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Economics of selected coastal aquaculture practices in Kerala, India

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Abstract

The growth and development of scientific aquaculture in the country is of recent origin although it is highly skewed towards shrimp culture. The diversified coastal aquaculture practices adopted in the country are different culture systems for shrimps, mud crab, various species of finfishes etc. Economics of both improved traditional and extensive systems of shrimp culture practices were discussed. All the farmers practicing traditional prawn filtration selectively stocked their farms with either Penaeus monodon or Penaeus indicus *or both. The costs and returns of crab fattening, milk fish culture and polyculture system with fishes were assessed. The cost structure of different culture practices were analysed and determined. Aquaculture is the most ideal and viable alternative available for productive employment without any displacement for the fishers in our coastal zone. In Kerala, hardly one third of the potential brackish water area is currently utilised for one or other aquaculture practices. The fresh water aquaculture sector in India surpassed the production from brackish water and marine regions due to the spectacular technological developments in culture, hatchery operations and feed manufacture with their high adaptability. It is high time to bring at least half of our potential brackish water area under culture with the diversified species. The various shortcomings in popularizing these culture practices are discussed and the possible solutions suggested.*

Keywords: *Coastal aquaculture, Prawn filtration, Pokkali*

1. Introduction

Coastal aquaculture in India is more or less confined to shrimp culture. The shrimp-farming sector faces several constraints like diseases, high production costs and pollution. There is enough scope for diversification with other cultivable species like mud crabs, finfishes, oysters and mussels. Potential areas, which are still unexploited, offer good scope for these coastal aquaculture activities. Polyculture of different compatible species offer a viable alternative to shrimp farming. They require less input compared to shrimp culture and are economically viable. The economics of some selected coastal aquaculture practices in Kerala are discussed in this paper.

2. Materials and methods

The present study was carried out in Ernakulam, Alappuzha and Kollam districts of Kerala during 2001-2002 comprising 58 farms

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covering an area of 403.12 ha under different systems. Sampling area and sample size of each of the aquaculture practice are given in Table-1. All the farmers were visited three times for the collection of details, one during the beginning of the culture period, one mid way of the culture period and last one during or after harvest. This helped to establish a good rapport with the farmers and to obtain correct details on inputs, expenditure and returns with as much accuracy as possible.

Table 1. The sampling pattern followed for different culture practices

Sl.No.	Type of culture observation	Area of sample farms	No. of
1	Improved traditional (seasonal)	Ernakulam and Alappuzha districts	20
2	Improved traditional (perennial)	Ernakulam and A lappuzha districts	13
2	Extensive tiger shrimp culture	Ernakulam, Alappuzha and Kollam districts	11
3	Mud crab fattening	Ernakulam, Alappuzha and Kollam districts	8
6	Finfish culture	Ernakulam district	3
7	Polyculture of fish	Ernakulam district	3
		Total	**58**

The simple economic indicator of net profit was worked out for different culture practices (Shang 1990). Fixed cost included lease value of the land (in the case of farms operated by lessee) or opportunity cost of the land (in case the farm is owner operated), interest at the rate of 13 % on investment items like shed, pump, sluice gate, canoe and depreciation on items like shed, sluice gate, pump and canoe. (Depreciation is calculated adopting straight-line method by dividing the cost of the item by its life span in years). Variable cost comprises expenditure on items like feed, seed, labour, etc.

Net profit = Gross revenue - total operating cost of production (fixed cost + variable cost)

3. Results

3.1 Improved traditional prawn filtration (seasonal)

The traditional practice of trapping juvenile prawns in *pokkali* fields by letting in water during high tide and letting out water during low tide was improved further by selective stocking with fast growing

species like *P.monodon* and *P.indicus*, nursery rearing of post larvae, controlled feeding during early days with egg and sometimes with eradication in nursery area. As followed in the traditional practice, the culture period was from November to April. Periodic harvest was done during the '*thakkom*', 2-3 days before and after every full moon and new moon day in the culture period. Complete harvest was done at the end of the culture period. Paddy cultivation (pokkali) is done during the monsoon period, but farmers are reluctant to do paddy cultivation these days because of escalated labour costs and less returns from paddy.The economics of the seasonal prawn filtration practice is given in Table2.

