AN ANALYSIS OF FACTOR-PRODUCT RELATIONSHIP IN PRAWN FARMING – A PRODUCTION FUNCTION APPROACH

DISSERTATION SUBMITTED BY

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C E R T I F I C A T E

This is to certify that this Dissertation is a bonafide record of the work done by Shri. Ajith Kumar, V. under my supervision and that no part thereof has been presented before for any other degree.

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CONTENTS

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P R E F A C E

A perusal of fisheries development programmes of different countries of the world reveals that the development of prawn culture is a field to which most of the countries have attached great importance. Among the two general kinds of prawn culture being practiced in different parts of the world, extensive or traditional culture involves operations in more or less natural aminities available and is devoid of proper management procedures. The more systematic method of cultivation involves preparation of ponds, selective stocking of prawns and implementation of management procedures (Bensam, 1982). In the former method, the production is rather low, but in the latter, it is quite high.

In India and south-east Asian regions, a great deal of interest is shown in expanding and improving the traditional extensive methods of prawn culture. Here, generally biological and technical problems have received much attention. Biologists have focused on measures to overcome the constraints to production and modify existing traditional systems. While the development of hatchery system for prawn seed production, formulation of different and efficient compounded diets, monitoring of stocked prawns in the field, control of diseases in the hatcheries and growout systems and perfection of pond management principles are some of the fields in which active researches are pursued, there are several areas which need intensive studies and experimentation. Progress can be made if biologists can determine the production response of different technologies and the effects of these technologies on producer's profit can be evaluated by economists (Muthu et al. 1982). In this aspect, aquaculture economics comes into play.

Research on the production economics plays an important role in the development of aquaculture. It provides a basis not only for decision making among farmers but also for the formulation of government aquaculture policies.

A wellconducted economic analysis will provide substantive direction for development. Farm operators and policy makers can avail themselves of different options in aquaculture as a result of comparative studies. Research in production economics such as the study of input-output relations can contribute to improved farm management and to the formulation of public policy regarding the allocation of scarce resources.

The current emphasis in Asian countries on management and development in fisheries sector, be it artisanal fisheries, fish farming or commercial fishery is increasing the need for sound planning and investment decision making and improved research and extension. An understanding of the implications of the existing social, cultural and economic interactions and the extent of resource allocation in a society is an important element in the introduction and development of aquaculture technology. Also, it is highly essential to study the input-output relationship both in traditional and new aquaculture production techniques and the profitability of these techniques. As in any other industry, the aquaculturist is also an enter-preneur, and his business activity is mostly guided by the net economic yield, which is the difference between cost of inputs and value of output. Hence, the study of input-output relationship in aquaculture industry is of considerable importance for its planning and development.

However, in many developing countries, such interest and capacity to carryout extensive economic studies is presently lacking, thus making it difficult for sound development policies to be formulated. At the present time, the shortage of reliable data on aquaculture economics and lack of understanding of the importance of such data impede economic analyses.

Though much efforts have been made in the dissemination of information of prawn farming, till now no serious attempt has been made to analyse the extent of adoption of these practices and the profitability of culture operations in field situations. The present study, which aims at analysing the economics of semi-intensive prawn farming being practiced in Kerala could provide a feed back information on the profitability of field situations of the culture practice and also on the allocation efficiency of inputs used in prawn farming. This will help to provide basic information on the economic feasibility of the existing technology and correct the imbalances in the resource utilisation.

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INTRODUCTION

Stabilisation of the yield of marine shrimps from the 40 fathom zone of the shelf waters despite the increase in efforts of capture has made it imperative to seek alternative sources to augment shrimp production. While the exploratory fishing by deepsea trawlers indicated certain resources of finfish in the sea beyond 40 fathoms, the marine penaeid shrimps which form the backbone of offshore trawling industry have not been located at sufficient density to warrant profitable exploitation (Raje and Rande, 1978). So efforts have been made in the experimentation with culture fishery on the shore itself. Experience of several south-east and far east countries have shown that brackishwater areas are immensely suitable for shrimp farming (Milne, 1972; Bardach et al., 1972; Shigueno, 1975).

In India, the traditional way of culturing prawns is by holding the juveniles in small areas of water where tidal influence is maintained, and allow them to grow for a few months till they attain maximum possible size. This type of prawn culture in low lying areas or paddyfields is carried out in certain regions of backwaters of Kerala. (Kurian and Sebastian, 1982). Panikkar (1937), Menon (1954), Gopinath (1956), Panikkar and Menon (1956), Kestevan and Job (1956), George (1974), Muthu et al. (1982) and George (1983) have given a general account of this kind of culturing of prawns.

Various studies on the trapping of juvenile prawns in the incoming tide in the fields and similar impoundments and allowing them to grow before harvesting, represented by the traditional practices of prawn filtration in Kerala and Bhasha-Badha fisheries of W. Bengal clearly indicate possibilities of profitable prawn culture if scientific practices in stocking and management measures are adopted (Alikunhi, 1978). But the traditional practice though prevailing over the years, has neither undergone any change in its efficacy during its long life history nor extended appreciably to other regions (Verghese, 1978). However, with a wealth of information coming forth on the potential and prospects of prawn culture employing modern techniques, considerable interest is being evinced to bring in more and more areas into the fold of aquaculture. The cultivable brackishwater area in India is estimated at 2.02 million ha (Jhingran and Gopalakrishnan, 1972), with 1.43 million ha under brackishwater swamps (George , 1974). The extent of estuaries and brackishwater in Kerala is estimated at about 0.243 million ha. Of this 0.122 m. ha could be cited for penaeid prawn culture, and at present, prawn culture is being practiced only in about 5000 ha following the traditional practice of filtration (Rao, 1978). The extent of brackishwater area which could be reclaimed and used for brackishwater prawn culture is as follows (Anon, 1978).

This traditional culture, though a simple indegenous technique involving very little input, is neverthless limited in its efficacy. The production is often less quantity as well as quality, obviously due to the indiscriminate stocking of both desirable and undesirable species brought in by the tide, and to the short period of impoundment during which no appreciable growth is possible (George et al.,1968).

Region	Area available in ha.
Kuttanad	49,000
Shertallai	4,900
Cochin-Kanayannur	5,700
Parur	10,000
Trichur District	10,000
Vaikom	10,000
North Kerala	32,000
Total area available	1,21,600 ha

The Central Marine Fisheries Research Institute has evaluated the above practice and suggested an improved method of prawn culture. This is the semi-intensive method of prawn culture involving the selection of fast growing and high priced prawns for culture, preparation of the ponds by eradicating unwanted organisms, stocking with only selected species at appropriate stocking densities, feeding them with supplementary feed and culturing the stocked prawns for 3-4 months when they attain marketable size (Silas, 1983). This improved method of prawn culture has been demonstrated by CMFRI and is being propogated among the farmers through the Krishi Vigyan Kendra of this Institute. It has been shown that by following this system, not only yield could be enhanced, but also the quality of the product could be improved to obtain higher unit price (George, 1983).

Experimental studies on the growth of shrimps contributing to the paddy field fishery has been made by George, Mohammed and Pillai (1968). A comparative study of the species wise yield and economics of the traditionally operated seasonal and perennial fields of Vypeen island has been carried out by George (1974) and Sathiadas (1989). These authors have directly or indirectly pointed out the need for introducing improved culture techniques to enhance the yield as well as the farm income from the paddy field.

The paddy field shrimp culture of Kerala involves an element of risk as the returns depend largely on the coincidence of environmental factors conducive to the ingression of the juveniles and post larvae of shrimps into the field. However, the improved operation incorporating culture techniques such as nursery, supplementary feeding, retrieval of undersized juveniles, weeding and elimination of predators and uneconomic species, and fertilization of the pond can certainly reduce the risk by enhancing the production of desirable species such as P. indicus (Gopalan et al., 1978).

In Ernakulam district, where there is a greater conglomeration of prawn farms much effort has been made by Central and State Government agencies to encourage scientific prawn farming as mentioned earlier.

Inspite of all these efforts, the extent of adoption of scientific prawn farming practices is not up to the satisfactory level. In this context, it is essential to analyse the relative advantage of the innovation in terms of economic feasibility or profitability in field situations. The present investigation is aimed at assessing the economic feasibility of semi-intensive prawn farming under field situations and to study the costs of production, farm income level of employment generated and to analyse the factor-product relationship and profitability in prawn farming business.

MATERIALS AND METHODS

AREA OF SURVEY:

The survey area is in Ernakulam district, and is distributed in various places such as Tripunithura, Maradu, Edavanakkad and Panangad and is indicated in the map given. (Fig. I.).

Although a large number of farms are distributed in the Vypeen and Parur areas also, the farmers there did not adopt the semi-intensive prawn farming in a large scale. In these areas, the practice was just traditional filtration of prawns, in which no management practice was followed. Some of the farmers adopted an improved method with selected stocking of juveniles. The level of production in this region was of the order of 700-1000 kg/ha which is due to the high productivity of the area due to the nearness to the barmouth (George, 1974). But in the interior areas such as the area of the study, the yield obtained through the traditional system of prawn filtration, was much less, and so more and more farmers adopted the semi-intensive system of farming. As the present study was conducted only in semi-intensive prawn farms, this area was selected.

METHOD OF SURVEY:

The explanation of output variation through a production function requires data collected from a sufficiently large number of farms to allow the reliable estimation of parameters (Smith, 1981). A sample size of 30 was established in this study. The farms were selected on a random basis and the data on inputs, output, prices, costs and also the socio-economic condition of the farmers were collected by personal interview. For that, a questionnaire was prepared, the format of which is given in the appendix.

