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Economic Evaluation of Traditional Prawn Filtration Practice in Central Kerala, South India

Sahadevan, P.[1]* and Sureshkumar, S.[2]

[1]*Department of Fisheries, Kerala, 4th Floor, Vikas Bhavan, Thiruvananthapuram-695 014, Kerala, India*
[2]*School of Ocean Science and Technology, Kerala University of Fisheries and Ocean Studies Panangad, Kerala, India*
**Email: sahadevanpayyadakath@yahoo.co.in*

Abstract

Traditional brackish water shrimp farming with varying degrees of sophistication exists in many parts of the world. Such a system of prawn farming in paddy fields, popularly known as prawn filtration, is prevalent in more than 12,000 hectares of low lying coastal brackish water fields adjoining the Vembanad Lake in Central Kerala (South India). The prawn filtration fields, confluent with the lake directly or through canals, are subjected to tidal influence and are important sources of farmed shrimp in the State. The farming system involves entrapping juvenile prawns, brought into the fields by the tidal water, and catching them by filtration at regular intervals. Supplementary stocking with hatchery-produced seeds is also done in most of these farms. These farming systems are on the decline due to various reasons. This study aims to evaluate the economics of traditional prawn farming, which was expected to provide information on whether or not economic factors were responsible for the observed decline of the area under filtration. For the study, a total of 48 traditional shrimp farm units were selected, observing a simple random sampling method. Cost- return analysis was used to evaluate the economic feasibility of various units. The possible existence of pure profits (resource rents above all costs) was calculated by comparing returns to the capital with the opportunity cost. In the present study, the returns to capital were found to be less than the opportunity costs of capital and labour. The study revealed that prawn filtration, in its present form, was not economically attractive in this part of the country. This is perhaps one of the most important reasons why the farmers leave this avocation in large numbers and sell or convert their land for non-farming purposes, leading to the decline of the area under farming. If the situation continues, more and more farmers will lose interest in the activity, and the area under traditional prawn filtration would come down drastically shortly. As a way forward, the paper makes a strong case that necessary interventions should be made to ensure that this traditional, intricate agriculture-fishery system survives indigenously, as examples of local heritage and environment-friendly ways of raising shrimp. Certain suggestions of the local farmers to revert the situation were also critically examined in the present paper.

Keywords: Traditional farming, *Pokkali*, Kerala, Economics

1. Introduction

Traditional brackish water fish farming with varying degrees of sophistication exists in many parts of the world. The *tambak* farming in Indonesia, brackish water farming in the Mekong Delta of Vietnam and *valli* culture of the Mediterranean region are examples of this farming practice. In India, such systems of traditional aquaculture in low lying fields are prevalent in *pokkali* fields of Central Kerala, *kaipad* lands of North Kerala, *gazani* lands of Karnataka, *khazan* lands of Goa and *bheries* of West Bengal.

The traditional system of prawn farming in paddy fields, popularly known as *pokkali* prawn filtration, is prevalent in more than 12,000 hectares of low lying coastal brackish water fields adjoining the Vembanad Lake in Central Kerala (South India). These fields, varying in size from 0.5 ha to more than 10 ha (George and Suseelan, 1983), and lying adjacent to the coastal villages of Thrissur, Ernakulam, Alleppey and Kottayam districts, are confluent with the Vembanad Lake directly or through canals and are subject to tidal influence. The farming system involves entrapping juvenile prawns brought into the fields by the tidal water and catching them by filtration at regular intervals (Kurien and Sebastian, 1982).

Prawn filtration is a traditional operation carried out only during the pre-monsoon period, November to April. During the southwest monsoon (June- September), water in these fields become almost salt-free. During this period, a unique variety of paddy called '*pokkali*', which is tolerant to salinity up to 6 ppt is grown in these fields (Unnithan, 1985). This is a short-term crop lasting for about 90-100 days.

Soon after the paddy harvest, if prawn filtration is not intended to be undertaken by the owner himself, the fields are leased out to prawn farmers for six months, *i.e.*, October/ November -mid-April. The lease value varies depending on the field's productivity, which is decided by the location and proximity of the field to the estuary and based on past performance. The lessee prepares the areas for the shrimp farming operation by repairing the bunds, fixing sluice gates for regulating the flow of tidal water and other works. Paddy stumps and straw left out in the fields are not removed but allowed to decay there to form fertile organic manure conducive for the growth of algae, including periphyton.

