

TECHNO-SOCIO-ECONOMIC EVALUATION OF FISH FARMING PRACTICES IN ASSAM

Ph. D. THESIS

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TECHNO-SOCIO-ECONOMIC EVALUATION OF FISH FARMING PRACTICES IN ASSAM

*Thesis submitted in
partial fulfilment of the requirement
for the award of the degree of*

**DOCTOR OF PHILOSOPHY
(INLAND AQUACULTURE)**

BY

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*Dedicated to my
Beloved "Maa & Deuta"*



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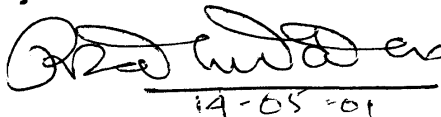
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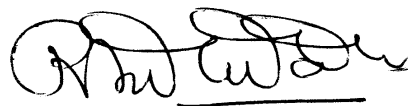


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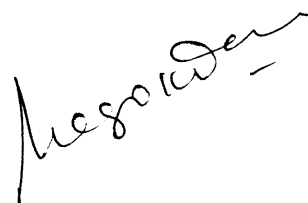
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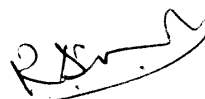
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Chapter I

INTRODUCTION

INTRODUCTION

Increasing population in Asian countries has led to over-utilization of land and subsequent diminishing returns in actual and potential agricultural productivity. Currently India's population has crossed the mark of 1 billion and has reduced the per capita availability of land, which is assumed to be 0.14 ha by the turn of the century. Food and other basic requirements for such a huge population will have to be arranged through optimum utilization of the potential resources on sustainable basis. In spite of the tremendous technological advancements achieved in various land based farming systems, major section of the population is still suffering from malnutrition. In this context it is high time to utilize the potential resources to enhance fish production on sustainable basis to meet the ever-increasing nutritional requirement of the growing population.

One of the major public health problems facing in our country is the protein malnutrition. To solve this problem of malnutrition, we have to depend mainly on fish. Fish has 16-22 per cent protein on an average along with vitamins, minerals and low cholesterol fatty acids. Fish accounts for nearly one quarter of the world supply of animal protein and it has been described as the meat of the "Third world". In many Asian countries, over one half of animal protein intake comes from fish, while in Africa the proportion is 17.5 per cent (FAO, 1998).

The importance of the fisheries sector in both developing and developed economies is mainly that it provides nutritious food and forex earnings. The fishery sector can provide employment to 7 million people in India by involving various fisheries activities. During 1999-2000, the volume of seafood exported was 3,40,000 tonnes worth Rs.5,096.00 crores (Ayyapan and Biradar, 2001). The share of fisheries in GDP from agriculture has almost doubled from 1.90 per cent in 1980-81 to 3.89 per cent in 1993-94. The fish production up to 1997 has shown an annual average growth rate of

about 7.5 per cent. In spite of the phenomenal increase in fish production during the last decade, the present per capita availability of fish in India is still only about 8 kg per annum against world average of 12.1 kg per annum. To fulfill the minimum nutritional requirement of 11 kg per capita as per the World Health Organization (WHO) recommendation and with the assumption of 56 per cent of population as fish eaters in India, 6.34 million tonnes of fish will be required by the turn of the century and 12.0 million tonnes by 2020 A.D. for the country's projected population (Sinha, 1999).

Extensive and continuous research and developments during the past decades have added many glorious chapters in the annals of inland fisheries by developing a number of technologies and package of practices in accordance with developmental needs. In some regions freshwater fish represent an essential, often irreplaceable source of high quality and cheap animal protein, crucial to the balance of diets in marginally food secure communities. Most Inland fish is consumed locally, marketed domestically and often contributes to the subsistent livelihood of poor people. Recently, some inland fish products are also traded internationally generating additional forex earnings. The degree of participation, including a significant number of women and children, in fishing and fish farming can be high in some rural communities, and fish production often is undertaken in addition to agricultural or other activities.

In 1997, the reported global production from inland waters amounted to more than 24.83 million tones, in which contribution of aquaculture was 17.13 million tones. Total marine production was 97.17 million tones where coastal aquaculture contributed 11.14 million tones (FAO, 1998).

The contribution from marine and inland fisheries was 2.9 million tonnes and 2.4 million tonnes respectively to the total Indian fish production. India's fish production of 5.3 million tonnes in 1998 places it at seventh position in the world and accounts 4 per cent of world fish production. India

ranks 2nd position in global inland aquaculture production with a contribution of 1.78 million tonnes to the global aquaculture production of 36.05 million tonnes (Upare, 1999).

Inland fish production in our country has shown a phenomenal growth rate during the last four decades. As against 0.2 million tonnes produced in 1950-51, the production has gone up to 2.4 million tonnes in 1998-99. Out of the total potential inland fish production of 4.5 million tonnes only 50 per cent is now produced through the culture. One of the major production systems in inland fisheries is composite fish culture, which received a tremendous boost after the launching of the IDA (International Development Association) - assisted inland fisheries project in 1980. The average production has reached 2,105 kg ha⁻¹ yr⁻¹ in fishponds managed and supported through Fish Farmers Development Agencies (FFDA). Considering the gap between the highest production achieved and the average, there is ample scope to increase the yields through proper extension of scientific management .

The future of the aquaculture sector is of interest to both the planners and the industry. This interest has been heightened by the growing importance of aquaculture in global fish production and the fact that the capture fisheries probably will not be able to meet the increasing demand for fish as the world population increases. As marine fish catch rate is declining at an increasing level due to over exploitation through indiscriminate fishing poor people can't depend solely on marine fisheries to solve the problems of malnutrition, low income and unemployment. Aquaculture can be one of the solutions in providing the basic needs of the rural poor through generation of employment and earnings. These provisions depend, of course, on the species cultured and the intensity of operations. More importantly, aquaculture holds the promise of becoming a viable alternative to capture fisheries. With increasing depletion of fish from natural sources and rising employment and income needs of small scale fishermen and other socio-

economic groups, contribution of aquaculture for the over all development can't be ignored.

Some major applications of aquaculture for rural development can be identified as meeting basic human development needs, particularly food and livelihood, rehabilitating the environment and maintaining social harmony and promoting social equity. In order to solve the problem of malnutrition in rural areas, knowledge in fish production is vital to rural people. Rural aquaculture is an important sub-sector that contributes significantly to the national food security, family nutrition, rural employment livelihood security of poor especially in the remote and most forward areas.

Fish production from village tanks and ponds can be increased through scientific farming, which will improve the socio-economic condition of rural population by providing them employment opportunities. India is blessed with 2.212 million ha of tanks and ponds, which has a production potentiality of 3.3 million tonnes. Proper utilization of these water resources will ensure increase in fish production in the country. Although plenty of resources are available in our country aquaculture production is not contributing significantly for our national income. Fisheries development in India is, thus, focused on prospecting and developing various water resources for fish production, welfare and development of fishermen communities to improve their socio-economic standards.

There are manifold interactions between fisheries and agriculture through the common use of land and water resources and concurrent production activities to support rural village communities and supply urban areas with the needed quality and variety of food. Such interactions extend to the institutional sphere, as fisheries and agriculture often fall within one government ministry. Improved integration between the two sectors is therefore an important means to enhance fish production and food security.

Integrated approaches to resource management are challenging, but provide significant avenues to enhancing fish production. There are various levels and areas where integrated measures for enhanced fish production are possible or desirable i.e. at the farm level, at the community level and at state and national levels.

The socio-economic status of the fishermen could not permit them to adopt scientific fishing or fish farming. They are least conscious about the existing fish culture technology. To narrow down the gap between actual and potential levels of fish production, propagation and popularization of fish culture technologies along with appropriate legal and policy intervention and infrastructure support are essential.

Fish farming involve economics because fish farmers produce fish and sell them; other people buy the fish and eat them. The fish farmer is called producer because he grows the fish and looks after it just as he does with any other crop and animals. Reasons like better earnings from fish farming than agriculture, utilization of inherited water areas, higher demand for fish, in addition to the opportunity to earn money from other jobs where the farmer lives have motivated people to go for fish farming (Williams, 1983). If the main motivation is mainly to earn money, he will probably produce fish as much as he can from fish farming. If his motivation is simply to keep up with tradition of fish farming he may be less interested in earning, but is happy in producing enough fish for his family. This is why some farmers work hard and try to use the most effective methods of farming while others are happy to just earn enough from the amount of fish that can be produced without much effort.

Studies related to aquaculture economics are very few in our country, costs and benefits of traditional fish culture has first analyzed by Ranadhir (1976). Then Tripathi and Ranadhir (1981) studied the economics of composite fish culture. Economic evaluation of various fish farming practices

at farmers level is essential to know the techno-economic viability of their farming practice. The feed back knowledge of the farmers will help the policy makers and scientist to refine the technology for better profit and technological adoption.

Fish culture is an important economic activity for generating income and employment for a section of population in Assam (Srivastava, 1994). Due to the paucity of the fish production with in the state, middle and lower class people spend a major share of their income on buying fish at exorbitant prices. As the man to land ratio is declining, agriculture can't bear the entire burden of providing food to the population of the region. In this regard fish culture in the available unutilized water resources will be the best option to meet the protein requirement of the people of the region.

Assam, situated in the North-eastern region of the country, has rich fishery resources in the form of riverine fisheries (combined length 4820 km, area 2.05 lakh ha), floodplain wetlands/beels (1.0 lakh ha), ponds and tanks (0.25 lakh ha), swamps (0.1 lakh ha), forest fisheries (0.05 lakh ha), and so on totalling 3.47 lakh ha. These resources are not fully tapped to produce fish to fulfill the demand of the people. There is wide gap between supply (1.55 lakh tonnes in 1995-96) and requirement (2.5 lakh tonnes) of fish which is partially met by supplying fish from Andhra Pradesh, Uttar Pradesh, West Bengal and Bihar. Though aquaculture contributed only 26.2% of total fish production at present (Ali, 1997), it has tremendous scope for development. Availability of a large number of cultivable water bodies, increased availability of quality fish seed and prevailing high demand/price of fish are some of the factors favouring growth of aquaculture in the State. Pond aquaculture is increasingly becoming popular even though the recommended culture packages are not followed *in toto* in most cases. To meet the domestic demand of the state and to stop draining out of money from the state the individual fish farmers of the state whose water resources are primarily tanks and ponds are to be encouraged to adopt scientific fish culture technology.

Adequate credit and banking facilities are required to expand their water area by excavating new ponds or extension of the existing ones.

Information on socio-economic framework of the fish farmer community forms a good base for planning and development of this economically backward sector. The socioeconomic characteristics pertaining demography, caste and age structure, literacy and education, employment and wages, ownership of means of production and capital investment, income and expenditure, savings and indebtedness and customs, conventions and habits of people living in a particular location strongly influence their responses to technological changes and participation in developmental schemes. Lack of adequate and authentic data on Socio-economic condition of the target population is one of the serious impediments in the successful implementation of developmental programmes. In the fisheries sector, several micro and macro level socio-economic surveys had been conducted by various agencies and research workers in different regions of our country to study one or the other problems of the fishermen community.

A number of studies have been conducted on the socio-economic status of fishermen population both in inland and marine sectors of capture fisheries (Chaudhury, 1989). However attempts have not been made to carry out similar studies among the inland fish culturists. The package of practices of improved aquacultural methods have been standardized and applied in various experimental and demonstration centres in different parts of the country. Such studies carried out in Assam from 1975 to 1977 under composite fish culture, showed fish production ranging from 3.71 to 6.5 t under experimental conditions (Sinha, 1978). But studies on Socio-economic status of fish farmer, knowledge and attitude towards composite fish culture and adoption of recommended improved culture practices are not sufficient enough in the country as a whole and more particularly in case of Assam. Keeping in view of all these factors the present study is attempted to evaluate the technical as well as social status of fish farming practices in Assam.

Objectives of the study

- To analyse costs and earning details of different fish farming practices.
- To analyse comparative economic efficiency of various fish farming practices.
- To workout input-output relationship of different fish farming practices.
- To assess the market potential, marketing channel and market structure.
- To assess socio-economic status of the fish farmers with special emphasis to adoption behaviour of fish farmers, their technical knowledge, source of technical information to adopt fish culture practices, problems affecting the adoption of scientific fish culture and women's participation in fisheries.
- To suggest policy guidelines for improving socio-economic conditions of fish farmers.

Limitation of the study

The results of the present study are based on the ability of the respondents to recall the information. The objective of the study is limited to their ability to recall and also to their openness in furnishing the required information. The number of respondents were limited to 120 due to limitation of resources like time and finance. Moreover some of the places under study were declared as disturbed areas due to extremist activities.

Hypotheses set for the study

In the background of postulated relationship of variables as per the theoretical orientation and based on the objectives and assumptions underlying the present investigation, the following null hypotheses were formulated.

- There is no significant difference in the level of adoption among the fish farmers of the two districts.
- Farmers are conscious about cost reduction and profit maximisation in fish farming practices.

Scope of the study

The present study is a pioneering and unique attempt in the field of socio-economics and related aspects of fisheries extension in Assam. Since no basic data is available on the above aspects, the present study will bridge this gap and the constraints for economic development of fish farmer. Further with particular reference to the present study, the credit policies of the financial institutions could be planned for optimum production of fish as well as socio-economic development of the inland fish farmer.

Chapter II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

A good understanding of techno-socio-economic feasibility of any production process is very essential to take any policy decision. Several production technologies with regard to inland and marine fisheries sectors are available in our country. The location specific resource oriented techno-economic feasibility of any production system ensures widespread adoption by fish farmers. Different researchers in various locations made several studies about the technical as well as economic viability of different production technologies. However these studies are either concentrating on economic or social or technical feasibility of the systems. Hence literature survey and their review was undertaken under the following major aspects.

2.1 Freshwater Aquaculture

In the total global inland fish production of 24.83 million tonnes in 1997, aquaculture contributed 17.13 million tonnes., where as mariculture contributed 11.14 million tonnes in total marine fish production of 97.17 million tonnes. At global level freshwater species shared 34 per cent by value and 42 per cent by quantity, where as that of India contribute 50 per cent in terms of value and 11 per cent by quantity (FAO, 1998).

Aquaculture in India can contribute 7 million tonnes of fish by 2,000 A.D. and can offer employment opportunities to 9 lakhs people. To achieve this goal the development of all the aquacultural resources like freshwater ponds and tanks, reservoirs, brackishwaters, estuaries and the mariculture in coastal areas should receive urgent attention (Dwivedi, 1982).

Freshwater aquaculture has become an industrial enterprise in recent years with its immense possibilities of providing rich protein food, generating employment as also much required economic returns for any enterprise to establish. With the marine fish landings getting stabilized over the years and the inland capture fishery resources getting affected due to increasing

pollution, dams and barrages in the river system, aquaculture sector is assuming greater importance in the present scenario. Apart from 1.00 million ha of ponds and tanks and 0.60 million ha of derelict water-bodies ready for aquaculture, irrigation canals and reservoirs are also amenable for aquaculture. The growth rate of 5.80 per cent in inland fisheries as compared to 3.7 per cent in the fisheries sector as a whole is a pointer to the potentials of the sector. The gross domestic product from aquaculture is in the order of Rs.2,351.00 crores and freshwater aquaculture is expected to provide 4.5 million metric tonnes of fish / shell fish by the turn of the century (Tripathi, 1993).

The last two decades have witnessed immense growth in fish production from pond culture, especially freshwater, because of emphasis given for popularization of scientific technologies of fish-seed production and composite fish-culture in India and the efforts made for its development through Fish Farmer's Development Agencies. With all emphasis laid during the last two decades only about 19 per cent of the available resource in freshwater and 7 per cent in brackishwater could be brought so far under scientific fish culture. The remaining areas still either under traditional culture system or lying untapped. There is an urgent need for horizontal expansion by bringing in available ponds/ tanks under scientific aquaculture. Available deep-water paddy fields can form additional resource (Sinha, 1999).

In comparison to crops and live stock, aquaculture needs little house hold labour. The studies revealed that introduction of improved aquaculture would enable labour to obtain a higher marginal productivity. Although the household labours are used mainly on crops, farm households would be able to allocate labour to aquaculture also without hampering other enterprises. Unlike agriculture crop aquaculture does not have no peak and lean season hence farmers can adjust fish stocking and harvesting to suit their resources (Ahmed and Rab, 1992).

Technological changes in aquaculture is considered important as the development of a new product, significant improvements in the characteristic or performance of an existing product and/or the development of improved technique of production. This distinction is useful for categorizing the kinds of developments that is required in aquaculture (Easley, 1992).

The development of aquaculture has been accelerating in recent years throughout India, particularly in the southern India. It has become the men profession for many small as well as big farmers in Andhra Pradesh, and 1.5 lakh ha of paddy fields had been changed into fish farms in West Godavari district. Similarly coastal agricultural farmers of Tamil Nadu had changed their lands either into fish farms or prawn farms (Rao, 1996).

The development witnessed in recent years in freshwater aquaculture led to the emergence of aquaculture in the inland water as an industry. With the technological inputs, scientific management and heavy investments, productivity of fish farming has increased tremendously. Inland pond productivity has increased best 600-800 kg ha⁻¹ yr⁻¹ to 2 tones ha⁻¹ yr⁻¹ and in some cases it is more than 10 tones. National inland fish production has touched the figure of 2.4 million tonnes, nearly 1.7 million coming from inland fish farming (Gopakumar, 1999).

Rural aquaculture is an important sub-sector that contributes significantly to the national food security, family nutrition, and rural employment especially in the remote and disadvantaged areas. About 30% of the animal protein intake by Vietnamese people come from fish. Small holders of aquaculture contribute over 70 per cent to the national aquaculture production. It is a potential resource for improving household food security and supplementing family income of the rural poor communities (Luu, 1999).

Rural aquaculture pertains to the farming of aquatic organisms by small scale farming of households or communities, usually by extension or

semi-intensive, low cost production technology appropriate to their resource base. The main objectives of rural aquaculture are to ensure household food security and to generate income from surplus production system (De and Saha, 1999).

Fish production from village tanks and ponds can be increased through scientific farming which will help to improve the socio-economic condition of the rural population by providing them employment opportunities in aquaculture. Proper utilization of available tanks and ponds for fish culture with the application of a package of inputs is likely to increase the production manifold (Rout and Tripathi, 1985).

Amblypharyngodon mola can be successfully cultured in small seasonal ponds, which can play important role in ensuring greater diet diversity, and increased intake of vitamin A, calcium and other essential nutrients among rural populations. An average production of 0.34 tons ha⁻¹ in seven months in mola ponds and 0.44 tons ha⁻¹ in seven months in the mixed ponds were achieved in some village ponds of Bangladesh (Roos *et al.*, 1999).

Fish production either in fresh or brackishwater culture systems depends upon the quantities of inputs such as seed, feed and fertilizers. Quantitative relationships between inputs and output in many cases are not linear. It is not possible to produce unlimited quantities of fish from a given area of pond even if seed, feed and fertilizers are available in unlimited quantities. There are biological limitations beyond which one can not augment production from a given area of pond even with modern tools of aquaculture (Ranadhir and Tripathi, 1991).

The most important centrally sponsored agency for aquaculture extension service is the Fish Farmers Development Agency (FFDA) which is a district level organization for the development of freshwater aquaculture. To

date, 423 FFDA's have been working through out the country covering a water area of 0.359 million ha of ponds/tanks under aquaculture with average production of about 2,000 kg ha⁻¹yr⁻¹ (Kumar, 1996).

2.1.1 Polyculture and monoculture

In an ecosystem such as fishpond there exist various positions which can be filled by different species. By combining different species in the same pond the total fish production can be raised to a higher level than which would be possible with only one species. The term polyculture can also be used to describe the integrated farming of fish with other animals. In monoculture only one species of fish is kept in the pond. This is used where very high levels of production are aimed at, with the use of supplementary feeds (Swift, 1985).

Poly-culture has been the most popular in China, India, U.S.S.R. and Israel. Bighead carp, grass carp, common and grey mullet were stocked with milkfish, *Tilapia*, sea perch in Taiwan province of China and Hongkong. Common carp, crucian carp and shrimp formed the main component candidate species for culture in Japan. Polyculture in Yugoslavia utilizes common carp as the primary species supplemented by tench, catfish, pike-perch and pike. A common carp tilapia mixed culture was found to be very successful in Israel (Sinha, 1976).

Lin (1955) reported the details of poly-culture as practiced with several species of carp in China. The use of grass carp, together with tawes (*Puntius gonionotus*) and *Oreochromis mossambicus* appeared to be very successful than the traditional Chinese carp culture.

Culture of single species in a given culture unit, regardless of whether it is a pond, a raceway, a tank, a cage or other type of culture chamber is known as Mono-culture (Stickney, 1979). In pond mono-culture the animal being reared usually fails to utilize all positions of environment. Polyculture,

the rearing of two or more species in each culture unit, enjoys wide popularity throughout much of the world (Bardach *et al.*, 1972).

Polyculture is commonly practised in pond where several fish species are reared together, creating multi-output production structure. Sharma *et al.* (1999) applied a non-parametric data envelopment analysis (DEA) technique for multiple out puts to measure economic efficiency and its technical and allocative components for Chinese polyculture fish farms and to derive optimum stocking densities for different fish species. Smaller farms from developed regions were found to be relatively more efficient technically and economically.

Cage culture of *Catla catla* has been carried out successfully in a freshwater tank. Rearing of fingerlings to table size at a stocking density of 1.26 lakh ha⁻¹, 1.41 kg⁻¹m⁻²month⁻¹ and 1.31 kg⁻¹m⁻²month⁻¹ was achieved (Govind *et al.*, 1988).

Carp polyculture has gained much importance all over the world because it contribute to the extent of 90 per cent of total aquaculture production Planktophagous, herbivorous, fast growing, non-predatory species of fish are generally preferred for culture in freshwater ponds because they efficiently convert organic matter into fish flesh and consequently give high yields (Michael, 1988).

During the late fifties exotic species of carps, viz., grass carp, silver carp and common carp, were introduced into India. Extensive research on their compatibility in mixed culture was conducted at the pond culture division of the Central Inland Fisheries Research Institute (CIFRI), Cuttack (Lakshmanan *et al.*, 1971).

The compatible combination of Indian major carp and exotic carp which termed as composite fish culture is quite distinct from Indian polyculture

of carps where only Indian major carp are reared together. The fish production increased much more when the pond was stocked with 6 species combination, viz. catla, rohu, mrigal, silver carp, grass carp and common carp compared to the production obtained either with rohu, catla and mrigal combination or silver carp, grass carp and common carp combination. This high yielding combination of 6 species of carps is termed as Composite Fish Culture. On the basis of growth performance of different species, modifications are made in stocking density, species ratio, fertilization and supplementary feeding programmes to improve the growth rates of the fishes and thus to achieve better production (Sinha and Gupta, 1975).

In addition to the six species of carps, other fishes comprising a feather back (*Notopterus chitala*) and three catfishes (*Ompok bimaculatus*, *Mystus seenghala* and *Pangasius pangasius*) were included to feed on minnows, insects, shrimps and molluscs. With the extension of composite fish culture to larger ponds of about 2 ha, a production of about 4,000 kg ha⁻¹ yr⁻¹ was obtained in West Bengal (Sinha *et al.*, 1973).

The composite fish culture technology innovated and standardized during seventies at Central Inland Fisheries Research Institute (Chakraborty *et al.*, 1974) was successfully demonstrated throughout the country with an average production potential of 3,000 kg ha⁻¹ yr⁻¹ and formed a major aquaculture system in freshwater of West Bengal and neighboring states (Bhaumik and Saha, 1998).

Carp poly-culture is the most prevalent system among freshwater pisciculturist in the country, with large varieties of fish species, stocking densities, water management, feeding practices etc. depending on the resource availability and local demands. CICFRI developed a package of practices of carp culture with an average production potential of 4,000 kg ha⁻¹ yr⁻¹. Composite fish culture aims of fuller utilization of pond productivity at different ecological niches by culturing together fast growing six compatible

species of complementary feeding habits. The ratio and number of different species is suitably regulated in an environment free of weeds and harmful fishes under hygienic condition with health monitoring as and when required (Sinha, 1990).

Most of the fish harvested from farmed and non-farmed water bodies, consist of both stocked and wild fish and the average fish yield in Bangladesh was only about 550 kg ha⁻¹ yr⁻¹ (Ahmed, 1992). New aquaculture systems that combine culture of Indian major carps with common carp (*Cyprinus carpio*) and Chinese carps and the short cycle culture of species such as tilapia (*Oreochromis niloticus*) and silver barb (*Puntius gonionotus*) could increase productivity by as much as three times (Gupta *et al.*, 1992).

Dalai and Das (1992) reported average low fish production i.e. 800 kg ha⁻¹ yr⁻¹ from extensive fish culture in selected blocks of Ganjam district of Orissa. The study revealed which could be attributed to lack of proper management practices. The farmers were found to use inferior quality and low quantity of different inputs indicating lack of awareness among farmers about aquaculture practices.

Shankar *et al.* (1998) studied on the role of substrates based microbial biofirm in the production of *Cyprinus carpio* and *Labeo rohita* using an easily available and bio-degradable agricultural waste product (Sugarcane bagasse) as substrate. Results indicated the potential for increasing fish production at cost by adding easily available and bio-degradable agricultural substrates in to the ponds. Development of viable, low cost technologies and their application to current farming practices will help to increase the area under aquaculture as well as its yield.

A yield gap and constraints in inland fish culture study made by Suresh *et al.* (1988) revealed that the presence of predators and weed fishes, poo:

quality and inadequate application of inputs as the major production constraints.

2.1.2 Integrated aquaculture

The integrated approach of development of agriculture, animal husbandry and fish farming is essential for an over all rural development, since it would result in farm produce diversification, increased cash income, improved quality and quantity of food produced for home consumption, and exploitation of unutilized resources available to small farmers (Sinha, 1978).

The nutritional potential of aquatic resources is very important in developing countries. To realize this potential, integrated research and management for sustainable water resource use are needed. An interdisciplinary communication and research collaboration of various disciplines of limnology, hydrology, aquaculture, fisheries ecology and management and pollution ecology is essential for sustainable use of inland aquatic resources (Mitchell and DeSilva, 1992).

New way of farming that regenerates environment and increase household purchasing power must be designed, tested and put into operation by large number of farmers. Important components of such systems both for environmental and economic objectives, will be biological diversification and nutrient recycling. The integration of aquaculture and forestry into agriculture based farms provides an appropriate starting point on the design of regenerative farming systems (Lightfoot, 1990).

Carp polyculture is well integrated with other farming systems like poultry, piggery, duckery and horticulture as also with paddy cultivation. Around 2 cows, 40 sheeps, 250 ducks, 500 poultry birds, 40 pigs can sustain fish production levels to the extent of 3-6 tonnes $\text{ha}^{-1} \text{yr}^{-1}$. Integrated system provides a high risk aquaculture but the yields are also high in the order of 3000 kg $\text{ha}^{-1} \text{yr}^{-1}$ in cattle-based, 3,500 kg $\text{ha}^{-1} \text{yr}^{-1}$ in duck based, 4,000 kg

ha⁻¹ yr⁻¹ in poultry based and 6,000 kg ha⁻¹ yr⁻¹ in pig based system (Tripathi, 1993).

Agriculture, animal husbandry and fish farming were viewed as both complementary and supplementary to the ecological niche. An extensive type of paddy-cum-shrimp culture is a unique practice in certain parts of India. Fish-culture in paddy fields was extensive and well developed in Indonesia (Sinha, 1976). A three way rotation of fish, soyabeans and rice is being tried with considerable success by some farmers in Arkansas, U.S.A. (Pillay, 1973).

Paddy-cum-fish culture in India had been described in detail by Hora (1951), Chacko and Ganapati (1952), Iyengar (1953), Alikunhi (1960), Tripathi (1963), etc.

The village resources are best suited for integrated system of fish culture. The integrated systems available are paddy-cum-fish, poultry-cum-fish, cattle-cum-fish and pig-cum-fish farming. Some of the systems can be adopted either in single or in combination. Paddy-cum-fish culture is one of the most appropriate technologies for rural development (Ranadhir, 1998).

Integrated rice-fish culture is practiced within rice areas protected from excess flooding by dikes. A wide variety of fish species have been cultured, including common carp (*Cyprinus carpio*); Indian major carps such as rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigala*) and catla (*Catla catla*); Chinese carps such as silver carp (*Hypophthalmichthys molitrix*), and occasionally grass carp (*Ctenopharyngodon idella*); Nile Tilapia (*Oreochromis niloticus*) and silver barb (*Puntius gonionotus*) (Gupta *et al.*, 1998). Reported fish production figures under paddy-cum-fish culture vary widely, ranging from under 100 kg ha⁻¹ to over 2000 kg ha⁻¹, depending on the intensity of the system (Lightfoot *et al.*, 1992).

Our country has a resource of 2.3 million ha of deepwater rice plots in the freshwater sector, which can be exploited through rice-fish culture. States with heavy monsoon precipitation, particularly West Bengal, Assam, Tripura, Manipur, Orissa, parts of Bihar in the eastern part of the country, some parts of Andhra Pradesh, Karnataka and Kerala in the south have good potential for further development of rice-fish farming. The deep water rice fields, retaining around 50 cm of water or above during monsoon months, are ideal for fish integration. In Assam many parts of the old fortresses constructed by tribal chiefs of the states are considered most suitable for rice-fish farming. The 37 ha Jangal Balahu Garh fortress in Nagaon district offers a ready-made site for rice-fish farming. There are other noflood prone areas in Goalpara and Dhubri districts of the state which could also be developed for rice-fish culture (Ghosh, 1992).

Paddy-cum-fish culture in freshwater paddy fields has not been popular although considerable potentiality exist in West Bengal, Assam, Bihar, Orissa and Andhra Pradesh and technology in this regard is available (Ghosh *et al.*, 1985).

Paddy cultivation in the North Eastern states continues to be on the traditional pattern, providing a subsistence level of income only. Added to this, geographical isolation and high demand of fish has rendered paddy-cum-fish culture as a highly cost effective and financially viable agrarian practice. Ghosh and Pathak (1988), studied economics of paddy-cum-fish culture in North eastern states in different situations like monocropped areas in the low hills, the monocropped areas in the plains of Assam, Manipur and Tripura and irrigated double cropped areas of Manipur and Assam. The additional production prospects from fish in the three situations vary from 200 kg ha⁻¹ crop⁻¹ to 1000 kg ha⁻¹ crop⁻¹ at a negligible extra cost.

Paddy-cum-fish culture is practised in some appreciable extent only in Nagaland among Northeastern state. There are some traditional practices of

growing fish in the paddy fields in certain other areas like Juria block of Nagaon district (Assam) and the hill tracts of Ukhrul district (Manipur). But these culture practices are low yielding and mostly subsistence in nature. The Agricultural Finance Corporation / CIFRI study has identified enormous potential for developing paddy-cum-fish culture in the north-east. Out of the potential 45,000 ha, only 2,7780 ha were developed till 1991 (Sugunan, 1998).

Bayan *et al.* (1996), observed that the practice of collection of various fish species from the waterlogged rice fields during rainy season is common among the rice farmers of Barpeta district of Assam. Though the true culture fishery was hardly observed some farmers stocked their paddy field with fry and fingerlings of carps and obtained a fish production of 300 kg ha⁻¹season⁻¹. This study revealed that less productive rice areas (1-1.8 tonnes of rice) where water logged for 3-7 months may be used for the production of fishes with rice.

The state fisheries department of West Bengal, undertook nursery rearing of carps in rice fields where carp fry (19-64 mm) were stocked at 1,457 ha⁻¹ and raised up to 127-135 mm size in three to four months to get production of 112 kg ha⁻¹ (Hora, 1951).

Experiments on double cropping of paddy by creating facilities of storing water in a part of rice field through its conversion in to a trench, canal or a small pond for fish farming as an additional component resulted in a total production of 5,500 kg ha⁻¹ of paddy and 700 kg ha⁻¹ of quality fish (Ghosh, 1979).

Delacruz (1992) reported that fish culture was practised in Cordillera Administrative Region, rainfed mountainous area in the Northern Philippines, during rainy months (August-December) followed by concurrent rice-fish-culture from January to August. The major species cultured were Nile Tilapia

(*Oreochromis niloticus*) and common carp where 250-200 kg ha⁻¹ of fish production was obtained. Rice mono-culture without fertilizers (one crop per year) yielded an average 2.38 tonnes ha⁻¹ as against 3.13 tonnes ha⁻¹ with inorganic fertilizer plus 0.38 tonnes ha⁻¹ of fish (two crops) for the experimental pattern.

Ghosh (1990), reported that an experimental rice-cum-paddy fish culture was carried out in west Bengal in 1.02 ha paddy plot with 0.27 ha perimeter canal of 6 m width and 1.2 m depth where carp fingerlings were stocked at the rate of 6, 000 fingerlings ha⁻¹ maintaining the species ratio of rohu 30 : catla 40 : mrigal 30. This experimental culture practice showed a production of 1,200 kg ha⁻¹ kharif paddy and 4, 300 kg ha⁻¹ rabi paddy besides 700 kg fish ha⁻¹ per 10 months.

Felix *et al.* (1992) reported that under the integration of paddy and fish two crops of paddy and a single crop of fish was raised. Rohu, catla, mrigal, common carp and minor carp were stocked at the rate of 4,000-6,000ha⁻¹ and harvested after attaining average weight of 400-500 gm per fish at the end of kharif season. Annual turnover of Rs.34,550.00 was achieved by annual investment of Rs.11,397.00 with rice production of 6 tonnes and fish production of 1 tonnes.

Stocking of hatchery produced fingerlings in semi deepwater rice fields in Mekong Delta region of Vietnam resulted in production of fish from 99 to 730 kg ha⁻¹. In most cases fish yields are below 300 kg ha⁻¹ for a rearing period of 6-9 months. Typical fish species in this system are silver barb (*Puntius gonionotus*), common carp (*Cyprinus carpio*) and tilapia (*Oreochromis niloticus*). Reasons for the low farm input include a combination of technological and socio-economic factors and natural hazards. The fish profitability was also affected by low market price and high production cost (Nhan *et al.* 1997).

Household scale integrated farming in Vietnam combines three diverse farming components - the vegetable or fruit trees garden, fish / shrimp pond and livestock pen practice is a popular farming practice. This system is based on optimum use of by products and wastes through recycling in aquaculture ponds. In such a system, the aquaculture component contributes about 30-70 per cent to the total income from the household farming system. Fish is produced primarily for family consumption; the surplus is sold. Pond water is used for live stock and for irrigating the garden. From time to time, the bottom sediment is dredged and used as organic fertilizer for vegetables and fruit crops (Luu, 1999).

Mazumder and Lorenzen (1999) studied to explore recent changes in the availability of small native species (SNS) in relation to agro-ecology and related issues as the small native species of fish have played important role in the livelihood of rural people in Bangladesh. Poor people have gained from the intensification of agriculture in terms of rice consumption but they have lost in terms of reduced access to fish and other animal products. The integration of small native species into aquaculture systems may be an effective method of increasing their availability to the local population and to conserve the biological diversity that they represent.

The system of integrating fish culture with live stock rearing is rather developed in China, Malaysia, Hungary and Germany. In some of these countries fish farming is integrated with poultry rearing or pig farming (Woynarovich, 1979). In India experiments of integration of fish culture with piggery were initiated at CICFRI, Barrackpore in the year 1979 (Sharma *et al.*, 1979). Pig keeping in India is associated with weaker sections of the society and tribals who maintain indigenous breeds of non-descript types. Pigs are fed and / or allowed to graze on pond banks, slopes and edges, the wastes either automatically flowing down into the pond or else drying up and getting converted into a manure which is washed into the pond during rain (Tripathi, 1993).

In pig-cum fish culture 60 per cent of the area is used for fish ponds while 10 per cent is used for raising grass and the remaining 30 per cent for piggery and duckery, besides canals. Pigsties are erected on the pond embankments and each pig house is divided into several compartments of 2.5 x 2.5 m² size. About 5-25 pigs of six weeks old per hectare of farm area reared depending on the type of integration (Joseph, 1993).

Daily application of fresh, raw wastes collected from pigsties and placed in heaps in the four corners of a 0.1 ha pond resulted in a production of 7,300 kg ha⁻¹yr⁻¹. It was estimated that 35-40 pigs would void 20,000 kg ha⁻¹ yr⁻¹ in one year and hence could be safely reared for fertilizing a 1 ha pond (Jhingran and Sharma, 1979).

Experience has also shown that approximately 3-5 kg of carp can be produced by using 100 kg of pig manure as a fertilizer (Woynarovich, 1979). In the Central African Republic, pig raising in conjunction with fish farming has more than tripled farmer's earnings and significantly improved fish production. Pig-cum-fish culture influenced in increasing farmer's earnings by more than three times with a significant improvement in fish production (Pillay, 1973).