Table 2. Comparative economics of shrimp culture practices

Items	Improved Traditional seasonal	Improved traditional perennial	Extensive tiger shrimp culture
Number of farms	20	13	11
Total costs /5 months (Rs. ha^{-1})	56,177	83,087	2,00,420
Total fixed cost /5 months(Rs.ha^{-1})	31,001	37,795	54,891
Total variable cost /5 months(Rs. ha^{-1})	25,176	45,292	1,45,529
Production /5 months (kg ha^{-1})	978	836	1,016
Gross revenue /5 months(Rs. ha^{-1})	94,176	1,00,250	2,93,406
Net profit /5 months(Rs. ha^{-1})	37,999	17,163	92,986

3.2 Improved traditional prawn filtration (Perennial)

Perennial ponds were little deeper than seasonal ones and hence paddy could not be cultivated. In the improved perennial system, the only difference was in the culture period, which extended throughout the year. The economics of shrimp culture in the perennial farms is given in Table-2.

3.3 Extensive culture of *Penaeus monodon*

Under this system, shrimp culture is done systematically on a scientific basis. There is no auto stocking. Extensive systems are relatively new farms compared to traditional ponds and are relatively smaller in area. Ponds are prepared before stocking. Eradication is done to kill unwanted organisms and predators. The hatchery-reared seed is acclimatized to the pond environment slowly. Artificial feed,

either imported pellet feed or locally made compounded feed is given. Water exchange is done with pumps or through sluices. Complete harvest is done at the end of the culture period. Two-three crops are taken in a season (October to May). The area of the farms ranged from 0.24-6 acres. Most of the farmers cultivated 2-3 crops/ season (October to May). The economics of the culture practice is given in Table-2 along with seasonal and perennial farms.

3.4 Crab fattening

Crab fattening is rearing of soft shelled crabs (water crabs) for short periods of 2- 4 weeks until their shell gets hardened. The culture is undertaken in smaller ponds. Bamboo fencing with overhanging nets is put to prevent their escape over the dykes. Dykes are strengthened to prevent the escape of crabs through holes. Hide-outs are given in the pond bottom for the water crabs to hide themselves. Crabs are fed with trash fish or salted fish. Crab fattening was done on a continuous basis through out the year (twelve crops of two to four weeks duration). Hardened crabs are harvested using lift nets. The area of the farms ranged from 0.1 to 2 acres. The economics of crab fattening is given in Table-3. Hatchery production of crab seed commercially will help a long way in wide spread adoption of this culture practice.

3.5 Milk fish culture

Milkfish culture is conducted for four to five months in brackish water ponds. Seed obtained from seed collectors are stocked in the pond. Some farmers have stocked seeds collected from Mandapam area of Tamil Nadu. They are fed with rice bran, rice, groundnut oil cake, etc. Harvest is done using cast nets. Drain harvest is also carried out. The culture was done for a period of four to five months. The size of the farms ranged from 0.16 to 10 acres. The stocking density varied from 3,969 to 12,700 seeds per hectare. The details of cost and returns are given in Table-3.

Table 3. Economics of crab fattening, milk fish culture and polyculture system with fishes

Items	Crab fattening (6 months)	Milkfish culture	Polyculture of fishes
No. of crops	8	3	3
Production (kg ha^{-1})	5,423	1,746	5,647
Total costs (Rs. ha^{-1})	9,44,422	73,053	2,01,168
Total fixed cost (Rs. ha^{-1})	49,320	9,602	13,574
Total variable cost (Rs. ha^{-1})	8,95,102	63,450	1,87,593
Gross revenue (Rs. ha^{-1})	14,82,659	1,10,596	4,03,437
Net profit (Rs. ha^{-1})	5,38,237	37,543	2,02,269

Milkfish culture does not require much of inputs. It can be undertaken as a small family venture. Even then milkfish culture is not picking up as it is expected to. The people are attracted to shrimp culture for the higher price it fetches. The relative difficulty in getting the seed is also another constriant. Farmers are going up to Mandapam in Tamil Nadu to procure seed. Hatchery for milkfish has to be established commercially for propagating the widespread adoption of this culture practice.