Stocking is done by letting tidal water into the fields during the high tide. Along with the tidal water, juvenile prawns from the adjoining backwater areas enter the field. They are attracted into the field by the light kept at the sluice gate during the night. When the tidal water starts receding at low tide, a closely tied screen made of split bamboo or areca nut tree (at present mostly nylon nets) is inserted

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across the sluice gate, letting out water and trapping the juvenile prawns. This sort of entrapment is continued at every high tide throughout the operation. Of late, obviously, on account of the scarcity of juvenile prawn in the incoming water, farmers undertake supplementary stocking with hatchery-produced seeds of black tiger prawn (*Penaeus monodon*) in the field at a low density of 1-2 seed m^{-2}. Supplementary stocking of hatchery-produced seeds is done generally during the initial phase of the culture period (November/ December) but, in some cases, quite later (January/ February).

Harvesting, known as filtration, begins from mid-December. This is done during the low tide by operating a conical net fixed at the sluice gate. Sluice net operation (filtration) is done at dawn and dusk for five to eight days around every new moon and full moon period (locally known as *thakkom*) during which the maximum tidal amplitude is experienced. The final harvesting, locally known as *kalakki pidutham* or *kettu kalakkal*, is done at the end of the season by operating sluice net, cast net and also by handpicking.

The economic performance of any farming practice is greatly influenced by the geographic location of the farm, market demand for the produce, input cost, prevailing economic situation, supply of substitutes to prawns etc., which vary greatly from time to time and from place to place. Hence studies on economics are to be revalidated frequently. Further, in recent times owing principally to increased urbanization and other anthropogenic activities, the extent of the traditional shrimp cultivation has declined drastically. More and more farmers are selling or converting their land for non-farming purposes and are leaving this avocation every year.

In addition, the adoption of any aquaculture technology rests mainly on its economic viability (Prasad, 2006). Economic analysis is essential to evaluate the viability of investment in the field, to determine the efficiency of resource allocation, to improve the existing management practices, to adopt new culture technology, to assess market potential and to intensify areas in which research success would have high potential payoff (Shang, 1990). Under these circumstances, the present study was undertaken with a view to analyze the economics of the traditional shrimp culture practices of Kerala and to understand whether economic factors are responsible for the observed lack of interest of farmers to continue the avocation.

The term shrimps and prawns are used synonymously in the present paper due to the absence of systematic basis to mark a distinction as opined by Wickins (1976) and Holthuis (1980).

2. Materials and Methods

The present study was conducted as a part of a larger study on the status, problems and economics of shrimp farming in the State of Kerala. The source of data for the present study was the socio-economic survey carried out among the traditional shrimp farmers in the districts of Thrissur, Ernakulam, Alleppey and Kottayam. For the purpose, a list of all traditional shrimp farmers in the districts were collected from the respective office of the Fish Farmers' Development Agencies and from the office of the Marine Products Export Development Authority. A consolidated list was prepared avoiding duplications. This list formed the basis for the present study. A sample was selected from the list by employing simple random sampling technique and data on topics of interest in the present study were collected from the selected units using an appropriate questionnaire designed for the purpose and which was pre-tested. The questionnaire was in vernacular language *i.*e., Malayalam. For the study a total of 48 shrimp farms, with a total water spread area of 294.66 ha were selected. Data were collected for two consecutive crops during the period from November 2016 to May 2018 and average per hectare per crop was taken.

Complete data were collected on various aspects of interest in the present study by frequent visits and from the farm records. Prior to the beginning of the collection of data on costs and returns, interviews were conducted with each farmer to determine their investment costs. The present study focused on average costs and earnings for the farm units to determine the returns to capital. Multiple visits were made to confirm data, especially during the days of harvests.

Cost- return analysis, which is perhaps the most common method used to evaluate the economic feasibility of aquaculture units was adopted in the present study. It answers questions such as cost of starting the venture, cost of operating the farm, major types of cost incurred, profitability of investment in the aquaculture venture, average cost of return to capital, etc. (Shang, 1992).

Profitability is examined from two points of view. First, return to owner is calculated by subtracting fixed and operating costs from the owners' earnings and the residual treated as a return to owners' own labour, capital, risk and management (Ovenden, 1961).