Even though poultry-fish farming has not yet been widely practiced integrated fish farming as pig-fish or duck-fish, seems to be more advisable due to the high nutritive value of poultry droppings. The poultry droppings maintain primary production levels above 300 mg⁻¹cm⁻¹hr⁻¹. A mixed culture of milk fish (fingerlings), Tilapia (fingerling) and shrimp (juveniles) were carried out at a stocking density of 200, 1,500 and 5,000 respectively in a 0.1 ha pond where a poultry house of 4x8 m size stocked with 90 chicks of 3 weeks old was installed. Two chicks crop were harvested along with one fish crop during 90 days culture period (Banerjee *et al.*, 1989).

Ayyappan (1999), described a new floating shelter system for duck-cum-fish culture in an integrated farm. This system prevents the predation of fishes by the ducks and movement of the floating unit throughout the ponds makes uniform distribution of duck droppings. The recommended shelter area for each duck is 0.5-1 m² and spacing is 1 duck /2-4 m². He also described a new system of poultry-cum-fish culture that overcomes collection of wastes and adding them to the pond. This system prevents eutrophication as bird wastes are no longer accumulated at one site.

2.2 Costs and Earnings of Various Fish Farming Practices

Economics is concerned primarily with the study of problems associated with the production and distribution of economic goods and services. Economics deals with choices between alternatives. Problems of choice arise only when resources are scarce and alternative uses can be made of them.

The cost of anything is the expenditure involved to produce it. The revenue received from the next best use is referred to as the opportunity cost. Total cost of production is often divided into variable costs and fixed costs. Variable costs include money payments for fertilizers, fingerlings, chemicals, feed and payments for labour. Fixed costs are those costs incurred even if there is no production. The two normal fixed costs are depreciation and interest for the initial investment. Variable costs are related to the quantity of output produced. The total fixed costs (TFC) curve is parallel to the horizontal axis. This means that cost is same for the production period. The total variable cost (TVC) curve begins from the origin and increases at an increasing rate and then at a decreasing rate. The total cost (TC) is the sum of the TVC and TFC. Thus the TC curve originates at the point where TFC curve meets the vertical axis then runs parallel to TVC, because fixed costs don't vary in the short run (Sundharam and Vaish, 1973) .

The relationship between the cost function and output may be better studied by examination of marginal cost curves. Marginal cost is the additional cost necessary to produce one more unit of output. Marginal costs depend on the nature of the production function and the unit costs of the variable inputs.

The total costs in inland fishery consist of variable and fixed costs. The variable costs are expenditure made toward seed, fertilizers, feed, chemicals to control pest and diseases, fuel and electricity charges, annual pond preparation costs, wages to hired labour, interest on working capital and imputed value of family labour. The fixed costs are insurance charges, depreciation cost annuity value of pond construction cost and interest on fixed capital.

There are not many studies on aquaculture economics in the country. Ranadhir (1976) first reported the costs and earnings of traditional fish culture operations. Tripathi and Ranadhir (1981) presented an economic analysis of composite carp culture technology. Recently, based on 156 case studies, a model on composite carp culture has been developed with input use and output elasticity (Ranadhir, 1989), which explains 84% variations in the output. The model indicates feed to be the most important variable with high output elasticity.

Experimentation with various methods of data collection and analysis is a necessary step for assessing economic health of the fishery. Smith *et al.* (1983) conducted an investigation to collect costs and earnings and price data from sample respondents in the harvesting and marketing sectors from San Magual Bay.

Cost of production is the most important factor for understanding the profitability of an aquaculture enterprise. Sinha (1978) worked out cost of

production at Rs.2.80 to produce fish at the rate of 6537kg ha⁻¹ yr⁻¹ from a pond area of 0.25 ha in Assam.

A fish farmer has to plan very carefully in advance about his expected expenditure on the inputs involved so as to reduce his cost of production on land, labour and technological aspects. In addition to the variable costs, fixed costs such as insurance, interest on capital, taxes have to be brought down for earning high profits (Rao, 1996).

Easley (1992) stated that reduction in the production cost may be possible through genetic and biological manipulation. The economic effects of such improvements can be analysed at both the firm and industry levels. At the firm levels by improving food conversion, the cost of growing an additional fish can be reduced.

The size, shape and depth of the pond and the clearing work required also affect the cost of construction. Generally larger the pond size the greater the efficiency of land and water utilisation and lower the construction costs. On the other hand the smaller the pond size the greater the convenience of pond management and lower the earth work maintenance (Tang, 1979).

The profitability of fish culture in the ponds depends mostly on the cost of production and market price of the fish besides the yield. High profitability can be achieved by better biological and technological management of the ponds. Padmavathi and Anjaneyulu (1992) studied the cost of inputs, production and earnings in two successive crops in three ponds with different managerial practices in Krishna district, Andhra Pradesh. The study revealed that fish yield, operational costs and returns varied among the ponds and also between successive crops.

Leopold (1978), revealed that bigger the individual size of stocking material lower the cost of production per unit of marketable fish and higher

the profit. Fish kept in one pond for longer period to produce larger size would result in higher cost per unit of fish harvested. It would not be economically feasible to produce larger sizes if the increased cost of feed could not be offset by the increased unit price of a larger fish.

An analysis of the production costs was made on the basis of the data collected from different parts of India, under the All India Co-ordinated Research Project on Composite Fish Culture to know the potentiality of the pond for fish production and cost involved in the major inputs such as feed, fertilizers and fingerlings required. The improved composite fish culture could be adopted in existing old ponds with an expenditure of Rs.1,000.00 ha⁻¹ for every 10 years. The cost for certain implements like nets could be considered as Rs.1,500.00 for five years; annual developmental cost for net will be about Rs.400.00 (Sinha, 1976).

The cost of feed can be reduced by improving the conversion ratio or by lowering the unit price of feed or by combining these two factors. The economic principle of feeding is that the amount of feed should be at a level where the additional cost of feed equals its additional revenue. Amounts above this level would be a waste from an economic point of view. Using either organic or any combination of organic and inorganic fertilizers might reduce the total cost of fertilizer. The amount of fertilizer applied should not cost more than the additional revenue it produces, and the least cost combination of fertilizers occurs when the marginal rate of substitution equals the inverse ratio of the price of fertilizers (Shang, 1981).

Feed and/or fertilizer comprise more than 50% of the total cost of production (Rabanal and Shang, 1979; Wattanuchariya and Panayotau, 1982, Shang, 1981). Cost of feed per unit of fish production (C_f) depends primarily on two elements: the conversion ratio of fish to flesh R and the unit price of feed (P_f). Shang (1981) expressed this as $C_f = RP_f$.

In traditional fish culture, the important aspects of pond preparation, manuring and fertilization are almost absent except that at times organic manure is supplied. But in composite fish culture besides selecting suitable compatible species and their ratio, feeding of fish with supplementary feeds and fertilization of ponds are done. Thus all these necessitate and justify a full time occupation. A fish farmer himself with the help of one fisherman should be able to carry out feeding and fertilization programme and the watch ward of the fish pond/ farm. For a 2 ha unit a skilled fish farmer along with two fishermen and two watchmen would be needed (Sinha and Ramachandran, 1998). Small and marginal aquaculture farmers who are having nearly 200 days of excess labour can fruitfully utilize their excess manpower towards culture of fishes which may raise their income level above Rs.8000.00 which is taken as the poverty line (Ranadhir, 1997).

An economic analysis of polyculture of Indian and exotic carps revealed that a net profit of Rs.22,100.00 could be obtained by investing a total amount of Rs.37,900.00 where percentage of return on variable cost was 58.30. This analysis showed cost of production of one kilogram fish at Rs.9.47 (Sinha, 1990).

An analysis worked out by Ranadhir and Tripathi (1991) revealed that an additional production of 4,847kg ha⁻¹ of exotic carp was obtained by foregoing a production of 1,378 kg of IMC at Killa fish farm in Cuttack. The farmer has to incur an additional cost of Rs.27,348.00 ha⁻¹ besides a loss in income of Rs.27,560.00 ha⁻¹ in not producing Indian major carps to the production capacity at current price levels. The additional cost and loss was more than compensated by production of additional exotic carps. The production of exotic carps could offer an alternative to the lower middle class and poorer sections of the society in view of the high cost of IMC.

Suresh *et al.* (1992) evaluated the costs and returns from composite fish culture in Madurai-North and Melur Taluks of Madurai district. The cost of

stocking and harvesting associated for a major share followed by feeding and fertilization. The total cost of production per ha was Rs.2,930.00 in Madurai-north Taluk. The average cost of production per kg of fish was Rs.5.60 in Madurai-north Taluk and Rs.4.50 in Melur Taluk. Net return per ha was Rs.2,863.00 and Rs.818.00 in Melur Taluk and Madurai-north Taluk respectively. Output input ratio indicated that for every rupee invested in fish culture, returns of Rs.1.27 and Rs.1.74 were found in Madurai and Melur Taluk respectively. Total cost function showed that on increase in pond size by one ha would increase total cost by Rs.395.00 and every additional kilogram of fish produced would involve a marginal cost of Rs.3.40. Variable cost function showed that an increase in fish production by one kilogram would increase total variable cost by Rs.3.10.

Dalai and Das (1992) studied economic analysis of extensive fish culture in selected blocks of Ganjam district, Orissa where the expenditure on lime, manure and fertilizer ranged from Rs.295.00 to Rs.3,500.00 ha⁻¹. There was a significant correlation ($P < 0.05$) between cost of fertilizers and manures with total fish production. The regression equation developed was $Y = 604.105 + 0.282 X_1$ ($r^2 = 0.414$). The expenditure on feed was Rs.250.00 to Rs.1,200.00 ha⁻¹ yr⁻¹. Significant correlation was found between cost of feed and fish production and regression equation developed was $Y = 508.148 + 0.792 X_2$ ($r^2 = 0.495$). The labour cost ranged from Rs.50.00 to Rs.500.00. A significant of correlation between cost of labour and fish production was found and regression equation was developed as $Y = 547.172 + 1.439 X_4$ ($r^2 = 0.275$). Total cost indicated the degree of input used and influenced the yield. Total cost ranged from Rs.900.00 to Rs.16,500.00 which showed significant correlation between total cost and fish production. The regression equation developed was $- Y = 327.768 + 0.0652 X_5$ ($r^2 = 0.489$).

Rao and Raju (1998) studied the cost structure of a freshwater fish farm of 8.93 ha size. The variable costs shared 86 per cent of total costs whereas fixed costs shared 14 per cent. The total variable cost ha⁻¹ of

freshwater fish culture on an average came to Rs.35,710.00 from the sampled farms on an average. The total fixed costs accounted to Rs.5,747.00 ha⁻¹ of which annuity value which was the spread out value of initial pond construction costs over its life period, shared 4.25 per cent of total cost i.e. 1,760 .00 ha⁻¹. Depreciation cost was reported to be Rs.692.00 ha⁻¹ i.e. 2 per cent of total cost. The supervision charges, watch and ward came to Rs.1,587.00 i.e. 3.82 per cent ha⁻¹. On an average the total costs ha⁻¹ of freshwater fish culture was Rs.41, 457.00 on an average and the productivity under freshwater fish culture was 3,903 kg. Total returns was reported was Rs.82,880.74 as against the total costs of Rs.41, 457.00.00.

Ranadhir (1998) reported minimum production of 500 kg of 700-750 gm individual size fish in a year's time with a gross income of Rs.7,500.00 by investing Rs.3,008.00 from a 0.2 ha pond size. Starting with the simplest technology where ponds are prepared, manured and stocked, the farmers can easily leap the benefits to the tune of Rs.22500.00 ha⁻¹ yr⁻¹. In case of an intermediate level of input application with a total cost of Rs.76,000.00 a net profit of Rs.44, 000.00 ha⁻¹ was obtained where average gross yield was 6 tonnes ha⁻¹ and cost of production was Rs.12.65 kg⁻¹. A net profit of Rs.76,000.00 was obtained in a high level of input technology culture practice where total cost was Rs.1.29 lakh ha⁻¹ and average gross yield was 10 tonnes. The stocking density of Indian and exotic carps followed in the low input, intermediate input and high level of input technology was 5,000 (only IMC), 3,500 and 6,000 numbers (IMC and exotic carps) respectively.

Singh *et al.* (1995) worked out the economics of fish production in Hasanpur block of Bihar where average fish production per hectare was found to be 1,477 kg. While the productivity was higher on medium ponds i.e. 1,675 kg ha⁻¹, it was much less on small ponds i.e. 952 kg ha⁻¹. The cost of production of fish was Rs.17.84 kg⁻¹ though on higher side yielding a net income of Rs.14.52 kg⁻¹. Returns on investment per rupee in fish production was worked out to be 123.00 per cent. The study revealed that fish farmers

were using indigenous species of fishes and practicing traditional method of fish culture, generally on rented public ponds. For these types of ponds the average cost of fish production per hectare was Rs.17,490.00 accounting for 67.41 per cent variable costs and 32.59 per cent fixed costs.

Ghosh *et al.* (1985) worked out the capital and operating cost and return on the basis of one ha in paddy-cum-fish culture system developed by CIFRI and this revealed that a net profit of Rs.3,629.00 could be achieved by an annual investment of Rs.18,140.70.

The operational economics of integrated system shows a far higher return than paddy cultivation. At an operational cost of Rs.4,714.00 ha⁻¹, the total out put value was Rs.9,040 ha⁻¹ including Rs.4840.00 ha⁻¹ from paddy and Rs.4200.00 ha⁻¹ from fish showing a net profit of Rs.4326.00 ha⁻¹ (Tripathi, 1993). If no trenches were dug for fish, the income from two crops of paddy alone from the canal area would have been worth Rs.1306.00 ha⁻¹ as against the value of fish worth Rs.4200.00 ha⁻¹ (Ghosh, 1979).

In organized system of coastal-fish culture system with distinct brackishwater and freshwater aquaculture phases the return to investment is 35 per cent where annual investment was Rs.22,555.00 ha⁻¹ for a gross return of Rs.30,454 ha⁻¹ on the basis of 1985 price index. The economic analysis of modified Bhasabada-type of rice-fish culture system in West Bengal revealed that an annual profit of Rs.21,755.00 was achieved against a total annual investment of Rs.38,645.00 where return to investment was 56.29 per cent (Ghosh, 1990).

Ranadhir (1998) worked out an additional net income of Rs.17,000.00 ha⁻¹ in fish-cum-cattle farming where operational cost was estimated at Rs.5,400.00. The excreta from 3-4 pigs is sufficient to fertilize a small pond of size about 0.1 ha, earning an additional income of Rs.3,000.00 whereas, 40-50 ducks are sufficient to fertilize 0.1 ha pond and giving a net income of

Rs.4,650.00. A technology of raising 50 country poultry will provide sufficient manure to fertilize a pond of 0.1 ha and a net income of Rs.4,000.00-5,000.00. The releasing of 5,000 fingerlings ha⁻¹ of magur (*Clarias batrachus*) fingerling in the paddy field can give an additional fish crop of 350 kg and net income of about Rs.6,000 ha⁻¹.

The average of total fish production of 155, 73 and 11 kg ha⁻¹ for rice-introduced fish, rice- indigenous fish and rice-monoculture was reported by Nhan *et al.* (1997) in rice-fish farming in Mekong Delta in Vietnam. The study revealed that total farm return above variable costs (RAVC) and total farm net return (NR) of the rice introduced fish and the rice-indigenous fish systems are lower than those of the rice-monoculture system. The total farm cash return from rice introduced fish, rice indigenous fish, rice-monoculture were Rs.3,243.00, Rs.3,180.00 and Rs.3,914.00 per ha respectively.

Raju and Reddy (1998) reported that integrated farming system of rice-cum-fish culture is more suitable for small and marginal farmers. Experiment conducted on Rice-fish Farming at the Agricultural Research Station of West Godavari district in Andhra Pradesh revealed that paddy cultivation gave a net profit of Rs.6,000.00 to Rs.8,000.00 ha⁻¹ yr⁻¹ only, whereas under rice-fish and banana farming a net profit of about Rs.18,000.00 to Rs.23,000.00 ha⁻¹ yr⁻¹ was obtained. The cultured fish species were catla, rohu, mrigal, common carp and *Macrobrachium rosenbergii*.

Shingare and Shirgur (2000) reported that paddy-cum fish culture in summer yielded a production of an average of 140 kg of fish per hectare in a duration of 80 to 90 days. The yield of paddy went up by 38 per cent in the paddy plot with fish culture than in case of the plot with paddy culture alone. An appraisal of the economics of the trial operation revealed a net profit of around Rs.3103.00 through the sale of common carp.

The average cost of fish production in pig-cum-fish culture worked out to Rs.0.93 kg⁻¹ and the profit to be Rs.48,816.30 ha⁻¹ (Sharma *et al.*, 1979). Jhingran (1991) reported that a net profit of Rs.5,726.56 was achieved from a cultivable area of 0.1 ha in pig-cum-fish culture.

Fish feeds directly on the pig excreta which contains 70 per cent digestible food and hence this acts as substitute to fish feed and pond fertilizer which accounts for 60 per cent of the input cost in fish culture. The excreta of 30-40 pigs is adequate enough to fertilize one hectare water area and to stock 8000-8500 fingerlings of IMC. The economic evaluation revealed that an investment level of Rs.45,804.00 assures a return of Rs.69,600.00 in pig-cum-fish culture. The net return on variable cost worked out to 51.90 per cent and cost of fish production was Rs.6.90 kg⁻¹ (Das, 1990).

Fisheries co-management is increasingly seen as a solution to the problems of resource use conflicts and over-exploitation. Co-management is expected to lead to improved economic efficiency, equity and sustainability. The transaction cost in fisheries co-management can be broadly categorized into 3 major cost items: (i) information cost, (ii) collective fisheries decision making costs, (iii) collective operational costs. These costs need to be determined for evaluating the feasibility of a co-managed fishery compared to a centrally managed one (Abdullah *et al.*, 1998).

The importance has been given for the use of various modern devices like computer management aid for planning, budgeting, record keeping, accounting and development of techno-economic aspects for profitability and sustainability of fish seed production as well as farm management. The development of a model suitable for each region pertaining to the agro-climatic condition, resource availability and cost is essential for the sustainability of such programmes (Selvaraj and Goswami, 1996).

Heady and Dillon (1991) stated that the production function would explain the relationship between the input of factor services and output of the product. Samuelson (1973) defined production function as the maximum amount that could be produced by each and every set of specified inputs as factors of production. Strigler (1974) defined production as the relationship between inputs of production services and output of production per unit time. Sadeghi (1978) used Cobb Douglas type of production function to study the impact of increased water supply on small farmers and concluded that small farmers were rational in the allocation of resources.

Reddy (1982) defined production function as the locus of efficient points of feasible production set and indicated quantitative relationship indicating maximum amount of physical product obtainable with in a set of inputs at a given technology.

Rout (1991) used six independent variables like mohua oil cake, lime, cowdung, fertilizer, feed and area to form a multiple regression model.

Ranadhir and Tripathi (1992) used Cobb-Douglas production function to find out the statistical relationship of physical quantities of inputs and outputs in fisheries. In the present study a linear form of production function was fitted to examine input and output relationship in fish farming system.

Rao and Raju (1997) studied efficiency of resource use in freshwater fish culture using Cobb-Douglas production function model where independent variables like pond area, stocking density, fertilizers, fed, fuel and electricity, pest and disease control, labour and capital service were used against dependent variable fish output in kg. This study revealed that fertilizers, pest and disease control measures and labour were found non-significant.

Marketing costs include preservation, processing, storage, transportation, commission and waste. Lack of efficient method of preservation, poor transportation and marketing facilities decrease farm prices as they result in poor quality and excess supply. With government support for improved transportation, storage and ice-plants, marketing cost can be substantially reduced. The development of co-operatives or associations would be also helpful to reduce marketing costs and to increase the marketing efficiency (Shang, 1981; Sathiadhas, 1997).

2.3 Fish Marketing Aspect

Marketing is process which starts with the decision to produce a saleable farm commodity and it involves all aspects of market structure or system, both functional and institutional, based on technical and economic considerations and includes pre-harvest and post-harvest operations, assembly, grading, storage and transport.

The importance of aquaculture to rural development is situational. The feasibility of aquaculture development efforts depends on local marketing conditions and marketability, which depends on the consumer preference and social attributes. Market prices of fish may be insufficient to stimulate farmers to invest in aquaculture. Thus, unless the fish can be marketed at a reasonable price, farmers are unlikely to invest in aquaculture.

Marketing function can be defined as a major specialized activity performed in accomplishing the marketing process. The important five marketing functions involved in the fish marketing process are preservation, transportation, facilitating, risk bearing and financing function. Intermediaries involved in the fish marketing system in Sri-Lanka were grouped as fish assemblers, fish wholesalers and fish retailers (Singhe, 1995).

The marketing systems for fish and prawn are explained in terms of use flows, physical flows, channel flows and farmer's share in consumers

rupee (Kulkarni and Srivastava, 1985). The production from freshwater aquaculture is largely consumed in fresh form. The physical flows indicated that about 78 per cent of the aquaculture production is consumed in rural areas and the remaining 22 per cent in urban centres. For the transportation of fish bamboo baskets were used as packing material. The retailer was the most prominent market intermediary followed by significant intermediaries like wholesaler, commission agent and vendor. The least important intermediaries were pre-harvest contractors, wholesaler-cum-retailer, contractor-cum-wholesaler and co-operative society. The farmer's share in the consumer's rupee was observed between 66.1 and 79.3 per cent for one member channel in direct sale through retailers. The average share of the farmer in more than one member channel was 61.3 per cent with the lowest at 36.5 per cent and highest at 69.6 per cent. In pond and tank aquaculture the farmer's share in the consumer rupee was high but the consumer price of fish was very low.

There are 12 market intermediaries and fish flow takes place through various combination of the intermediaries like pre-harvest contractor, contractor-cum-wholesaler-cum-retailer, co-operative society, commission agent, commission agent-cum-wholesaler, wholesaler, wholesaler-cum-retailer, worker-cum-retailer, worker-cum-vender, retailer and vendor. Marketing is the most essential and important link in the success of aquaculture, but it is the most neglected activity today. Remunerative price for the producer and reasonable price for the consumer can be assured only by strengthening the fish marketing structure (Srivastava, 1992).

In Indian fish markets, the fishes are normally sold by auction system. In this system the auctioneer does not dispose of the fish until the highest bid price is reached. This type of auction system is followed in Crawford Market, Mumbai and some other parts of India whereas 'Dutch' method of auction system is followed in Kakinada, Andhra Pradesh and in some parts of Calcutta. In 'Dutch' method, the auctioneer commences with a very high price and stops shouting when a buyer comes forward to purchase the fish at a

lower bid. The best quality fish generally obtain better price by adopting auction method. No weighing and grading methods are practised in a large number of fish markets. The cultured fish in most cases is sorted out species-wise and also size-wise packed with ice, kept in bamboo baskets or wooden boxes and dispatched to distant markets. These activities are performed by the dalals on behalf of wholesalers or commission agent. In some cases primary co-operative society directly consigns the fish to the private trader. By the time fish reaches the consumer, it is handled by five or six middlemen, if the market is far away from the production centre (Rao, 1991).

Increased commercialization and pressure on the resource base has resulted in greater emphasis on higher value fish marketing than the traditional processed products which fishing communities were obliged to produce when marketing opportunities were fewer. A well organized and motivated fisherman groups in southern India have been very successful in obtaining a higher export price (Gordon, 1997).

Improved understanding of the market is important in predicting economic effects of changing consumption, production, and production innovations and assisting better management of marine resources. Marine and aquaculture production are related through production of potentially substitute products for consumer markets. Product market factors that appear to be important in determining the relative success of an aquaculture species include the price of related species, the potential size of the market (numbers of the potential consumers) and particular characteristics of consumer tastes for product form and quality of a given species related to other species (Easley, 1992).

Freshwater fisheries sector totally lack the necessary infrastructure facilities like cold storage's, good approachable roads from farm sites to marketing centres for quick transport. The fish markets are controlled by powerful groups of middlemen who buy from the producers at prices which

generally average about one third of the price paid by the consumer. Organized arrangements for storage and marketing of fish are necessary, and would be helpful in stabilizing price structure to benefit both the producer and consumer. Efficient co-operative marketing organizations may minimize and ultimately do away the vicious circle of the middlemen (Sinha and Ranadhir, 1980).

Lack of marketing facilities such as organized fish markets, market sheds or auction platforms, fish curing yards, availability of ice, salt, storage place, transportation, dependence on money-lenders and middlemen for credit and disposal of catches are the main factors leading to the exploitation of the fish farmers. The absence of institutional finance along with the above factors, put them in a precarious position involving a lot of strenuous work and heavy expenditure leaving marginal returns (Rao, 1995).

In most fishing communities of Asia and Africa, women have the primary and often exclusive responsibility for marketing fish and fishery products. This success of women in marketing depends on many factors like price level of competition, distance to market outlets, preservation of fish (Anon, 1997b).

Under conditions of imperfect competition, which include monopoly, oligopsony and monopsonic competition, pure profit is expected to be positive in long run equilibrium and it can't be explained wholly in terms of the opportunity costs of the services provided by the middlemen (Sathiadhas, 1997).

The fish marketing in India is yet to develop on sound and modern structure. It is bounded by traditional paraphernalia and lacks by and large modern techniques of management despite some changes occurred in many fishery sectors (Rao, 1973).

Fisheries co-operative have miserably failed to intervene in fish marketing and ensure a better consumer price to fishermen. The failure is considered to be one of the main reasons for the low incomes of fishermen. In order to extricate fishermen from the clutches of money lenders, it is necessary to confer the right for first sale of fish on bonafide fishermen through enactment of an appropriate fishery registration. The local bodies can also intervene effectively in a number of areas of marketing improve the present situation (Velayudhan, 1999).

2.4 Socio-economic Aspects of Fisheries

In fisheries, 'social' can be defined as a relation to the interaction of human beings with each other, as individuals or as groups. Economics is one form of interaction between people, and is therefore regarded as one of the 'social' sciences. Socio-economics is particularly common combination encountered in the field of planning and development work. Socio-economics has been brought into existence by the demands of planners attempting to combine coverage of the social sphere into one role with in the project or planning team. Sociologists must include economic factors in their analysis of development issues, and economists clearly need to take sociological factors into account (Townesley, 1998). Panayotou (1985) defined socio-economics as the amalgamation of sociology and economics.

The social science research in Asian aquaculture has been mostly on socio-economic aspects and there have been very few studies on the subject. Socio-economic studies begin with a detailed description of the socio-demographic characteristics of the sample (or population) under study. Factors such as family size, age structure, religious beliefs and educational attainment are among the variables which are considered for socio-economic study. Some studies use supplementary or alternative indicators of living such as food expenditure as a percentage of total consumption expenditures, nutritional status, acquisition of consumer durable, educational levels and

other 'quality of life' variables. Public services, social amenities and community life may also be considered.

In the fisheries sector, several micro and macro level socio-economic surveys had been conducted by various agencies and research workers in different regions of our country to study one or the other problems of the fishermen community (Desai and Baichwal, 1960; Sen, 1973; Prakasam, 1974; George, 1974; Amarasini Desilva, 1977; Lawson, 1977; Panikkar, 1980; Sathiadhas and Venkatraman, 1981; Shambhu Dayal, 1973; Prasad Rao and Kumar, 1984; Subba Rao, 1986; Sathiadhas and Panikkar, 1988).

Proper incorporation of social issues into the process of policy making, formulating strategies and designing interventions for fisheries will inevitably require an increase in the number of social scientists involved in fisheries. In practical terms, sociological analysis in fisheries can be focused on a five key levels like gender, age, community, household and production unit (Townsend, 1998). These levels can be used to provide a basic framework to sociological analysis for fisheries. These five elements can generally be considered the 'building blocks' of most social systems through out the world so an understanding of how they are constituted and their significance is fundamental.

Gender issues are concerned with complex of social, economic and cultural factors, which distinguish men from women. Development agencies throughout the world are mostly run by men but much of the productive work in many societies is carried out by women. The consideration of gender issues is a key element in the analysis of any fisheries system.

The community is often the most convenient administrative level at which to implement activities in the field. It is often assumed that people living within certain administrative boundaries, or living in close proximity to one

another automatically constitute a community, which has certain common interests, goals and a communal sense of identity. Age is an issue which can not be approached with cultural preconceptions about what the roles and need of specific age groups might be. A better understanding of the role of age in determining levels of economic and social participation may be of great importance when it comes to targeting interventions. Considerable attention is to be given regarding what constitutes a household in different social and cultural context. Household level analysis is of great importance in understanding how plans will affect people at the grass-root level.

In fisheries as in many other countries, production frequently brings together groups of people not necessarily related or linked in other ways, such as by kinship or community. The production unit may therefore be the focus for a whole new set of social, cultural and economic dynamics, which need to be part of any sociological analysis (Dixitulu, 1990).

Social taboos among fishermen communities have deeply penetrated and it is not an easy task for developmental planners to change them over to modern scientific methods early. The best way to convince them is by showing them the actual practices in their ponds successfully (Sinha and Ranadhir, 1980).

Fishermen engaged in their traditional occupation whether in the coastal or inland areas happen to be in the bottom of the social and economic pyramid. So integrated rural development, which can improve the economic condition of the fishermen, should go a long way towards achieving the national developmental goals. Achievement of these goals will require the development and extension of appropriate technologies, the setting up of efficient organisational network and the development of marketing procedures and processing methods to look after the post-harvest technology. The laboratory to field network should be strengthened by the creation of a good

extension service as well as through establishing links with banks for the supply of credit (Anon, 1986).

Socio-economic parameters such as family size, age structure, customs, beliefs and habits, employment potentials and education and living standards of fishermen influence their response to new technology and their participation in development schemes. Studies on these variables attempt not only to explain the overall socio-economic conditions of the fishermen but also identify the factors constraining the realisation of full potential of traditional fishery and the appropriate area on government intervention (Sathiadhas and Panikkar, 1988).

Siddiqui (1996) conducted a study of socio-economic problems of the fishermen in Tamilnadu and Orissa where their caste and language, age distribution, marital status, household size, literacy rate, location, livelihood, insurance, source of funding, marketing facilities, expenditure and indebtedness were studied. Studies revealed that socio-economic condition of the traditional fishermen were far from satisfactory on account of lack of infrastructure and communication facilities. Efforts are required to provide basic infrastructure facilities like pucca roads, drinking water supply, sanitation facilities, transportation, schools and medical facilities etc.

Cheng and Capps (1988) observed some demographic variables, which significantly affect expenditures on some species of fish or shellfish, were region of the country, urbanization, occupation of head of household presence of children, race and season.

The worsening problem of inequity in fisheries shifted the concern to the socio-economic issues of sustainability and equity in Philippines. Research gaps and researchable areas were determined to identify future research directions in a study on socio-economic research in the Philippine fishery sector (Anon, 1992).

In the fishery sector, adoption of technological innovations and enhancement of fishery infrastructure facilities have been supported by government. In spite of encouragement of govt. for co-operative and banking facilities, most of the fishermen are still in the grip of poverty. In this context, status of fishermen pertaining to different regions of the country will be immensely useful for future planning of developmental schemes (Sehera *et al.*, 1988).

Choudhury (1989) analysed econometrically the socio-economic conditions of fishermen community in two districts of lower Assam. The studies revealed that income and family size were directly correlated. Family size, expenditure on food, cloth and fuel were reported to have direct bearing on the total monthly expenditure of fishermen households.

Easley (1992) reported some socio-demographic changes under way in the United States that may affect future demand for fishery products and some that may affect aquaculture products specifically. The apparent increasing interest in knowledge of, the nutritional content of alternative foods, the aging of the US population and growth in female labour-force participation are the socio-demographic changes underway in US.

In fisheries sector, socio-economic status of fishermen plays a key role in productive activities. No one has time to listen, appreciate and assess the severity or magnitude of their personal, profession and other related problems. These are responsible for age-old backwardness and poor performance of the fishermen, both as individual and as human resources. Singh *et al.* (1995) studied the social status and socio-economic problems of fishermen living along the Ganga and the Yamuna at Allahabad. The study revealed that the fishermen were highly indebted to fish marketing intermediaries and betrayed of remunerative returns for their catch. Their socio-economic status was very poor which needs an in-depth study.

Studies revealed that majority of the fishing villages were situated on the banks of rivers, estuaries, lakes etc. far away from urban and industrial centres and other rural villages isolating themselves geographically and socially from the main stream of national life. Due to lack of proper transportation and communication facilities, the fisherfolk had little contact with outside world. Hence their problems fail to receive sufficient attention from the local authorities (Rao, 1995).

Fish farmers, artisanal fishermen and fisherwomen engaged in fish culture, collection of fish seed from natural resources, fishing in closed and open inland and coastal waters, processing, transport and marketing of the fishery products etc. are the primary producers of the sector and as such they are the focal object for sectoral development and welfare schemes. Unlike agriculture, there is marked socio-economic and functional stratification among the primary producers. They are divided into small scale aquaculturists belonging to landless / pondless marginal farmer category, the artisanal fishermen and fisherwomen engaged in fishing, transport, crude processing and retail marketing of fishery products, and the last group consisting of affluent and well-off aquaculture entrepreneurs, corporate bodies, trading houses etc (Kumar, 1996).

The traditional fishers operating in the inshore regions are caught in a low-income trap due to diminishing returns from capture fisheries. Hence, integration of small-scale mariculture with small-scale capture fisheries is a viable alternative to supplement their income (Sathiadhas, 1996). This integrative approach can also be tried for the economic development of the inland fisher-folk.

Fish culture is liable to be affected by pollution, disease, flood, inadequate water supply, predation, etc. most of these are because of

management failures, but others are purely socio-economical. These aspects need proper understanding (Sinha and Ramachandran, 1998).

Fisheries in wider term have global economic importance. In India it is all the more important as it has religious, social and commercial values. Fisheries has the potential and capacity to become a giant industry so as to create significant impact on socio-economic status of countrymen who are the nucleus of all the economic activities. This objective is already spelt out in Ninth Plan document when it states that in a development of fisheries with bio-physical processes at the expense of social process would be detrimental to the over all progress. Considering this, it is but natural to expect that the benefits of various development projects should reach the fishermen and fish farmers (Pathak, 1998).

Socio-economic milieu under which the inland fishers / fish farmers operate is not conducive enough to attract credit and infrastructure support for required aquaculture inputs as well as modern craft and gear from traditional banking and financial institutions. The migratory character, seasonality of fishing activities, unstable catch composition of inland fisheries and economic status resulting in lack of credit worthiness of inland fisheries / fish farmers does adversely affect investment appraisal and assessment of funding possibilities. There is an inescapable need to evolve some distinct criteria for financing the inland fisheries. This would need evolving a new set of criteria for assessing credit - worthiness and repaying capacity of inland fishers / fish farmers (Sinha, 1999).

The need for raising the socio-economic status of people above poverty level is an urgent need in our country and effort are focused on identifying technology which can help in this direction. The socio-economic status of aquaculture has been studied by many workers (Nengu and Nitsene, 1988; Lemna and Angwazi, 1988; Corvert 1988). The socio-economics of aquaculture development in India indicated that the pond

resource is generally not available to the fishermen or the fish farmer with the lack of credit facility at reasonable rates of interest.

Dutta (1998) assessed the state of fish culture development and the socio-economic conditions of the fish farming families which may have an impact in determining the present level of fish culture development in Assam. The studies revealed that 75 per cent of people of fish farming families were literate and for 80 per cent of them primary occupation was agriculture. Average annual household income of the fish farming families had been estimated at Rs.10,020.00 in which contribution from agriculture, livestock, fishery and horticultural crop were 44 per cent, 19 per cent, 17 per cent and 12 per cent respectively.

Rout and Das (1992) studied on the socio-economic aspects of extensive shrimp aquaculture in Ganjam district of Orissa and revealed that capital was scarce in the rural areas. So knowledge and skill of brackishwater prawn farming should substitute the capital of villagers.

Poaching became a serious problem for fish culture throughout India, especially in the eastern part of the country where fish is in great demand. Besides employing watchmen, perhaps it may be helpful if bushy plant materials are kept inside ponds to prevent easy netting (Sinha and Ranadhir, 1980).

Samonte, 1992 studied socio-economics of oyster and mussel farming in Philippines using a combination of rapid rural appraisal techniques and a semi-structured questionnaire. The socio-economic condition of oyster and mussel farmers were described in their studies. The development of oyster farming would be sustained by providing appropriate management policies.

A socio-economic study of Tilapia culture in seasonal ponds in Bangladesh indicated that it improved the nutrition of farming families.

Revenue obtained from 28 per cent of fish and fingerlings sold was enough to meet the operational costs and this makes the operations sustainable. In addition to economic returns, the implementation of the technology resulted in social benefits to farmers, in that they were able to present fish to their neighbours, resulting in better relationship. Also, some farmers could pay for the education of their children through income generated from the operation (Gupta *et al.*, 1992).

