ECONOMICS OF PADDY CUM PRAWN CULTURE IN POKKALI LANDS OF ERNAKULAM DISTRICT

By

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THESIS

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DECLARATION

I here by declare that this thesis entitled "**Economics of paddy cum prawn culture in pokkali lands of Ernakulam district**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, fellowship, associateship or other similar title, of any other university or society.

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INTRODUCTION

Fish is a cheap source of animal protein, available to meet the nutritional requirement of our growing population. Because of its nutritive value supplementing our protein and vitamin deficient diet, the demand for fish and fish products has been rising. In the context of increasing health consciousness in the modern world, fish and fish products are considered to be among the safest foods of animal origin. But the per capita consumption of fish in India is five kg against world average of 12 kg. Apart from being a source of food, fishery products also find some significant industrial uses. Fish is an efficient converter of energy, converting plant food to nutritional animal food and, therefore, has a number of advantages in terms of productivity. In order to increase our food supply, attention has now been diverted to the sea. Fishery products are either exploited from natural water bodies or through various kinds of aquaculture.

Marine products have been as important group of commodity exported from India. Among marine products exported shrimp is the dominant item. India is recognised as one of the world leaders in fish production and export. India ranks 7th in world in terms of fish production and India's share in world fish production is 3.9 per cent. India exported 13,9419 tonnes of marine products worth 893.37 crores in 1990-91 of which frozen shrimps accounted for 44.75 per cent in quantity and 74.2 per cent in value*. The country's fish production has increased from 1.9 million tonnes (1981) to 4.2 million tonnes (1991-92) - a growth of 4.5 per cent over the previous years. Fish production during 1991-92 was 4.2 million tonnes and the

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* Marine Products Export Development Authority. 1992. Hand book on shrimp farming. p.23

ultimate potential is 8.4 million tonnes, both from marine and inland sectors which offers vast scope for further exploitation*.

The major contribution of shrimp is from the sea. But of late, the production from the sea catch is diminishing due to various reasons such as over exploitation, aquatic pollution etc. and now it has reached the stage of stagnation with regard to production from natural resources.

In order to augment shrimp production and to meet external demands and to increase foreign currency earnings, aquaculture is the alternative method.

The problem

India's dependence on capture fisheries for fish is high. In India, marine fish production by 1992-93 was 2.29 million tonnes against potential of 3.9 million tonnes. Besides, in India, fish consuming population is about 56 per cent and is growing at the rate of 0.6 per cent per annum*. This is because fish protein forms a good base for human nutrition due to its high quality, high digestability and high growth promoting value.

Eventhough we have an immense potential in marine fisheries sector our production is not commensurate with the available potential. We have already achieved a limit of 82 per cent of exploitable resources of the inshore fisheries and very little scope is left for further exploitation. To meet the needs of projected

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* James, P.S.B.R., Sehara, D.B.S. and Kumar, M.R. 1993. Prospects for marine fisheries development in new economic environment. *Agricultural Situ. in India.* : 345-351

global population by 2025 AD, 162 million tonnes of fish products are required to maintain an estimated per capita level of 19.1 kg. The world production from capture fisheries was 80.4 million tonnes by 1989, which may stabilize to around 100 million tonnes by 2000 AD. Hence the solution to feed the seafood hungry population rests on the rapid expansion of aquaculture. Out of 1.2 million hectare of coastal land available for brackish water aquaculture, only 68,000 hectare is under shrimp farming at present in India. The area under shrimp/fish culture is 68,237 hectare and of this about 75 per cent are following traditional practices of prawn culture. Emphasis should be given to develop these farms on scientific lines so that the productivity can be increased to 4 to 5 times from a mere 350 kg/hectare at present.

Fish culture along with paddy cultivation is a widely practised system of integrated farming in many parts of South-East Asian countries. In India although paddy cum fish culture was practised in certain areas, with the advent of improved varieties of paddy which requires intensive application of pesticides, fish culture was neglected. However, of late, efforts are being made to revive fish culture along with paddy cultivation. Out of 7 million hectare of saline affected soils of India, 5 million hectare are under rice cultivation and the latter offers scope for paddy cum fish culture*.

The coastal belt of Kerala has a unique system of rice cultivation in saline soils known locally as pokkali cultivation. The term `pokkali' refers to a saline resistant variety largely cultivated in Ernakulam district. The total area under saline

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* Uppal, H.L. 1962. Land reclamation research institute, Punjab publ. p.47

soils of Kerala is estimated to be 26,400 hectare of which 20,000 hectare are in Ernakulam district alone, the remaining area being distributed among Alleppey, Cannanore and Trichur districts. The pokkali area is characterised by the vast difference in salinity between the seasons. The water is low in salinity, nearly fresh, during the period June-November during which a paddy crop is taken. After the monsoon ceases, the salinity builds up and high salinity makes rice cultivation impossible. During this period these fields are utilised for the traditional practice of prawn culture. It is estimated that 5000 hectare of pokkali fields are used for the traditional method of prawn culture known as 'prawn filtration'**. With the ever increasing export market for prawn ways and means to improve the prawn, production from the pokkali fields, and more essentially the quality of the prawn produced have got special significance. In this context improved method of prawn culture by selectively stocking suitable and commercially important species of prawn in these fields has got great potential.

Recognising the importance of prawn culture as a source of seafood supply, and it also being the major contributor to India's seafood export, the present study on economics of paddy-cum-prawn culture was undertaken in pokkali fields of Ernakulam district of Kerala state where the practise is mostly confined to. This study is an attempt to understand the extent to which farmers are benefited by practising prawn culture along with paddy cultivation. An attempt is also made to work out economics of paddy cultivation as well as of prawn cultivation and to analyse their resource use efficiency.

** Jose, M.M., Mathew, P.M. and Jose, S. 1987. Feasibility and economic viability of selective culture of *Penaeus indicus* in pokkali fields. Proc. of National Seminar on Estuarine Management, Thiruvananthapuram, p.379-381

The specific objective of the study are

1) To compare the cost and returns of paddy cultivation, paddy-cum-prawn filtration and improved method of prawn cultivation.
2) To measure the resource use efficiency and to identify the factors responsible for profitability.
3) To identify the constraints in the development of prawn culture.

Scope of the study

Comparative study on the economics of paddy-cum-traditional method of prawn culture and improved prawn cultivation in pokkali lands would be of much help to prawn farmers and entrepreneurs who wish to have a realistic picture on the feasibility and economic viability of prawn cultivation. Analysis of resource use efficiency will be useful to farmers, in helping them to maximise production through judicious utilization of resources and in reducing input cost by integrating prawn culture with paddy cultivation in pokkali area. Information on the cost structure will be of use to policy makers in developing plans.

Limitations

The sample survey method was adopted for collecting relevant data. There were no production records with respondents and hence information and data relating to costs and returns were elicited from the memory of the respondents. However, every effort was made to minimise the errors by cross questioning and cross checking. Data were collected only from farmers undertaking paddy and prawn crops in their own land and those farmers leasing in or leasing out land for cultivation were not included in the sample. In the case of improved method of

prawn culture, since almost all farmers were rearing *Penaeus indicus* (Naran), data relating to costs and returns were collected for this species of prawn only.

Plan of work

This thesis is divided into six chapters including the present introductory chapter. The second chapter deals with the review of related studies in the context of the present investigation. The third chapter deals with description of the study area and fourth chapter deals with methodology used in the process of investigation in the areas under study. This is followed by a presentation of the results and discussion of the findings in the fifth chapter. Chapter six summarises the study, which is followed by the list of references and an abstract.

Review of Literature

REVIEW OF LITERATURE

A comprehensive review of past studies is important for proper perception of concepts, research design and method of analysis of any research project. Hence an attempt has been made to review the past studies which are relevant to the economics of paddy and prawn culture in terms of methodology and subject matter. Since the literature on paddy-cum-prawn culture is scanty literature pertaining to the subject on different types of integrated farming has also been reviewed.

Nair (1962) conducted a study on mixed farming in pokkali lands. He estimated that a typical pokkali farmer gets ten thousand pounds of paddy fetching Rs.3000 for every six acres of land. About seven thousand nuts were gathered from coconut trees grown on bunds, and these, when sold, fetched about Rs.1000. The lease amount that was gained by leasing out land for fish farming was Rs.1000. The total expense amounted to Rs.500 which included labour charges for preparing the field, maintenance of bund and harvesting coconuts. A total profit of Rs.4500 per annum was realised from this type of mixed farming.

A study on the economics of fish culture in paddy fields (1964) found out that an average yield of 90 kg of fish/acre can be obtained by taking up fish culture in paddy field with the additional benefit of a slight increase in the yield of paddy. Fishes feed on weeds and insects, and sap the nutrients in the field. The author is of the view that application of super phosphate, ammonium sulphate and sodium nitrate tends to increase the production of microscopic floating algae, and simlarly,

manuring with cowdung enhances the production of wheel animalcules and waterfleas which constitute food for fish.

Lakshmanan (1974) conducted experiments to compare the difference in growth and production of fishes with and without fertilization and supplementary feeding and found a 5-7 fold increase in growth and production of fish which were supplemented with artificial feed and fertilization. In general 5-30 kg of artificial feed is needed daily, thus a quantity of 4500 kg to 6750 kg feed per hectare per year is required to feed a fish stock of 4500 fishes. Since the growth of fish has a direct relationship to the quantity of feed supplied, the rate of daily ration may be adjusted to the growth of fish. According to him, minimum wastage and maximum utilization are the criteria to be observed in adopting the supplementary feeding method.

George (1974), in his study on prawn culture in the seasonal and perennial fields of Vypeen island, found that the total expenditure required to run the seasonal field is higher than that of the perennial field, and the net income realised from the seasonal field is always better. In seasonal fields paddy is also cultivated during May-October and income per hectare for paddy cultivation realised was Rs.2261.45. The average total income from paddy as well as prawn amounted to Rs.4278/hectare from seasonal fields while the average total income from perennial fields was estimated to Rs.2871/hectare. From the above results it was concluded that paddy cum prawn culture is more profitable than the culture of prawn alone.

Nair (1975) compared the production and revenue obtained from paddy-cum-traditional method of prawn culture and the scientific culture of prawn

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alone. Prawn production by the traditional method of prawn culture with the law market priced Metapenaeus dobsoni varied from 500 kg to 1200 kg per hectare per year and the average revenue from this production amounted to Rs.3,500 per hectare per year. By adopting scientific cultural practices it would be possible to obtain a production rate of 1000 kg/hectare of *Penaeus indicus* and *Penaeus monodon* alone twice a year. This will bring in Rs.30,000 per hectare per year. He is of the view that selective stocking of desirable species and adoption of systematic cultural operations can certainly increase the yield and its value considerably.

Alikunchi (1978) in his study on role of hatcheries in commercial farming of penaeid shrimps stated that in the context of the ever increasing demand for export of shrimp, artificial breeding and successful larval rearing of desired species of prawn on a large scale could easily be organised in India if proper hatchery facilities are provided. There are possibilities of organising systematic collection of prawn seed from natural resources as an industry which would be the first step to encouraging shrimp farming as seed would then be available to interested shrimp farmers. The inherent bottlenecks of uncertain supplies, non-uniform size, mixture of species, prolonged storage etc. necessitate controlled breeding of desired species to ensure adequate supply of quality seeds.

According to Chitambaram (1978) certain strategies are to be adopted for boosting up commercial shrimp farming in India. The sites of prawn farming should be given on a long term lease for minimum period 30 years. Supply of shrimp fry and juveniles on a commercial basis by selected agencies may be encouraged for each region. Another important step is to develop suitable measures for prevention of depletion of fisheries and protection of natural nursery grounds by enforcing closed seasons and preventing the capture of small shrimps by destructive gears.

Dwivedi (1978) in his study on prospects and perspectives in prawn culture states that to develop brackish water farming, it is necessary to obtain stocking material of the desired species of fish and prawn under controlled conditions. Artificial feed of appropriate particle size for young ones of fish should also be developed. Since backwaters are a highly changing and dynamic environment, one should ensure enough supply of neretic water and supply of supplementary food should be controlled in order to avoid pollution.

George (1978) studied the economics of traditional prawn culture in paddy fields in Kerala and compared the profitability with that of intensive prawn culture. The results of experiments conducted in Vypeen island near Cochin during 1977 shows that the income per hectare for paddy realised was Rs.2261.45, the net profit being Rs.674.25/hectare. The yield of prawn from traditional fields was 734.6 kg per hectare. This yield realised an income of Rs.6,888.87 per hectare as against an expenditure of Rs.6237.50 per hectare with a net profit of Rs.651.37. The prawn catch was invariably dominated by the smaller species 'Thelly' which fetched very low price. The combined expenditure for paddy and prawn culture per hectare amounted to Rs.7554.50 and income to Rs.8880.12. Thus the net income from both paddy and prawn culture operations was Rs.1325.62 while, the results of intensive prawn culture carried out under the project showed that in perennial fields, one could obtain an yield of 1040-1560 kg of Naran per hectare per year. The above results shows that the intensive culture is definitely more remunerative than the traditional prawn culture.

Gopalan *et al.* (1978) conducted case studies on improved method of prawn culture and traditional method of prawn culture. They found that on an average the net yield of edible organisms from improved operation came to

1273.45 kg per hectare. The average yield of shrimps came to 864.80 kg per hectare. *Penaeus indicus* which fetches a higher price formed the main bulk of the shrimp yield. A total yield of 1372.39 kg per hectare was available from traditional field of which shrimp yield came to 637.46 kg per hectare and the highest contribution was that of *Metapenaeus dobsoni* which fetches a lower price. The results showed that the improved method of operation is economically more advantageous than the traditional one eventhough the former involves more initial expenditure. Improved operation could enhance the production of more economically important species and at the same time facilitated efficient utilization of juvenile shrimp resource naturally recruited to the paddy fields.

Kumardas (1978) suggested certain measures to evolve effective strategy for the development of commercial shrimp farming. An important aspect of the strategy was providing the necessary infrastructure for the effective utilization of abundant brackish water resource and secondly the production of prawn seed by collection of natural resources and by artificial feeding. Another aspect of the strategy is the dissemination of technical know-how by scientific research in the field of prawn farming among prospective prawn farmers.

Mammen *et al.* (1978) conducted demonstrations on shrimp farming assisted by MPEDA (Marine Products Export Development Authority) and found that the average rearing period of Naran (*Peneaus indicus*) ranged from 67 days to 137 days and yield per hectare ranged between 214 kg to 387 kg with an average of 272 kg. The net profit averaged at Rs.2500 per hectare after meeting an input cost of Rs.2280 per hectare and the survival rate was 43.34 per cent.

Panicker and Kadri (1978) conducted cage culture of giant fresh water prawn *Macrobrachium rosenbergii* by feeding with cattle feed @ 3 per cent of body weight of prawns. Mortality rate in the course of experiment was only 25 per cent. The prawns had attained average size of 29 cm and 1200 g weight with 9 months of stocking from the size of 3 cm per 5 g at soaking. The gain in length and weight were encouraging and were indicative of feasibility of cage culture of fresh water prawn on commercial scale. An amount of Rs.230.12 was estimated to be the net profit, the total cost being Rs.67.88.

Raje and Ranade (1978) found out the projected expenditure of shrimp farming separately for 1 and 2 hectare suitable for small scale farming of fisherman, 5 and 10 hectare farms suitable for small scale industry and 25 and 50 hectare farm suitable for medium scale industry. The gross returns are calculated on the basis of shrimp production of 1 tonne per hectare at a selling price of Rs.30 per kg. Gross returns from the sale proceeds are directly related to the cultivation operations. Seed stocking is assumed to be at the rate of 1,00,000 post larvae per hectare. The total outlay increases with farm hectarage. However, cost of development of a 10 hectare farm will not be 10 times the cost of 1 hectare farms. Cost of cultivation operation will increase proportionately with farm hectarage with possible reduction in cost of feed and it is also found that with the increase in farm hectarage, expenditure on management will increase. Phasing of the farm economics over five years of operation shows that average annual returns on the investment comes to 32 per cent for 1 hectare farm, 36 per cent for 5 hectare farm, 14 per cent for 10 hectare, 23 per cent for 25 hectare farm and 26 per cent for 50 hectare farm.

Rao (1978) studied the seed requirement for intensive culture of penaeid prawns in coastal waters in Kerala. According to him selection of species plays an

important role in intensive culture of prawns and the criteria such as availability, growth rate, resistance to disease, cost of culture etc. determine the suitability of the species. He estimated the requirement of prawn seed for stocking in the existing fields of 5117 hectare and additional fields of 500 hectare that are to be reclaimed within years, to be 11,364 millions. The needed prawn seed can be obtained either from wild stock or from hatcheries established for this purpose.

Reddi (1978) experimented with mixed culture of fish and prawn. The ponds were generally manured with raw cattle manure and superphosphate in initial stages and occassionally manuring was resorted to subsequently. Very rarely artificial feeding with groundnut oilcake and rice bran was given in small quantities in a few ponds when they are found unproductive. A production of 2000 kg of fish (chanos and mullets) plus 260 kg of prawns (*P. monodon* and *P. indicus*) per hectare per annum was obtained. Total capital investment amounted to Rs.30,000 and recurring cost about Rs.8000. Total income realised per hectare was about Rs.19,250, net profit being Rs.11,250. It was also found that with the increase in pond area the personnel required would be proportionately less. He concluded that there is immense scope for increase in production of fish and prawn with use of artificial feeding.

Silas (1978) studied the status of prawn culture in India and strategy for its development. The traditional practice of prawn filtration as carried out in Kerala was evaluated and its disadvantages were identified for the immediate development of prawn culture. He suggested streamlining the practice by selective stocking of faster growing species like *P. indicus* and *P. monodon*. Polyculture of prawn with compatible species of fishes such as chanos and mullets is also highly remunerative. According to him for quicker development of prawn farming it is essential that clear

policies and planned projects with defined objectives and resource allocation be evolved.

Varghese (1978) studied the potential of brackish water prawn culture in India. To develop selective stocking and culture of prawns in brackish water infrastructure facilities should be improved. Controlled breeding of prawn that has shown promising results should be taken up seriously and hatchery production of prawn is to be commercialised. The cost of production on a per hectare basis of brackish water prawn culture shows that cost of production on variable costs is Rs.9630/- for *P. monodon* and Rs.8855/- for culture of *P. indicus*. Projected yield shows 1055 kg/hectare in case of *P. monodon* and 906 kg/hectare in case of *P. indicus* and total income realised is projected to be Rs.42200/- in case of *P.monodon* and Rs.32616/- in case of *P. indicus* on per hectare basis.

Venkatesan (1978) studied brackish water prawn farming in Tamil Nadu. *Peneaus indicus* and *Peneaus monodon* are suitable species in brackish water and *P. semiculatus* in marine ponds of Tamil Nadu. Selection of proper site and suitable design for the construction of ponds and sluice gates are the most important factors that decide the success or failure of the farming project. Absence of appropriate legal frame work to facilitate the establishment of prawn farms is the most important bottleneck in the development of prawn culture in Tamil Nadu. He recommended that all the brackish water area under government which are suitable for prawn culture should be taken over by the Fisheries department for rational distribution among various agencies which seek them on long lease.

Sinha (1979) conducted a study on cost and returns of paddy cum prawn culture at Lembecherra Fish Seed Centre of Tripura state. Application of fertilizers

and manuring is done during pond preparation and artificial feeding during the growing season. Analysis of cost and returns shows that total expenditure amounts to Rs.2930 per hectare and the total return to Rs.6600 per hectare, realising a net profit Rs.3670 per hectare within 3 months. According to him fish culture in paddy fields not only yields an additional income but also augments the paddy yield.

Chen and Li (1980) in their study on integrated agriculture-aquaculture in the Inland fisheries of Taiwan found that the turnover of pond water was large and the production was low. The application of super phosphate has increased the yield per hectare by 50-80 per cent, when phytoplankton feeders (silver carp) formed the dominant species. Fish farming in irrigation ponds is widely practised in Taiwan; where about 2,000 hectare of irrigation ponds are used for polyculture of Chinese carps.

Chitambaram (1980) conducted an experiment in commercial prawn culture in Pondichery stocking 5000 prawn seeds of species *P. semiculatus*, *P. indicus* and *P. monodon* in 1979. Manuring with 500 kg of cowdung was carried out in the pond. The culture was maintained for 80 days and then harvested to yield 330 kg of prawns, 200 kg of fishes and 50 kg of crabs realising a net profit of Rs.10,860. Since the pond was in existence and used for prawn culture by natural stocking, no expenses for the preparation of the pond were included in the cost economics. Total expenditure amounted to Rs.1540/- and total income realised was Rs.12,400/-. These encouraging results show that there is considerable scope for expansion of prawn culture in Pondichery.

Huat and Tan (1980) studied, rice-fish culture in South East Asia and observed that the yield of rice increased by 15 per cent by the introduction of fish.

The excreta of fish, additional fertilizers used and any remmants of supplemental food increased the fertility of the soil. The income obtained from the sale of fish, compensates the loss, if any, in rice production. The introduction of herbivorous fish, control weeds and reduces weeding labour cost. They are of the view that since there are extensive areas of irrigated rice fields in Asian countries, there is immense scope for expansion by introducing fish culture.

Tan and Khoo (1980) in their study on integration of fish farming with agriculture in Malaysia estimated that farmer's income from fish culture constituted 22-60 per cent of the farm income in single cropped area of rice and 4-19 per cent in double cropped area. They concluded that fish formed a significant part of the total income of at least 60 per cent of the tenant farmers interviewed. According to him efficient management is of utmost importance in increasing the profit margin.

Rajendran *et al.* (1981) conducted experiments in culturing fishes simultaneously with paddy in pokkali fields of Rice Research Station, Vyttila during 1977-78 and observed that in ideal conditions production upto 183 kg per hectare can be achieved within a 109 days period with *Etroplus*. Since paddy cultivation is not so economical, additional income gained through fish culture is of great help to farmers. There was also a possibility of increasing the production of paddy as *Etroplus* had helped in removing hydrilla. The locally available as well as highly preferred food fish of Keralites viz. *Etroplus suratensis*, common carp and *Ospironemus goramy* are the suitable species for culture along with paddy.

Purushan (1986) in his study on recent advances in paddy cum fish culture observed that the culture of fish and paddy together can potentially increase and stablise income on rice farms and also the paddy post fish culture increased the

total annual yield. The fish can be beneficial in eliminating weeds mollusces and mosquitoes, thereby reducing labour cost. He also studied the scope of paddy cum fish culture in Kerala and found that the rate of fish production in paddy fields stands much better and suggested the introduction of this practice in Kayal lands of Kuttanad and Kole, in addition to 26,000 hectare of pokkali fields.

In a study on fish based mixed farming in waterlogged areas (1987), the author estimated the economics of a one hectare fish seed farm in water logged paddy fields and found that the total expenditure for the one hectare farm amounted to Rs.54370/- and income per hectare amounted to Rs.83500/-. The net income amounted to Rs.29,130/- per hectare which is a highly encouraging result of fish based mixed farming.

Ahmed (1987) in his study on economics of different aquaculture systems in and around *Kata* water found that fresh water prawn may be stocked in shallow and small water impoundments - *Katas* and *Mudas* - to get more profit. According to him most suitable species of fish is grass carp which is to be cultured along with other crops in poly culture system.

Jose *et al.* (1987) conducted preliminary experiments on selective culture of *P. indicus* in pokkali fields, during 1982. The study was mainly conducted to assess the feasibility and economic viability of *P. indicus* in pokkali fields. No fertilizer or supplementary feed was used for rearing the prawn. The prawn yield was 17 kg and production rate worked out to 100 kg per hectare per 36 days. It could have been significantly higher if sufficient growing period was given. In adaptive trials conducted in two farmers field, where groundnut oil cake was used as supplementary food, production rate of 552 kg of prawn in 83 days was obtained

with net profit of Rs.13,958. The results of this study shows that selective culture of *P. indicus* in pokkali fields is much more advantageous than the traditional prawn culture both in terms of yield and economy.

Mathew and George (1987) conducted experiments in traditional pokkali fields in Panangad areas of Cochin during 1985-86 with a view to assess the feasibility of prawn culture along with paddy in pokkali lands. When fresh water fishes - major carps and brackish water fish - milk fish - were cultured in two fields along with the cultivation of improved variety of paddy Vyttila-1, the yield of which ranged between 1452 and 1641 kg per hectare, fish production in the range of 147 to 418 kg perhectare per 4 months was obtained. The retrieval rate of carps was very poor but the common carp showed the maximum growth among all cultivated species. On the contrary, the performance of brackish water fish *Chanos chanos* was highly satisfactory both in terms of retrieval rate and average final weight. However higher growth rate of common carp indicates that it has considerable potential and can be raised in pokkali fields. In conclusion it is felt that with judicious manipulation of species combinations and stocking rates and adoption of suitable management practices fish production of about 500 kg per hectare per 4 months can be obtained from the pokkali fields which will in turn enhance the economics of pokkali cultivation significantly.

Mukundan (1987) estimated the economics of paddy cultivation and prawn cultivation in pokkali fields of Kerala. The total income from paddy amounted to Rs.5086 per hectare and net profit realised was Rs.506 per hectare. A net profit of Rs.1402 per hectare and Rs.22,000 per hectare were obtained from traditional prawn culture and improved method of prawn culture respectively. The benefit cost ratios were also worked out as 1.10 and 1.69 for traditional and improved method

of prawn culture respectively. He also suggested policy changes for improved prawn farming system like pooling of the land, establishment of more number of hatcheries and organised marketing system.

Purushan (1987) studied the economics of traditional prawn farming in Kerala and found that the proposition of paddy cultivation and prawn culture is encouraging if properly operated. On comparing the two, it is seen that almost double the profit is realised by way of traditional prawn culture than that of paddy cultivation. If improved method of prawn culture is adopted at large, prawn production from pokkali fields can be raised to at least 1 tonne per hectare which will definitely boost the economic returns manifold.

Sethiadhas *et al.* (1989) evaluated the economics of paddy cum prawn culture in Kerala during 1981-84 based on data collected through sample survey covering Ernakulam district. The cost of paddy cultivation is worked out to about Rs.2020-2780 per hectare. Labour accounted for 81 per cent of the total cost, seed 10 per cent, sluice gate 7 per cent and miscellaneous expenditure 2 per cent. The average yield per hectare worked out to 19 quintal realising a gross return of Rs.3270-3900. The analysis of cost and returns of prawn filtration revealed that 80 per cent of the total cost was accounted for lease value, labour cost 10 per cent, expenditure of sluice gate 5 per cent. The net returns per hectare from prawn filtration worked out to Rs.1200/-. Annual net returns worked out to about Rs.8200 per hectare were received by farm owners from both paddy cultivation and prawn filtration, while those who cultivate paddy and lease out for prawn receive annual returns of Rs.5130/-. It is also found that on an average 53 mandays and 50 women days were employed per hectare for paddy cultivation and 81 mandays per hectare for prawn filtration.

Vyas (1989) in his study on fresh water fish culture in Indonesia reveals that common carp is used in this system very often and yields 1200 kg per hectare per year as an additional product besides the production of rice. It is also found that 15 per cent higher returns can be obtained by growing fish along with rice.

Mathew (1990) conducted experimental culture of giant fresh water prawn (*Macrobrachium rosenbergii*) to study the culture potential of pokkali lands of Kerala. Juvenile prawns were stocked @ 3 prawns per m^2 and were fed daily with supplementary food approximately @ 5 per cent of body weight. A food conversion ratio 0.9 to 1 was obtained for supplementary feed. The net profit obtained was Rs.7962 per hectare in 115 days with benefit cost ratio of 1.68. The above results show that pokkali fields of Kerala are well suited for farming of giant fresh water prawn during low saline period.

Mathew (1990) studied the production and yield in selective culture of prawn and traditional prawn culture in pokkali fields in Ernakulam district during 1987-89 and found that production rate in selective culture of prawn varied from 305 kg per hectare per 68 days to 728 kg per hectare per 73 days as compared to production rate of 231 kg per hectare per 83 days to 419 kg per hectare per 151 days from traditional prawn culture. The net profit realised from selective culture ranged from Rs.2478 per hectare per 61 days to Rs.6757 per hectare per 73 days while from prawn filtration it ranged from Rs.1415 per hectare per 83 days to Rs.2310 per hectare per 151 days. The percentage contribution of *P. indicus* in selective prawn culture was 36.7 to 81.7, while it was 17.2 to 35.4 in prawn filtration. It is found that *P. indicus* has been the most ideal species for the culture in pokkali fields, while the performance of *P. monodon* was not satisfactory. Lateral

entry of metapenaeids into selective cultural fields has been found as serious problem affecting the production and economics of prawn culture.

Ganesan *et al.* (1991) studied the role of duck-cum fish culture as a component in rice farming and also the economics of farming system under small farmer's conditions in Cauvery delta region of Tamil Nadu. A net profit of Rs.24,117 was obtained in mixed farming with duck cum fish culture and Rs.13,790 was obtained from existing cropping system (rice-rice-pulses) from one hectare farm. The introduction of duck cum fish culture as a component of mixed farming yielded more income and income per day increased from Rs.37.78 in arable farming to Rs.66.07 in mixed farming. The employment generated increased to 383 man days; an additional 144 mandays of employment was generated by the introduction of mixed farming over the conventional cropping system. The results of this study shows that the Cauvery delta region of Tamil Nadu is suitable for duck-cum-fish culture to earn steady income and employment throughout the years.