Second, the possible existence of pure profits (resource rents above all costs) is calculated by comparing returns to labour and capital with their respective opportunity costs (Panayotou, 1981) This comparison reveals whether pure profits exist in the operation and whether there is room to expand farming to redistribute the benefits. For example, if the sum of returns to capital exceeds the opportunity costs of capital, it would be to society's benefit to increase the amount of capital and labour used in farming. If the reverse is found to be the case, the amount of capital and labour in farming should be reduced, and the excess diverted to alternative activities where they can earn more. In the present study, the opportunity cost was calculated as 7.5% per annum for the farming period (rate of interest for fixed deposits in commercial banks at the study time). Depreciation was calculated by the straight-line method considering the salvage value as zero. Depreciation on items like bird fencing materials, meshes, frames, sluice planks and harvesting nets was calculated at the rate of 50%, as these items would stand only for two crops.

The rate of return was calculated by representing the residual return to owner's capital and management as a percentage of invested capital. The rate of return based on average investment cost to the present farming units is calculated as:

$$\text{Rate of return (\%)} = \frac{\textit{Residual return}}{\textit{Investment}} \text{X } 100$$

(The farming period is considered as six months and hence multiplied by two to get the annual rate of return).
During the days of the visit, farmers' views on the ways and means of improving production and productivity and making the filtration activity sustainable were also collected.

3. Results

Information on initial investment required for prawn filtration (per hectare) is provided in Table 1, and those on annual costs and earnings are provided in Table 2. Returns to capital, opportunity cost and pure profit of seasonal prawn filtration farms are presented in Fig. 1. The relative contribution of economically important finfishes, prawns and crabs in the harvest from the traditional farms is presented in Fig.2. The percentage contribution of different species of prawns to total prawn harvest by weight is presented in Fig. 3, and that by value realized is presented in Fig. 4. Month- wise catch data of traditional prawn fields (kg) is presented in Fig. 5.

4. Discussion

Entry into traditional shrimp farming operation requires moderately high initial investment. On an average, one-hectare traditional farm units require Rs. 2,73,500 as initial investment. Certain fixed costs inevitably become sunk cost, which cannot be retrieved without undue loss. In the case of traditional shrimp farms, fixed costs consist of lease rent (68.66%), depreciation of the farm assets (30.60%) and the license fee (0.74%). Average annual depreciation per hectare of shrimp filtration units was Rs. 20,500. This amount must be reserved for eventual replacement of assets after they wear out. Earnings must be high enough to cover the fixed costs in addition to the operating costs, if farming is to continue in the long run.

Table 1. The initial investment required for traditional prawn farming (per hectare)[1]

Sl. No.	Items	Amount (Rs)[2]
1.	Lease rent	46,000
2.	License fee	500
3.	Repair of bunds, sluice gates, temporary farm house etc.	20,100
4.	Lime and fertilizers	4,800
5.	Cost of supplementary stocking of seed (including transportation and stocking expenses)	11,000
6.	Supplementary feeds	30,000
7.	Wages	1,00,000
8.	Bird fencing	20,300
9.	Meshes, frames, sluice planks, harvesting nets etc.	20,700
10.	Harvesting expenses	9,900
11.	Miscellaneous	10,200
	Total	2,73,500

[1]crop duration is 6 months
[2]Average rounded off to the nearest hundred Rupees

Table 2. Annual costs and earnings of traditional prawn farming (per hectare)

Items	Amount (Rs)
A. Fixed cost	
1. Lease rent	46,000
2. Depreciation	20,500
3. License fee	500
Total fixed cost	67,000
B. Variable cost	
1. Repair of bunds, sluice gates, temporary farm house etc.	20,100
2. Lime and fertilizers	4,800
3. Cost of supplementary stocking of seed (including transportation and seed stocking expenses)	11,000
4. Supplementary feeds	30,000
5. Wages	1,00,000
6. Harvesting expenses	9,900
7. Miscellaneous	10,200
Total variable cost	1,86,000
C. Total cost of production	2,53,000
D. Revenue	
1. Sale of 881.4 kg of shrimp at an average price of Rs. 244 kg^{-1}	2,15,062
2. Sale of 216 kg of fin fishes at an average price of Rs. 179 kg^{-1} and 19.6 kg of crabs at an average price of Rs. 342 kg^{-1}	45,367
Total revenue	2,60,429
E. Net revenue per crop (D-B)	74,429
F. Residual return to owner's capital (D-C)	7,429
G. Rate of return (%)	5.43