Unlike the magnitude of extension efforts of the government agencies in technology transfer in the agriculture sector, it is inadequate in case of fishery, further more the modicum efforts made so far are non convincing for acceptance of the fish farmers. A concerted effort on farm practical training in carp polyculture to potential fish farmers; literature support in local language; exposure through communication media and institutional funding support through government departments is considered essential to bring adequate impact on the socio-economic status of fish farming families, by adoption of scientific methodologies of carp polyculture (Dutta *et al.*, 1979).

Mahandra Kumar, 1996 reported that age was not a significant factor in composite fish culture practices. Sheela (1996) reported that age was not found to be significant in sea weed collection and cultivation by fishers. Age was also found non-significant in poultry technology (Nimji *et al.*, 1992), dry farming practices (Manjunath *et al.*, 1996) dry land agricultural technologies (Prasad and Sundarswamy, 1999) etc. where as age was found to be negatively significant in paddy seed production practices (Pattnayak, 1996), fishing (Jagatap, 1997), dairy practicing by women (Sheela and Sundaraswamy, 1999).

Education is an important socio-economic factor which has lot of bearings on fish farming technology. The studies revealed that education was positively and significantly co-related with composite fish culture

(Mahandra Kumar, 1996), seaweed collection and cultivation by fishers (Sheela, 1996), fishing (Jagtap, 1997).

Mahandra Kumar (1996) reported that experience was negatively significant in composite fish culture practices but positively co-related with paddy seed production (Pattnayak, 1996), seaweed collection and cultivation by fishers (Sheela, 1996).

In most of the cases total annual income and social participation show positive significance in farming practices. Total annual income was positively significant in composite fish culture (Mahandra Kumar, 1996), farm implementation (Sontakki, 1989), buffalo husbandry practices (Thangavel *et al.*, 1996) where as total annual income had negative significance in dairy practicing by women (Sheela and Sundarswamy, 1999). Social participation showed positive significance in farm mechanization (Singh, 1983), farm implementation (Sontakki, 1989), composite fish culture (Mahandra Kumar, 1996).

2.5 Role of Women in Fisheries

The basic goal for women in fisheries development is to make them equal partners, productive and self reliant participants in the process of improving their own and their family's nutritional and living standard and to enable them to realize their full potential as human beings in their own right and as members of their family and community.

A landmark seminar on "Women in Fisheries in Indo-China countries, 6-8 March, 1996 in Phnompenh, Cambodia, examines the status of women in the fisheries sector and spells out recommendations for future action to further enhance the role of women. Apart from their contribution to traditional sectors like aquaculture, their participation in fisheries research, education and extension is highly emphasized. A holistic approach for gender balanced programme for rapid development is essential.

As in agriculture, participation of women in fishery is gradually gaining momentum, research and training programmes for them are now being planned and executed. But such programmes can be made successful only if these are based on facts and realities (Sadangi *et al.*, 1999).

The 'technologicalisation' and intensification of production has often led to a decrease in the participation of women. Even in areas where aquaculture is promoted as a novel supplement to any or alternative livelihood strategy. Women are commonly excluded from management and decision making. Extension efforts are mostly directed at men (Felsing *et al.*, 2000).

The various economic activities in which the women of the fishing villages participated were grouped as fishery based and non-fishery based. The fishery based includes fisheries and aquaculture whereas non-fishery based comprised of agricultural work and other miscellaneous activities. Women-folk participated in shore based activities like fish handling, processing, preservation (drying and curing of fish), distribution and marketing, net making, seashell collection, etc. besides their routine domestic chores and occasional participation in non-fishery based activities. The women belonging to prosperous category of households do not participate in fish marketing or any other fishery or non-fishery based activities. The women belonging of less prosperous category participate in all activities related to fishery and non-fishery (Rao, 1995).

Owing to the nature of various tasks involved in fisheries, men and women tend to undertake different tasks. In aquaculture, men dig the ponds and play an active role in pond preparation. While women become more active in post stocking operations like fertilization and daily feeding of fish. These division of labour are not fixed and absolute, but they vary from area to area and also over a period of time. Many aspects of women in fisheries are

related to the creation of household food security i.e. the sustainable supply of and access to food (Nandeesh, 1996).

Sharma *et al.* (1988) reported that Small backyard ponds are also ideally suited for rearing carp seed by Women. The manufacture of fishing nets, fish traps and baskets for fresh fish transportation can be taken up by women as a cottage industry. Once trained women, could earn more from net fabrication than from agricultural activities (Radheyshyam *et al.*, 1986).

Gupta and Rab (1994) stated that women could participate in aquaculture in Bangladesh, without diverting the efforts of men, which could be in agriculture. Women introduced in aquaculture were seen to stock fingerlings of silver barb (*Puntius gonionotus*) using lime and rice-bran and involved in harvesting.

Kvam (1987) reported that both men and women actively participated in production activities in Thailand. He observed several instances of women's group engaged in aquaculture activities. They are often better than men as they do not leave the village on labour migration as often like the men. Further, they have more experience in income generating activities.

In capture fisheries most of the works are carried out by men, particularly in the commercial sector and the concerns of women in fisheries are easily ignored. Women dominate many key sub sectors in fisheries. Small-scale fishing and collection of other foods found in water may be carried out by women and constitute an important source of household food supply. Women predominantly carry out marketing and processing in both the artisanal and the industrial sectors in many parts of the world. In West Africa, the central role played by women in the handling of fish catches extends to the financing of artisanal fishing companies (Townesley, 1998).

The role of women in fisheries in the production, processing or marketing is not always adequately recognized. Women's contribution to increase aquaculture production especially in Asia where they form the major share in population, has largely gone unnoticed. On the other hand, most fishing and fish processing nations are conspicuous in limited representation of women in fishery management and policy formulating process (Anon, 1999).

At subsistence level, aquaculture can provide animal protein food and cash income to the family. Aquaculture in homestead family ponds is also developing as a family farming in Vietnam where women play a big role and earn better benefits (Luu, 1999).

Aquaculture is the emerging potential sector where women can benefit from the technology leading to their empowerment and contribution to the development of fisheries (Bhanot *et al.*, 1998). Rural women are engaged in a host of activities in the freshwater culture practices, contributing to the production systems. These include aquatic weed management and culture of commercially important macrophytes like Makhana, pond fertilization, fish seed rearing and integrated fish farming.

Fish retailing is mainly women's domain all over the country, both in the inland and marine sectors. In the coastal belts, after the fish haul, fisherwomen lend a big hand in sorting, grading, processing etc and constitute a substantial work force in the export oriented marine products processing units. In aquaculture, the regular application of supplementary feeds, manuring, intermittent checking of water quality etc. can very well be attended by the women members. These additional components of fish cultural husbandry can augment fish production from rural ponds, thereby helping substantially to the rural economy (Banerji, 1993).

The potential areas where women can play important role are ornamental fish breeding and culture, catfish and prawn breeding, freshwater pearl culture, spirulina cultivation, production of bio-fertilizers like Azolla, net making and mending, preparation of feeds. In brackishwater sector women have played important roles by participating in both natural collection of seed and induced breeding. Women have also participated in traditional prawn rearing for short duration in Pokkali fields of Kerala. Of late, their involvement has also been appreciable in scientific prawn farming practice in terms of seed collection or production, pond preparation, stocking, manuring and post-harvest operations. New technologies of mariculture like seaweed culture, edible oyster culture, mussel culture, pearl culture provide new avenues for women enterprises (Dube, 1999).

Fisher-women can improve their economic lot by joining co-operative movement. If co-operative movement is to succeed, it is absolutely necessary and important that the women are involved and made to play a very positive and active role in implementing the programmes (Anon, 1988).

Varghese and Nandeesha (1992) suggested a few avenues for increasing the employment opportunities for rural women through small-scale aquaculture units. A characteristic feature of rural West Bengal, Orissa and Assam is that most houses have small backyard ponds, or a ditch. The women members of the family can easily go for fish cultivation in that ponds. They can periodically fertilize the ponds with cowdung and feed the fish by dumping all the spoiled food, left over and kitchen refuse. Under this kind of fish culture it is possible to get a production of about 100 kg annually from a pond of 200 m².

Women in fishing communities have decision-making role in community management. With the increasing commercialization of fishing industry, women's access to post-harvest operations in fisheries has been declining. It is estimated that only about 20 per cent of women from traditional

fishing house-holds get opportunities for income generation from fishery related activities which are seasonal. As a result of marginalization and lack of alternatives and also the irregularity of income from fishing, women in traditional fishing communities are adversely affected (Srinath *et al.*, 1994). It was reported that income generation through on-farm feed production by women was considered to be very appropriate. The creation of awareness on financial support was crucial as people are often misguided by local advises.

Rao (1995) studied the status and role of women in fishing communities in India. The study revealed that the women are totally uneducated and imbued feelings of religious and superstitious beliefs. There is no gainful employment either in fisheries or outside for majority of women. They could not avail the opportunities in modern fishing to their best advantage due to the absence of proper skills and training. Poverty, landless and other economic factors along with Socio-cultural factors influence the women to participate in earning process (Anon, 1981).

2.6 Knowledge

The common assumption of knowledge means the sum total of what is known, the whole body of truth, fact, information, principles, or other objects of cognition required by mankind. Bloom *et al.* (1956) defined knowledge which involves the recall of specific and universals, the recall methods and procedures or the recall of a pattern, structure or setting.

Rogers and Shoemaker (1971) stated knowledge as a function or a stage of the decision process when “the individual is exposed to an innovation's existence or gains some understanding of how it functions”. Knowledge is the totality of understood information processed by a person.

Knowledge means knowing about something, which contain an element of the concept insight (Ban and Hawkins, 1988) knowledge is to be

considered the vision of an explanation for the world in which we live, knowledge is relative in the sense that the vision can differ between people among others because of differences in experience.

A nation's ability to convert knowledge into wealth and social good through the process of innovation is going to determine its future. The power of knowledge in the knowledge society is there for all of us to see. To meet the twin objectives of growth with equity, knowledge can't be the prerogative of a few, every one in the society must have access to knowledge and become a knowledge worker. It is not scientists and technologists alone, who will be knowledge workers. Even a farmer can be a knowledge worker provided he understands the soil he is sowing his seeds in, he understands why and how of the micro-nutrient and pesticide addition that he makes, he lives in an information village, where he has the benefit of short and medium range weather forecasting to plan his farming activity and so on. If he does so, then he will be a continuous user of knowledge and he will be a knowledge worker (Mashelkar, 1999).

Knowledge on the role of important independent variables in acceptance or rejection of technological innovation by farmer is prerequisite in extension programme formulation (Das *et al.*, 1988).

In fisheries, there are at least four reasons for researchers, development workers and policy makers attempting to understand the indigenous knowledge shared by a particular community. First, indigenous knowledge constitutes a community's adaptation to its environment. Second, solution to problems in fisheries lie outside the sector. This assertion underscores the necessity of understanding the complexities of a fishing community before any intervention designed to uplift its standard of living is recommended and implemented (Smith, 1981). Third, with in the context of a common property resource like fishery, it is important to identify the different groups that have stakes in changes that could occur in institutional

arrangements and access to the resources (Ruddle, 1988). Finally fisheries management would benefit from the fishers time tested practices.

Seenapa and Surendra (1988) revealed that training has influenced the participants to gain more information about fish culture, its economic feasibility and profitability. The increase in favourable attitude of trainees noticed after the training could be attributed to the imparting of knowledge regarding various facilities such as leasing of tanks, supplying of quality fish seed, subsidies on the inputs and financial assistance. The resultant high level of gain in over all knowledge may be due to the strong desire of participants to adopt new practices to get high yield. The correlation values indicated a negative relationship between age and knowledge, education and attitude and landholding and attitude. A significant positive relationship was found only between landholding and knowledge before the training and between age and attitude after the training.

Sharma and Nair (1974) reported that knowledge was positively and significantly related with the adoption of high yielding varieties of paddy.

Sanoria and Singh (1978) found that level of knowledge of farmers regarding the improved practices was a significant factor affecting the adoption of improved practices.

2.7 Adoption

Technological advance in aquaculture envisages through continuous research and by transfer of technology to fish farmers. Even when improved technology is available, expected aquaculture production could be achieved only when there is no gap between the recommendation and adoption (Suresh *et al.*, 1988)

Research investigations on technology generation in India during the last decades have laid the strong foundation of scientific fish farming with

promise of high economic returns. With this background of technological innovations, effective extension service for the desired fisheries development is the present requirement in the country (Natarajan, 1982).

The success of fish culture depends to a great extent on the adoption of proven new technology evolved for the purpose of obtaining higher yields and return. Adequate information about any new farming practice and interaction complements to bring about desirable change in human behaviour in any programme of planned change (Haque and Ray, 1983).

Vasanthakumar (1988) studied the information seeking behaviour of traditional fishermen to measure the extent of adoption of improved technology and to identify the problems limiting adoption of improved technology by traditional fishermen of Chidambaranar district, Tamil Nadu. Technique of pond management such as stocking, feeding, fertilizing harvesting etc. should be closely linked with need and interest of farmers through well planned extension methods. Active involvement of farmers with result oriented high yield demonstration programme should be adopted (Rout and Das, 1992).

Gupta and Rab (1994) studied the adoption and economics of silver barb *Puntius gonionotus* culture in seasonal waters in Bangladesh. The study revealed that rapid growth of *P. gonionotus*, low investment and simple technology were perceived as the most important encouraging factors for the adoption of the technology, whereas non-availability of credits for inputs, inadequate supply of *P. gonionotus* fingerlings and small size of ponds, were conceived as constraints to expansion.

Das *et al.* (1988) carried out a study to find out the relationship of adoption of fish culture innovations with 14 selected independent variables like situational (total pond area, maximum and minimum water depth), socio-

personnel (age and education of the fish farmers), socio-psychological (experience in traditional and improved fish culture) and communication (participation in training programme and fish farmers days, utilization of mass media, cosmopolite source of information and localite source of information). The findings revealed substantial positive contribution by the variables 'minimum water area in ponds' in adoption of the technology of composite fish culture. Haque (1981) made similar observations in fishery extension. Studies conducted under Indian conditions in agriculture have shown that the size of the farm was positively and significantly associated with the adoption of farming practices (Sinha, 1978).

A negative relationship of the variable 'age of the fish farmers' with the adoption of composite fish culture was found in the study of Das *et al.* (1988). This showed that younger fish farmers are progressive while the older ones are conservative. Experience in improved fish culture in the study was observed to have strong positive relation with the adoption of composite fish culture. Positive contribution was made by training programmes followed by fish farmers days which are in lines with the observations in agriculture (Sinha, 1978) and animal husbandry (diary extension) (Sohi and Kherdar, 1980). Haque (1981) in fishery extension found that the use of 'mass media' and 'personnel cosmopolite' sources were positively and significantly associated with the adoption behaviour of the farmers.

According to Siar *et al.* (1994) researchers, development workers and policy makers must understand the indigenous knowledge shared by a particular community. Indigenous knowledge constitutes a community's adoption to its environment. Adoption here means the way fisherfolk harness the resources of their environment in order to establish a viable relationship to it (Jacano and Velor, 1976).

Gupta *et al.* (1996) undertook a study to assess the extent of adoption of integration of aquaculture with rice, factors contributing and limiting

adoption, factors affecting farmers management decisions and the effects of rice fish farming on local farming systems and the families general welfare. The three stimuli encouraged farmer to take up the practices were motivation by extension workers, the experience of being involved in on farm research and direct observation of examples.

Bhaumik and Saha (1998) carried out investigations in some areas of west Bengal to know the level of adoption, extent of continuance of recommended package of practices, constraints as perceived by the fish farmers and its implications. The results indicated that the technology had been taken up by a particular group of fish farmers who could overcome most of the constraints. The study further revealed that there was positive and significant relationship between adoption behaviour and fish farmer's characteristics viz. education level, socio-economic status and contact with extension functionaries. Age and caste did not show any significant association with adoption. The problem faced by the farmers in adopting recommended package of practices were in the descending order due to high cost of input, poaching of fish, poisoning in the pond, high rent of water body , lack of follow-up action, marketing of harvested fish, non availability of subsidy non availability of finance, multiple ownership of water body and stagnancy of capital.

Training of fish farmers on new fish culture practices has been recommended to induce motivation, create awareness and confidence and inculcate efficiency. The training can be more fruitful, if designed according to the participant's needs, which are based on the knowledge and attitude already possessed by them. Socio-economic factors viz. Age, education, land holding etc., may also play a role on the knowledge and attitude at adopters (Singh and Kunzroo, 1985 & Zhagon and Singh, 1986).

Chapter III

RESEARCH METHODOLOGY

RESEARCH METHODOLOGY

The study was conducted during the year 1998-2000 to evaluate techno-socio-economics of fish farming practices in Assam. Both primary and secondary data were collected for this purpose. This chapter deals with the research design used and description of the procedures followed to collect valid and reliable data. The procedure adopted in the primary data collection and statistical methods followed in the analysis are described below.

3.1 Location of the Study

The State of Assam was purposively selected for the study as the State has immense resource potential for aquaculture development and 95 per cent of the population are fish eaters. The researcher hails from this State and is well versed with the fish farmers and the fisheries scenario of the State. Two districts namely Nagaon and Darrang had been selected purposively as the former one is leading in fish production where as the latter one is trailing behind fish production inspite of rich fishery resource. Four blocks from each district were covered under the study. Three villages from each block had been selected by simple random sampling. From each village ten respondents had been interviewed for the study i.e. one hundred and twenty farmers from each district were selected.

3.2 Description of the Study Area

Darrang district is situated in lower Brahmaputra valley on North bank of Brahmaputra with an area of 3481 sq.km (Fig.3.1). Nagaon district is in the agro-climatic zone of central Brahmaputra valley and located on South Bank of Brahmaputra river with a geographical area of 3831 sq.km (Fig.3.2). The district Darrang is comprised two subdivisions and eleven blocks. Total number of villages in the district is 1328. Out of the 2,16,131 total households, 2,04,663 households are in the rural areas where as 11,468 households are in the urban areas. Total population of the district is 20,00,071 of which 6,55,215 and 13,44,856 are the urban and rural population respectively.

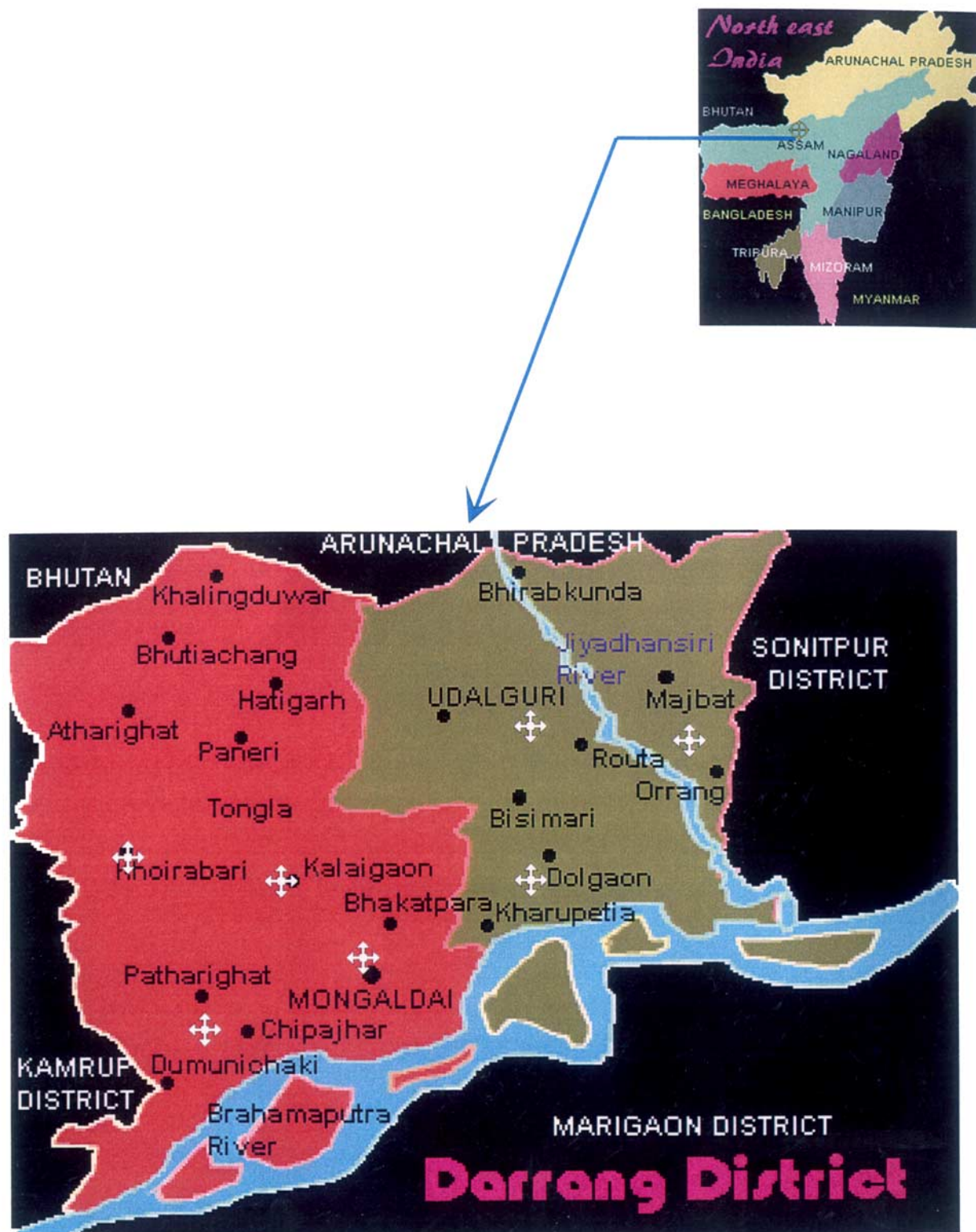


Fig 3.1: Location of the study area and fishery resources of Darrang District

Fishery Resources

Ponds and Tanks: 2008.00 ha

Beel/Swamp area: 6092.37 ha

 **Study area**

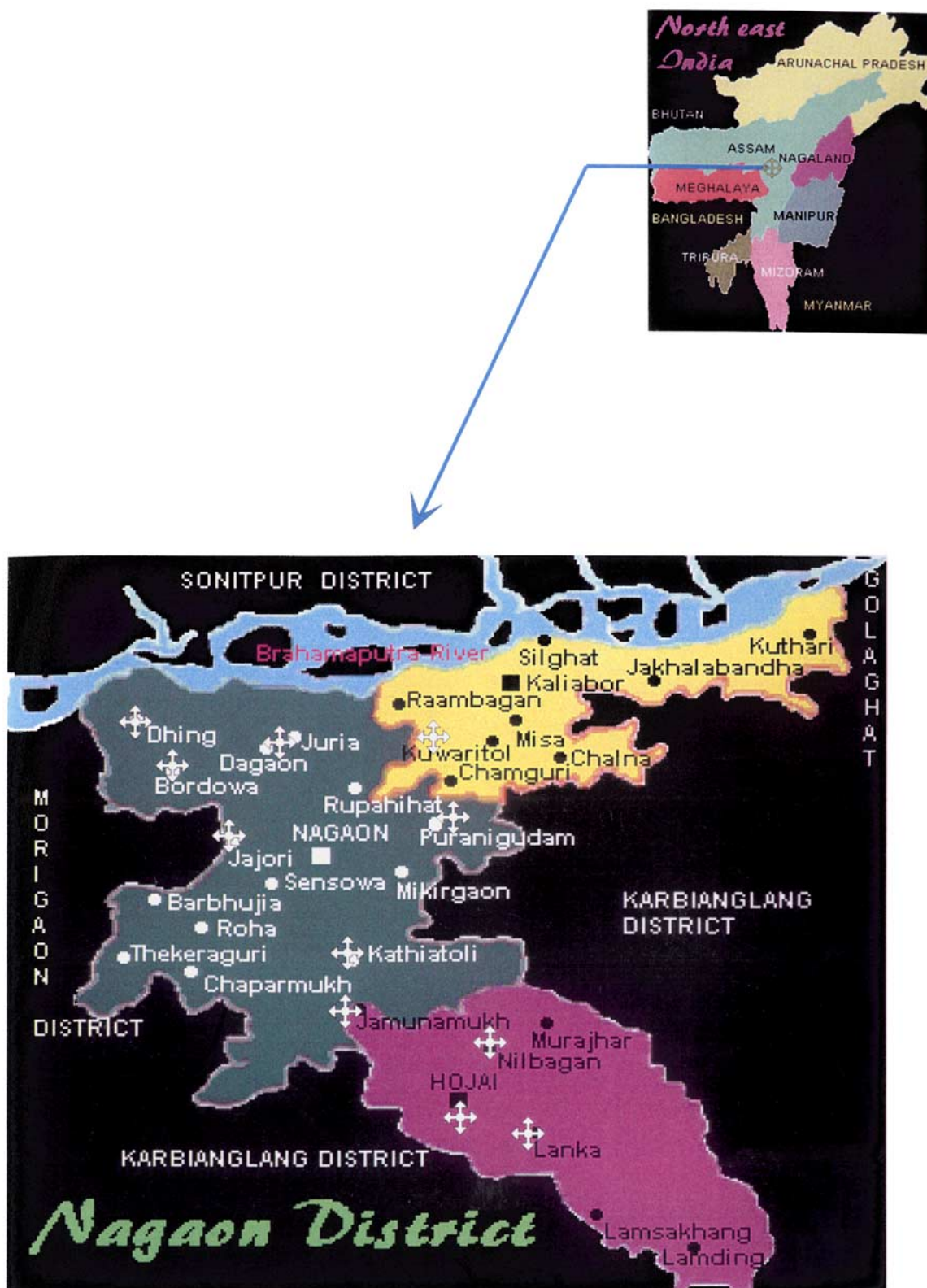


Fig 3.2: Location of the study area and fishery resources of Nagaon District

Fishery Resources

Ponds and Tanks: 3910 ha

Beel/Swamp area: 16532.40 ha



Study Area

The literacy rate in the district is 42 per cent against the state's literacy level of 53 per cent. The district is rich in fisheries resources with 2008.37 ha of ponds and tanks and 6092.37 ha. of *beel* / swamp low lying areas. But these resources are not fully utilized for fish culture purposes. The district's contribution to the State's total fish production of 1.55 lakh tonnes is 6089.10 tonnes. Now an increasing trend is observed among the fish farmers to adopt the high yielding composite fish culture. There is a great scope for integrated paddy-cum-fish farming in paddy field and pig-cum-fish culture in the tribal areas.

Nagaon district consists of three subdivisions and eighteen blocks. Total number of villages spread out through the district is 1375. There are 18,93,171 households in the district, where 16,87,449 and 20,5722 households are the rural and the urban respectively. Out of the total population of 18,93,171 in the district, 2,05,722 are the rural and 1,68,749 are the urban. The literacy rate in the district is 54.74 per cent, which is higher than the State's average of 52.89 per cent. Nagaon district is rich in *beel* fisheries resources, having good potential for the development for culture based capture fisheries. Total fish production of the district is 13065 tonnes. This district is also leading in fish seed production and supplies seeds to other North-Eastern states.

3.3 Sample and Sampling Procedure

A simple random sampling procedure was employed in the present study to select the respondents. The two districts i.e. Darrang and Nagaon were selected purposively.

Out of 11 blocks in Darrang District, four blocks namely Chipajhar, Khairabari, Pub-Mangaldai and Kalaigaon were selected as maximum number of fish farmers were residing in these four blocks. Similarly in Nagaon District, out of the 18 blocks four blocks i.e. Hozai, Juria, Rupahi and Nilbagan were selected and a discussion was made with District Fishery Development Officer before selection of each block.

The villages from these blocks were selected for the study from the list of villages provided by the Fishery Extension Officer. From the list of villages three villages having more number of fish farmers in each block were selected. Thus twelve villages were selected from each district.

3.4 Selection of Respondents

The present study aimed at exploring the techno-economic evaluation of fish farming practices followed by the fish farmers of two districts of Assam. A brief review of the district fisheries scenario was made on the basis of discussions with the District Fishery Officer of each district. A list of fish farmers of the selected villages was collected from the concerned Extension Officer. Out of fifty fish farmers from each villages ten fish farmers were selected on the basis of simple random sampling technique. Thus one hundred and twenty fish farmers from each district were taken as respondents for detailed primary data collection.

3.5 Method of Data Collection

A structured interview schedule was developed incorporating all the queries to accomplish the objectives set for the study. The interview schedule was developed in consultation with the experts in the subject. An attempt was made to prepare an unbiased, clear, concise, complete and comprehensive interview schedule.

The schedule was pre-tested with twenty fish farmers out side the study area to identify and remove ambiguities and redundancies existing, if any. The schedule was suitably modified in accordance with the experience of pre-testing. Finally the interview schedule was translated to Assamese language (regional language) for easy communication and data collection. Final interview schedule was cited in Appendix I.

The data was collected during the period of September '98 to September 2000. The selected fish farmers were interviewed personally at

their home during leisure time. Every sincere effort was made to clarify the question by repetition to ensure and collect reliable data from the respondents. The collected data were tabulated for statistical analysis.

3.6 Costs and Earnings Evaluation Method

Fish-farming cost consists of both fixed and variable costs. It is assumed that the value of the land in general is appreciating every year. Hence, the current resale value of the land is considered for the present study to estimate the fixed cost component of fish farming practices. Most of the farmers are doing fish culture on their own ponds and leasing out the pond for fish culture is not in practice. So the opportunity cost / lease value of the land is worked out at 5 per cent of the land value in the annual fixed cost component. Similarly the farmers are doing renovation of ponds on an average once in 5 years and hence 20 per cent of the same is considered for working out the annual fixed cost component.

The variable costs in the present study for fish farming constitutes the cost incurred by individual farmers on lime, fish seed, rice bran, oil cake, organic and inorganic fertilizers, labour, prophylactic measures and other day to day operational expenses. For paddy-cum-fish culture variable costs comprised rice seed, paddy plots preparation, fertilizers, harvesting etc. in addition to fish farming variable costs. Similarly for pig-cum-fish culture additional variable costs was piglet, fodders, feed, medicine etc. The cost of lime, cowdung, urea, SSP, rice bran, oilcake, piscicide etc. were assessed at their actual purchase price. The farm produced manures and seeds were valued at their prevailing market prices. Labour cost includes opportunity cost of family labour in addition to hired labour involved in the fish farming. The unit price of the product was considered at current market price.

The total production was expressed in kg and the total revenue was worked out by multiplying total production with current unit price of fish (Rs./kg). The net profit was obtained by subtracting the total cost from the

total revenue. Similarly the net operating income was calculated by subtracting the total operating cost from the total revenue.

Rate of Return was evaluated by using the following formula

$$\text{Rate of return} = \frac{\text{Net Profit}}{\text{Total Capital Investment}} \times 100$$

Pay back period was worked out by the following formula

$$\text{Pay back period} = \frac{\text{Total Capital Investment}}{\text{Net Profit}}$$

3.7 Production Function Model

The production function in their pure mathematical sense is the technical relationship that existed between the resource inputs and the product output. They have proved to be effective tools for finding out resource use efficiency in farms.

For the present study, production function was fitted to estimate the resource efficiency in fish production. Based on the scatter diagram showing a linear relationship between the dependent and the independent variables, the fish production in kg was taken as the dependent variable and pond area, fish seed, fish feed and labour as the independent variables. A Cobb-Douglas production was worked out to find out the bio-economic relationship of the various inputs on the output. It is algebraically expressed as

$$Y = a \cdot X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6}$$

Where 'Y' is the total fish production in kilograms, 'a' is a constant and the variables are given below:

- i) Extensive fish culture
 - X_1 = Pond area in hectare
 - X_2 = Lime in Kg
 - X_3 = Fish seed in nos.
 - X_4 = Labour in man days

ii) Semi-intensive

X_1 = Pond area in hectare

X_2 = Lime in Kg

X_3 = Fish seed in nos.

X_4 = Feed in Kg

X_5 = Labour in man days

iii) Paddy-cum-fish culture

X_1 = Pond area in hectare

X_2 = Lime in Kg

X_3 = Urea in Kg

X_4 = Fish seed

X_5 = Feed in Kg

X_6 = Labour in mandays

b_1, b_2, b_3, b_4, b_5 and b_6 are the production elasticities of the variables X_1, X_2, X_3, X_4, X_5 and X_6 respectively.

The co-efficient of each variable was tested to find out the level of significance using t-test. The mean value for output and the economics of scale was worked out.

The Marginal Physical Product (MPP) was calculated by using the following formula

$$MPP = b \frac{\bar{X}}{\bar{Y}}$$

Where MPP is the marginal physical product of the input, b is the partial elasticity of production of the input, Mean of Y is the geometric mean of all inputs and Mean of X is the geometric mean of the input.

In order to find out whether the use of each variable input were in terms of maximising their profits, the MPP of each variable input were

calculated and compared with the input-output price. The price ratio is expressed as follows

$$MPP_x = \frac{P_x}{P_y}$$

Where P_x is the price of the input X and P_y is the price of the product Y .

The Marginal value Product (MVP) was calculated by multiplying MPP with P_y and then compared with P_x . If MVP of a particular input is more than the P_x , then that particular input can be increased to increase total output. Otherwise that particular input has to be reduced in order to get maximum profit.

The maximum profitable level of the input was worked out using the following formula.

$$\bar{X} = \frac{b \bar{Y} P_y}{P_x}$$

3.8 Market Studies Method

The study was conducted during January to July 1999 and data was collected from different fish markets from the study area. Data on fish seed markets were collected in the month of June, which is the peak season, during prime market hours (morning). Information on the dried fish markets were collected in the month of March at Jagiroad of Nagaon districts. The fresh fish markets were observed through out the study period in the selected fish markets. The data, collected by interviewing the sellers and purchasers, was analyzed using simple tabular analysis.

3.9 Selection and Measurement of Socio-economic Variables

In the context of the objectives of the present study, adoption of composite fish culture was considered as dependent variables. Independent variables that were supposed to be related with the dependent variables were

identified by review of relevant literature and discussion with the experts in the field of aquaculture, fisheries extension and economics. Based on this, ten independent variables having some bearing on the dependent variables, were considered in the study. These variables represented personnel and socio-economic characteristics of the respondents. The measurement procedure of these variables is shown in Table 3.1.

Initially twenty independent variables were identified and they were mailed to experts in the field of aquaculture, fisheries extension and economics. Based on the responses of the judges, eight independent variables were selected for the present study.

Table 3.1 : Measurement scale of the variables

Variables	Measurement scale
A. Dependent variables	
1. Adoption	Procedure followed by Singh (1992)
B. Independent Variables	
1. Experience	Scale developed for the study
2. Age	Chronological age in computed years
3. Education	Scoring Procedure followed by Sontakki (1989)
4. Social Participation	Scoring procedure developed by Trivedi (1963) and Bhaskaran (1976)
5. Pond Size	Procedure developed for the study
6. Total Annual Family Income	Procedure developed for the study
7. Total Annual Family Expenditure	Procedure developed for the study
8. Knowledge	Procedure developed by Haque (1981)

3.9.1 Adoption

The extent of adoption is conceptualized as the acceptance of a culture technology by fish farmers and way of practising it in their own pond. Singh (1992) measured the level of adoption of the recommended composite

fish culture technology. To follow the procedure, a list of the recommended practices were prepared and included in the interview schedule. The questionnaire used to measure the extent of adoption were cited in Appendix II.

The responses were obtained on a 3-point continuum of full adoption, partial adoption and non-adoption, with scores of 2, 1 and 0, respectively for each of the practices. The adoption score of a respondent was computed by adding his scores of all the practices. Based on the scores using mean and standard deviation as a measure of check, the respondents were grouped in to adoption categories viz. Low, Medium and High.

Level of adoption	Score
Full	2
Partial	1
Not Adopted	0

Categories	Adoption Range		
	Darrang	Nagaon	Total
Low	<12	<14	<13
Medium	12-22	14-22	13-23
High	>22	>22	>22

3.9.2 Experience

The total experience in fish farming practices by the respondent in completed years at the time of investigation was considered as his experience. The same was questioned by assigning a score of one for each year of experience. The respondents were categorized in to Low, Medium and High using mean and standard deviation as a measure of check.

Categories	Experience in years		
	Darrang	Nagaon	Total
Low	<9	<8	<8
Medium	9-15	8-16	8-16
High	>15	>16	>16

3.9.3 Age

Age is referred to the chronological age of the respondent in completed years at the time of the investigation. One score was assigned for each completed year for the purpose of analyses. The respondents were categorized in to the following age categories for the profile analysis of respondents.

Categories	Age (Years)
Younger	<36
Middle	36-50
Older	>50

3.9.4 Education

Education was operationalized as the extent of formal schooling undergone by the respondents. Following the scoring procedure of Sontakki (1989) one score was assigned for each year of formal schooling attended by the respondents on the basis of class completed. The respondents are categorized in to the following categories for profile analysis.