3.6 Poly culture systems

Polyculture systems grow more than one species. Care should be taken while selecting the species so that they are compatible with each other. Shrimps, fishes, crabs, seaweed, etc. are stocked in the pond in different combinations and stocking densities. Polyculture practices are more efficient than monoculture systems as it utilises the available area and inputs in a more efficient way.

In the polyculture system of fishes, milkfish (*Chanos chanos*), grey mullet (*Mugil cephalus*), mullets, Asian sea bass (*Lates calcarifer*), tilapia etc. are included. Seeds of these fishes are obtained from the wild collectors. Fishes are fed with rice, rice bran, locally made feeds etc. Tilapia is grown with sea bass as forage species. Polyculture of mullets, milkfish, tilapia and sea bass conducted by three farmers was selected for the study. The farms were located in Puduvypu and Malippuram of Vypeen Island. The size of the farms ranged from 0.24 to 0.5 acres. The production ranged from 1,626 to 9,072 kg^{-1} ha^{-1} $crop^{-1}$. The culture period extended from six to ten months.

The percentage contribution of various items of expenditure towards total cost in these different culture practices is given in Table-4.

Table 4. The cost structure (percentage) of various items of expenditure in the total cost of the different coastal aquaculture practices

Items	ITS	ITP	ET	CF	MF	PF
Interest	1	1	5	1	2	1
Depreciation	3	2	4	2	2	2
Seed	14	13	12	70	26	13
Feed	2	5	21	10	7	10
Labour	22	25	25	14	44	70
Land lease	55	47	19	2	11	4
Others	3	7	14	1	8	0

ITS-Improved traditional (seasonal) ITP- Improved traditional (perennial)
ET-Extensive tiger shrimp culture system CF- Crab fattening system
MF-Milkfish culture system PF-Polyculture system with fishes

4. Discussion

4.1 Economics of shrimp culture practices

Menon (1954) reported a yield of 1,079 kg ha^{-1} from the traditional prawn filtration ponds and Gopinath (1956) had observed 1,184 kg ha^{1}. George *et al.* (1968) indicated a production of 514 kg ha^{-1}. Gopalan *et al.* (1978) recorded higher yields from improved operations in traditional fields from Cherai and Narakkal, *i.e.*, by restocking undersized juveniles of *P.monodon* and *P.indicus* caught from the nets back into the fields. The traditional system had several shortcomings like indiscriminate stocking, presence of predators and undesirable species, lack of control over the environmental factors, inadequate growing period, predominance of low valued shrimp species like *M.dobsoni* in the catch, etc. (George 1978) and hence people resorted to improved traditional practices like selective stocking with fast growing species like *P.monodon* and *P.indicus*.

A regressive trend in the yields of shrimps from the traditionally operated paddy fields has been observed from 1950s to late 1970s. The increase in the intensity of exploitation of natural stock and environmental degradation would be the probable reasons. Although more and more farmers resorted to selective stocking from late 1980s, the effect was not shown in the total shrimp production (Sathiadhas *et al.*, 1989; Nasser and Noble 1992). Sathiadhas *et.al.* (1989) stated frequent harvesting followed in the traditional fields as the reason for the low shrimp production in spite of selective stocking.

In the study by Jayagopal & Sathiadhas (1993) in Ernakulam district, the average production in the farms, which stocked seeds was 1,163 kg ha^{-1} whereas the farms, which depended on natural seeds alone, reported a production of 952 kg. In the present study, a production of 978 kg ha^{-1} reported was less than that obtained by Jayagopal & Sathiadhas (1993) for selectively stocked farms.

In the study conducted by George (1974), the shrimp production was 811.55 kg ha^{-1} from perennial fields. Nasser and Noble (1992) reported shrimp production of 695.7 kg ha^{-1}. In the present study an average shrimp yield of 836 kg $ha^{-1}year^{-1}$ was obtained from perennial ponds.

