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COUNTRY REVIEW

Economic evaluation of mud crab farming under different production systems in India

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Abstract

Apart from penaeid shrimp culture, crab farming and fattening and other several diversified aquaculture practices are now emerging as viable ventures in India. About 11 types of crab products are being exported from India with an average unit value realization of US$ 3.73 kg^{-1}, pinpointing its importance in the foreign exchange earnings. An economic evaluation of mud crab culture, fattening and fattening with composite culture of shrimp/finfish has been attempted in this paper. The major operating cost was that of seed and it was higher for crab fattening (87% of the total operating cost). Feed costs were very low compared to that of shrimp farming. Annual profit obtained was US$ 22812.5 ha^{-1} $year^{-1}$ for culture and US$ 30820.8 ha^{-1} $year^{-1}$ for fattening. Economic indicators such as net profit, rate of return, pay back period and breakeven price indicate that crab fattening/culture is much more profitable than any other coastal aquaculture operations currently in practice, provided hatchery production is established in the country to ensure adequate supply of mud crab seeds.

Keywords: economics, mud crab, *Scylla serrata*, crab products, crab landings

Introduction

Aquaculture is emerging as one of the fastest growing industries at the global level, where India occupies second position with a production of fish, crustaceans and molluscs of about 2.1 million tonnes $year^{-1}$ (FAO 2002). In spite of the availability of different technologies for diversified farming practices of various candidate species, coastal aquaculture in India is synonymous with shrimp culture, for which hardly 10% of the potential area is currently utilised (Ganapathi & Viswakumar 2001). The major reason for this limited utilisation is the non-adoption of appropriate location specific production systems to obtain optimum profit. Although penaeid shrimp culture started as a lucrative industry, recently white spot and other diseases have caused a serious setback, which prompted the farmers to find an alternative that could promise comparable profits to shrimp farming (Devaraj & Appukuttan 2000). The Indo-Pacific swamp crab *Scylla serrata* (commonly called as mud crab) is now widely regarded as one of the most promising alternatives to penaeid shrimp culture in India.

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Site selection is a decisive factor in the success of the aquaculture of a particular species. Instead of converting the unutilised, under-utilised and less productive areas for more and more shrimp farming, the culture of suitable alternative species could be substituted, ensuring maximum production and optimum profit with sustainability of the ecosystem. Moreover, the outbreak of viral diseases has compelled shrimp farmers to go for crop rotation or a fallow period. The great demand and high price of mud crabs in the domestic and foreign markets has motivated the farmers to expand mud crab culture utilising the locally available wild seeds. Mud crab farming and fattening activities are expanding in recent years in states like Andhra Pradesh, Tamil Nadu and Kerala. But the pace of development has been quite slow compared with shrimp culture, due to lack of baseline information and the non-availability of seeds in sufficient quantity at the appropriate time. Although India is bestowed with 1.19 million hectares of brackish water area suitable for aquaculture activities, aquaculture is confined to an area of less than 0.12 million hectares (Raj et al. 1998). Hence there is enough scope to develop crab farming in the unutilised potential areas, which are not fully conducive for shrimp farming.

Exports from crabs and crab products from India for the last two decades indicate increasing demand. About 11 types of crab products are being exported from India with an average unit value realisation of US$ 3.73 kg^{-1}, pinpointing its importance in foreign exchange earnings (MPEDA 2000). Even though the average annual crab landings from the marine sector during the last two decades showed an increasing trend, the share of mud crab was only 4.5% and the major part was contributed by *Portunus pelagicus* and *Charybdis cruciata.* However, the mud crab *Scylla serrata* is the high valued species compared to the other two species both in the local as well as in the export market. The only way to meet the increasing export demand of mud crab is its production through farming/fattening.