Categories	Education
Illiterate	No formal schooling
Primary Level	Studied up to class IV
Middle	Studied from V to VII
Higher Secondary	Studied from class VIII to X
Pre Degree	Studied from XI to XII
Graduate Level & above	Studied Degree and above

3.9.5 Size of pond

The water area (in hectare) used by a respondent for fish culture practice was referred as the size of the pond. The respondents were categorized arbitrarily in to three categories on the basis of size of the pond viz. Small, Medium and Large.

Category	Size (ha)
Small	<0.25
Medium	0.25-0.50
Large	>0.50

3.9.6 Total annual family income

Total annual income of the family is referred to the total earnings (in rupees) of the respondent in a year from all sources excluding fisheries. One score is assigned for one thousand rupees and respondents were categorized in to different classes.

3.9.7 Total annual family expenditure

Total annual family expenditure is referred to the total expenditure (in rupees) of the respondent in a year to meet their domestic need. One score is assigned for one thousand rupees and percentage wise expenditure was worked out.

3.9.8 Social participation

Social participation was conceptualized as the extent to which a respondent participated in formal social organizations as member or office bearer during past five years. The scoring procedure developed by Trivedi (1963) and Bhaskaran (1976) with minor modification was followed for the present study. The scoring pattern is outlined as follows.

For members	Score
Non Member	0
Member in one organization	1
Member in more than one organization	2

For office bearers

Office bearer in one organization	3
Office bearer in more than one organization	4
Distinctive feature (MLA/ MP)	6

Participation in the activities of the organization

Never Participated	0
Occasionally participated	1
Regularly participated	2

The scores obtained by a respondent for membership/ office bearer status as well as participation in the activities were then added up to arrive at his social participation score. Then the respondents were categorized in to Low, Medium and High categories using mean and standard deviation as a measure of check.

Categories	Social Participation		
	Darrang	Nagaon	Total
Low	<2	<4	<3
Medium	2-12	4-10	3-11
High	>12	>10	>11

3.9.9 Knowledge

In the present study, the knowledge is conceptualized as the amount of scientific composite fish farming information understood by the fish farmers. The knowledge of the respondents was measured by using the knowledge test developed by Haque (1981) with modifications. The items comprising the knowledge test and procedure for data collection are furnished in Appendix III. A score of 1 and 0 were assigned for correct and incorrect answers respectively. The scores obtained by an individual against each item were summed to get his knowledge score. Based on their knowledge scores

the respondents were grouped in to three categories viz. Low, Medium and High, using mean and standard deviation as measure of check.

Categories	Knowledge Level		
	Darrang	Nagaon	Total
Low	<11	<11	<11
Medium	11-21	11-19	12-20
High	>12	>19	>20

3.10 Statistical Methods used for Data Analysis

Data collected from the respondents during the study period were edited, scored, tabulated and analysed using the following statistical tools and techniques.

3.10.1 Frequencies and percentages

Frequencies and percentages were used to interpret the data pertaining to personnel and socio-economic characteristics of the respondents, their levels of adoption of recommended composite fish culture practices and knowledge level.

3.10.2 Correlation coefficient (r)

This was used to find out the relationship between the dependent and independent variables. The formula used to compute the 'r' is as follows.

$$r = \frac{\sum XY - \frac{(\sum X) \cdot (\sum Y)}{n}}{\sqrt{\left[\frac{(\sum X^2) - \frac{(\sum X)^2}{n}}{n} \right] \left[\frac{(\sum Y^2) - \frac{(\sum Y)^2}{n}}{n} \right]}}$$

Where

r = Correlation coefficient

$\sum X$ = Sum of X values

$\sum Y$ = Sum of Y values

ΣX^2 = Sum of squares of X values

ΣY^2 = Sum of squares of Y values

ΣY = Sum of products of X and Y values

n = Number of paired observations.

3.10.3 't' test

The 't' test of significance was employed to see whether the correlation of coefficient between independent variables and dependent variables were significant or not. The 't' value was computed by using the following formula.

$$t' = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

Where r = correlation coefficient

n = Size of sample

If calculated t value is greater than table value at n-2 degree of freedom with 5 per cent or 1 per cent level of significance, then r is significant at 5 per cent or 1 per cent level of significance ($P < .05$ or $P < .01$) and null hypothesis is rejected. Otherwise null hypothesis will be accepted.

3.10.4 Multiple linear regression analysis

This analysis was carried out to determine the combined effect of the independent variables in explaining the variation in the dependent variable and to identify the variables, which contributed significantly towards the variation in the dependent variable.

Chapter IV

**GENERAL PROFILE OF THE
ECONOMY OF ASSAM VIS-À-VIS
FISHERIES**

GENERAL PROFILE OF THE ECONOMY OF ASSAM VIS-À-VIS FISHERIES

Pisciculture has been identified as one of the important income generating and protein rich food supplying activities to the rural poor. Fish culture along with crop production and animal husbandry is a major potential avocation in Assam which can generate income and employment opportunities for the rural poor. This can play a vital role in improving their socio-economic status. Comparative economic analysis of different sectors is indispensable for formulating development policies. Sehera *et al.* (1988), emphasized on the understanding of status of fishermen pertaining to different regions of the country for future planning of developmental schemes.

Assam, one of the “Seven sisters” that comprise the North-Eastern States, is a land that is at once both culturally alive and visually beautiful. Sprawling across the fertile plain on both sides of the mighty Brahmaputra river, Assam is indeed a verdant paradise with terraced tea gardens, dense rain forests and lush green paddy fields. With breathtaking scenic beauty of the landscapes and the pristine environment teeming with wild life, Assam is the nation’s pride. Due to political, economical and insurgency problems the State is not keeping pace with the progress made by the rest of the country in terms of industrialisation, urbanisation and communications.

Assam is situated in the Eastern Himalayan region between 24° N and 28.18° N and 89°50' E to 97°4' E longitude and covers an area of 78,532 Sq. Km. (Fig.4.1). There are 23 administrative districts with 48 subdivisions, 218 blocks, 149 revenue circles and 43 *mahkuma parishads*. The State is divided into 3 geographical zones i.e. Brahmaputra valley, Barak valley and Hill zones.

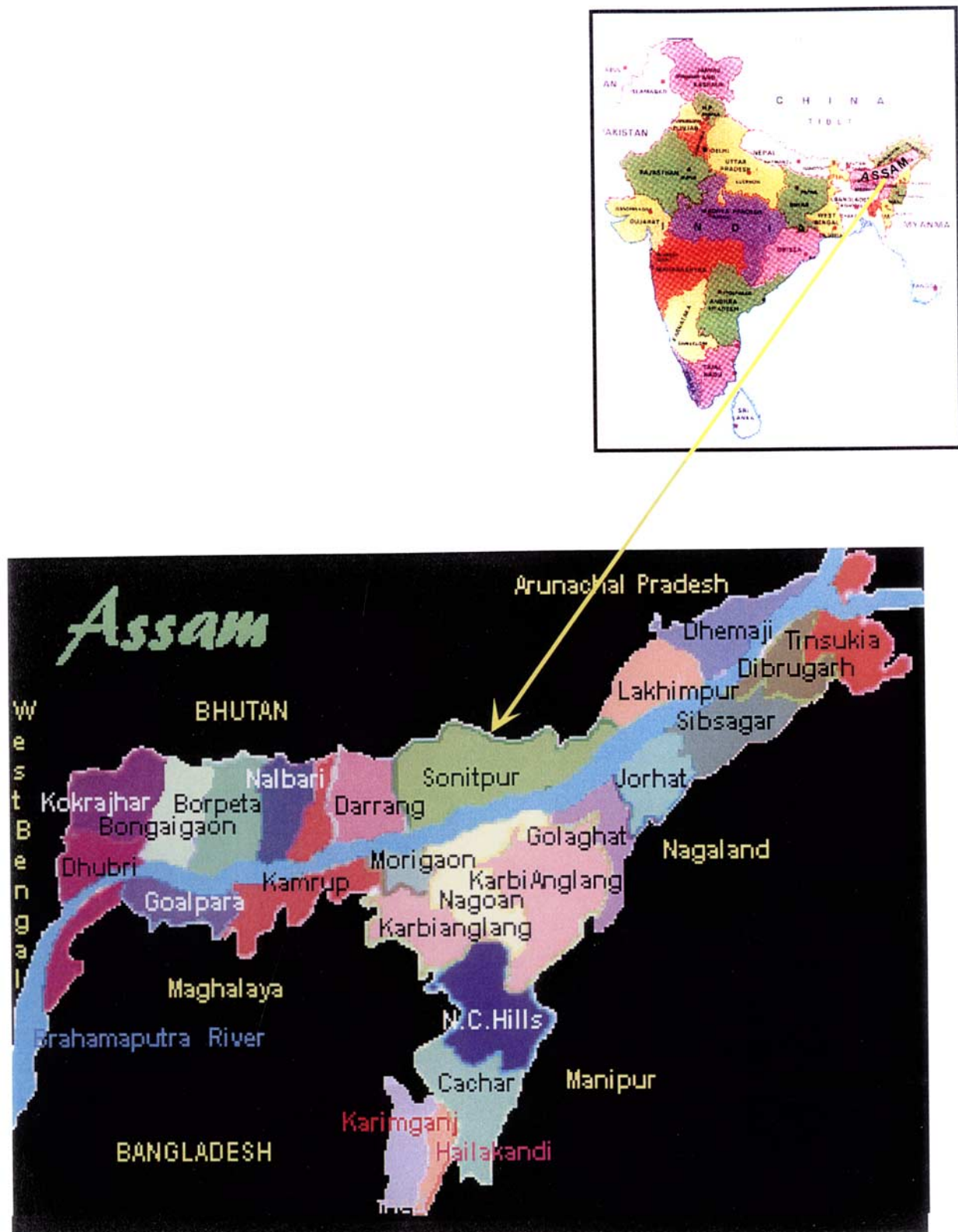


Fig. 4.1: Map showing the state of Assam with the mighty Brahmaputra river

The study area Darrang and Nagaon districts fall under Brahmaputra valley. The Brahmaputra valley is bordered by the sub-himalayan Mountain range of Bhutan and Arunachal Pradesh in the North and East, Nagaland hills in the east and south-east and the hills of Meghalaya in the south west. The valley is bisected by the mighty river Brahmaputra from east to west. The Brahmaputra river is both a life-giver and destroyer in this fertile field. The river with its 25 tributaries irrigates the rich alluvial plain the year round, but wreaks havoc and destruction during the monsoon season.

For the purpose of agro-climatic regional planning for development of agriculture and allied fields the State has been divided into eight of proximate homogenous subzones based on (1) Physiography (2) Rainfall and temperature and (3) Soils (Anon, 1998). These eight agroclimatic sub zones are given in Table 4.1 The area experiences sub-tropical climate with high rainfall (annual average 1700 mm). The mean maximum (summer) temperature ranges from 24.1° to 31.1°C while minimum (winter) temperature varies from 9.4° to 25.6°C. The average rainfall, temperature and relative humidity are shown in Table 4.2. The soil and water are both acidic with pH of water ranging from 5.5 to 6.5. The soil is new alluvium along the bank of river Brahmaputra and old alluvium towards the foothills of Bhutan Himalayas. The State has fairly humid climate-ranges from RH 65.00 to 55.00 (dry season) and 75.00 to 100.00 (rainy season).

According to 1991 census the population of Assam is 22.4 million, which is 2.65 per cent of total Indian population. The density of population in the State is 283 persons as against 267 persons per sq. km. in the country. The population statistics of Assam is given in Table 4.3. The scheduled castes constitute 7.40 per cent of the total population and scheduled tribe population is 12.82 per cent. The urban population accounts 11.10 per cent. Table 4.4 represents the demographic profile of the districts selected for present study.

Table 4.1: Agro-climatic sub-regions of Assam.

No.	Name of the sub-zone	Districts included
I	Upper Brahmaputra valley (North)	1. Lakhimpur 2. Dhemaji 3. Sonitpur
II	Upper Brahmaputra valley (South)	1. Tinaukia 2. Dibrugarh 3. Sibaagar 4. Jorhat 5. Golaghat
III	Central Brahmaputra valley	1. Nagaon 2. Morigaon
IV	Lower Brahmaputra valley (North East)	1. Nalbari 2. Barpeta 3. Darrang
V	Lower Brahmaputra valley (North West)	1. Dhubri 2. Kokrajhar 3. Bohgaigaon
VI	Lower Brahmaputra valley (South)	1. Kamrup 2. Goalpara
VII	Barak valley	1. Cachar 2. Karimnagar 3. Hailakandi
VIII	Hill zone	1. Karbi Anglong 2. North Cachar Hills

Table 4.2: Average relative humidity, rainfall, temperature of Assam.

Month	RH		Rainfall		Temperature (°C)	
	RH ₁	RH ₂	Minimum	Days	Maximum	Minimum
January	97.0	62.4	12.6	3	21.8	11.1
February	91.8	48.0	12.8	4	25.9	13.0
March	92.2	51.0	48.8	9	27.4	15.9
April	92.9	57.9	147.8	16	30.1	19.1
May	93.3	73.7	109.2	15	33.0	24.0
June	94.9	75.3	209.2	26	32.0	25.3
July	93.1	76.9	249.2	18	32.6	25.9
August	94.4	78.8	368.4	25	32.2	25.7
September	92.1	71.6	162.0	14	32.6	25.0
October	93.7	72.8	253.8	8	31.8	24.0
November	94.5	61.5	20.0	5	29.1	18.7
December	97.1	58.0	0	0	26.2	12.8

More than 75 per cent of the total population are agriculture cultivators. Number of fulltime fishermen is estimated at 3,62,819 and part time fishermen is 1,12,181 (Ali, 1997). At all India level fishermen constitute about 1 per cent (about 9 million) of the population of which 3.6 million are full time and 5.4 million are part time.

A little more than 36 per cent of the total population of the State are workers and out of this 45 per cent are engaged in agriculture while 29 per cent are engaged in other occupations. The literacy rate (1991) is 53 per cent, which ranks 16th position among all the States as against National average of 52.2 per cent.

Table 4.3: Population statistics of Assam.

Item	Unit	1981 census	1991 census
Population	Lakh	180	224
Density	Per sq. km.	230	286
Sex-ratio	Females per '000 males	910	923
Literacy	Per cent	N. A.	52.89
Urban Population	Per cent	9.9	11.10
Rural Population	Per cent	90.1	88.90
S C population	Per cent	N. A.	7.40
S T population	Per cent	N. A.	12.83

Table 4.4: Demographic profile of the selected district (population in 1000).

District	Area (sq. Km.)	Total Popu-lation	SC popu-lation	ST Popu-lation	Sex ratio Female Per 1000 male	Literacy (%)	Density Per sq km
Darrang	3481	1299	64	225	938	42.00	373
Nagaon	3831	1893	190	70	929	54.74	494
Assam	78438	22414	1659	2874	923	52.89	286

The average size of operational land holding in the State is less than the national average of 1.69 ha. Land holdings below 2.0 ha account for 83 per cent where as 15 per cent have land in the size of 2-5 ha. Rice is the principal food crop of Assam, which occupies 74.25 per cent of the total cropped area.

The agriculture sector occupies a very important place in the economy of the State. As per 1991 census about 89 per cent of the State's population are living in rural areas and about 69 per cent of the total working force are being engaged in agriculture and allied activities. The share of this sector in

the gross domestic product (GDP) of Assam at constant (1980-1981) prices during 1996-1997 was 35.3 per cent. The agriculture sector witnessed a mixed performance during 1997-98. The total rice production in 1997-98 was reported at 33.28 lakh tones, where as wheat, rabi pulses, sugarcane, rape and mustard, jute, mesta and cotton recorded a production level of 1.10 lakh tonnes, 58,000 tones, 128700 tonnes, 1.55 lakh tones, 8.87 lakh tonnes and 29,000 tones respectively. The index of agricultural production (base triennium ending 1981-82 = 100) is reported at 155.19 in 1997-98. The frequent occurrences of flood in Assam during monsoon and drought during summer adversely affect the agricultural sector of the State.

Assam holds a unique position in the production of oil. Besides oil, coal, limestone, refractory clay, dolomite and natural gases are also available in the State. The index of mineral production in 1994 is 148 (base 1970 = 100). In the year 1996 production of coal, crude oil and lime stone was reported as 8.6 lakh tonnes, 45.5 lakh tonnes and 4.4 lakh tonnes respectively.

Assam is world-wide well known for its tea industry. Tea industry is playing a major role in the State's economy by contributing 15.6 per cent of world tea production and 55 per cent of the country's production. Out of the total of 37,319 tea estates in the country during 1995, 1196 tea estates were located in Assam alone. The total area under tea cultivation in the State was 2.26 lakh ha during aforesaid period accounting for more than half of the total area of 4.27 lakh ha of the country as whole. The number of tea factories in the State was 568 in 1991 as per latest report available from Tea Board of India. The tea industry is also playing a vital role in employment generation programme of the State and provided largest number of employment with 5.75 lakh labourers on its roll in 1995. Total cattle population of Assam was estimated at 72.78 lakh as per 1988 livestock census. The total poultry and pig population was estimated at 11.45 million and 6.42 million respectively.

The khadi and village industries have played a vital role in employment generation. These industries provide employment to 1.09 lakh persons during 1996-97. Sericulture and weaving have been playing an important role in the economic life of a large section of the State's rural population. The number of families engaged in sericulture activities totaled nearly 1.5 lakh during the year comprising engagement of 1.16 lakh families under endi-culture, 14.2 thousand families under muga-culture and about 22.2 thousand families under mulberry culture.

Assam is world famous for her extensive forest area and forest sanctuaries like Kaziranga and Manas with varieties of flora and fauna. The forest products of the State mainly comprise of industrial wood, fuel wood, bamboo, stone, thatch, cane, sand etc. The State government from its various forest products earns a good amount of revenue.

The livestock population of Assam mainly belong to the indigenous non-descript type. Hence the average productivity of livestock in Assam is low as compared to many other States of India. The cattle populations numbering about 77.86 lakh during 1994, constituted the largest group among the livestock population of the State, followed by goat population (26.45 lakh), pigs (8.29 lakh) and Buffaloes (6.52 lakh).

Banking facilities are not adequate in the State to benefit the rural poor. The average population covered per bank office (based on the estimated population of 1997) in the State stands at twenty-one thousand in 1997-98 which is however, much below the all-India average of fifteen thousand population during the same year.

The State's economy in terms of Net State Domestic Product (NSDP) has registered an annual average growth rate of 2.8 per cent at constant (1980-81) prices during the eighth five year plan. According to quick estimates of NSDP the economic growth of the State during the year 1997-98

was 2.7 per cent against 3.5 per cent in 1996-98 and 5.4 per cent in 1995-96. The per capita income for the year 1997-98 has estimated as Rs.7335 at current prices. As per the advance estimates of Gross Domestic Product (GDP) prepared by the Central Statistical Organization (CSO), GDP for the year 1997-98 was estimated as 5 per cent which was less than the previous year GDP (7.5%). The drop in the GDP growth rate in 1997-98 attributable mainly to a sharp fall in the growth of Agriculture and reduction in the growth of industry. The menace of flood in Assam, which is a regular feature during the monsoon period besides occurrence of drought at times, continues to adversely affect the agricultural sector of the State.

According to planning commission estimates with modification of Expert Group, percentage of rural and urban population of Assam under poverty line is 45.01 and 7.73 per cent where as in Indian scenario it is 37.27 and 32.36 respectively. On an average 40.86 per cent of people of Assam are under the poverty line as compared to all India level of 35.97 per cent.

The population explosion is engulfing most of the fruits of our national development exercises and has conspicuously put on test the agricultural development to fulfill the basic requirement of quantity as well as quality food supply to the expected populace. As the availability of protein rich food has constrained, fish is reorganized as the most important and easily digestible animal protein to play a great role in fulfilling the protein requirement in future (Sinha, 1999).

Analysis of sectoral contribution revealed that fishery occupies 1.80 per cent at current price where as agriculture dominated by contributing 47.64 per cent. Agriculture is the most important sector of the economy employing about 66 per cent of the States population. Fishery, is another important occupation of the rural people, which contributes to about 2.4 per cent of the States net domestic product and provides employment to about 4.75 lakh persons (Anon, 1997a). However, this mainly included the traditional

fishermen population belonging to different scheduled caste groups. Although fish culture is gaining popularity in the rural areas as an economic activity, it is still taken up mainly as a subsidiary occupation by different socio-economic groups (Upadhyaya and Dutta, 1991).

India is endowed with vast water resources, both marine and freshwater. Following are the inland water resource potential of India (Table 4.5). The estimated fish production potential from inland sector in

Table 4.5: Inland water resources of India.

Rivers and Canals	171334 km
Rivers	45000 km
Reservoirs	3.15 million ha
Ponds and Tanks	2.36 million ha
Beels, Oxbow lakes and derelict waters	1.07 million ha
Brackishwater	1.42 million ha

India is around 4.5 million tonnes but as on today we are exploiting only 50 percent of this potential. Hence, there is every scope for doubling our inland production if our policies are planned well. The inland fishery resources of the State is categorized as rivers and streams, reservoirs, *beels*, tanks & ponds, paddy fields swamps and forest water resources. The total fishery resources is 3,47,153 ha. Inland fisheries resource wise Assam ranks 10th among the States of India (Table 4.6). In comparison to other States inland fishery resources of Assam shows vast scope to contribute significantly to the country's total fish production (Table 4.7).

Table 4.6: Inland water resources in India as on 1995.

(Area in Lakh Hectares)

Sl. No	State/U.Ts.	Length of rivers & canals (Kms)	Area of Reservoirs	Area under Tanks, lakes and ponds	Beels, Ox-bow lakes & Derelict water	Brackish water Area	Total W.S.A. (Col. 4+5+6+7)
1	2	3	4	5	6	7	8
1	Andhra Pradesh	11514	2.34	5.17	--	0.64	8.15
2	Assam	4820 (2.05 lakh ha)	0.02	0.23	1.10		1.35
3	Bihar	3200	0.60	0.95	0.05		1.60
4	Goa	250	0.03	0.03	--	--	0.06
5	Gujarat	3865	2.43	0.71	0.12	3.76	7.02
6	Haryana	5000	NEG	0.10	0.10	--	0.20
7	Himachal Pradesh	3000	0.42	0.01	--	--	0.43
8	Jammu and Kashmir	27781	0.07	0.17	0.06	--	0.30
9	Karnataka	9000	2.20	4.14	--	0.08	6.42
10	Kerala	3092	0.30	0.30	2.43	2.43	5.46
11	Madhya Pradesh	20661	2.94	1.19	--	--	4.13
12	Maharashtra	1600	2.79	0.50	--	0.10	3.39
13	Manipur	3360	0.01	0.05	0.40	--	0.46
14	Meghalaya	5600	0.08	0.02	NEG	--	0.10
15	Nagaland	1600	0.17	0.50	NEG	--	0.67
16	Orissa	4500	2.56	1.14	1.80	4.17	9.67
17	Punjab	15270	NEG	0.07	--	--	0.07
18	Rajasthan	NA	1.20	1.80	--	--	3.00
19	Sikkim	900	--	--	0.03	--	0.03
20	Tamil Nadu	7420	0.52	6.91	NA	0.50	7.99
21	Tripura	1200	0.05	0.12	--	--	0.17
22	Uttar Pradesh	31200	1.50	1.62	1.33	--	4.45
23	West Bengal (P)	2526	0.17	2.76	0.42	2.10	5.45
24	Arunachal Pradesh	2000	--	0.01	0.03	--	0.04
25	Mizoram	1395	--	0.02	--	--	0.02
26	Andaman & Nicobar	115	0.01	0.03	--	0.37	0.41
27	Chandigarh	2	--	NEG	NEG	--	--
28	Delhi	150	0.04	--	--	--	0.04
29	Lakshadweep	--	--	--	--	--	--
30	Pondichery	247	--	NEG	0.01	0.01	0.02
31	Dadar and Nagar Haveli	54	0.05	--	--	--	0.05
32	Daman & Diu	12	--	--	--	--	--
Total		171334	20.50	28.55	7.88	14.25	71.15

NA
NEGNot Available
Negligible(P)
WSAProvisional
Water Spread Area

Table 4.7: Statewise total fish production during the year 1998-99.

	States/UT	1998-99
1.	Andhra Pradesh	410.82
2.	Arunachal Pradesh	2.30
3.	Assam	155.71
4.	Bihar	202.29
5.	Goa	09.02
6.	Gujarat	630.00
7.	Haryana	32.52
8.	Himachal Pradesh	6.79
9.	Jammu & Kashmir	18.85
10.	Karnatak	255.61
11.	Kerala	649.22
12.	Madhya Pradesh	119.59
13.	Maharashtra	520.38
14.	Manipur	15.31
15.	Meghalaya	4.53
16.	Mizoram	2.78
17.	Nagaland	4.50
18.	Orissa	284.23
19.	Punjab	44.50
20.	Rajasthan	12.00
21.	Sikkim	0.14
22.	Tamilnadu	469.75
23.	Tripura	28.41
24.	Uttar Pradesh	183.03
25.	West Bengal	995.00
26.	Andaman & Nicobar	27.44
27.	Chandigarh	0.00
28.	Dadra & Nagar Haveli	0.02
29.	Daman & Diu	26.85
30.	Delhi	4.42
31.	Lakshadweep	13.54
32.	Pondicherry	42.70
	Total	5232.25

It can be observed from the Fig. 4.2 that the State has rich inland fishery resources, which can supply fish to meet the entire demand of the State. North Eastern Council (NEC), Shillong, 1993 estimated average production from rivers tanks and ponds and *beels* as 50, 180 and 460 kg ha⁻¹ respectively. As per the estimate 37 per cent (excluding rivers) of the total water resources have been tapped for fish production. To increase the fish production of the State and to stop the inflow of supplied fish from outside the State, unutilized resources have to be exploited to their potential level. This will also improve the State's economy and employment opportunities.

The present annual fish production from all sources is about 1.55 lakh tones as against the demand of 2.50 lakh tones. Assam occupies third position in inland fish production in India. But this present level production of the State is not sufficient to meet the State's demand. The demand is likely to go up further to about 3.20 lakh tones by 2000 A.D. Currently the deficiency is partially met by supplying fish to the tune of around 0.25 lakh-tones annually by private traders from the States like Andhra Pradesh, Uttar Pradesh, West Bengal and Bihar (Anon, 1998).

A perusal of Table 4.8 implies that selected district Nagaon with a total fish production of 13065 tonnes occupies first position in the total fish production of the State where as Darrang district shows a mere production level of 6089 tonnes. The fish production from Darrang district is in an increasing trend as the fish farmers started adopting the fish culture technology. Moreover the resources of the district are not exploited fully for fish production.

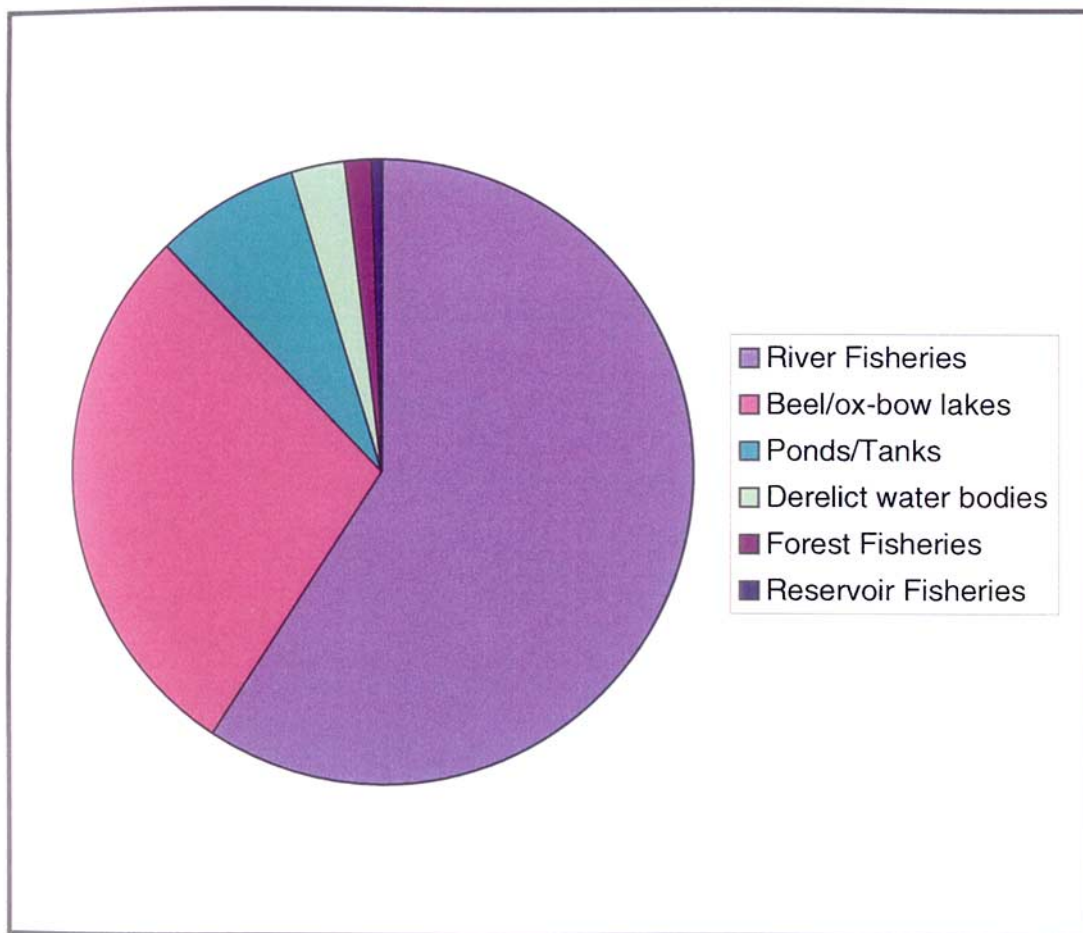


Fig. 4.2: Fishery resources of Assam

Table 4.8: Districtwise water resources and fish production in different districts of Assam.

Sl. No.	District	Ponds/Tanks (Ha)	Beel/Swamp Low-Lying area (Ha)	Total (Ha)	Fish production (M. Tonnes)
1	Nagaon	3910.00	16532.40	20442.40	13065.16
2	Barpeta	1659.71	6764.80	8424.51	9956.95
3	Goalpara	754.49	10487.29	11241.78	5873.83
4	Lakhimpur	621.03	5255.97	5875.00	5732.00
5	Sonitpur	1226.69	7390.45	8617.14	5802.51
6	Tinsukia	182.82	3907.27	4090.09	7775.12
7	Dhemaji	270.00	7015.98	7285.98	3857.70
8	Cachar	3200.00	4812.58	8012.58	9790.20
9	Nalbari	2245.19	2863.83	5109.02	8766.10
10	Dhubri	726.36	7287.42	8007.78	10088.81
11	Darrang	2008.00	6092.37	8700.37	6089.10
12	Sibsagar	956.27	5068.31	6024.58	5570.10
13	Jorhat	289.30	6778.98	7068.28	6488.32
14	Hailakandi	1261.69	2103.05	3364.74	5485.88
15	Dibrugarh	125.73	4755.85	4881.58	7870.00
16	Golaghat	795.33	2819.21	3114.54	4178.55
17	Kokraihar	451.93	913.50	1365.43	4150.30
18	Morigaon	587.14	2955.96	3543.10	6892.50
19	Kamrup	1500.00	1607.16	3107.16	9985.00
20	Karimganj	2267.26	4310.44	6577.70	9470.97
21	Bongaigaon	330.35	1758.09	2088.44	5243.00
22	Karbi-Anglong	503.07	97.18	600.25	2245.20
Total		25423.81	113295.96	138719.77	155132.80

A survey of fish fauna of Brahmaputra in Assam revealed the presence of 126 species belong to 26 families, of which 41 species are commercially important (Motwai *et al.*, 1962). Though the river Brahmaputra is rich in fish fauna, at the northern slope of Himalayas are of little economic value, but the

middle and lower stretches having strong current are rich with carps, catfishes, air-breathing fishes, clupeids, featherback etc.

The river Brahmaputra with its 25 tributaries in the North and 15 tributaries in the south in the Brahmaputra valley and the river Barak with 9 tributaries in the Barak valley are the main fresh water resources in the State. But these resources have not so far been fully utilized for the fishery purposes. The river Brahmaputra flows with strong current both at surface and underneath up to Guwahati. So commercial fishing is not possible in this portion of the river due to the lack of suitable craft and gear. Fishing is done, of course, in this portion in the marginal areas where the river has been divided into several channels. But the lower portion of Brahmaputra river i.e. from Guwahati to Dhubri, is commercially exploited where as in Barak river commercial fishing is done throughout the year. Total production of fish from the riverine resources in Assam is little more than one third of the total fish production of the State (Borah, 1997).

Floodplain wetlands (oxbow lakes, tectonic depressions and other wetland formations on the floodplains of rivers) and associated swamps constitute an important fishery resource of the North-eastern region especially in the States of Assam and Manipur. *Beels* and swamps, which form the mainstay of Assam fisheries, can produce 75,000 tonnes of fish through appropriate combination of culture and capture fisheries development (Sugunan, 1998). The development of *beels* will help local inhabitants, particularly the scheduled castes, scheduled tribes and other backward class people to improve their socio-economic development.

The State has two newly constructed reservoirs (10,730 ha) in the district of North cachar under the kapilee hydro-electric power. The CICFRI, Barrackpore had taken initiation for tapping the potentialities of the reservoirs by stocking of major carp fingerlings in 1992-993. The introduction of cage

and pen culture in these water bodies can give a fish production of 1078 tonnes year⁻¹ over the present production of 322 tonnes year (Ali, 1997).

It was estimated that 15,000 ha of ponds could be brought under intensive aquaculture by 2000 A. D. with a production potential of 45,000 tonnes at a yield rate of 3,000 kg ha⁻¹ and the traditional pond culture in 7,500 ha at 1500 kg ha⁻¹ yield rate could add another 11,250 tonnes. Expected production from rivers, paddy-cum-fish culture and the reservoirs were 25,250 tonnes, 14,000 tonnes and 1,610 tonnes respectively. The remaining 4,500 ha can be converted into fishery estates for culture fishery development, adding another 11,250 tonnes (Sugunan, 1998).

Kumar (1986) reported that 200 km of riverine cold water fisheries potentialities are existing in Assam. The mahseer, game fish of India, is one of the most prized fish and provides the main fishery in uplands of Assam. Among the seven species of true Mahseer available in India, *Tor putitora*, *Tor tor*, *Tor progenius* and *Acrossocheilus hexagonolepis* are found in the State. These species are depleting day by day and entered in the list of endangered fish species. Breeding of Mahseer and transplanting of the stock in the stream is the need of the hour in order to conserve the might Mahseer from further depletion. The other important cold water species available in the State are *Labeo dero*, *Barilius bendelesis* and *Schizothorax plagiostomus*.

More than 40 varieties of indigenous ornamental fish species are available in the State. The important varieties include barbs, loaches catfishes, noble fish, glass fish, knife fish, zebra fish, hill trout etc. The export of these ornamental fish can play an important role in the State's economic development by generating foreign earnings and providing employment opportunities to unemployed youth.

Fish culture in ponds and tanks is an age-old practice in Assam as most of the household has small pond. At present 25,423 ha ponds and

tanks are available in the State. There are numerous small size ponds on an average size of 0.012 ha which are estimated to be 40,00 in numbers with a water spread of area of 500 ha. The average size of the ponds available in the State is 0.13 ha (Ali, 1997). Till two decades back only few private fish farmers used to practice fish culture in the State without any technical guidance and extension support. But now-a-days about 10.5 per cent of the pisciculturists are undergoing training and established fish seed farms and fish seed raising farms with the extension support (Sharma, 1999). The fish farmers receiving financial and technical help from the FFDA of the concerning district more or less followed the recommended package. Average production of 1680 kg ha⁻¹ was obtained in FFDA ponds (Anon, 1998).

The community tanks scattered through out the State have immense potentiality to increase fish production. These community tanks are mostly used for bathing, clothes washing, drinking water etc. Although the State Fisheries Department has taken initiation for utilization of these unused water bodies for pisciculture purpose under community tank development programme, only limited number of these tanks covered under this programme. The State fisheries Department has included 150 nos. of community tanks covering 300 ha water area for pisciculture purpose under world bank funded "Assam Rural Infrastructure and Agricultural Services Project (ARIASP). In Darrang district 660 ha community tank water area can be utilized for pisciculture purpose. The community tank development for pisciculture purpose in the district is showing some fruitful results.