The average yield obtained from seasonal fields was higher than the perennial fields in the present study. This is confirmed by the findings of George (1974), Nasser and Noble (1992) and Jayagopal and Sathiadhas (1993). The higher yields from seasonal fields may be attributed to the higher productivity of the fields. The paddy stumps help to increase the organic production in the field and offer better biological environment to the juvenile shrimps (George, 1974).

The average production from scientific prawn farming in Kerala reported by Kumar and Panikkar (1993) was 820.65 kg ha^{-1}. A production of 1,016 kg ha^{-1} was reported in the current study.

4.2 Economics of crab fattening practices

In crab fattening a production of 1.87 t^{-1} ha^{-1}crop was reported by Devaraj *et al.* (1999) in Tuticorin mother crab farm. Marichamy and Rajapackiam (2001) also reported a production of 1.87 t^{-1} ha^{-1}crop. Sathiadhas and Najmudeen (2004) reported a yield of 2.89 t^{-1} ha^{-1}crop. In the present study an average yield of 5.42 t $^{-1}ha^{-1}$ 6crops was observed from crab fattening practices. When production for a single crop was compared, the current investigation observed lower production than reported by (Devaraj, *et al.*, 1999; Marichamy and Rajapackiam 2001; Sathiadhas and Najmudeen 2004).

Marichamy and Rajapackiam (2001) noted a net profit of Rs.2.19 $lakh^{-1}ha^{-1}$crop. Sathiadhas and Najmudeen (2004) reported net profit of Rs.14.8 $lakhs^{-1}ha^{-1}$year for 5 crops. The average net profit realized from crab fattening was Rs.5.38 $lakhs^{-1}ha^{-1}6$ $crops^{-1}$ in the present study. The unit price realised for the hard-shelled crabs in the present study was only Rs. 273 whereas it was Rs. 300 in the investigation by Sathiadhas and Najmudeen (2004). The low production and unit price observed in the current study led to lower profits.

In spite of the high profitability, crab fattening practices are not picking up as shrimp farming practices. The lack of consistent supply of seed crab is found to be the main reason for this. Crab fattening utilises the water crabs available in wild and those, which are rejected by, export units. All these lead to the over exploitation of the natural population. In the present study, it was observed that people who were associated with export units, which were marketing crabs, mostly did the crab fattening practices. They only could manage consistent supply of water crabs from export rejections. Moreover crab fattening requires lot of care and attention on the part of farmers as crabs escape easily from the ponds. Culling practice is to be done on a regular basis to avoid cannibalistic behaviour of crabs. The soft shelled water crabs are to be provided with shelters. Crabs have to be fed with fresh fish daily. Procurement of fresh fish daily is difficult compared to pellet feeds and other locally available feeds which could be stocked in advance. All these account for the low adoption rate of crab fattening practices.

Establishment of commercial crab hatcheries can solve the seed problem and thereby lessen the stress on the natural population. Extension education programmes and field training programmes by research institutes and governmental agencies can accelerate the rate of adoption of this culture technique.

4.3 Economics of milkfish culture practice

The yield from milkfish ponds under modular culture system ranged from 278 to 341 kg $ha^{-1}run^{-1}$ in Philippines (Agbayani *et al.*, 1989) and was 398.43 $kg^{-1}ha^{-1}92$ days (Baliao *et al.*, 1999). Tampi (1960) reported a production of 212 $kg.ha^{-1}$, James (1986) recorded productions of 457 kg $ha^{-1}year^{-1}$ and 857 kg $ha^{-1}year^{-1}$ in Mandapam and Tuticorin in experimental conditions respectively. Gandhi and Mohanraj (1986) estimated 216 kg ha^{-1} and 852 kg ha^{-1} in fertilized and unfertilized ponds of Mandapam respectively. An average production of 1,746 kg $ha^{-1}crop^{-1}$ obtained in the present study was higher than that reported by Sundararajan *et al.* (1979); James *et al.* (1984) at Mandapam and Anon (1995) at Ela Dauji and Keshpur. The production reported by the present study is less than that reported for milkfish monoculture in Guam (Fitzgerald 1988) and in Indonesia (Lim 1991).