Mud crab is a fast growing species and highly tolerant to salinity variations. The only problem reported in the grow-out phase of mud crabs is mortality due to cannibalism (Trino et al. 1999). This can be minimised by providing crab shelters for moulting and post moult crabs (Fielder et al. 1988) or providing seaweeds such as *Gracilaria* sp. (Chen 1990). Low stocking density is also advisable to reduce mortality due to cannibalism and enhance growth rate (Baliao et al. 1981). Economic indicators on mud crab culture at different stocking densities have been studied (Agbayani et al. 1990; Samonte & Agbayani 1991). Discounted economic indicators for mud crab monoculture were shown to be highest at a stocking density of 5000 ha^{-1} (Kristensen 1991; Samonte & Agbayani 1991). In India, crab fattening/hardening to the marketable size for a short duration is found to be more profitable than the culture of crabs, which takes a period of 4-5 months (Kathiravel et al. 1997; Anil & Suseelan 2000). Economics of crab fattening in association with shrimp and fish farming in Kerala also indicated high profitability and investment turnover ratio (Sathiadhas et al. 1996). Chong (1995) suggests larviculture of crabs as a supplementary method to overcome the problem of adequate supply of seed for monoculture and for fattening purpose. In Australia, the mud crab *Scylla serrata* is recognised to be a potential candidate for commercial aquaculture (Williams & Field 1999). Overton (1997) takes into account the positive and negative aspects of crab farming. On the negative side the competition for wild crab seed, competition for coastal sites for crab ponds and pollution risks and on the positive side, the commercial hatcheries could take the pressure off the wild crab stocks.

The present analysis was undertaken with the specific objectives of analyzing the importance of crabs in India's export front and to evaluate the techno-economics of various crab farming systems in Kerala to provide information for investors and policy makers on their comparative efficiency.

Materials and Methods

Data and Analysis

Primary data on production patterns, packages of practices followed, costs and earnings, employment and labour utilisation were obtained from 10 sample farm units from each farming system having area ranging from 0.25 ha to one hectare, located in the Vypeen Island of Ernakulam District for a period of two years. Secondary data pertaining to annual crab production have been obtained from the National Marine Living Resources Data Centre of the Central Marine Fisheries Research Institute and export figures from the publications of the Marine Products Export Development Authority. Percentage analysis was done for analysing the importance of crabs in India's foreign exchange earnings and to determine the contribution of different operational cost items to the total cost. Comparative economic analysis of three production systems was done using output-input ratio, rate of return and break even analysis. The project feasibility was tested using pay back period and net present worth analysis. Sensitivity analysis was also done by working out the net returns at varying prices of crab seeds.

Production Systems

Three different farming systems were evaluated, namely, crab farming, crab fattening and crab fattening with composite culture of fish and shrimps. In the former method, young crabs were being grown in earthen ponds for a period of 4-5 months. The grow-out culture occurred in ponds used for prawn/fish culture provided with proper fencing. As the crabs are highly cannibalistic, especially on freshly moulted animals, 'refugee cages' made out of hollow bamboo pieces or stones were placed inside the ponds to minimise mortality. Seed crabs collected from the wild were purchased and stocked after acclimatisation at the rate of 6000 ha^{-1}. The animals were fed with bivalve meat, trash fish or slaughterhouse wastes at a daily ration of 8-10% of body weight. Daily water exchange was done @35% using the tidal amplitude. Whenever necessary water exchange was carried out by using motor pumps. Juvenile crabs attained a marketable size of 800-900 g in a period of 4-5 months. Production ranged from 2.0 to 3.0 tonnes ha^{-1} $year^{-1}$. Costs and revenue data were regularly collected from the selected ponds at bimonthly intervals for a period of two years and the information obtained from all the crops were used for annual economic analysis.

In the fattening method, the soft-shelled crabs or 'water crabs' were held in smaller impoundments for 25-40 days until the shells hardened. The fattening system also had fencing, water exchange facility and other environmental conditions, as described earlier. Stocking density was 4000 ha^{-1} with artificial feeding as in the case of farming. In a year, 5-6 cycles of fattening/ hardening could be taken from a pond by this method. The total weight gain ranged 340-350 kg ha^{-1} in a duration of one month. Monthly visits for collecting the cost and revenue data were undertaken for a period of two years.

The composite culture practice of crab fattening with fish/shrimp farming in traditional filtration farms is also picking up momentum because of the very high income received from polyculture compared to the monoculture of different varieties of shrimps and finfishes. Shrimp such as *Penaeus monodon, Fenneropenaeus indicus* and *Metapenaeus dobsoni* are caught in considerable quantities under this system. Apart from the shrimp, *Etroplus suratensis* (Pearlspot), *Mugil cephalus* (Mullet) and *Chanos chanos* (Milkfish) are the most important fishes caught under the polyculture system. In addition to natural entry by tidal influence, the fishermen also stock fish juveniles and shrimp seeds according to their availability. Water crabs collected from the landing centres were stocked at 2000 ha^{-1} $crop^{-1}$. Water exchange was done mostly using the tidal current. The locally available clam meat,

slaughter house wastes, trash fish etc were used as feed. The crabs were harvested at monthly intervals, shrimps were harvested at bimonthly intervals and the fishes were harvested at 6 month intervals. Bimonthly visits for a period of two years were made to collect cost data, and details of crabs/fishes/shrimps caught regularly from the composite culture ponds.