The fish culture practices in the study area were in between traditional and scientific systems of fish culture. Natural spawn/ fry of the Indian Major Carps (IMC) and minor carps (*Labeo bata* and *Cirrhina reba*) as well as noncarp species (*Notopterus chitala*, *N. notopterus*, *Clarias batrachus* etc.) were collected from adjoining rivers/beels and released in to ponds. Since naturally occurring uneconomic fish species were not eradicated and no

management practices other than occasional partial stocking was undertaken, the yield from these traditional culture systems was very low i.e. 400-800 kg ha⁻¹ yr⁻¹ (average 600 kg ha⁻¹ yr⁻¹). The composite fish culture technology developed by the Central Inland Fisheries Research Institute (Indian Council of agricultural research), Barrackpore (Sinha, 1990) became gradually popular among the fish farmers of the region since mid eighties. In this improved fish culture technology, two Chinese carps viz. Silver carp (*Hypophthalmichthys molitrix*) and grass carp (*Ctenopharyngodon idella*) and common carp (*Cyprinus carpio* var. *communis*) were included in polyculture along with the three preferred IMC thus making it a six species culture and an ideal combination mainly because of their different but compatible feeding habits (Kumar, 1996). Large-scale adoption of this technology in the region was facilitated by the availability of hatchery raised seeds of these carps imported from neighbouring West Bengal. The total fish seed production in the State is at present 2547.54 million which is 2nd in seed production in the country. There are 61 hatcheries in the State in which 13 are in the private sector. Number of hapa and bag breeders and mini bundh are 251 and 9 respectively.

Both live stocks integrated fish farming as well as crop based integrated fish farming are practiced in the State at a lower level. Under these integrated fish farming system paddy-cum-fish and pig-cum-fish culture are prominent. The fish farming and its integration to live stock raising and crop cultivation, holds great promise for increasing the production of animal protein in the form of fish, egg and meat. Moreover it can generate lot of employment opportunities in the State more particularly in the rural areas among the socio-economically backward people. The tribal population of the State invariably rears pig and other live stock in addition to their paddy cultivation. Thus the crop as well as livestock based integrated fish farming has a great scope for development in the State.

The six species composite culture gradually gave way to five, four or three species culture in the region. The three IMC remained the mainstay of stocking and their proportion was observed to be increasing in most cases at the cost of exotic carps. Common carp was the worst casualty of this trend; it is now only occasionally stocked in polyculture ponds of the area. In its place, the bighead carp (*Aristichthys nobilis*) has made its entry into the study area. Though silver and grass carp were still being cultured, they were stocked at much lower proportion than the species ratio suggested for six species composite fish culture. In most cases, these two exotic carps were reared in very small numbers more for controlling aquatic macrophytes and algal blooms than for obtaining higher total production. Apparently, high consumer's preference leading to higher demand/price for indigenous major carps is responsible for preference for three species IMC polyculture over six species composite fish culture in the region.

The major carp, (*L. calbasu*); minor carps (*L. bata*, *L. gonius*, *C. reba*) and silver barb (*Puntius gonionotus*) are observed to be partially replacing common, grass and silver carp in polyculture ponds in many cases. Four indigenous (*Clarias batrachus*, *Notopterus chitala*, *Notopterus notopterus* and *Anabas testudineus*) and three exotic (*Aristichthys nobilis*, *C. gariepinus*, *Oreochromis mossambicus*) fish species were observed to be cultured occasionally. Seed of *C. batrachus*, *A. testudineus* and *N. notopterus* was collected from *beels* and swamps while that of *N. chitala* was collected from rivers during monsoon months in low numbers. In majority of cases, these were stocked along with carps. Since *N. chitala* is a predatory fish, it may devour a large number of carp fry in polyculture ponds thereby resulting in overall yield loss. Its inclusion in polyculture system from the misplaced belief that these predators made the carps more active and healthy by chasing them. A couple of *N. chitala* released after carp fry has grown to sufficiently big size may be helpful in controlling weed fishes like *Puntius* spp., *Colisa* spp., *Mystus* spp., etc. common in many of these ponds. *N. notopterus* was

found to be suitable for culturing in shallow ponds on account of its pond breeding habits and acceptability of insects / native small prawns as food.

The indigenous air-breathers, *magur* (*C. batrachus*) and *kawai* (*A. testudineus*) commanded very high price (up to Rs. 200-240 kg⁻¹ for *C. batrachus*). Though techniques of semi-intensive and intensive culture of air-breathing fishes (with yield rates of 4.0-7.3 t ha⁻¹ in six months) are available (Dehadrai *et al.*, 1985), separate air-breathing fish culture was not been taken up in the region due to non availability of adequate quantity of seed and lack of knowledge about the culture packages. Though seed production techniques are available for *C. batrachus*, *H. fossilis*, *etc.* (Tripathi, 1996), hatchery raised seed of these catfishes were not available at present.

Many farmers released tilapia into polyculture ponds mainly because it spawned in the ponds, multiplied quickly and did not need much care. However, within 2-3 years it multiplied enormously becoming the dominant species and their average size decreased due to overcrowding. Because of its small size and low consumer preference the farmers tried to eradicate it in subsequent years, which was difficult in undrainable ponds. *O. mossambicus* was found to devour carp spawn in pond culture experiments besides competing for food with them. The species showed distinct signs of deterioration in economic traits in sewage-fed estuarine wetlands (*bheries*) in West Bengal (Mitra *et al.*, 1989).

The bighead carp and African catfish were recent unauthorized entrants into the area. In most instances, farmers released fry of this large catfish (maximum size 1.30 m/12.8 kg) into carp polyculture ponds. Since most of these farmers overstocked their ponds with little or no manuring/supplementary feeding, survival rates as low as 10 per cent and overall low fish production was observed. In the absence of adequate natural food, the larger individuals of these species might have fed on stocked carps as well as on smaller ones of their own.

Most of the farmers practiced multiple stocking and harvesting in place of initial stocking and terminal harvesting which is normally suggested. The size and number of seed stocked in polyculture is mainly influenced by its availability. Seed vendors usually collected seed from the wholesale markets and carried them in cycle-borne aluminum *hundies* to the farmers. A few fish seed farms of the region also produced a sizable portion of major carp seed. Stocking was done intermittently in batches during the monsoon and post-monsoon months (May to October).

Harvesting operation usually started from October onwards. The fry stocked during May grew sufficiently to be harvested by October. Due to prevailing high demand and shortage of fish, major carps of 250 g size fetched reasonably good price. Thus the marketable size has come down from 750 g and above (Sinha, 1990) to 250 g and above in the study region. Partial harvesting frequency ranged from 4-8 times within a year depending on festive occasions (*Magh bihu, Durga puja, etc.*) and monetary requirements. As a result, stocking density started declining gradually from October onwards. Most farmers overstocked their ponds during monsoon months since seeds were scarcely available after October. The study area lacked sufficient rearing ponds and only fry were available and that too only during monsoon months. Thus, many large ponds served as stocking and rearing ponds at the same time. Fry stocked during October grew to 250-500 g size by April-May depending on food availability. A portion of the juveniles was retained for the next growing season. They grew to become over one kg in size during the second year and fetched good prices.

The effect of simultaneous stocking of different sizes of carps on the growth and survival of fry in polyculture ponds is not known and needs detailed studies. Over two-thirds of the farmers practicing polyculture in the region resorted to this practice indicating that was more remunerative and convenient than that of single stocking and terminal harvesting. One notable

advantage of this practice was that the sale proceeds of partially harvested fishes helped the farmers in meeting recurring expenditures on feed, fertilizer, etc. Multiple harvesting also facilitated monitoring of disease and growth of stocked fishes.

Chapter V

**COSTS AND EARNINGS OF
VARIOUS FISH FARMING
PRACTICES**

COSTS AND EARNINGS OF VARIOUS FISH FARMING PRACTICES

The techno-economic performance and comparative efficiency of different types of fish farming practices are determinant and decisive factors in the selection and adoption of any technology. Absence of detailed information on the economics of operation of different fish farming methods is the present major lacuna in the selection of appropriate technology with in each sector.

5.1 Size of Fish Pond

Ponds are small fresh water bodies usually artificial, occasionally natural, in rainfed and irrigated areas where aquaculture particularly integrated with agriculture is possible. Ponds are normally characterized as being under private, individual or group ownership's or leasing arrangements. The water source can either be rain runoff, irrigation or ground water. Ponds are either drainable and are harvested by seining, trapping, draining or combination of these three procedures. Most ponds can be utilized at all time, but some may be seasonal. Ponds are used either for the culture of a single species of fish (monoculture) or fish species in various proportions (polyculture) to maximise feeding niches and nutrient cycling.

The water area in ha used by the respondents for pisciculture purpose was considered as the size of the pond. Based on available size of the pond in the study area it was categorized arbitrarily in to three categories i. e. small, medium and big. Less than 0.25 ha, 0.25-0.50 ha and more than 0.50 ha were considered as small, medium and big size pond respectively. The distribution of respondents based on acquisition of size of pond are given in Table 5.1. Majority of the respondents of Darrang (50%) and Nagaon (41%) had small size of pond. A less number of the respondents i.e. 33.33 per cent of Darrang and 34.17 per cent of Nagaon had ponds in the size range of 0.25-

0.50 ha. It can be inferred that large 3majority of the respondents had small to medium size ponds.

Table 5.1: Distribution of respondents based on acquisition of size of pond.

District	< 0.25 ha F (%)	0.25-0.50 ha F (%)	>0.50 ha F (%)
Darrang District	60 (50.00)	40 (33.33)	20 (16.67)
Nagaon District	49 (41.00)	41 (34.00)	30 (25.00)
Total	109 (45.42)	81 (33.75)	50 (20.83)

5.2 Fish Culture Practice

Fish farming system prevailing in the study area was categorized mainly under two main systems like extensive (low input) and semi-intensive (medium input) for our study. In extensive fish farming, the farmers practised the fish culture operation almost in traditional way with little addition of inputs like lime and fish seed. Under this farming system average variable cost was very low, no artificial food and fertilizer was used. The semi-intensive fish farming was in between extensive and intensive. In case of intensive farming average variable cost was very high, all the inputs were used in very high quantity in comparatively lower water area.

An unmanaged fishpond under extensive fish farming practice was shown in Plate 5.1. In extensive farming system the applied lime at an average dose of $179 \text{ kg ha}^{-1} \text{ yr}^{-1}$ which was much lower than the recommended dose of $400\text{-}600 \text{ kg ha}^{-1} \text{ yr}^{-1}$. They mainly stocked fish species of both IMC (rohu, mrigal and catla) and exotic varieties (common carp and Chinese carp) at a much higher level ($18,000 \text{ nos of } 3\text{-}4 \text{ cm size ha}^{-1} \text{ yr}^{-1}$) than the recommended level of $5,000 \text{ nos of } 10\text{-}15 \text{ cm size ha}^{-1} \text{ yr}^{-1}$. Other major carp (*L. calbasu*), minor carps (*L. bata*, *L. gonius*, *C. reba*) and silver

barb (*Puntius gonionotus*) were also observed to be partially replacing common, grass and silver carp in polyculture ponds in many cases. Four indigenous (*Clarias batrachus*, *Notopterus chitala*, *Notopterus notopterus* and *Anabas testudineus*) and three exotic (*Aristichthys nobilis*, *C. gariepinus*, *Oreochromis mossambicus*) fish species were observed to be cultured occasionally. They didn't maintain at all recommended species combination and ratio. They harvested the stock after a period of one year and achieved a fish production level of $1146 \text{ kg ha}^{-1} \text{ yr}^{-1}$.

A scientifically designed fishpond under fish farming is shown in Plate 5.2. In the category of semi-intensive (medium input) culture practice the farmers used lime, organic and inorganic fertilizer, feed and seed with some improved managerial aspects. They prepared the pond more or less scientific way before releasing fish seed (Plate 5.3 & 5.4). They used lime for correction of soil only, which was at the rate of $346 \text{ kg ha}^{-1} \text{ yr}^{-1}$. They also used cowdung as organic manure and urea and single super phosphate without maintaining the recommended schedule. The rate of application of cowdung was $9483 \text{ kg ha}^{-1} \text{ yr}^{-1}$ against the recommended dose of $13000 \text{ kg ha}^{-1} \text{ yr}^{-1}$. They used urea and SSP used at the rate of 181 and $41.51 \text{ kg ha}^{-1} \text{ yr}^{-1}$ which was far lower than the recommended dose of 275 and $220 \text{ kg ha}^{-1} \text{ yr}^{-1}$ respectively. They mostly applied rice bran and oil cake as major feed items. About 5 per cent of respondents also applied tracel, multiplex and other feed supplements along with rice bran and oil cake. They didn't maintain the recommended schedule and the use of these inputs depended upon the availability of stock and finance to bear the expenditure. They used rice bran and oil cake at the rate of $1000 \text{ kg ha}^{-1} \text{ yr}^{-1}$ and $750 \text{ kg ha}^{-1} \text{ yr}^{-1}$ respectively. They stocked fish at a very high stocking density of 16.000 nos. $\text{ha}^{-1} \text{ yr}^{-1}$, which is higher than the recommended numbers. Mostly the farmers didn't follow any scientific methods for aeration. An indigenously

designed aerators was found to be in use by an progressive farmer in Darrang district (Plate 5.5).

Farming systems were also categorized in to two category based on the species used for culture. They were Indian Major Carp culture where only Indian major carp were cultured and Composite fish culture (CCP) where IMC were cultured with exotic varieties. These fish farming practices can be regarded as a gainful employment for family members (Plate 5.6).

A fraction of the selected respondents also adopted paddy-cum-fish culture and pig-cum-fish culture. Fish culture was practiced in adjoining deep water paddy along with paddy. It was just like a simultaneous type of paddy-cum-fish culture (Plate 5.7). Fishes like IMC, common carp, silver carp, minor carps, silver barb were stocked initially in heavy numbers ($30,000 \text{ nos. ha}^{-1} \text{ yr}^{-1}$) in the fish pond of 0.29 ha average size. As the water level increases with the onset of monsoon the fish farmers releases fish seed in heavy quantities and the fish migrate to the paddy field They will grow in the paddy fields for about 3-4 months. When water level comes down in the paddy fields fish come back to the actual pond and then they are harvested. In pig-cum-fish culture the farmers mostly from ST, SC and OBC caste reared pig on the embankment of pond (Plate 5.8). They made permanent shed to keep them on the embankment. The pig wastes are drained out into the fishpond during cleaning through drainpipe. In pig-cum-fish culture farmers didn't use any fertilizer, only used feed in minor quantities and fish seed in higher numbers. The pig varieties used were mostly Australian and Hampshire. The distribution of respondents based on the category of fish farming is given in Table 5.2. As a whole 45 per cent of the farmers adopted extensive type of fish culture followed by semi-intensive (30%), paddy-cum-fish culture (16.67%) and pig-cum-fish culture (8.33%).



Plate 5.1: Pond under extensive fish culture.



Plate 5.2: Scientifically designed pond (0.25 ha) under semi-intensive carp polyculture.



Plate 5.3: Pond construction in progress for scientific fish culture.



Plate 5.4: Pond preparation and strengthening embankment.



Plate 5.5: An indigenously designed aerator in use by a progressive farmer.



Plate 5.6: Gainful employment for family members.



Plate 5.7: Better resource utilization under paddy-cum-fish culture.



Plate 5.8: Pig-cum-fish culture- A profitable venture.

Table 5.2: Distribution of respondents according to their culture practice.

Category	Darrang District F(%)	Nagaon District F(%)	Total F(%)
A. Input wise			
i) Extensive (low input)	61 (50.83)	47 (39.17)	108 (45.00)
ii) Semi-intensive (medium input)	39 (32.50)	33 (27.50)	72 (30.00)
B. Species wise			
i) Composite fish culture (CFC)	65 (54.17)	75 (62.50)	140 (58.33)
ii) Indian major carp culture (IMC)	25 (20.83)	15 (12.50)	40 (16.67)
C. Integration wise			
i) Paddy-cum-fish culture	15 (12.50)	25 (20.83)	40 (16.67)
ii) Pig-cum-fish culture	14 (11.67)	6 (5.00)	20 (8.33)

5.3 Costs and Earnings

5.3.1 Extensive (Low input) fish farming

Under the extensive fish farming altogether 108 fishponds were observed in which 61 ponds belonged to Darrang District and 47 ponds were belonged to Nagaon District respectively. The size of fishponds varied from 0.06 ha to 0.25 ha, the average being 0.12 ha and 0.16 ha in Darrang and Nagaon Districts respectively.

Only smaller size of fishpond was used for pisciculture under this category of farming. About 45 per cent of the total respondents from both the districts adopted this farming practice. The average cost and earnings of this fish farming system in the selected districts was worked out and given in Table 5.3. The average initial investment for the ponds of above mentioned Darrang (0.12 ha) and Nagaon (0.16 ha) was Rs.21,762.00 and Rs.27,773.00 respectively. With the increasing thrust on aquaculture practices in recent years land suitable for fish culture fetch a premium price. The average purchase value of 0.12 ha size pond area in Darrang was Rs.19,750.00 where as in Nagaon the purchase value for 0.16 ha was Rs.25,545.00. The remaining capital investment was for the renovation of pond. Lease value of land and renovation cost were the three major components of annual fixed cost. On an average operating cost constituted 68.37 per cent (Rs.3421.31)

of total cost. Labour, fish seed and lime shared 77, 16 and 7 per cent of the total operational cost respectively. Average net profit and net operating income worked out as Rs.3064.00 and Rs.4647.00 respectively at 12.14 per cent rate of return. It can be conferred from the results that net profit gained from the pond of Darrang District (0.12 ha) of Darrang (Rs.3211.25) was higher than that of 0.16 ha pond of Nagaon i.e. Rs.2858.00.

Table 5.3: Economics of extensive fish farming practices in Assam.

Sl. No.	Items	Darrang District 61 (50.83%)	Nagaon District 47 (39.17%)	Average 108 (45.00%)
I	Average pond size (ha)	0.12 (0.06-0.25)	0.16 (0.06-0.25)	0.14
II	Capital Investment (Rs.)			
	1. Value of land	19750.00	25545.45	23105.26
	2. Renovation	2012.00	2227.27	2136.84
	Total (Rs.)	21762.00	27772.72	25242.10
III	Fixed cost (Rs.)			
	1. Lease value of land	987.50	1277.27	1155.26
	2. Renovation cost	402.50	445.45	427.37
	Total (Rs.)	1390.00	1722.72	1582.63
IV	Operational cost (Rs.)			
	1. Lime	192.50	287.00	245.00
	2. Fish seed	481.25	690.91	552.63
	3. Labour cost			
	i) Culture operation/ Maintenance	2000.00	2500.00	2100.00
	ii) Harvesting cost	412.50	518.18	523.68
	Total (Rs.)	2773.75	3996.09	3421.31
V	Total Cost (Rs.)	4163.75	5718.81	5003.94
VI	Total Fish Production (kg)	147.50	170.00	160.53
VII	Total Revenue	7375.00	8576.50	8068.24
VIII	Net Profit	3211.25	2857.69	3064.30
IX	Net Operating Income	4601.25	4580.41	4646.93
X	Rate of Return	14.76	10.28	12.14
XI	Pay Back Period (Years)	6.8	9.7	8.2

5.3.2 Economics of semi-intensive (medium input) fish farming

Under semi-intensive fish farming altogether 72 fishponds were observed in which 39 belonged to Darrang District and 33 belonged to Nagaon District respectively. The size of pond varied from 0.13 ha to 1.74 ha, the average being 0.34 ha in Darrang and 0.75 ha in Nagaon District. On average 32.50 per cent respondents of Darrang adopted semi-intensive fish farming practices in their fishpond. Among these respondents 38.46 per cent adopted this medium input technology in 0.14 ha size pond with another 38.46 per cent in 0.33 ha size fishpond and the remaining 23.08 per cent in 0.60 ha pond. The costs and earnings were worked out and given in Table 5.4.

The major operational cost items were labour, fish feed, seed and lime. Among the operational cost items labour, feed and seed shared maximum percentage. In smaller size pond labour, feed and seed together constituted 75.57 per cent of the total operational cost (Rs.4832.83) where as in medium and bigger size pond it was 79.00 per cent and 79.37 per cent respectively. The fish farmers practised fish culture in smaller size pond gained an annual net profit of Rs.6807.17 where rate of return was 28.01 per cent. The net profit obtained from medium size pond was Rs.13,977.57, which indicated a rate of return of 20.41 per cent. The fish farmers gained a net profit of Rs.18,917.25 at 19.19 per cent rate of return from bigger size pond. The net profit obtained from smaller size pond was at faster rate than medium and bigger one. The cost of production per kilogram fish was also worked out, and it was, on an average Rs.23.24 in smaller fishpond which was comparatively more in medium size pond (Rs.24.70) and bigger size pond (Rs.25.98). This revealed that cost of production increases with the increase in size of fish pond.

About 27.50 per cent of the respondents of Nagaon district followed medium input semi-intensive fish farming practices. Of these respondents 54.55 per cent adopted it in 0.24 ha pond and the rest 24.24 and 21.21 per

cent practised it in pond size of 0.45 ha and 1.74 ha respectively. The costs and earnings were worked out and given in Table 5.5. Total operational cost (Rs.12,425.00) in smaller size fishpond included 79.66 per cent of total cost where feed and seed shared maximum proportion (56%) of the operational cost. The fish farmers incurred 78.14 per cent of total cost (Rs.38,129.99) as operational cost in medium size ponds, in which feed and seed alone constituted 40.72 per cent. In bigger size pond operational cost (Rs.78,142.50) shared 82 per cent of total cost where feed and seed accounted for 44.85 per cent. The annual net profit from smaller size pond worked out at Rs.13,701.20. The farmers obtained a net profit of Rs.25,870.91 from the fish culture practice done in medium size pond where as they obtained Rs.45,807.50 as a net profit from bigger size pond. Although net profit gained from bigger size pond was higher than that of other two, their rate of return (17.48) was lower than that of smaller (28.28%) and medium ones (20.83%) respectively. The cost of production per kilogram was worked out at Rs.24.84 in smaller fish pond where as it was Rs.27.24 and Rs.28.70 in medium and bigger size fish pond. The cost of production increases with the increase in size of pond.

On an average 32.50 per cent respondents of Darrang District and 27.50 per cent respondents of Nagaon adopted semi-intensive fish farming practices in average size of pond of 0.34 ha and 0.75 ha respectively. The average operational cost shared 80.82 per cent (Rs.23,780.65) of total cost (Rs.29,422.23) in fish farming practices of average of 0.53 ha fish pond (Table 5.6). On an average, labour, feed and seed constituted 84.72 per cent of the total operational cost. The average net profit worked out at Rs.16,577.77 where rate of return was 18.97 per cent. The farmers gained a higher net profit from the pond of Nagaon (0.75 ha) than that of Darrang but the farmers of Darrang got their at faster rate of return (27.83%) than that of Nagaon (20.31%).

Table 5.4: Economics of semi-intensive fish farming practices in Darrang District.

Sl. No.	Items	DARRANG DISTRICT		
		15 (38.46%)	15 (38.46%)	9 (23.08%)
I	Average pond size (ha)	0.14 (0.06-0.25)	0.33 (0.25-0.50)	0.60 (0.50-.65)
II	Capital Investment (Rs.)			
	1. Value of land	22000.00	63000.00	85000.00
	2. Renovation	2300.00	5500.00	10000.00
	Total (Rs.)	24300.00	68500.00	95000.00
III	Fixed Cost (Rs.)			
	1. Lease value of land	1100.00	3150.00	4250.00
	2. Renovation cost	460.00	1100.00	2000.00
	Total (Rs.)	1560.00	4250.00	6250.00
IV	Operational cost (Rs.)			
	1. Lime	280.00	812.00	1650.25
	2. Rice bran	380.00	1744.00	2950.00
	3. Oilcake	552.00	1451.43	2245.00
	4. Cowdung	367.50	600.00	1250.00
	5. Urea	133.33	270.00	300.00
	6. SSP	200.00	250.00	137.50
	7. Fish seed	800.00	1460.00	4000.00
	8. Labour cost			
	i) Culture operation / maintenance	1500.00	3000.00	5500.00
	ii) Harvesting	420.00	685.00	2000.00
	9. Prophylactic Measures	200.00	300.00	1000.00
	Total (Rs.)	4832.83	10572.43	21032.75
V	Total Cost (Rs.)	6392.83	14822.43	27282.75
VI	Total Fish Production (kg)	275.00	600.00	1050.00
VII	Total Revenue	13200.00	28800.00	46200.00
VIII	Net Profit	6807.17	13977.57	18917.25
IX	Net Operating Income	8367.17	18227.57	25167.25
X	Rate of Return	28.01	20.41	19.19
XI	Pay Back Period (Years)	3.6	4.9	5.0

Table 5.5: Economics of semi-intensive fish farming practices in Nagaon District.

Sl. No.	Items	NAGAON DISTRICT		
		18 (54.55 %)	8 (24.24%)	7 (21.21%)
I	Average pond size (ha)	0.24 (0.06-0.25)	0.45 (0.25-0.50)	1.74 (0.75-1.85)
II	Capital Investment (Rs.)			
	1. Value of land	43444.44	116666.67	235000.00
	2. Renovation	5000.00	12500.00	27000.00
	Total (Rs.)	48444.44	129166.67	262000.00
III	Fixed Cost (Rs.)			
	1. Lease value of land	2172.22	5833.33	11750.00
	2. Renovation cost	1000.00	2500.00	5400.00
	Total (Rs.)	3172.22	8333.00	17150.00
IV	Operational cost (Rs.)			
	1. Lime	750.56	2660.00	4812.50
	2. Cowdung	755.56	2800.00	5900.00
	3. Urea	245.71	720.00	880.00
	4. SSP	244.29	150.00	1250.00
	5. Rice bran	1573.33	4333.00	13500.00
	6. Oil cake	2133.33	3800.00	12900.00
	7. Fish seed	3222.22	4000.00	8650.00
	8. Labour cost			
	i) Culture operation/ maintenance	2500.00	9500.00	2500.00
	ii) Harvesting	800.00	1633.00	5000.00
	9. Prophylactic measures	200.00	200.00	250.00
	Total (Rs.)	14758.33	29796.00	78142.50
V	Total Cost (Rs.)	15597.22	38129.00	95292.50
VI	Total Fish Production (kg)	627.78	1400.00	3320.00
VIII	Total Revenue	29298.49	64000.00	141100.00
IX	Net Profit	13701.27	25870.00	45807.50
X	Net Operating Income	16873.49	34203.31	62957.50
XI	Rate of Return	28.28	20.03	17.48
XII	Pay Back Period (Years)	3.5	4.9	5.7

Table 5.6: Economics of semi-intensive fish farming practices in Assam.

Sl. No.	Items	Darrang District Average 39 (32.50%)	Nagaon District Average 33 (27.50%)	Average 72 (30.00%)
I	Average pond size (ha)	0.34	0.75	0.53
II	Capital Investment (Rs.)			
	1. Value of land	56842.11	105062.50	78885.71
	2. Renovation	5605.26	11906.25	8485.71
	Total	62447.37	116968.75	87371.42
III	Fixed Cost (Rs.)			
	1. Lease value of land	2842.11	5253.13	3944.29
	2. Renovation cost	1121.05	2381.25	1697.14
	Total (Rs.)	3963.16	7634.38	5641.58
IV	Operational cost (Rs.)			
	1. Lime	848.47	2124.06	1431.60
	2. Cowdung	692.78	2425.00	1507.94
	3. Urea	243.33	513.85	384.00
	4. SSP	90.83	128.46	110.40
	5. Rice bran	1428.42	5072.50	3094.29
	6. Oil cake	1118.75	5137.50	3128.13
	7. Fish seed	1794.74	4725.00	3134.29
	8. Labour cost			
	i) Culture operation/ maintenance	6000.00	12000.00	9000.00
	ii) Harvesting	1434.00	2093.75	1790.00
	9. Prophylactic Measures	300.00	200.00	200.00
	Total (Rs.)	13951.33	34420.12	23780.65
V	Total Cost (Rs.)	17914.49	42054.50	29422.23
VI	Total Fish Production (kg)	728.95	1483.13	1000.00
VIII	Total Revenue	35295.76	65821.31	46000.00
IX	Net Profit	17381.27	23766.61	16577.77
X	Net Operating Income	21344.43	31401.19	22219.35
XI	Rate of Return	27.83	20.31	18.97
XII	Pay Back Period (Years)	3.6	4.9	5.2

5.3.3 Composite fish culture (CFC)

Altogether 140 fishponds were studied under CFC practice where 65 ponds belonged to Darrang District and 75 belonged to Nagaon District respectively. The size of pond varied from 0.06 ha to 1.75 ha, the average being 0.22 ha in Darrang District and 0.36 ha in Nagaon District. On an average 58.33 per cent of the total respondents adopted composite fish culture practice. In Darrang 54.17 per cent respondents followed CFC practice in three different sizes of ponds 0.13 ha (46.15%), 0.30 ha (30.37%) and 0.62 (23.00%). Economics of CFC practices in Darrang worked out and is given in Table 5.7. Operational cost items included labour, feed, seed, fertilizer, lime, and prophylactic measures. Operational cost constituted 78.23 per cent (Rs.6337.74) of total cost (Rs.8101.74) in smaller size ponds where feed, seed and fertilizer shared 46.07 per cent of the total operational cost. In medium and bigger size ponds it was 48.35 and 61.40 per cent of total cost respectively.

The net profit from CFC in smaller size ponds worked out at Rs.8698.26 where rate of return was 29.02 per cent. The evaluated net profit from that of medium and bigger size ponds was Rs.17,338.68 and Rs.22,887 respectively. The cost of fish production per kilogram in smaller pond was worked out at Rs.23.00 which was lesser than that of medium (Rs.23.33) and bigger size pond (Rs.24.00).

On an average 62.50 per cent respondents of Nagaon followed CFC practices in pond sizes like 0.18 ha, 0.46 ha and 1.74 ha. About 40 per cent respondents adopted it in smaller size pond and the rest 36 and 24 per cent adopted it in medium and bigger size ponds. Economics of CFC practices evaluated and is given in Table 5.8.

The total fixed cost in smaller size pond was Rs.2113.07, which constituted 19.47 per cent of total cost. In medium and bigger size ponds it was Rs.6865.00 (25%) and Rs.15,850.00 (21%) respectively. The operational cost shared 80.53 per cent (Rs.8742.45) of the total cost (Rs.10,855.50) in smaller pond whereas Rs.20,821.25 (75%) and Rs.59,037.50 (79%) accounted for operational cost in medium and bigger size ponds. The major percentage of operational cost came from the purchase of feed and seed which was 45.00 per cent in smaller size pond where as in medium and bigger size pond it was 40.34 and 42.00 per cent. On an average Rs.7144.50 was gained as a net profit at 20.65 per cent rate of return in smaller size pond. The net profit achieved from medium and bigger size pond was Rs.24,063.75 and Rs.46612.50. The rate of return obtained was higher in medium size pond (21.64%) followed by small size pond (20.65%) and bigger size pond (18.24). The cost of fish production per kilogram was worked out which was more in bigger size pond (Rs.27.74) followed by smaller (Rs.27.13) and medium (Rs.24.07) size pond.

On an average 58.33 per cent of the farmers adopted CFC practices in 0.30 ha size pond. The average economics worked out and is given In Table 5.9. A critical analysis of the contents of the table revealed that 78 per cent cost of the culture operation came from the operational cost items. Major operational cost items were labour, feed and seed which constituted about 82 per cent (Rs.11843.14) of operational cost. The net profit gained from CFC practices in average pond size of 0.22 ha in Darrang was Rs.10,817.58 which is lower than that of average size of 0.36 ha pond in Nagaon (Rs.11540.11). On an average net profit obtained was Rs.12,154.48 against where rate of return was 22.55 per cent. On an average cost of fish production per kilogram was Rs.26.27 in CFC culture practice.

Table 5.7: Economics of CFC culture practices in Darrang District.

Sl. No.	Items	DARRANG DISTRICT		
		30 (46.15%)	20 (30.37%)	15 (23.00%)
I	Average pond size(ha)	0.13 (0.06-0.25)	0.30 (0.25-0.50)	0.62 (0.50-0.75)
II	Capital Investment (Rs.)			
	1. Value of land	28200.00	61363.64	80000.00
	2. Renovation	1770.00	4290.91	7500.00
	Total	29970.00	65654.55	87500.00
III	Fixed Cost (Rs.)			
	1. Lease value of land	1410.00	3068.18	4000.00
	2. Renovation cost	354.00	858.18	1500.00
	Total (Rs.)	1764.00	3926.36	5500.00
IV	Operational cost (Rs.)			
	1. Lime	366.10	707.64	1750.00
	2. Cowdung	300.00	514.29	1200.00
	3. Urea	200.00	165.00	150.00
	4. SSP	100.00	182.00	137.50
	5. Rice bran	697.14	1454.55	3600.00
	6. Oil cake	822.50	1543.75	3875.00
	7. Fish seed	800.00	1572.73	4000.00
	8. Labour cost			
	i) Culture operation/ maintenance	2500.00	4000.00	7500.00
	ii) Harvesting	352.00	795.00	3200.00
	9. Prohylactic measures	200.00	300.00	300.00
	Total (Rs.)	6337.74	11234.96	21112.50
V	Total Cost (Rs.)	8101.74	15161.32	26612.50
VI	Total Fish Production (kg)	350.00	650.00	1100.00
VII	Total Revenue	16800.00	32500.00	49500.00
VIII	Net Profit	8698.26	17338.68	22887.50
IX	Net Operating Income	10462.26	21265.010	28387.50
X	Rate of Return	29.02	26.41	26.16
XI	Pay Back Period (Years)	3.4	3.8	3.8

Table 5.8: Economics of CFC practices in Nagaon District.

Sl. No.	Items	NAGAON DISTRICT		
		30 (40%)	27 (36%)	18 (24%)
I	Average pond size(ha)	0.18 (0.06-0.25)	0.46 (0.25-0.50)	1.74 (0.60-1.80)
II	Capital Investment (Rs.)			
	1. Value of land	32051.28	102500.00	235000.00
	2. Renovation	2552.56	8700.00	20500.00
	Total	34603.84	111200.00	255500.00
III	Fixed Cost (Rs.)			
	1. Lease value of land	1602.56	5125.00	11750.00
	2. Renovation cost	510.51	1740.00	4100.00
	Total (Rs.)	2113.07	6865.00	15850.00
IV	Operational cost (Rs.)			
	1. Lime	488.92	1251.25	3762.50
	2. Cowdung	480.77	800.00	2600.00
	3. Urea	180.00	720.00	880.00
	4. SSP	165.83	150.00	1250.00
	5. Rice bran	1151.67	2300.00	6780.00
	6. oil cake	1584.23	2350.00	6940.00
	7. Fish seed	1200.00	3750.00	17575.00
	8. Labour cost			
	i) Culture operation/ maintenance	2600.00	7500.00	14000.00
	ii) Harvesting	691.03	1700.00	5000.00
	9. Prophylactic Measures	200.00	300.00	250.00
	Total (Rs.)	8742.45	20821.25	59037.50
V	Total Cost (Rs.)	10855.50	27686.25	74887.50
VI	Total Fish Production (kg)	400.00	1150.00	2700.00
VII	Total Revenue	18000.00	51750.00	121500.00
VIII	Net Profit	7144.50	24063.75	46612.50
IX	Net Operating Income	9257.55	30928.75	62462.50
X	Rate of Return	20.65	21.64	18.24
XI	Pay Back Period (Years)	4.1	4.6	5.5

Table 5.9: Economics of CFC practices in Assam.

Sl. No.	Items	Darrang District Average 65 (54.17%)	Nagaon District Average 75 (62.50%)	Average 140 (58.33%)
I	Average pond size (ha)	0.22	0.36	0.30
II	Capital Investment (Rs.)			
	1. Value of land	42393.94	55319.15	49987.50
	2. Renovation	2957.58	4603.19	3924.38
	Total	45351.52	59922.34	53911.88
III	Fixed Cost (Rs.)			
	1. Lease value of land	2119.70	2765.96	2499.38
	2. Renovation cost	591.52	920.64	784.88
	Total (Rs.)	2711.22	3686.60	3284.26
IV	Operational cost (Rs.)			
	1. Lime	563.82	847.67	727.58
	2. Cowdung	450.00	766.67	640.00
	3. Urea	182.86	318.57	273.33
	4. SSP	157.86	268.33	240.71
	5. Rice bran	1146.67	1712.00	1444.21
	6. Oil cake	1180.45	2186.76	1791.43
	7. Fish seed	1339.39	3191.91	1927.75
	8. Labour cost			
	i) Culture operation/ maintenance	2600.00	4500.00	3500.00
	ii) Harvesting	500.00	1056.38	1098.13
	9. Prophylactic Measures	200.00	300.00	200.00
	Total (Rs.)	8321.20	15148.29	11843.14
V	Total Cost (Rs.)	11032.42	18834.89	15127.40
VI	Total Fish Production (kg)	475.00	675.00	575.81
VII	Total Revenue	21850.00	30375.00	27281.87
VIII	Net Profit	10817.58	30375.00	12154.48
IX	Net Operating Income	13528.80	11540.11	15438.73
X	Rate of Return	23.85	19.26	22.55
XI	Pay Back Period (Years)	4.1	5.2	4.4

5.3.4 IMC culture practice

Under IMC culture practices all together 40 fish pods were observed in which 25 belonged to Darrang District and 15 belonged to Nagaon District. The size of fish pond varied from 0.06 ha to 0.50 ha, the average being 0.20 ha in Darrang and 0.59 ha Nagaon. The farmers practised IMC culture in small and medium size pond only.

