used for producing seed of other species such

as *P. monodon*, *P.semisulcatus* or *P.merguensis* depending on the location.

Table 3. **Economics of small scale hatchery**

A.	**Initial investment**	**Rs.**	
i.	Land 225 m2	:	22,300
ii.	Larval rearing tanks	:	50,000
iii.	Algal culture tanks	:	6,700
iv.	Water storage tanks	:	17,000
v.	Laboratory and store-cum-pump house	:	23,300
vi.	Temporary covering for tanks	:	9,600
vii.	Pump 1/2 HP	:	5,000
	Pump 3.5 HP with installation	:	25,000
	Diesel engine 5 HP	:	12,000
viii.	3 HP blower and motor	:	20,000
ix.	Other equipment	:	7,100
	Salinometer	:	3,500
	Kitchen balance	:	500
	Pressure cooker	:	1,000
	Mixer	:	2,000
	Thermometer	:	100
	Water, air & electrical connections	:	22,400
	Total	**:**	**220,400**
B.	**Annual fixed cost:**		
i.	Interest @ 18%	:	39,672
ii.	Depreciation @ 20% of initial investment excluding land	:	39,620
	Total	**:**	**79,292**

C. Annual operating cost (for five runs)			
i.	Labour (2 labour for 150 days @ Rs.100/day/labour)	:	30,000
ii.	Spawner	:	3,150
iii.	Feed	:	1,875
iv.	Fuel & electricity	:	8,000
v.	Chemicals	:	2,000
vi.	Net materials	:	2,000
vii.	Packing	:	2,000
viii.	Seives, plastic items, glasswares, filters	:	1,975
	Total	:	**51,000**
D.	**Annual total cost : B + C**	:	**1,30,292**
E.	**Gross annual income:**		
i.	Number of seed produced	:	16,50,000
ii.	Revenue @ Rs.100 for 1000	:	1,65,000
F.	**Gross profit E ii - C**	:	**1,14,000**
G.	**Net profit F - B**	:	**34,708**
H.	**Rate of return**	:	**34%**
I.	**Cost of production of 1000 seed**	:	**79**

Shrimp feed production

The traditional shrimp farmers were not using supplimentary feed earlier and solely depending on natural food available in the ponds. Due to the unprecedented increase in shrimp prices in recent years, the traditional shrimp farmers started adopting selective stocking of high priced shrimp varieties such as *P.indicus* and *P.monodon* (commonly known as Indian white shrimp and tiger shrimp) and apply indigenous feeds such as clam meat, mussels, snails, groundnut cake, etc.

Most of the formulated feeds available in India are imported ones and

cost above Rs.50/-kg which is beyond the reach of the small farmers. The *Mahima* shrimp feed developed by CMFRI is a low cost indigenous formula involving a simple technology which is suitable for on-farm-production. A combination of low cost and locally available ingredients of both animal and plant origin such as mantis shrimp, prawn waste, soyabean and coconut oil cake which meet the nutritional requirements, are used in the preparation of the feed. These ingredients are easily digested and meet the quality control requirements. The economics of a small scale prawn feed making unit of 200 kg production capacity per day is given in *Table 4*.

Table 4. **Economics of a prawn feed making unit (Production capacity 200 kg per day)**

I. Initial investment		**Rs.**
1.	Pulveriser	40,000
2.	Pelletizer	10,000
3.	Packing machine	6,500
4.	Weighing machine	5,000
5.	Drier	15,000
	Total	**76,500**
II.	**Annual fixed cost**	
1.	Depreciation on the equipments @ 10%	7,650
2.	Interest on fixed capital @ 18%	13,770
	Total	**21,420**
III.	**Operating cost**	
1.	Raw materials	4,000
2.	Wages (4 labour days @ Rs.50/day)	200
3.	Electricity/fuel	20
4.	Rent for building	20
5.	Packing @ Rs.1/kg	200
6.	Marketing expenses	200