The economic analysis of the culture practices was done using parameters such as fixed costs, operating costs, gross revenue, annual profit, rate of return, payback period and breakeven price. Depreciation, a component of annual fixed cost, was calculated according to the life expectancy of each item in the capital investment. The economic feasibility and efficiency of different production systems were also assessed.

Results and discussion

Importance of Crabs in India's foreign exchange front

The contribution of crabs in India's total marine exports was analysed for the period 1996 to 2000 using MPEDA Statistics (Table1). It is obvious from the table that in 1996 there were only 4 types of crab products exported from India. In 2000 the total number of crab products in India's export basket rose to 11, indicating there an increasing demand for diversified crab products in India's export market. The different items in the export basket are crab shells, frozen cut swimming crab, frozen mud crab, frozen crab claws, frozen whole crab, frozen soft shell crab, frozen stuffed crab, frozen pasteurised crab, frozen crab meat, frozen cut crab with claws and live crabs. Total crab exports was 1.1 % of total marine exports in terms of quantity in 1996 increased to 1.47 % in 2000. In terms of value it was 0.99 % of total marine exports in 1996, which increased to 1.46% in 2000. The crab exports stood 6197 tonnes in 2000 and the value realised was US$ 19.44 million. Contribution by live and frozen mud crabs together was US$ 5.5 million in 2000, indicating their enormous scope in the export market.

Production characters of farming systems

Annual yield from crab fattening was significantly higher than crab culture. About 5-6 crops could be obtained annually through crab fattening as against only 2 crops from crab culture. Average yield from crab culture was 2800 kg $ha^{-1}crop^{-1}$ and that from fattening was 3100 kg $ha^{-1}crop^{-1}$ (Table 2). Production details of different components of the composite farming are shown on annual basis. The annual production per hectare constituted 8000 kg of crab, 2125 kg of shrimps with mostly low priced *M. dobsoni* and 1958 kg of finfishes containing tilapia, mullets and pearlspot (Table 3).

Average Body weight (ABW) of the crabs obtained through culture was 800g, whereas that of fattening was 850g. The weight increase after 30-40 days of fattening was very little, ranging 50-100g. Average Feed Conversion Ratio (FCR) calculated for 4-5 months culture was 4.9, which was higher compared to that of other aquaculture species cultured locally. Stocking density, survival rate and level of production of the pond-reared mud crab under two farming systems are given in Table. 2

Economic analysis

Capital Investment

Land value was the major item in capital investment for all three types of crab farming systems, which accounted 70% of the total capital investment. Rest of the investment included pond construction, sluice gate, fencing, diesel pump sets and construction of watchman shed. Average purchase value of one hectare of farm works out to US$ 10416.67

Table 1 Crabs in the export front of India

Years	1996		1997		1998		1999		2000	
Items	Q	V	Q	V	Q	V	Q	V	Q	V
Crab shells	9.52	25.94	0.00	0.00	2.75	18.81	3.75	17.73	80.29	91.85
Frozen cut swimming crab	0.00	0.00	0.00	0.00	1302.17	1381.54	2282.10	2389.60	8522.15	12051.31
Frozen mud crab	0.00	0.00	26.63	16.13	1.38	2.90	84.46	73.63	48.10	65.25
Frozen crab claws	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	47.94	36.88
Frozen whole crab	0.00	0.00	0.00	0.00	0.00	0.00	101.52	84.88	291.96	317.63
Frozen soft shell crab	0.00	0.00	0.00	0.00	0.00	0.00	12.21	50.44	23.21	97.21
Frozen stuffed crab	20.04	87.44	30.00	266.46	467.00	571.77	381.25	406.19	40.42	28.23
Frozen pastuarised crab	0.00	0.00	0.00	0.00	0.00	0.00	19.19	91.15	122.98	457.60
Frozen crab meat	3827.19	3109.00	2761.50	3509.52	1558.52	2061.71	289.56	782.25	419.46	823.38
Frozen cut crab with claws	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	23.33	34.94
Live crab	4225.90	5014.44	3088.88	3994.00	3702.50	6383.90	3132.19	5437.67	3291.04	5435.90
Total crab exports	8082.67	8236.79	5907.00	7786.13	7034.29	10420.65	6306.25	9333.50	12910.88	19440.19
Total marine exports	736822.92	829168.75	831202.08	971162.50	653131.25	981156.25	681677.08	991122.92	877239.58	1332618.75
% share of crab exports in total marine exports	1.1	0.99	0.71	0.8	1.08	1.06	0.93	0.94	1.47	1.46