METHODOLOGY:

A general form of Cobb-Douglas production function was used to study the relation between the output and a set of factor inputs.

THE PRODUCTION FUNCTION:

The application of formal production function concepts in aquaculture is a relatively recent development. Production function, when used for economic analyses and recommendation provide valuable information needed for choice and decision making (Heady and Dillon, 1961). The model used for production function analysis in this paper is the general form of Cobb-Douglas production function which is given as

$$Y = a \; x_1^{b1} \; x_2^{b2} \; x_3^{b3} \; x_4^{b4} \; x_5^{b5}$$

Where Y is the dependent variable (output) and x_1 through x_5 are the explanatory variables (inputs); 'a' is a constant and 'b' values are the regression coefficients for the respective inputs, x_1 to x_5. The explanatory variables included in the function are land area (x_1), seed (x_2), feed (x_3), fertilizer (x_4) and labour (x_5).

The physical relationship between inputs and output is established through the estimated Cobb-Douglas function. Then the marginal analysis is employed to evaluate the producer behaviour. Profit is maximum when the value of marginal product of certain input is equal to its price.

$$\text{ie. when } MVP_x = P_x \quad \ldots\ldots\ldots \quad (1)$$

$$MVP_x = MPP_x \text{ X } P_y \quad \ldots\ldots\ldots \quad (2)$$

Where MVP_x is the marginal value product of x, P_x is price of input x, P_y is price of output y and MPP_x is the marginal physical product of x.

$$\text{Hence } MPP_x = \frac{P_x}{P_y} \quad \ldots\ldots\ldots \quad (3)$$

ie. profit is maximum when marginal physical product is equal to price ratio of input and output.

$$MPP_x = b.\frac{\bar{y}}{\bar{x}} \quad \ldots\ldots\ldots \quad (4)$$

$$\text{Hence } b\frac{\bar{y}}{\bar{x}} = \frac{P_x}{P_y} \quad \ldots\ldots\ldots \quad (5)$$

The optimum level of input use for maximising profit is calculated by substituting values of b, $\bar{y}$, P_x and P_y in equation (5) and solving for $\bar{x}$.

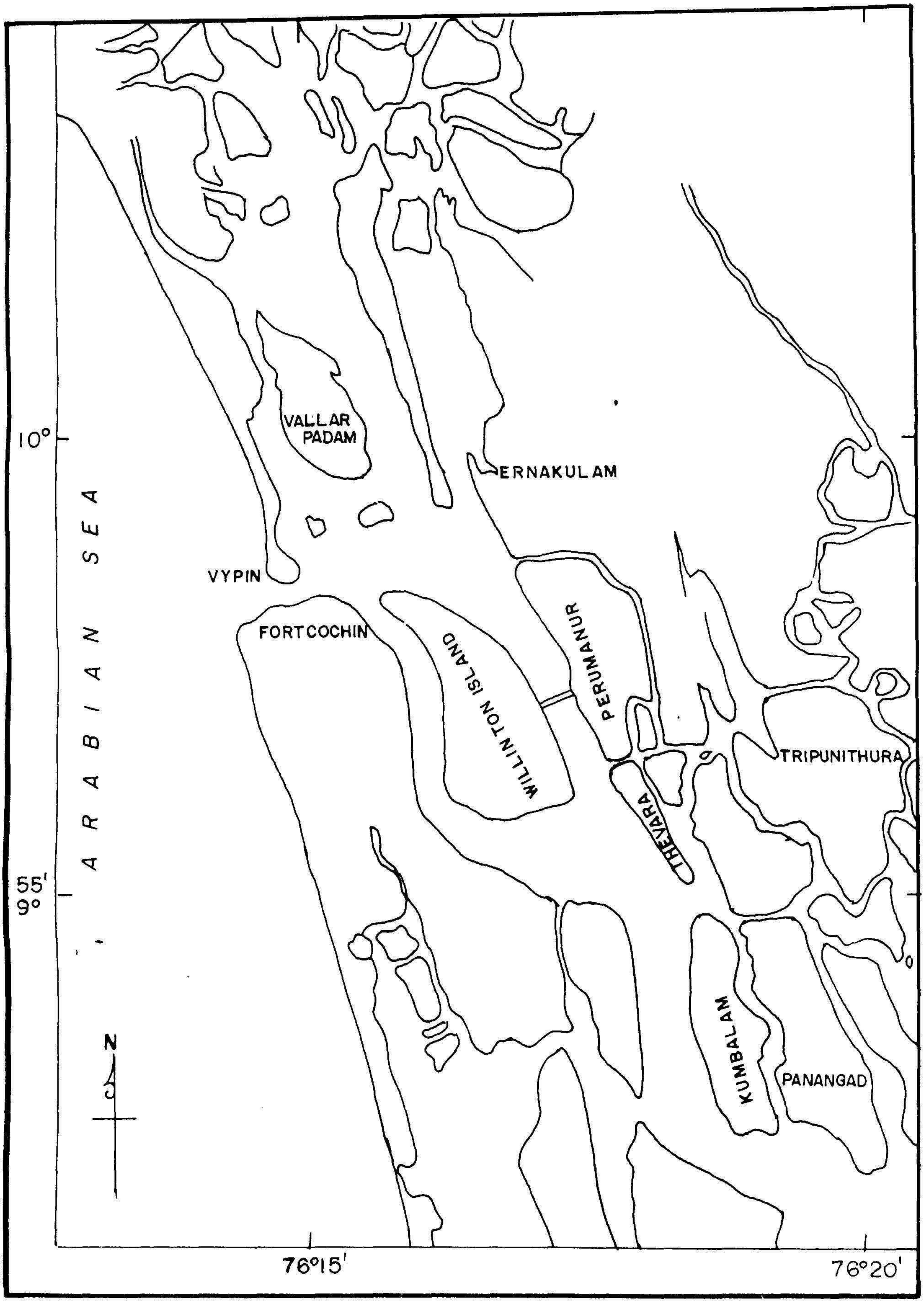


Fig. I. Map showing area of survey

RESULTS AND DISCUSSION

CULTURE PRACTICE:

The prawn culture practice covered under the present study may be called a semi-intensive farming in which selective stocking of prawns, feeding them with supplementary feed, fertilization of the pond, and eradication of the unwanted organisms are done. Culture of P. japonicus, P. monodon and P. chinensis practiced in Japan, Taiwan, and Korea can be included under this category, although in Kerala,the scientific methods are not so strictly followed due to various reasons. In foreign countries, yields of 2000-3000 kg/ha are obtained. (Shigueno, 1975). While in India, the yield through such semi-intensive operations are of the order of 1000-1500 kg/ha Muthu et al. (1982). In Kerala, the prawn culture is done in the fields lying along the coastal village of Trichur, Ernakulam, Alleppey and Kottayam districts, which are subjected to tidal influence and the farming system involves along with selective stocking, entrapment of juveniles of prawns brought in by the tidal water also.

This operation is seasonal and usually done only during the pre-monsoon period, ie., November to April. With the arrival of the Southwest monsoon, (June-September) water in these fields become salt free making it non-conducive to the farming of marine prawns. In some low lying fields where there is availability of saline water all throughout the year, the farming operation is done all round the year. The former fields are called seasonal fields and the latter, perennial fields. A comparative study of production from these fields has been done by George, (1980). In the seasonal fields, a special variety of paddy called 'Pokkali' which is tolerent to salinities upto 6-8 ppt is grown in the monsoon time (Silas, 1978).

Soon after paddy harvest, the fields are leased out to prawn farmers for a period of 5 months, ie., mid November to mid April. The lessee prepares the field for prawn culture by repairing the bunds, fixing sluice gates for regulating the flow of water coming with the tide and such other work (Mohammed, 1972). The prawn farmers of Kerala usually use an ordinary box type sluice gate made of wood whose main components are a bottom frame, side frames, top frame, shutter planks and sliding velone screens. The size and position of the sluice depend greatly on the general layout and extent of the field, width of the peripheral bund and also on the velocity and direction of water flow.

The fixation of the sluice gate is done as follows. The bottom frame or platform is first kept after ascertaining that the substratum is in even level and hard enough to hold the platform. The platform is rammed well by manual trampling to firmly set it right on the ground. Side frames are then inserted into the slots of the platform. The top frame is subsequently inserted into the butts of the side frames and the gate is thus made into a single unit. The gate is trampled heavily on the top to set the unit into the sill level of the ground. Shutter planks meant for regulating the flow of water and the velone screen for preventing the entry of predators are introduced into the grooves only after proper fixation of the gate. These wooden sluice gates are generally made of country wood and similar box type sluice gates can be made of concrete or in cement masionary as a permanent structure (George, 1983).

The food and space available in the culture system should be efficiently utilized to have optimum yield. However, this may not be possible in the system where predators and competitors are present. For successful farming, these undesirable organisms should be eliminated from the culture system to the maximum extent possible. The main predators that are encountered in the prawn culture fields of the Indo - Pacific region are clupeids (Elops sp. and Megalops), perches, carangids, gobids (Glossogobius sp) and threadfins (Polnaemus sp.) catfishes and even snakes. Draining and drying the pond is the most cheapest method of getting rid of undesirable organisms. The pond is drained and dried for 1-3 weeks till the bottom cracks, and water is let in temporarily for a few days to induce the bottom dwelling fishes to come up and the pond is again dried for killing these fishes also. By drying the pond, toxic gases and foul odours produced by the degradation of noxious weeds such as Salvinia and Eichhornia and filamentous algae are removed (Gopalan et al., 1982). But draining the ponds completely is not possible in some tidal farms where other means of eradication are resorted to. Handpicking or repeated netting is another cheap method of eradication of unwanted organisms (Thirunavukkarasu, 1983).