7.	Repair and maintenance	40
	Total	**4,860**

Assuming 200 days working for the unit in a year, the total annual operating coast = 9,36,000

IV. Profit

1.	Total cost of operation/year = 21,420 + 9,36,000	= 9,57,420
2.	Total feed production @ 200 kg/day	= 40,000 kg
3.	Gross income from the sales of 40,000 kg of feed @ Rs.28/kg	= 11,20,000
4.	**Annual profit**	**= 1,62,580**

At present the farmers who are engaged in semi-intensive system of shrimp farming apply mostly imported feeds. But the prospective entrepreneurs should be given full support to establish small scale feed mills in our country because the domestic feeds have the following advantages:

1. More suitable feeds for Indian farming conditions can be formulated;
2. It can be made available to farmers at a lower price as compared to imported feeds;
3. Bulk quantity of imported feed will lead to high inventory holding cost and so fresh stock is not made available to farmers. Transport cost of imported feed will be very high;
4. Intensity of pollution can be reduced by formulating indigenous feeds and,
5. Domestic feed payment has to be made in rupees only whereas for the imported feed foreign exchange is required.

Cost and earnings of open sea mussel farming

The sea mussels popularly known as '*Kallumekai*' or '*kadukka*' in Malayalam and '*pachaiazhi*' or '*kadalkai*' in Tamil, are bivalve molluscs of the family Mytilidae. They are found firmly attached to the rocks or any other hard objects in the sea by means of a thread-like substance secreted by body.

Duration of mussel farming is 5-6 months and in the longline method, in an year, two crops can be taken. The growth of mussels in the open sea farming is very rapid. Each mussel gains 11.6 to 12.9 mm in length and 5.9 to 7.3 g in weight per month. A production of 10 - 12.5 kg marketable size mussels can be obtained from one metre of rope. From a longline unit of 360 m^2 a total production of 54,720 kg shell-on mussels can be obtained of which 40% will be the meat.

The initial investment required for the establishment of a longline unit in an area of 0.36 ha (60 m X 60 m) in open sea works out at Rs. 2.5 lakhs. An entrepreneur has to spend about Rs.2 lakhs towards operating expenses for a crop. Since it is a labour-intensive technique, about 66.5% of the operating cost is incurred towards wages of the labourers. The net profit to an entrepreneur, venturing into open sea mussel culture, works out to Rs.2.2 lakhs per crop (Table 5). At the existing price level of Rs.10 per kg, the break-even production required to cover all costs works out to 33 tonnes of mussels as against the expected production of 55 tonnes per crop. The cost of production of one kg of mussel in open sea culture works out at Rs.6/- at the current level of input prices. Besides generating alternative employment to fishermen, the entrepreneur earns substantial profit by adopting this technique of mussel farming.

Table 5. **Economics of open sea mussel farming (0.36 ha area)**

I.	**Initial investment**	**Rs.**
i)	Cost of construction of a longline unit (floats, anchors, anchorline, horizontal & vertical line)	1,28,000
ii)	Floating platform for watch & ward	25,000
iii)	FRP dinghy & OB engine	75,000
iv)	Spat collectors	10,000
v)	Others	12,000
	Total	**2,50,000**
II.	**Fixed Cost (Annual/crop)**	
i)	Depreciation @ 33.3%	83,250
ii)	Interest @ 18%	45,000

	Sub Total	**1,28,250**
III.	**Operational cost (per crop)**	
i)	Seed	30,000
ii)	Materials (cotton cloth, cement block etc.)	15,000
iii)	Labour	1,33,000
iv)	Miscellaneous	22,000
	Sub Total	**2,00,000**
IV.	**Total cost (annual Rs) (II + III)**	**3.3 lakhs**
V.	**Expected production**	**55 Tonnes**
VI.	**Gross revenue (Rs) at Rs.10/kg**	**5.5 lakhs**
VII.	**Net profit (Rs) (VI-IV)**	**2.2 lakhs**