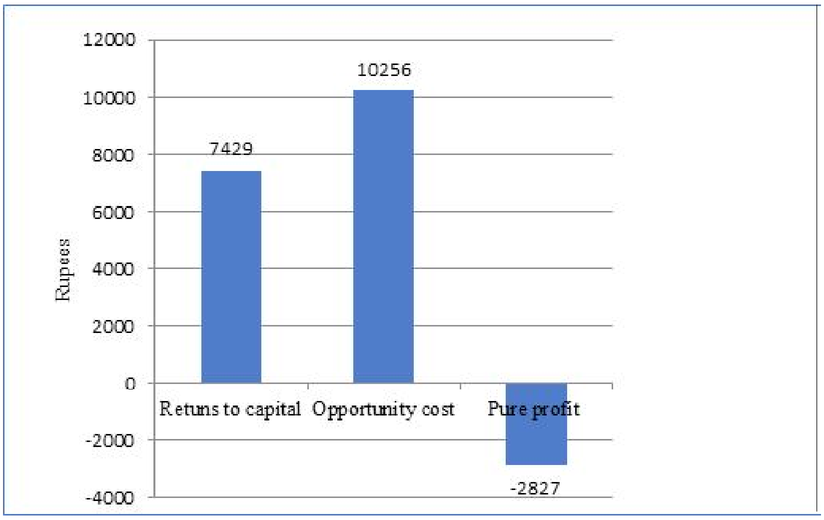

Fig. 1. Returns to capital, opportunity cost and pure profit of traditional prawn farming (per hectare)

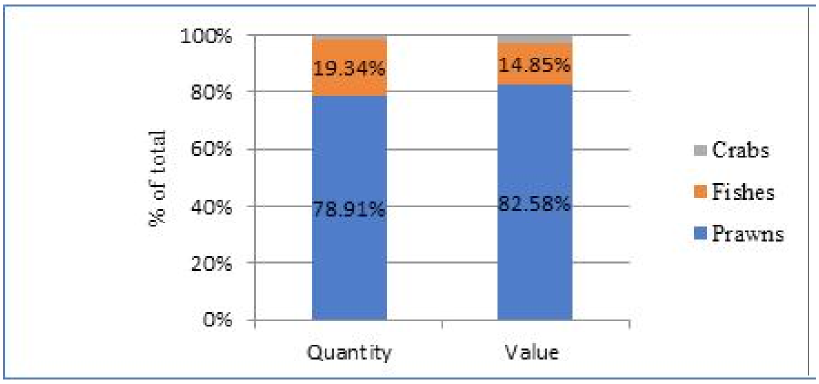

Fig. 2. Relative contribution of prawns, fin fishes and crabs in the harvest of traditional farms

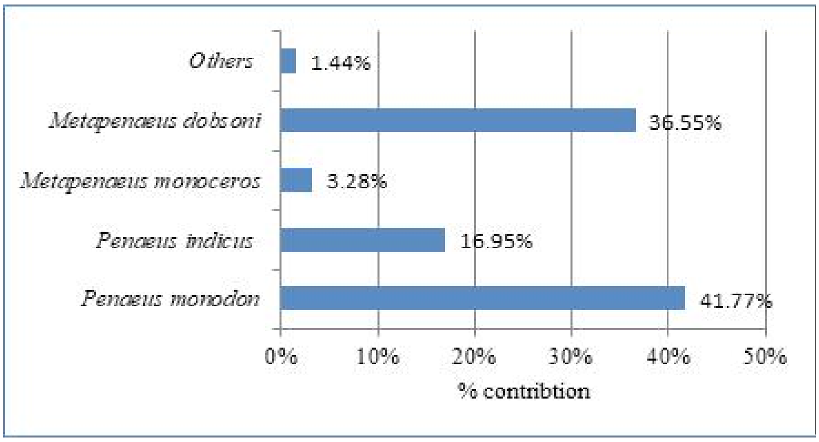

Fig. 3. Percentage contribution of different species of prawns in total prawn harvest of traditional farms (weight)