The most commonly followed method in the eradication of unwanted organisms in the study area is the application of fish toxicants such as Mahua oil cake or lime. Quick lime (CaO) when applied into the pond, absorbs water and transforms into Calcium Hydroxide, which increases the pH of the soil and releases heat as it is an exothermic reaction so as to kill the organisms (Yap et al., 1978; Jamil Ahmed, 1982). Mahua oil cake is obtained when oil is extracted from Mahua (Bassia latifolia) seeds. The cake is ground well spread over the pond. it contains 4-6% saponin which has toxin in it. Saponin is soluble in water and acts as a detergent on the fishes, removing the mucous layer of the body and gill membranes thereby affecting their normal locomation and respiration in water. It also enters the bloodstream through the gills and buccal tissues and haemolyses the red blood cells resulting in death. (Kartha, 1984). Ammonia released at a concentration of 15 ppm will also kill the organisms in water (Subrahmanian, 1983). Although the effectiveness of this method of application of Ammonia has been experimentally proved, the farmers of Kerala are yet to adopt this method in a large scale (Asokakumaran, 1985).

Fertilization is done in the pond to increase the carrying capacity of the pond by increasing its productivity by supplying major fertilizing elements like Nitrogen, Phosphorus and Pottassium and minor elements like manganese, boron, sulphur, ,iron etc. (Jhingran, 1974). The fertilizer mainly used is organic, such as cowdung or poultry manure. Application of organic fertilizers such as cowdung or poultry manure will increase the abundance of zooplankters in the pond. Cowdung contains about 0.3% Nitrogen

0.15% Phosphorus, as P_2O_5 and 0.2% Potassium as K_2O (Gupta, 1981). The manure if spread over the bottom uniformly, oxygen depletion may occur due to sudden and wide spread decomposition. Therefore, they are heaped at different locations in the pond allowing the nutrients to leach out gradually into the pond. Thirunavukkarasu, (1983) has advocated the use of cowdung at a rate of 1000-4000 kg/ha (Asokakumaran, 1985).

In the traditional practice, stocking is done by letting in tidal water into the fields at high tide. The trapped juveniles are prevented from escaping from the field at low tide by placing a bamboo screen in the sluice. In addition to this, post larvae of fast growing species of prawns such as P. indicus and P. monodon are stocked in the ponds. The post larvae are either collected from the natural waters or are bought from commercial hatcheries. The natural population of juveniles entering the culture system is mainly constituted by Thelly or M. dobsoni (George, 1978; 1983).

The natural production in the pond system with the interaction of so many abiotic factors is subject to high fluctuations. Most of the cultivable prawns are omnivorous in nature, feeding on both animal and plant materials available in water and soil. The availability of animal protein in the pond favour better growth of prawns. In well stocked ponds, the availability of natural food organisms will be depleted due to grazing of prawns. Under these circumstances, the supply of suitable supplementary food becomes necessary.

The supplementary feed is mainly clam meat, which is bought from local people, is minced and spread over the pond. In some ponds, in addition to clam meat, poultry wastes prepared in an indegenous manner and ground nut oil cake were given as supplementary feed. Feeding is done in the evening hours of the day since the prawns have nocturnalfeeding habits. Adequate protein levels in feed (in case of prawns, 30-50%) is proved to give better growth (Colvin, 1976; Syed Ahmed Ali, 1982).

The crop is short term, lasting for about 90-100 days only. Conical bagnets, otherwise known as sluice nets are extensively used for harvesting of prawns in the study area. The sluice net measuring about 6-9 m in length with 5-12 mm mesh size is fabricated according to the dimensions of the sluice gate (Kathirvel, 1978). The operation of the net is mainly taking advantage of the water current from pond to the feeder canal.

SOCIO-ECONOMIC ANALYSIS:

Before selecting the families to bring under the study of input-output relationship in prawn farming, a comprehensive socio-economic survey was conducted covering the sample families in the selected villages such as Tripunithura, Edavanakkad, Maradu and Panangad in Ernakulam district where there is much concentration of prawn farming. The results of the survey are summarised below.

Size of the family:

The average size of the family of all the farmers was worked out at 6.5. Adult males formed the largest percentage of the population, 39%. Adult females formed 25%.

Literacy:

Percentage of literacy was 100% in the sample families. Among children in the age group of 5 to 18 years, both male and female, 98% were school/college going.

Occupational pattern:

In this area, prawn farming is the main occupation for most of the farmers involved in it. Most of them have been traditionally indulged in paddy cum prawn culture. In the sample, 70% of the farmers took prawn culture as the main occupation.

Family income:

The average annual income from sources other than prawn farming was worked out at Rs. 6240/-. About 60% of the dwelling houses were concrete or tiled roof.

Experience:

Experience in prawn farming plays a major role in tackling the various problems encountered in it and as far as the experience of the farmers under the survey is concerned, 50% of them were having more than 10 years of experience and 37% less than 5 years.

Social problems:

Prawn farming though not a new industry, it is being transformed by the application new technology, many technical, institutional and social problems will arise on the adoption of this practice. Some of the social problems, according to the farmers in the present survey were the following.

The private money lenders play a major role in financing the prawn farmers. They advance loans to the farmers for culture operations on condition that the product should be sold to them only. This condition reduces the bargaining capacity of the farmers and usually they do not get prevailing market price for their product. Inspite of the facilities available for institutional financing at some of these villages most of the farmers are not in a position to utilise it mainly because they are already in the clutches of the money lenders. This problem can be solved only by forming the co-operative societies of prawn farmers with adequate financial support from the government or any public agency. (Panikkar, 1990).

Another major problem frequently encountered by the farmers is poaching. Especially in the final months of the culture period, that is, March and April, poaching has been causing a great loss for the farmers. Implementation of strict laws by the government may be able to reduce the intensity of this problem, although it is impossible to put an end to it.

ECONOMICS OF PRAWN FARMING

Costs of production:

The level of production from a pond depends on the efficiency of various inputs used in the farm such as feed, seed, fertilizer, toxicants, labour etc. To study the input-output relationship these inputs were considered, and their costs worked out. The results are summarised below:

Cost of seed:

The seed used was mainly *P. indicus*. Of the 30 farmers surveyed some of them bought seed from commercial hatcheries and some from private collectors of seed from the wild. The quantity of seed used per hectare varied from 4167 to 83333 depending upon the size of the juvenile. All together, the average number of seeds in 30 farms was calculated as 20413/ha. The price of seed varied from Rs. 30 to 40/1000 and the average cost of seed worked out at Rs.32.02/1000. Thus, the amount spent on seed on an average in all the 30 farms was about Rs. 654/ha.

Cost of feed:

Most of the farmers used minced clam meat as feed and in addition, some used ground nut oil cake and poultry viscera. The quantity of feed used per hectare varied from 167 kg to 1250 kg. The average quantity of feed used was 467 kg/ha. The cost of feed fluctuated widely from Rs. 3.5/Kg to Rs.8.0/Kg from place to place and the average unit cost of feed worked out at Rs. 4.63/kg. Thus the amount incurred on feed on an average in 30 farms was Rs. 2162 per ha.

Cost of fertilizer:

The fertilizer generally used was cowdung. Some of the farmers used hay and poultry wastes also as fertilizer. For the last crop the quantity of fertilizer used varied from 56 kg to 667 kg/ha, the average quantity being 234 Kg/ha. The cost of fertilizer varied from Rs. 1/kg to Rs. 2/kg. The average unit cost worked out at Rs. 1.05/kg. The cost of fertilizer per ha worked out at Rs. 246.

Cost of toxicants:

The toxicant used was lime and in certain farms, Mahua oil cake. The quantity used varied from 33 Kg/ha to 405 Kg/ha. The average quantity in all the 30 farms worked out at 156 Kg/ha. The average unit cost of the toxicant was Rs. 1.41/Kg. The cost of lime varied from Rs. 1.50 to Rs. 2.0/Kg. Thus the average cost incurred on toxicants in all the 30 farms was Rs. 220/ha.

Wages:

In large farms, the farm activities are usually carried out by hired labour and the cost incurred on labour was high, while in smaller, much of the work was done by the family labour. Since all the adult males in the working force are engaged in farming activities throughout the duration of the crop family labour was calculated as 150 mandays for every adult male in the family. The labour engaged was calculated in terms of mandays of 8 hrs. The mandays used for one crop varied from 120/ha to 349/ha and the average number in all the 30 worked out at 169 days/ha. The wage rate per manday was fixed at Rs. 40/day and thus the cost incurred on labour was worked out at Rs. 6760/ha. (Table - I)

Fixed costs:

The cost of land in case of owned farms, the amount spent on the preparation of the pond, amount spent on the construction of the sluice gates, nets and other inventory of assets whose life span is more than one culture period were included in the fixed costs. The lease amount of leased in farms was not calculated with the fixed costs because the lease was for 5 months and was recurring every year.

Operating costs:

The average operating costs incurred for one crop worked at Rs. 10040/ha.