Note: Quantity in tones; Values in '000 US$ (1US$ = Rs.48)

with a lease value or opportunity cost of US$ 1041.67 ha^{-1} year^{-1}. Many of the farmers have erected strong net fencing around the pond supported by bamboo poles upto a height of 5-6 feet to avoid poaching and to prevent escape of crabs.

Table 2 Production details of mud crab culture& fattening

Particulars	Crab culture	Crab fattening
Average Farm size (ha)	0.40	0.40
No. of crops year^{-1}	2	5
Stocking density (Nos. ha^{-1})	6000	4000
Crab seed price (US$ kg^{-1})	1.67	2.92
Duration of culture (days)	120-150	30-40
Average initial weight (g)	200	750
Average harvesting weight (g)	800	850
Survival (%)	70	85
Production crop^{-1} (kg ha^{-1})		
a. Hard shelled crabs	2835	2543
b. Soft shelled crabs	315	347
Farm gate price (US$ kg^{-1})		
a. Hard shelled crabs	6.25	6.25
b. Soft shelled crabs	2.92	2.92

Table 3 Production details of mud crab fattening in composite shrimp/fish culture system

Items	Details (ha^{-1})	Farm gate price (US$ kg^{-1})
Duration of culture (months)	12	-
No. of crab fattening crops (No year^{-1})	5	-
Seed price		
Crabs (US$ kg^{-1})	2.92	-
Shrimps (US$ 100no^{-1})	0.52	-
Fishes (US$ 100no^{-1})	6.25	-
Stocking density (Nos ha^{-1}crop^{-1})		
Crabs	2000	-
Fishes	3500	-
Production (US$ ha^{-1})		
Crab (*S. serrata)*	8000	5.21
Prawns		
P. monodon	125	6.25
F. indicus	250	3.13
M. dobsoni	1750	0.83
Fishes		
Tilapia	500	0.83
Mullets (Big size)	200	2.08
Mullets (Small size)	376	1.04
Pearl spot	257	1.46
Miscellaneous	625	20

Operating costs

The procurement cost of water crabs is the major operating cost of fattening (87% of the total operating costs), whereas seed cost for culture practice works out only 36% of the total operating costs (Table 4). There are crab collection agents at Vypeen Island who directly

represent export companies. The local crab collectors gather soft-shelled crabs either from brackish water fishermen or from crab collecting agents. The cost of pond preparation was also not identical for both the operations with US$ 833.33 ha^{-1} $year^{-1}$ for fattening and US$ 1250.00 ha^{-1} $year^{-1}$ for culture. Ponds for culture operation should be prepared well with proper fertilisation and liming so as to provide a better environment for baby crabs. Expenditure for pond preparation included value and transportation charges of lime, labour charges for strengthening the bund etc. Fuel cost and electricity were lower for crab fattening than culture operation. Most of the farms were depending on tidal inflow for water exchange, which in turn reduced the fuel/electricity charges to a mere 1% of the total operating expenditure. Feed materials such as trash fish/ slaughterhouse wastes were purchased at US$1.04-1.67 $100kg^{-1}$. Feed cost was much less than that of semi-intensive shrimp culture, where formulated feed was purchased for US$ 0.83 kg^{-1}, which accounted 40% of the total

Table 4 Comparative Economics of mud crab *Scylla serrata* culture, fattening and crab fattening with composite shrimp/fish culture systems.