The social climate along our country's coastline is very congenial for promoting sea farming of mussel and the fishermen communities can participate in the production programme. If open sea mussel culture is carried out in an area of 0.36 ha by a group of ten fishermen, each one would receive about Rs.13,300 as wages for the maintenance of installation and obtain a profit share of about Rs.22,700 per head per annum. The social and economic benefits are very high as the annual per capita earning of a fisherman works out to Rs.36,000/- including wages. The dwindling catch rates in the capture fisheries and the declining employment opportunities have resulted in diminishing annual and per capita income to traditional fishermen. In this juncture mussel farming offers a sustainable and viable economic activity to the coastal rural communities.

Economics of pearl culture

The production of Indian marine natural pearls came to a stand still since the closure of the pearl fishery in the Gulf of Mannar in 1961 and in the Gulf of Kutch in 1966.

The Central Marine Fisheries Research Institute has achieved a breakthrough in 1973 in the production of pearls from *Pinctada fucata* by techniques of culture and hatchery production of pearl oyster seeds in 1982 at its Tuticorin Research Centre. Since then the technology has been refined for

large scale production of pearls and also pearl oyster seeds in the hatchery. Pearl culture technology comprises three phases namely (i) seed production in the hatchery, (ii) nursery rearing of the seed, mother oyster farming and (iii) culture of implanted oysters. The latter two phases are carried out in the sea where a pearl farm is established. The pearl farm comprising racks can be constructed in the coastal waters, upto 2.5 m depth. Rafts or longlines can also be moored in 8-15 m depth. Long line can withstand the rough sea conditions better than floating rafts. In Indian waters the pearls grow fast and reach marketable size in 3-4 months with 2-3 mm nuclei and 15-18 months with 6-7 mm nuclei. The indicative economics of pearl culture by cages suspended from a 6 x 6 m raft is given in *Table.6*. The rate of return worked out to 55.7% and pearl culture gives the highest gross income for unit area when compared to various production systems in aquaculture.

Table 6. **Economics of pearl culture**

Method: cages suspended from a 6 X 6 m raft

Input cost (for two years)	Rs.	
Cost of teakwood poles, floats, anchors, anchor chains	:	13,000
Cages (100 nos) for rearing 10355 oysters	:	10,000
Cost of 10355 pearl oysters at Rs.1.40/seed	:	14,500
Cost of 9414 shell bead nuclei at Rs.1/bead	:	9,500
Cost of menthol, glasswares, plasticwares, surgical instruments:		5,000
Labour charges for pearl oyster surgery	:	3,000
Total	:	**55,000**
Production and revenue		
Total pearls produced	:	1,849
Revenue	:	85,633
Net profit	:	30,633

The remaining 303 pearls were of inferior quality and fetched low market price.

The rate of return worked out to 55.7%. Pearl culture gives the highest gross income for unit area when compared to various production systems in aquaculture.

Economic feasibility of edible oyster farming

The technology of edible oyster culture consists of two important phases namely oyster seed production and farming them to marketable size. Seed requirements for culture are met from natural spat collection or through hatchery system. Oyster shells, mussel shells, coconut shells, asbestos sheets, semi-cylindrical roofing tiles and bamboo poles bearing branches are found to be good spat collectors. Seven to ten days after peak spawning these spat settlers are laid on the bottom or suspended from racks. Based on the information on gonadal condition of oysters and duration of larval life, prediction of the approximate time of spatfall is possible. The method and the season of collection and the nature of spat collector to be used varies from place to place, depending on the local conditions. On-bottom culture and off-bottom culture are the methods followed in oyster farming. Off-bottom methods include raft, rack-and-string, rack-and-tray, stake and longline culture. Rack-and-string method is mainly advocated for Indian conditions. The racks are constructed in a depth of 1 to 2.5 m. A series of vertical poles are driven into the bottom in rows and horizontal bars are connected on the top of the poles. Oyster shell rens for spat settlement and culture are made with 5-6 empty cleaned oyster shells strung in 5 mm thick nylon rope, keeping each shell at a distance of 10 cm. Shell strings are suspended from the racks.