On an average 20.83 per cent respondents of Darrang District it adopted IMC culture practice. About 52 per cent adopted it in pond size of 0.12 ha and the rest 48.00 per cent adopted it in 0.31 ha. Average cost and earnings of the practice was worked out and given in Table 5.10.

Total operational cost in the farming practices of small size pond was Rs.5614.50 (80.12%) in which feed and seed shared 38.82. The net profit worked out at Rs. 4816.44 where rate of return was 20.69 per cent.

The farming practised in medium size pond included an amount of Rs.13,320.00 as operational cost, which was 76.67 per cent of the total cost in which feed and seed shared 38.00 per cent (Rs.5058.00). The farmers gained a net profit of Rs.1126.47 at 16.48 per cent of rate of return.

On an average 12.50 per cent farmers of Nagaon District practised IMC culture in medium size pond of 0.48 ha. The farming practised in this size pond incorporated Rs.20115.00 (76.01%) as operational cost. The major constituent of the operational cost was labour (34.00%) followed by fish seed (28.59%) and feed (19.46%). The net profit worked out at Rs.31,035.00 at 31.27 per cent rate of return.

On an average a net profit of Rs.10576.86 could be achieved by investing a total cost of Rs.13,048.28 from an average size of 0.25 ha at 21.96 per cent rate of return. The cost of fish production per kilogram fish was also worked at Rs.32.03. It can be conferred that IMC practised in bigger

size pond gave a higher profit but the rate of return was lower than smaller and medium one.

Table 5.10: Economics of IMC culture practices in Assam.

Sl. No	Items	Darrang District		Nagaon District	Average
		13 (52.00%)	12 (48.00%)	15 (12.50%)	40 (33.33)
I	Average pond size (ha)	0.12 (<0.25)	0.31 (0.25-0.50)	0.48 (0.25-0.50)	0.25
II	Capital Investment (Rs.)				
	1. Value of land	21750.00	63000.00	90000.00	44600.00
	2. Renovation	1525.00	4520.00	9250.00	3553.33
	Total	23275.00	67520.00	99250.00	48153.33
III	Fixed Cost (Rs.)				
	1. Lease value of land	1087.50	3150.00	4500.00	2230.00
	2. Renovation cost	305.00	904.00	1850.00	710.67
	Total (Rs.)	1392.50	4054.00	6350.00	2940.00
IV	Operational cost (Rs.)				
	1. Lime	315.00	732.20	1550.00	618.80
	2. Cowdung	270.00	700.00	1300.00	613.64
	3. Urea	100.00	373.33	400.00	288.57
	4. SSP	200.00	450.00	200.00	325.00
	5. Rice bran	496.00	1720.00	1300.00	1087.27
	6. Oil cake	546.00	1340.0	2615.00	789.00
	7. Fish seed	1137.50	1998.00	5750.00	2039.33
	8. Labour cost				
	i) Culture operation/ maintenance	2000.00	5000.00	5500.00	3500.00
	ii) Harvesting	450.00	800.00	1300.00	546.67
	9. Prophylactic measures	100.00	200.00	200.00	200.00
	Total (Rs.)	5614.50	13313.53	20115.00	10108.28
V	Total Cost (Rs.)	7007.00	17370.53	26465.00	13048.28
VI	Total Fish Production (kg)	201.25	500	1000.00	407.33
VII	Total Revenue (Rs.)	11823.44	28500.00	23647.50	23625.14
VIII	Net Profit (Rs.)	4816.44	11126.47	31035.00	10576.86
IX	Net Operating Income (Rs.)	6208.94	15180.47	37385.00	13516.86
X	Rate of Return	20.69	16.48	31.27	21.96
XI	Pay Back Period (years)	4.9	6.1	3.2	4.5

5.3.5 Paddy-cum-fish culture

A technology to be accepted by the farmers must satisfy farmer's socio-economic settings and farm environment. But detailed farm level study is yet to be done to confirm rice fish production system. The present study aimed to work out the economic efficiency of the paddy-cum-fish culture system practised by the farmers in the selected district.

On an average 16.67 per cent of total respondents adopted paddy-cum-fish culture. About 12.50 per cent respondents of Darrang adopted the technology in 0.14 ha pond size with an adjoining 0.12 ha paddy area whereas 20.83 per cent of respondents of Nagaon adopted it in 0.36 ha pond along with an adjoining 1.76 ha paddy area. The average cost and earnings of paddy-cum-fish culture practices is given in Table 5.11.

The major operational cost items were labour, seed, feed and cowdung. A total operational cost of Rs.5164.00 and Rs.1285.40 was invested towards fish farming and paddy cultivation respectively in Darrang. In Nagaon this amount was Rs.15267.79 under fish farming and Rs.17,669.93 under paddy cultivation. The farmers of Darrang gained a net profit of Rs.7889.00 where rate of return was 28.52 per cent. The net profit achieved by Nagaon was Rs.36,217.00 at 64.48 per cent of rate of return. It can be conferred that farmers of Nagaon got their profit at faster rate because of more investment of input and more paddy area available for culture than that of Darrang. On an average from a fishpond of 0.29 ha and 1.25 ha of paddy field a net profit of Rs.25,123.00 can be achieved at 56.29 per cent rate of return.

Table 5.11: Economics of paddy-cum-fish culture practices in Assam.

Sl. No.	Items	Darrang District Average 15 (12.50%)	Nagaon District Average 25 (20.83%)	Average 40 (16.67%)
A.	Fish Farming			
I	Average pond size (ha)	0.14	0.36	0.29
II	Capital Investment (Rs.)			
	1. Value of land	25800.00	52272.73	44000.00
	2. Renovation	1860.00	3327.27	2868.75
	Total	27660.00	55600.00	46868.75
III	Fixed Cost (Rs.)			
	1. Lease value of land	1290.00	2613.64	2200.00
	2. Renovation cost	372.00	665.45	573.75
	Total (Rs.)	1662.00	3279.28	2773.75
IV	Operational cost (Rs.)			
	1. Lime	277.00	515.45	440.94
	2. Cowdung	300.00	420	380
	3. Rice bran	1032.00	1127.27	1097.50
	4. Oil cake	320.00	1842.00	1490.77
	5. Fish seed	1635.00	2745.45	2500.00
	6. Labour cost			
	i) Culture/maintenance	1000.00	3000.00	4000.00
	ii) Harvesting	400.00	900.00	743.75
	9. Prophylactic Measures	200.00	200.00	200.00
	Total (Rs.)	5164.00	15267.79	10852.96
VI	Total Fish Production (kg)	250	500	425
VIII	Total Revenue (Rs.)	12000.00	22500.00	18861.50

Table 5.11 (Contd. 2)

Sl. No.	Items	Darrang District Average 15 (12.50%)	Nagaon District Average 25 (20.83%)	Average 40 (16.67%)
B.	Paddy Cultivation			
I	Average Paddy field Area (ha)	0.12	1.76	1.25
II	Recurring Expenditure for paddy (Rs.)			
	1. Rice seed	36.40	507.00	359.94
	2. Cowdung	248.00	1088.18	825.63
	3. Urea	100.00	709.09	530.00
	4. SSP	100.00	1881.82	1359.38
	5. Labour cost			
	i) Paddy plot preparation	250.00	3129.09	2678.67
	ii) Seeding cost	305.00	4227.27	3186.67
	iii) Paddy cleaning	224.00	3078.00	2334.00
	iv) Paddy Harvesting	222.00	800.00	2312.67
	Total (Rs.)	1285.40	17669.93	13586.96
III	Total Paddy Production	550.00	8139.00	5723.75
IV	Revenue from Paddy	4000	49567.06	35658.96
C.	Cost and earnings of paddy-cum-fish culture			
I	Average paddy-cum-fish area (ha)	0.26	2.12	1.54
II	Total cost (fish and paddy) (Rs.)	8111.00	36217.00	28401.17
II	Total Revenue (fish and Paddy) (Rs.)	16000.00	72067.00	54520.46
D.	Income			
I	Net Profit (Rs.)	7889.00	35850.00	25123.00
II	Net Operating Income (Rs.)	9551.00	39129.38	27896.00
III	Rate of Return	28.52	64.48	53.60
IV	Pay Back Period (Years)	3.5	1.5	1.9

5.3.6 Pig-cum-fish culture

Pig keeping in India is associated with the weaker section of the society and tribes. Fish cum-pig farming provides promising production levels, pig dung being richer in nutrients in comparison to cattle dung. In this integration system pig sties are found to construct on the pond embankment so that pig waste are drained directly through drain pipe into the fish pond during cleaning.

On an average 8.33 per cent respondents adopted pig-cum-fish culture practices in an average size of 0.22 ha pond. In Darrang 11.67 per cent adopted it in 0.21 ha and in Nagaon 5 per cent adopted it in 0.25 ha pond. The average costs and earnings of the farming practice was given in Table 5.12.

The major operational cost items were feed, fish seed, piglet, pigmash, green fodder and medicine. Total operational cost involved in Darrang District's pond was Rs.28,868.25 (89.12%) in which pigmash, piglet and fish seed constituted 30, 27 and 9 per cent respectively. The total operational cost in Nagaon District was Rs.30,112.50 (90%). The net profit achieved by the farmers of Darrang was Rs.32,391.00 at 71.61 per cent rate of return. The farmers of Nagaon attained a net profit of Rs.21712.50 at 54.97 per cent rate of return. It can be conferred on an average a net profit of Rs.23,623.00 can be gained under pig-cum-fish culture from a 0.22 ha fish pond.

Table 5.12: Economics of pig-cum-fish culture practices in Assam.

Sl. No.	Items	Darrang District 14 (11.67%)	Nagaon District 6 (5.00%)	Average 20 (8.33%)
A.	Fish Farming			
I	Average pond size (ha)	0.21	0.25	0.22
II	Capital Investment (Rs.)			
	1. Value of land	33714.29	30000.00	30666.67
	2. Renovation	3114.29	4000.00	3311.11
	Total	36828.58	34000.00	33977.78
III	Fixed Cost (Rs.)			
	1. Lease value of land	1685.71	1500.00	1533.33
	2. Renovation cost	622.86	800.00	662.22
	Total (Rs.)	2308.57	2300.00	2195.52
IV	Operational cost (Rs.)			
	1. Lime	433.00	232.50	410.67
	2. Rice bran	466.67	400.00	457.14
	3. Fish seed	2604.29	2280.00	2593.00
	4. Labour cost			
	i) Culture operation/ maintenance	4500.00	6000.00	5000.00
	ii) Harvesting	571.43	800.00	622.22
	5. Prophylactic Measures	400.00	400.00	400.00
	Total (Rs.)	8975.39	10112.50	9483.03
V	Total Cost (Rs.)	11283.96	12412.50	11678.55
VI	Total Fish Production(kg)	400	400	400
VII	Total Revenue (Rs.)	18000.00	18000.00	18000.00

Table 5.12 (Contd. 2)

Sl. No.	Items	Darrang District 14 (11.67%)	Nagaon District 6 (5.00%)	Average 20 (8.33%)
B.	Pig Farming			
I	Capital Investment (Rs.)			
	1. Pig shed	4357.14	5000.00	4500.00
	2. Feeding & Water trough	500.00	500.00	500.00
	Total	4857.14	5500.00	5000.00
	Total (Rs.)	1214.28	1375.00	1250.00
II	1. Piglet cost	7785.71	6500.00	7500.00
	2. Pig mash	8714.29	10500.00	9111.11
	3. Green fodder	1300.00	1500.00	1357.14
	4. Medicines	635.71	550.00	616.67
	5. Annual Maintenance	1457.14	950.00	1344.45
	Total	19892.85	20000.00	21179.37
	Total cost	21107.13	21375.00	21679.37
III	Total Pig production			
	1. Piglet (no.s)	18	15	16
	a. Unit price (Rs./piglet)	600	500	550
	2. Pig meat (Kg)	821.43	600	705.50
	a. Unit Price (Rs/ Kg)	40.71	50	42.78
V	Total revenue from pig (Rs.)	44240.35	37500.00	389812.29
C	Cost & revenue of pig-cum-fish farming			
I	Total Cost (Rs.)	32391.09	33787.50	33357.92
II	Total Revenue	62240.35	55500.00	56981.29
III	Net Profit	29849.26	21712.50	23623.37
IV	Net Operating Income	33372.11	25387.50	26318.89
V	Rate of Return	71.61	54.97	60.60
VI	Pay Back period (Years)	1.4	1.8	1.4

Chapter VI

**COMPARATIVE ECONOMICS
AND PRODUCTION FUNCTION
ANALYSIS**

COMPARATIVE ECONOMICS AND PRODUCTION FUNCTION ANALYSIS

6.1 Comparative Economic Efficiency

A simple comparison of cost of production, net profit and net operating income from extensive (low input), semi-intensive (medium input) and integrated fish culture (paddy-cum-fish culture and pig-cum-fish culture) would indicate the lucrativeness of the improved fish culture practices. The differences in net profit are very significant between traditional and scientific methods of culture, and this will ensure adoption of scientific fish culture by fish farmers on large scale.

6.1.1 Comparative economics of different size of pond

An attempt was made to compare the economic efficiency of fish farming practices in different size of fishpond per hectare pond area (Table 6.1). It was found that fish production obtained from smaller size pond (1964 kg) was more than that of medium (1818 kg) and bigger size pond (1750 kg). The farmers gained a maximum net profit of Rs.48,623.00 from smaller size pond followed by Rs.42356.00 from medium size pond and Rs.31529.00.

The cost of production was worked out at Rs.23.24 in fish farming practised in smaller size pond where as it was Rs.24.70 in medium size and Rs.25.98 in bigger size fishpond.

6.1.2 Comparative economic efficiency of extensive (low input) and semi-intensive (medium input) fish farming

The comparative economic efficiency of extensive and semi-intensive fish farming systems per hectare was worked out and given in Table 6.2. The comparative economic analysis showed that fish production in semi-intensive system was almost doubled than the extensive system. This could be achieved due to more addition of inputs with better management practices. The net profit in semi-intensive system worked out at Rs.31279.00 where as in extensive system it was Rs.21888.00. The semi-intensive farming system

showed more rate of return i.e. 18.97 per cent than that of extensive farming system i.e. Rs.12.14 per cent.

The cost of producing one kilogram fish in extensive and semi-intensive system was Rs.31.17 and Rs.29.42 respectively.

Fish production of the state can be enhanced by motivating more numbers of farmers for adopting semi-intensive fish farming system. Adequate financial and technological support to the farmers through rural development schemes should be extended to adopt it at rapid rate.

6.1.3 Comparative economic efficiency of composite fish culture (CFC) and Indian major carps (IMC) culture

The comparative economic efficiency of CFC and IMC culture practice was evaluated and given in Table 6.3. The analysis revealed that fish production obtained from CFC (1919 kg) was more than the IMC culture (1629 kg). However the gross revenue realized from the IMC culture was Rs.94,500.00 against Rs.90,940.00 in CFC practice. This was due to the higher consumer preference for IMC than exotic carps. The rate of return obtained from CFC (22.55%) culture was more than that of IMC culture practice (21.96%).

6.1.4 Comparative economic efficiency of paddy-cum-fish culture and pig-cum-fish culture

The comparative economic analysis of paddy-cum-fish culture and pig-cum-fish culture was worked out in order to find out their economic efficiency (Table 6.4). The tabular analysis revealed that total fish production in pig-cum-fish culture was more than the paddy-cum-fish culture. The net profit obtained from pig-cum-fish culture i.e. Rs.1073739.00 was far higher than that of paddy-cum-fish culture (Rs.35709.00). The cost of producing one kilogram of fish in pig-cum-fish culture was Rs.29.19 which, was lesser than that of paddy-cum-fish culture. This could be inferred that pig-cum-fish culture will be highly advisable to improve the socio-economic condition of the rural

poor. The technology can be adopted in better way by providing adequate technological and financial supports.

Table 6.1: Comparative economic efficiency of fish farming practices in small, medium and big size (per ha area).

Item	Small (<0.25 ha)	Medium (0.25-0.50 ha)	Big (>0.50 ha)
I. Fixed cost	Rs.11142.85	Rs.10644.49	Rs.10416.67
II. Operational cost	Rs.34520.21	Rs.32037.67	Rs.35054.58
III. Total cost	Rs.45663.00	Rs.44916.46	Rs.45471.25
IV. Fish Production (kg)	1964	1818	1750
V. Total revenue	Rs.94285.71	Rs.87272.72	Rs.77000.00
VI. Net Profit	Rs.48623.00	Rs.42356.00	Rs.31529.00
VII. Net Operating Income	Rs.59765.50	Rs.55235.06	Rs.41945.41
VIII. Rate of return (%)	28.01	20.41	19.19
IX. Payback period (years)	3.6	4.9	5.1
XII. Cost of production	Rs.23.24	Rs.24.70	Rs.25.98

Table 6.2: Comparative economic efficiency of extensive and semi-intensive fish farming practices (per ha area).

Item	Extensive	Semi-intensive
I. Fixed cost	Rs.11304.50	Rs.10644.49
II. Operational cost	Rs.24437.93	Rs.44869.15
III. Total cost	Rs.35742.43	Rs.55513.64
IV. Fish Production (kg)	1146	1886
V. Total revenue	Rs.57630.28	Rs.86792.45
VI. Net Profit	Rs.21888.00	Rs.31279.00
VII. Net Operating Income	Rs.33192.36	Rs.41923.30
VIII. Rate of return (%)	12.14	18.97
IX. Payback period (years)	8.2	5.2
XII. Cost of production	Rs.31.17	Rs.29.42

Table 6.3: Comparative economic efficiency of CFC and IMC culture practices (per ha area).

Item	CFC	IMC
I. Fixed cost	Rs.10947.53	Rs.11760.00
II. Operational cost	Rs.39477.13	Rs.40433.12
III. Total cost	Rs.50424.66	Rs.52193.12
IV. Fish Production (kg)	1919.36	1629.32
V. Total revenue	Rs.90940.00	Rs.94500.00
VI. Net Profit	Rs.40515.00	Rs.42307.44
VII. Net Operating Income	Rs.51462.43	Rs.54067.44
VIII. Rate of return (%)	22.55	21.96
IX. Payback period (years)	4.4	4.5
X. Cost of production	Rs.26.27	Rs.32.03

Table 6.4: Comparative economic efficiency of paddy-cum-fish and pig-cum-fish culture practices (per ha area).

Item	Paddy-cum-fish	Pig-cum-fish
I. Fixed cost	Rs.9564.65	Rs.12252.36
II. Operational cost	Rs.48293.57	Rs.139374.54
III. Total cost	Rs.57858.22	Rs.140599.90
IV. Fish Production (kg)	1465.51	1919.18
V. Total revenue	Rs.109613.35	Rs.259005.86
a. Fish	Rs.65039.65	Rs.81818.18
b. Paddy	Rs.44573.70	-
c. Pig	-	Rs.177187.68
VI. Net Profit	Rs.35709.00	Rs.107379.00
VII. Net Operating Income	Rs.72189.35	Rs.119631.32
VIII. Rate of return (%)	53.60	60.60
IX. Payback period (years)	1.86	1.43
X. Cost of production	Rs.32.00	Rs.29.19

6.2 Production Function

The input-output relationship was estimated by the model Cobb-Douglas production function to find out the efficiency of individual inputs, their influence on the total production and to estimate the maximum profitable level of input application. The input-output relationship was worked out separately for extensive (low input), semi-intensive (medium input) fish culture and paddy-cum-fish culture.

6.2.1 Extensive (low input) fish culture

As the input feed was not at all used by the farmers under extensive farming this input was not considered here. The coefficients of area (X_1) and lime (X_2) had positive sign where as fish seed (X_3) and mandays X_4 had negative sign. The coefficient of the variables X_3 and X_4 significant at 1 per cent level. The production elasticities of the variables X_1 , X_2 , X_3 , and X_4 were 0.0783, 0.0808, -0.0938 and -0.1688 respectively (Table 6.5).

The production elasticity of feed (X_2) i.e 0.0808 indicated that a 10 per cent increase in the use of feed could enhance total fish production by 0.80 per cent. The number of fish seed and labours showed a negative relationship with the fish production. This could be due to the excess use of both the fish seed and labour.

The marginal physical product (MPP) of each input was calculated to find out whether the use of input was at the maximum profitable level or not. MPP is addition to total output for a small change of a particular input when all other inputs are held constant. There is a scope of augmenting fish production by increasing the quantity of lime as its marginal value product (MVP) is more than its price. To maximize profit, the land area can be increased from 0.14 ha to average 0.50 ha. Similarly fish production can be increased by increasing the quantity of lime from 25 kg to the maximum level of 74 kg. Regarding the other inputs taken into consideration production co-

efficient of fish seed and labour indicating that these two inputs were used even beyond the carrying capacity of the pond. So it is essential to reduce these two inputs to increase fish production and reduce cost of production.

The equation worked out to find out the input-output relationship is as follows

$$Y = 2.5279 X_1^{0.0783} X_2^{0.0808} X_3^{-0.0938} X_4^{-0.1688}$$

6.2.2 Semi-intensive (medium input) fish culture

The production co-efficient of the variables area (X_1), lime(X_2) and feed (X_4) had positive sign where as fish seed (X_3) and labours (X_4) had negative sign. The co-efficient of the variables X_1 , X_2 and X_3 were significant at 1 per cent level where as the co-efficient of the variable X_4 and X_5 was not significant. The production elasticities of the variables X_1 , X_2 , X_3 , X_4 and X_5 were 0.0365, 0.0933, -0.0802, 0.2593 and -0.2126 respectively (Table 6.6). The production elasticity of feed indicated that a 10 per cent increase in the use of feed could produce a 2 per cent increase in the total fish production. The number of fish seeds and man days showed a negative relationship with the production, which indicates excess use of these two inputs beyond the optimum level.

The marginal value product (MVP) of lime and feed were more than their corresponding prices where as MVP of area, seed and labour were less than their corresponding prices. As per the maximum profitable level of lime and feed it can be inferred that increasing their quantity can enhance the fish production. Lime can be increased from average level of 180 kg to 493 kg where as feed can be increased from average level of 1500 kg to 1918 kg. The maximum profitability level of area shows that land area can be decreased from 0.52 ha to 0.33 ha. Similarly it is essential to reduce the number of fish seed and mandays to increase profitability.

The equation worked out to find out the input-output relationship is as follows

$$Y = 2.0167 X_1^{0.0365} X_2^{0.0933} X_3^{-0.0802} X_4^{0.2593} X_5^{-0.2126}$$

6.2.3 Paddy-cum-fish culture

As most of the farmers used the inorganic fertilizer urea under paddy-cum-fish culture this input was considered. The coefficient of the variables area (X_1) lime (X_2), urea (X_3) and feed (X_5) had positive sign where as fish seed (X_4) and labour (X_6) had negative sign. The co-efficient of the variables X_1 and X_6 was significant at 1 per cent level and X_3 was significant at 5 per cent level. The production elasticities of the variables X_1 , X_2 , X_3 , X_4 , X_5 and X_6 were 0.4452, 0.0783, 0.0103, -0.1242, 0.0365 and -0.5061 respectively. The variable seed and labour showed negative relationship with the production, which indicated over use of the inputs.

The maximum profitability level of area indicates that the land area can be increased from average of 0.27 ha to 3.24 ha to increase fish production under this integrated system. There is a scope to increase to increase other inputs like lime, urea, feed to their maximum profit level to augment fish production. At the same time it is also essential to decrease the excess use of the inputs like fish seed and labour to the maximum profitable level.

The equation worked out to find out the input-output relationship is as follows:

$$Y = 4.4735 X_1^{0.4452} X_2^{0.0783} X_3^{0.0103} X_4^{-0.1242} X_5^{0.0365} X_6^{-0.5061}$$

Table 6.5: Estimated production function (Cobb-Douglas), input means and estimated output for extensive (low input) fish culture.

Items	Area (ha) X_1	Lime (kg) X_2	Fish seed (Numbers) X_3	Labour (Mandays) X_4
Production coefficient	0.0783	0.0808	-0.0938	-0.1688
Standard error	0.2098	0.0767	0.0340	0.0666
t-value	0.37	1.05	2.77	2.53
Input mean	0.14	25	2500.00	50
MPP	89	0.06	-0.006	0.54
Price of input (P_x)	1000.00	7	0.65	50
MVP	3579.42	20.68	-0.24	27
Maximum profitable level	0.50	74.00	923	22
Average Fish Production (Y)=160 kg, Price of fish (P_y)=40.00				

$$R^2 = 0.60$$

$$\text{Intercept} = 2.5279$$

Table 6.6: Estimated production function (Cobb-Douglas), input means and estimated output for semi-intensive (medium input) fish culture.

Items	Area (ha) X_1	Lime (kg) X_2	Fish seed (Numbers) X_3	Feed (kg) X_4	Labour (Mandays) X_5
Production coefficient	0.0365	0.0933	-0.0802	0.2593	-0.2126
Standard error	0.1959	0.0091	10.31	0.1461	0.1461
t-value	5.3	10	2.53	1.33	-1.4551
Input mean	0.52	180	8000.00	1500.00	200
MPP	65	0.48	-0.01	0.16	-0.9833
Price of input (P_x)	4000.00	7.00	0.65	5.00	50.00
MVP	2599	19	-0.40	6.4	-39.33
Maximum profitable level	0.34	493	6594	1918	157
Average Fish Production (Y) =925kg, Price of fish =Rs.40.00					

$$R^2 = 0.71$$

$$\text{Intercept} = 2.0167$$

Table 6.7: Estimated production function (Cobb-Douglas), input means and estimated output for the paddy-cum-fish culture.

Items	Area (ha) X_1	Lime (kg) X_2	Urea (kg) X_3	Fish seed (Numbers) X_4	Feed (kg) X_5	Labour (Mandays) X_6
Production coefficient	0.4452	0.0783	0.0103	-0.1242	0.0365	-0.5061
Standard error	0.0839	0.2098	0.0094	0.0658	0.1959	0.1662
t-value	5.30	0.37	1.09	1.88	0.1865	3.044
Input mean	0.27	30	25	9194	59	178.57
MPP	1444	1.02	0.1611	-0.0044	0.0097	-1.04
Price of input (P_x)	2000.00	7	4.00	0.75	5.00	50.00
MVP	25723.00	40.72	6.4	-0.1760	0.3867	-41.75
Maximum profitable level	3.47	174.50	40	2980.00	114.00	157.00
Average Fish Production(Y) = 390 kg Price of fish(Y) = Rs.40.00						

$R^2 = 0.69$

Intercept =4.4735

Chapter VII

FISH MARKETING

FISH MARKETING

Fish marketing is a flourishing trade in the economy of Assam as fish is a preferred food item of 95 per cent of the state's population. There is a wide gap between the present supply and the requirement of fish, which is partially met by the supply from the other fish producing states. The distribution process of the fresh fish, dried fish and fish seed has been discussed in this paper. There is a high consumer preference for Indian major carps. Large number of intermediaries are involved in the distribution process of the fresh fish marketing. Women are also involved in the retail trade in the markets and door to door sales in some selected parts of the study area. A well-organized marketing network is essential for the distribution of fish in the state at reasonable price. A well-organized marketing network is essential for the distribution of fish in the state at reasonable price. The present study highlights the prevailing marketing system, market channels, market availability and the market-related constraints in the growth of fish marketing in the state.

Animal protein has great demand in Assam as 95 per cent of its population is non-vegetarian. Of the various sources of animal protein, fish enjoys the high consumer preference because of its delicious taste and nutritional value. The high demand for the fish coupled with its insufficient production and supply, has led to the continuous inflow of fish from other states.

The Figure 7.1 shows that there was a gradual increase in both the fish production and requirement of fish from 1988 to 1991. But there was a quantum jump for supply and demand in the year 1991-92 and afterwards the fish production remained almost stagnant. The internal production of fish is not enough to meet the growing demand of fish in the state. To combat outflow of money and to strengthen the economy of the state, the potential for fisheries resources are to be appropriately utilized.

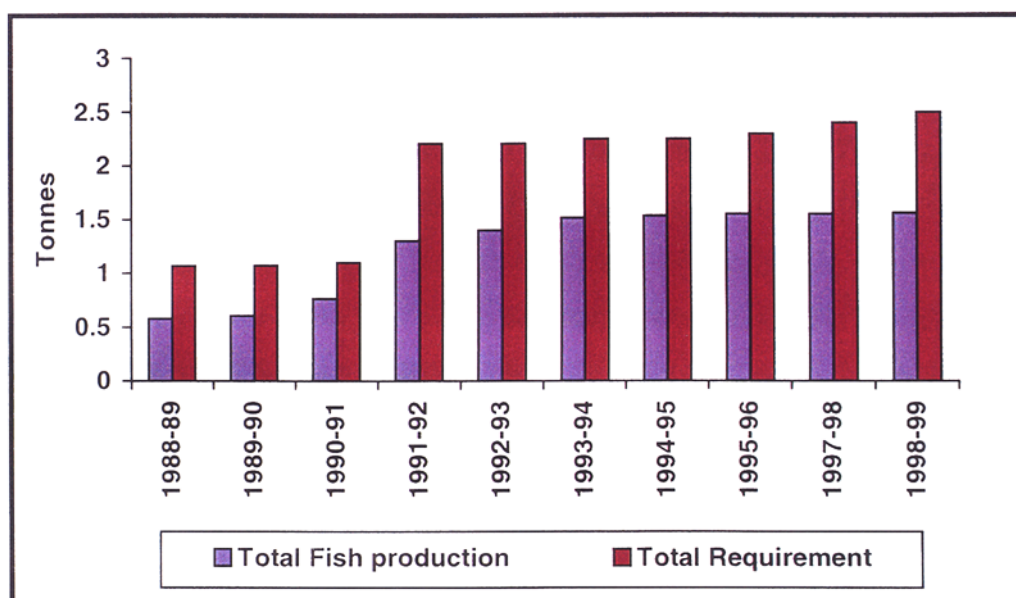


Fig.7.1: Total fish production and requirement in the state during last ten years.

7.1 Fresh Fish Marketing

High market demand was observed among the consumers for the fresh fish of Indian major carps followed by the exotic varieties of carp and catfishes. Locally available fish were costlier than those brought from other states due to their freshness and high consumer preference. The fish coming from outside were preserved in ice. Frequent political disturbances has often led to the collapse of market system and price equilibrium there by causing manifold increase in the price of local fish. Guwahati is the main landing-cum-consumption centre of the state. Paltanbazar and Panbazar are large centres having modern facilities like ice-plants, proper drainage, disposal system and permanent sheds. The fish coming from outside is first assembled in Guwahati and then it is distributed throughout the state and also to the other North-Eastern states. Now, due to the improved transportation facilities, outside fish directly arrives at the market places like Tezpur, Nagaon, Tinsukia, Dibrugarh, Borpetaroad, Shillong and Dimapur. With the ever increasing requirement of the fish, the quantity of fish coming from outside is also increasing. The peak marketing season observed for the locally available fish and the outside fish was January to July and August to December, respectively.

Harvesting of fish from the rivers is done in a systematic manner by contract system. The rivers are divided into different blocks, which are then leased out to a contractor or a society for getting the fishing rights for one year. The contractor, in turn, appoints a person for each block called *Mahaldar* on monetary agreement to look after the business. The fishes are disposed in the landing centre itself by auction system. The wholesalers purchase the local fishes assembled in the landing centre at Uzanbazar which is the major landing centre of the state and are subsequently brought to the main market of Guwahati and important market places of the other districts for the wholesale as well as the retail sale. The retailers also take the fish to the terminal markets of the cities and other places from *Mahaldar* and wholesalers. Most of the fishes sold in the terminal markets are brought by

the fishermen or his family members. Entire load of the fish brought by the respective sellers is purchased at a time by a negotiator. In some places of the study area, the women members of the family bring the fish catch collected by male members to the market for sales. Some of these women are also involved in door to door sales taking the fish in bamboo basket or motor tube.

The disposal of the fish from the capture fisheries and the culture fisheries is undertaken through the following prominent market channels.

- I) Fishermen → *Mahaldar* → Commission agent at terminal market → Whole- salers → Retailers → Consumer.
- II) Fish farmers → Wholesalers → Retailers → Consumer.

The two main types of fish available in the market are local fish and iced fish come from outside. The study revealed that Indian major carps constitute the major portion of the fish available in the market followed by catfish and other miscellaneous varieties. The local as well as out side fishes available locally in the market are shown in Table 7.1. Among the Indian major carps, rohu, catla and mrigal are the important species available in the market. Rohu and catla are coming from outside also, where as mrigal available in the market comes from local places only. Similarly other carps like *Labeo gonius*, *L. calbasu*, *Cirrhina reba* and exotic species like silver carp, grass carp and common carp are also sold in the retail market. Although locally available catfishes are mostly sold in the market, some small percentage of catfishes like *Clarias gariepinus* (Thai magur) and *Heteropneustes fossilis* (Singhi) brought from Bihar and West Bengal are also available. Major catfishes available in the market during the study period were *Aorichthys seenghala*, *Clarias batrachus*, *Clarias gariepinus* and *Heteropneustes fossilis*.

Table 7.1: Major fish coming from outside and locally available fish in the market.

Major group of fish from outside	Major locally available group
<i>Labeo rohita</i> <i>Catla catla</i> <i>Tenuulosa ilisha</i> <i>Clarias gariepinus</i> <i>Wallago attu</i> <i>Notopterus chitala</i> <i>Aorichthys seenghala</i>	<i>Labeo rohita</i> , <i>L. gonius</i> , <i>L. calbasu</i> , <i>L. bata</i> , <i>Catla catla</i> , <i>Cirrhina mrigala</i> , <i>C. reba</i> , <i>Wallago attu</i> , <i>Notopterus chitala</i> , <i>N.</i> <i>notoptreus</i> , <i>Aorichthys seenghala</i> , <i>Hypophthalmichthys molitrix</i> , <i>Ctenopharyngodon idella</i> , <i>Cyprinus carpio</i> , <i>Clarias batrachus</i> , <i>Heteropneustes fossilis</i> , <i>Anabas testudineus</i> , <i>Channa punctatus</i> , <i>C. striatus</i> , <i>Macrobrachium rosenbergii</i> , <i>M. malcolmsonii</i> , <i>Oreochromis</i> <i>mossambicus</i> , <i>Puntius sophore</i> , <i>P.</i> <i>javanicus</i> , <i>Amblypharyngodon mola</i>

Market arrivals of fresh fish from outside

In the year 1975 fishes from Kanpur, Lucknow and Howrah were reported in Paltanbazar market of Guwahati. Then from the year 1981 onwards fish started coming from Andhra Pradesh. The peak marketing season for outside fishes is August to December. During January to April, on an average, 15-20 quintals of fish by train and 5 truck loads of refrigerated fish arrive daily in the state, where as during the lean season the quantities drop to 10 quintals of fish by train and 2 truck loads of refrigerated fish per day. The annual inflow of fish to the state by train is much higher than that of train during last five years. Rohu and catla are mainly coming from Kanpur, Lucknow and Andhra Pradesh while *Notopterus chitala*, *Wallago attu* and *Aorichthys seenghala* are coming from Kanpur and Lucknow.

The main sources of hilsa found in the market are Bangladesh and Calcutta. During the study period *Anabas testudineus* (kaoi), *Heteropneustes fossilis* (singhi) and *Clarias gariepinus* (Thaimagur) were also seen in the market coming from Bihar. Market availability and price of fish were also studied and given in Table 7.2.

Table 7.2: Market availability and price of fish studied in some selected market.

Species	Average Market availability (daily) (kg)	Average Retail Price /kg (Rs.)	
		Local	Outside
<i>Labeo rohita</i>	250	60-80	40-45
<i>Catla catla</i>	250	55-75	40-45
<i>Wallago attu</i>	20	100-110	80-90
<i>Notopterus chitala</i>	25	120-140	100-120
<i>Aorichthys seenghala</i>	15	120-150	90-110
<i>Cirrhina mrigala</i>	50	60-80	NA
<i>Clarias batrachus</i> ,	10	150-180	NA
<i>Heteropneustes fossilis</i>	15	150-175	100-150
<i>Anabas testudineus</i>	100	65-80	50-55
<i>Channa punctatus</i>	10	35-40	NA
<i>C.striatus</i> ,	10	60-80	NA
<i>Macrobrachium rosenbergii</i>	10	120-150	NA
<i>Oreochromis mossambicus</i>	10	50-60	NA
<i>L. calbasu</i>	30	50-80	NA
<i>L. goni</i>	30	50-60	NA
<i>Anabas testudini</i>	150	50-100	NA
<i>Puntius sophore</i>	100	25-30	NA
<i>Puntius gonionatus (java puthi)</i>	50	35-45	NA
<i>Amblypharyngodon mola</i>	150	15-30	NA

The price of the fish varies with the season and availability. The price of local fish remains high during September to December where as the price of fish coming from outside remains almost constant.