Production trend:

The products consisted of different species of prawns such as P. indicus, P. monodon, M. dobsoni and M. monoceros; and fishes such as

TABLE - I

COST AND REVENUE/HA IN PRAWN CULTURE BY THE SIZE OF THE HOLDING

	Size of the Holding	No. of Holding	COST (Rs/ha)					REVENUE (Rs/ha)		
			Seed	Feed	Ferti-lizer	Toxi-cants	Labour	Qty. Kg.	Value	Net farm surplus
GROUP-I	Less than 2 ha	10	1243	3332	484	489	9543	959.4	23482	12261
GROUP-II	2-5 ha	10	539	2123	222	210	7630	799.61	18927	7592
GROUP-III	More than 5 ha	10	603	1996	218	184	6047	806.77	20807	3578
ALL FARMS		30	654	2162	246	220	6760	820.65	20656	5363

E. suratensis and crabs. But, the farmers were more concerned about prawns, as the fishes and crabs were taken by the labourers who did the final harvest by hand picking. Also, the amount realised by the farmers on the fishes and crabs, if any, was comparitively meagre and so these are not included in the total output.

The production per hectare ranged from 708 Kg to 1292 Kg. The average production from all the 30 farms was worked out at 820 Kg/ha. This yield is much higher than the state average production of 300-400 Kg/ha from the traditional sector.

M. dobsoni formed the largest percentage of the prawn production with 49.39% of the total, P. indicus followed with 39.35%, M. monoceros accounted for 7.77% and P. monodon just 3.49% (Table-II). The percentage of P. indicus is much more than what realised from the traditional culture practices, whose catch is much dominated by M. dobsoni (George, 1978;1983). Here, in this improved practice, the percentage of the fast growing, and more money yielding P. indicus is more due to the artificial recruitment or selective stocking of seed. The percentage of P. monodon which also is a costly prawn, is very low. If further attempt is made to increase the availability of seed of P. monodon, which can fetch a very high unit price the farm returns can be considerably increased. But at present, there are no commercial hatcheries in Kerala which produces and distributes the seed of P. monodon.

Farm Income:

The revenue realised in the sample farms ranged from Rs. 8550/ha to Rs. 38820/ha. The average revenue per crop in all the 30 farms worked out at Rs. 20656/ha. The average unit value realised was Rs. 25.17/Kg. Species wise, the average unit value realised for *P. indicus* was Rs. 37.75/Kg. For *P. monodon*, the unit value was Rs. 99.50/Kg, for *M. dobsoni* Rs. 10.05/Kg and *M. monoceros* Rs. 24.09/Kg. In value, *P. indicus* contributed the largest share with 59.01%, *M. dobsoni* followed with 19.72%, *P. monodon* accounted for 13.84% and *M. monoceros* 7.43% (Table-II).

Profit:

The average profit for all the 30 farms worked out at Rs. 5363/ha. This level of profit is much higher than the net profit realised from the traditional prawn filtration which is of the order of Rs.2186/ha (CMFRI, 1985), thus explaining the superiority of scientific farming over the traditional one.

Marketing:

Most of the farmers under the present study sold their prawn directly to the peeling sheds. In marketing of the prawns, the private moneylenders caused a major social problem, not enabling the farmer to realise the deserved price for their product. Intervention of the government agencies in fields such as giving loans to the farmers on easy terms can reduce this problem to a certain extent.

TABLE - II

AVERAGE PRODUCTION OF *PRAWN* (SPECIES-WISE) AND REVENUE

Species	Quantity of Production Kg/ha	Unit price Rs/Kg	Value
P. indicus	322.91 (39.35%)	37.75	12190 (59.01%)
P. monodon	28.72 (3.49%)	99.50	2858 (13.84%)
M. dobsoni	405.28 (49.39%)	10.05	4073 (19.72%)
M. monoceros	63.74 (7.77%)	24.09	1535 (7.43%)
TOTAL	820.65	25.17	20656

(Values given in the brackets are percentages)

The bulk of the area under the paddy cum prawn culture in Kerala is in Ernakulam district, estimated to be 4920 ha (Sathiadas et. al. 1987). In this district, commentable work has been done by central organisations such as CMFRI and MPEDA in the supply of certain inputs, and technical advice for the farmers. They have encouraged the farmers to adopt prawn farming in a more scientific manner so as the net profit can be considerably increased. However, some farmers are still reluctant to adopt scientific farming, because of the higher risk involved in making a large investment.

ECONOMICS OF FARMS (Group wise):

For the purpose of comparative study, the 30 farms surveyed were grouped into 3 clusters, based on the area of the farm. These groups were, farms with an area of less than 2 ha; medium sized farms with an area of between 2 ha and 5 ha; and large sized farms with an area of more than 5 ha. The small sized farms with an area of less than 2 ha were called Group I; the medium sized farms Group II and the large sized farms called Group III. There were 10 farms in each group, thus constituting 30 farms. The average values of the inputs and output were calculated separately for each group and the results are summarised below.

The stocking density was highest in the small sized farms, ie, Group I. This was followed by the large and then the medium sized farms. The average stocking density in all the 10 farms in Group I was 42429/ha. The average unit cost of seed was calculated as Rs.30/1000 and the cost incurred on seed in Group I was Rs.1243/ha. Group II had an average stock size of 17657/ha and the average unit cost was little higher than Group I, because, some of the farmers in Group II depended on private collectors of seed who demanded more price for the seed than the Government hatcheries. The average unit cost was calculated as Rs.30.55/1000, and the average total cost incurred on seed in 10 farms in Group II was Rs. 539/ha. In Group III, the average stock size was 18172/ha and the average unit cost estimated as Rs.33.19/1000, which was the highest, due to more number of farmers depending upon private collectors for prawn seed. The increasing trend of depending upon private people for seed with increase in area of the farm is notable. As the area of the farm increased, the number of seeds that has to be used to stock the farm also increased. Due to the inavailability of such large number of prawn seeds from the government hatcheries at the right time, the farmers depended upon the private collectors although they had to pay a higher amount when compared to the government hatcheries. The total value of seed used in Group III was calculated as Rs.603/ha.

The quantity of feed used in Group I was on an average, 768 kg/ha, which was the highest. The average unit cost was calculated as Rs.4.34/kg and the total cost incurred on feed in Group I was Rs.3332/ha. In Group II, the value of the feed estimated was higher, due to the farmers using groundnut oil cake as feed which was slightly costlier than the conventional feed, clam meat. The unit cost of feed in this group was estimated at Rs.4.99/Kg. The quantity of feed used was 425 Kg and the value incurred on feed in Group II was Rs.2123/ha. In Group III, the average quantity of feed used in all the 10 farms was 435 Kg/ha and the average cost was calculated as Rs. 4.95/Kg. Thus, the total value incurred on feed in Group III was Rs. 1996/ha. The highest quantity of feed was used in Group I followed by Group III and then Group II. The higher value of feed calculated in Group II was due to the slightly higher unit price realised for ground nut oil cake which was used on a greater extent in the medium sized farms.

The quantity of fertilizer used was highest in Group I, being 429 Kg/ha. The average unit cost was estimated at Rs.1.13/Kg which was slightly greater than the unit cost realised in other groups. The cost incurred on fertilizer in Group I was calculated as Rs. 484/ha. In Group II, the average quantity of fertilizer used was 222 Kg/ha and the average unit cost Rs.1.00/Kg. So the cost incurred on fertilizer in Group II was Rs.222/ha. In Group III, the average quantity of fertilizer was 209 Kg/ha at a unit price of Rs.1.04/Kg. Thus, the cost incurred on fertilizer in Group III was on an average, Rs. 218/ha.

The quantity of toxicants used also was highest in Group I which was calculated at 300 Kg/ha. The average unit price was Rs.1.63/Kg and the amount incurred on toxicants in Group I was Rs. 489/ha. In Group II, the quantity of toxicants used on an average was 156 Kg/ha at unit cost estimated at Rs.1.35/Kg. Thus, the average cost spent on toxicants in Group II was Rs. 210/ha. In Group III, the quantity of toxicants used on an average was 135 Kg/ha, at a rate of Rs.1.36/Kg and so the average cost of toxicants in Group III was Rs.184/ha. (Table-1).

The labour used was highest in Group I, being 239 mandays/ha In Group II, the number of mandays used on an average was 191 days/ha and in Group III, it got reduced to 151 days/ha.

The production was highest in the smaller farms, ie., in Group I. The average production in Group I was calculated as 960 Kg/ha. In the medium sized farms, ie., Group II, the production trend was almost similar to that of the large sized farms. The production in Group II was 800 Kg/ha and that in Group III was 807 Kg/ha.

In Group I, the average annual income in this group was Rs.23485/ha The average unit value realised was Rs.24.47/Kg and species wise, for P. indicus, of Rs.38.4/Kg, M. dobsoni Rs. 10.09/Kg, P. monodon, Rs. 100/Kg and M. monoceros, Rs.23.46/Kg. Of the total production, P. indicus formed 40.19% by quantity and 63.07% by value. M. dobsoni formed by quantity, 49.13% and by value, 20.32% ; P. monodon formed only 2.88% by quantity and by value, formed 8.52%. M. monoceros formed 8.4% by quantity and 8.09% by value. In Group II, the average production realised was 799.61 Kg/ha. The total average income realised /ha in the group was Rs. 18927/ha. The average unit price for the prawns in Group II was calculated as Rs.23.66/ Kg. In this group, P. indicus formed 37.58% by quantity and 59.17% by value with an average unit price of Rs.37.27/Kg. M. dobsoni realised an average unit price of Rs.10.16/Kg. It formed 51.67% by quantity and 22.17% by value. P. monodon realised an average value of Rs. 87.37/Kg. and it formed 2.3% by quantity and 8.57% by value. M. monoceros formed

8.43% by quantity and 8.9% by value with an average price of Rs.25/kg. In Group III the average production got was 806.77 Kg/ha and the unit price realised for the prawns was Rs.25.79/Kg. The total average income in the group was, Rs.20808/ha.