Nasser *et al.* (1991) compared prawn culture in seasonal and in perennial fields in Vypeen, Kerala and found that prawn production per hectare per month was higher in seasonal fields than in perennial ponds. Absence of predatary fishes and rare occurance of soft prawn disease in seasonal fields added to its high production and also due to rich organic matter left behind as paddy stumps after harvest selective stocking of prawn seed and supplementary feeding will augment production from perennial ponds. The author is of the view that converting extensive systems to smaller semi intensive ones, though costly, will add to the economy of the country by increasing the overall prawn production and providing employment opportunities.

Sebastian *et al.* (1992) conducted a preliminary study on intensive farming of fresh water prawn in Kerala and found that a production of 3500 kg per hectare per year of *Macrobrachium rosenbergii* can be achieved under the climatic conditions prevailing in Kerala, if proper management measures are followed. A phased harvesting is advisable due to the high variation in the individual growth rates.

Singh (1992) conducted a study on integrated farming with Magur fish among small farmers and proposed a model for integrated farming that integrated Magur fish with poultry, ducks and horticulture as components: Waste products from duck, cattle and poultry were used efficiently by the magur fishes and excess water and nutrient rich sedements are utilized for growing vegetables and fruits. The fish culture gave a yield of 4-6 tonnes per hectare. A net profit of Rs.41,000 was realised from this integrated complex and benefit cost ratio on gross profit realised to be 0.95. He concludes that farming Magur fish with other systems of farming is highly productive, besides it provides gainful employment to the farm family throughout the year.

According to Gupta (1993) water canals in homesteads connected directly or indirectly with backwaters having free tidal water movements can be converted to productive prawn farms. Application of lime 10 g/m^3 or mahua cake at the rate of 200 g/m^3 of water is recommended for small culture areas and ammonia for larger fields, for eradicating predatary organisms. Productivity of the farms can be improved by applying organic or inorganic fertilizers. Growth and survival of prawns should be observed at regular intervals. Harvesting can be done as the prawns reaching a marketable size (in case of *P. indicus*, 110-120 g). From an area

of 400 m^2 of water canal, 12-16 kg of *P. indicus* can be produced which can fetch Rs.50-60 per kg.

Thomas *et al.* (1993) studied prawn culture in Ernakulam district of Kerala state and found out constraints in prawn production. It is found that about 2 per cent of the farmers trained by KVK (Krishi Vigyan Kendra) continue traditional method of prawn culture. The reason is that they need not wait for 3 months culture period for scientific farming. Even if they get less amount frequent harvest can be done. About 6 per cent of farmers trained by KVK (Krishi Vigyan Kendra) on commercial prawn culture, were found to be engaged in semi scientific or prawn filtration supplemented by stocking seeds of *P. indicus* and *P. monodon*. Major constraint is the lack of finance for the adoption of the new method. Non-availability of prawn seed is an another problem faced by prawn farmers. He suggested that more hatcheries should be set up by the state and Central Government to augment the production. The various financial assistances may be extended to the prawn farmers including the landless person also.

Dube (1995) studied integrated aquaculture and found that through fish cum crop integration the production cost can be reduced to one third and also reduces soil erosion by 57 per cent. Due to synergetic effect of fish on rice, rice yield increases by 10 per cent and weeds and insects are controlled by fish. Fish cum crop integration leads to increased efficiency of resource utilization, reduced investment risk through crop diversification and serve as additional resource of food and income. It was also found that with improved management practice a production of 50 kg/hectare of *P. monodon*, 250 kg/hectare of mullets, 3000 kg/hectare of telapia besides 2.4 tonnes/hectare of rice can be achieved.

Gupta *et al.* (1995) estimated economics of scientific prawn culture and traditional farming with crab, fish and prawn in 4050 m and 8100 m water area in coconut groves, respectively. The total cost incurred in scientific prawn culture was Rs.4,200 and the total income earned was Rs.14,400. The prawn yield was 144 kg from 4050 m water canal. While in traditional farming the crab yield was 10 kg in 3 months which realised a price of Rs.1800, fifty kg of fish was sold @ Rs.40 giving a gross return of Rs.2000. The three types of prawns that were stocked by natural trapping got a weight of 145 kg and earned an income of Rs.9000 within one year. Thus, the traditional farming realised a net income of Rs.9500 while the total cost incurred was Rs.3,300 per 8100 m water canal.

Pandiaraj (1995) conducted a case study on rice-fish-duck farming in 0.2 hectare homestead area and found that the fishes reduced the need for pesticide as they feed on insects such as stem borer. Ducks in rice field feeds on emerging weeds which reduces the cost of labour. The average yield of rice is estimated to be 900-1200 kg/hectare and that of straw 600-800 kg/hectare. The cost of cultivation for rice in Rs.200 per 0.2 hectare excluding labour cost. The income from rice alone amounted to Rs.9000 per year and Rs.3000 per year from the sale of ducks and their eggs. He concludes that the pratice is cheap requiring no major modifications in existing farming situations. Integration of fish in the system increased the yield/unit area, improves the family income and conforms with the environment.

Rao (1995) conducted a study on giant prawn farming and found out that lime can be used @ 200-400 kg/ha to correct the pH and also to disinfect the ponds. Water temperature should be 20-34°C, pH between 7 and 9 and dissolved oxygen more than 3 ppm. In monoculture system a stocking rate of 5 post larvae/m^2 was recommended and requisite diets were recommended for feeding the prawn. Shell

disease and black spot disease were seen in prawns, caused by bacteria followed by fungus. These were controlled by antibiotics and copper sulphate. He observed that the prawn reached the marketable size in about 4 to 6 months and the yield of prawn ranged from 550 to 880 kg/ha.

Sasidharan (1996) studied the cultivation practices of paddy in pokkali lands and found that, pokkali, cheruvirippu, chettivirippu, orkazhama etc. are the traditional varieties suitable for growing in pokkali fields. Sprouted seedlings are planted in mounds in monsoon season. Fertilizers and pesticides are not generally used in these fields as they become toxic to fishes and prawns in the next season. Since the backwaters inundates the field the weeds may be controlled naturally as they are submerged in water. While harvesting, only the panicles are cut and the stumps are left behind in the field, which are converted to the habitat for the fishes and prawn juveniles.

Rao *et al.* (1997) conducted a study on economics of fresh water fish culture in Guntur district of Andhra Pradesh during 1992-93 by randomly selecting 60 fresh water fish farmers in eight villages. Fresh water fish rearing consisted of polyculture of Rohu, Catla and Mrigal species. The total costs of fresh water fish culture were Rs.41,457 per hectare and Rs.3,70,356 per farm on the average. He estimated that variable costs constituted 86 per cent of total cost and fixed costs 14 per cent which indicate the more flexible nature of cost structure and the mobility of capital resource investment. The total return was Rs.7,40,401 per farm and Rs.82,880 per hectare. The productivity per hectare under fresh water fish culture was 3903 kg. The average price realised was Rs.16.62 per kg of fish. Due to high mortality rates the stocking densities were very high. Feed constituted the major item of cost. The profitability measures indicated that fresh water fish culture was

viable in short run as well as in long run under normal years. The technical coefficients revealed that one per cent expansion in pond size will increase the output by 1.55 per cent. The stocking rates, fuel and electricity charges, fertiliser and labour resources need to be reduced and rationalised to the levels of marginal value products equal to respective input prices.

AREA OF STUDY

A unique system of paddy cultivation is prevalent in the coastal belt of Kerala, locally known as `Pokkali' cultivaion. The present study is based on the paddy-cum-prawn culture in pokkali lands in six villages of Ernakulam district. The district has been selected for the study since the pokkali area is mostly confined to this district of the State.

3.1 Location

In 1958 Ernakulam district was formed by carving the regions from Thrissur and Kottayam districts. Cochin, Kanayannur, Parur, Aluva, Kunnathunadu, Muvattupuzha and Kothamangalam are the seven taluks of the district. In all there are 96 villages in the district.

The district is bounded by a 30 km coastal belt of Arabian sea on the west, Kottayam and Alappuzha district in the south, Idukki on the east and Thrissur on the north. It is located between the latitude 9° 42' 38" to 10° 18' 00" north and longitude 76° 12' 00" to 76° 46' 00" east. The area of the district accounts for 6.1 per cent of the total area of the state with 2407 km^2.

3.2 Physiography

According to physiographic conditions the district can be divided into 3 natural divisions such as high land, mid land and low land. The low land space

division includes the entire Paravur and Cochin taluks and western part of Kanayannur taluk. The pokkali lands are mostly confined to this low land region. The eastern portion of the Kanayannur taluk, Aluva, Muvattupuzha and Kothamangalam come under the mid land region. The major part of the Kunnathunadu taluk is in the midland region and the remaining portion is in high land region.

3.3 Climate

A tropical humid climate with almost uniform temperature throughout the year is experienced in the district. The total annual rainfall per year is more or less equal to the total average rainfall per year in the state. It is more than 3000 mm, the major part of which is received in the months of June, July and August. The maximum day temperature varies from 27°C to 34°C and minimum temperature from 21°C to 28°C. Humidity is often very high, recording more than 90 per cent. Heavy rains occuring continuously for 10-15 days result in flooding, which is usual during June, July and August.

3.4 Soil

Laterite soil, sandy loam and alluvial soil are the 3 types of soil of the district. In pokkali lands soil is stiff impervious clay, rich in organic matter. It is bluish black in colour and is more than one metre deep. The soil is hard and creates deep fissures when dry and is sticky when wet.

The characteristic feature of the pokkali tract is that soil is acid saline. They are characterised by highly acidic and saline sulphidic soil that are

Table 3.1. Average monthly rainfall in Ernakulam district for the year 1995

Months	Rainfall in (mm)
May	471.6
June	615.5
July	764.4
August	570.3
September	358.7
October	331.6
November	239.7
December	00.0
January	08.7
February	06.6
March	69.6
April	156.0
Annual	3592.7

Source: Farm Guide, 1997, Farm Information Bureau, Government of Kerala

waterlogged with saline tidal water. But when salinity is washed off in heavy monsoon rains, the inherent acidity of the soil regenerates. The soil is normally acidic, the pH being 1.0 to 5.5.

With regard to nutrient status, the soil is very low in phosphorus, medium in nitrogen and high in potash. Water soluble salts like sulphates and chlorides of sodium and magnesium are present in high proportion. In dry conditions white incrustations of aluminium hydroxide also develop on soil surfaces. Electrical conductivity of the soil during summer months (January-May) varies from 12-24 mmhos/cm and average salt content reaches upto 18 ppt (1.8%). During rainy season (June-August) water becomes almost fresh, salt content reduces to traces and electrical conductivity ranges from 6-8 mmhos/cm.

3.5 Population

According to census reports 1991, Ernakulam district supports a population of 28.18 lakhs of which 14.09 lakhs are males and 14.08 lakhs females. The density of population is 1170 per square kilometre. Effective literacy rate is 92.35.

3.6 Occupation

The occupational distribution of population in the district for the year 1991 is given in the Table 3.2. Ninety two per cent of the total number of workers are main workers and 7.3 per cent are marginal workers. Seventy seven per cent of the total number of workers are males and 23 per cent are females. The work participation rate of workers in Ernakulam district worked out to be 33.44 per cent.

Table 3.2. Occupational distribution of population of Ernakulam district 1991

Occupation	Number of persons
Cultivators	81257
Agricultural labourers	137948
Other workers	225492
Total main workers	873634
Marginal workers	68736
Work participation rate	33.44

Source: Agricultural Sensus, 1991. Department of Economics and Statistics, Thiruvananthapuram

Agricultural labourers constitute 31.0 per cent of the total number of main workers and cultivators constitute 18.27 per cent. Other occupations are manufacturing, processing, servicing and repairs in household industry (50.73 per cent).

3.7 Land utilization pattern

The total geographical area of the district is 235319 hectares which is 6.06 per cent of the area of the State. Land utilization pattern of the district given in Table 3.3 revealed that the area under forest constituted 3.45 per cent while land put to non-agricultural uses occupied 15.02 per cent and cultivable waste land accounted for 1.02 per cent of the total geographical area. The net area sown was 181423 hectares which constituted 77.09 per cent. Out of the total cropped area of 226127 hectares, area sown more than once accounted for 19.77 per cent.

3.8 Land holding pattern

Data on the size of holdings in Ernakulam district are given in Table 3.4.

It can be seen that more than 88 per cent of the total number of holdings are owned by small holders having less than half hectare of agricultural land.

3.9 Water resources

The district has many water resources such as rivers, canals, tanks, wells etc. The most important rivers in the district are the Periyar and the Muvattupuzha.

Table 3.3. Land utilization pattern for the year 1994-95

Description	Area (in hactare)	Percentage
Total geographical area	235319	100.00
Forest	8123	3.45
Land put to non-agriculture	35339	15.02
Barren and uncultivable land	1556	0.66
Permanent pastural and other grazing land	64	0.03
Land under tree crops	651	0.27
Cultivable waste	3260	1.39
Fallow other than current fallow	2394	1.02
Current fallows	2509	1.07
Net area sown	181423	77.09
Area sown more than once	44704	
Total cropped area	226127	

Source: Farm guide, 1997, Farm Information Bureau, Govt. of Kerala

Table 3.4. Land holding pattern of Ernakulam district

Holding size (ha)	No. of holding (000's)	Percentage	Total area (000 ha)	Area in (%)
Below 0.02	189.51	17.56	1.23	1.04
Between 0.02-0.5	360.67	70.74	41.14	34.70
Between 0.5-1.0	31.50	6.21	24.24	20.44
Between 1.0-2.0	20.12	3.90	26.81	22.61
Between 2.0-4.0	67.00	1.30	17.16	14.47
Between 4.0-10	1.16	0.23	5.81	4.90
10 and above	0.09	0.01	2.18	1.84
Total	509.86	100.00	118.57	100.00

Source: Panchayat level statistics, Ernakulam, Dept. of Economics and Statistics, Trivandrum

The Periyar is the longest river stretched over with a length of 229 kms. The river plays as prominant role in the development of the agricultural, industrial and commercial sector of the district. The Muvattupuzha river is formed by the union of three rivers such as the Kaliyar, the Thodupuzhayar and the Kothamangalamyar. The major irrigation projects operating in the district are Muvattupuzha, Idamalyar and Periyar valley. Crop wise area under irrigation is shown in Table 3.5.

3.10 Backwaters

The district is blessed with an attractive network of canals and backwaters such as Vembanad and Kodungalloor Kayals stretching along western and north eastern coast of the district and many riverlets empty themselves into these backwaters. The Vembanad Kayal is a large spacious lake with a length of 82 km and maximum breadth of 40 km extending to an area of 205 km^2. Taluk wise area under backwaters in Ernakulam district is given in Table 3.6. Total backwater area in Ernakulam district is 16212.71 hectares, which is 24.86 per cent of the total backwater area of the State. Taluk wise backwater area of the district shows that 42.42 per cent of the total backwater area is in Kochi taluk, 41.37 per cent in Kanayannur taluk, 16.05 per cent in Parur taluk and 0.16 per cent in Kunnathunadu taluk.

3.11 Cropping pattern

Major crops grown in the district are coconut, rice, rubber, spices and condiments, fruit trees and vegetables. The cropping pattern of Ernakulam district is shown in Table 3.7. Coconut is cultivated in 61241 hectares of land which is 27.08 per cent of the total cropped area and is the important oil seed crop of the district.

Table 3.5. Area under irrigation in Ernakulam district (crop wise) 1995

Crops	Area under irrigation (hectare)
Paddy	43824
Tubers	10
Vegetables	312
Coconut	18243
Arecanut	1005
Clove and nutmeg	706
Other spices and condiments	123
Banana	1746
Betelvine	4
Sugarcane	6
Others	621
Total	66600

Source: Farm Guide, 1997, Farm Information Bureau, Government of Kerala

Table 3.6. Area under backwaters in Ernakulam district (Taluk wise) 1994-95

Taluk	Area in hectares
Parur	2602.63
Kanayannur	6707.88
Kunnathunadu	25.52
Kochi	6876.68
Total	16212.71

Source: Land resources of Kerala State, 1995, Kerala State Land use Board, Thiruvananthapuram

Table 3.7. Cropping pattern in Ernakulam district for the year 1994-95

Crop	Area (in hectares)	Percentage to total cropped area
Paddy	60018	26.54
Cereals and millets	7779	0.03
Pulses	2276	1.00
Sugar yielding crops	274	0.12
Spices and condiments	13977	6.18
Fruit crops	19849	8.78
Vegetables	8564	3.79
Coconut	61241	27.08
Other oil seed crops	964	0.43
Drugs and narcotics	58	0.02
Tea	2	0.00
Rubber	54803	24.24
Cocoa	488	0.22
Fodder grass	62	0.03
Green manure crops	323	0.14
Other non food crops	3151	1.40
Total cropped area	226127	100.00

Source: Farm Guide, 1997, Farm Information Bureau, Government of Kerala

Rice is the major food crop. It occupies 60018 hectares which is 26.54 per cent of the total cropped area. Fruit crops are grown in 54803 hectares of land which is 24.24 per cent of the total cropped area.

3.12 Sample villages

Out of 96 villages in the district, three villages each were selected from high saline and low saline tracts of pokkali lands*. The pokkali lands are confined to Paravur, Cochin and Western part of Kanayannur taluks. The selected villages were Chellanum, Mulavukadu and Narakkal from the high saline tract and Chittoor, Nayarambalam and Varappuzha from the low saline tract.

Geographical area and certain features of population in the selected villages can be seen from Table 3.8. Among the selected villages, Nayarambalam has the highest population (25535) followed by Chittor (18975) and the lowest is in Varappuzha (13267). However, the highest density of population was in Varappuzha (1154) and lowest in Mulavukad (905). Sex ratio was in favour of females in all villages with the highest in Chittoor (1088).

Major crops grown in these villages are shown in Table 3.9. They are paddy, coconut, banana, vegetables and pepper. Rice is the most important crop occupying the highest area in all villages except in Chellanum, where the major crop is coconut.

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* Purushan, K.S. 1992. Studies on improved practices of prawn farming for higher production in Central Kerala. Ph.D. Thesis, Cochin University of Science and Technology, p.19, 57

Table 3.8. Geographical area and population features of selected villages

Indicators	Villages					
	High saline tract			Low saline tract		
	Narakkal	Mulavukad	Chellanum	Chittoor	Varappuzha	Nayarambalam
Geographical area (sq.km)	15.60	18.25	15.21	20.60	11.49	22.65
Population	14642	16532	15623	18975	13267	25535
Density of population	938	905	1027	921	1154	1127
Sex ratio	1069	1082	1077	1088	1062	1031

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Paddy area occupied 410 hectares in Nayarambalam, the highest area among all other villages. Other crops include ginger, turmeric, pulses, tuber crops etc.

Table 3.9. Cropping pattern of the study area (in hectares)

Name of crops	Villages					
	Narakkal	Mulavukad	Chellanum	Chittoor	Varappuzha	Nayarambalam
Paddy	220	380	340	525	180	410
Coconut	321	250	582	250	460	380
Arecanut	12	10	7.5	20	0.3	0.20
Banana	5	10	10	7	4	7
Vegetable	20	15	20	10	8	12
Pepper	2	5	2	3	5.5	3.8
Other crops	18	20.5	20	4.5	6.5	8.5

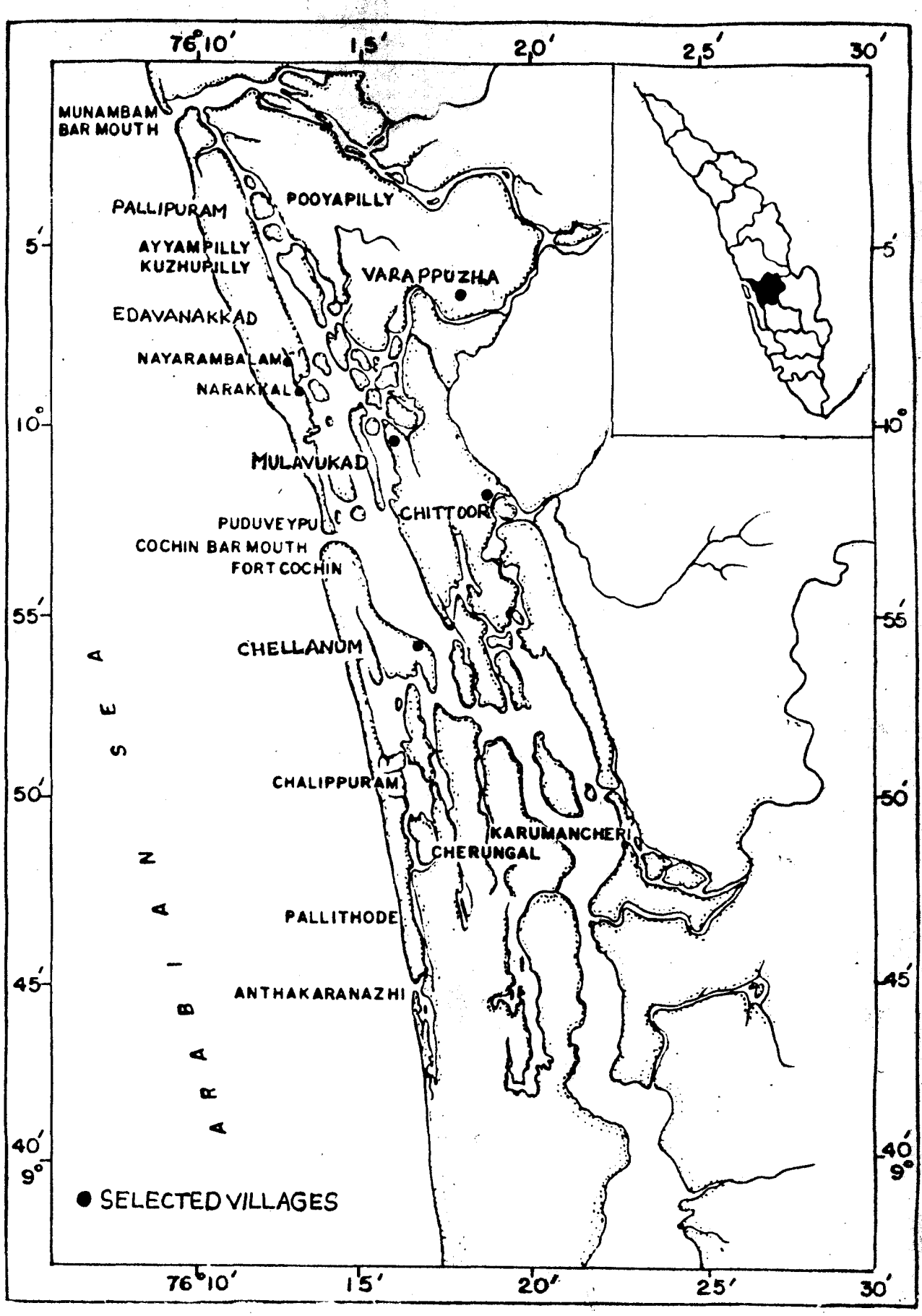

FIG.1. POKKALI REGION OF ERNAKULAM DISTRICT

Methodology

METHODOLOGY

The present chapter deals with the materials, methods and tools of analysis adopted in estimating cost and returns and resource use efficiency of paddy cum traditional method of prawn culture and paddy cum improved prawn culture. The study was conducted in pokkali lands of Ernakulam district and data for the study were collected through sample survey. A brief description of the procedures followed in the selection of sample, data collection as well as analytical techniques employed in this study are presented in this chapter.

4.1 Sampling procedure

A two stage sampling technique was adopted for the selection of sample farmers with high saline and low saline tracts as strata, villages as the primary sampling units and prawn farmers as the secondary sampling units. Separate lists of prawn farmers practising traditional method of prawn culture and improved method of prawn culture were collected from central marine fisheries research institute (CMFRI). Three villages were selected from each tract at random. From each selected villages 11 farmers cultivating paddy and traditional prawn culture and 11 farmers cultivating paddy and improved prawn culture were randomly selected. Thus the total sample respondents of each method of prawn culture came to 66 making a total sample of 132. The classification of respondents adopted is as follows:

Class I - one crop of paddy and one crop of traditional prawn culture

Class II - one crop of paddy and two crops of traditional prawn culture

A5

Class III - one crop of paddy and three crops of traditional prawn culture

Class IV - one crop of paddy and one crop of improved prawn culture

Class V - one crop of paddy and two crops of improved prawn culture

Class VI - one crop of paddy and three crops of improved prawn culture

4.2 Period of study

Reference period of the study was the agricultural year 1995-96. Data collection was done during the months of June-August, 1995.

4.3 Collection of data

Farm level data were collected with the help of a well structured and pre-tested interview schedule through personal interview method. Information on the socio-economic condition of farmers, cost and returns, problems encountered by farmers in paddy as well as prawn cultivation were collected. Secondary data on land holding pattern, land utilization pattern, population, occupation, climate and rainfall, land and soil, water resources backwaters and cropping pattern were obtained from various government publications and other records.

4.4 Tools of analysis

Though the samples were collected from high saline and low saline tracts, analysis was not done separately for the two groups since there was no significant difference between these two groups as revealed by the F-test. The sample farmers were classified based on the method of prawn culture and number of prawn crops taken along with paddy crop and analysis was done for these classes separately.

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Percentage analysis was employed for the estimation of the cost and returns of the paddy cultivation and prawn cultivation. The concepts used in the present study are explained below.

Cost concepts

Cost A_1

Cost A_1 approximates the actual expenditure incurred in cash and kind and it includes the following items of costs.

1. Value of hired human labour

In case of paddy cultivation, human labour employed for various items like land preparation, sprouting of seeds, sowing, weeding and harvesting were included in determining the value of hired human labour.

In case of prawn cultivation hired human labour employed for pond preparation, bund formation, fixing sluice gates, shrimp care (supervision) and harvesting are the operations common for both traditional as well as improved method of prawn cultivation. Human labour is also employed for other operations like stocking the fingerlings, eradication, fertilizing and manuring and feeding in case of improved prawn culture. The actual wages paid for labour was considered as value of hired labour for both paddy cultivation and prawn culture. Bullock labour and machine labour were not commonly used in pokkali lands either for paddy or prawn cultivation since the fields are in flooded condition almost throughout the year.

2. Value of seeds

In case of paddy cultivation, farm produced seeds are evaluated on the basis of the prevailing market price. Purchased seeds were accounted for at the purchase price.

Fingerlings, in the case of prawn cultivation, were evaluated on the basis of prevailing market price.

3. Cost of gunny bags

With regard to paddy cultivation, half of the market price of gunny bags was used for evaluating the value of this item since they can be used for two years.

4. Value of eradicants

In case of prawn cultivation cost incurred for the purchase of eradicants was estimated at the prevailing market price.

5. Value of manures and fertilizers

No manures and fertilizers are applied for rice cultivation. Regarding prawn cultivation cost incurred for manures and fertilizers was estimated by multiplying the physical quantities of the different manures and fertilizers with their respective market price.

6. Value of sluice gates

In case of prawn cultivation, value of sluice gate is estimated by the expenditure incurred for the purchase of materials for the make of sluice gates, since they can not be used for more than one year.

7. Value of lights

With regard to prawn cultivation, cost of illumination include the cost for bulbs and other accessories and electricity charges. Half of the purchase price of bulbs and accessories were taken since they can be used for two years.

8. Value of feed and feeding pots

The value of feed is evaluated at the purchase price and half of the purchase price of feeding pots was taken since they can be used for two years, incase of prawn cultivation.

9. Value of watchmen's shed

Regarding prawn cultivation, cost incurred for the purchase of materials to build the shed is estimated at their purchase price because the materials used for construction cannot be used after one year.

10. Value of filtration nets and fishing nets

In case of prawn cultivation value of filtration nets and fishing nets were evaluated by taking 1/3rd, 2/3rd and full cost of the purchase price of these items respectively for one crop of prawn, two crops of prawn and three crops of prawn.

11. Interest on working capital

Interest on working capital was charged at the rate of 12 per cent per annum. This was the rate of interest charged by State Bank of travancore for short term agriculture loan. The interest was charged only for the duration of crops.

12. Cost of transportation

With respect to paddy cultivation cost of transportation include the charge paid for transporting in the produce from the field to the farm house carried through small county boats.

13. Miscellaneous expenses

In case of paddy cultivation, expenses incurred for dewatering, land revenue etc. were included in this item.

Hiring charge paid for electric motors used for dewatering the ponds, was included in the miscellaneous item in case of prawn cultivation.

Cost A_2

Since the respondents in the sample included were cultivating paddy and prawn crops in their own land, cost A_2 is the same as cost A_1.

Cost B_1

Cost B_1 includes cost A_1 plus interest on own fixed capital. An interest rate of 10 per cent was adopted for computing interest on own fixed capital.

Cost B_2

Cost B_2 consists of cost B_1 plus rental value of own land. Rental value of own land was calculated at Rs.7500/- per hectare, the leasing rate prevailed in the study area.

Cost C_1

Cost C_1 includes cost B_1 plus imputed value of family labour. The cost of family labour was imputed based prevailing wage rate paid to hired labour in the area during the period. It was Rs.75/- per day for men and Rs.30/- per day for women.

Cost C_2

Cost C_2 is computed as cost B_2 plus imputed value of family labour.

Income measures

The following income measures associated with different cost concepts were also used to measure the efficiency of paddy cum prawn cultivation.

1. Gross income

It is the total value of a farm activity and includes the total value of the main product and byproduct. This is based on the prevailing harvest price in the area.

2. Farm business income

It was calculated by taking the difference between gross income and cost A_1. This represents income to the farmer when only production expenses are considered as costs.

3. Family labour income

It was calculated by adding the imputed wages for family labour to the net income or the difference between gross income and cost B_2.

4. Net income

This is the difference between the gross income and cost C_2.

5. Benefit-cost ratio

Benefit-cost ratio reveals the physical production efficiency. In the present study it was calculated by dividing gross income by total costs.