7.2 Dried fish marketing

Dried fish market is invariably associated with the fresh fish market. Freshwater as well as marine fishes were found in the Jagiroad market. Dried fish market situated at Jagiroad of Nagaon district are the largest dried fish markets in Asia which function as supply centers of dried fish to the entire North-Eastern India. The peak market season is January to March and it remains closed during the monsoon season. The wholesale marketing is there only on Fridays and about forty wholesalers were observed in the market. Normally five trucks daily during the season used to come here from states like Gujarat, Maharashtra, Tamil Nadu, Uttar Pradesh and West

Bengal. One special kind of dried fish sold in the market known as "*Sindal*" is the costliest item of dried fish and is considered as anti-malarial by local people. This is prepared by putting the smaller fishes (fingerling size) in bamboo cylinder and then sun dried. Among the freshwater groups of dried fish, most commonly found were *Channa punctatus*., *Aorichthys seenghala*, *Puntius sophore*, *Amblypharyngodon mola*, *Notopterus chitala*, *Wallago attu*, *Labeo rohita* etc. The marine species like Bombay duck and shrimps were also found in the market.

Dried fishes are first assembled at Jagiroad wholesale market, then dried again and sorted out quality wise. The marine group of fishes are coming from the states of Gujarat, Tamil Nadu and Maharashtra. The dried fishes are disposed through the following prominent marketing channels.

- I) **Outside state → Jagiroad Dried Fish Market → Wholesalers of the North-Eastern states → Retailers → Consumers**
- II) **Outside state → Jagiroad Dried Fish market → Wholesalers of the state → Retailers → Consumers**

7.3 Fish Seed Marketing

Fish seed marketing in Assam is seasonal in nature and is confined mainly from May to September every year. The fish seed markets are situated in the rural areas. Earlier fish seeds were collected from the river and adjoining areas and sold to the farmers by the local fish seed vendors. These fish seed vendors transport the seed in earthen or aluminum *hundies* and sell it to the potential fish farmers. The problems of these wild seeds are that they are not only impure on many occasions but also not available in the appropriate time. The success of induced breeding led to the setting up of large number of hatcheries, which revolutionized fish seed production in the state. Table 7.3 shows the achievement of fish seed production in the state for the last 10 years.

Table 7.3: Fish Seed Production of Assam for last ten years.

Year	Seed Production (million fry)
1986-87	33
1987-88	56
1988-89	84
1989-90	660
1990-91	1188
1991-92	1616
1992-93	1626
1993-94	21000
1994-95	23000
1995-96	25000

Though the state is reported to have achieved self-sufficiency in carp seed production (Anon, 1998), the demand for seed appears to be more than the local production especially in the beginning of the season. The fish seed produced in West Bengal reaches the market of Assam by truck or train before the local producers start their production. The local seed farmers are handicapped by their inability to produce seed as early as May due to its seasonal nature and lack of adequate facilities. However, competition is still there to produce the seed in advance among the seed producers to realize maximum price.

The process of fish seed marketing is totally different from that of fresh fish sales as the seeds are to be sold in live condition. Locally available carp and other fresh water fish seeds are marketed in the village areas by fish seed vendors by carrying them on their bicycles keeping them in aluminum *hundies* filled with water. Seed Producers sell the hatchery-produced seed by packing them in steel pools and transported through out the state and also other North-Eastern states by means of minitrucks. The seed of Indian major carps dominates the market followed by the exotic carp varieties such as silver barb (*Puntius javanicus*), bighead carp (*Aristichthys nobilis*) and

thaimagur (*Clarias gariepinus*). The current market prices of the different varieties of seeds are given in the Table 7.4.

Table 7.4: Market price of some important varieties of fish seed.

Species	Riverine seed (price range Rs./100)		Hatchery seed (Rs./100)	
	1-1.5"	4-6"	1-1.5"	4-6"
<i>Labeo rohita</i>	60-100	250-300	20-25	150-200
<i>L. calbasu</i> and <i>L. gonius</i>	50-70	150-200	NA	NA
<i>L. bata</i>	10-20	25-30	NA	NA
<i>Cirrhina mrigala</i>	60-100	250-300	NA	NA
<i>Catla catla</i>	60-100	250-300	20-25	150-175
<i>Notopterus chitala</i>	NA	1000	NA	NA
<i>Wallago attu</i>	NA	1000	NA	NA

The market price depends upon the size and variety of the seed. The fish seed coming from outside are purchased by the wholesalers and then installed in nursery ponds. In some cases they keep the seed in a section of the river by making small pools by surrounding mosquito net. Then they sell these to the retailers or to the fish seed vendors and they in turn supply it to the fish farmers in the village area. Some retail sellers stock the seed in the nursery pond and raise them to fingerling size to get high price. The apparent high profitability of the fish seed trade in the study area has reportedly encouraged even some local enterprising persons to initiate steps towards starting fish seed supply centres on the bank of the river by making appropriate enclosures by nets.

The flow of fish seed is mainly undertaken through the following three prominent marketing channels

- I) Fish seed vendors → Wholesaler → Fish seed vendors → Fish farmers
- II) Fish seed vendors → Fish seed vendors → Fish farmers
- III) Fish seed vendors → Fish farmers

Small fish traders can't afford to use ice to preserve the quality of small and medium fishes because of high price of ice and reduction of the margin of profit.

The study indicates that the fish marketing system in Assam requires modernization. Lack of adequate transport and communication facilities has confined the sale of fish to limited outlets and prevents the growth of specialized marketing. Insufficient credit and differential pricing policies are emerging as hindrance to the market development. Police atrocities and extremist activities are discouraging the producers as well as fish traders to run their business smoothly. Market regulation and quality control is not properly implemented any where in the state. The vast potential for inland fish production has not been tapped fully due to several production and marketing bottlenecks. Marketing system requires sufficient infrastructure development by means of providing ice plants, storage and processing facilities and improvement in transportation system. Fishermen should be motivated to start fish production including seed production and marketing through co-operative system. The government intervention in the form of providing adequate financial support will go a long way in the development of fisheries in the state.

Chapter VIII

SOCIO-ECONOMIC DIMENSIONS

SOCIO-ECONOMIC DIMENSIONS

Very few analytical socio-economic studies have been done in the area of aquaculture. There are many descriptive studies that provide useful background information on the socio-economic conditions and farming practices of fish farmers, but future research should focus more on explaining rather than describing observed behaviour and prevailing conditions.

The interaction of personal, psychological and situational factors always influence on the earnings and the adoption of scientific culture practices. Hence the profile of the respondents is important to explain the possible relationships among different variables. The characteristics representing the personnel and socio-economic attributes are presented in this chapter.

8.1 Socio-economic Parameters of Fish Farmer Households

The distribution of respondents based on the attributes like family size and caste, housing, educational status and occupation are given in Table 8.1.

8.1.1 Family size and caste

A critical analysis of the details reveals that 20 per cent respondents of Darrang and 8.33 per cent respondents of Nagaon had small size of family consisting of four members. A large majority of the respondents i.e. 80 per cent of Darrang and 92 per cent of Nagaon had the family size of more than four members. The cast pattern of the respondents shows that majority of the respondents of Darrang i.e. 48.33 per cent were from general caste followed by 20 per cent of ST, 17 per cent of OBC and 15 per cent of SC. In Nagaon large majority of respondents represented by general caste (43.33%) followed by OBC (33.33%), SC (13.33%) and ST (10.00%).

8.1.2 Housing

Housing pattern is one of the most important indicators used to asses the economic well being of any community or village. On an average, 41.67

per cent of the respondents in the surveyed area of Darrang and Nagaon Districts were living in huts, where as 52.00 per cent and 6.25 per cent were living in *kutchha* and *pucca* houses respectively. A large number of respondents of Darrang and Nagaon i.e. 58.33 per cent and 45.83 per cent resided in *kutchha* houses.

8.1.3 Educational Status

With regards to educational level of respondents, it could be observed that 75 per cent of the respondents were literate while only 25 per cent are illiterate. Among the literate, schooling up to high school level occupied 39 per cent followed by middle school level, pre-degree level, primary level and graduate level with percentage of 21, 17, 14 and 8 respectively. Majority of the respondents (46%) from Darrang district was educated from high school level followed by middle school level (19%), pre-degree level (17%), primary (10%) and degree level (8%). Majority of the respondents from Nagaon district were from high school level education (32%), followed by middle school level (24%), primary level (19%), pre-degree level (18%) and graduate level (7%). It implies that more number of literate farmers were involved in fish culture practices than illiterates. It is quite interesting to observe that graduates are also taking part in fish farming practices.

8.1.4 Occupation

The standard of living and earnings of fish farmers depend on their occupation. It was observed that fishery constituted a major occupation for 16.67 per cent respondents of Darrang and for 25 per cent respondents of Nagaon. On an average major occupation of 57 per cent of respondents was agriculture followed by fishery (21%), business (18%) and government service (5%). It can be inferred that majority of respondents of both the district had agriculture as a primary occupation along with fishery as secondary activities. Since time requirement for fish culture is less, agriculture farmers can go for aquaculture practices during lean period without effecting on their primary activities.

Table 8.1: Distribution of size of family, caste, housing pattern, literacy rate, educational status and occupational pattern.

Attributes	Darrang F(%)	Nagaon F(%)	Total F(%)
1.Number of households studied	120	120	240
2. Average size of family			
a. Small (2+2)	24 (20.00)	10 (8.33)	34 (14.17)
b. Big (>2+2)	96 (80.00)	110 (91.67)	206 (85.83)
3. caste			
a. ST	24 (20.00)	12 (10.00)	26 (10.83)
b. SC	18 (15.00)	16 (13.33)	34 (14.17)
c. OBC	20 (16.67)	40 (33.33)	60 (25.00)
d. General	58 (48.33)	52 (43.33)	110 (45.83)
4. Housing Pattern			
a. Hut	40 (33.33)	60 (50)	100 (41.67)
b. Kutchha	70 (58.33)	55 (45.83)	125 (52.00)
c. Pucca	10 (8.33)	5 (4.17)	15 (6.25)
5. Literacy rate	96 (80)	84 (70)	180 (75)
6. Educational status			
a. Primary (to 4 th)	10 (10.42)	16 (19.05)	26 (14.44)
b. Middle (5-7)	18 (18.75)	20 (23.81)	38 (21.11)
c. High School (8-10)	44 (45.83)	27 (32.14)	71 (39.44)
d. Pre-degree (11-12)	16 (16.67)	15 (17.86)	31 (17.22)
e. Degree (>12)	8 (8.33)	6 (7.14)	14 (7.78)
7. Major occupation			
a. Agriculture	62 (51.67)	74 (61.67)	136 (57)
b. Fishery	20 (16.67)	30 (25.00)	50 (21)
c. Business	30 (25.00)	12 (10.00)	42 (17)
d. Govt. Service	8 (6.67)	4 (3.33)	12 (5)

The distribution of respondents based on age, experience, social participation and training are given in Table 8.2.

8.1.5 Age

The Table 8.2 reveals that 45 per cent of total fish farmers belong to middle age group followed by 39.17 per cent and 15.83 per cent belong to younger and older age group respectively. In Nagaon district 51.67 per cent represented medium age group followed by 40 per cent younger age group and 8.33 per cent older age group. However, younger age group and middle age group (38.33%) were equally distributed in Darrang district followed by 23.34 per cent older age group. It could, therefore, be inferred that fish farming practices in the two districts attracted the interest of young and middle age group.

8.1.6 Experience

A perusal of the contents of Table 8.2 reveal that 76.66 per cent of the total respondents belong to medium level of experience i.e. 8-16 years in composite fish culture, followed by higher level categories represented by 16.67 per cent with more than 16 years of experience and lower level category i.e. 6.67 per cent with less than 8 years of experience in composite fish culture. In Darrang district 66.67 per cent of respondents were in the category of medium level experience i.e. 9-15 years. Where as 18.33 per cent of respondents have high level experience i.e. more than 15 years and 15 per cent of the respondents have low level experience of less than 9 years. Medium level experience category respondents of Nagaon district were represented by 73.33 per cent of the total respondents. However 16.66 per cent respondents have high level experience of more than 16 years, followed by lower level category (10%) with less than 8 years experience in composite fish farming.

8.1.7 Social participation

It is distinct from the Table that majority of the respondents have higher level of social participation i.e. 78 per cent. This is followed by lower and higher level category with a percentage of 12 and 10 respectively. About 78 per cent of respondents of Nagaon district had shown higher level of social participation where as 77 per cent of respondents of Darrang district had shown higher level of social participation. The farmers participated in social institution like club, school, library, co-operative and village welfare organizations.

8.1.8 Training

Training is an effective tool of transfer of technology. Eventhough training programmes are being organized by the FFDAs and other agencies, the fish farmers were not willing to under go training for fear of wage loss, lack of time and lack of incentives (Mahandrakumar, 1996). Majority of the

respondents didn't receive training on fish culture practices. The number of trained respondents in Darrang and Nagaon were 25 and 20 respectively.

Table 8.2: Distribution of respondents based on age, experience, social participation and training.

Attributes	Darrang F (%)	Nagaon F (5%)	Total F (%)
1. Age			
a. Younger (<36)	46 (38.33)	48 (40)	94 (39.17)
b. Middle (36-50)	46 (38.33)	62 (51.67)	108 (45)
c. Older (>50)	28 (23.34)	10 (8.33)	38 (15.88)
2. Experience			
a. Low	(<9) 18 (15.00)	(<8) 12 (10.00)	(<8) 16 (6.67)
b. Medium	(9-15) 80 (66.67)	(8-16) 88 (73.33)	(8-16) 184 (76.66)
c. High	(>15) 22 (18.33)	(>16) 20 (16.67)	(>16) 40 (16.67)
3. Social participation			
a. Low	(<2) 16 (13.33)	(<4) 12 (10.00)	(<3) 28 (12)
b. Medium	(2-12) 92 (76.67)	(4-10) 94 (78.33)	(3-11) 186(78)
c. High	(>12) 12 (10.00)	(>10) 14 (11.66)	(>11) 26 (10)
4. Training			
a. Trained	30 (25)	24 (20)	54 (22.50)
b. Non-trained	90 (75)	96 (80)	186 (77.50)

8.1.9 Total family income

In general, employment and income are the twin decisive factors mostly used for determining the living standard of any community or region. Equitable distribution of income further enhances the social harmony among different sections of population. Analysis of income levels of the fish farmer families in both the districts studied has brought out some interesting features. The classification of fish farmer families based on income level is given in Table 8.3.

On an average 6.67 per cent fish farmer households of Darrang and 5 per cent fish farmer households of Nagaon had an annual income of less than Rs.*0,000.00. Majority of the respondents i.e. 30.83 per cent of Darrang and 37.50 per cent of Nagaon had annual income in the range of Rs.20,000-30,000. About 20.83 per cent respondents of Darrang had annual income in

the range of Rs.15,000-20,000 where as in Nagaon 7.50 per cent had this level of income. As a whole the annual family income of fish farmer household of Darrang and Nagaon was Rs.25,000.00 and Rs.32,000.00. This low level of income reflects their poor economic condition, which was not sufficient to maintain, their normal livelihood. They can't afford much for fish culture activities.

Table 8.3: Classification of respondents according to different income groups in Darrang and Nagaon.

Income level (Annual) Rs.	Darrang F(%)	Nagaon F(%)	Total F (%)
Less than 10000	8 (6.67)	6 (5.00)	14 (5.83)
10,000-15,000	12 (10.00)	18 (15.00)	30 (12.50)
15,000-20,000	25 (20.83)	9 (7.50)	34 (14.17)
20,000-30,000	37 (30.83)	45 (37.50)	82 (34.17)
30,000-40,000	18 (15)	21 (17.50)	39 (16.25)
40,000-50,000	8 (6.67)	7 (5.83)	15 (6.25)
50,000-75,000	5 (4.17)	5 (4.17)	10 (4.17)
75,000-1,00,000	4 (3.33)	4 (3.33)	8 (3.33)
Above 1,00,000	3 (2.50)	5 (4.17)	8 (3.33)

8.1.10 Total Family Expenditure pattern of fish farmer households

The share of expenditure items in farmer's expenditure on percentage basis is given in Table 8.4 . Most of the fish farmers were in the low-income trap and they couldn't meet even their consumption expenditure from their earnings. The average annual expenditure of a fish farmer household works out at Rs.23,000 and Rs.31,000 in Darrang and Nagaon respectively. The perusal of expenditure pattern clearly indicates that about 70 per cent of the income of the respondents of Darrang and 66 per cent of that of Nagaon was spent for their or food alone. The clothing was found to be next major expenditure among the respondents of both the districts. The low level of spending for education (7% of earnings in Darrang and 5% of that in Nagaon) and medical (5% of earnings in Darrang and 8% of that in Nagaon) indicated their socio-economic backwardness.

Table 8.4: Expenditure pattern of fish farmers households.

Item	Darrang (% of earnings)	Nagaon (% of earnings)	Total (% of earnings)
Food	70	66	67
Clothing	15	18	17
Education	7	5	6
Medical	5	8	7
Entertainment	1	1	1
Others	2	2	2

8.2 Sources of Information

The present study in the selected districts identifies the sources of information for fish culture practices as fish seed vendors, friends and relatives, fisheries extension personnel, radio, TV and newspaper. On an average large majority of the respondents (52%) got their information from fish seed vendors followed by extension personnel (30%), radio (8%), TV (6%) and newspaper (4%). The distribution of respondents based on the receiving information are given in Table 8.5.

Table 8.5: Distribution of respondents based on source of information.

Source	Darrang F (%)	Nagaon F (%)	Total F (%)
Fish seed vendors	55 (45.83)	70 (58.33)	125 (52)
Fisheries extension personnel	38 (31.67)	34 (28.33)	72 (30)
Radio	10 (8.33)	8 (6.67)	18 (7.50)
TV	7 (5.83)	6 (5.00)	13 (5.42)
News paper	5 (4.17)	5 (4.17)	10 (4.17)

8.3 Problems for Adopting Scientific Fish Culture Practices

The distribution of respondents based on the problems they faced were given in Table 8.6. The tabular analysis reveals that lack of finance **was** emerged as the major problem to adopt fish culture practices for 70 per cent respondents of Darrang and 65 per cent respondents of Nagaon. The farmers were not assisted with adequate finance by government and other agencies to practice fish farming in their existing ponds. The next important problem faced by the respondents are the non-availability of quality fish seed at proper time. On an average 68.33 per cent of Darrang and 60 per cent of Nagaon faced the problem of lack of availability of quality fish seed in time. In general farmers obtained their fish seed from private and government hatchery. Farmers also stocked riverine seed in their ponds. Although riverine seed shows good growth, most of them are mixed with undesirable predatory fishes. Hatchery raised seeds were available in adequate quantity, but they were not timely available.

Lack of adequate extension service was also observed as major lacuna for the expansion of fish culture practice in the study areas. About 60 per cent of Darrang and 70 per cent of Nagaon faced this problem. The number of extension personnel and visiting time given by them to the fish farmers were found to be insufficient.

Epizootic Ulcerative Syndrome (EUS) emerged as major disease problem faced by the farmers. It was a common problem for 60 per cent respondents of Darrang and 55 per cent respondents of Nagaon. The occurrence of EUS almost every year leads to mass mortality of fish and there by discouraged the farmers to expand the culture practices. Moreover they were not aware of preventive measures and medicine to control disease problem.

As most of the farmers were lying under low category group they found difficult to afford the **expenditure** for feed, fertilizer and other necessary inputs

due to their high cost. About 48.33 per cent Darrang and 45 per cent of Nagaon found it as a problem for adopting scientific fish culture practices. Low farm gate price fetched by the fish farmers was also a major problem. On an average 60 per cent of Darrang and 37.50 per cent of Nagaon faced this problem. The farmers harvested frequently and sell them to curtail their daily expenditure.

Frequently occurring flood year after year, some times two to three times in year discouraged them as they experienced heavy loss. For 37.50 per cent respondents it appeared as a major problem. Poaching and poisoning were also appeared as major problems for 37.50 per cent and 23.33 per cent of respondents of both the district respectively.

Table 8.6: Distribution of respondents based on their problem for adopting scientific fish culture practices.

Problems	Darrang F (%)	Nagaon F (%)	Total F (%)
1. Lack of finance	84 (70)	78 (65)	162 (67.50)
2. Lack of adequate extension service	72 (60)	84 (70)	156 (55)
3. Lack of quality fish seed in time	82 (68.32)	48 (40)	130 (54.17)
4. Disease	72 (60)	66 (55)	138 (57.50)
5. Non-availability of medicine and treatment measures	72 (60)	66 (55)	138 (58.00)
6. Low farm gate price	72 (60)	45 (37.50)	117 (48.75)
7. High cost of feed / fertilizer	58 (4.33)	54 (45)	112 (46.67)
8. Flood	48 (40)	42 (35)	90 (37.50)
9. Poaching	42 (35)	48 (40)	90 (37.50)
10. Poisoning	26 (21.67)	30 (25)	56 (23.33)

8.4 Participation of Women in Fisheries

Women can play a significant and crucial role in agricultural development and allied fields including crop production, animal husbandry,

horticulture, fisheries etc. Studies on women in agriculture conducted in India and other developing and under developed countries pointed out the facts that women contribute far more to agricultural production than that has generally been acknowledged. As in agriculture, participation of women in fisheries is gradually gaining momentum. Research and training programmes for them are now being planned and executed. But such programmes can be made successful only if these are based on facts and realities. Keeping this in mind an attempt was made to study the participation of women in fisheries with their socio-economic back ground in the selected area.

The major area of fisheries where women were seen to participate actively were aquaculture, fishing, fish trading and net making. The distribution of women based on their activities is given in Table 8.7.

Majority of women of the study area i.e. 42 per cent participated in aquaculture practices followed by fishing (26%), net making and mending (18%) and fish trading (14%). The major aquaculture activities adopted by women were manuring, seed rearing, stocking , feeding and harvesting.

Table 8.7: Distribution of women based on their participation in fisheries.

Activities	Total F (%)
I. Aquaculture	
a. Pond preparation	101(42.08)
b. Seed rearing	40(39.60)
c. Stocking	25 (24.75)
d. Feeding	15 (14.85)
e. Harvesting	21 (20.79)
II. Fishing	62 (25.83)
III. Fish trading	43 (17.92)
IV. Net making and mending	34 (14.17)

In addition to aquaculture they were also engaged in fishing in open waters individually or in a group. Community fishing was seen to be major practice among the women group of Darrang, giving the scope for the growth of co-operatives. These efforts are also remunerative and recreative in nature and increases fellow feelings in the community. In Darrang fish trading was not regular practice among the women population. They traded their catch in local market by retail selling or selling the fish door to door by carrying them in bamboo made structure/ motor tubes. The plate 8.1 and 8.2 shows the women involved in fish harvesting and fish marketing respectively.

Socio-economic studies of the women revealed a poor socio-economic status of the women. The distribution of women based on socio-economic attributes is given in Table 8.8.

Table 8.8: Distribution of women based on socio-economic attributes.

Attributes	Total F (%)
1. Age	
a. Less than 26 years	55 (22.92)
b. 26-35 years	185 (77.08)
2. Literacy rate	37.5%
3. Educational status	
a. Primary (up to 4 th)	145 (60.42)
b. Middle (5-7)	67 (27.92)
c. High school (8-10)	23 (9.58)
d. Pre-degree(11-12)	3 (1.25)
e. Degree(>12)	2 (0.83)
4. Family size	
a. Small (2+2)	77 (32.08)
b. Big (>2+2)	163 (67.92)
5 Annual Family Income('000.00)	
a. Low (<1000.00)	120 (50.00)
b. Medium(1000-4000)	80 (33.33)
c. High (>4000.00)	40 (16.67)
6. Housing pattern	
a. Hut	45 (18.75)
b. Kutcha	160 (66.67)
c. Pucca	35 (14.58)



Plate 8.1: Participation of women in fish harvesting.



Plate 8.2: Role of women in fish marketing.

On an average 22.92 per cent of women were below 26 years of age where as 77.08 per cent were in the range of 26-35 years. The over all literacy rate of the women engaged in fisheries was 37.5 per cent. Majority of the women studied up to primary level i.e. 60.42 per cent. It is quite interesting that graduate women also participated in fisheries activities. A large majority of women (67.92%) had big size family. On an average 66.67 per cent of the women respondents were staying in *kutcha* house. The average annual family income was Rs.3000.00. About 50 per cent of the women had family income more than Rs.1000.00, where as 17 per cent had family income in the range of Rs.3000.00.

Chapter IX
**KNOWLEDGE AND
ADOPTION BEHAVIOUR**

KNOWLEDGE AND ADOPTION BEHAVIOUR

Development of a fishery depends on generation of innovations by researchers, diffusion by extension and adoption by clients. Gearing up research and extension efforts to result in increased adoption can accelerate development. An analysis of adoption would provide clues for evolving an appropriate strategy for researchers and extension workers. Aquaculture extension process should be reoriented in line with need and interest of farmers. Much emphasis is required on fishery extension machinery for adoption of modern technology in farmer's field to boost the fish production. Knowledge plays an important role in acceptance or rejection of a technological innovation by farmers. It is important to know the level of knowledge and adoption behaviour of the farmers and their interrelationship to work out technological evaluation of any farming practices.

9.1 Knowledge Level of Respondents about Fish Culture

An attempt was made to know the knowledge level of the respondents about various aspects of fish culture. Distribution of respondents based on their knowledge level about the fish culture is given in Table 9.1.

Table 9.1: Distribution of respondents based on their knowledge about fish culture.

(N=240)

Sl. No	Knowledge Category	Darrang F (%)	Nagaon F (%)	Total F (%)
1.	Low	(<11) 28 (23.33)	(<11) 32 (26.67)	(<12) 60 (25.00)
2.	Medium	(11-21) 80 (66.67)	(11-19) 60 (50.00)	(12-20) 140 (58.33)
3.	High	(>21) 25 (11.67)	(>19) 15 (8.33)	(>20) 40 (16.67)

A perusal of Table 9.1 reveals that 58.33 per cent of the total respondents were observed in medium category, followed by 25 percent and 16.67 per cent in low and high categories, respectively. In Darrang District 66.67 per cent of the respondents represented the medium level category,

followed by low (23.33%) and high (11.67%), where as 50.00 per cent from Nagaon District represented medium category followed by low (26.67%) and high (8.33%). From these observations it could be safely inferred that a large majority of the respondents of both the districts have medium level of knowledge about fish culture. Such a positive observation might be due to the fact that majority of the respondents were observed to be practicing fish culture for more than a decade.

An attempt was also made to analyse the level of knowledge of the respondents against each knowledge item which is given in Table 9.2. From Table 9.2 it is evident that all the respondents had correct knowledge about selection of species, type of feed for fish culture, harvesting method, marketable size of fish. An overwhelming majority of the respondents i.e. 70-87% had correct knowledge about type of soil, necessity of liming, time interval between liming and manuring / fertilization, necessity of organic manuring, feeding habit of *Ctenopharyngodon idella* (grass carp) and *Cirrhina mrigala* (mrigal) and necessity of supplementary feed.

A good majority of respondents ranging from 50-70 per cent had correct knowledge about depth of pond, necessity of inorganic fertilizer, feeding habit of *Catla catla*, culture period of carps and marketing of the fish.

However, all the respondents didn't know about weedicide, the interval of subsequent doses of manure alternating with fertilizer, nutritional requirement of carps. It is distinct from the Table that more than half of the respondents didn't have correct knowledge about colour of water, time of lime application before releasing the fish, necessity of piscicide, recommended dose of lime, manure and fertilizer, time interval of manuring and fertilization before stocking, feeding habit of silver carp and common carp, recommended stocking density, water quality management and control measures of disease.

Table 9.2: Distribution of the respondents based on their extent of knowledge of fish culture.

Sl. No.	Knowledge Items	DARRANG		NAGAON		TOTAL	
		Right F (%)	Wrong F (%)	Right F (%)	Wrong F (%)	Right F (%)	Wrong F (%)
1.	Which type of soil is good?	100 (83.33)	20 (16.66)	90 (75)	30 (25)	190 (79.17)	50 (20.83)
2.	What depth of pond is required?	92 (76.67)	28 (23.33)	70 (58.30)	50 (41.67)	162 (67.50)	78 (32.50)
3.	What colour of water is good?	60 (50)	60 (50)	50 (41.67)	70 (58.33)	110 (45.83)	130 (54.17)
4.	Is it liming required?	110 (91.67)	10 (8.33)	100 (83.33)	20 (87.50)	210 (87.50)	30 (12.5)
5.	How many days before stocking liming is required?	50 (41.67)	70 (58.33)	30 (25)	90 (75)	120 (33.33)	120 (66.67)
6.	Do you follow recommended dose?	30 (25)	90 (91.67)	20 (16.67)	100 (83.33)	50 (12.50)	190 (87.50)
7.	Do you use any piscicide?	10 (8.33)	110 (91.67)	20 (16.67)	100 (83.33)	30 (12.50)	210 (87.50)
8.	Do you use any weedicide?	0	0	0	0	0	0
9.	Is it necessary to apply manure and fertilizer?	100 (83.33)	20 (16.66)	90 (75)	30 (25)	190 (79.17)	50 (20.83)
10.	Do you use any organic manure like cowdung ?	90 (75)	30 (25)	80 (66.67)	40 (33.33)	170 (70.83)	70 (29.17)
11.	Do you follow the recommended dose ?	40 (33.33)	80 (66.67)	28 (23.33)	92 (76.67)	120 (28.33)	120 (71.67)
12.	Do you use any inorganic fertilizer in your pond?	84 (70)	36 (30)	60 (50)	60 (50)	120 (60)	120 (40)
13.	Do you follow the recommended dose?	32 (26.67)	88 (73.33)	26 (21.67)	94 (78.33)	58 (24.17)	182 (75.83)
14.	How many days before stocking manure and fertilizer should be used?	30 (25)	90 (75)	20 (16.67)	100 (83.33)	50 (20.83)	190 (79.17)
15.	After stocking , what interval of subsequent fertilization is required?	0	0	0	0	0	0
16.	In which portion of the pond and what item feeds						
	i) <i>Catla catla</i>	80 (66.67)	40 (33.33)	50 (41.67)	70 (58.33)	130 (54.17)	110 (91.67)
	ii) <i>Labeo rohita</i>	60 (50)	60 (50)	50 (41.67)	70 (58.33)	120 (50)	120 (50)
	iii) <i>Cirrhina mrigala</i>	100 (83.33)	20 (16.67)	90 (75)	30 (25)	190 (79.17)	50 (41.67)
	iv) <i>Hypophthalmichthys molitrix</i>	50 (41.67)	70 (58.33)	40 (33.33)	80 (66.67)	90 (75)	150 (62.50)
	v) <i>Ctenopharyngodon idella</i>	100 (83.33)	20 (16.67)	110 (91.67)	10 (8.33)	210 (87.50)	30 (12.5)
	Vi) <i>Cyprinus carpio</i>	100 (83.33)	20 (16.67)	90 (75)	30 (25)	190 (79.17)	50 (20.83)

Table 9.2 (Contd. 2)

Sl. No.	Knowledge Items	DARRANG		NAGAON		TOTAL	
		Right F (%)	Wrong F (%)	Right F (%)	Wrong F (%)	Right F (%)	Wrong F (%)
17.	Do you follow six species combination?	34 (28.33)	86 (71.67)	70 (58.33)	50 (41.67)	104 (43.33)	136 (56.67)
18.	Do you follow recommended stocking density?	48 (40)	72 (60)	40 (33.33)	80 (66.67)	88 (36.67)	152 (63.33)
19.	What size of fish do you stock ?	76 (63.33)	44 (36.67)	70 (58.33)	50 (41.67)	120 (60.83)	120 (39.17)
20.	Do you know nutritional requirement of carps?	0	0	0	0	0	0
21.	Is it necessary to provide supplementary feed?	104 (86.67)	16 (13.33)	102 (85)	18 (15)	206 (85.83)	34 (5.83)
22.	Do you maintain recommended feeding dose/ schedule?	0	0	0	0	0	0
23.	Do you maintain desirable water depth?	20 (16.67)	100 (83.33)	16 (13.33)	104 (86.67)	36 (15)	204 (85)
24.	Do you know how to manage water quality problem like oxyegen depletion, algal bloom etc?	22 (18.33)	98 (81.67)	20 (16.67)	100 (86.33)	42 (17.50)	198 (82.50)
25.	Do you know required water quality parameter?	10 (8.33)	110 (91.67)	4 (3)	116 (96.67)	14 (5.83)	226 (94.17)
26.	Do you use any chemical for disease control?	38 (31.67)	82 (68.33)	20 (16.67)	100 (86.33)	58 (24.17)	182 (75.83)
27.	Do you know harvesting method of fish?	110 (91.67)	10 (8.33)	120 (100)	0	230 (95.83)	10 (4.17)
28.	Do you know marketable size of fish?	90 (75)	30 (25)	100 (86.33)	20 (24.17)	190 (79.17)	50 (20.83)
29.	Do you know how to market your harvested fish?	50 (41.67)	70 (58.33)	90 (75)	30 (25)	140 (58.33)	100 (41.67)

A good majority of the respondents from Darrang ranging from 75 to 90 per cent had correct knowledge about the type of soil, required depth of the pond, necessity of liming, necessity of organic manure, necessity of supplementary feed and the feeding habit of *Cirrhina mrigala* (mrigal).

Respondents ranging from 50 to 74 per cent from Darrang District had correct knowledge about necessity of inorganic fertilizer, feeding of catla and grasscarp, culture period and stocking size of fish. While half majority of the respondents didn't know colour of water, time of liming before stocking of fish, recommended dose of lime, organic manure and fertilizer, necessity of

piscicide and inorganic fertilizer, time interval of using manure and fertilizer before stocking, feeding habit of *Labeo rohita* (rohu),) *Hypophthalmichthys molitrix* (silver carp), recommended stocking density, water quality management and the controlling measures of disease.

In comparison to the respondents of Darrang district, respondents of Nagaon district had less knowledge about fish culture. The knowledge items like type of soil, necessity of organic manure, feeding habit of *Cirrhina mrigala* (mrigal) and grass carp, necessity of supplementary feed, marketing of fish were known correctly by overwhelming majority of respondents i.e. 70 to 80 per cent of Nagaon district whereas a good majority of respondents ranging from 50 to 70 per cent had correct knowledge about suitable depth of pond, necessity of inorganic fertilizer, feeding habit of rohu and silver carp and culture period. More than half of the respondents didn't have correct knowledge about colour of water, time of liming before seed releasing, necessity of piscicide, recommended dose of lime, manure and fertilizer and their interval before releasing seed and also time interval of subsequent doses, feeding habit of catla, silvercarp, and common carp, recommended stocking density and appropriate size of fish to be stocked, water quality management and disease controlling measures.

From the above results it can be inferred that majority of the respondents lacked correct knowledge about some important aspects of fish culture. They didn't have correct idea about recommended dose of the inputs like lime, organic manure, inorganic fertilizer and seed, time interval of using these different inputs, the controlling measure of disease. Since disease is emerging as main hurdle for aquaculture development, farmers should have good knowledge of disease control. The knowledge level of the farmers in above mentioned important aspects have to be strengthened through adequate extension service by organization regular training programme. At the same time it is essential to get their feed back for refinement of the technology. Technology transfer without testing their knowledge will be

meaningless. Based on their knowledge level emphasis should be given to update their knowledge to adopt more new technology.

9.2 Extent of adoption of fish culture by the respondents

To know the extent of adoption by the respondents, collected information against a structured interview schedule were presented under main packages like pond preparation, stocking of fish, feeding, management and marketing.

A scrutiny of the details presented in Table 9.3 reveals that majority of the respondents (73%) were observed under 'medium' category, while 14 per cent and 13 per cent of them belonged to 'high' and 'low' adoption categories respectively. From the contents of the Table 9.3 it is seen that 75 per cent of

Table 9.3: Distribution of respondents based on their level of adoption of fish culture.

(N = 240)

Categories	Darrang District F(%)	Nagaon District F(%)	Total F(%)
Low	(<12) 16 (13.33)	(<14) 16 (13.33)	(<13) 32 (13.33)
Medium	(12-22) 84 (70)	(14-22) 90 (75)	(13-23) 174 (72.50)
High	(>22) 28 (23.33)	(>22) 16 (13.33)	(>22) 34 (14.17)

the respondents from Nagaon District and 70 per cent of the respondents from Darrang District fall under the category Medium. However, 23.33 per cent of respondents from Darrang District and 13.33 per cent of respondents from Nagaon district were observed under high category of adopters. In Darrang and Nagaon Districts less number of low category adopters (13.33) were observed.