In spite of the high production, profits and less disease risk, milkfish culture is not picking up as expected. The lack of proper awareness among farmers, inconsistent seed supply, lack of export market and lower unit price when compared to shrimp are all the reasons for this.

4.4 Economics of polyculture practice

Polyculture of brackish water fishes like *Chanos chanos, Valamugil seheli* and *Sillago sihama* in Mandapam yielded 1,864.5 kg ha^{-1}, 1,560 kg ha^{-1} and 1,377.8 kg ha^{-1} during 1979-80, 1980-81 and 1981-82 respectively (James *et al.*, 1984). Polyculture trials of brackish water fishes in Vyttila fish farm showed production in the range of 943 kg $ha^{-1}11$ $months^{-1}$ to 2189 kg $ha^{-1}13$ $months^{-1}$ in annual crop and 674 kg $ha^{-1}6$ $months^{-1}$ to 1321 kg $ha^{-1}7$ $months^{-1}$ in short term crops (Mathew *et al.*, 1988). Polyculture of grey mullet and milkfish showed a production of 5.7 $t{\cdot}ha^{-1}crop^{-1}$ and with improved management it yielded 7.2 t $ha^{-1}crop^{-1}$ (Sathiadhas *et al.*, 2003). Polyculture of fishes yielded an average of 5647 kg $ha^{-1}8$ $months^{-1}$ in the present study which is higher than that reported by other sources, except by Sathiadhas *et al.* (2003).

5. Conclusion

In spite of the possible risk of white spot disease in shrimp farms, the people are reluctant to move away from shrimp culture to other cultivable organisms because of the higher profits realised for a good crop. This is mainly because of the high unit price of the shrimp compared to others. While one kg of shrimp (20-25 count) fetches Rs.410 to Rs.500 in the export market, the Asian sea bass or grey

mullet fetches a maximum of Rs.150. Crab commands a price of Rs.320 for excel grade (more than 800 g). Developing an export market for brackish water fishes could increase their demand and price and hence will popularise their culture in the long run. Promoting product diversification (fish minced meat, fish balls, fish wafers, fish pickles, ready to cook fish curries) can increase their demand in the domestic market. In brackish water fish culture, seed is a constraint and culture is entirely dependent on the wild seed. Hatchery production of seed on a commercial basis can help in popularising these culture practices in a phased manner.

Although crab fattening was found to be highly profitable, the lack of consistent supply of seed crabs restricts large-scale adoption. The constraints like absence of commercialised hatchery to provide consistent seed supply, lack of proper marketing, channels and the negligence and lack of knowledge in quality control aspects, which act as stumbling blocks in popularising other coastal aquaculture practices, should be addressed. GIS and remote sensing techniques should be adopted to identify areas suitable for different culture practices.

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References

Anon 1995. Hand Book on fisheries statistics of Andhra Pradesh, Commissioner of Fisheries, Government of Andhra Pradesh, Hyderabad.

Agbayani, R.F., Baliao, D.D., Franco, N.M., Ticar, R.B., Guanzen, N.G., 1989. An economic analysis of the modular pond system of milkfish production in the Philippines. Aquaculture 83, 249-259.

Baliao, D.D., Santos, M.A., Franco, N.M., 1999. The modular method milkfish pond culture, Aquaculture extension manual 25, Aquaculture department, SEAFDEC, Philippines, 12-13.

Devaraj, M., Pillai, V.K., Appukuttan, K.K., Suseelan, C., Murthy, V.S.R., Kaladharan, P., Rao, G.S., Pillai, N.G.K., Pillai, N.N., Balan, K., Chandrika, V., George, K.C., Sobhana, K.S., 1999. Packages of practices for sustainable, eco-friendly Mariculture, Proceedings of International symposium "Environment aquaculture interaction", 1996, In: *Aquaculture and the environment*, Joseph, M.M. (Ed.), Asian Fisheries Society, Indian branch, Mangalore, 48-59.