4.5 Functional analysis

Functional analysis was carried out using Cobb-Douglas production function separately for paddy cum traditional method of prawn culture and paddy cum improved method of prawn culture. Cobb-Douglas production function is logarithmically linear and it assumes a constant rate of change in the dependent variable with respect to the independent variable. It also allows economic use of

degrees of freedom. This function has asymptotic isoquants, straight line isoclines passing through the origin, the regression coefficients is same as production elasticity and allows only constant, increasing or decreasing marginal productivity.

Cobb-Douglas production function was fitted with five explanatory variables such as area, human labour, seed, manures, fertilizers and eradicants and feed and two dummy variables to represent the effects of number of crops of prawn taken along with paddy, in case of paddy cum improved prawn culture. The function was fitted separately for paddy cum traditional method of prawn culture with three explanatory variables such as area, human labour and seed and two dummy variables to represent the effects of the number of crops of prawn taken along with paddy.

The specification of the model fitted for paddy cum improved method of prawn culture is

$$y_1 = a x_{1.1}^{b_{1.1}} x_{1.2}^{b_{1.2}} x_{1.3}^{b_{1.3}} x_{1.4}^{b_{1.4}} x_{1.5}^{b_{1.5}} D_{1.1}^{'b_{1.6}} D_{1.2}^{'b_{1.7}} + u$$

where,

y_1 - value of output in rupees both from paddy and prawn estimated by multiplying the production with farm price

$x_{1.1}$ - Area in cents

$x_{1.2}$ - Labour - this includes both hired and family male and female labour used in paddy and prawn crops in rupees

$x_{1.3}$ - Seed - cost of paddy seed and prawn fingerlings is taken by multiplying physical quantities with its price

$x_{1.4}$ - Manures, fertilizers and eradicants - value of manures, fertilizers and eradicants (used in prawn culture) were taken by multiplying physical quantities with its price

$x_{1.5}$ - Value of feed used in prawn culture is taken by multiplying the physical quantities with the corresponding price

$D'_{1.1}$ and $D'_{1.2}$ - dummy variables used to represent effects of number of prawn crops taken along with paddy crop

$D_{1.1}$ 1 - for 1 crop of prawn
0 - for others (ie. 2 and 3 crops of prawn)

$D'_{1.2}$ 1 - for 2 crops of prawn
0 - for others (ie. 1 crop and 3 crops of prawn)

where,

$D'_{1.1} = 10^{D1.1}$

$D'_{1.2} = 10^{D1.2}$

a - intercept

$b_{1.1}$, $b_{1.2}$, $b_{1.3}$, $b_{1.4}$, $b_{1.5}$, $b_{1.6}$ and $b_{1.7}$ are corresponding partial regression coefficients or elasticities of production

u - random error

The specification of the Cobb-Douglas model fitted for paddy cum traditional method of prawn culture is

$$y_2 = a x_{2.1}^{b_{2.1}} x_{2.2}^{b_{2.2}} x_{2.3}^{b_{2.3}} D'^{b_{2.4}}_{2.1} D'^{b_{2.5}}_{2.2} + u$$

where,

y_2 - Value of output in ruppees both from paddy and prawn estimated by multiplying the produce with farm price

$x_{2.1}$ - Area in cents

$x_{2.2}$ - Labour - This includes both hired and family male and female labour used in paddy and prawn crops in rupees

$x_{2.3}$ - Seed - cost of paddy seed is taken by multiplying physical quantities with its price

$D'_{1.1}$ and $D'_{1.2}$ - dummy variables used to represent effects of number of prawn crops taken along with paddy crop

$D'_{1.1}$ 1 - for 1 crop of prawn
0 - for others (ie. 2 and 3 crops of prawn)

$D'_{1.2}$ 1 - for 2 crops of prawn
0 - for others (ie. 1 crop and 3 crops of prawn)

where,

$D'_{2.1} = 10^{D2.1}$

$D'_{2.2} = 10^{D2.2}$

a - intercept

$b_{2.1}$, $b_{2.2}$, $b_{2.3}$, $b_{2.4}$ and $b_{2.5}$ are corresponding partial regression coefficients or elasticities of production

u - random error

Results and Discussion

RESULTS AND DISCUSSION

This chapter which is divided into four sections deals with the results of the study and discussions thereon. The first section is about the general socio-economic characteristics of sample cultivators studied and section two deals with the method of cultivation of paddy and prawn. Section three includes the operation wise and input wise cost of cutlivation of paddy and prawn, cost of cultivation of paddy and prawn according to different cost concepts, income measures in relation to different cost incepts, yield and returns from paddy and prawn cultivation and resource use efficiency. Finally section four deals with important constraints in paddy and prawn cultivation.

5.1 General economic and social conditions of the sample

A brief idea about the social and economic conditions in which farmers operate would be very useful for proper understanding of their farming activities. In this section therefore, an attempt is made to present salient features of the social and economic conditions viz., family size, age and sex, literacy, occupation, ownership holding and cropping pattern.

As already mentioned, the study was conducted in six villages, three each coming under high saline tract and low saline tract. The selected villages were Narakkal, Mulavukadu and Chellanum from high saline tract and Chittoor, Varappuzha and Nayarambalam from low saline tract. The selected farmers are grouped into six classes based on the method of cultivation of prawn and number of

prawn crops taken along with paddy cultivation. Farmers cultivating one crop of paddy and one crop of traditional method of prawn culture belongs to Class I, Class II consists of farmers taking two crops of traditional prawn culture along with one paddy crop. Farmers taking three crops of traditional prawn culture along with one paddy crop classified into Class III. Class IV, Class V and Class VI consists of farmers taking one crop of improved method of prawn culture, two crops of improved prawn culture and three crops of improved prawn culture along with one paddy crop respectively. Hereinafter whenever reference is made to Class I, Class II, Class III, Class IV, Class V and Class VI, they have to be understood in terms of the above descriptions. The distribution of sample farmers (village and class wise) is presented in Table 5.1.

5.1.1 Family size

The respondent farmers were classified based on their family size and their distribution is given in Table 5.2. As much as 64 per cent of the total sample families came under the size group of 4 to 6 members, 22 per cent had 7 and above members and the remaining 14 per cent had 1 to 3 members.

In case of all classes of farmers, 50 per cent or more of the respondents belong to the size class of 4 to 6 members. Class V possess highest per cent (70%) of respondents in this size group. The class wise analysis shows that the next major size group is with members 7 and above to which respondents of all classes except class IV belong to. In case of class IV, 64 per cent of the respondents came under the size group of 4 to 6 members, 23 per cent belong to size group 1 to 3 members and remaining 13 per cent with 7 members and above.

Table 5.1. Distribution of sample farmers (village wise and classwise)

Classes	Tract/Villages					
	High saline tract			Low saline tract		
	Narakkal	Mulavukad	Chellanum	Chittoor	Varappuzha	Nayarambalam
Class I	3	2	4	1	2	2
Class II	7	7	6	3	5	4
Class III	3	3	3	2	1	2
Class IV	2	2	1	6	5	5
Class V	3	4	3	6	6	5
Class VI	3	4	4	2	2	2
Total	21	22	21	20	21	21

Table 5.2. Classification of respondents according to family size

Class of families	Family size and number of families				Average size of the family
	1-3	4-6	7 and above	Total	
Class I	3 (21.43)	7 (50.00)	4 (28.57)	14 (100)	5.14
Class II	2 (6.25)	22 (68.75)	8 (25.00)	32 (100)	4.91
Class III	0 (0.00)	9 (64.29)	5 (35.71)	14 (100)	4.78
Class IV	5 (22.73)	14 (63.64)	3 (13.63)	22 (100)	5.18
Class V	5 (14.81)	19 (70.37)	3 (14.82)	27 (100)	4.96
Class VI	2 (11.76)	10 (58.82)	5 (29.42)	17 (100)	5.18
Total	17 (13.49)	81 (64.29)	28 (22.22)	126 (100)	

(Figures in parantheses show percentage to total)

In case of Class III, there were no respondents belong to size group with 1 to 3 members and the average size of the family is 4.78 which is the lowest of all classes. The average family size is highest in case of Class IV and Class VI (5.18).

5.1.2 Age and sex

Classification of the respondents on the basis of the age and sex is given in Table 5.3. As much as 51.59 per cent of total members came under the age group 40 to 59 and 24.60 per cent came under the age group of above 60. About 22.22 per cent was in age group of 18 to 39 years and the rest was below 18 years of age. All the respondents were males.

5.1.3 Literacy and educational status

Classfication of respondents according to their educational status is given in Table 5.4. Analysis showed that 56 per cent was below SSLC and 28 per cent attained secondary school level. Out of the total respondents 13 per cent attained pre-degree, 2 per cent attained degree and the rest 2 per cent was illiterate.

Class wise analysis showed that no respondents had attained degree in case of Class I, II, IV and VI and in case of Class I, IV, V and VI, none of the respondents was illiterate.

5.1.4 Occupation

Distribution of respondents according to their occupation is shown in Table 5.5. Analysis showed that 47 per cent of the total number of sample farmers

Table 5.3. Distribution of respondents according to age and sex

Class of families	Age group (years)				
	0-17	18-39	40-59	>60	Total
Class I	1 (7.14)	3 (21.43)	8 (57.14)	2 (14.29)	14 (100.00)
Class II	-	8 (25.00)	15 (46.87)	9 (28.13)	32 (100.00)
Class III	-	2 (14.29)	8 (57.14)	4 (28.57)	14 (100.00)
Class IV	-	4 (18.18)	12 (54.55)	6 (27.27)	22 (100.00)
Class V	1 (3.70)	7 (25.93)	14 (51.85)	5 (18.52)	27 (100.00)
Class VI	-	4 (23.53)	8 (47.06)	5 (29.41)	17 (100.00)
Total	2 (1.59)	28 (22.22)	65 (51.59)	37 (24.60)	126 (100.00)

(Figures in parantheses show percentage to total

Table 5.4. Classification of respondents according to literacy

Class of respondents	Illiterate	Below SSLC	SSLC	PDC	Degree	Total
Class I	-	8 (57.14)	4 (28.57)	2 (14.29)	-	14 (100.00)
Class II	1 (3.12)	16 (50.00)	9 (28.13)	6 (18.75)	-	32 (100.00)
Class III	1 (7.14)	6 (42.86)	4 (28.57)	2 (14.29)	1 (7.14)	14 (100.00)
Class IV	-	14 (63.64)	6 (27.27)	2 (9.09)	-	22 (100.00)
Class V	-	16 (59.26)	7 (25.93)	3 (11.11)	1 (3.70)	27 (100.00)
Class VI	-	11 (64.71)	5 (29.41)	1 (5.89)	-	17 (100.00)
Total	2 (1.59)	71 (56.34)	35 (27.78)	16 (12.70)	2 (1.59)	126 (100.00)

(Figures in parantheses show percentage to total)

had agriculture as the main occupation, while for 43 per cent agriculture was the sole occupation. For 10 per cent of the farmers agriculture was the sub occupation.

Class wise analysis also revealed that in Classes I, II, III and IV, majority of the farmers indicated agriculture as the main occupation. But majority of the respondents indicated agriculture as the sole occupation in case of Class IV and V.

5.1.5 Ownership holding

The respondents classified based on their ownership holding size are given in Table 5.6. It was found that 40 per cent of the total number of respondents were having area between 2 and 4 hectares, 35 per cent having area below 2 hectares and 24 per cent having area between 4 and 6 hectares. It is also revealed that the percentage of respondents having area between 6 and 8 hectares is only 6 per cent and 6 per cent were having area above 8 hectares.

5.1.6 Cropping pattern

Cropping pattern of the respondent farmers is given in Table 5.7. The major crops grown are rice, coconut, banana and vegetables. Total gross cropped area was highest in case of Class II and lowest in the case of Class I.

5.1.7 Area under particular combinations of paddy and prawn crops

Distribution of sample farmers according to the area under particular combination of paddy and prawn crops is presented in Table 5.8. In case of Class I and Class III, total number of respondents were 14, each occupying 23.25 and

Table 5.5. Classification of respondents according to occupation

Class of farmers	Agriculture as the only occupation	Agriculture as main occupation	Agriculture as sub occupation	Total
Class I	4 (28.57)	8 (57.14)	2 (14.29)	14 (100.00)
Class II	14 (43.75)	16 (50.00)	2 (6.25)	32 (100.00)
Class III	5 (35.72)	8 (57.14)	1 (7.14)	14 (100.00)
Class IV	10 (45.46)	8 (36.36)	4 (18.18)	22 (100.00)
Class V	14 (51.85)	11 (40.74)	2 (7.41)	27 (100.00)
Class VI	7 (41.18)	8 (47.06)	2 (11.76)	17 (100.00)
Total	54 (42.86)	59 (46.82)	13 (10.32)	126 (100.00)

(Figures in parantheses show percentage to total)

Table 5.6. Distribution of respondents according to ownership holding

Class of respondents	Area (hectares)					Total No. of respondents
	0-2	2-4	4-6	6-8	>8	
Class I	10 (71.42)	2 (14.29)	-	2 (14.29)	-	14 (100.00)
Class II	8 (25.00)	11 (34.37)	7 (21.87)	3 (9.38)	3 (9.38)	32 (100.00)
Class III	3 (21.43)	6 (42.86)	2 (14.29)	1 (7.13)	2 (14.29)	14 (100.00)
Class IV	9 (40.91)	9 (40.91)	2 (9.09)	-	2 (9.09)	22 (100.00)
Class V	10 (37.04)	14 (51.85)	2 (7.41)	-	1 (3.70)	27 (100.00)
Class VI	5 (29.41)	8 (47.06)	3 (17.65)	1 (5.88)	-	17 (100.00)
Total	45 (35.71)	50 (39.68)	16 (12.70)	7 (5.56)	8 (6.35)	126 (100.00)

(Figures in parantheses show percentage to total)

Table 5.7. Cropping pattern of respondent farmers

Name of crop	Area in hectares						Percentage to gross cropped area					
	Class I	Class II	Class III	Class IV	Class V	Class VI	Class I	Class II	Class III	Class IV	Class V	Class VI
Rice	23.25	121.54	45.84	53.10	59.78	41.97	56.32	26.38	33.03	32.09	25.05	34.10
Coconut	5.25	95.65	26.40	33.80	40.65	10.78	12.72	20.76	19.02	20.92	17.03	8.76
Banana	2.87	54.53	14.95	17.65	24.09	15.78	6.95	11.83	10.78	10.67	10.09	12.82
Vegetables	0.73	13.87	4.40	4.48	43.28	4.05	1.77	3.01	3.17	2.70	18.13	3.30
Other annual crops	3.20	60.80	17.28	19.68	24.64	17.60	7.75	13.20	12.45	11.89	10.32	14.30
Other perennial crops	5.98	114.33	29.90	36.77	46.24	32.89	14.49	24.82	21.55	22.22	19.37	26.72
Total	41.28	460.72	138.77	165.48	238.68	123.07	100.00	100.00	100.00	100.00	100.00	100.00

Table 5.8. Distribution of sample farmers according to area under particular combinations of paddy and prawn crops

Class of farmers	No. of farmers	Area (hectare)
Class I	14	23.25
Class II	32	121.54
Class III	14	45.84
Class IV	22	53.10
Class V	27	59.78
Class VI	17	41.97
Total	126	345.48

45.84 hectares respectively. Class II is having highest number of respondents and highest area (32 numbers and 121.54 hectares). Class IV, V and VI possess 22, 27 and 17 number of respondents and having area 53.1, 59.78 and 41.97 respectively.

5.2 Economics of production

5.2.1 Cultivation practices

5.2.1.1 Paddy

As far as paddy is concerned more than 95 per cent of the total area are single crop land. In about 5 per cent of the area, two crops are raised mainly by varietal mixture. More than 90 per cent of single crop pokkali lands are cultivated during first crop season (virippu) from May-June to September-October. Cultivation starts in the month of April with strengthening of outer bunds and setting up of sluices to control the level of water. The fields are drained during low tide and sluices are closed at high tide. Traditional paddy varieties like pokkali, cheruvirippu, chettivirippu, orkazhama and hybrids like Vyttila-1, Vyttila-2, Vyttila-3 and Vyttila-4 are tall, flood and salt resistant, suitable for pokkali cultivation. A high seed rate of 100 kg/hectare is adopted. A special method is adopted for sprouting of paddy seeds. The seeds are tightly packed in country baskets made of plaited coconut leaves the inside of which are lined by banana or teak leaves. Gunny bags are also used for this purpose. These baskets are then immersed in fresh water ponds for 12-15 hours, after which they are taken out and stored in shade. The radicle just sprouts out and remain quiescent under that condition for more than 30 days. Further growth of radicle occurs after resoaking of the seeds. When the soil and weather conditions become favourable for sowing, the baskets containing seeds are resoaked for 3-6 hours before sowing.

Plate 1. Paddy ready for harvest in pokkali lands

Plate 2. A typical prawn rearing pond

In March-April when the soil becomes dry it is heaped up to form mounds of one metre base and half a metre height and then allowed to dry and weather The mounds in the field are then raked and the top levelled. The sprouted seeds are sown on the top of the mounds which act as a nursery 'insitu'. The pokkali varieties, have early seedling vigour and they attain a height of 40-45 cms in 30-35 days. At about this stage, when field conditions become favourable, the mounds are cut into pieces in such a way as to have the seedlings uniformly spread in the field. The seedlings are tall enough to survive in the flooded field condition. The clods of earth attached to the clumps give anchorage to the seedlings.

Generally, manuring or plant protection operations are not done by the farmers, since it may be toxic to subsequent prawn crops. Management of water level in the field is the only operation attended to after spreading of seedlings. Water minimises lodging and helps to keep the tall plants erect and therefore water level is kept constant with the growth of plants. The crop matures in about 120 days. The earheads alone are harvested, leaving major portions of the vegetative matter in the field. Since the paddy fields are distant from farm house, the produce are transported in small country boats and the cost is paid at Rs.40 per country boat. Harvesting cost includes the cost for threshing and drying operations. After the harvest of rice, the fields are used for fish or prawn culture. Farmers bring their produce to nearby local markets or to rice mills for processing. The average price they get for paddy is Rs.4.50 per kg. Farmers take one or more than one crop of prawn depending on number of factors such as investment capacity, inherent productivity of land etc. Duration of one crop of prawn ranges from 2½ to 3 months.

5.2.1.2 Traditional prawn culture (prawn filtration)

After the harvest of paddy by the end of October, the fields are allowed to have free exchange of water. The fields are then cleaned by removing weeds and other undesirable species of organisms. The outer bunds are strengthened, the sluice gates are fixed in place where there is medium flow of water from canals or backwaters to the fields. After these preliminary operations water is let into the fields during high tides at night, through the sluice, where the lights are arranged for luring in prawns. During low tide water is let out through a bamboo screen which prevents escape of fingerings of prawn and fish already entered into the field and brings down the water level, so that water can again be taken in during high tide. The actual fishing operations starts by the middle of January coinciding with the lunar phase. When the water is let out of the fields, during low tide the prawns and fishes carried along with water and are collected in prawn filtration net fitted to the sluice gate. The harvesting of prawns starts in November but becomes intensive from January. The filtration is carried out for about a week around every full moon and new moon, the period being locally called as 'thakkam'. The process of filtration is continued for a period of 2 to 3 hours, depending on the force of out flow, the bulk of the prawns being caught during the initial hours. When the filtration is over sluice gates are closed. By the middle of April, when the season terminates, a complete harvesting of entire stock of prawns and fishes is made by cast nets and drag nets and even hand picking after draining out the water to the extent possible. The process is called 'Kettukalakkal'.

The catches mainly consists of *Metapenaeus dobsoni, Penaeus indicus, Metapenaeus monoceros, Peneaeus monodon*, crabs, fishes like Etroplus, Tilapia and Mugil. Advantage of traditional method of prawn culture is that it requires only

low investment and low input. Poor quality of yield is obtained in traditional method because the catches mainly constitute lower priced prawns, metapenaeids and majority of the prawns may belong to smaller size group. Many undesirable species of fishes of predatory behaviour enter the field along with incoming tidal water and is one of the reasons for low yield in such fields. Since the quantity and quality of prawn the farmers get from traditional fields is low, the average price they get per kg of prawn is low as Rs.43.38. Selective stocking of desirable species of commercially important prawns may enhance the yield from these farms.

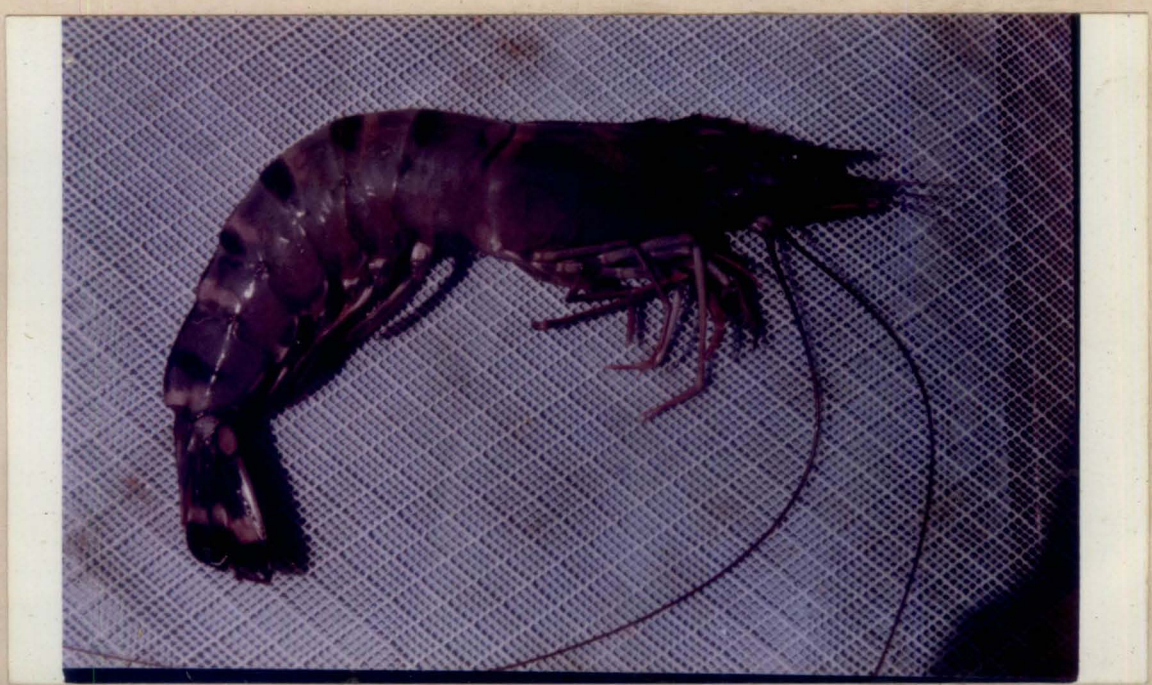
Production level of a prawns field depends upon factors such as its geographical position, nearness to open backwater system, inherent productivity, the nature of traversing canals, and possibility of adequate prawn fry recruitment. More often unified combination of these factors determines the quality and quantity of prawn production.

5.2.1.3 Improved method of prawn culture

The process of growing baby shrimps upto marketable size in an enclosed, created aquatic environment can be termed as shrimp farming. The traditional practice can be improved by incorporating culture techniques such as nursery pond, supplementary feed etc. Selective stocking of commercially important species of prawn will improve the quantity and quality of prawn yield. Although several species of both penaeid and non-penaeid shrimps are available in our waters, only a few species are suggested for culture. The criteria for selection of suitable species for culture is based on its ecological adaptability, ability to grow fast adjusting to certain fluctuations in the culture medium, accepting supplementary feed and market value. Shrimp varieties like white prawn (*Penaeus*

Plate 3. White shrimp (*Penaeus indicus*)

Plate 4. Tiger prawn (*Penaeus monodon*)



indicus) and tiger prawn (*P. monodon*) have proved to be most suitable species for culture. These grow fast in impoundments, fetch high price and are in great demand. Farmers obtain prawn seed from local as well as commercial hatcheries of other states.

Preliminary operations include strengthening the bunds and fixing sluicegates in position. After dewatering, the ponds are eradicated (eliminating unwanted fishes and plants) using Mahua cake, generaly at the rate of 600 kg per hectare or tea seed at the rate of 25-30 kg per hectare. In large farms, ammonia gas is used for this purpose usually at rate of 30 kg per hectare. Manuring in farms with calcium hydroxide is at the rate of 1000 kg per hectare is a general practice. Fertilizers like urea, diammonium phosphate, ammonium chloride, ammonium sulphate, superphosphate etc. are used in ponds to activate the growth of phyto plankton and zoo plankton which form the food for early stages of growth of prawn. Nursery is prepared and prawn juveniles are stocked and feeding is done for a short period of 1-2 weeks to adapt to the environment after which the juveniles are transferred to main field. The stocking rate of prawn juveniles ranges from 30,000 to 50,000 per hectare. Generally *Penaeus indicus* and *P. monodon* are the species of prawn used for cultivation. Prawn juveniles are fed with supplementary feed usually at the rate of 1000 kg of feed per hectare per 2½ to 3 months. The feed used for prawn generally used by the farmers are known under the trade names `Mahima' and `Higashimaru' produced by local factories and the price ranges from Rs.25 to 32 per kg. Some of the farmers use home made feed prepared by mixing wheat flour, tapioca flour, rice bran, soyabean powder and shell meat. Water conditions such as temperature, salinity, pH and growth and size of the prawn are monitored regularly. Prawn juveniles from sea are also collected according to the

tidal variation through the sluice gate. Harvesting is carried out every week around every full moon and new moon.

Farmers use small country boats in large farms so as to reach every part of the farm and harvesting is done using fishing net. Filtration through sluice gate is also resorted to for harvesting. A complete harvesting is done finally after draining out the water from the field. The catch will consist of prawn, fishes, crabs etc. The prawn species will be uniform size and growth and fetch high price. The fishes and other varieties of prawn will contribute only a small percentage of the yield. With regard to marketing of prawn, farmers sell the produce immediately after harvest as raw or in processed form after peeling. Agents of export or marketing will take the produce from their farms directly. The average price the farmers get for prawn from fields of improved farming is Rs.99.90 per kg.

5.2.2 Operation wise cost of cultivation

Costs and returns are two elements of any business enterprise. Costs represent the value of the inputs used in the production process, while returns represent the value of output achieved or gain to the operator. The relative magnitude of the costs and returns from the enterprise indicates the success of business.

Operationwise cost of cultivation of paddy cum prawn culture in aggregate, and costs of paddy crops and prawn culture separately were computed for traditional method and improved method of prawn culture and are presented in Tables. The costs are presented in two parts, viz., operational expenses including land preparation, intercultural operations, harvesting. The other expenses include

rental value of land, interest on working capital and miscellaneous expenses. Interest on working capital was estimated at the rate of 6 per cent (half of the lending rate of 12 per cent for short term agricultural loan) since the capital investment is spread throughout the season. The rental value of land was estimated based on the leasing rate which prevailed in the study area fixed as Rs.7500/hectare. It is estimated at half of the rate each in paddy and prawn crop for class I (1 crop of paddy + 1 crop of traditional prawn), One third of the leasing rate computed for paddy crop and 2/3 of the rate for prawn crop for class II (1 crop of paddy + 2 crops of traditional prawn) and for class III (1 crop of paddy + 3 crops of traditional prawn) 1/4 of the rate for paddy and 3/4 of the rate for prawn crop were computed. Similar procedure was adopted for computing rental value of land for class IV, V and VI respectively. Interest on fixed capital is estimated at 10 per cent of the value of materials. Fixed capital include gunny bags, filtration rate and fishing nets, feeding pots, bulbs and accessories. Farmers generally do not use their own agricultural implements for land preparation because labourers bring their own implements to the field and the wages they get include the rent for the implements also. The operations like dewatering, irrigation etc. were done for the `padasekharam' as a whole by the padasekharam committee. `Padasekharam' refers to the compact paddy area registered under one body known as `padasekharam committee'.

5.2.2.1 Paddy cum traditional prawn culture

The total cost of cultivation in class I (1 crop of paddy + 1 crop of traditional prawn culture) was Rs.24990.43. It was Rs.28921.30 for class II (1 crop of paddy + 2 crops of traditional prawn culture) and Rs.33442.78 for class III (1 crop of paddy + 3 crops of traditional prawn culture). The operational expenses

constututed 63.76 per cent in class I, 67.79 per cent in class II and 71.10 per cent in class III. Other expenses accounted for 36.24 per cent, 32.21 per cent and 28.90 per cent in class I, class II and class III respectively (see table 5.9).

Among different items of cost, land preparation accounted for highest share in all the three classes constituting 36.39 per cent, 33.42 per cent and 31.35 per cent respectively. Rental value of own land was the next important item of cost in class I and class II, which accounted for 30.01 per cent in class I and 25.93 per cent in class II, while for class III intercultural operations is the next important item of cost (28.65%). Expenses for intercultural operations constituted 18.50 in class I and 24.32 per cent in class II. Cost of harvesting accounted for 8.86 per cent, 10.05 per cent and 11.10 per cent respectively in class I, class II and class III.

5.2.2.2 Paddy cultivation

Operationwise cost of cultivation of paddy for class I, class II and class III were computed and are presented in Table 5.10. The total cost of cultivation in class I was Rs.12822.84, Rs.11744.80 in class II and Rs.11144.50 in class III. The operational expenses constituted 61.68 per cent in class I, 68.56 per cent in class II and 72.32 per cent in class III.