In Group III, P. indicus formed 39.78% by quantity and 57.07% by value with an average price of Rs. 37/Kg. M. dobsoni realised an average price of Rs. 10.45/Kg with the percentage by quantity being 48.65% and by value, 19.71%. P. monodon formed 4.15% by quantity and 16.02% by value, with an average price of Rs. 99.68/Kg. M. monoceros had an average price of Rs. 25/Kg. It formed 7.4% by quantity and 7.19% by value (Table IV).

Key economic indicators:

Key economic indicators are those values which can be used to evaluate the performance of farm operation. As indicated in Table -III, the average production and average income was 820 Kg/ha and Rs. 20656/ha respectively. Net farm surplus worked out at Rs. 5363/ha. Rate of return was about 31% which is much higher than the opportunity cost of capital. Hence it indicates a higher level of profitability. The yield per unit of major inputs such as feed, seed, and mandays are used to measure the efficiency of the particular inputs. In case of labour, mandays required/Kg of production was found to be 0.21. In case of feed, feed required/Kg of production was 0.57Kg and in seed, the number of seeds/Kg of production,

TABLE - III

KEY ECONOMIC INDICATORS (Shang, 1978)

1.	Average production/ha	-	820.65 Kg/ha
2.	Average income/ha	-	Rs.20656/ha
3.	Profit/ha	-	Rs.5363/ha
4.	Rate of return on investment	-	31%
5.	Rate of return on operating cost	-	53%
6.	Production/manday	-	4.85 Kg/manday
7.	Labour required/Kg of production	-	0.21 mandays
8.	Production/Kg of feed	-	1.8 Kg.
9.	Amount of feed/Kg of production	-	0.57 Kg.
10.	Number of seeds/Kg of production	-	25
11.	Cost of production per kg of prawn	-	Rs. 12.23/Kg.
12.	Value realised per Kg. of prawn	-	Rs. 25.17/Kg.

TABLE - IV

GROUPWISE FARM INCOME

	P. indicus			*M. dobsoni*			*P. monodon*			*M. monoceros*		
	Qty Kg/ha	Value Rs/ha	Unit Price Rs/kg.	Qty Kg/ha	Value Rs/ha	Unit Price Rs/ha	Qty Kg/ha	Value Rs/ha	Unit Price Rs/kg	Qty Kg/ha	Value Rs/ha	Unit Price Price Rs/kg.
Group I (less than 2 ha)	385.71 (40.19%)	14811.43 (63.07)	38.4	472.86 (49.13)	4771.43 (20.32)	10.09	20	2000	100	81.07	1901.79	23.46
Group II (2.5 ha)	300.48 (37.58)	11199.68 (59.17)	37.27	413.16 (51.67)	4195.83 (22.17)	10.16	18.55 (2.3)	1621.19 (8.57)	87.37	67.42 (8.43)	1685.39 (8.9)	25
Group III (more than 5 ha)	320.97 (39.78)	11875.81 (57.07)	37	392.47 (48.65)	4101.08 (19.71)	10.45	33.44 (4.15)	3333.33 (16.02)	99.68	59.89 (7.4)	1497.31 (7.19)	25

(Values given in brackets are percentages).

was 25. Also, the average cost of production of 1 Kg of prawn was Rs. 12.23/Kg; as against the average amount of Rs. 25/- realised per Kg of prawn.

PRODUCTION FUNCTION ANALYSIS:

The Cobb-Douglas production function used for the present study is represented by $Y = a\, x_1^{b_1}\, x_2^{b_2}\, x_3^{b_3}\, x_4^{b_4}\, x_5^{b_5}$

Where Y is the dependent variable and x_1 through x_5 are the explanatory variables, 'a' is a constant and b_1 through b_5 are the regression coefficients for x_1 through x_5 factors of production respectively.

The concepts and definitions of variables used in the production function are discussed as follows.

Y. Production

It is the average production of prawns in Kilograms per hectare from the sample ponds.

X_1 Area:

The land input was measured in hectares of land and was calculated by considering the hectares of land owned by the farmer plus the leased in area.

X_2 Seed:

It is the average number of post larvae stocked per hectare. The species used was <u>Penaeus indicus</u> and average size of seed varied from 1.5 to 2.5 cm.

X_3 Feed:

It is the average quantity of feed used in Kilograms per hectare. The feed used by the farmers was clam meat which was minced and spread over the pond.

X_4 Fertilizer:

It is the average quantity of fertilizer used in Kilograms per hectare. The fertilizer used by the farmers was mainly cowdung.

X_5 Mandays:

It is the labour input in terms of adult mandays engaged for different farm operations. It was measured in terms of average number of mandays per hectare, which included family labour, permanent and hired labour.

The estimated equation is

$$Y = 11.3158 \quad x_1^{-0.0289} \quad x_2^{0.1266} \quad x_3^{0.3108} \quad x_4^{0.0126} \quad x_5^{0.2124}. \quad R^2 = 94\%$$

In this equation, the elasticities (regression coefficients) indicate the percentage change in gross output for one percent increase in the respective input. For example the input feed had a statistically significant coefficient of 0.3108 which indicated that a ten percent increase in the quanity of seed used from the mean level, would bring forth an addition of 3.1 percent to the total output. So also ten percent increase in the number of seed used would add to the total out put by 1.27 percent. However the coefficient of farm area was negative indicating that the increase in land area would reduce the output per hectare. The production elasticities of fertilizer and labour were not significant. One percent increase, in fertilizer would bring forth only 0.12 percent of output and one percent increase in labour (mandays) would add to the total output by 0.212 percent. The coefficient of farm area, seed used and feed used were significant at 5% level.

The coefficient of determination (R^2) was 94% which indicated that 94% of the variation in the total output was explained by the variables included in the equation.

MARGINAL VALUE PRODUCTIVITY(MVP):

The marginal value product of a particular input represents the expected addition to the gross returns by an addition of one unit of that resource while other inputs are held constant. The most reliable and perhaps the most useful estimate of marginal physical products is obtained by taking the inputs as well as the output at their geometric means. The marginal value product was computed by multiplying marginal physical product (MPP) with the product price. For example, marginal value product of x_1 would be

$$MVP\ x_1 = b_1 . \frac{\bar{y}}{\bar{x}_1} . Px_1$$

Where b_1 is the production elasticity of x_1, $\bar{y}$ and $\bar{x}_1$ are mean values of output (y) and input (x_1) and Px_1 is the prevailing market price of the input. Marginal value productivity of seed was measured in terms of rupees per 1000 seeds, that of feed was in rupees per Kg of feed and that of labour was measured in rupees per manday of labour.

ECONOMIC EFFICIENCY OF INPUTS

In order to evaluate the economic efficiency of farmers as users of inputs, the marginal value products of input factors were compared with their respective acquisition costs. The ratios of marginal value products of different inputs with their acquisition costs were calculated. A ratio that is equal to unity indicates the optimum use of that factor. A ratio more than unity indicates that the returns could be increased by using more of that resource and less than unity indicates the unprofitable level of resource which should be decreased to minimise the losses.

Among those inputs, for which production elasticities were significant; for seed and feed MVPs were much higher than their respective acquisition costs indicating that the use of these inputs can increased to increase the net returns. However, the MVP of labour was only Rs.25.75 as compared to the acquisition cost of Rs. 40 per manday; which means that utilisation of one more manday of labour from the mean level would add to the total revenue only Rs. 25.75 whereas the total cost would be increased by Rs.40.

This indicates that the labour used per hectare has to be reduced to increase the profit from the farm. The excess utilisation of labour days in the farms is mainly due to the engagement of family labour for which the opportunity cost in this region is comparatively nil.

MARGINAL VALUE PRODUCTIVITY AND ECONOMIC EFFICIENCY:

The main objective of the functional analysis is to measure the effect of various inputs on output and to evaluate the economic rationale of resource use by the prawn farmers.

Coefficients of parameters, mean values of output, and inputs, acquisition costs of output and inputs, marginal value products and ratios of marginal value products to their factor costs are given below.

As seen from the table, the ratios of MVP to the acquisition cost was more than unity for seed and feed and for fertilizer it is about unity. For other inputs, land area and labour, it is less than one. The optimum level of the inputs for maximising the net returns was estimated by using the previous equation.

By substituting the values of production elasticity of x, (b), mean value of output, (Y) price of Y, (P_y) and acquisition value of x,(P_x) ,value of x is estimated. The optimum level of inputs to maximise the net returns are given in the table given below.

Variables	Regression coefficient	Mean values	Acquisition costs (Rs.)	MVPs of inputs(Rs.)	Ratios of MVPs to their Acquisition costs	Maximum Profitable level/ ha.
1. Intercept	11.3158	--	--	--	--	--
2. Output (Y)	--	820 Kg.	25.75/Kg.	--	--	1268 Kg.
3. Operational area(x_1)	-0.0289 (0.0119)	4.61 ha	6000/ha	-132.03	0.023	4.12 ha
4. Seed (X_2)	0.1266 (0.0334)	20413	32/1000	131	4.09	83500
5. Feed (x_3)	0.3108 (0.0629)	467 Kg.	4.63/Kg.	13.64	2.95	1417 Kg.
6. Fertilizer	0.0126 (0.0613)	234 Kg.	1.05/Kg.	1.14	1.05	252 Kg.
7. Labour (x_5)	.2124 (0.0604)	169 days	40/day	26.54	0.66	112 days

(Standard error values are given in brackets).