Particulars	Crab culture (US$ ha^{-1})	Crab fattening (US$ ha^{-1})	Crab fattening & Composite fish prawn farming
I. Capital Investment			
1. Land	10416.67	10416.67	10416.67
2. Watchman's shed	104.17	104.17	104.17
3. Pond construction	1250.00	1250.00	729.17
4. Sluice gate	937.50	937.50	729.17
5. Fencing/construction of bunds	312.50	312.50	312.50
6. Diesel pump set	416.67	416.67	416.67
Total	**13437.50**	**13437.50**	**12708.33**
II. Annual fixed cost			
1. Lease value of land	1041.67	1041.67	1041.67
2. Depreciation (15% of capital investment excluding land cost)	452. 08	452. 08	452. 08
	2016.67	2016.67	1906.25
3. Interest (15% of capital investment)	**3510.42**	**3510.42**	**3291.67**
Total			
III. Annual operating cost			
1. Pond preparation	1250.00	833.33	125.00
2. Seed crabs /big water crabs	2954.17	43750.00	23333.33
3. Prawn /fish seed			260.42
4. Feed	4000.00	3010.42	937.50
5. Labour charges	2125.00	2083.33	1902.08
6. Fuel/electricity charges	625.00	520.83	52. 08
Total	**10954.17**	**50197.92**	**26610.42**
IV. Total costs (II+III)	**14464.58**	**53708.33**	**29902.08**
V. Annual Revenue (ha^{-1} $year^{-1}$)			
Revenue from crabs	35447.92	79468.75	41666.67
a) Hard shelled crabs	1837.50	5062.50	
b) Soft shelled crabs (crab fattening at 5 times per year)			3020.83
			1860.82
Revenue from Prawns	**37275.00**	**84531.25**	**46541.67**
Revenue from Fishes	**22812.50**	**30820.83**	**16639.58**
Total			
VI. Net profit			

operating costs (Prasad 1999). Feed cost substantially varied between the two culture systems.

Salaries and labour charges were computed annual basis assuming that a caretaker/ manager was paid US$ 104 month^{-1} and labourers were paid US$1.46 day^{-1} person^{-1}. Two labourers were required daily for a one-hectare farm to carryout the fattening/culture in an efficient manner. Salaries for the watchmen also were included in labour cost. Low feed costs and cheap labour costs make the annual operating costs of mud crab farming lesser and thereby enabling more small-scale farmers to enter into this field. The initial expenditure required to set up farms with less than one hectare area is also comparatively lesser than that of more intensive shrimp farming.

Comparative profitability

Economic indicators such as rate of return, pay back period and breakeven price were worked out for all the three farming systems. Net annual profit obtained from the fattening system was US$.30820.8 ha^{-1} and that of culture was only US$ 22812.5 ha^{-1} (Table 4). Annual profit from crab fattening with composite culture with fish and shrimp was about US$ 16639.6 ha^{-1} and it is found much more profitable than fish culture alone. A study on the economic analysis of semi intensive culture of *F. indicus* in Kerala (Sathiadhas et al. 2003) showed that annual net profit realised was less (US$ 12880 ha^{-1} year^{-1}) when compared to crab culture and fattening. The rate of returns in this case was only 90% (Table 4).

All the systems have high rate of return and very low pay back period indicating its higher economic efficiency as compared to shrimp farming. Fattening system provided the highest rate of return of 244% followed by culture system (189%). Analysis of factor-product relationship in prawn farming in India has shown a rate of return of only about 31% (Kumar & Panikkar 1993) and it is much lower than the figures obtained in the present analysis for crabs. Crab fattening with composite culture provided a rate of return of 145%. Pay back period for crab fattening was only 5 months and that for culture was 7 months. The composite culture method has the highest pay back period among the three systems with 10 months (Table 5). Samonte & Agbayani (1991) have reported a pay back period of 1.17 years from a mud crab monoculture pond at a stocking density of 5000 ha^{-1}. The pay back period obtained in the present study is far better than that reported for the highly profitable shrimp culture (Sukumaran et al. 1993). Even though the net profit and other indicators were higher in

Table 5 Economic indicators of mud crab culture, fattening, crab fattening with composite shrimp/fish culture systems and semi-intensive shrimp farming.

Indicators	Crab culture	Crab fattening	Crab fattening & Composite fish/ prawn farming	Semi-intensive shrimp farming (*F.indicus*)
Net profit (US$ in '000 ha^{-1} year^{-1})	22.81	30.82	16.46	12.88
Rate of return (%)	185	244	145	90
Pay back period (Year)	0.6	0.43	0.8	1.3
Break even price (US$ kg^{-1})	2.29	3.71	-	3.81
Cost & earnings ratio	2.58	1.57	1.55	1.63
Net Present Worth for 5 years (US$ in '000)	56.69	127.08	47.27	-

fattening system, the breakeven price of crabs was higher (US$ 3.54 kg^{-1}) compared to the culture system (US$ 2.29 kg^{-1}). An experimental fattening of the blue mud crab *Scylla oceanica* conducted at Vypeen Island, Kerala also indicated its higher profitability as compared to other forms of aquaculture (Anil & Suseelan 2000). The major reason for enhanced economic efficiency of crab culture and fattening is that it can be done with minimal initial requirements.