The results show that major share of total cost was accounted by land preparation for all the classes and constituted 34.28 per cent, 37.89 per cent and 39.62 per cent in class I, II and III respectively. Rental value of own land was the next important item of cost which accounted for 29.24 per cent, 21.29 per cent and 16.82 per cent respectively for class I, II and III. The next important item of expenditure was sowing constituted 13.98 per cent in class I, 15.9 per cent in class

Table 5.9. Operation wise cost of cultivation of paddy cum traditional prawn culture (Rs/ ha)

Particulars	Class I	Class II	Class III
I. Operational expenses			
1. Land preparation			
Paddy	4395.50	4450.72	4415.03
	(17.59)	(15.39)	(13.20)
Prawn	4698.02	5215.48	6068.06
	(18.80)	(18.03)	(18.15)
Sub total	9093.52	9666.20	10473.09
	(36.39)	(33.42)	(31.35)
2. Intercultural operations			
Paddy	2035.24	2123.09	2091.31
	(8.14)	(7.34)	(6.24)
Prawn	2588.40	4911.95	7491.27
	(10.36)	(16.98)	(22.41)
Sub total	4623.64	7035.04	9582.58
	(18.50)	(24.32)	(28.65)
3. Harvesting			
Paddy	1427.05	1478.19	1552.92
	(5.71)	(5.11)	(4.65)
Prawn	790.71	1426.76	2158.15
	(3.16)	(4.94)	(6.45)
Sub total	2217.76	2904.95	3711.07
	(8.86)	(10.05)	(11.10)
Total operational expenses	15934.92	19606.19	23776.74
	(63.76)	(67.79)	(71.10)
II. Other expenses			
1. Rental value of own land	7500.00	7500.00	7500.00
	(30.01)	(25.93)	(22.43)
2. Interest on working capital	254.52	290.79	357.82
	(1.02)	(1.00)	(1.07)
3. Cost of transportation (paddy)	252.99	231.06	248.62
	(1.01)	(0.81)	(0.74)
4. Miscellaneous	1048.00	1293.26	1559.60
	(4.20)	(4.47)	(4.66)

Total other expenses	9055.57	9315.11	9666.04
	(36.24)	(32.21)	(28.90)
Total	24990.43	28921.30	33442.78
	(100.00)	(100.00)	(100.00)

(Figures in parantheses show percentages to total)

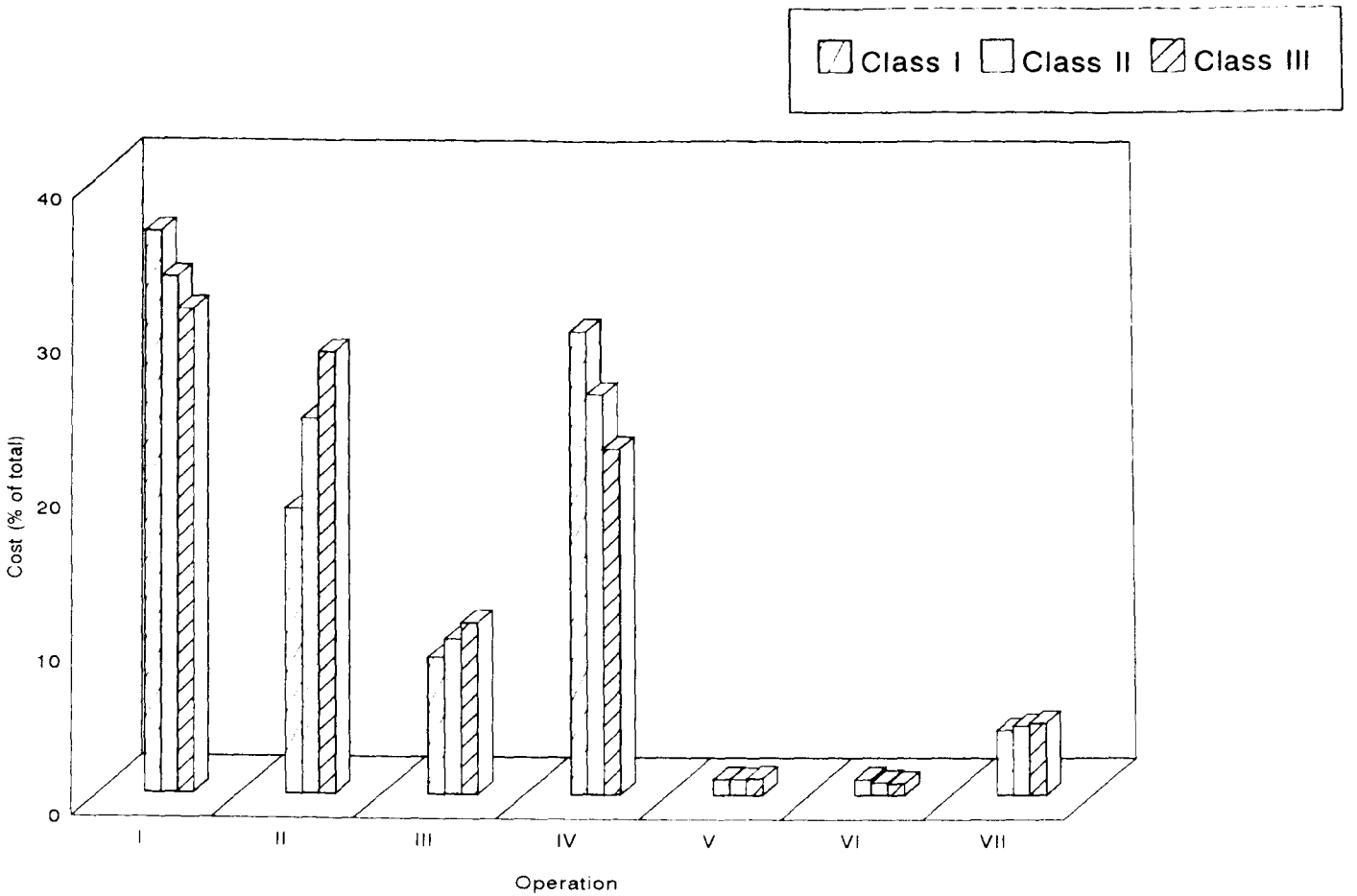


Fig.2. OPERATION WISE COST OF CULTIVATION OF PADDY CUM TRADITIONAL PRAWN CULTURE

I. Land preparation
II. Intercultural operations
III. Harvesting
IV. Rental value of own land
V. Interest on working capital
VI. Cost of transportation (paddy)
VII. Miscellaneous

II and 16.51 per cent in class III respectively. Cost of harvesting formed 11.13 per cent in class I, 12.59 per cent in class II and 13.94 per cent in class III. Miscellaneous item of expenditure accounted for 6.33 per cent, 6.99 per cent and 7.24 per cent in class I, class II and class III respectively. Cost of weeding shared only small percentage and it constituted 1.89 per cent, 2.18 per cent and 2.25 per cent in class I, II and III respectively.

Land preparation for paddy include preparation of bunds, ploughing, levelling, mound making and dismantling of mounds. Sowing of seedlings and weeding are the intercultural operations performed in paddy cultivation. Sowing operation also include soaking of seeds in water for sprouting. Manual weeding is usually carried out in paddy cultivation. The expenditure on harvesting operations include the expenses for threshing and drying also. Harvesting cost was paid in kind at the rate of 1/9 of the produce. Miscellaneous items of expenditure include the cost for dewatering and land revenue.

5.2.2.3 Traditional prawn culture

Operationwise cost of cultivation of traditional prawn culture were computed and has been presented in Table 5.11. Cost of cultivation of first crop and second crop of prawn and their aggregate in class II and 1st crop, 2nd crop and 3rd crop of prawn and their aggregate in class III are separately presented. The total cost of cultivation in class I was Rs.12167.59. Rs.10846.76 for first crop of prawn and Rs.6289.74 for 2nd crop of prawn were in class II. While it was Rs.10995.55 for first crop of prawn, Rs.5458.80 for second crop of prawn and Rs.5843.93 for third crop of prawn in class III.

Table 5.10. Operation wise cost of cultivation of paddy (Rs/ha)

Particulars	Class I	Class II	Class III
I. Operational expenses			
1. Land preparation			
Labour cost	4395.50	4450.72	4415.03
	(34.28)	(37.89)	(39.62)
2. Seed and sowing			
Cost of seed	722.24	727.98	731.61
	(5.63)	(6.20)	(6.56)
Cost of gunnybag	34.75	34.98	34.99
	(0.27)	(0.30)	(0.31)
Labour cost	1035.95	1103.95	1073.67
	(8.03)	(9.40)	(9.63)
Subtotal	1792.94	1866.91	1840.27
	(13.95)	(15.90)	(16.51)
3. Weeding			
Labour cost	242.30	256.18	257.04
	(1.89)	(2.18)	(2.25)
4. Harvesting			
Labour cost	1427.05	1478.19	1552.92
	(11.13)	(12.59)	(13.93)
Total operational expenses	7857.79	8052.00	8059.26
	(61.28)	(68.56)	(72.32)
II. Other expenses			
Rental value of own land	3750.00	2500.00	1875.00
	(29.24)	(21.29)	(16.82)
Interest on working capital	150.60	140.45	151.99
	(1.17)	(1.19)	(1.36)
Cost of transportation	252.99	231.06	248.63
	(1.97)	(1.97)	(2.23)
Miscellaneous	811.46	821.29	809.63
	(6.33)	(6.99)	(7.24)
Total other expenses	4965.05	3692.80	3085.24
	(38.72)	(31.44)	(27.68)
Total cost	12822.84	11744.80	11144.50
	(100.00)	(100.00)	(100.00)

(Figures in parantheses show percentages total)

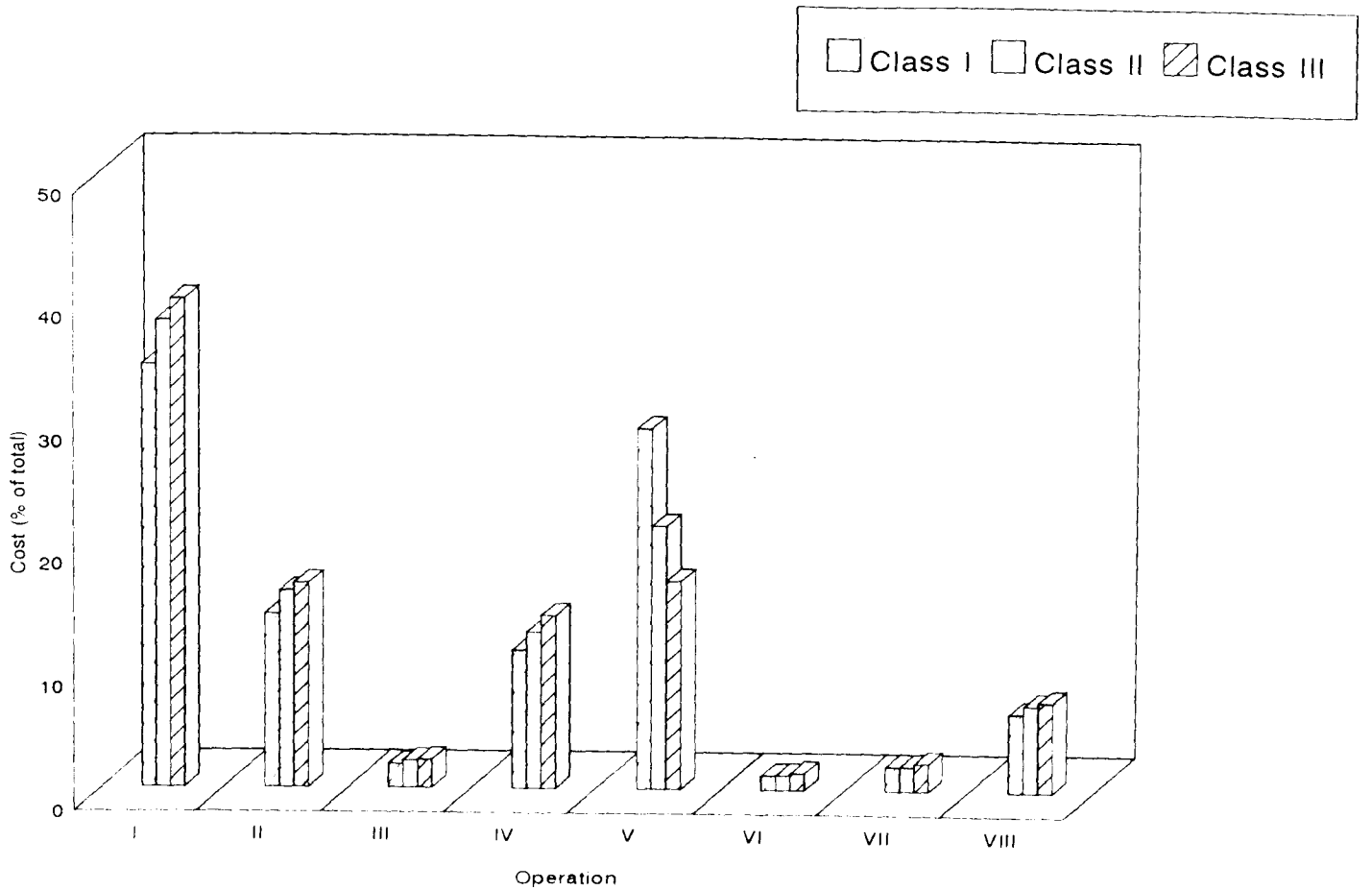


Fig.3. OPERATION WISE COST OF CULTIVATION OF PADDY

I. Land preparation
II. Seeds and sowing
III. Weeding
IV. Harvesting
V. Rental value of own land
VI. Interest on working capital
VII. Cost of transportation
VIII. Miscellaneous

Operational expenses accounted for 66.38 per cent in class I, 67.26 per cent in class II and 70.49 per cent in class III. Among different items of cost, land preparation accounted for the highest share in both class I and class II and constituted 38.61 per cent and 30.36 per cent respectively. For class III, shrimp care accounted for the highest share with 33.59 per cent and land preparation constituted for 27.22 per cent. Rental value of own land was found to be the next item of expenditure which constituted 30.83 per cent in class I, 29.11 per cent in class II and 25.23 per cent in class III. Expenditure on shrimp care accounted for 21.27 per cent, 28.59 per cent and 33.59 per cent in class I, class II and class III respectively. Cost of harvesting accounted for 6.50 per cent, 8.31 per cent and 9.68 per cent of the total cost in class I, class II and class III.

In case of traditional prawn culture land preparation includes strengthening or repair of bunds and fixing sluice gate. The value of sluice gate, filtration net, fishing net, lights and accessories and watchman's shed is included in first crop of prawn in classes II and III because they are invested during the first crop of prawn. Shrimp care is the only intercultural operation performed in traditional prawn culture.

5.2.2.4 Paddy cum improved prawn culture

Operationwise cost of cultivation of paddy cum improved prawn culture was computed and are presented in Table 5.12. The total cost of cultivation in class IV (1 crop of paddy + 1 crop of improved prawn culture) was Rs.46817.77, Rs.63282.10 in class V (1 crop of paddy + 2 crops of improved prawn culture) and Rs.86631.48 in class VI (1 crop of paddy + 3 crops of improved prawn culture). The operational expenses constituted 80.10 per cent in class IV, 84.53 per cent in

Table 5.11. Operationwise cost of cultivation of traditional prawn culture (Rs./ha)

	Class I	Class II			Class III			
		1st crop of prawn	2nd crop of prawn	Aggregate	1st crop of prawn	2nd crop of prawn	3rd crop of prawn	Aggregate
1	2	3	4	5	6	7	8	9
I. Operational cost								
1. Land preparation								
Value of sluice gate	1978.32	1960.26	-	1960.26	1975.45	-	-	1975.45
	(16.26)	(18.07)		(11.41)	(17.97)			(8.86)
Value of filtration net	151.96	329.93	-	329.93	500.65	-	-	500.65
	(1.25)	(3.04)		(1.92)	(4.55)			(2.25)
Value of lights	112.03	110.21	-	110.21	253.27	-	-	253.27
	(0.92)	(1.02)		(0.64)	(2.30)			(1.14)
Labour cost	2455.71	2236.92	578.16	2815.08	2355.75	568.82	414.12	3338.69
	(20.18)	(20.62)	(9.13)	(16.39)	(21.42)	(10.42)	(7.09)	(14.97)
Sub total	4698.02	4637.32	578.16	5215.48	5085.12	568.82	414.12	6068.06
	(38.61)	(42.75)	(9.13)	(30.36)	(46.24)	(10.42)	(7.09)	(27.22)
2. Shrimp care								
Value of watchman's	311.80	363.87	-	363.87	334.86	-	-	334.86
shed	(2.56)	(3.35)		(2.12)	(3.05)			(1.50)
Labour cost	2276.60	2175.28	2372.80	4548.08	2358.66	2109.11	2688.64	7156.41
	(18.71)	(20.05)	(37.49)	(26.49)	(21.45)	(38.64)	(46.00)	(32.09)
Sub total	2588.40	2539.15	2372.80	4911.95	2693.52	2109.11	2688.64	7491.27
	(21.27)	(23.40)	(37.49)	(28.59)	(24.50)	(38.64)	(46.00)	(33.59)

Contd.

Table 5.11. Continued

1	2	3	4	5	6	7	8	9
3. Harvesting								
Value of fishing net	131.89	267.67	-	267.67	386.12	-	-	386.12
	(1.08)	(2.46)		(1.56)	(3.51)			(1.73)
Labour cost	658.82	583.60	575.49	1159.09	606.88	590.77	574.38	1772.03
	(5.42)	(5.38)	(9.09)	(6.75)	(5.52)	(10.82)	(9.83)	(7.95)
Sub total	790.71	851.27	575.49	1426.76	993.00	590.77	574.38	2158.15
	(6.50)	(7.84)	(9.09)	(8.31)	(9.03)	(10.82)	(9.38)	(9.68)
Total operational expenses	8077.13	8027.74	3526.45	11554.19	8771.64	3268.70	3677.14	15717.48
	(66.38)	(74.00)	(55.71)	(67.26)	(79.77)	(59.88)	(62.92)	(70.49)
II. Other expenses								
Rental value of	3750.00	2500.00	2500.00	5000.00	1875.00	1875.00	1875.00	5625.00
own land	(30.83)	(23.04)	(39.49)	(29.11)	(17.05)	(34.35)	(32.09)	(25.23)
Interest on working	103.92	103.05	47.29	150.34	112.59	44.24	49.00	205.83
capital	(0.85)	(0.95)	(0.74)	(0.88)	(1.03)	(0.81)	(0.84)	(0.92)
Miscellaneous	236.54	215.97	256.00	471.97	236.32	270.86	242.79	749.97
	(1.94)	(1.99)	(4.04)	(2.75)	(2.15)	(4.96)	(4.15)	(3.36)
Sub total	4090.46	2819.02	2803.29	5622.31	2223.91	2190.10	2166.79	6580.80
	(33.62)	(26.00)	(43.93)	(32.74)	(20.23)	(40.12)	(37.08)	(29.51)
Total cost	12167.59	10846.76	6289.74	17176.50	10995.55	5458.80	5843.93	22298.28
	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

(Figures in parantheses show percentage total)

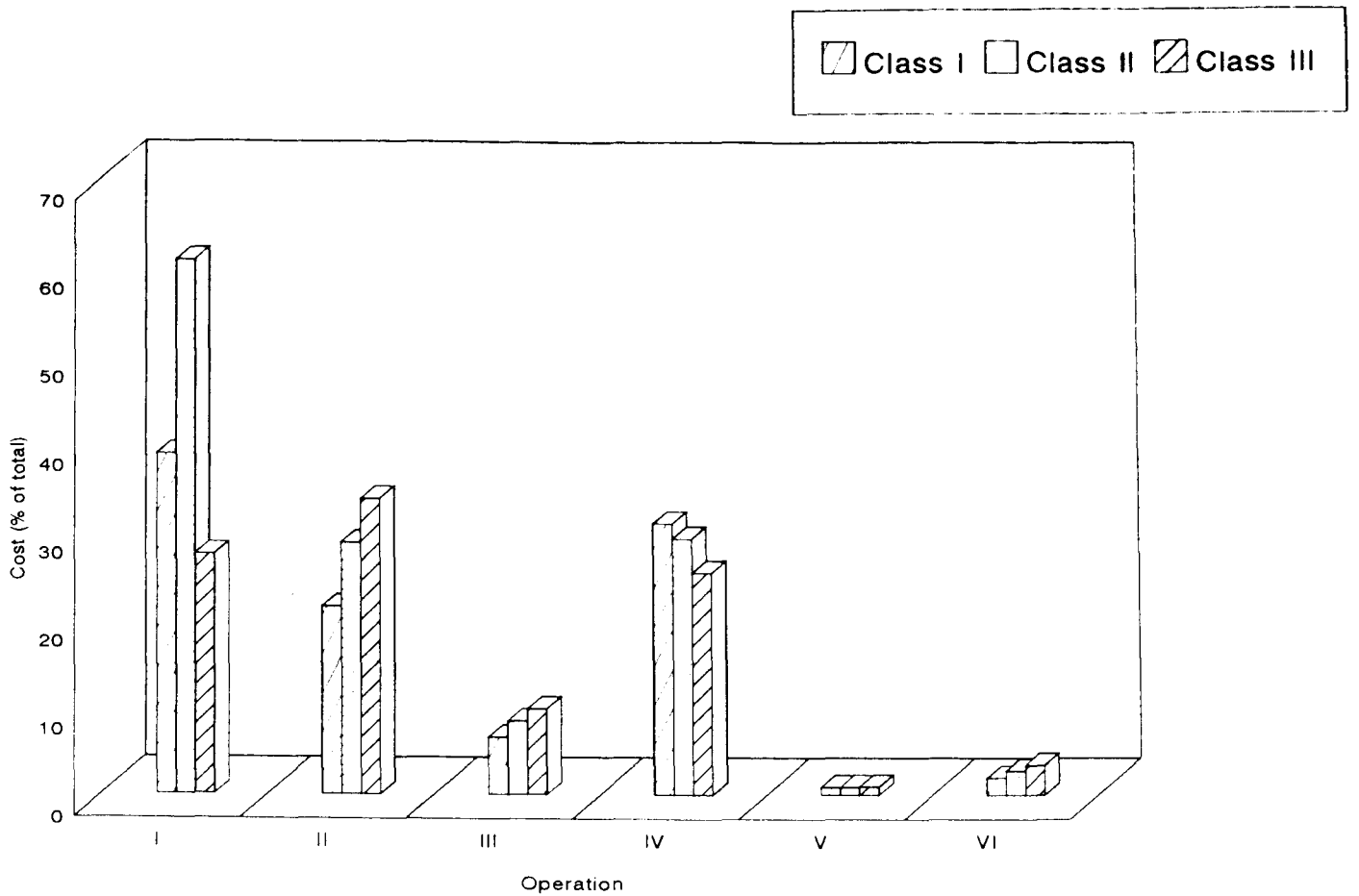


Fig.4. OPERATION WISE COST OF CULTIVATION OF TRADITIONAL PRAWN CULTURE

I. Land preparation
II. Shrimp care
III. Harvesting
IV. Rental value of own land
V. Interest on working capital
VI. Miscellaneous

Table 5.12. Operation wise cost of cultivation of paddy cum improved prawn culture (Rs/ha)

Particulars	Class IV	Class V	Class VI
I. Operational expenses			
1. Land preparation			
Paddy	4420.64	4172.92	4234.69
	(9.44)	(6.59)	(4.89)
Prawn	5448.51	6367.23	7473.29
	(11.64)	(10.06)	(8.62)
Sub total	9869.15	10540.15	11707.98
	(21.08)	(16.65)	(13.51)
Intercultural Operations			
Paddy	1902.51	2030.53	2018.21
	(4.06)	(3.21)	(2.33)
Prawn	22795.50	36892.00	57038.89
	(48.69)	(58.30)	(65.84)
Sub total	24698.01	38922.53	59057.10
	(52.75)	(61.51)	(68.17)
3. Harvesting			
Paddy	1386.12	1573.84	1580.19
	(2.96)	(2.49)	(1.83)
Prawn	1547.30	2453.84	3843.22
	(3.30)	(3.88)	(4.44)
Sub total	2933.42	4027.68	5423.41
	(6.27)	(6.37)	(6.27)
Total operational expenses	37500.58	53490.36	76188.48
	(80.10)	(84.53)	(87.95)
II. Other expenses			
Rental value of own land	7500.00	7500.00	7500.00
	(16.02)	(11.85)	(8.66)
Interest on working capital	523.53	723.64	1012.49
	(1.12)	(1.14)	(1.17)
Cost of transportation (paddy)	240.32	226.99	261.22
	(0.51)	(0.36)	(0.30)
Miscellaneous	1053.34	1341.11	1669.28
	(2.25)	(2.12)	(1.93)

Sub total	9317.19 (19.90)	9791.4 (15.47)	10442.99 (12.05)
Total cost	46817.77 (100.00)	63282.1 (100.00)	86631.48 (100.00)

(Figures in parantheses show percentage to total)

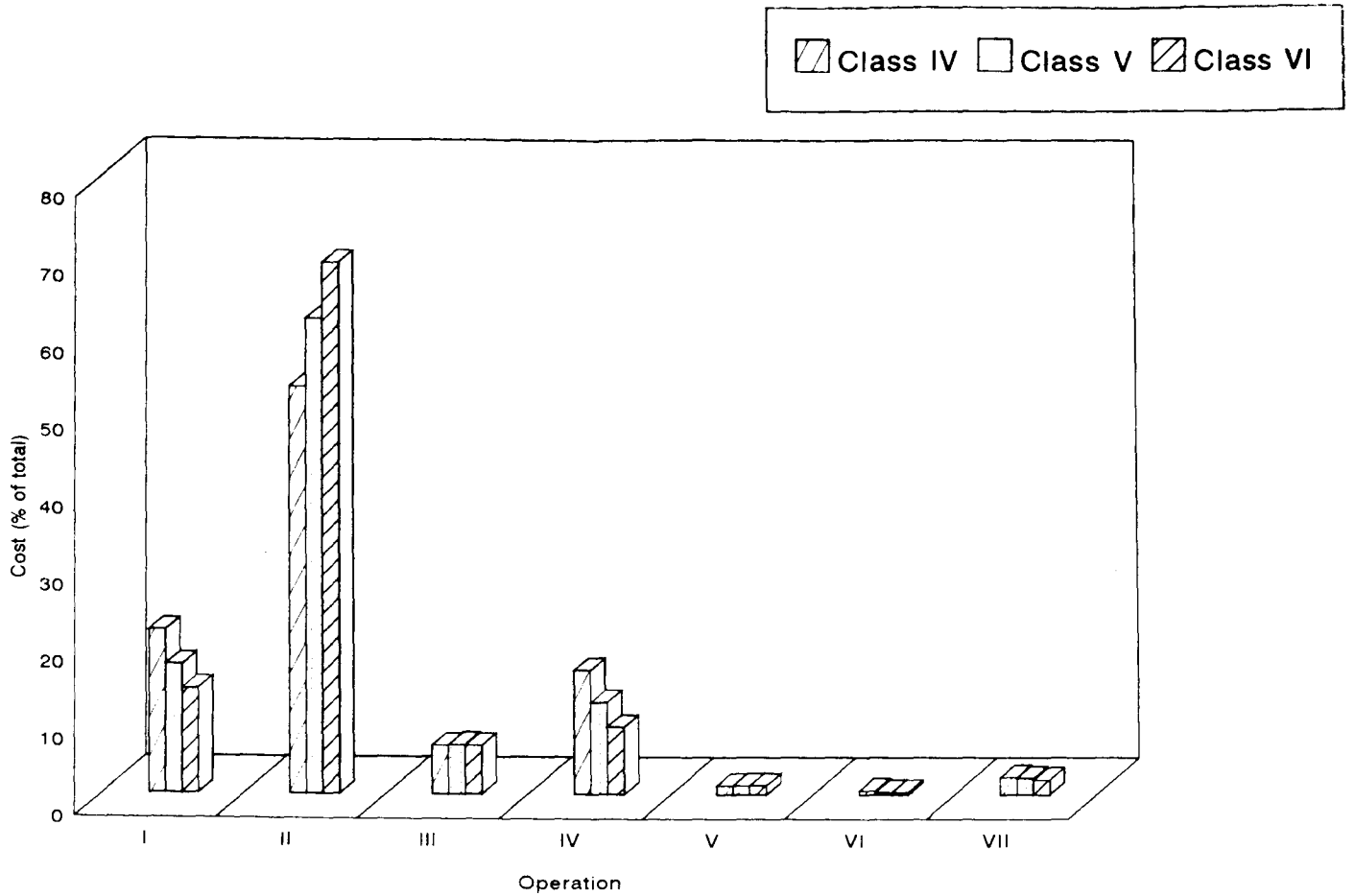


Fig.5. OPERATION WISE COST OF CULTIVATION OF PADDY CUM IMPROVED PRAWN CULTURE

I. Land preparation
II. Intercultural operations
III. Harvesting
IV. Rental value of own land
V. Interest on working capital
VI. Cost of transportation
VII. Miscellaneous

class V and 87.95 per cent in class VI. Other expenses accounted for 19.90 per cent, 15.47 per cent and 12.05 per cent of the total cost in class IV, class V and class VI respectively.

Among different items of costs, intercultural operations accounted for the highest share in classes IV, V and VI constituting 52.75 per cent, 61.51 per cent and 68.17 per cent of the total cost respectively. Land preparation is the important items of expenditure which accounted for 21.08 per cent in class IV, 16.65 per cent in class V and 13.51 per cent in class VI. The percentage share constituted by the cost of harvesting of the total cost came to be 6.27 per cent, 6.37 per cent and 6.27 per cent in class IV, V and VI respectively.

Rental value of our land is the major item of expenditure among other expenses which constituted 16.02 per cent in class IV, 11.85 per cent in class V and 8.66 per cent in class V, of the total cost.