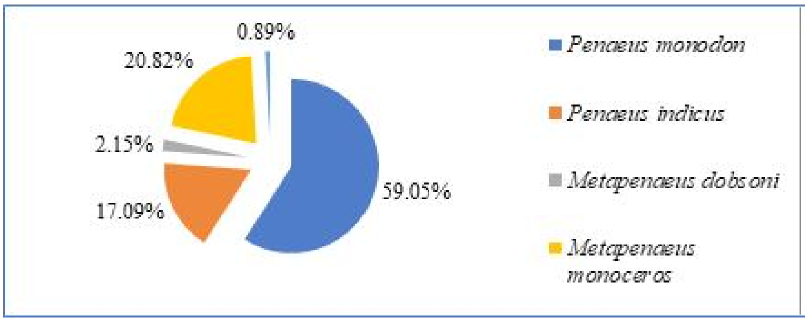

Fig. 4. Percentage contribution of different species of prawns in total prawn harvest of traditional farms (value realization)

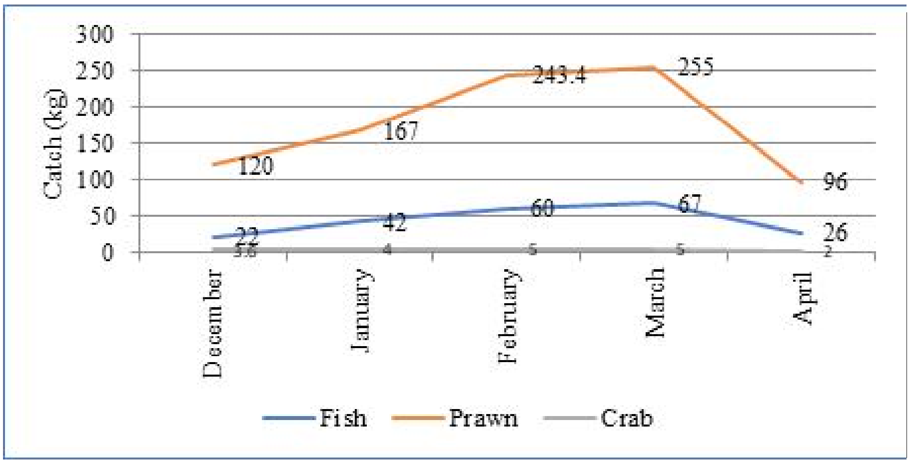

Fig. 5. Month-wise catch data of traditional prawn farms (kg)

Operating costs such as repair and maintenance, cost of lime, fertilizers, seed, feed, harvesting expenses, wages and other cash costs vary with the level of production and hence are considered variable costs. It may be of interest to note that the largest component of variable cost was wages to labourers (53.76%) followed in order by supplementary feed (16.13%), repair and maintenance (10.81%), cost of seed (5.91%), harvesting expenses (5.32%) and cost of lime and fertilizers (2.58%). Miscellaneous expenses accounted for 5.48%.

The average net income from the farming operation was of Rs. 74,429. From this net income, it is necessary to deduct fixed cost to determine the annual residual return to owner's capital. This averaged Rs. 7,429 ha^{-1}. When the opportunity cost of capital (Rs. 10,256 for the crop period of six months) was deducted from the residual return to capital, seasonal prawn filtration units were found to incur an average pure loss of Rs. 2827. Though not actually incurred, opportunity costs are fundamental costs in economics and are used in computing cost- benefit analysis of a project. Such costs, however, are not recorded in the account books but are recognized in decision making by computing the cash outlays and their resulting profit or loss. It, in fact, gives an idea about the gain or loss on an investment over a period of six months. Investment in an economic activity may be justified only if it can generate sufficient income to offset its opportunity cost.

A fairly large number of studies have been carried out on the economics of traditional prawn farming in Kerala at various points of time. These include Gopalan *et al*. (1978), George (1980), Sathiadhas *et al*. (1989), Nasser and Noble (1992), Jayagopal and Sathiadhas (1993), Raju (1997), Pillai (1999), Krishnan *et al.*, 2001 and Prasad (2006). A direct comparison of the profits reported by various authors with the present observation is not possible because of difference in the conditions of farming and difference in time frame of the study. Traditional farming has many variables which cannot be predicted in advance or controlled. It may also be mentioned here that the above referred papers deal with case studies based on a few farms. But the present investigation on the other hand is a sample survey based on a large number of farms for estimating the average costs and revenue and the economics of operations.