In one hectare area, 125 to 145 racks can be constructed (24 units of 300 m^2 each). After a period of 7-8 months, each string yield 4-5 kg oyster and the production is estimated at 80-105 tonnes per hectare per crop. In the east coast it takes twelve months for the harvest of oysters after settlement, whereas in the west coast it takes only 7-9 months. The meat yield is about 10% of the total oyster weight. The economic feasibility of edible oyster farming by rack and ren method in an area of 300 m^2 is given *Table 7*.

In an area of 1 ha, 24 units of 300 m^2 each can be accommodated. The cost of materials indicated are based on the current market rates. Production of meat and shell per hectare is estimated as 10.2 t and 81.6 t respectively. There is good demand for shell-on oysters in the international market. In the local market the cost of 100 shell-on oyster is Rs.25. The international export market value of 1 kg of chilled/frozen oyster meat varies form Rs.125 to 300. The demand and high price of oyster meat in the international market augur well for the expansion of edible oyster culture in the country.

Table 7. **Economics feasibility of edible oyster farming by rack-and-ren method in an area of 300 m²**

I.	**Material Cost**			
	(a) Poles		Rs.	
	Horizontal poles 6 m X 30		1,200	
	Horizontal poles 2 m X 9		120	
	Vertical poles 3 m X 126		2,520	
	Total		**3,840**	
	(b) Nylon ropes and strings			
	1. Nylon rope for strings and racks 40 kg		2,800	
	2. Number of strings 1060		110	
	Total			**6,750**
	II. Labour Cost and other Charges			
1.	Fabrication of oyster strings		480	
2.	Fabrication of racks		240	
3.	Harvest		640	
4.	Depuration		640	
5.	Shucking		880	
	Total		**2,880**	
	Total cost (I + II)		**9,630**	
III.	**Production and revenue**			
1.	Shell-on weight of oyster	tonnes	4.25	
2.	Meat weight (10%)	kg	425	
3.	Value of meat @ Rs.30/kg	Rs.	12,750	
4.	Value of shell @ Rs.350/tonnes	Rs.	1,190	
	Gross Revenue		**13,940**	
IV.	**Net Profit (III - I + II)**		**4,310**	

Economics of mud-crab fattening

The demand for live crabs in freign markets especially in the South-east Asian countries has prompted efforts to large growing species in confinements and harvest them at attractive sizes for exports in live form. In India mud-crab farming is picking up in recent years in Andhra Pradesh, Tamil Nadu and Kerala. The farming is done by two methods. In the first, young crabs are grown in earthern ponds for a period of 5 to 6 months. In the second method which is known as crab fattening, softshelled crabs or water crabs are held in smaller impoundments for 20-30 days till the shell is hard-

ened. Crab farming in earthern ponds can be done either in monoculture or in polyculture along with milkfish, shrimps and mullets. As mud crabs are highly tolerant to varying salinity conditions, brackishwater areas of all salinity gradients can be used for crab farming and fattening. Small pond (0.3 to 0.5 ha) with sandy or sandy clay bottom and a water depth of 1.5 m are suitable for crab farming. Newly moulted crabs (water crabs) measuring above 8 cm in width can be obtained alive form commercial catches and subjected to fattening in ponds, cages or pens. The crabs may be harvested after the shell becomes sufficiently hardened and before next moulting in a selective manner according to the condition of the animal. The economics of mud crab farming is given in Table 8.