5.2.2.5 Paddy cultivation

Operationwise cost of cultivation of paddy for classes IV, V and VI was computed and are presented in Table 5.13. The total cost of cultivation in class IV was Rs.12644.48, and it was Rs.11460.02 and Rs.10993.30 in class V and class VI respectively. The operational expenses constituted 60.97 per cent in class IV, 67.86 per cent in class V and 68.35 per cent in class VI. the other expenses accounted for 39.03 per cent, 32.14 per cent and 28.75 per cent of the total cost in class IV, class V and class VI, respectively.

The results show that major share of total cost was covered by land preparation which constituted 34.96 per cent in class IV, 36.41 per cent in class V and 38.52 per cent in class VI. Rental value of own land was the next important item of expenditure which accounted for 29.66 per cent, 21.82 per cent and 17.06 per cent respectively in class IV, class V and class VI. The cost of sowing operation constituted 13.36 per cent in class IV, 15.87 per cent in class V and 15.76 per cent in class VI. The cost of harvesting accounted for 10.96 per cent of the total cost in class IV, 13.73 per cent in class V and 13.79 per cent in class VI. Weeding cost constituted only small percentage of the total cost constituting 1.68 per cent, 1.85 per cent and 1.86 per cent in classes IV, V and VI respectively. Miscellaneous item of cost shared 6.30 per cent, 7.07 per cent and 7.96 per cent of the total cost in class IV, class V and class VI respectively.

5.2.2.6 Improved prawn culture

Total cost of cultivation of improved prawn culture for the three classes were computed and are presented in Table 5.14. Cost of cultivation of first crop and second crop of prawn in class V, and of first crop, second crop and third crop of prawn in class VI are separately computed and presented. The total cost was estimated to be Rs.34173.29 in class IV, Rs.51822.08 in class V and Rs.75639.18 in class VI. Operational expenses constituted 87.18 per cent, 88.21 per cent and 90.37 per cent in classes IV, V and VI. Other expenses accounted for 12.82 per cent in class IV, 11.79 per cent in class V and 9.63 per cent in class VI. Among operational expenses feeding cost accounted for the highest share with 26.77 per cent, 30.28 per cent and 33.10 per cent in class IV, class V and in class VI respectively. The next major item of expenditure was fingerlings stocking which constituted 20.00 per cent in class IV, 20.71 per cent in class V and 22.64 per cent

Table 5.13. Operationwise cost of cultivation of paddy (Rs/ha)

Particulars	Class IV	Class V	Class VI
I. Operational expenses			
1. Land preperation			
Labour cost	4420.64	4172.92	4234.69
	(34.96)	(36.41)	(38.52)
2. Seeds and sowing			
Cost of seed	728.64	736.19	732.89
	(5.76)	(6.42)	(6.40)
Cost of gunnybag	34.03	38.69	38.70
	(0.27)	(0.34)	(0.34)
Labour cost	927.12	1043.27	1033.97
	(7.33)	(9.11)	(9.02)
Sub total	1689.79	1818.15	1805.56
	(13.36)	(15.87)	(15.76)
3. Weeding			
Labour cost	212.72	212.38	212.65
	(1.68)	(1.85)	(1.86)
4. Harvesting			
Labour cost	1386.12	1573.84	1580.19
	(10.96)	(13.73)	(13.79)
Total operational expenses	7709.27	7777.29	7833.09
	(60.97)	(67.86)	(68.35)
II. Other expenses			
1. Rental value of own land	3750.00	2500.00	1875.00
	(29.66)	(21.82)	(17.06)
2. Interest on working capital	147.88	145.59	148.56
	(1.17)	(1.27)	(1.35)
3. Cost of transportation	240.32	226.99	261.22
	(1.90)	(1.98)	(2.38)
4. Miscellaneous	797.01	810.15	875.43
	(6.30)	(7.07)	(7.96)
Total other expenses	4935.21	3682.73	3160.21
	(39.03)	(32.14)	(28.75)
Total cost	12644.48	11460.02	10993.30
	(100.00)	(100.00)	(100.00)

(Figures in parantheses show percentages total)

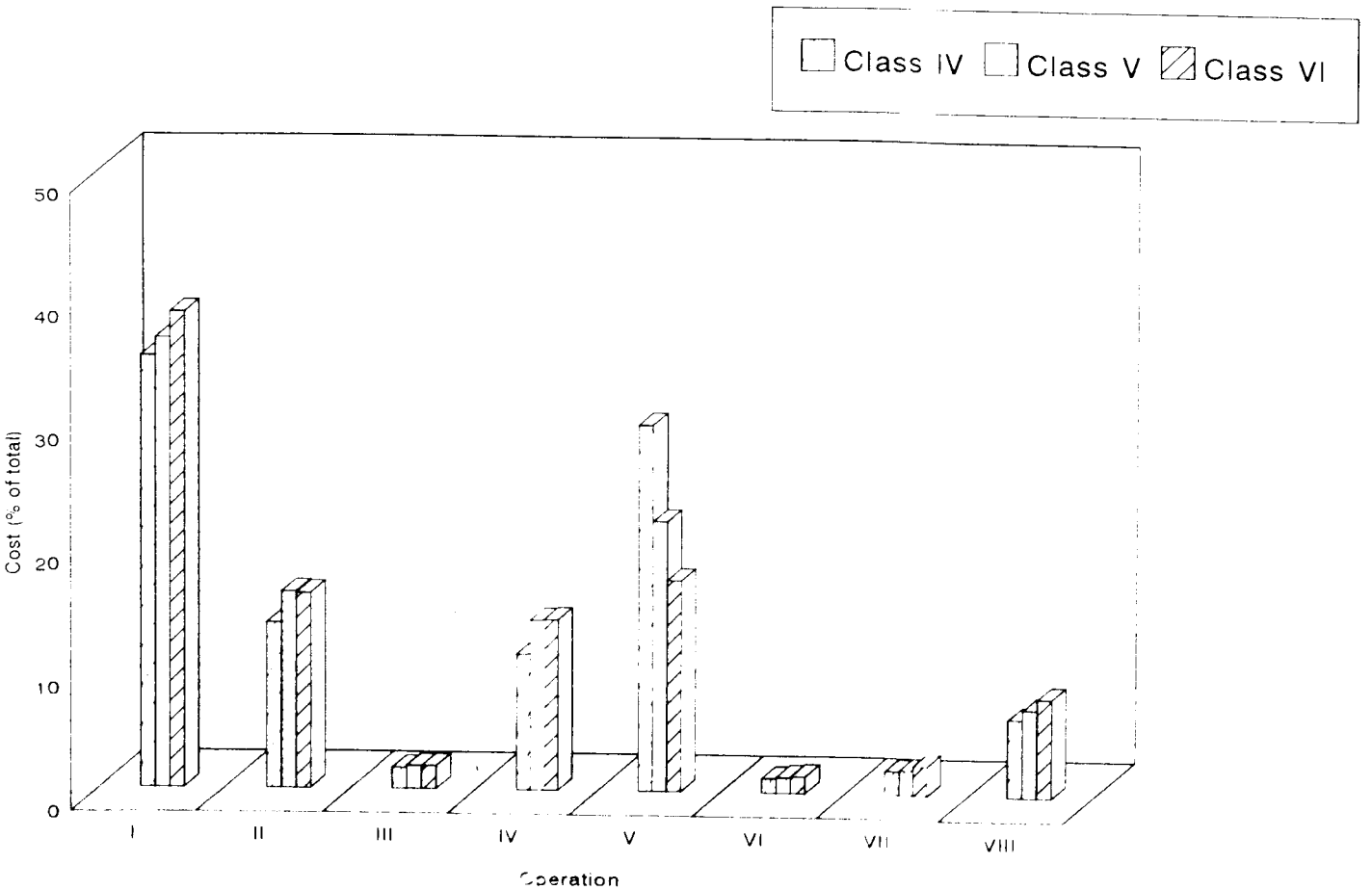


Fig.6. OPERATION WISE COST OF CULTIVATION OF PADDY

I. Land preparation
II. Seeds and sowing
III. Weeding
IV. Harvesting
IV. Rental value of own land
V. Interest on working capital
VI. Cost of transportation
VII. Miscellaneous

Table 5.14. Operationwise cost of cultivation of improved prawn culture (Rs/ha)

	Class IV	Class IV			Class VI			
		1st crop of prawn	2nd crop of prawn	Aggregate	1st crop of prawn	2nd crop of prawn	3rd crop of prawn	Aggregate
1	2	3	4	5	6	7	8	9
I. Operational expenses								
1. Land preparation								
Value of sluice gate	2250.47	2233.19	-	2233.19	2418.39	-	-	2418.39
	(6.59)	(7.18)		(4.31)	(7.44)			(3.20)
Value of filtration	158.82	328.43	-	328.43	543.25	-	-	543.25
net	(0.46)	(1.06)		(0.63)	(1.67)			(0.72)
Value of lights	126.74	140.82		140.82	1140.25	-	-	140.25
	(0.37)	(0.45)		(0.27)	(0.43)			(0.19)
Labour cost (hired)	2912.48	3041.98	622.81	3664.79	2943.36	672.77	755.27	4371.40
	(8.52)	(9.79)	(3.00)	(7.07)	(9.05)	(2.97)	(3.69)	(5.78)
Subtotal	5448.51	5744.42	622.81	6367.23	6045.25	672.77	755.27	7473.29
	(15.94)	(18.48)	(3.00)	(12.28)	(18.59)	(2.97)	(3.69)	(9.89)
2. Eradication								
Value of eradicants	1334.76	1343.48	-	1343.48	349.65	-	-	1349.65
	(39.91)	(4.32)		(2.59)	(4.15)			(1.62)
Application cost	77.82	83.25	-	83.25	86.44	-	-	86.44
(hired)	(0.23)	(0.27)		(0.16)	(0.27)			(0.11)
Subtotal	1412.58	1426.73		1426.73	1436.09			1436.09
	(4.14)	(4.59)		(2.75)	(2.75)			(1.89)

Contd.

Table 5.14. Continuing

1	2	3	4	5	6	7	8	9
3. Manuring								
Value of manures	1234.60	1212.05	-	1212.05	1223.04	-	-	1223.04
	(3.61)	(3.90)		(2.34)	(3.76)			(1.62)
Application cost	80.26	88.65		88.65	83.07	-	-	83.07
(hired)	(0.23)	(0.28)		(0.17)	(0.26)			(0.11)
Subtotal	1314.86	1300.70		1300.70	1306.11			1306.11
	(3.84)	(4.18)		(2.51)	(4.02)			(1.73)
4. Fingerlings stocking								
Value of fingerlings	6645.95	5220.24	5139.41	10359.65	6271.53	5998.04	4292.13	16561.70
	(19.45)	(16.79)	(24.78)	(19.99)	(19.28)	(26.50)	(20.95)	(21.90)
Labour cost (hired)	188.32	179.98	192.02	372.00	197.70	183.67	178.85	560.22
	(0.55)	(0.59)	(0.93)	(0.72)	(0.61)	(0.81)	(0.87)	(0.74)
Subtotal	6834.27	5400.22	5331.43	10731.65	6469.23	6181.71	4470.98	17121.92
	(20.00)	(17.38)	(25.71)	(20.71)	(19.89)	(27.31)	(21.82)	(22.64)
5. Feeding								
Value of feed	8512.42	8157.43	6532.57	14690.00	8296.44	7936.01	7473.87	23706.32
	(24.91)	(26.24)	(31.50)	(28.34)	(25.51)	(35.07)	(36.48)	(31.34)
Value of feeding pots	258.79	259.45	-	259.45	277.70	-	-	277.70
	(0.76)	(0.83)		(0.50)	(0.85)			(0.37)
Labour cost (hired)	376.64	367.50	376.27	743.72	362.29	356.68	328.90	1047.87
	(1.10)	(1.18)	(1.81)	(1.44)	(1.11)	(1.58)	(1.61)	(1.39)
Sub total	9147.85	8784.38	6908.79	15693.17	8936.43	8292.69	7802.77	23031.89
	(26.77)	(28.26)	(33.31)	(30.28)	(27.47)	(36.65)	(38.09)	(33.10)

Contd.

Table 5.14. Continued

1	2	3	4	5	6	7	8	9
6. Shrimp care								
Cost of watchmen's shed	359.70 (1.05)	367.60 (1.18)	-	367.60 (0.71)	389.56 (1.20)	-	-	389.56 (0.52)
Labour cost								
Hired	2643.31 (7.74)	2426.08 (7.81)	2298.70 (11.90)	4724.78 (9.12)	2428.67 (7.47)	2682.91 (11.86)	2536.18 (12.38)	7647.76 (10.11)
Family	1083.43 (3.17)	1120.66 (3.60)	1526.71 (7.36)	2647.37 (5.11)	1344.57 (4.13)	1298.06 (5.74)	1462.93 (7.14)	4105.56 (5.42)
Subtotal	4086.44 (11.96)	3914.34 (12.59)	3825.41 (18.45)	7739.75 (14.93)	4162.80 (12.80)	3980.97 (17.59)	3999.11 (19.52)	12142.88 (16.05)
7. Harvesting								
Value of fishing net	129.94 (0.38)	275.45 (0.89)	-	275.45 (0.53)	455.09 (1.40)	-	-	455.09 (0.60)
Labour cost								
Hired	778.73 (2.28)	810.48 (2.60)	625.69 (3.02)	1436.17 (2.77)	737.84 (2.27)	728.66 (3.22)	698.05 (3.41)	2164.55 (2.86)
Family	638.63 (1.87)	314.22 (1.01)	428.00 (7.36)	742.22 (1.43)	448.69 (1.38)	386.07 (1.71)	388.82 (1.90)	223.58 (1.62)
Subtotal	1547.30 (4.53)	1400.15 (4.50)	1053.69 (5.08)	2453.84 (4.73)	1641.62 (5.05)	1114.73 (4.93)	1086.87 (5.31)	3843.22 (5.08)
Total operational cost	29791.31 (87.18)	27970.94 (89.98)	17742.13 (85.56)	45713.07 (88.21)	29997.53 (92.24)	20242.87 (89.45)	18115.00 (88.43)	68355.40 (90.37)

Contd

Table 5.14. Continued

1	2	3	4	5	6	7	8	9
II. Other expenses								
Rental value of own land	3750.00 (10.97)	2500.00 (8.04)	2500.00 (12.05)	5000.00 (9.65)	1875.00 (5.77)	1875.00 (8.29)	1875.00 (9.15)	5625.00 (7.44)
Interest on working capital	375.65 (1.20)	352.91 (1.14)	225.14 (1.09)	578.05 (1.12)	378.36 (1.16)	256.24 (1.13)	229.33 (1.12)	863.93 (1.14)
Miscellaneous	256.33 (0.75)	262.08 (0.84)	268.88 (1.30)	530.96 (1.02)	271.22 (0.83)	256.57 (1.13)	266.06 (1.30)	793.85 (1.06)
Subtotal	4381.98 (12.82)	3114.49 (10.02)	2994.02 (14.44)	6109.01 (11.79)	2524.58 (7.76)	2387.81 (10.58)	2370.39 (11.57)	7282.78 (9.63)
Total cost	34173.29 (100.00)	31085.93 (100.00)	20736.15 (100.00)	51882.08 (100.00)	32522.11 (100.00)	22630.68 (100.00)	20485.39 (100.00)	75638.18 (100.00)

(Figures in parantheses show percentages to total)

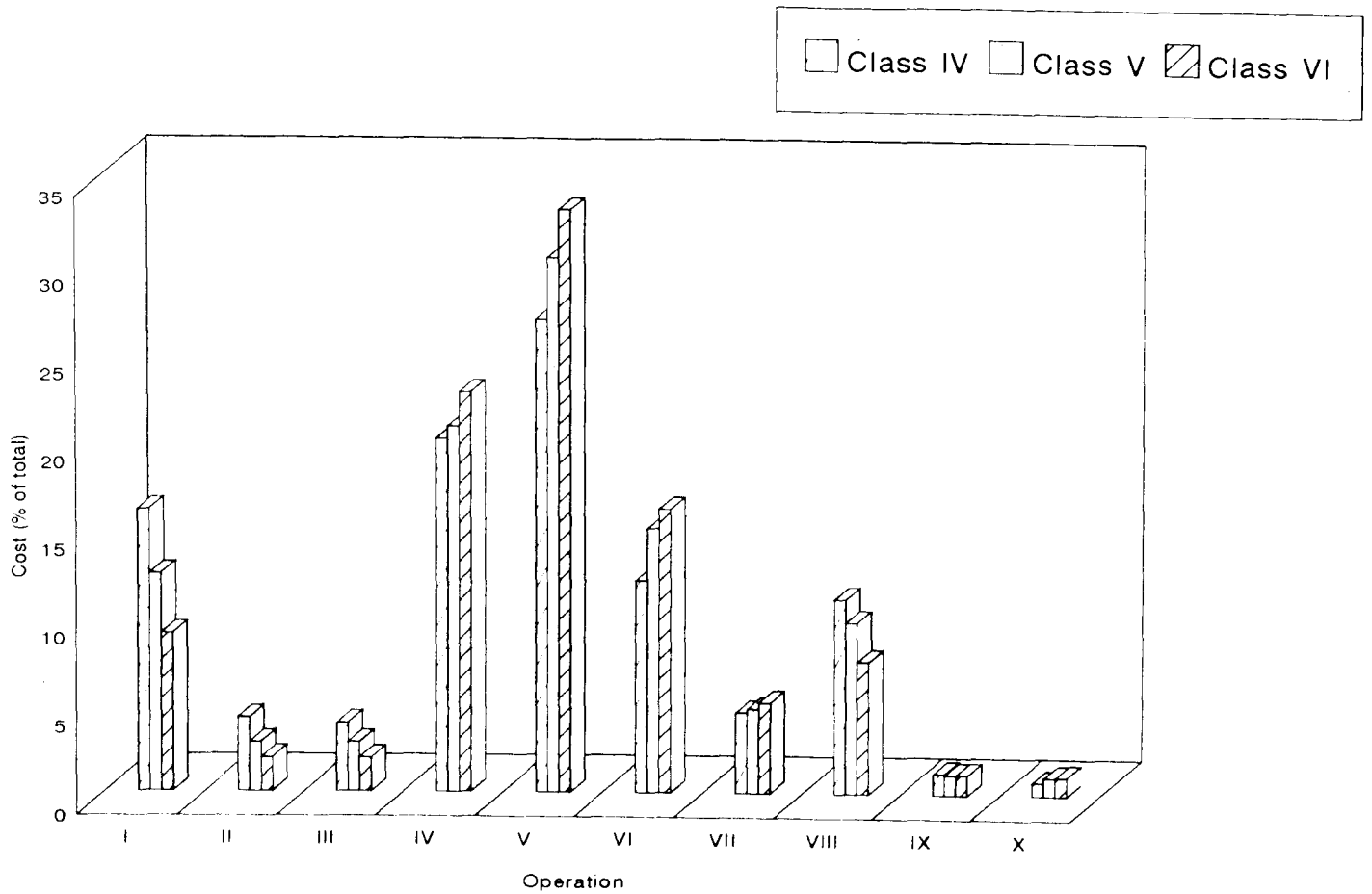


Fig.7. OPERATION WISE COST OF CULTIVATION OF IMPROVED PRAWN CULTURE

I. Land preparation
II. Eradication
III. Manuring
IV. Fingerlings stocking
V. Feeding
VI. Shrimp care
VII. Harvesting
VIII. Rental value of own land
IX. Interest on working capital
X. Miscellaneous

in class VI. Expenditure on land preparation constituted 15.94 per cent, 12.28 per cent and 9.89 per cent in class IV, class V and class VI respectively. The expenditure on shrimp care accounted for 11.96 per cent in class IV, 14.93 per cent in class V and 16.05 per cent in class VI. Harvesting cost shared only small percentage of the total cost. It constituted 4.53 per cent, 4.73 per cent and 5.08 per cent of the total cost respectively in classes IV, V and VI.

Among other expenses, rental value of own land accounted for highest share with 10.97 per cent, 9.65 per cent and 7.44 per cent of the total cost. In case of improved prawn culture land preparation includes strengthening and repair of bunds and fixing sluice gate. Intercultural operations include eradication, manuring, stocking of fingerlings, feeding and shrimp care. Operations like eradication and manuring are performed only during the first crop of prawn and they are not repeated in subsequent crops of prawn.

5.2.3 Inputwise cost of cultivation

The inputs included in the cultivation of paddy and prawn were grouped into three viz material inputs, labour and other items. Material cost of paddy included cost of seed and gunny bags and in case of prawn culture, it consisted of expenses for sluice gate, filtration net, fishing net, light and accessories and watchman's shed. The cost of fingerlings, eradicants, manures and fertilizers, feed and feeding pots are also included in the material cost of improved prawn culture. Labour consisted of male and female labour (both family and hired). Allocation of labour to different operations of paddy cum traditional prawn culture and paddy cum improved prawn culture were worked out in mandays. The actual wage rate prevailed in the area are used for computing labour cost in mandays involved in

different operations of paddy and prawn cultivation. Wage rate for men was Rs 75 day and Rs.30 day for women. Manday refers to 8 hours of man's work. Thus one manday is equvalent to 2.5 women day in case of paddy and prawn cultivation. The other items include interest on working capital, rental value of own land and miscellaneous expenses in case of both paddy and prawn cultivation. Cost of transportation is also included in other expenses in case of paddy cultivation.

Inputwise cost of cultivation of paddy cum prawn culture in aggragate and paddy and prawn crops separately were computed and are presented.

5.2.3.1 Paddy cum traditional prawn culture

Inputwise cost of cultivation of paddy cum prawn culture was worked out for different classes and the results are presented in Table 5.15. This will help to have an idea about the relative importance of various inputs among the different classes

The total cost was estimated to be Rs.24990.43 in class I, Rs.28921.30 in class II and Rs.33442.78 in class III. The results show that the major share of the total cost was accounted for by labour followed by other items and material cost for all the classes. Labour cost accounted 49.99 per cent, 54.67 per cent and 58.99 per cent in classes I, II and III respectively. This was followed by other items constituting 36.23 per cent, 32.21 per cent and 28.90 per cent in classes I, II and III respectively. Material cost constituted only small percentage of total cost and it was 13.78 in class I, 13.12 per cent in class II and 12.61 per cent in class III.

Allocation of labour cost to different operations are presented in Table 5.16. It shows that mandays involved in land preparation is the highest among all items followed by intercultural operations and harvesting. The mandays involved in land preparation was estimated at 88, 91 and 99 in class I, class II and class III respectively. Mandays involved in intercultural operations was 50 in class I, 82 in class II and 115 in class III, while mandays involved in harvesting was 28, 37 and 45 in classes I, II and III respectively. Mandays involved in operations like drying of paddy are also included in harvesting.

Among other items, rental value of own land accounted for the highest share of cost in all classes with 30.01 per cent, 25.93 per cent and 22.43 per cent in classes I, II and III respectively. This was followed by cost on miscellaneous items constituting 4.19 per cent in class I, 4.47 per cent in class II and 4.66 per cent in class III. Interest on working capital and cost of transportation of paddy shared only small percentage of total cost in all three classes.

Percentage share of material cost of paddy to the total material cost was estimated to be 21.99 per cent, 20.10 per cent and 18.18 per cent in classes I, II and III respectively. Material cost of prawn shared 78.01 per cent in class I, 79.90 per cent in class II and 81.82 per cent in class III.

5.2.3.2 Paddy cultivation

Inputwise cost of cultivation of paddy for classes I, II and III was worked out separately and are presented in Table 5.17. The labour cost accounted for major share in total cost of cultivation followed by cost on other items and material cost. Labour cost consituted 55.38 per cent in class I, 62.06 per cent in class II and 65.44

Table 5.15 Inputwise cost of cultivation of paddy cum traditional prawn culture (Rs/ha)

Particulars	Class I	Class II	Class III
Material cost			
Paddy	756.99	762.96	766.60
	(3.03)	(2.64)	(2.29)
Prawn	2686.00	3031.94	3450.35
	(10.75)	(10.48)	(10.32)
Sub total	3442.99	3794.90	4216.95
	(13.78)	(13.12)	(12.61)
Labour cost			
Paddy	7100.80	7289.04	7292.66
	(28.42)	(25.20)	(21.81)
Prawn	5391.13	8522.25	12267.13
	(21.57)	(29.47)	(36.68)
Sub total	12491.93	15811.29	19559.79
	(49.99)	(54.67)	(58.99)
Others			
Rental value of own land	7500.00	7500.00	7500.00
	(30.01)	(25.93)	(22.43)
Interest on working capital	254.52	290.79	357.82
	(1.02)	(1.01)	(1.07)
Cost of transportation (paddy)	252.99	231.06	248.62
	(1.01)	(0.80)	(0.74)
Miscellaneous	1048.00	1293.26	1559.60
	(4.19)	(4.47)	(4.66)
Sub total	9055.51	9315.11	9666.04
	(36.23)	(33.21)	(28.90)
Total	24990.43	28921.30	33442.78
	(100.00)	(100.00)	(100.00)

(Figures in parantheses show percentages to total)

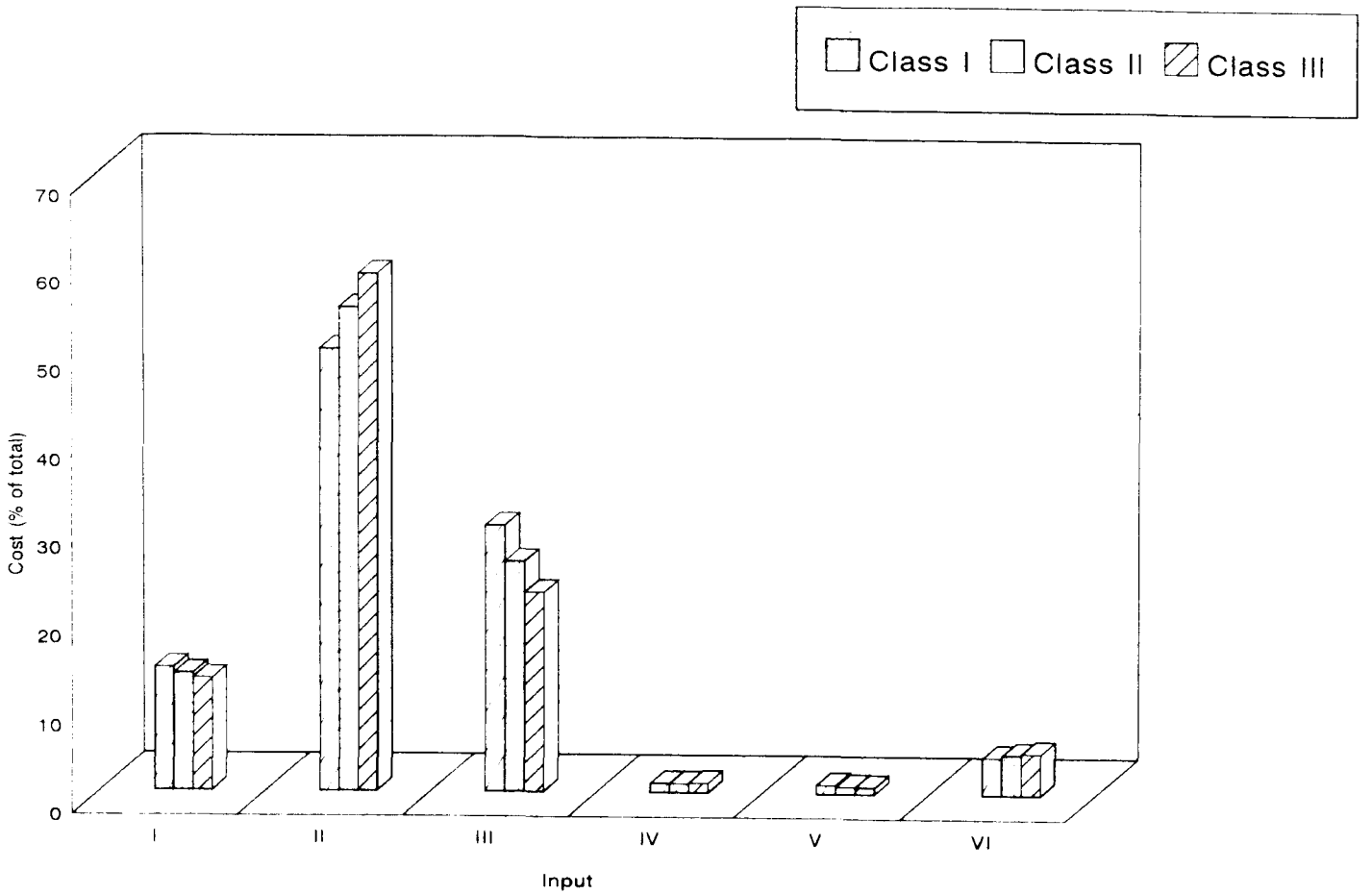


Fig.8. INPUT WISE COST OF CULTIVATION OF PADDY CUM TRADITIONAL PRAWN CULTURE

I. Material cost
II. Labour cost
III. Rental value of own land
IV. Interest on working capital
V. Cost of transportation
VI. Miscellaneous

Table 5.16. Allocation of labour to different operations of paddy cum traditional prawn culture (Mandays)

Operation	Class I			Class II			Class III		
	Family	Hired	Total	Family	Hired	Total	Family	Hired	Total
Land preparation	8.85	79.23	88.08	9.89	80.87	90.76	8.58	90.41	98.99
Intercultural operations	8.51	42.29	50.80	14.66	67.73	82.39	21.80	93.29	115.09
Harvesting	3.08	24.89	27.97	4.62	32.48	37.10	4.57	40.78	45.35
Total	20.44	146.86	166.85	29.17	181.08	210.25	34.95	224.48	259.43