By substituting the optimum values of the inputs in the production function equation, the optimum level of production is estimated at 1268 Kg/ha.

This level of production is optimum or in other words, is most profitable level only with the given technology and also the given level of input and output prices. However, it can be increased by using more efficient feed and better pond management.

On the whole, the functional analysis indicated that the farmers can increase their net returns by increasing the use of seed and feed and by reducing the number of labour days to the extent shown above. Profit can be increased by rational utilisation of the inputs and thereby increasing the production by about 50% from the present mean level of 820 Kgs. However, the under utilisation of feed and seed is mainly because of its non-availability. Hence, for the overall development of prawn farming sector, it is essential to provide the farmers adequate quantity of suitable seeds and efficient and effective feed through any public or government agency.

INPUT REQUIREMENTS

An attempt is made here to predict the requirements of major inputs such as seed, feed and labour, in coming years using the maximum profitable levels of these inputs.

The role of aquaculture in the integrated rural development has been recognized now and the development of rural communities depending on aquaculture as the main economic activity has received active consideration. The culture of species with export potential, like prawns is being attempted in a number of countries in Asia. In prawn culture, India has received much attention from the foreign countries (Gopalakrishnan, 1972). The large scale development of aquaculture is being considered and included in our national development plans. However, it was deemed necessary to examine the current programmes in the light of the medium and short term food production and the basic requirements for sound development of the aquaculture sector. In India, the national policy on fisheries development centers around the concept of improving the socially backward communities, providing more and better employment opportunities, and evolution of short and long term programmes to raise production. The national policy also places emphasis on optimum utilization of all natural resources, accelerated development of technology for rational exploitation of the resources, and development of necessary infrastructure for organized production storage and distribution. Earning of foreign exchange through export of fishery products without adversely affecting domestic supplies, is also an integral part of the national programme (George and Sinha 1975).

In India at present, the potential area for coastal aquaculture is about 1 million ha and now 58,000 ha is used. In Kerala, 121600 ha could be cited for penaeid prawn culture, and at present, prawn culture through the traditional practice of filtration is being practiced only in

5117 ha (Anon, 1978). The Kerala Government in collaboration with the Kuwait government has proposed to develop 7500 ha by the year 1993. In this project, the first phase consists of developing 1500 ha of fields under semi intensive farming of the prawns (Anon, 1989).

A prerequisite to an aquaculture planning is a clear conception of the requirements for the developing of industry (Pillai, 1977). Assuming that, the above 1500 ha is to be developed under the semi intensive farming, with the costs and prices remaining the same, the requirements of the major inputs such as seed,feed, fertilizer and labour, to be used to the maximum profitable level, are given below.

Seed:

At present the seed required for the stocking practice is mostly collected from the wild or to a lesser extent bought from the commercial hatcheries. In the improved extensive practice of culture, the stocking density used is of order of 20,000/ha (George, 1983). As indicated in the study, the maximum profitable level of the seed that can be stocked is 83500/ha. So, for maximising the returns from the area presently under culture and to bring 1500 ha more into culture in 1991, 793.25 million seeds are needed. At present the prawn seeds collected from the wild and supplied to the farmers by various agencies can meet only a fraction of this demand. This constraint can only be overcome by mass production of seeds in the hatcheries.

Feed:

Similarly, with the efficacy of available feed being used at present, the maximum profitable level of the feed to be used was 1417 Kg/ha. The total requirement of the feed for 9500 ha will be 13.46 million Kg. This indicates the chances of feed formulation factories in the state, which at present is practically nil.

Employment generated:

The employment generated through the semi intensive system of prawn farming can also be calculated from the present study. The maximum profitable labour in terms of mandays was 112/ha and so if 9500 ha is to be developed under the same system. 1.06 million mandays will be generated per each crop.

It has been observed that the prawn production from the traditional pokkali fields of Vypeen area, which is highly productive, due to the nearness to the barmouth, was of the order of 1000 Kg/ha. During the fifties and sixties it showed a declining trend and in seventies, it was of the order of about 7000 Kg/ha only (Menon 1954, Gopinath 1956, George et al. 1968; George 1974 & 1978, Gopalan 1978 & 1981). According to Sathiadas et al. (1989), the pokkali fields in Vypeen area indicated an average yield of 620 Kg/ha only. In interior regions, such as the area surveyed under the present study, the production was only about 350 Kgs/ha, due to the lesser natural productivity of the ponds. In any case, from the available information it is evident that there has been a declining trend in prawn production in pokkali fields in Ernakulam district.

Eventhough the value of the prawns has been increasing over the years, the production from the paddy fields has not shown any increase This may be due to the continuation of the traditional practice of filtration without much improvement. Prawns are merely let into the fields during the high tide and are caught while letting them out during the low tide. The decline in production from such operations may be attributed to the heavy exploitation of prawns in the inshore waters during the last decade. Such exploitation will have an adverse effect on the ingression of juveniles from the sea into the backwaters. Environmental constraints may be another reason for the declining productivity (Sathiadas et al., 1989).

The only possible way to overcome the above constraint is the selective stocking of prawn seed. With proper management practices such as eradication of the unwanted organisms in the pond before stocking the seed, fertilizing the culture system to increase the natural productivity and feeding the prawns with supplementary feed.

The superiority of this semi- intensive culture practice over the traditional filtration is clearly revealed in the present study. An average production rate of 820 Kg/ha could be achieved in the sample farms located away from the barmouth, where the natural productivity is comparatively low. The average profit per hectare worked out at Rs. 5363.

The above results can be improved if the inputs are used to the maximum profitable level. The data collected under the present study indicates that these seed and feed inputs are not used in sufficient quantity.

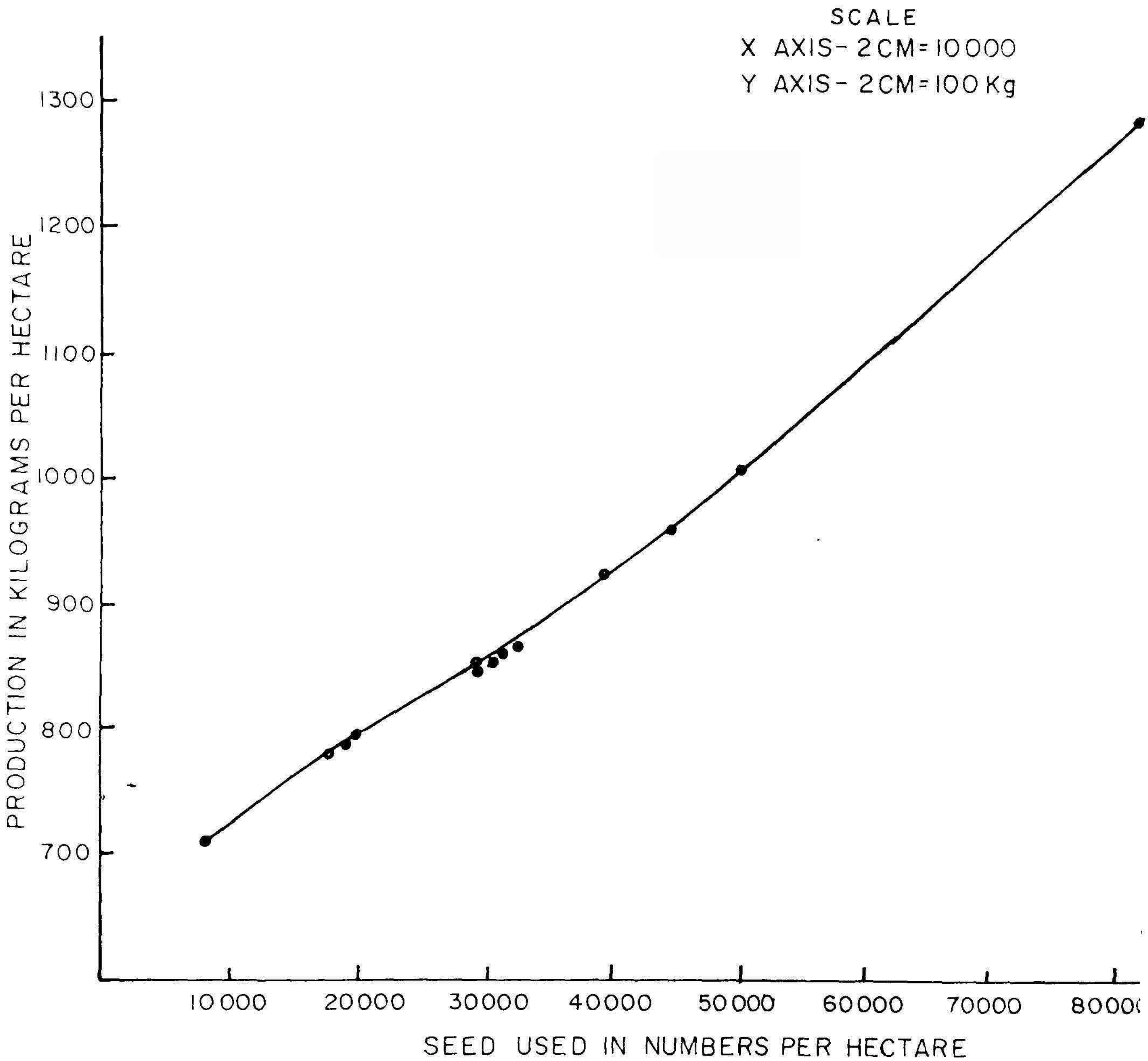
In the case of seed, the average number stocked was 20413/ha, while the maximum profitable level is 83500. This shows that production can be increased by increasing the stocking density. The graph shows the increasing production with increasing stocking density. The maximum profitable level of 83500 is only under the present conditions, both environmental and economic (Graph I).