Table 8. **Economics of mud crab farming**

I.	**Initial investment**	**(Rs)**	
	Land	:	50,000
	Cost of 5 HP Diesel pump	:	15,500
	Watchman shed	:	5,000
	Pond preparation, fencing, sluice gate, other expenses	:	11,500
	Total	:	**82,000**
II.	**Annual Fixed cost**		
	Lease value for the land (@ 10% of the cost)	:	5,000
	Depreciation (20% of initial investment excluding land)	:	6,400
	Interest (18% initial investment)	:	14,760
	Total	:	**26,160**
III.	**Operating/working cost (one operation)**		
	Pond preparation	:	500
	Cost of stocking material 330 water crabs (@ Rs.75.00/kg)	:	17,325
	Feed	:	2,000
	Operational cost of pump	:	750
	Labour charges	:	3,000
	Total	:	**23,575**
	Annual operating cost (6 crops)	:	1,41,450
IV.	**Annual total cost (Rs.) (II + III)**	:	**1,69,250**

V.	**Gross Annual Income**	
1.	Quantity of crabs	: 1,404 kg
2.	Revenue	: Rs. 2,80,800
VI.	**Net Profit (V - IV)**	**: 1,11,550**

Based on the average performance of a series of crab culture operations noted in a brackishwater pond in Vypeen Island in Ernakulam District during 1994, the economics of 0.1 ha farm has been worked out for crab fattening and the results are given below (Table 9). It could be seen that compared to shrimp farming, crab fattening is more remunerative. Among the two types of culture, crab fattening or hardening is more advantageous provided enough stocking material is available at the appropriate time.

Table 9. **Economics of crab flattening and composite fish-prawn farming in Ernakulam District, Kerala.**

I.	**Initial investment (average)**	Rs.
	Value of land 0.405 ha (1 acre)	3,00,000
	Development of fish pond, bund construction and fencing	15,000
	5 HP Diesel pump	15,000
	Sluice gate	10,000
	Watchman shed	5,000
	Total	**3,45,00**
II.	**Annual fixed cost**	
	Lease value for the land	15,000
	Depreciation (20% of initial investment excluding land)	9,000
	Interest (18% initial investment)	62,100
	Total	**86,100**
III.	**Annual operating/working cost**	
	Pond preparation	1,000
	Cost of big water crabs (3200 Nos. at Rs.110/kg)	3,52,000
	Average cost of prawn/fish seed	5,000
	Feed	18,000
	Fuel/Electricity for pump	10,000
	Labour charges (2 persons @ Rs.50/day)	36,500
	Total	**4,22,500**
IV.	**Total annual cost (II + III)**	**5,08,600**

V.	**Annual production and revenue**	
	Crab (3,200 Kg/Rs.220)	
	(Present market rate)	7,04,000
b)	Prawns & fishes	
	P. monodon, 50 kg @ Rs.260/kg	13,000
	P.indicus 100 kg @ Rs.130/kg	13,000
	M.dobsoni 700 kg @ Rs. 18/kg	12,600
	Tilapia 200 kg @ Rs. 40/kg	8,000
	Mugil cephalus (Thirutha) 100 kg @ Rs. 80/kg	8,000
	Mullets (smaller size) 150 kg @ Rs.30/kg	4,500
	Pearl spot 100 kg @ Rs. 70/kg	7,000
	Miscellaneous fishes 250 kg @ Rs. 20/kg	5,000
	Total	**7,75,100**
VI.	**Profit**	**7,75,100**
	V-IV	**5,08,600**
		2,66,500

Conclusion

Aquaculture has proved a boon to the coastal fishermen in providing ample employment opportunities and also to raise their income level. Besides prawn culture, there is good scope for producing clams, mussels, edible oysters, crabs and some varieties of fin-fishes in coastal waters. Comparative economic advantages of culturing shrimps, open sea mussel farming, pearl culture, edible oyster farming, culture of mud crabs, and also small scale prawn hatchery and feed making units discussed in this article clearly indicate the excellent scope of developing aquaculture industry in our country. The economic indicators such as net profit and rate of returns to capital also suggest that with proper management practices, the various production technologies discussed here can successfully be adopted by the entrepreneurs in different locations.

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