Table 5.17. Inputwise cost of cultivation of paddy (Rs/ha)

Particulars	Class I	Class II	Class III
Material cost			
Seed	722.24	727.98	731.61
	(5.63)	(6.20)	(6.57)
Gunny bag	34.75	34.98	34.99
	(0.27)	(0.30)	(0.31)
Sub total	756.99	762.96	766.60
	(5.90)	(6.50)	(6.88)
Labour cost			
Family - Male	32.48	31.46	24.63
	(0.25)	(0.27)	(0.22)
Female	75.04	63.45	62.40
	(0.59)	(0.54)	(0.56)
Hired - Male	3729.35	3776.09	3720.52
	(29.09)	(32.15)	(33.39)
Female	3263.93	3418.04	3485.11
	(25.45)	(29.10)	(31.27)
Sub total	7100.80	7289.04	7292.66
	(55.38)	(62.06)	(65.44)
Others			
Rental value of own land	3750.00	2500.00	1875.00
	(29.24)	(21.29)	(16.82)
Interest on working capital	150.60	140.45	151.99
	(1.17)	(1.19)	(1.36)
Cost of transportation	252.99	231.06	248.62
	(1.97)	(1.97)	(2.23)
Miscellaneous	811.46	821.29	809.63
	(6.33)	(6.99)	(7.27)
Sub total	4965.05	3692.80	3085.24
	(38.72)	(31.44)	(27.68)
Total	12822.84	11744.80	11144.50
	(100.00)	(100.00)	(100.00)

(Figures in parantheses show percentages to total)

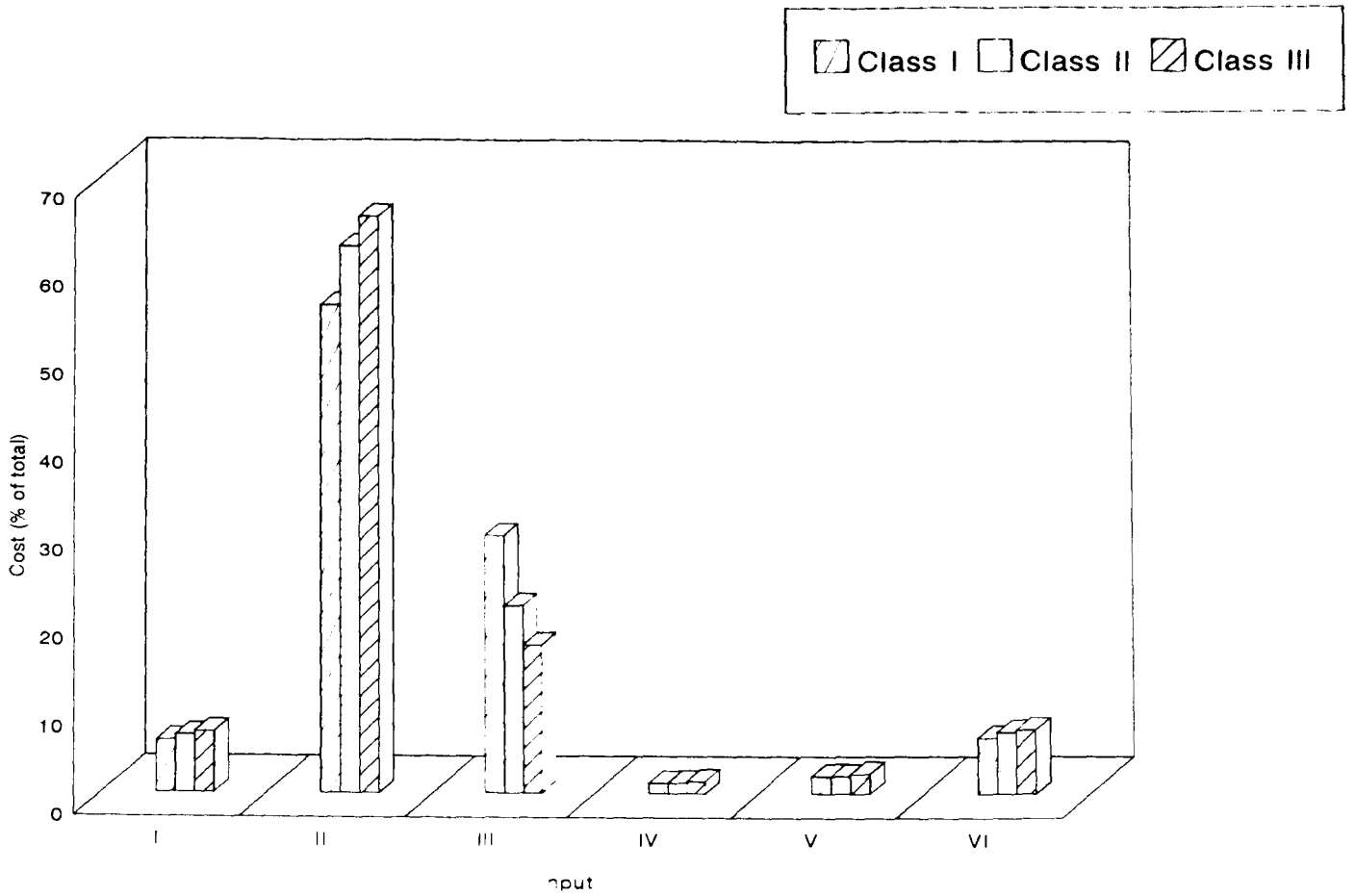


Fig.9. INPUT WISE COST OF CULTIVATION OF PADDY

I. Material cost
II. Labour cost
III. Rental value of own land
IV. Interest on working capital
V. Cost of transportation
VI. Miscellaneous

Table 5.18. Allocation of labour to different operations of paddy cultivation (Mandays)

Operation	Class I			Class II			Class III		
	Family	Hired	Total	Family	Hired	Total	Family	Hired	Total
Land preparation	-	55.05	55.05	-	54.50	54.50	-	56.86	56.86
Sowing	0.51	15.85	16.36	0.66	16.04	16.70	1.01	15.55	16.56
Weeding	0.45	4.00	4.45	0.98	4.67	5.65	-	3.95	3.95
Harvesting	1.12	12.96	14.08	0.48	13.85	14.33	-	15.18	15.18
Threshing and drying	-	4.95	4.95	0.5	5.40	5.90	0.48	4.06	4.54
Total	2.08	92.81	94.89	2.62	94.46	97.08	1.49	95.60	97.09

class I, 49.62 per cent in class II and 55.02 per cent in class III respectively. Allocation of labour to different operations of traditional prawn culture are presented in Table 5.20. The results show that mandays involved in land preparation is more as compared to other operations and estimated to be 33, 37 and 44 in classes I, II and III respectively. This was followed by shrimp care (supervision) and harvesting. Mandays involved shrimp care was estimated to be 30, 60 and 94.5 respectively in classes I, II and III. The next important operation is harvesting, in which mandays involved was estimated to be 9 in class I, 16.5 in class II and 25.5 mandays in class III.

Other items constituted 33.62 per cent in class I, 32.73 per cent in class II and 29.51 per cent in class III. Among other items, rental value of own land has the highest share with 30.83 per cent, 29.11 per cent, 25.23 per cent in class I, class II and class III respectively.

Material cost accounted for 22.08 per cent, 17.65 per cent and 15.47 per cent of total cost in class I, II and III respectively. Among the materials used in traditional prawn culture, expenditure on sluice gate constituted major share with 16.26 per cent in class I, 11.41 per cent in class II and 8.86 per cent in class III. Expenditure on materials like sluice gate, filtration and fishing nets, lights and watchman's shed is invested during first crop of prawn, hence their costs are not computed in 2nd and 3rd crop of prawn in both class II and III.

5.2.3.4 Paddy cum improved prawn culture

Inputwise cost of cultivation of paddy and improved prawn culture in aggregate for different classes was computed and are presented in Table 5.21. The

Table 5.19. Inputwise cost of cultivation of traditional prawn culture (Rs./ha)

	Class I	Class II			Class III			
		1st crop of prawn	2nd crop of prawn	Aggregate	1st crop of prawn	2nd crop of prawn	3rd crop of prawn	Aggregate
1	2	3	4	5	6	7	8	9
I. Material cost								
Sluice gate	1978.32	1960.26	-	1960.26	1975.45	-	-	1975.45
	(16.26)	(18.07)		(11.41)	(17.97)			(8.86)
Filteration net	151.96	329.93		329.93	500.65	-	-	500.65
	(1.25)	(3.04)		(1.92)	(4.55)			(2.25)
Fishing net	131.89	267.67	-	267.67	386.12	-	-	386.12
	(1.08)	(2.47)		(1.56)	(3.51)			(1.73)
Lights	112.03	110.21	-	110.21	253.27	-	-	253.27
	(0.92)	(1.02)		(0.64)	(2.30)			(1.36)
Watchmen's shed	311.80	363.87	-	363.87	334.86	-	-	334.86
	(2.56)	(3.35)		(2.12)	(3.05)			(1.51)
Sub total	2686.00	3031.94		3031.94	3450.35			3450.35
	(22.08)	(27.95)		(17.65)	(31.38)			(15.47)
II. Labour cost								
Family - Male	879.06	776.42	711.19	1809.26	808.64	826.58	860.50	2495.72
	(7.22)	(7.16)	(11.24)	(10.53)	(7.35)	(15.14)	(14.72)	(11.20)
Hired - Male	4512.07	4219.38	2815.26	6712.99	4512.65	2442.12	2816.64	9771.41
	(37.08)	(38.90)	(44.47)	(39.08)	(41.04)	(44.74)	(48.20)	(43.82)
Subtotal	5391.13	4995.80	3526.45	8522.25	5321.29	3268.70	3677.14	12267.13
	(44.30)	(46.06)	(55.71)	(49.62)	(48.39)	(59.88)	(62.92)	(55.02)

Contd.

Table 5.19. Continued

1	2	3	4	5	6	7	8	9
III. Others								
Rental value of own land	3750.00 (30.83)	2500.00 (23.05)	2500.00 (39.50)	5000.00 (29.11)	1875.00 (17.05)	1875.00 (34.35)	1875.00 (32.08)	5625.00 (25.23)
Interest on working capital	103.92 (0.85)	103.05 (0.95)	47.29 (0.75)	150.34 (0.88)	112.59 (1.03)	44.24 (0.81)	49.00 (0.84)	205.83 (0.92)
Miscellaneous	236.54 (1.94)	215.97 (1.99)	256.00 (4.04)	471.97 (2.74)	236.32 (2.15)	270.86 (4.96)	242.79 (4.16)	749.97 (3.36)
Subtotal	4090.46 (33.62)	2819.02 (25.99)	2803.29 (44.29)	5622.31 (32.73)	2223.91 (20.23)	2190.10 (40.12)	2166.79 (37.08)	6580.80 (29.51)
Total	12167.59 (100.00)	10846.76 (100.00)	6329.74 (100.00)	17176.50 (100.00)	10995.55 (100.00)	5458.80 (100.00)	5843.93 (100.00)	22298.28 (100.00)

(Figures in paranthesis show percentages to total)

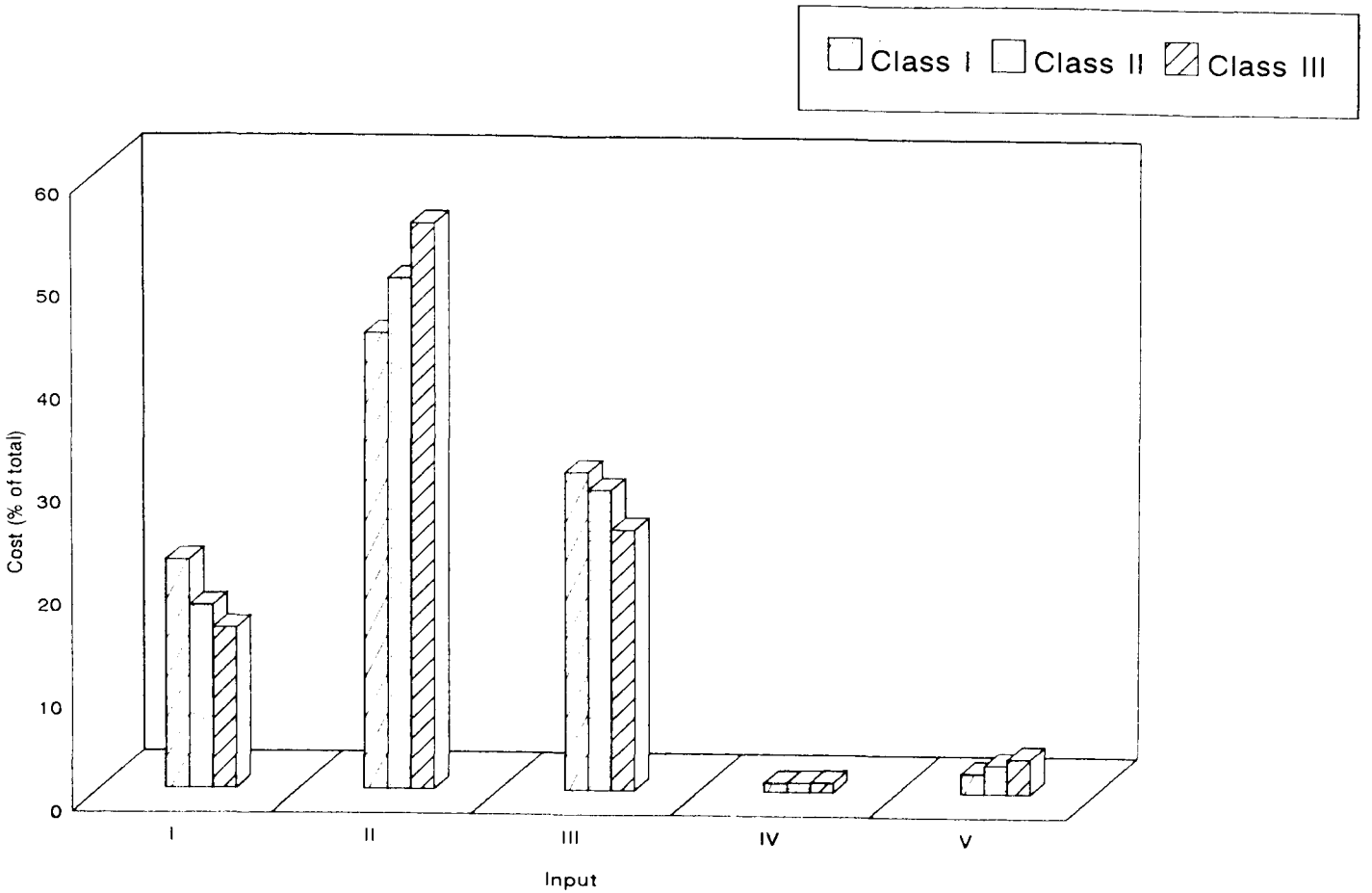


Fig.10. INPUT WISE COST OF CULTIVATION OF TRADITIONAL PRAWN CULTURE

I. Material cost
II. Labour cost
III. Rental value of own land
IV. Interest on working capital
V. Miscellaneous

Table 5.20. Allocation of labour to different operations of traditional prawn culture (mandays)

	Class I			Class II									Class III											
				1st crop of prawn			2nd crop of prawn			Aggregate			1st crop of prawn			2nd crop of prawn			3rd crop of prawn			Aggregate		
	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T
Land preparation	8.85	24.18	33.03	7.88	21.21	29.09	2.01	5.16	7.17	9.89	26.37	36.26	7.02	24.10	31.12	2.00	5.45	7.45	1.56	4.00	5.56	8.58	33.55	42.13
Shrimp care	7.55	22.44	29.99	6.06	23.16	29.22	6.96	23.86	30.82	13.02	47.02	60.04	6.48	25.00	31.48	4.13	23.95	28.08	10.18	24.84	35.02	20.79	73.79	94.58
Harvest	1.96	6.98	8.94	1.58	7.05	8.63	2.06	6.18	8.24	3.64	13.23	16.87	2.11	7.93	10.04	1.98	6.05	8.03	-	7.56	7.56	4.09	21.54	25.63
Total	18.96	53.60	71.96	15.52	51.42	66.94	11.03	35.20	46.23	26.55	86.62	113.17	15.61	57.03	72.64	8.11	35.45	43.56	11.74	36.40	48.14	33.46	128.88	162.34

F - Family, H - Hired; T - Total

result reveals that the material cost accounted for major share of total cost in all classes constituting 46.51 per cent, 50.54 per cent and 55.22 per cent in classes IV, V and VI respectively. The next important input is labour cost which constituted 33.59 per cent in class IV, 33.99 per cent in class V and 32.73 per cent in class VI. Other inputs accounted for 19.90 per cent, 15.47 per cent and 12.05 per cent in classes IV, V and VI respectively.

Allocation of labour to different operations of paddy cum improved prawn culture is given in Table 5.22. It reveals that the most labour-intensive operation is land preparation which involved 94 mandays, 103 mandays and 112.75 mandays in classes IV, V and VI respectively. Mandays involved in intercultural operations were 77 in class IV, 136 in class V and 201 in class VI followed by harvesting in which 39, 47.5 and 65.25 mandays were involved respectively in these three classes.

Among other inputs, rental value of own land constituted 16.02 per cent, 11.85 per cent and 8.66 per cent in classes IV, V and VI respectively, followed by miscellaneous items, interest on working capital and cost of transportation of paddy.

5.2.3.5 Paddy cultivation

Cost of cultivation of paddy was computed separately and are presented in Table 5.23. The results show that labour cost has accounted for major share of the total cost and constituted 54.94 per cent, 61.10 per cent and 64.23 per cent in classes IV, V and VI respectively. Other items accounted for 39.03 per cent in class IV, 32.14 per cent in class V and 28.75 per cent in class VI. Material cost accounted

Table 5.21 Inputwise cost of cultivation of paddy cum improved prawn culture (Rs/ha)

Particulars	Class IV	Class V	Class VI
Material cost			
Paddy	762.74	774.88	771.59
	(1.63)	(1.22)	(0.89)
Prawn	21011.69	31210.12	47063.95
	(44.88)	(49.32)	(54.33)
Sub total	21774.36	31985.00	47835.54
	(46.51)	(50.54)	(55.22)
Labour cost			
Paddy	6946.60	7002.41	7061.50
	(14.84)	(11.07)	(8.15)
Prawn	8779.62	14502.95	21290.45
	(18.75)	(22.92)	(24.58)
Sub total	15726.22	21505.36	28351.95
	(33.59)	(33.99)	(32.73)
Others			
Rental value of own land	7500.00	7500.00	7500.00
	(16.02)	(11.85)	(8.66)
Interest on working capital	523.52	723.64	1012.49
	(1.12)	(1.14)	(1.17)
Cost of transportation (paddy)	240.32	226.99	261.22
	(0.50)	(0.36)	(0.30)
Miscellaneous	1053.34	1341.11	1669.28
	(2.25)	(2.12)	(1.92)
Sub total	9317.19	9791.74	10442.99
	(19.90)	(15.47)	(12.05)
Total	46817.77	63282.10	86630.48
	(100.00)	(100.00)	(100.00)

(Figures in parantheses show percentage to total)

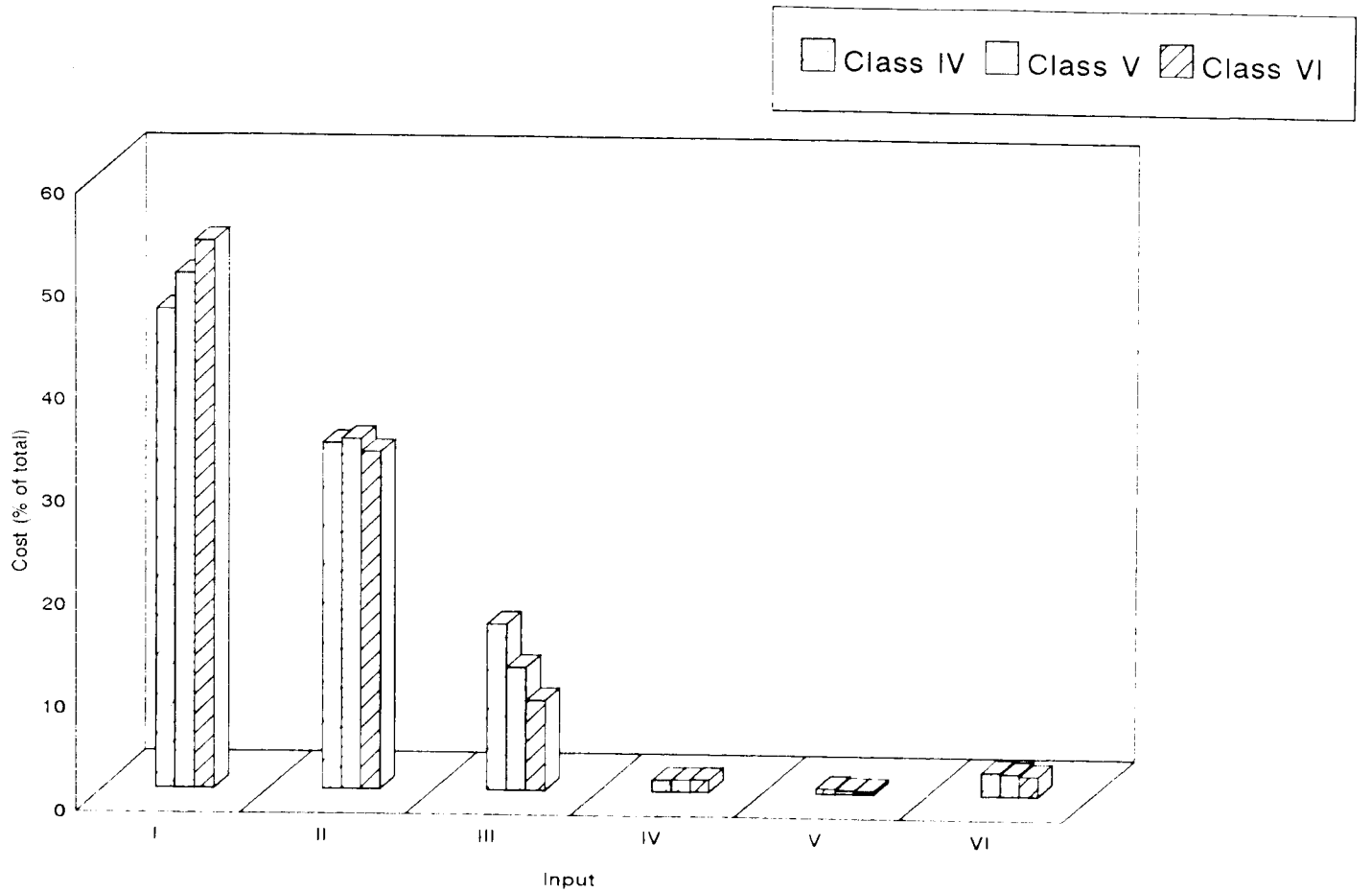


Fig.11. INPUT WISE COST OF CULTIVATION OF PADDY CUM IMPROVED PRAWN CULTURE

I. Material cost
II. Labour cost
III. Rental value of own land
IV. Interest on working capital
V. Cost of transportation
VI. Miscellaneous

Table 5.22 Allocation of labour to different operations of paddy cum improved prawn culture (Mandays)

Operation	Class IV			Class V			Class VI		
	Family	Hired	Total	Family	Hired	Total	Family	Hired	Total
Land preparation	-	94.00	94.00	-	103.11	103.11	-	112.89	112.89
Intercultural operations	15.30	62.14	77.44	36.25	99.66	135.91	55.26	145.62	200.88
Harvesting	9.66	29.36	39.02	10.98	36.47	47.45	17.25	48.06	65.31
Total	24.96	185.50	210.46	47.23	239.24	286.47	72.51	306.57	379.08

for only a small percentage of the total cost which constituted 6.03 per cent in class IV, 6.76 per cent in class V and 7.02 per cent in class VI.

Allocation of labour to different operations (Table 5.24) show that land preparation involves more mandays followed by sowing and harvesting. Mandays involved in land preparations were 55, 54.5 and 54.5 in classes IV, V and VI respectively. Sowing involved 15 mandays in class IV, 16.00 mandays in class V and 15.50 mandyas in class VI. Mandays involved in harvesting were 15, 14 and 15 in classes IV, V and VI respectively. Weeding, threshing and drying required only few mandays.

Among other items, rental value of own land has shared highest percentage with 29.66 per cent, 21.82 per cent and 17.06 per cent in classes IV, V and VI respectively followed by miscellaneous expenditure which constituted 6.30 per cent in class IV, 7.07 per cent in class V and 7.96 per cent in class VI respectively.

Among material cost, seed cost constituted 5.76 per cent, 6.42 per cent and 6.67 per cent in classes IV, V and VI respectively. Gunny bags accounted for 0.27 per cent, 0.34 per cent and 0.35 per cent of the total cost in classes IV, V and VI respectively.

5.2.3.6 Improved prawn culture

Inputwise cost of cultivation of improved prawn culture was worked out and are presented in Table 5.25. Cost of cultivation of first crop and second crop of prawn in class V and first, second and third crop of prawn in class VI respectively

Table 5.23 Inputwise cost of cultivation of paddy (Rs/ha)

Particulars	Class I	Class II	Class III
Material cost			
Seed	728.64	736.19	732.89
	(5.76)	(6.42)	(6.67)
Gunny bag	34.03	38.69	38.70
	(0.27)	(0.34)	(0.35)
Sub total	762.67	774.88	771.59
	(6.03)	(6.76)	(7.02)
Labour cost			
Family - Male	34.82	31.46	24.63
	(0.28)	(0.27)	(0.22)
Female	65.55	62.46	62.40
	(0.52)	(0.55)	(0.57)
Hired - Male	3542.61	3633.27	3600.48
	(28.01)	(31.70)	(32.75)
Female	3303.62	3275.22	3373.99
	(26.13)	(28.58)	(30.69)
Sub total	6946.60	7002.41	7061.50
	(54.94)	(61.10)	(64.23)
Others			
Rental value of own land	3750.00	2500.00	1875.00
	(29.66)	(21.82)	(17.06)
Interest on working capital	147.88	145.59	148.56
	(1.17)	(1.27)	(1.35)
Cost of transportation	240.32	226.99	261.22
	(1.90)	(1.98)	(2.38)
Miscellaneous	797.01	810.15	875.43
	(6.30)	(7.07)	(7.96)
Sub total	4935.21	3682.73	3160.21
	(39.03)	(32.14)	(28.75)
Total	12644.48	11460.02	10993.29
	(100.00)	(100.00)	(100.00)

(Figures in parantheses show percentages to total)

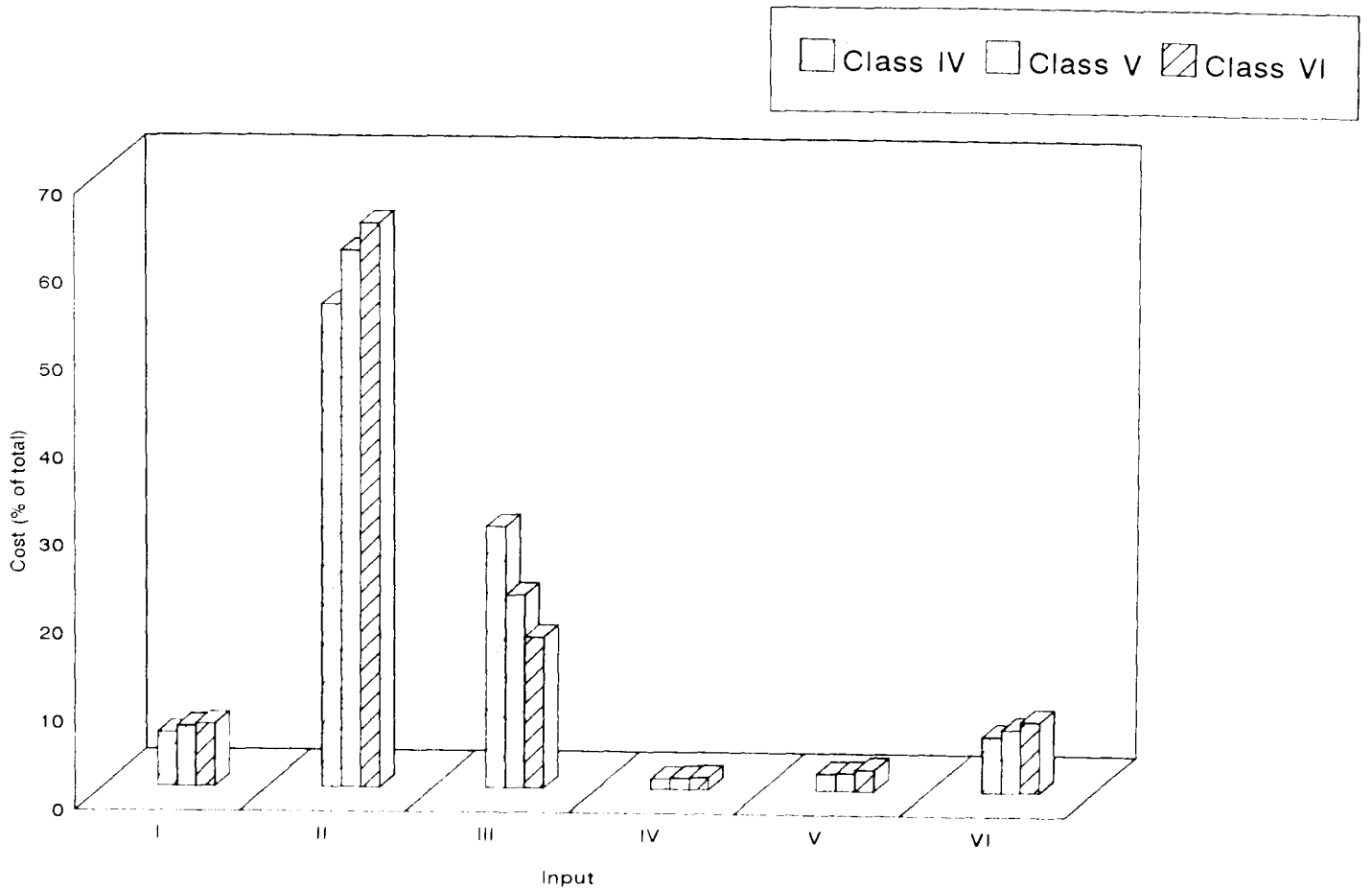


Fig.12. INPUT WISE COST OF CULTIVATION OF PADDY

I. Material cost
II. Labour cost
III. Rental value of own land
IV. Interest on working capital
V. Cost of transportation
VI. Miscellaneous

Table 5.24 Allocation of labour to different operations of paddy cultivation (Mandays)

Operation	Class IV			Class V			Class VI		
	Family	Hired	Total	Family	Hired	Total	Family	Hired	Total
Land preparation	-	55.00	55.00	-	54.50	54.50	-	54.46	54.46
Sowing	0.5	14.50	15.00	0.48	15.71	16.19	0.54	15.11	15.65
Weeding	0.45	2.95	3.40	0.5	3.66	4.16	-	3.52	3.52
Harvesting	1.05	13.65	14.70	1.17	12.99	14.16	1.08	13.78	14.86
Threshing and drying	-	5.50	5.50	0.50	3.98	4.48	0.58	4.02	4.60
Total	2.0	91.60	93.60	2.65	90.84	93.49	2.20	90.89	93.09

were worked out and are presented. Classwise analysis showed that material cost accounted for highest share of the total cost followed by labour cost and other expenses, in all the three classes. Material cost constituted 61.49 per cent, 60.23 per cent and 62.22 per cent in classes IV, V and VI respectively. Among the material cost, feed accounted for highest share with 24.91 per cent, 28.35 per cent and 31.34 per cent in classes IV, V and VI respectively followed by fingerlings which constituted 19.45 per cent in class IV, 20.00 per cent in class V and 21.89 per cent in class VI.