Though the natural productivity of the pond was not taken into account, The higher level of production with the use of increasing levels of feed can be seen in Graph II. The production/Kg of feed indicated in the key economic indicators is influenced by natural productivity also.

In the survey, it was found that the levels fertilizer and toxicants as used by the farmers do not have a significant relationship to the level of production.

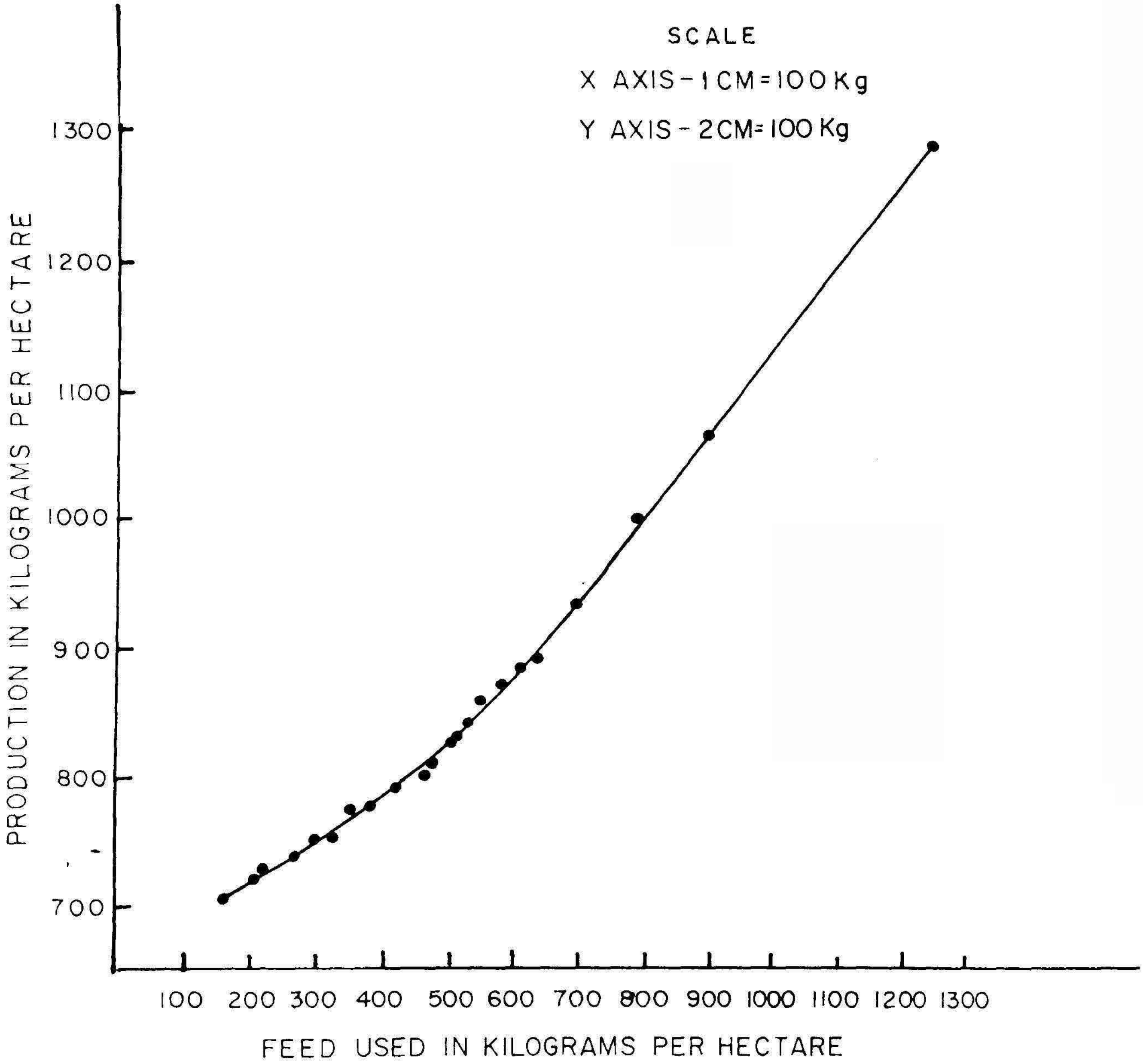
The mandays used for production included the family labour also and it was calculated that labour was used on a quantity more than the maximum profitable level. The production rate from the smaller ponds was comparatively high, as farmers could more efficiently manage small farms than the larger farms. The same reason can also be attributed to explain decreasing trend of profit as the area of the farms increased as indicated in Table-I, Graph-III. The larger sized farms had a better stocking rate and also got a better production/ha, than the middle sized farms, through the feed used/ha was higher in the 2nd group.

GRAPH-I

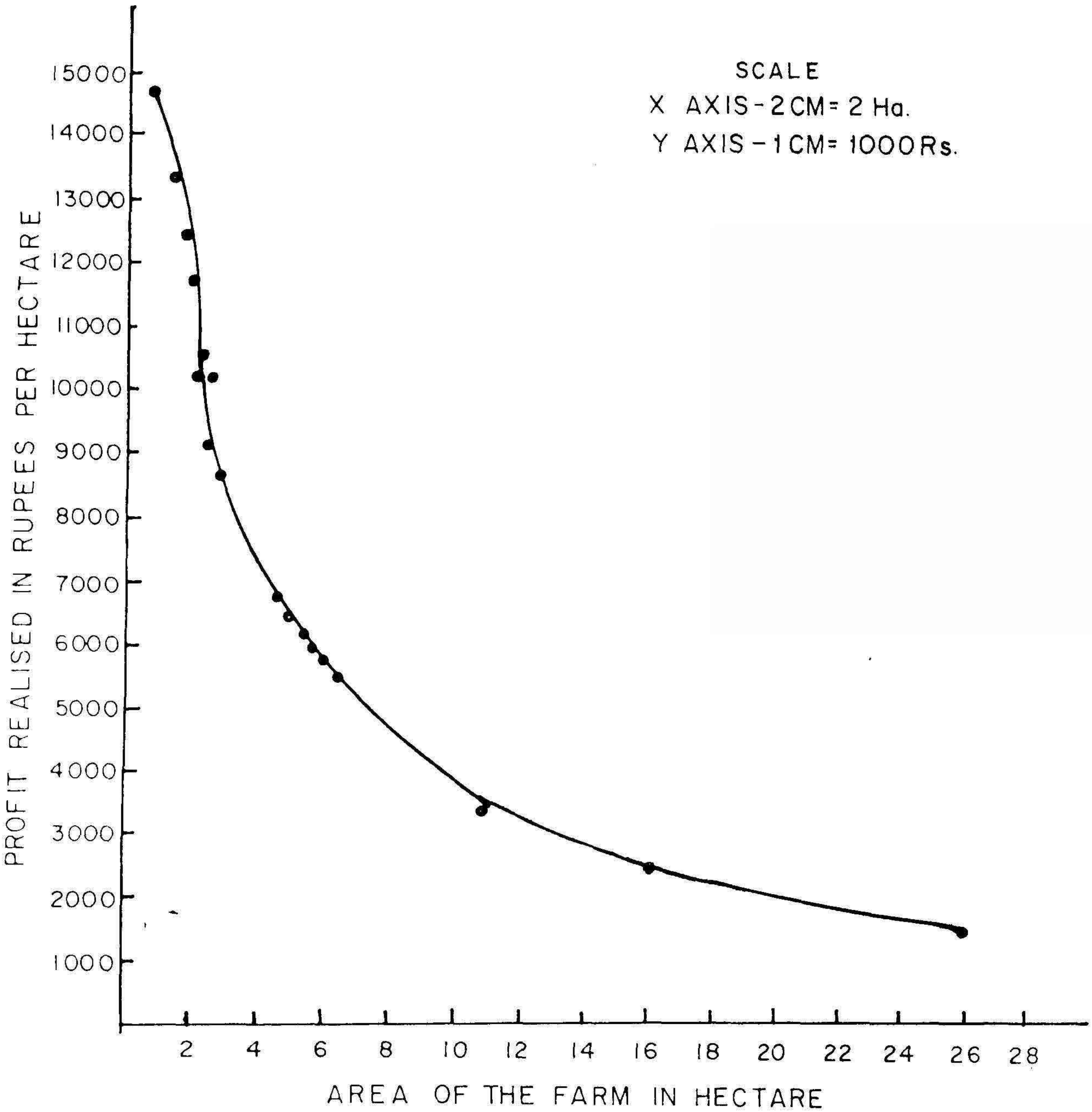


SCALE
X AXIS - 2CM = 10000
Y AXIS - 2CM = 100 Kg
PRODUCTION IN KILOGRAMS PER HECTARE
1300
1200
1100
1000
900
800
700
10000
20000
30000
40000
50000
60000
70000
80000
SEED USED IN NUMBERS PER HECTARE