The lack of time series data on economic aspects of traditional prawn farming is a major handicap to any serious analysis. Only with time series data can trends be determined. The present study on economic viability provides only a picture of the traditional farming at a particular point in time, but a particularly valuable one because it allows conclusions to be drawn regarding the likely generation of benefits from the traditional farming activity. However, one should clearly understand that the findings on economic viability in the present study are the averages of the 48 farm units studied. Indeed, not all farming units were running at a loss. A few might be profitable because of their geographic proximity to the estuarine mouth where the availability of prawn seed is generally greater and the water quality is better. Some farming units may also have been profitable because of the Government financing/ subsidy provided at present. But they may find it more difficult to remain so when private or commercial bank sources or own capital are the only means to finance the activity. However, with the available data in general, one can very well conclude that pure profit does not exist in traditional prawn farming. Although there are no hard data to substantiate, it appears that this traditional farming activity, if no interventions are made to improve the situation, will disappear in future due to economic compulsions.

However traditional shrimp farming is an example of organic farming of shrimp, as minimal quantity of external inputs like feed, lime, fertilizers, disinfectants and other chemicals are used. Factory produced feeds are generally used in these systems only during the nursery rearing of seeds which is restricted to a few days. During the grow out phase, either no feed is used or fresh feeds (mostly clam meat) are used. Lime is applied only to correct the pH. In prawn filtration fields, use of fertilizers are also very limited. Similarly, in these systems, no disinfectants are used. Since it is a low input system, the chances of pollution are very minimum. Further, unlike in scientific farming, the practice of eradication of weed and predatory fishes are not done here. Thus, from fish conservation point of view also, traditional prawn filtration assumes great importance. In the context, there is an imperative need for governmental interventions to ensure that this traditional, intricate agriculture-fishery system survives indigenously, as examples of local heritage and environment friendly practice of shrimp culture.

The average production of shrimp in traditional prawn farms was 881.4 kg ha^{-1} which was dominated by *P. monodon* (41.77%) followed in order by *M. dobsoni* (36.55%), *P. indicus* (16.95%), *M. monoceros* (3.28%) and others (1.44%). Similarly, in terms of revenue realization *P. monodon* (59.05%) was the most important species followed in order by *M. dobsoni* (20.82%) *P. indicus* (17.09%), and *M. monoceros* (2.15%). The observed differences between percentages of quantity and value realization were because of the difference in market price of the four species. In addition, 216 kg ha^{-1} of fin fishes and 19.6 kg ha^{-1} of crabs contributed to the total revenue realized.

The observed percentage contributions of different species were different from the figures reported by George (1980) and Unnithan (1985), obviously on account of selective stocking with hatchery-produced seeds of *P. monodon* practiced in the present case which led to an increase in its percentage of occurrence. The reports by the above-mentioned authors were based on studies in the fields where no selective stocking was practiced.

Many earlier workers reported different levels of production of shrimp in traditional shrimp fields at different points in time. Menon (1954) reported a yield of 1079 kg ha^{-1} from the traditional prawn filtration ponds and Gopinath (1956) reported 1184 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 by restocking under-sized juveniles of *P. monodon* and *P. indicus* caught from the nets back into the fields. Sathiadhas *et al.* (1989) indicated an average yield of 620 kg ha^{-1} in Vypeen island of Kochi. A regressive trend in the yields of shrimps from traditionally operated fields has been observed from 1950s to late 1970s by Joseph and Sathiadhas (2006). The authors found the increase in the intensity of exploitation of natural stock and environmental degradation as the probable reasons for the observation. According to Sathiadhas *et al.* (1989) and Nasser and Noble (1992) although more and more farmers resorted to selective stocking from late 1980s, the effect was not seen in total fish production. The authors stated frequent harvesting followed in the traditional fields as the reason for the low shrimp production in spite of selective stocking. A direct comparison of the yields obtained by various researchers with the yield obtained in the present study cannot be made because of difference in the farming conditions and time of the study. George (1974, 1978) and Unnithan (1985) reported many short comings in traditional farming like indiscriminate stocking, presence of predators and undesirable species, lack of control over the environmental factors, inadequate growing period, predominance of low valued species like *M. dobsoni* in the catch etc. as the reasons for the low production of traditional prawn farming units.