Labour cost accounted for 25.69 per cent, 27.98 per cent and 28.15 per cent in class IV, V and VI respectively. Analysis of allocation of labour to different operations (Table 5.26) shows that more mandays are required in shrimp care followed by land preparation, harvesting and feeding. Eradication, manuring and stocking of fingerlings required only few mandays. Mandays involved in shrimp care were 49.75, 98.5 and 157.5 in classes IV, V and VI respectively, while land preparation involved 39, 48.5 and 58.25 in classes IV, V and VI respectively.

Expenditure on other items constituted 12.82 per cent, 11.79 per cent and 9.63 per cent in classes IV, V and VI respectively. Among other expenses, rental value of own land accounted for the highest share with 10.97 per cent in class IV, 9.65 per cent in class V and 7.44 per cent in class VI respectively, followed by interest on working capital and miscellaneous expenses.

Expenditure on sluice gate, filtration and fishing nets, lights, watchman's shed, eradicants, manures and feeding pots are invested during the first crop of prawn. They are not repeatedly invested in subsequent prawn crops in classes V and

Table 5.25. Inputwise cost of cultivation of improved prawn culture (Rs./ha)

	Class IV	Class V			Class VI			
		1st crop of prawn	2nd crop of prawn	Aggregate	1st crop of prawn	2nd crop of prawn	3rd crop of prawn	Aggregate
1	2	3	4	5	6	7	8	9
Material cost								
Sluice gate	2250.47	2233.19	-	2239.19	2418.39	-	-	2418.39
	(6.59)	(7.18)		(4.31)	(7.44)			(3.20)
Filtration net	158.82	328.43	-	328.43	543.25	-	-	543.25
	(0.46)	(1.06)		(0.63)	(1.67)			(0.72)
Fishing net	129.94	275.45	-	275.45	455.09	-	-	455.09
	(0.38)	(0.89)		(0.53)	(1.40)			(0.60)
Lights	126.74	140.82	-	140.82	140.25	-	-	140.25
	(0.37)	(0.45)		(0.27)	(0.43)			(0.18)
Watchman's shed	359.70	367.60	-	367.60	389.56	-	-	389.56
	(1.05)	(1.18)		(0.71)	(1.20			(0.52)
Eradicants	1334.76	1343.48	-	1343.48	1349.65	-	-	1349.65
	(3.91)	(4.32)		(2.59)	(4.15)			(1.78)
Manure	1234.60	1212.05	-	1212.05	1222.04	-	-	1222.04
	(3.61)	(3.90)		(2.34)	(3.76)			(1.62)
Feed	8512.42	8157.43	6532.57	14690.00	8296.44	7936.01	7473.87	23706.32
	(24.91)	(26.24)	(31.50)	(28.35)	(25.51)	(35.07)	(36.49)	(31.34)
Feeding pot	258.29	259.45	-	259.45	277.70	-	-	277.70
	(0.76)	(0.83)		(0.50)	(0.85)			(0.37)
Fingerlings	6645.95	5220.24	5139.41	10359.65	6271.53	5998.04	4292.13	16561.70
	(19.45)	(16.79)	(24.78)	(20.00)	(19.28)	(26.50)	(20.95)	(21.89)
Sub total	21011.69	19538.14	11671.98	31210.12	21363.90	13934.05	11766.00	47063.95
	(61.49)	(62.85)	(56.28)	(60.23)	(65.70)	(61.57)	(57.44)	(62.22)

Contd.

Table 5.25. Continued

1	2	3	4	5	6	7	8	9
Labour cost								
Family								
Male	1722.06 (5.04)	1434.88 (4.62)	1954.91 (9.43)	3389.59 (6.54)	1793.26 (5.51)	1684.13 (7.44)	1851.75 (9.04)	5329.14 (7.05)
Hired								
Male	7057.56 (20.69)	6997.92 (22.51)	4115.44 (19.85)	1113.36 (21.44)	6839.37 (21.03)	4624.69 (20.44)	4497.25 (21.95)	15961.31 (21.10)
Sub total	8779.62 (25.69)	8432.80 (27.13)	6070.15 (29.28)	14502.95 (27.98)	8632.63 (26.54)	6308.82 (27.88)	6349.00 (30.99)	21290.45 (28.15)
Others								
Rental value of own land	3750.00 (10.97)	2500.00 (8.04)	2500.00 (12.06)	5000.00 (9.65)	1875.00 (5.77)	1875.00 (8.29)	1875.00 (9.15)	5625.00 (7.44)
Interest on working capital	375.65 (1.10)	352.91 (1.14)	225.14 (1.09)	578.05 (1.12)	378.36 (0.83)	256.24 (1.13)	229.33 (1.12)	863.93 (1.14)
Miscellaneous	256.33 (0.75)	262.08 (0.84)	268.88 (1.29)	530.96 (1.02)	271.22 (0.83)	256.57 (1.13)	266.06 (1.30)	793.85 (1.05)
Sub total	4381.98 (12.82)	3114.99 (10.02)	2994.02 (14.44)	6109.01 (11.79)	2524.58 (7.76)	2387.81 (10.55)	2370.39 (11.57)	7282.78 (9.63)
Total	34173.29 (100.00)	31085.93 (100.00)	20736.15 (100.00)	51822.08 (100.00)	32521.11 (100.00)	22630.68 (100.00)	20485.39 (100.00)	75637.18 (100.00)

(Figures in parantheses show percentage to total)

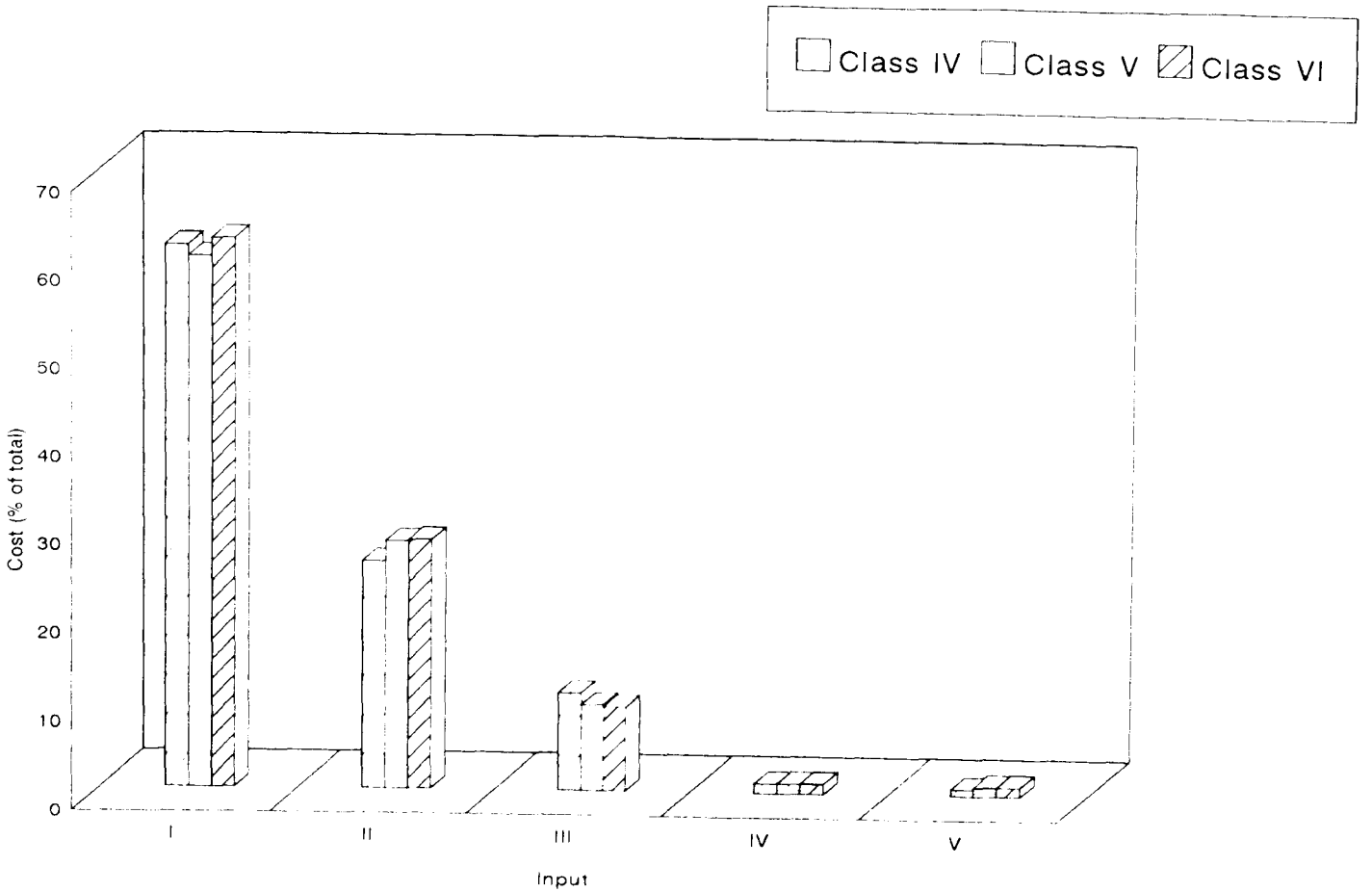


Fig.13. INPUT WISE COST OF IMPROVED PRAWN CULTURE

I. Material cost
II. Labour cost
III. Rental value of own land
IV. Interest on working capital
V. Miscellaneous

Table 5.26 Allocation of labour to different operations of improved prawn culture (mandays)

	Class IV			Class V									Class VI											
				1st crop of prawn			2nd crop of prawn			Aggregate			1st crop of prawn			2nd crop of prawn			3rd crop of prawn			Aggregate		
	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T
Land preparation	-	39.00	39.00	-	40.50	40.50	-	8.11	8.11	-	48.61	48.61	-	39.25	39.25	-	9.06	9.06	-	10.12	10.12	-	58.43	58.43
Eradication	-	1.06	1.06	-	0.86	0.86	-	-	-	-	0.86	0.86	-	0.99	0.99	-	-	-	-	-	-	-	0.99	0.99
Manuring	-	0.84	0.84	-	1.02	1.02	-	-	-	-	1.02	1.02	-	0.98	0.98	-	-	-	-	-	-	-	0.98	0.98
Fingerlings stocking	-	2.46	2.46	-	2.61	2.61	-	2.62	2.62	-	5.23	5.23	-	2.45	2.45	-	2.60	2.60	-	2.51	2.51	-	7.56	7.56
Feeding	-	4.88	4.88	-	5.02	5.02	-	4.93	4.93	-	9.95	9.95	-	5.05	5.05	-	5.05	5.05	-	4.55	4.55	-	14.65	14.65
Shrimp care	14.35	35.45	49.80	14.96	32.50	47.46	20.31	30.71	51.02	35.27	63.21	98.48	18.16	32.34	50.50	17.00	35.72	52.72	19.56	34.15	53.71	54.72	102.81	157.53
Harvesting	8.61	10.21	18.82	4.18	10.84	15.02	5.13	8.66	13.79	39.31	19.50	28.81	5.87	9.91	15.78	4.87	10.18	15.05	4.85	10.17	15.02	15.59	30.26	45.85
Total	22.96	93.90	116.86	19.14	93.35	112.49	25.44	55.03	80.47	44.58	148.38	192.96	24.03	90.97	115.00	21.87	62.61	84.48	24.41	61.50	85.91	70.31	215.68	285.99

F - Family; H - Hired; T - Total

VI. Fingerlings and feeds are the inputs that are repeatedly used in every crop of prawn.

5.2.4 Cost of cultivation under different cost concepts

Cost concepts refers to the classification of cost which regroups the components so as to distinguish between constituents that are price determining from those that are price determined. This classification gives some ideas of the element of elasticity obtaining in agricultural costs and may be helpful to the price fixing authority (Kahlon and Tyagi (1983)*.

The cost concepts used in this study are cost A_1, cost A_2, cost B_2, cost C_1 and cost C_2. The costs according to cost concepts were worked out for different classes of paddy cum traditional prawn culture as well as paddy cum improved prawn culture. Here cost A_1 is the same as cost A_2 since the respondents included in the sample do not use leased in land for cultivation.

5.2.4.1 Paddy cum traditional prawn culture

Cost A_1, A_2, B_1, B_2, C_1 and C_2 per hectare in class I worked out to Rs.17490.43, Rs.17490.43, Rs.17604.95, Rs.25104.95, Rs.18591.53 and Rs.26091.53 respectively. In class II, the respective costs were Rs.21421.30, Rs.21421.30, Rs.21530.10, Rs.29030.10, Rs.23434.27 and Rs.30934.27. And in class III these costs were Rs.25942.78, Rs.25942.78, Rs.26063.88, Rs.33563.88,

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* Kahlon, A.S. and Tyagi, D.S. 1983. *Agricultural price policy in India.* Allied publishers private Ltd., New Delhi: 104

Rs.28646.63 and Rs.36146.63. Classwise analysis (Table 5.27) showed that all the costs were highest in class III.

5.2.4.2 Paddy cum improved prawn culture

The costs according to different cost concepts were worked out and presented in Table 5.28. Cost A_1, A_2, B_1, B_2, C_1 and C_2 per hectare in class IV were worked out to Rs.39321.78, Rs.39321.78, Rs.39492.17, Rs.46992.17, Rs.41314.60 and Rs.48814.60 respectively. In class V, the respective costs were Rs.55782.10, Rs.55782.10, Rs.55950.41, Rs.63450.41, Rs.59443.92 and Rs.66933.92. For class VI, these costs worked out to Rs.79121.36, Rs.79121.36, Rs.79284.25, Rs.86784.25, Rs.84700.42 and Rs.92200.42 respectively. The costs were the highest in class VI.

5.2.5 Income measures in relation to different cost concepts

Estimate of gross returns, although a good measure to gauge the productivity and efficiency of the farm, it alone does not indicate the success of the farm business. That is, it gives only a one sided picture of the business, until we examine the other side of business, i.e. cost part and make a comparison between the two. The higher the gross returns over the costs, the more successful is the business and vice versa.

The gross income, farm business income, family labour income and net income at cost C_1 and at cost C_2 were worked out for different classes of both paddy cum traditional prawn culture and paddy cum improved prawn culture, and are presented in Tables 5.29 and 5.30.

Table 5.27. Cost of cultivation of paddy cum traditional prawn culture under different cost concepts (Rupees per hectare)

Costs	Class I	Class II	Class III
Cost A_1	17490.43	21421.30	25942.78
Cost A_2	17490.43	21421.30	25942.78
Cost B_1	17604.95	21530.10	26063.88
Cost B_2	25104.95	29030.10	33563.88
Cost C_1	18591.53	23434.27	28646.63
Cost C_2	26091.53	30934.27	36146.63

Table 5.28. Cost of cultivation of paddy cum improved prawn culture under different cost concepts (Rupees per hectare)

Costs	Class IV	Class V	Class VI
Cost A_1	39321.78	55782.10	79121.36
Cost A_2	39321.78	55782.10	79121.36
Cost B_1	39492.17	55950.41	79284.25
Cost B_2	46992.17	63450.41	86784.25
Cost C_1	41314.60	59433.92	84700.42
Cost C_2	48814.60	66933.92	92200.42

5.2.5.1 Paddy cum traditional prawn culture

Gross income was worked out to Rs.27238.67 in class I, Rs.34510.17 in class II and Rs.42912.36 in class III respectively. Farm business income worked out to Rs.9788.26, Rs.13088.87, Rs.16969.58 in classes I, II and III respectively. The family labour income was found to be Rs.2133.74, Rs.5480.07, Rs.9348.48 in classes I, II and III respectively. Net income which is the most suitable income measure to judge the profitability of crop production was Rs.8647.16 in class I, Rs.11075.90 in class II and Rs.14265.73 in class III at cost C_1. Net income at cost C_2 was worked out to be Rs.1147.16, Rs.3575.90 and Rs.6765.73 respectively for these three classes.

5.2.5.2 Paddy cum improved prawn culture

Gross income was found to be Rs.65941.55, Rs.96984.45, Rs.138544.08 in classes IV, V and VI respectively. Farm business income was Rs.26619.77, Rs.41200.35 and Rs.59422.72 in classes IV, V and VI respectively. Family labour income came to be Rs.18949.38 in class IV, Rs.33532.04 in class V and Rs.51759.83 in class VI respectively. Net income at cost C_1 was estimated to be Rs.24626.95, Rs.37548.53 and Rs.53843.66 in classes IV, V and VI respectively. Net income at cost C_2 was found to be Rs.17126.95 in class IV, Rs.30048.53 in class V and Rs.46343.66 for class VI.

5.2.6 Yield and Returns

Yield obtained from main products, and returns from main product and byproducts of paddy and prawn crops for different classes were worked out and are presented in Tables 5.31 and 5.32.

Table 5.29. Income measures in relation to different cost concepts of paddy cum traditional prawn culture (Rupees per hectare)

Particulars	Class I	Class II	Class III
Gross income	27238.67	34510.17	42912.36
Farm bussiness income	9788.26	13088.87	16969.58
Family labour income	2133.74	5480.07	9348.48
Net income at cost C_1	8647.16	11075.90	14265.73
Net income at cost C_2	1147.16	3575.90	6765.73

Table 5.30. Income measures in relation to different cost concepts of paddy cum improved prawn culture (Rupees per hectare)

Particulars	Class IV	Class V	Class VI
Gross income	65941.55	96982.45	138544.08
Farm bussiness income	26619.77	41200.35	59422.72
Family labour income	18949.38	33532.04	51759.83
Net income at cost C_1	24626.95	37548.53	53843.66
Net income at cost C_2	17126.95	30048.53	46343.66

5.2.6.1 Paddy cum traditional prawn culture

The results given in Table 5.31 shows that in class I yield from paddy and prawn were 2138.59 kg/ha and 385.25 kg/ha respectively. In class II the yield obtained from paddy and prawn were 2189.30 kg/ha and 498.67 kg/ha respectively, while in class III the yield estimated to be 2211.25 kg/ha from paddy and 655.92 kg/ha from prawn. Gross returns obtained from main product and byproduct of paddy and prawn were Rs.27873.68, Rs.34510.17 and Rs.42972.56 respectively in classes I, II and III.

5.2.6.2 Paddy cum improved prawn culture

The results presented in Table 5.32 show that yield obtained from paddy and prawn were 2143.33 kg/ha and 553.20 kg/ha respectively in class IV, and 2174.90 kg/ha and 865.21 kg/ha respectively in class V. In class VI, the yield estimated to be 2272 kg/ha and 1246.26 kg/ha from paddy and prawn respectively. Gross returns obtained from main product and byproduct of paddy and prawn were Rs.65941.55, Rs.96982.45 and Rs.138544.08 in classes IV, V and VI respectively.

5.2.7 Benefit cost ratio

5.2.7.1 Paddy cum traditional prawn culture

Benefit cost ratio of paddy cum traditional prawn culture is given in Table 5.33. Benefit-cost ratio based on costs A_1, A_2, B_1, B_2, C_1 and C_2 for class I were 1.56, 1.56, 1.54, 1.08, 1.46 and 1.04. In class II benefit-cost ratio based on these costs were 1.61, 1.61, 1.60, 1.18, 1.47 and 1.12 respectively. Benefit-cost ratio based on various cost concepts were higher for class III and were computed as 1.65,

Table 5.31. Yield and returns of paddy cum traditional prawn culture

Group	Output (kg/hectare)		Value (Rs/hectare)				Gross returns
	Paddy	Prawn	Paddy		Prawn		
	Main product	Main product	Main product (paddy)	By-product (straw)	Main product (prawn)	By-product (other fishes)	
Class I	2138.59	385.25	9623.61	316.25	16568.82	1365.00	27873.68
Class II	2189.30	498.67	9851.88	322.46	21425.33	2910.50	34510.17
Class III	2211.25	655.92	9950.63	311.46	28971.72	3738.75	42972.56

Table 5.32. Yield and returns of paddy cum improved prawn culture

Group	Output (kg/hectare)		Value (Rs/hectare)				Gross returns
	Paddy	Prawn	Paddy		Prawn		
	Main product	Main product	Main product (paddy)	By-product (straw)	Main product (prawn)	By-product (other fishes)	
Class IV	2143.33	553.20	9644.99	302.19	55325.62	668.75	65941.55
Class V	2174.90	865.21	9787.05	315.46	85423.69	1456.25	96982.45
Class VI	2272.00	1246.26	10224.00	318.23	125859.80	2142.05	138544.08

Table 5.33 Benefit-cost ratio of paddy cum traditional prawn culture based on different cost concepts

Costs	Class I	Class II	Class III
Cost A_1	1.56	1.61	1.65
Cost A_2	1.56	1.61	1.65
Cost B_1	1.54	1.60	1.64
Cost B_2	1.08	1.18	1.27
Cost C_1	1.46	1.47	1.50
Cost C_2	1.04	1.12	1.19

1.65, 1.64, 1.27, 1.50 and 1.19. Returns generated from rupee invested was found to be greater that one . on the basis of all the cost concepts in all the three classes.

5.2.7.2 Paddy cum improved prawn culture

Benefit-cost ratio of paddy cum improved prawn culture is given in Table 5.34 and it show that the benefit-cost ratio based on cost A_1, A_2, B_1, B_2, C_1 and C_2 in class IV were 1.68, 1.68, 1.67, 1.40, 1.60 and 1.35 respectively. In class V benefit-cost ratio based on these costs were 1.74, 1.74, 1.73, 1.53, 1.63 and 1.45. In class VI benefit-cost ratio were estimated to be 1.75, 1.75, 1.74, 1.59, 1.64 and 1.50 respectively based on corresponding costs.

5.2.8 Resource use efficiency

In the present study, resource use efficiency has been estimated using Cobb-Douglas production function. Separate functions have been fitted for categories of prawn productions viz., paddy cum improved prawn production and paddy cum traditional prawn production.

5.2.8.1 Paddy cum improved prawn culture

The variables used in the model as explanatory variables are area ($x_{1.1}$), labour ($x_{1.2}$), seed ($x_{1.3}$), feed ($x_{1.4}$) and eradicants and manures ($x_{1.5}$). Two dummy variables ($D_{1.1}$ and $D_{1.2}$) are used in the model to represent the effects of numbers of prawn crops taken along with paddy crop. For facilitating discussion the results of the estimated parameters of the regression equation are given below.

Table 5.34 Benefit-cost ratio of paddy cum improved prawn culture based on different cost concepts

Costs	Class IV	Class V	Class VI
Cost A_1	1.68	1.74	1.75
Cost A_2	1.68	1.74	1.75
Cost B_1	1.67	1.73	1.74
Cost B_2	1.40	1.53	1.59
Cost C_1	1.60	1.63	1.64
Cost C_2	1.35	1.45	1.50

$$\text{Log } y = \underset{(0.53)}{\text{Log } 2.30^{**}} + \underset{(0.158)}{0.375^{*} \text{ Log } x_{1.1}} + \underset{(0.161)}{0.108 \text{ Log } x_{1.2}} + \underset{(0.122)}{0.163 \text{ Log } x_{1.3}} +$$

$$\underset{(0.090)}{0.077 \text{ Log } x_{1.4}} + \underset{(0.118)}{0.146 \text{ Log } x_{1.5}} - \underset{(0.081)}{0.212^{**} \text{ Log } D_{1.1}} - \underset{(0.064)}{0.180^{**} \text{ Log } D_{1.2}}$$

$R^2 = 0.76$

(Figures in parentheses are standard errors)

* Significant at one per cent level of probability
** Significcant at five per cent level of probability

The function fitted for paddy cum improved prawn production has an R^2 value of 0.76 which indicates that 76 per cent of the variation in paddy cum improved prawn production could be explained by the independent variables included in the function. The results are given in Table 5.35. The estimated regression cofficient (b_i) of independent variables represent the production elasticities of the respective factors (x_i). The regression coefficient (b_i) indicate the percentage by which the output y would change if input 'x_i' changes by one unit while all the other factors remain constant at their geometric mean levels. The sum of regression coefficients (Sb_i) represent the expected retruns to scale.

All the explanatory variables used in the function have expected signs for the coefficients. Positive signs for independent variables viz., area, labour, seed, feed and eradicants and manures clearly indicate that greater income is generated in a farm of more of these inputs are used. The regression coefficient of one independent variable, area, alone was found to be significant. The elasticity of production of each input was less than one showing decreasing returns to each additional input i.e., gross income declined when increasing only one input and

holding other inputs constant. The sum of elasticities of the production for paddy cum improved prawn production was estimated to be 0.48 which indicates decreasing returns to scale i.e., a simultaneous proportionate, increase in investment in all of these above inputs ($x_{1.1}$, $x_{1.2}$, $x_{1.3}$, $x_{1.4}$ and $x_{1.5}$) by one per cent will increase the gross income of paddy and prawn per farm by only 0.48 per cent.

The partial regression coefficients of explanatory variable area and the two dummy variables $D_{1.1}$ and $D_{1.2}$ were found to be significant. The significance of dummy variable $D_{1.1}$ indicates that class IV is significantly different from class VI. In other words, class VI (one crop of paddy and 3 crops of improved prawn culture) is more profitable than class IV (1 crop of paddy and 1 crop of improved prawn culture). The dummy variable $D_{1.2}$ was found to be significant which shows that class VI is more profitable than class V (1 crop and paddy + 2 crops of improved prawn culture). The intercept of the function was also significant which clearly indicates that class VI is more beneficial than class IV and V.

A high R^2 with non-significant regression coefficients can be indicative of the presence of multi-collinearity. In order to reduce the presence of multi-collinearity in the production function, observations on all explanatory variables were expressed on per hectare basis so that area effect can be reduced considerably. The model was rerun with four explanatory variables viz., labour ($x_{1.1}$), seed ($x_{1.2}$), feed ($x_{1.3}$) and eradicants and manures ($x_{1.4}$), each expressed on per hectare basis and two dummy variables ($D_{1.1}$ and $D_{1.2}$) to represent the effect of frequency of prawn crops taken along with paddy. The results are given in Table 5.36.

Table 5.35. Per farm estimates of parameters of the Cobb-Douglas production function for paddy cum improved prawn culture

Variables	Production elasticities (bi)	Standard error	't' value
Area (x_{11})	0.375*	0.158	2.376
Labour (x_{12})	0.108	0.161	0.668
Seed (x_{13})	0.163	0.122	1.333
Feed (x_{14})	0.077	0.090	0.856
Eradicants and manures (x_{15})	0.146	0.118	1.240
Dummy 1 (D_{11})	-0.212**	0.081	2.613
Dummy 2 (D_{12})	-0.180**	0.064	2.808
Intercept	2.30**		
Standard error of intercept	0.53		
Coefficient of differentiation	0.76		
F-value	26.51**		
Returns to scale	0.48		

* Significant at one per cent level of probability
** Significant at five per cent level of probability

The results reveal that coefficient determination was reduced to 0.37 indicating that only 37 per cent variation in the output was attributed by the independent variables in the function. The fitted production function for the data on resource use of paddy cum improved prawn production expressed on per hectare basis is the following.

$$\text{Log } y = \underset{(0.90)}{\text{Log } 6.14^{**}} - \underset{(0.144)}{0.125 \text{ Log } x_{1.1}} - \underset{(0.109)}{0.014 \text{ Log } x_{1.2}} + \underset{(0.089)}{0.156 \text{ Log } x_{1.3}} +$$

$$\underset{(0.123)}{0.176 \text{ Log } x_{1.4}} - \underset{(0.082)}{0.278^{**} \text{ Log } D_{1.1}} - \underset{(0.066)}{0.212^{**} \text{ Log } D_{1.2}}$$

$R^2 = 0.37$

(Figures in parentheses are standard errors)

** Significant at five per cent level of probability

Per hectare estimates of the function were analysed and it reveals that the regression coefficients of two explanatory variables-labour and seed were negative and though non-significant, indicated the possibility of excess use of these inputs. The regression coefficient of seed is expected to be negative, as most of the farmers use high rates prawn seed/fry stocking resulting in high mortality and further, overcowding in pond leading to ouptut reduction.