Most of the farmers are using small ponds with about 0.25 to 0.50 ha area for conducting crab fattening and culture. The economic indicators presented here and the averages ha^{-1} were worked on the basis of production results of these ponds. If the culture is extended to ponds with more area, then the economies of scale will bring forth better returns. The comparative analysis was indicated that a stocking density of 5000 ha^{-1} is more suitable for this area to obtain good profit both from culture as well as fattening. The commercial evaluation done in Philippines by Trino et al. (1999) has shown that monosex culture of male crabs at a density of 5000-15000 ha^{-1} was economically more viable. Confirming the present findings, Agbayani et al. (1990) have shown that the return on investment and return on equity were highest for monoculture of mud crab at a stocking density of 5000 ha^{-1}.

Net Present Worth

Net present worth for a period of 5 years was worked out for testing the feasibility of the three projects. All the three farming systems showed positive net present values and found to be feasible. Among the different farming systems, crab fattening showed the highest positive net present worth (Table 5).

Sensitivity Analysis

Since the major constraint in mud crab culture and fattening is the availability of crab seeds, sensitivity analysis was done by working out the costs and net returns for varying prices of crab seeds (Table 6). The sensitivity analysis at 5, 10, 15, 20 and 50 percent increase in price of crab seeds showed that all the three production systems are profitable with positive net profit values at these price levels.

Table 6 Sensitivity analysis for varying prices of crab seeds in the three farming systems

Price increase-Crab seeds (%)	**(in US$ '000s)**					
	Crab culture		**Crab fattening**		**Crab fattening with composite fish/prawn farming**	
	Operating cost	Net profit	Operating cost	Net profit	Operating cost	Net profit
5	14.61	22.66	55.90	28.64	31.08	15.46
10	14.76	22.51	58.08	26.45	32.26	14.28
15	14.91	22.37	60.27	24.26	33.44	13.10
20	15.06	22.22	62.46	22.07	34.62	11.92
50	15.94	21.33	75.58	8.95	41.70	4.84

Conclusion and policy implications

The ability of mud crab to grow fast and its suitability for culture in brackish water and estuarine areas make it attractive to develop mud crab culture/fattening programmes in India to meet the increasing demand. The major constraint faced by the crab farmers in India is the non-availability of stocking materials in sufficient quantity at the appropriate time. Seeds are mainly obtained from backwater fishing. Due to this reason, farmers are mostly concentrated in crab fattening than grow-out culture. Crab farming is mostly performed by the farmers having direct or indirect relation with fishing activities and thereby having accessibility to wild seeds. Until and unless hatchery production is established in the country for ensuring enough supply of seeds, mud crab farming will not reach sustainable development.

Owing to increased export demand, targeted fishing for mud crab have been intensified in brackish water and marine sector using specific gears. This eventually leads to over exploitation and depletion of natural stock. Sea ranching of berried female crabs during the spawning season is one of the solutions to increase the natural stock.

In many South East Asian countries, soft-shell crab production is initiated recently due to commercial interests and that could detrimentally affect natural stocks and small-scale farmers. Increased demand for soft-shelled crabs in the foreign market will also adversely affect the mud crab fattening system, which utilises the soft-shelled crabs as stocking material. Hence crab culture practice will be the most sustainable and advisable farming option in spite of lesser profitability. It is obvious from the present analysis that all the three types of crab farming practices give better profits than penaeid shrimp culture practices.

Aquatic pollution and environmental problems that arise due to crab culture are negligible under optimum stocking density, when compared to penaeid shrimp culture and hence it is considered as environment friendly venture. More area can be brought under aquaculture without disturbing the environmental equilibrium of the ecosystem for enhancing foreign exchange earnings of the country. If mud crab hatcheries develop, they could provide a stimulus to commercialise crab farming and take pressure off the wild stocks. Credit facilities have to be provided for prospective crab farmers to develop their farming activities. There should be greater institutional support, especially for research into hatchery production of seeds and for formulating highly efficient feed for sustainable development of mud crab farming in India.

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