GRAPH-II


SCALE
X AXIS - 1 CM = 100 Kg
Y AXIS - 2 CM = 100 Kg
PRODUCTION IN KILOGRAMS PER HECTARE
1300
1200
1100
1000
900
800
700
100 200 300 400 500 600 700 800 900 1000 1100 1200 1300
FEED USED IN KILOGRAMS PER HECTARE

GRAPH-III


SCALE
X AXIS-2CM= 2 Ha.
Y AXIS-1CM= 1000Rs.
PROFIT REALISED IN RUPEES PER HECTARE
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
2
4
6
8
10
12
14
16
18
20
22
24
26
28
AREA OF THE FARM IN HECTARE

The present study revealed the fact that even when the scientific practices are adopted, the inputs such as seed, and feed are not used to the maximum profitable level. The average number of seeds stocked per/ha was calculated at 20413/ha, while a stocking density of 83500 can be had under the present conditions for increasing returns. The feed used, on an average was, 467 Kg/ha, while a quantity of 1417 Kg was found to give maximum profit. In the case of toxicants and fertilizer, the same trend was found. Also, the farmers relied much upon the organic fertilizers. The use of inorganic fertilizers can significantly reduce the amount of fertilizer to be used. The optimum level of labour required for one crop worked out at 112 mandays as against the 169 mandays already engaged for one crop per hectare indicating a major problem of disguised unemployment among the farmers.

Constraints:

Some of the constraints which hindered the proper development of prawn culture in this region are summerised below.

According to the farmers, the main constraint is the heavy investment required for the scientific practice. Traditional system even though low productive, the investment requirement is also much less. Most of the prawn farmers were not in a position to raise enough fund required for investment purpose. They had to depend on local moneylenders who are mostly fish traders also, which put them in a vicious circle due to the unfavourable terms and conditions of the loans. These conditions included selling the product to the moneylender only, which reduced the bargaining capacity of the farmers, who could not realise a remunderation price for their products. The recently started facilities for institutional financing for aquaculture development are found to be not much effective.

Another constraint was the nonavailability of the prawn seed at right time in sufficient quantity. Although there are 5 hatcheries working at present in Kerala, these hatcheries could not provide the required number of seeds at the right time. So they had to be satisfied with the seed they got from the local collectors, a meagre amount of seed from these hatcheries and depend much on natural seeds, that got in with the tide. This has led to understocking in most of the ponds surveyed.

Pollution caused another major constraint. According to the farmers view, the industrial effluents which came into the culture system caused heavy mortality in the prawns cultured, thus making the culture economiccally unviable.

Poaching caused another problem which also resulted in heavy loss to the farmers. Poaching, particularly in final months of culture, ie., April-May is a quite common phenomenon, according to the farmers.

S U M M A R Y

The socio economic analysis of the prawn farmer's families selected for the study revealed that for about 70 percent of them, prawn farming is the main occupation. Literacy is 100 percent and almost all children in the age group of 5 to 18 were school/college going. All adult males, even with other occupations, were also involved in prawn farming activities. About 60% of the dwelling houses are concrete or tiled roofed. About 50 percent of the farmers have more than 10 years experience in prawn farming.

The prawn culture practice covered under the study is a semi-intensive type of farming, in which selective stocking of seeds of high priced prawn species, feeding them with supplementary feeds, fertilisation of the pond and eradication of unwanted organisms are done.

Under this system, the average production in the sample farms of Ernakulam District worked out at 820 Kg/ha valued at Rs. 21000/ha realising a net farm surplus of about Rs.5400/ha. Labour cost constitutes more than 50 percent of the total variable costs. It could be attributed to the inclusion of family labour in the calculation of total wages. Since the opportunity cost of family labour in this area is almost nil, this income through wages can also be considered as a farm surplus after deducting

other variable costs. Cost of production of prawns per ha. came about Rs. 11000. The rate of return on investment realised from the 30 sample farms was, 31%. The rate of return on the operationg cost showed a value of 54%. Both of the above percentages are well above than that can be realised from the traditional operations. Also, from the present study, the production from 1 Kg of feed was found as 1.8 kg and the number of seeds required for production of 1 Kg of prawn was found as 25.

Cost of production per Kg. of prawn worked at Rs. 12 as against the revenue of Rs. 25 realised per Kg. of prawn. The analysis of economics of groupwise farms indicated that the profit per hectare realised was more in the smaller farms, and it decreased with increasing area of the farms. This result gives stress to the fact that, improved management practices can result in higher production from the culture ponds.

The production function analysis indicated that the 94% of the variation in output was explained by the factors such as land area, seed, feed, fertilizer and labour included in the function. The production coefficients of all these factors except that of fertilizer were significant at 5% level. Coefficient of area is negative, indicating that production/hectare is decreasing as area is increased. It may be due to the better pond management possible in the small ponds.

It was found that, a 1% increase in the use of seed from the mean level would bring forth 0.13% of output, similarly, a 1% increase in feed would add to the total production 0.31%.

The marginal analysis indicated that the farmers are not rational in their utilization of inputs, as the major inputs are not allocated to the maximum profitable levels. The average stock size was 20413/ha which can be increased to 83500/ha for maximising the returns of the farmer. So also, the utilization feed can be increased from 467 Kg/ha to 1417 Kg/ha. But in the case of labour, there was an over utilization and the average 169 labour days engaged/ha could be reduced to 112 days/ha to increase the returns to the farmer. Also, with the existing technology about 1300 Kg of prawns can be produced by utilizing all inputs rationally.

The calculation of maximum profitable level of inputs to be used helps us to have a tentative estimate of the requirements of these inputs such as feed and seed in coming years. Taking into account the development strategies of Kerala Government, it can be calculated that by 1991, in Kerala the requirement of prawn seed will be 793 million. Setting up of new hatcheries and improving the technologies in presently operating hatcheries to increase the survival rate, are the steps to be taken to meet this demand. The huge amount of feed required in the future indicates the bright prospects of setting up of aquaculture feed mills in Kerala which at present is none.

The traditional prawn culture of Kerala is being slowly replaced by some sort of a semi-intensive method of prawn cultivation. This can be accelerated by creating proper motivation among the farmers through well organised extension services and removing financial constraints by establishing links with rural funding agencies. It is all the more essential to provide the major inputs such as good quality seeds of high priced prawns and efficient feeds to the farmers in sufficient quantities at the right time so as to enable them to utilize these factors of production to the optimum levels. In this respect, along with research on biological constraints to production, economic studies also should be given deserved preference in areas of production and distribution and optimum level of inputs to be used to maximise the profits.

APPENDIX

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

ECONOMICS OF PRAWN FARMING

SCHEDULE - I

Code Number

Date of enumeration

1. Name and address of the Prawn Farmer :
2. Scheme under which assisted :
3. Name of agency assisting the farmer :
4. Location of pond :
5. No. and area of pond where prawn culture is done :
6. Family members of farmer:
   a) Male (adult) :
   b) Female (adult) :
   c) Son (children) :
   d) Daughter (children) :
7. Number of educated persons in family :
8. No. of children studying in school/college :
9. Cultivable land holding :
10. Dwelling house - hut/tile/concrete :

11. Usual profession :

12. Average annual income other than prawn culture :

13. Total annual income from all sources :

14. Year of construction of pond/farm :

15. Experience in culture of prawn :

SCHEDULE - II

1. Name of the farmer :

2. Address :

3. Area of pond with location :

4. Ownership of pond - Owned/leased :

   Value of land :

   If leased, lease amount.............length of lease..........

5. Nature of pond - seasonal/perennial. duration of culture ....
   to ....

6. Year of construction of pond :

7. Average depth of pond :

8. Salinity ....Dissolved oxygen................Nature of soil...........

9. Years of experience in prawn farming :

10. Usual profession (specify) :

11. Annual income from prawn farming :

II. Inventory of assets:

	Acquisition Year	Unit Cost	Economic Life	Prevailing Market value
1. Pond				
2. Sluice gates				
3. Pond excavation				
4. Water canals				
5. Others if any				

III. Equipments:

	Purchase Value	Lease amount/crop	Working charges
1. Pump			
2. Generator			
3. Feeding equipments			
4. Compressor			
5. Nets			
6. Other (if any)			

IV. Labour requirements/crop:

	Family members M.F.C.	Hired M.F.C.	Wage/day M.F.C.	Total Wages
1. Pond preparation				
2. Stocking				
3. Feeding				
4. Weeding				
5. Fertilization				
6. Repair and maintenance				
7. Harvesting				
8. Processing				
9. Marketing				
10. Others if any				

Total labour charge -

2. Monthly salary -

   Watchman -

   Other if any -

V. Seed - source

Transportation charges-

	Qty/crop	Unit cost	Total cost
1. Seeds			
2. Toxicants			
3. Fertilizer : Organic			
Inorganic			
4. Feed (Specify)			

V. Harvest:

Species	Counts	Unit Price	Qty Sold	Consumed/ wasted	Value

2. Morality rate from stocking to harvesting.
3. No. of harvests/crop
4. No. of crops/year
5. Method of harvesting

Other expenditure if any

1. Fuel and oil
2. Electricity
3. Water supply
4. Insurances
5. Taxes
6. Others (if any)

VII.

Source of finance	Amount	Rate of interest	subsidy	Repay- ment

VIII. 1. Gross Income -

2. Expenses -

3. Net Income

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