On superficial analysis, it seems that the supplementary stocking of hatchery- produced seeds of prawns in the traditional filtration fields, which are not scientifically prepared and where there are chances of occurrence of predatory and weed fishes, may not yield any benefits. In unprepared ponds, the predatory fishes are expected to take a heavy toll of the stocked seeds. However, in practice supplementary stocking was found to have beneficial effects in prawn production as is evident from the high percentage of occurrence of *P. monodon* in the harvest. It reveals that a sizeable number of stocked seeds survive in the system 'unharmed' by the predators. It may be because of the fact that most of the farmers now a days invariably stock nursery reared, advanced seeds and provide shelters in the form of coconut fronds, twigs of cashew trees etc., which would help the seeds to escape from the predators. Supplementary stocking with seeds of fast-growing species of prawn like *P. indicus, P. monodon* etc. were suggested by many earlier workers, too (Rao 1978; Muthu, 1978 and Unnithan, 1985) as a means to enhance prawn production and higher value realization.

The observation on the month -wise harvest showed that the production increased steadily from the month of December up to the month of March and declined thereafter. Generally, in the month of April the owners make an all-out effort to capture the entire prawn and fish stock left in the field. Even with this, there has been an overall decline in production. One reason could be decline in tidal amplitude and resultant lowering of water inflow during the summer months which would result in lower rate of stocking the field. Further, it also causes lowering of depth of water column which would lead to increase in temperature of water in the field during summer season making the habitat less favourable for the growth of prawns. A similar observation was also made by Sathiadhas *et al.* (1989).

Information collected during the period of actual observation of prawn farming operation brought out some of the views of the farmers regarding the ways and means for increasing production and for making the filtration activity sustainable. There was an opinion among some farmers to convert the shrimp filtration fields into farms undertaking semi-intensive farming of *L. vannamei*. However, such a proposal may not be viable. For the semi-intensive farming of *L. vannamei* the fields will have to be deepened to provide an effective depth of 1.50m. However, most of these fields are located in acid sulphate areas (Sahadevan, 2012). Deepening of acid sulphate areas may lead to further lowering of pH values on exposure to air which would make the fields unfavorable for prawn growth. High density farming of *L. vannamei* also requires artificial aeration for which availability of electricity is a pre-requisite. However, many of the prawn filtration farms are located in areas which do not have electrical connectivity (Sahadevan and Suresh Kumar, 2020).

Another opinion put forth by the farmers was to stop paddy cultivation and to undertake prawn farming in these fields throughout the year, instead of the current practice of undertaking rice production for six months and prawn production for the next six months. But perhaps this also may not be viable. Traditional shrimp farming is in fact an integrated farming system in which paddy farming alternates with shrimp cultivation, benefitting each other.

There is a favourable residual effect of paddy cultivation on the subsequent prawn production in that the decayed straw and other left-outs of paddy act as nutrient source for the plankton production. These also act as substratum for the growth of periphyton which serves as feed for the shrimps. On the other hand, the excreta of the prawns act as good bio fertilizer for the paddy. Thus, cessation of paddy cultivation will lead to a decline in nutrient release which will result in a reduction in food supply to the system, leading eventually to a decrease in prawn production. In addition, there is the land utilization policy of the Government restricting the conversion of paddy fields for raising other crops. Considering these aspects, it would appear that prawn culture round the year under the existing frame work may not be a practical proposal.

Another view expressed by a number of farmers was on the desirability of extending the present date of termination of shrimp farming from mid-April to the end of May. The month -wise shrimp production in the present study showed that the production declined sharply after March. The yield-trend indicates that prolonging the period beyond mid-April may not result in higher economic returns in prawn filtration fields. Similar observation was also made by Sathiadhas *et al.* (1989). Further, there is an age-old custom in this part of the country where prawn fields become a common property resource after 15th of April every year conferring the local fishermen the right to fish in the fields. In the light of these, the proposal was not viable.

Supplementary stocking with seeds of fast-growing species of prawns like *P. indicus, P. monodon* etc. were suggested by many workers (Rao 1978; Muthu, 1978 and Unnithan, 1985) for enhancing prawn production and higher value realization. The rationale behind supplementary stocking of tiny hatchery- produced seeds of shrimps in a system in which there is no control over the entry of predatory and weed fishes may be questionable. In the field there is always the presence of predatory and weed fishes which will eat away a large number of supplementarily stocked seeds. However, the observation in the present study proved otherwise. By stocking nursery reared advanced seeds and by doing some modifications, higher production could be achieved. Some modifications would also be required in the present harvesting technique when high yielding species are stocked. Frequent harvesting as is practiced now may have to be discontinued, to allow the added seeds to remain in the field for a longer time to facilitate satisfactory growth. It is suggested to evolve a complete technology to increase production which will fit into the broad frame work existing today.