Fitzgerald, W.J. Jr., 1988.Comparative economics of four aquaculture species under monoculture and polyculture production in Guam, J. World Aquacult. Soc. 19(3), 132-142.

Gandhi, V., Mohanraj, G., 1986.Results of experimental monoculture of milkfish in marine fish farm at Mandapam, J. Mar. Biol. Assoc. Ind. 28(1 & 2), 63-73.

George, K.V., 1974. Some aspects of prawn culture in the seasonal and perennial fields of Vypeen Island, Ind. J. Fish. 21(1), 1-19.

George, K.V., 1978. Economics of traditional prawn culture practice in Kerala with a note on the advantages of intensive prawn culture, In: *Proceedings of the first national symposium on shrimp farming*, 15-18 August, Bombay, 131-137.

George, M.J., Mohamed, K.H., Pillai, N.N., 1968.Observations on the paddy field prawn filtration of Kerala, India, FAO Fish Reports 57(2), 427-442.

Gopalan, U.K., Purushan, K.S., Rao, T.S.S., 1978. Case studies on the economics of an improved method of paddy field shrimp culture in Vypeen Island, Kerala, In: *Proceedings of the first national symposium on shrimp farming*, 15-18 August, Bombay, 175-186.

Gopinath, K., 1956. Prawn culture in the rice fields of Travancore-Cochin, India, In: *Proceedings of. Indo-Pacific Fisheries Council*, 6th Session, 18, 419-424.

James, P.S.B.R., Raju, A., Rengaswamy, V.S., 1984. Further observations on polyculture of finfishes and prawns in salt water ponds and in a net pen in Mandapam, Ind. J. Fish. 31(1-3), 31-46.

James, P.S.R.B., 1986.Fin-Fish culture, In: *Proceedings of the Symposium on Coastal Aquaculture* 4, 1450-1455.

Jayagopal, P., Sathiadhas, R., 1993. Productivity and profitability of prawn farming practices, C.M.F.R.I. Special Publication 55, 16-25.

Kumar, A.V., Panikkar, K.K.P., 1993. An analysis of factor-product relationship in prawn farming: A production function approach, C.M.F.R.I. Special Publication 54, 85-93.

Lim, C., 1991. *Hand Book of Nutrient Requirement of Fin Fish* Wilson, R.P. (Ed.), CRC Press, Boca Raton, FL, 97-104.

Marichamy, R., Rajapackiam, S., 2001. The aquaculture of Scylla species in India, Asian Fish. Sci. 14, 231-238.

Mathew, P.M., Jose, S., Jose, M.M., Mrithunjayan, P.S., 1988. Polyculture of brackish water fishes in Vyttila fish farm, Kerala. In: *Proceedings of the First Indian Fisheries Forum* Modayil, M.J. (Ed.), Asian fisheries society, Indian branch, Mangalore.

Menon, M.K., 1954. On the paddy field prawn fishery of Travancore-Cochin and an experiment in prawn culture, In: *Proceedings of Indo-Pacific Fisheries Council*, 5th Session, Section 2, 1-5.

Nasser, A.K.V., Noble, A., 1992. Economics of prawn farming in Vypeen, Kerala with emphasis on some little-known facts. In: Aquaculture economics. *Proceedings of the Workshop on Aquaculture Economics*, Tripathi, S.D., Ranadhir, M., Purushothaman, C.S. (Ed.), Asian Fisheries Society, Indian branch, Mangalore, India, 20-22 November 1991, Special publication 7, 55-64.

Sathiadhas, R., Panikkar, K.K.P., Satyavan, U.K., Jacob, T., 1989. Economic evaluation of paddy-prawn integrated farming in Kerala, Seafood Export Journal, 21(11), 9-21.

Sathiadhas, R., Immanuel, S., Laxminarayan, A., Krishnan, L., Noble, D., Jayan, K.N., Sadanandan, S., 2003. Institution Village Linkage Programme: Coastal agro ecosystem and interventions, CMFRI, Kochi.