The two dummy variables and the intercept of the function were found to be significant. The significance of dummy variable $D_{1.1}$ indicates that class VI is more beneficial than class IV. The dummy variable $D_{1.2}$ was also found to be significant and which indicated that class VI is more profitable than class V. The

Table 5.36 Per hectare estimates of parameters of the Cobb-Douglas production function for paddy cum improved prawn culture

Variables	Production elasticities (bi)	Standard error	't' value
Labour ($x_{1.1}$)	-0.125	0.144	0.872
Seed ($x_{1.2}$)	-0.014	0.109	0.125
Feed ($x_{1.3}$)	0.156	0.089	1.747
Eradicants and Manures ($x_{1.4}$)	0.176	0.123	1.431
Dummy 1 ($D_{1.1}$)	-0.278**	0.082	3.399
Dummy 2 ($D_{1.2}$)	-0.212**	0.066	3.188
Intercept	6.14**		
Standard error of intercept	0.90		
Coefficient of determination	0.37		
F-value	5.89**		
Returns to scale	0.30		

** Significant at five per cent level of probability

significance of intercept explains that class VI is more profitable than class IV and V.

5.2.8.2 Paddy cum traditional prawn culture

The Cobb-Douglas production function has been used for estimating resource use efficiency. The variables used in the model as explanatory variables are Area ($x_{2.1}$), labour ($x_{2.2}$), seed ($x_{2.3}$) and two dummy variables ($D_{2.1}$ and $D_{2.2}$) to represent the effects of frequency of prawn crops taken alongwith paddy crop. The estimated parameters of the regression equation is given below

$$\text{Log } y = \underset{(0.40)}{\text{Log } 3.44} + \underset{(0.187)}{0.799^{**} \text{ Log } x_{2.1}} - \underset{(0.130)}{0.063 \text{ Log } x_{2.2}} - \underset{(0.169)}{0.119 \text{ Log } x_{2.3}}$$

$$- \underset{(0.086)}{0.288^{**} \text{ Log } D_{2.1}} + \underset{(0.076)}{0.303^{**} \text{ Log } D_{2.2}}$$

$R^2 = 0.73$

(Figures in parantheses are standard errors)

** Significant at five per cent level of probability

The results given in Table 5.37 revealed that 73 per cent variation in the dependent variables was explained by the explanatory variables used in the function. Except area ($x_{2.1}$) and the dummy variables ($D_{2.1}$ and $D_{2.2}$) none of the other variables were found to be nonsignificant. The regression coefficient of area was found to be positive and significant; which indicated that one per cent increase in area will result in 0.799 per cent increase in output. The regression coefficient of labour and seed was found to be negative and nonsignificant. The dummy variable

Table 5.37. Per farm estimates of parameters of the Cobb-Douglas production function for paddy cum traditional prawn culture

Variables	Production elasticities (bi)	Standard error	't' value
Area ($x_{1.1}$)	0.799*	0.187	4.269
Labour ($x_{2.1}$)	-0.063	0.130	0.487
Seed ($x_{3.1}$)	-0.119	0.169	0.707
Dummy 1 ($D_{2.1}$)	-0.288**	0.086	3.364
Dummy 2 ($D_{2.2}$)	0.303**	0.076	3.968
Intercept	3.44*		
Standard error of intercept	0.40		
Coefficient of determination	0.73		
F-value	37.85**		
Returns to scale	0.632		

* Significant at one per cent level of probability
** Significant at five per cent level of probability

$D_{2.1}$ was found to be significant, that is class III (1 crop of paddy + 3 crop of traditional prawn culture) is more beneficial than class I (1 crop of paddy + 1 crop of traditional prawn culture). The dummy variable $D_{2.2}$ was also found to be significant which indicates that class III is more beneficial than class II (1 crop of paddy + 2 crops of traditional prawn culture). The intercept was found to be significant which clearly indicates that class III is more beneficial than classes I and II. The elasticity of production of each input was less than one showing decreasing returns to each additional input i.e., gross income declined when increasing only one input and holding other inputs constant. The sum of regression coefficients represents the returns to scale, and estimated to be 0.632, which is less than unity, indicating decreasing returns to scale.

The production function based on per hectare values of output and input variables is given below. The variables used in the model as explanatory variables are labour ($x_{2.1}$) and seed ($x_{2.2}$), and two dummy variables ($D_{2.1}$ and $D_{2.2}$) representing the effects of frequency of prawn crops taken along with paddy crop.

$$\text{Log } y = \underset{(0.39)}{\text{Log } 8.34^{**}} - \underset{(0.124)}{0.108 \text{ Log } x_{2.1}} - \underset{(0.104)}{0.261^{*} \text{ Log } x_{2.2}}$$

$$- \underset{(0.085)}{0.276^{**} \text{ Log } D_{2.1}} + \underset{(0.076)}{0.299^{**} \text{ Log } D_{2.2}}$$

$R^2 = 0.35$

(Figures in parantheses are standard errors)

* Significant at one per cent level of probability
** Significant at five per cent level of probability

The results are given in Table 5.38 and revealed that R^2 was reduced to 0.35 indicating 35 per cent variation in output was attributed by the independent variables included in the model. Here, a major part of variation in prawn production could be attributed to the fluctuations in acreage. The proportionate contribution of explanatory variables, seed and labour to the variation in prawn production was found to be as low as 35 per cent.

The regression coefficient of labour was found to be negative and non-significant. The regression coefficient of seed was found to be significant with negative sign which indicates over use of this input. The dummy variables $D_{2.1}$ was found to be significant indicating that class III is more profitable than class I, and the significance of dummy variable $D_{2.2}$ reveals that class III is more profitable than class II. The intercept was also found to be siginificant which indicates that class III is more profitable than classes I and II. The sum of regression coefficients which represents returns to scale, is estimated to be 0.42, i.e., decreasing return to scale.

5.3 Major constraints to paddy cum prawn culture

The last objective of the present study is to identify constraints in paddy cum traditional prawn culture as well as in paddy cum improved prawn culture. Major constraints identified were submergence, acidity and salinity, input price and labour cost, and they are common in both paddy cum traditional prawn culture and paddy cum improved prawn culture. Availability of prawn fingerlings was also included in paddy cum improved prawn culture. The response of farmers regarding these constraints were collected. Each constraint was ranked and the percentages have been worked out and are presented in Tables 5.39 and 5.40.

Table 5.38. Per hectare estimates of parameters of the Cobb-Douglas production function for paddy cum traditional prawn culture

Variables	Production elasticities (bi)	Standard error	't' value
Labour ($x_{2.1}$)	-0.108	0.124	0.871
Seed ($x_{2.2}$)	-0.261*	0.104	2.503
Dummy 1 ($D_{2.1}$)	0.276**	0.085	3.249
Dummy 2 ($D_{2.2}$)	0.299**	0.076	3.907
Intercept	8.34**		
Standard error of intercept	0.39		
Coefficient of determinations	0.35		
F-value	7.25**		
Returns to scale	0.42		

* Significant at one per cent level of probability
** Significant at five per cent level of probability

5.3.1 Paddy cum traditional prawn culture

About 90 per cent of respondents considered high labour cost as the major problem in paddy cum traditional prawn production. The non-availability of labour during peak agricultural operations and the resultant increase in their cost make the cultivation a difficult task. The same was identified as second important problem by another 10 per cent of the farmers.

Flood caused by rains during the monsoon will result in submergence of rice fields in pokkali lands. Timely dewatering is a problem resulting from flood/submergence which was considered as the second important constraint by 63.33 per cent of the farmers. The same was identified as third and fourth important problem by another 28.33 per cent and 8.34 per cent of the farmers respectively.

High price of various inputs was recognised as the next important problem of paddy and prawn cultivation. This was explained as the third important constraint by 51.67 per cent of the respondents and also as the first and second problem by 10.00 per cent and 18.33 per cent of the respondents respectively. Another 20 per cent of the farmers considered this problem as fourth major constraint.

Due to the proximity to the sea, salt water enters through canals to the pokkali field by tidal variation. Pokkali soil is acidic and this was reported as fourth important constraint by 71.67 and as third important constraint by 18.33 per cent of the farmers respectively. This was also remarked as the second important constraint by 8.33 per cent of farmers.

Table 5.39. Constraints to paddy cum traditional prawn culture

Constraints	Ranking of constraints			
	I	II	III	IV
Flood/Submergence	-	38 (63.33)	17 (28.33)	5 (8.34)
Acidity and salinity	-	5 (8.33)	12 (18.33)	43 (71.67)
High input price	6 (10.00)	11 (18.33)	31 (51.67)	12 (20.00)
High labour cost	54 (90.00)	6 (10.00)	-	-

(Figures in parantheses show percentages to total)

5.3.2 Paddy cum improved prawn culture

A vast majority of the farmers were of the view that higher labour cost due to non-availability during the season is the major constraint in paddy cum improved prawn culture.

Non-availability of desired species of prawn fungerlings during season was considered as the second important constraint by 69.70 per cent of the farmers. Due to high demand for prawn fingerlings farmers do not get enough quantity of fingerlings hence they are compelled to bring from distant hatcheries. This was the third and fourth major constraint for 18.18 per cent and 12.12 per cent of the respondents respectively.

Due to flood pokkali lands are completely submerged during monsoon. Hence this create problem with regard to dewatering as reported by 53.03 per cent of the farmers as their third important problem. About 27.27 per cent of the farmers identified this as fourth important constraint. Another 19.70 per cent of the farmers remarked this as a fifth major constraint.

Higher cost of the inputs was the fourth major constraint in this area (46.96 per cent of the respondents). This was explained as second and third important problem by 10.61 per cent and 13.64 per cent of the respondent respectively. This was the fifth major constraint for 28.79 per cent of the farmers.

The pokkali soil is acid saline and waterlogged with saline tidal water. This is a limiting factor to production. This formed fifth important constraint as identified by 54.51 per cent of the farmers. This was also remarked as second and third important constraint by 19.70 per cent and 15.15 per cent of the respondents respectively. This was the fourth major constraint to 13.64 per cent respondents.

Table 5.40. Constraints to paddy cum improved prawn culture

Constraints	Ranking of constraints				
	I	II	III	IV	V
Flood/Submergence	-	-	35 (53.03)	18 (27.27)	13 (19.70)
Acidity and salinity	-	13 (19.70)	10 (15.15)	9 (13.64)	34 (54.51)
High input price	-	7 (10.61)	9 (13.64)	31 (46.96)	19 (28.79)
High labour cost	66 (100.00)	-	-	-	-
Availability of prawn fingerlings	-	46 (69.70)	12 (18.18)	8 (12.12)	-

(Figures in parantheses show percentages to total)

Summary

SUMMARY

The present study on the economics of paddy cum prawn culture in pokkali lands of Ernakulam district was conducted during the year 1995-96. The study focussed on estimation of costs and returns, measuring resource use efficiency and identifying the constraints in paddy and prawn cultivation.

A two stage sampling technique was adopted for the selection of sample. Three villages, at random, were selected each from high saline tract and low saline tract. The selected villages were Narakkal, Mulavukad and Chellanam from high saline tract and Chittoor, Varappuzha and Nayarambalam from low saline tract. Simple random sampling was followed for the selection of farmers. From each selected villages, 11 prawn farmers from both, practising traditional method of prawn culture, and improved method of prawn culture alongwith paddy crop were randomly selected. Thus the total number of respondents of each method of prawn culture came to be 66 making a total sample of 132. Those farmers leased in or leased out land for paddy or prawn crop were excluded and the total sample size dropped to 126. The data were collected by personal interview method with the help of a well structured interview schedule. The sample was classified on the basis of the number of prawn crops taking along with paddy.

Tabular analysis was used to study the socio-economic features and to estimate the cost and returns. Cost concepts were used to estimate the income measures. Functional analysis was carried out using Cobb-Duglas production function on per farm and per hectare basis. The function was fitted with four explanatory variables such as human labour, seed, feed, eradicants and manures in the case of paddy cum improved prawn culture. In the case of paddy cum traditional

prawn culture the above function was fitted with two explanatory variables such as , human labour and seed cost.

Cost of cultivation was estimated for paddy cum prawn culture, and paddy and prawn crops separately for different classes of prawn production viz., paddy cum traditional prawn culture and paddy cum improved prawn culture. The total cost cultivation for paddy crop per hectare for classes I, II and III were Rs.12822.84, Rs.11744.80 and Rs.11144.50 respectively, and correspondingly the total cost of cultivation for traditional prawn crop were Rs.12167.59 in class I. It was Rs.10846.76 for first crop of prawn and Rs.6289.74 for second crop of prawn in class II. It was Rs.10995.55 for first crop of prawn, Rs.5458.80 for second crop of prawn and Rs.5843.93 for third crop of prawn in class III. The combined total cost of cultivation of paddy and traditional prawn crops were Rs.24990.43, Rs.28921.30 and Rs.33442.78 in respective classes.

The total cost of cultivation of paddy crop per hectare were Rs.12644.48, Rs.11460.02 and Rs.10993.30 respectively for classes IV, V and VI and correspondingly the total cost incurred for improved prawn crops was Rs.34173.29 in class IV, Rs.31085.93 for first crop and Rs.20736.15 for second crop of prawn in class IV. It was Rs.32522.11, Rs.22630.68 and Rs.20485.39 in first, second and third crop of prawn respectively in class VI. The combined total cost of cultivation of paddy cum improved prawn production was estimated to be Rs.46817.77, Rs.63282.10 and Rs.86631.48 in class IV, V and VI respectively.

Input wise analysis of costs incurred for paddy showed that major input in paddy cultivation was labour cost accounted for 55.38 per cent in class I, 62.06 per cent in class II and 65.44 per cent in class III. Cost on other items constituted 38.72 per cent, 31.44 per cent and 27.68 per cent of the total cost in classes I, II and III

respectively, followed by material cost which accounted for 5.9 per cent in class I, 6.50 per cent in class II and 6.88 per cent in class III. For traditional prawn culture, major item of cost was labour constituted 43.30 per cent, 49.62 per cent and 55.02 per cent of the total cost in classes I, II and III respectively, followed by other expenses which accounted for 33.62 per cent in class I, 32.73 per cent in class II and 29.51 per cent in class III. Material cost incurred in traditional prawn was accounted for 22.08 per cent, 17.65 per cent and 15.47 per cent respectively in classes I, II and III. The combined cost of cultivation of paddy and traditional prawn showed that major input was labour and accounted for 49.99 per cent, 54.67 per cent and 58.99 per cent respectively in classes I, II and III followed by other costs and material cost.

In case of paddy cultivation, in classes IV, V and VI, the major input was labour cost which constituted 54.94 per cent, 61.10 per cent and 64.23 per cent of the total cost respectively. The next important input was other expenses which accounted for 39.03 per cent, 32.14 per cent and 28.75 per cent in classes IV, V and VI respectively. The material cost accounted for 6.03 per cent in class IV, 6.76 per cent in class V and 7.02 per cent in class VI. In case of improved prawn cultivation, the major input was material cost and it constituted 61.49 per cent, 60.23 per cent and 62.22 per cent respectively for classes IV, V and VI, followed by other costs and labour cost. The combined cost of paddy and improved prawn culture showed that, major inputs were cost of materials which accounted for 46.51 per cent, 50.54 per cent and 55.22 per cent respectively for classes IV, V and VI, followed by labour cost and other costs.

The cost of cultivation per hectare, calculated under various cost concepts, revealed the costs were higher for paddy cum improved prawn culture than paddy cum traditional prawn culture. Cost A_1, cost A_2, cost B_1, cost B_2, cost C_1

and cost C_2 for class I were Rs.17490.43, Rs.17490.43, Rs.17604.95, Rs.25104.95, Rs.18591.53 and Rs.26591.53. The corresponding costs for class II were Rs.21421.30, Rs.21421.30, Rs.21530.10, Rs.29030.10, Rs.23434.27, and 30934.27. For class III, these costs were Rs.25942.78, Rs.25942.78, Rs.26063.88, Rs.33563.88, Rs.28646.63 and Rs.36146.63 respectively. Classwise analysis showed that class III recorded higher costs than classes I and II. With regard to paddy cum improved prawn culture, cost A_1, cost A_2, cost B_1, cost B_2, cost C_1 and cost C_2 were Rs.39321.78, Rs.39321.78, Rs.39492.17, Rs.46992.17, Rs.41314.60 and Rs.48814.60 respectively for class IV. While for class V, these costs were Rs.55782.10, Rs.55782.10, Rs.55950.41, Rs.63450.41, Rs.59433.92 and Rs.66933.92 respectively. Similarly the corresponding costs were Rs.79121.36, Rs.79121.36, Rs.79284.25, Rs.86784.25, Rs.84700.42 and Rs.92200.42. Classwise analysis showed that the class VI recorded highest costs than classes IV and V.

A comparison of yield of paddy and prawn crops for different classes on per hectare basis were computed. The yield of paddy in classes I, II and III were 2138 kg, 2189 kg and 2211 kg respectively, and corresponding prawn (traditional method) yields were 385 kg, 499 kg and 656 kg. The yield of paddy in classes IV, V and VI were 2143 kg, 2175 kg and 2272 kg respectively, and the corresponding prawn yields (improved method) were 553 kg, 865 kg and 1246 kg.

Farm business income from paddy cum traditional prawn culture at cost A_2, were Rs.9788.26, Rs.13088.87 and Rs.16969.58 respectively and for paddy cum improved prawn culture corresponding figures were Rs.26619.77, Rs.41200.35 and Rs.59422.72 respectively for classes IV, V and VI.

Family labour income in paddy cum traditional prawn production for classes I, II and III, Rs.2133.74, Rs.5480.67 and Rs.9348.48 respectively. For

paddy cum improved prawn culture, it was Rs.18949.38, Rs.33532.04 and Rs.51759.83 respectively for classes IV, V and VI.

In case of paddy cum traditional method of prawn culture, the net income at cost C_1 were Rs.8647.16, Rs.11075.90 and Rs.14265.73 respectively, and for paddy cum improved prawn culture corresponding figures were Rs.24626.95, Rs.37548.53 and Rs.53843.66. The net income at cost C_2 for paddy cum traditional prawn culture were Rs.1147.16, Rs.3575.40 and Rs.6265.73 respectively for classes I, II and III, and for paddy cum improved prawn culture, it was Rs.17126.95, Rs.30048.53 and Rs.46343.66 respectively for classes IV, V and VI.

Benefit cost ratio for class I under paddy cum traditional prawn culture were 1.56, 1.56, 1.54, 1.08, 1.46 and 1.04 respectively based on costs A_1, A_2, B_1, B_2, C_1 and C_2, where as the corresponding figures were 1.61, 1.61, 1.60, 1.18, 1.47 and 1.12 for class II. For class III benefit cost ratios were 1.65, 1.65, 1.64 1.27, 1.50 and 1.19 respectively on cost A_1, A_2, B_1, B_2, C_1 and C_2. Similarly the benefit cost ratio for classes under paddy cum improved prawn culture were estimated and were 1.68, 1.68, 1.67, 1.40, 1.60 and 1.35 for class IV. For class V benefit cost ratios were 1.74, 1.74, 1.73, 1.53, 1.63 and 1.45, and for class IV, they were 1.75, 1.75, 1.74, 1.59, 1.64 and 1.50 on respective costs.

The result of functional analysis showed that for paddy cum improved prawn culture only 37 per cent variation in output were explained by the explanatory variables - labour ($x_{1.1}$), seed ($x_{1.2}$), feed ($x_{1.3}$) and eradicants and manures ($x_{1.4}$) when the observations on all explanatory variables were expressed on per hectare basis. The regression coefficients of labour and seed found to be negative and nonsignificant. The production elasticity of feed, eradicants and

manures were positive but nonsignificant. The returns to scale was found to be decreasing (0.30).

With regard to paddy cum traditional method of prawn cultivation, analysis of per hectare estimates of the functional analysis revealed that only 35 per cent variation in output was explained by the independent variables - labour ($x_{2.1}$) and seed ($x_{2.2}$). The production elasticity of the labour was found to be negative and non-significant which can indicates excess use of labour. The production elasticity of seed was also found to be negative and non-significant. The returns to scale was 0.42 i.e. decreasing.

In the case of paddy cum improved prawn culture the dummy variables were found to be significant. The dummy variable $D_{1.1}$ was significant indicating that class I is significantly different from class III which means that clase III is more profitable than class I. The significant dummy variable $D_{1.2}$, indicates that class II is significantly different from class III i.e., class III is more beneficial than class II. The intercept of the function was found to be significant which clearly indicated that class III is more profitable than classes I and II.

Regarding paddy cum traditional prawn culture, dummy variable $D_{2.1}$ was found to be significant indicating that class IV is significantly different from class VI i.e., class VI is better than class IV. The dummy variable $D_{2.2}$ was significant and can be interpreted as class VI is better than class V. The intercept of the function was also found to be significant which clearly indicates that class VI were profitable than classes IV and V.

Non-availability of labour during peak agricultural season and their increased cost were reported to the most important constraint in both paddy cum traditional

prawn culture and paddy cum improved prawn culture. The problem of submergence of fields was recognised as second important constraint by 63.33 per cent of farmers in case of paddy cum traditional prawn culture while non-availability of prawn fingerlings during season was formed second major constraint by 69.2 per cent of farmers in paddy cum improved prawn culture. Higher price of inputs and problem of salinity and acidity were recognised as third and fourth constraint in the paddy cum traditional prawn culture, while the problem of submergence and higher price of inputs formed the third and fourth constraint in paddy cum improved prawn culture. Salinity and acidity was the fifth important constraint recognised by the farmers in case of paddy cum improved prawn culture.

In general, the study revealed that the integrated farming of paddy along with improved method of prawn culture was found to be more remunerative than paddy cum traditional prawn culture though cost of cultivation was higher which can be reduced by decreasing the use of material cost and labour cost. Among the inputs, labour cost was found to be dominant in case of paddy cum traditional prawn culture, while in case of paddy cum improved prawn culture major item of cost was material cost. The cost-income analysis revealed that cultivating 3 crops of improved prawn culture yields more compared to other combinations of paddy and prawn crops. Benefit cost ratio worked out for the different combinations of paddy and prawn culture revealed that cultivating paddy with 3 crops of improved prawn culture is the most profitable venture. The functional analysis carried out for paddy cum improved prawn production and for paddy cum traditional prawn culture and indicated over use of seed and labour.

Policy suggestions

* Prawn seeds are not available in plenty for mass rearing. Improvement in the economy of the system could be achieved if dependable source of juvenile shrimps could be opened by developing enough number of hatcheries and prawn seed farms.

** Prawn feed have to be developed on commercial lines and feeding schedules may be rationalised for different stages of growth of prawn and which may provide subsidiary and ancillary occupations for people in the area.

*** Successful adaptation of the technologies and their wide propagation depends on the extension and training facilities available in the field. To provide technical guidance to operators, short term and long term courses may be organised at central research institutes as well as at fisheries department.

**** Prawn farming involves huge financial investment. Adequate and timely financial assistance may be extended to prawn farmers including those cultivating on lease land. Credit should also be made available to the farmers adopting traditional method of culture.

***** Marketing of shrimps is carried mostly by private agencies and they generally finance the farmers for prawn cultivation. Under these circumstances farmers are compelled to sell their produce to the financiers with less advantage to the farmer. Government also should take up marketing of prawns with proper facilities.

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ABSTRACT OF THE THESIS

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ABSTRACT

The present investigation on the economics of paddy cum prawn culture in Pokkali lands of Ernakulam district was undertaken during the year 1995-96. The study focussed on estimation of cost and returns, measuring productivity of farm resources and identifying constraints in paddy cum prawn production.

Data for the study was generated through a sample survey of farmers. Two stage sampling technique was adopted for the study with villages as the primary sampling units and prawn farmers as secondary sampling units, selected by random sampling method.

The results of the cost structure analysis revealed that the largest single item of cost of operation was land preparation in paddy cum traditional prawn culture; and in paddy cum improved prawn culture, intercultural operations required the highest expenses. Among the explicit costs, labour accounted the highest share in paddy cum traditional prawn production and cost of materials was the most important item in paddy cum improved prawn production.

Classwise analysis showed that cost A_1, cost A_2, cost B_1, cost B_2, cost C_1 and cost C_2 per hectare in class I were Rs.17490.43, Rs.17490.43, Rs.17604.95, Rs.25104.95, Rs.18591.53 and Rs.26091.53 respectively. In class II, these costs were Rs.21421.30, Rs.21421.30, Rs.21530.10, Rs.29030.10, Rs.23434.27 and Rs.30934.27. In class III, corresponding costs were Rs.25942.78, Rs.25942.78, Rs.26063.88, Rs.33563.88, Rs.28646.63 and Rs.36146.63. In class IV, the costs were worked out to be Rs.39321.78, Rs.39321.78, Rs.39492.17, Rs.46992.17, Rs.41314.60 and Rs.48814.60 respectively. In class V, these costs were

Rs.55782.10, Rs.55782.10, Rs.55950.41, Rs.63450.41, Rs.59433.92 and Rs.66933.92 respectively. For class VI, these costs were estimated to be Rs.79121.36, Rs.79121.36, Rs.79284.25, Rs.86784.25, Rs.84700.42 and Rs.92200.42 respectively

The average yield from main products of paddy and prawn were 2138.59 kg/ha and 385.25 kg/ha respectively. In class II their yields were 2189.30 kg/ha and 498.67 kg/ha respectively, while in class III the yields estimated to be 2211.25 kg/ha and 655.92 kg/ha from paddy and prawn. The yield obtained from paddy and prawn were 2143.33 kg/ha and 553.20 kg/ha respectively in class IV, and 2174.90 kg/ha and 865.21 kg/ha respectively in class V. In class VI the yield estimated to be 2272 kg/ha and 1246.26 kg/ha from paddy and prawn respectively.

Benefit-cost ratios based on cost A_1, A_2, B_1, B_2, C_1 and C_2 for class I were 1.56, 1.56, 1.54, 1.08, 1.46 and 1.04. In class II, benefit-cost ratios based on these costs were 1.61, 1.61, 1.60, 1.18, 1.47 and 1.12 respectively. For class III, benefit-cost ratio were 1.65, 1.65, 1.64, 1.27, 1.50 and 1.19 respectively. In class IV, these were computed to be 1.68, 1.68, 1.67, 1.40, 1.60 and 1.35 respectively, while for class V, these ratios were 1.74, 1.74, 1.73, 1.53, 1.63 and 1.45. In class VI, they were estimated to be 1.75, 1.75, 1.74, 1.59, 1.64 and 1.50 respectively based on corresponding costs.

The income measures in relation to different cost concepts such as gross income, farm business income, family labour income and net income at cost C_1 in class I were Rs.27238.69, Rs.9788.26, Rs.2133.74 and Rs.8647.16. These measures were Rs.34510.17, Rs.13088.87, Rs.5480.07 and Rs.11075.90 in class II. In class III they were computed as Rs.42912.36, Rs.16964.58, Rs.9348.48 and Rs.14265.73. For class IV these income measures were worked out to be

Rs.65941.55, Rs.26619.77, Rs.18948.38 and Rs.24626.95. In class V, the corresponding figures were Rs.96984.45, Rs.41200.35, Rs.33532.04 and Rs.37548.53 respectively. These incomes were Rs.138544.08, Rs.59422.72, Rs.51759.83 and Rs.53843.66 in class VI respectively.

Production function analysis was carried out using Cobb-Douglas production function seperately for paddy cum traditional prawn production and paddy cum improved prawn production on per farm and per hectare basis. Per farm estimates of production function for paddy cum improved prawn production revealed that the regression coefficient of only one independent variable, viz., area, was estimated to be positive and significant. The production elasticity of labour, seed, feed, eradicants and manures were found to be positive but non-significant. Analysis of per hectare estimates of production function showed that elasticities of production for labour and seed were negative and non-significant. In both per farm and per hectare functional analysis the two dummy variables and also the intercept of the function were found to be significant which indicate that paddy cum 3 crops of improved prawn culture is more profitable than paddy cum for 1 and 2 crops of improved prawn culture.

Regarding paddy cum traditional prawn culture per farm estimates of the functions revealed that only the regression coefficient of area was found to be positive and significant. The elasticities of production of labour and seed were estimated to be negative and non-significant. Per hectare estimates of the function revealed that the production elasticity of labour was found to be negative and non-significant. The production elasticity of seed was found to be significant with negative sign which indicates over use of this input. In both per farm and per hectare functional analysis, the two dummy variables and the intercept of the function found to be significant which indicates the paddy cum 3 crops of

traditional prawn culture is more profitable than paddy cum 1 or 2 crops of traditional prawn culture.

Non-availability of labour and their increased cost formed the major constraint to both paddy cum improved prawn culture and paddy cum traditional prawn culture. Problem of submergence followed by higher price of inputs and salinity and acidity were the next important constraints in paddy cum traditional prawn culture. Non-availability of prawn seed/fry followed by submergence and high cost of inputs formed second, third and fourth important constraints in paddy cum improved prawn culture. Salinity and acidity formed the fifth important constraint in the case of paddy cum improved prawn culture.