To improve final survival rate of stocked seeds, most of the farmers stock nursery reared juveniles instead of post larvae directly in the grow-out ponds. Stages of post larvae usually supplied in the hatchery range from 5 to 25 days old (PL 5 to PL 25). The objective of nursery rearing is to produce fairly larger prawns which can escape from predatory and weed fishes. The aim is also to produce healthy, strong and uniform juveniles with significant potential for compensatory growth after their transfer for final grow-out. This juvenile production phase occurs when the post larval shrimp bodyweight reaches approximately 2 mg and can continue until the individual shrimp weighs 300 mg or more. Proper growth and development during this stage, conditions the animals to manage the challenges faced in the grow-out environments. Separate nursery infrastructures are increasingly being adopted by farmers due to the value they provide both biologically and economically. The advantages of nursery rearing also include control and bio security, efficiency operation and improved health and disease management. Many authors observed advantages of nursery rearing of seeds before grow-out socking in scientific farming of shrimp (Apud and Sheik, 1978; Cholik, 1978; Apud, 1979; 1988; Fernandez,1979; Gabasa, 1982; Hirono, 1983; De la Pena and Prospero, 1984; Unnithan, 1985; SEAFDEC AQD, 1989; Villalon, 1991; Sturmer *et al.*, 1992; Yta *et al.*,2004; Browdy *et al.*, 2016, 2017). Incorporation of a nursery phase into the production cycle is a significant management strategy and has been implemented by many progressive shrimp farmers. Nursery systems with water conditions similar to the hatchery eliminate predators, provide greater water quality control, and increase feeding efficiency during critical initial life stages (Pretto, 1983). This allows for larger and hardier shrimp at stocking into the grow-out pond. Use of nursery ponds also reduces culture time in the grow-out ponds and increases production.

Generous support from the Government is also required for enhancing profitability which is indispensable for the very survival of this traditional agri- aquaculture system and for ensuring its sustainability. It is essential that Government takes strong measures to prevent unscientific fishing in the backwaters. Today, there are numerous gill nets, cast nets, Chinese nets and stake nets operating in the backwaters which prevent the free entry of prawn seedlings into the fields. Appropriate actions are required to put a limit to gear numbers and strict enforcement of the same. There is also a need to clear weed chocking of many of the waterbodies which bring in seeds to the prawn filtration fields. Of late, the reclamation of the backwaters for various purposes is also on the increase which needs to be regulated so as to allow free flow of water from the estuary to the fields.

Another area where Government needs to act is the enforcement of laws to prevent pollution resulting from the discharge of effluents from the industrial units. It is essential that production and associated environmental factors are regularly monitored for proper understanding of yield fluctuations which may facilitate the formulation of remedial measures if need be, at the right time. A good information base would also help in planning suitable programmes for the sustainable management of the traditional shrimp farming practice. Yet another option is to adopt a strategy for branding and marketing of the produce as “organic shrimp” which can help realize higher price and improve the overall profitability. An important aspect which results in uncertainties in profitability is the recurrence of viral diseases which results in mass mortality of prawns (Sahadevan, 2013). Provision of insurance coverage to traditional shrimp farming can go a long way in circumventing the situation. The outer bunds which are common to many small farms may be strengthened or constructed by the Government agencies which would reduce the risk involved in cultivation and check the expenses on maintenance of bunds.

The results of the present study revealed in unambiguous terms, that traditional prawn farming as practiced today, is economically unattractive. With a unit investment of Rs. 2.73 lakh per hectare, prawn farming generates a net profit of Rs.7,429, within a crop period of 6 months. If opportunity cost is also considered the pure profit is negative. In the context of very low profit levels, coupled with the high risk associated with the frequent occurrence of viral diseases, pollution of water bodies and the non-availability of good quality seeds, this traditional activity will become unattractive and the area under cultivation is expected to decline in the years to come. In fact, at least in some cases, the commitment and the inclination of the farmers to continue the age-old tradition compels them to practice this avocation, even when the profitability is poor. However, they cannot continue for long, if the situation does not improve. The fields which are nearer to the estuarine mouth may prove to be profitable and may attract the farmers for some more time. But the overall prospects are unappealing. In the context there is an imperative need for Governmental interventions.

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