Scrutiny of the Table 9.4 reveals that majority of the respondents i.e. 62.5 per cent under present study fully adopted the species selection while only 15 per cent of the total respondents didn't adopt the same. This might be due to the easy availability of seeds of all varieties of carps for fish culture. In Nagaon District 66.67 per cent respondents and in Darrang District only 58.33 per cent fully adopted the same. The ratio of the fish species was not adopted by 58.33 per cent of the respondents. Only 12.5 per cent of the total respondents fully adopted this. Only 29.17 per cent fully followed the recommended stocking density where as large majority didn't follow it. In both the districts equal number of respondents (33.33%) adopted partially. Only 12.5 per cent of the respondents stocked appropriate size of fish, while 33.33 percent didn't do so. Appropriate density and size of fish seed with proper stocking ratio is important to attain optimal fish production. It was observed from the present study that non-availability of quality and quantity of required species of fish seed is the main reason for not adopting the recommended size as well as density.

On an average 45.33 per cent of the respondents partially adopted the liming practice for pond preparation where as 20.83 per cent fully adopted this practice for correction of soil. About 25 Per cent and 46.67 per cent respondents of Darrang District adopted it fully and partially respectively. In Nagaon District 16.67 per cent showed full adoption of it where as 50 per cent showed partial adoption.

A critical analysis of the Table 9.4 indicates that the practice of aquatic weed control and eradication of undesirable / predatory fish were adopted by less number respondents. On an average 8.33 per cent respondents fully adopted the eradication of predatory fish. Majority of the respondents i.e. 66.67 per cent of Darrang and 75 per cent of Nagaon District did not adopt the aquatic weed control practice. This may be due to the poor knowledge of the respondents regarding the importance of the practice.

Liming as a part of pond manuring was not adopted by large majority of the respondents. In Darrang District 15 per cent partially adopted the liming practice where as in Nagaon 11.67 per cent partially adopted it. Over all 33.33 per cent respondents adopted partially in-organic fertilization. About 41.67 per cent of Darrang and 25 per cent of Nagaon partially adopted inorganic fertilization. In Darrang 30 per cent fully and 50 per cent partially adopted it. In Nagaon District 33.33 per cent partially adopted the practice where as 35 per cent did not adopt it all. It was observed that basic pond manuring practices like liming and inorganic fertilization were not adopted by majority of the respondents. The lack of knowledge about manuring practices and non-availability of adequate finances are the prime reasons of non-adoption of the practice fully by the respondents. Farmers should be properly trained to acquire knowledge about these crucial practices as per the recommendation. The fish production depends upon the timely application of correct quantity of these inputs.

Analysis of the Table 9.4 shows that majority of the respondents (66.67%) adopted item wise feeding practices partially where as few respondents (12.5%) adopted it fully. On an average 16.67 per cent respondents of Darrang and 8.33 per cent respondents of Nagaon fully adopted it. The most commonly used feed items were rice bran and oil cake. They did not use exact quantity of feed at right time as per the recommended feeding schedule. Only 10 percent of the respondents maintained recommended ratio of 1:1 rice bran and oil cake. Only small per cent of respondents either fully or partially adopted the method of feeding. About 25 per cent respondents of Darrang and 16.67 per cent of Nagaon fully adopted the method of feeding whereas 13.33 per cent of Darrang and 6.67 per cent of Nagaon partially adopted the practice. They did not know at all the nutritional requirement of the cultured species. This was because of inadequate technical knowledge and high cost of feed. The utilization of the locally available agricultural waste and other noncompetitive feed materials with live stock will reduce the cost of feed.

Table 9.4: Pattern of adoption of fish culture practice by respondents

Sl. No.	Fish Culture Practice Items	Fully Adopted F (%)		Partially Adopted F (%)		Not Adopted F (%)	
		Darrang	Nagaon	Darrang	Nagaon	Darrang	Total
1.	Pond Preparation i) Liming (soil correction) ii) Aquatic weed control iii) Eradication of predatory fish iv) Pond Manuring a) Liming b) Inorganic Fertilizer c) Organic manure	30 (25.00) 10 (8.33) 10 (8.33)	20 (16.67) 10 (8.33) 10 (8.33)	50 (20.83) 20 (8.33) 20 (8.33)	40 (33.33) 20 (16.67) 10 (8.33)	80 (33.33) 50 (20.83) 30 (12.5)	110 (45.83) 170 (70.83) 190 (79.17)
2.	Stocking of Fish i) Selection of species ii) Ratio of Stocking iii) Density of Stocking iv) Size of fish seed	8 (6.67) 22 (18.33) 36 (30.00)	4 (3.33) 12 (10.00) 20 (16.67)	12 (05) 34 (14.17) 56 (23.33)	18 (15.00) 50 (41.67) 60 (50.00)	32 (13.33) 80 (33.33) 100 (41.67)	196 (81.67) 126 (52.5) 84 (35.00)
3.	Feeding i) Items ii) Feeding schedule iii) Method of feeding	70 (58.33) 20 (16.67) 40 (33.33) 20 (16.67)	80 (66.67) 10 (8.33) 30 (25.00) 10 (8.33)	150 (62.5) 30 (12.5) 70 (29.17) 30 (12.5)	30 (25.00) 40 (16.7) 40 (33.33) 70 (58.33)	60 (25.00) 70 (29.66) 80 (33.33) 130 (54.17)	30 (12.5) 140 (58.33) 90 (37.50) 80 (33.33)
4.	Management i) Water level maintenance ii) Aeration iii) Thinning / checking iv) Prophylactic Measures	0 4 (3.33) 30 (25.00) 0	0 0 12 (10) 0	0 4 (1.67) 42 (17.5) 0	0 20 (16.67) 40 (33.33) 10 (8.33)	0 34 (14.17) 70 (29.17) 20 (8.33)	240 (100) 202 (84.17) 128 (53.33) 220 (91.67)
5.	Marketing practice	10 (8.33)	10 (8.33)	20 (8.33)	30 (25.00)	50 (41.67)	80 (33.33)
							140 (58.33)

A perusal of the Table 9.4 reveals that a very few respondents adopted management practices. None of them maintained water level, oxygen, pH and other important water quality parameters as per the recommended level. Only a small fraction of the respondents i.e. 1.67 per cent adopted aeration practice in traditional way. They were not aware about the important water quality parameters suitable for fish farming. Only 8.33 per cent respondents adopted partially health management practices. The non-availability of chemicals, medicines and poor knowledge of disease treatment was the main reason for poor adoption of the practices. The farmers should have good knowledge regarding this management aspects otherwise they will not get actual benefit. This information should be given to the farmers properly through organization of various training and extension programmes.

These observations conclusively indicate an over all satisfactory trend on the adoption of fish culture practices by the fish farmers of both the districts. Respondents of Darrang District were adopting the fish culture technology at a higher level than the respondents of Nagaon District. fish culture is gaining popularity day by day among the farmers because of its high profit. Each and every household has a small pond in front of their house. Although these farmers are primarily agriculture farmers, they do fish culture during off-season. Some of the inputs like cow dung, banana leaf, rice polish and agriculture wastes are managed from their own side. Thus they are able to reap more benefits with little effort by resorting to fish culture. The finding also reveal that still there is scope to increase the adoption level of farmers. Hence the concerned extension agencies should gear up their activities to disseminate more information on fish culture besides arranging for the incentives like provision of cost inputs at their door steps, better marketing facilities, assured price etc.

9.3 Relationship between Knowledge and Adoption of Fish Culture

Data presented in Table 9.5 reveals that extent of adoption of fish culture practices by respondents was positively and significantly related to the knowledge level of respondents. From this it can be inferred that farmers with higher level of knowledge were found to adopt more number of fish culture practices. These findings are in conformity to the voluminous research evidences of Haque (1979), Ghosh *et al.* (1993), Mahandra kumar (1996). Rogers, 1983 also established a positive relation between knowledge and adoption. It is, thus, possible to increase the extent of adoption of fish culture practices by increasing knowledge level through training programme. Hence, the extension agencies may plan and implement more number of educational activities.

9.4 Relationship between Socio-economic Variables and Adoption Behaviour.

The relationship between selected independent variable of respondents and their adoption level was worked out by computing correlation coefficients. Their significance of difference was tested by comparing calculated 'r' value with Table 'r' value at 1per cent or 5 per cent level of significance. The results are shown in 9.5.

A perusal of the Table 9.5 reveals that total annual family income and experience were positively and significantly related to the adoption of fish culture by respondents of both the districts. Whereas age was negatively and significantly related to the adoption of fish culture by respondents of both the districts. Independent variables like social participation, size of pond, total family expenditure, education had no significant relationship with adoption. It can be inferred that farmers of young age with higher level of experience and family income adopted more number of fish culture practices while they

adopted at similar level irrespective of their social participation, size of pond, total family expenditure and education.

Table 9.5: Relationship between selected socio-economic variables and adoption behaviour .

Sl. No.	Variables	"r" value
1.	Knowledge	0.7016 *
2.	Age	-0.3108 *
3.	Education	0.0781 NS
4.	Experience	0.2570 **
5.	Size of Pond	0.0133 NS
6.	Total Family Income	0.0686 *
7.	Social Participation	-0.0311 NS
8.	Total Family Expenditure	0.0298 NS

The younger farmers being more enthusiastic for adopting fish culture were attracted more towards scientific technologies. Hence, the younger respondents adopted more practices. The findings are in conformity with the research of Singh (1983), Das *et al.* (1988) and Mahandra Kumar (1996).

Chapter X
CONCLUSION

CONCLUSION

Fish contributes to the food security of people directly through providing high quality food including animal protein and some important micro-nutrients, and indirectly through providing income and livelihood to the producers. In developing countries, fish is particularly important for many poor people - often those at high risk of food insecurity. Aquaculture can hold the promise of becoming a viable alternative to capture fisheries, as depleting capture fisheries will not be able to meet the ever-increasing demand for fish.

The State Assam with its immense freshwater resources can contribute significantly to the country's inland fisheries development. The State has rich fishery resources of 3.47 lakh ha water area. The vast wetlands of the State, the *beels* and lacustrine waterbodies, ponds and tanks offer enormous scope for fisheries development in the State. These waterbodies form the abode for nearly 80 endemic fish species, some of which have great potential as ornamental fishes for export purposes.

In spite of its high potential fishery resources, the State is yet to achieve self - sufficiency in production of fish. The present level of fish production in the State is 1.55 lakh tonnes which is not enough to meet the potential demand estimated at 2.5 lakh tones.

Beels are the major fishery resources with a potential production of 50,000 tonnes of fish annually. Present level of productivity in *beels* is in the range of $80\text{--}100\text{ kg ha}^{-1}\text{ yr}^{-1}$ which can probably be increased up to a level of $500\text{ kg ha}^{-1}\text{ yr}^{-1}$. The introduction of cage and pen culture in the *beels* will certainly enhance State's fish production. There is a tremendous scope for the development of aquaculture in the prevailing ponds and tanks. The productivity of these ponds and tanks at present level is much lower than the national average of $2250\text{ kg ha}^{-1}\text{ yr}^{-1}$. There is enough scope to increase it to

a level of 3000 kg ha⁻¹ yr⁻¹ or more than that. Aquaculture can play an important role in the State's economy by way of providing livelihood to thousands of people directly or indirectly. If all the resources can be utilized for fish production through culture and capture fisheries, the State will be able to produce surplus fish even for export to neighboring countries.

The State has attained self-sufficiency in carp seed production. However the availability of genetically improved fingerling size fish seed is yet to be achieved uniformly throughout the State in time. Availability of a large number of cultivable waterbodies, increased availability of fish seed and prevailing high demand of fish are some of the important factors which can support aquaculture development in the State.

The State Fisheries Department of Assam, with its allied agencies and corporation like Fish Farmers Development Agency, District Rural Development Agency and Assam Fisheries Development Corporation Ltd. can play a vital role in the economic emancipation of the people through its numerous productive schemes for scientific fish culture. The Department has secured a World Bank assistance under the "Assam Rural Infrastructure and Agricultural Services Project" with fund provision of Rs.2837.40 lakhs for a period of eight years. This fund should be utilized for development of farmer's pond, community tank, various culture technique like composite fish culture, airbreathing fish culture and integrated fish farming, fisheries extension, education and training and finally upgradation of research facilities in the State. Although efforts have been made in the national programme for development of fish farming through FFDAs to increase fish production to meet the demand, progress is not satisfactory as envisaged earlier and so it is essential to find out the socio-economic, technical, organizational or other factors which hamper the scheme to exhibit a satisfactory picture. At the same time it is also important to initiate corrective measures accordingly.

Information on techno-socio-economic framework of the fish farmers forms a good base for planning and development of this economically backward sector. Lack of adequate and authentic data on socio-economic conditions of the target population is one of the serious impediments in the successful implementation of developmental programmes. There is an immense scope of promoting fish farming technology in the State by utilizing the available resources for attaining sustainable production. Although the technology in practice is both in traditional and scientific systems, no information is not available on the extent of farmer's knowledge and adoption of this technology and their economic feasibility. Keeping this in view an empirical research study entitled "Techno-socio-economic evaluation of fish farming practices in Assam" was conducted during 1998-2000.

Fish farming system adopted by the farmers in the study area were extensive and semi-intensive. On an average 45 per cent respondents adopted the extensive fish farming. The average size of the fishpond under this system was 0.14 ha. The main inputs used in this farming system were fish seed without any management practice. They used lime (179 kg) much lower than the recommended dose where as they stocked fish in higher density. The fish production obtained was $1146 \text{ kg ha}^{-1} \text{ yr}^{-1}$.

As a whole 30 per cent of the farmers adopted semi-intensive fish culture in the study area. Under semi-intensive fish farming, the average size of fishpond used by the farmers was 0.53 ha. The main inputs used were labour, fish feed and fish seed with some management practice. The feed item consisted of rice bran and oil cake. The fish production obtained from this type of fish culture was $1887 \text{ kg ha}^{-1} \text{ yr}^{-1}$.

In all the above farming systems farmers didn't maintain the recommended package of practices. The Indian Major Carp (IMC) remained the mainstay of stocking species. In addition to that they also stocked other indigenous carps (*Labeo calbasu*, *L. gonius*), Chinese carps, common carp,

Puntius javanicus, *Oreochromis mossambicus* and locally available air-breathing fishes.

On an average farmers earned a net profit of Rs.21,888.00 per hectare under extensive fish farming where as under semi-intensive farming the net profit obtained was Rs.31,279.00 The cost of fish production in semi-intensive farming (Rs.29.42) was lower than that of extensive farming practices (Rs.31.17).

The farmers are also categorized on the basis of the fish species cultured. The majority of the farmers (58.33%) adopted composite fish culture (IMC and exotic carps) where as 16.67 per cent respondents adopted only IMC culture practice. The farmers obtained net profit of Rs. 40,515.00 per hectare under composite fish culture where as net profit obtained from IMC culture was Rs.42,307.00 The unit cost of fish production under composite fish culture practice (Rs.26.27) was lower than that of IMC culture practice (Rs.32.03).

In addition to the above fish farming practices, 25 per cent of the respondents adopted paddy-cum-fish culture and pig-cum-fish culture following a mixture of traditional and scientific methods of culture. On an average 16.67 per cent of the farmers followed paddy-cum-fish culture whereas 8.33 per cent followed pig-cum-fish culture in the study area. The fish production obtained from pig-cum-fish culture (1919 kg) was higher than that of paddy-cum-fish culture (1466 kg). The farmers obtained a much higher net profit per hectare under pig-cum-fish culture (Rs.1,07,379.00) than that of paddy-cum-fish culture (Rs.35,708.60). However there is not much variation in the cost of production of fish in these two systems.

The inputs used for fish farming in the study region like feed, seed and labour were considered to have significant effect on fish production. From the

production function analysis it was found that labour and seed was over used where as feed could be increased for profit maximisation.

The three marketing systems prevailing in the study area are fresh fish marketing, dried fish marketing and fish seed marketing. In fresh fish marketing demand is maximum for Indian Major carps followed by exotic varieties of carp and locally available cat fish. One special kind of dried fish sold in the market is known as "*Sindal*" which is considered as anti-malarial by local people. Fish seed marketing in Assam is seasonal in nature and is confined mainly from May to September of every year. The locally available carp and other fresh water fish seeds are marketed in the village areas by vendors by carrying them in their bicycles keeping in aluminum *hundies* filled with water.

Majority of the respondents (86%) had family members more than four. The caste pattern of the respondents reveals that OBC, ST and SC altogether constituted major proportion (54%) of the respondents practiced fish culture. On an average 42 per cent of the respondents in the study area of Darrang and Nagaon districts were living in huts, whereas 52 per cent and 6.25 per cent were living in *kutcha* and pucca houses respectively. Majority of the respondents (75%) were literate. Among the literates (39%) majority of the respondents educated up to high school level. Major occupation of 57 per cent of respondents was agriculture followed by fishery (21%), business (18%) and government service (5%).

Analysis of the socio-economic profile of the respondents revealed that majority of the respondents (76.66%) had 8-16 years of experience of fish farming in their own way.

About 34 per cent had annual family income in the range of Rs.20,000-30,000. The average annual expenditure of a fish farmer household worked out at Rs.23,000 and Rs.31,000 in Darrang and Nagaon district respectively.

About 70% of the earnings of the respondents of Darrang and 66 per cent of that of Nagaon was spent for food alone.

Fish farmers got information for fish-culture from vendors, fisheries extension personnel, radio, TV and newspaper. The problems for adopting scientific fish culture practices for more than 50 per cent respondents were lack of finance, lack of extension service and lack of timely availability of quality fish seed, fish disease and non-availability of medicine and treatment measures.

The studies on participation of women in fisheries indicated that majority of the women participated in aquaculture activities (42%), followed by fishing (26%), fish trading (18%), and net making and mending (14%). Their socio-economic studies revealed a majority of them were illiterate and were living in *kutcha* house. About 50 per cent of the women had annual family income less than Rs.1000.00.

Most of the respondents of both the districts had medium to low knowledge about fish culture. Almost all the respondents had correct knowledge about selection of species, type of fish feed, harvesting method and marketable size of fish. However, they lacked exact information on some important aspects of composite fish culture like recommended dose of lime, organic manure, inorganic fertilizer and fish seed, stocking density, ratio, time interval of using these inputs and controlling measure of diseases.

Majority of the respondents (75%) were medium category adopters. Under pond preparation practice 21 per cent fully adopted liming and 8.33 per cent fully adopted eradication of predatory fish. Most of them didn't adopt aquatic weed control. On an average 33.33 per cent respondents adopted partially inorganic fertilization whereas 42 per cent adopted organic fertilization.

Majority of the respondents i.e. 62.5 per cent under present study fully adopted species selection. The species ratio was partially adopted by the majority of the respondents as against advisable stocking density was not adopted by the majority of them. A majority (67%) of the respondents adopted feed item whereas a few respondents (10%) maintained recommended ratio of rice bran and oil cake (1:1). All of them didn't maintain recommended quantity of feed at right time. The management practice is not at all fully adopted by the respondents. A less number of the respondents 1.67 per cent and 8.33 per cent partially adopted aeration and health management respectively.

The adoption of fish culture practice by the respondents was positively and significantly co-related to the knowledge level of respondents. Total family income and experience were positively and significantly correlated to the adoption of fish culture by the respondents of both the district, whereas age was negatively and significantly correlated to the adoption of fish culture. The independent variables like social participation, size of pond, total family expenditure, education had no significant relationship with adoption.

Since there are significant differences in the adoption level of fish farming practices in the two districts, the first hypothesis that there is no significant difference in the level of adoption among the fish farmers of the two districts is found to be not correct. However the farmers are very much conscious about cost reduction and profit maximisation in fish farming practices in the two districts and hence the second hypothesis that the farmers are very much conscious about cost reduction and profit maximisation in fish farming practices is found to be correct.

SUGGESTIONS

- The fish pond size of 0.25 ha is found to be more profitable as compared to the bigger size of ponds. The unit cost of fish production in smaller size pond (Rs.23.24) is lower than that of bigger size ponds (Rs.25.98). Fish

culture in this small size fishpond can be operated with the available family labour without using hired labour so that it can be a family enterprise. This will help to solve the increasing unemployment problems in the State.

- Excellent opportunity exists for stepping up of rural economy in the State through development of small-scale fish culture enterprises. Most of the ponds, centered and scattered in the hinterland of the State should be used for aquaculture purpose.
- Farmers are advised to go for semi-intensive farming system since cost of fish production per kilogram is less and profit is high in such type of farming. Even in semi-intensive farming system the inputs are currently not used to the required level for maximising profit. Profit can be increased by increasing the inputs like lime, cowdung, inorganic fertilizer and feed. The locally available inputs like cowdung, rice bran are to be used optimally to reduce the cost of production.
- Profitability in Indian major carp and composite fish culture systems are more or less same indicating farmers can adopt these species specific farming systems according to their convenience.
- Pig-cum-fish culture eventhough is more profitable as compared to paddy-cum-fish culture is having its own limitations such as religious taboo and location specific restrictions for its widespread adoptions. It is ideal only in certain areas where there are no such restrictions. Since paddy is a staple food in Assam even its profitability is comparatively less, paddy-cum-fish culture should not be discouraged for the over all interest of the State.
- Labour and fish seed are overused mainly because of easy availability of seed at a comparatively lesser cost and excess use of family labour. The disguised unemployment is highly prevalent. Even if some labour are removed or even mandays are reduced, level of production will not be effected . Stocking density of fish seed should be considerably reduced to

increase profit. But other input feed can be increased from the average level for maximising profit.

- The cost of production would be lower if larger fingerlings are used instead of small fry. Since mechanization has not yet been developed to replace intensive use of labour, labour cost forms one of the major expenses of aquaculture. Efficient management and use of labour are essential in reducing the cost of production.
- Some efforts should be put to produce fish seed of air-breathing fish as it has high market demand. There should be some legislation to sell fingerlings of standard size and permitted species only. Total ban on undesirable species like *Clarias gariepinus* (Thai magur) and production cum distribution of uneconomic species is important. Easy availability of large quantity of fish seeds of different varieties would bring down seed prices and reduce pressure on natural seed resources and improve natural fauna.
- Necessary steps have to be taken to motivate farmers to invest more for fish farming through technological and financial aid. An appreciable change in aquaculture methodologies in the form of species and input use pattern is the need of the hour to increase fish production.
- In Assam, fish marketing system is in a primitive stage. With the advent of aquaculture in the region it is highly essential to provide better marketing infrastructure to facilitate the fish farmers to get a remunerative price. At present the farmers find it difficult to dispose their product at the farm gate so that they lose their bargaining capacity. It is suggested that the fish farmers co-operative society for both input and output marketing can be formed under the initiative of Fish Farmers Development Agency .
- Based on the knowledge level studies, the extension personnel should identify farmers of low level knowledge and necessary training facilities should be extended to them. At the same time it is also essential to find

out low and high level adopters and steps should be taken to update their farming practices.

- A positive and significant relation between level of knowledge and extent of adoption shown in the present study reveals that efforts to improve knowledge level of farmers about fish culture would help in increasing their adoption of this technology. The present study identifies the level of knowledge and adoption behaviour. The extension agencies (State Departments) may take plan and implement suitable strategies through training programme, demonstration, exhibition and distribution of extension literature to up date their knowledge.
- It is found that lack of trained extension personnel and adequate extension service, inadequate finance, non-availability of quality fish seed, fish disease like EUS, non-availability of medicines are the major constraints for the farmers to adopt scientific fish culture. Due attention should be given by State Fisheries Department and Fish Farmers Development solve these problems of the farmers.
- Emphasis should be given for community fish farming practice. Community based aquaculture schemes have the potential to reach many small-scale producers, including women. Planned intervention, however, is required to help the poor share the benefits of aquaculture technology more equitably.
- A direct linkage between fish farmers and fisheries specialist / scientist is required to be developed. At the same time a system has to be evolved to facilitate constant interaction between extension personnel and the scientists to refine the technology available to the farmers based on their feed back knowledge. Problems faced by the farmers have to be sorted out and their solutions should be found out in their field condition. A need based extension programme for speedy dispersion of the technology in the rural areas in the need of the hour.

- Although training programmes are organized by State Fisheries Departments and FFDA, their frequency and coverage is very less. Since training is the most preferred and credible source of fisheries information, short duration training programme on general aspects of fish farming should be organized to cover large number of people. Standardized, location-specific practice with more practical orientation should be introduced in these time bound training programmes with specific prescribed inputs. The contents of the programme should be of authentic one rather than on activity to fix up the number.
- Although provisions have been made in the national programme for development of fish farming through FFDA, the progress is not satisfactory. The State department has started "Assam Rural Infrastructure and Agricultural Services Project" with World Bank Assistance, but the farmers are not benefited as they are not getting inputs in sufficient quantity at appropriate time. This has to be monitored carefully or due attention has to be paid to ensure timely receipt of the inputs.
- Farmers mostly use rice bran and oil cake and the quantity used depends upon the availability of these inputs and their price. There is not even a single feed plant existing in the study area. So to encourage fish farming practices provision should be made to supply feeds at subsidized rate. The Govt. may arrange supply of feeds on credit basis which may be realized after harvest. At the same time the govt. may take necessary steps for establishment of feed plants to make up the shortage in the supply of feeds.
- Necessary steps for conducting demonstration programmes regarding the use of various instruments to check desirable water quality parameters would help in the adoption of the modern scientific technologies of pisciculture. The government should arrange mobile laboratory units for testing of soil and water at regular intervals.

- Adequate preventive measures on control of disease should be made available to the farmers. They should be trained properly to avoid the disease situation and also to get healthy stock. The State Fisheries Departments should open a publicity wing to make the farmers aware of various available disease controlling measures.
- Paddy-cum-fish culture / pig-cum-fish culture / duck-cum-fish culture can be adopted in potential areas. Such potential areas should be identified and policy should be formulated to adopt the culture technology by creating the necessary infrastructure.
- The prevailing system of institutional financing in the State is not encouraging the fish farmers with their cumbersome and lengthy process to extend financial support. Due to the complexity and delay of the process most of the farmers don't feel to approach the banks. The loan sanctioning procedures should be made simple and easy and the time lags should be minimized. The amount of loan with subsidy should meet their entire requirement for operation of the practice. As the frequent occurrence of flood is a major phenomenon in Assam, proper subsidies should be evolved to face such a situation. The bank can also play an important role in propagating the fish culture practices in rural areas. The insurance coverage is very essential for the protection of their crop against probable natural calamities.

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APPENDIX – I
INTERVIEW SCHEDULE
CENTRAL INSTITUTE OF FISHERIES EDUCATION, MUMBAI
TOPIC: TECHNO-SOCIO-ECONOMIC EVALUATION OF
FISH FARMING PRACTICES IN ASSAM

SCHEDULE I : GENERAL INFORMATION

Serial No. : _____
Date of Interview: _____

1. Name of Respondent :

2. Address Vill. _____ P.O.: _____
Block : _____ Dist.: _____

3. Age : _____ years

4. Sex : Male / Female

5. Total land area :

6. Size of farm/pond :

7. Description of ponds :

Pond No.	Type (drainable/ND)	Depth	Size (bigha)	Shape	Seasonal/Perrenial
1.	_____	_____	_____	_____	_____

8. Ownership of pond details : Privately owned/leased Pond1 Pond2 Pond3

Area :

Acquisition year :

If private, total approximate cost Rs. _____

If leased from whom : Govt./ Local bodies / Private parties

a) Period of lease (years) :

b) Yearly lease amount :

9. Type of culture practice : Monoculture / Polyculture / Composite carp culture / Integrated farming (Live stock based / Crop based).

10. Culture inputs (management level : (a) Stocking only, (b) Stocking and feeding, (c) Stocking, feeding and fertilization / manuring (d) Any other in addition to (c)

11. Grow out period : From _____ to _____

12. Experience in fish farming : Yes / No.
If yes, duration of experience :

13. If any training, nature and period of the training :

14. Source of various inputs :(a) Seed : Vendor / Govt. farm / Pvt. Hatchery

(b) Feed : _____

(c) Fertilizer : _____

(d) Manure : _____

(e) Others / specify : _____

15. Future credit need : Source Purpose Duration Rate of Interest

Bank _____ _____ _____

Cooperative

SCHEDULE II : COST AND EARNINGS OF AQUACULTURE PRACTICES

Pond / farm area :
Duration of culture period :
Fixed costs (Rs) :
Value of land :
Lease value :
Earthwork :
Renovation of old farm/pond :
Construction of farm house / shed, fencing, electrification, etc.:
Fish farming equipments :
Interest on amortized capital funds :
Depreciation :
Others (specify) :

(b) Record of Loans

Source of loan : Govt./Money lenders/ Private/ Cooperatives / Commercial bank/
Friends/ Relatives/ Others

Date of borrowing :
Amount (Rs.) :
Rate of Interest :
Purpose of loan :
Terms of loan :
Subsidy, if any :

Operating costs

(i) Pond preparation :

Input	Quantity (kg)	Source (own/purchased)	Total Value (Rs.)
Lime	_____	_____	_____
Organic manure	_____	_____	_____
Inorganic fertilizer	_____	_____	_____
Others (Weedicide/ mohua oilcake etc.)	_____	_____	_____

(ii) Stocking details :

Species	Numbers stocked	Av. Size (mm/gm)	Total cost (Rs.)
Rohu	_____	_____	_____
Catla	_____	_____	_____
Mrigal	_____	_____	_____
Silver carp	_____	_____	_____
Grass carp	_____	_____	_____
Common carp	_____	_____	_____
Others (specify)	_____	_____	_____

(iii) Feeding materials :

Feed stuffs	Total quantity (kg)	Total cost (Rs.)
Rice bran	_____	_____
Oilcake	_____	_____
Others (specify)	_____	_____

(iv) Labour charge for i, ii & iii: Family Hired Male/Female Mandays Total cost
(Rs.)

(v) Harvesting :

Method of harvesting : Dewatering / Drag nets / Cast nets / Gill nets

Cost of dewatering :

If partial harvesting is done, No. of harvests :

Peak harvesting season / month :

Labour charge :

Charges for net :

Quantity harvested :

Unit price (Rs./Kg) :

Total Revenue obtained :

(vi) Marketing details:

Proportion / quantity used for own consumption :

Marketing method : Sold at farm gate / to fishing party / middlemen / cooperative / marketed by self

Selling price :

Species	Size range (gm)	Place (Farm gate/party etc.)	Price (Rs./Kg)	
			Wholesale	Retail

(vii) Marketing channel : Fish farmer → _____ → Consumer

SCHEDULE III : SOCIO-ECONOMIC DETAILS

1. Details of the respondent :

- a. Material status
- b. Main occupation
- c. Educational level
- d. Caste / religion
- e. Other information

2. Details of family members :

Name	M/F	Age	Educational Level	Occupation	Monthly income	Nature of work in pond
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____	_____

3. Type of family : Nuclear / Joint

4. Household Expenditure (%) :
- (i) Food
 - (ii) Clothing
 - (iii) Education
 - (iv) Social and religious
 - (v) Medical
 - (vi) Recreation

5. Household conditioning :

- (a) Type of house - RCC/Assam type/Bombay type/Kutcha/Pucca/Thatched hut
- (b) Modern amenities/consumer durables (TV/Radio/Fridge/LPG stove etc.)
- (c) No. of rooms
- (d) Living area (sq. ft.)

6. Social participation :

Organization	Participation (member/office bearer)	Extent of interaction VG/G/B/VB/DK
Co-operative society	_____	_____
Panchayat	_____	_____
Farmers association	_____	_____
Any others	_____	_____

7. If a member of co-operative society, how it is helping fish culture (giving assistance / advice / training / any) :

8. Awareness of scientific aquaculture techniques : (a) Not aware (b) Have some idea (c) Fairly aware (d) Well trained/informed :

9. Reasons for not undertaking scientific culture : Lack of technical knowledge / Lack of money or other resources (manpower, seed, feed etc.) / Not very interested :

10. Are you satisfied with the level of support provided by the Govt. If No, specify the reason.

11. Role of extension personnel / FFDA / Other agency :

12. Source of technical information : Friends/Relatives/Fish seed vendors/Extension personnel/Radio/TV/New paper/Training programme.

13. Other Information

(i) Price of various inputs related to aquaculture. High/ Reasonable / Low

(ii) Transportation : Good / Bad
 Market distance : Near / Far away
 Electricity facility : Yes / No
 Telephone : Yes / No
 Water etc. : Yes / No
 Toilet : Yes / No

(ii) Source of seed - Vendors / Fish seed farm / etc.

(iv) Demand and Price of fish : High / Reasonable / Low

(v) Assistance by the fisheries department : Sufficient / Not sufficient

(vi) Availability of skilled labour : Sufficient / Not sufficient

14. Problems faced by the farmers :

- (i) Floods / Poaching / Social stigma / Disease / None
- (ii) (a) Non availability of mohua oilcake, (b) High cost of feed / fertilizer
(c) Difficult to get
- (ii) Marketing : Low farm gate price / Middlemen intervention / Inadequate extension service / No technical assistance by Govt. / Lack of information about the technology of composite fish culture.

15. Attitude towards small family norms : Favourable / Unfavourable

16. Dowry ; Favourable / Unfavourable

17. In your opinion impact of scientific farming.

18. Remarks :

Name and signature of Investigator

(MUKUNDA GOSWAMI)

APPENDIX -II
INTERVIEW SCHEDULE FOR ADOPTION BEHAVIOUR TEST
CENTRAL INSTITUTE OF FISHERIES EDUCATION, MUMBAI
TOPIC: TECHNO-SOCIO-ECONOMIC EVALUATION OF FISH FARMING PRACTICES IN ASSAM

Serial No. : _____ Date of Interview: _____ Name of Respondent : _____

Sl. No.	C F C Practice Items	Fully Adopted		Partially Adopted		Not Adopted	
		Darrang	Total	Darrang	Total	Darrang	Total
1.	Pond Preparation i) Liming (soil correction) ii) Aquatic weed control iii) Eradication of predatory fish iv) Pond Manuring a) Liming b) Inorganic Fertilizer c) Organic manure						
2.	Stocking of Fish i) Selection of species ii) Ratio of Stocking iii) Density of Stocking iv) Size of fish seed						

Sl. No.	C F C Practice Items	Fully Adopted			Partially Adopted			Not Adopted		
		Darrang	Nagaon	Total	Darrang	Nagaon	Total	Darrang	Nagaon	Total
3.	Feeding i) Items ii) Feeding schedule iii) Method of feeding									
4.	Management i) Water level maintenance ii) Aeration iii) Thinning / checking iv) Prophylactic Measures									
5.	Marketing practice									

Name and signature of Investigator

(MUKUNDA GOSWAMI)

APPENDIX - III
INTERVIEW SCHEDULE FOR KNOWLEDGE LEVEL TEST
CENTRAL INSTITUTE OF FISHERIES EDUCATION, MUMBAI
TOPIC: TECHNO-SOCIO-ECONOMIC EVALUATION OF FISH FARMING PRACTICES IN ASSAM

Serial No. : _____ Date of Interview: _____ Name of Respondent : _____

Sl. No.	Knowledge Items	D A R R A N G N A G A O N		T O T A L	
		Right	Wrong	Right	Wrong
1.	Which type of soil is good for pisciculture ?				
2.	What depth of pond is good for pisciculture ?				
3.	What colour of water is good for pisciculture ?				
4.	Is it require to use lime in fish pond ?				
5.	How many days before releasing fish liming should be done?				
6.	Do you follow recommended dose of lime ?				
7.	Do you use any piscicide in pond ?				
8.	Do you use any weedicide in pond ?				
9.	Is it necessary to use manure and fertilizer ?				

Sl. No.	Knowledge Items	D A R R A N G			N A G A O N			T O T A L	
		Right	Wrong		Right	Wrong		Right	Wrong
10.	Do you follow recommended dose of organic manure like cowdung ?								
11.	Do you use any inorganic fertilizer ?								
12.	Do you follow the recommended fertilizer dose ?								
13.	How many days before stocking first dose of manure and fertilizer do you use ?								
14.	At what intervals do you apply subsequent doses of manure and fertilizer ?								
15.	In which portion of the pond and what item feeds								
	i) <i>Catla catla</i>								
	ii) <i>Labeo rohita</i>								
	iii) <i>Cirrhina mrigala</i>								
	iv) Silver carp								
	v) Grass carp								
16.	vi) Common carp								
	Do you know recommended Stocking density ?								

Sl. No.	Knowledge Items	D A R R		A N G		N A G		A O N		T O T A L	
		Right	Wrong	Right	Wrong	Right	Wrong	Right	Wrong	Right	Wrong
17.	Do you know appropriate size of fish to stock ?										
18.	Do you know nutritional requirement of carps ?										
19.	Is it necessary to provide supplementary feed?										
20.	Do you know how to manage water quality problem like oxygen depletion, algal bloom ?										
21.	Do you know required water quality criteria ?										
22.	Do you know how to control disease ?										
23.	Do you know how to harvest fish ?										
24.	Do you know marketable size of fish?										
25.	Do you know culture period of carps ?										
26.	Do you know how to market your harvested fish ?										

Name and signature of Investigator