

**CAPTURE PRODUCTION AND ECONOMIC PERFORMANCE OF
INLAND FISHERIES IN KERALA**

by

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THESIS

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2022

DECLARATION

I, hereby declare that this thesis entitled “**CAPTURE PRODUCTION AND ECONOMIC PERFORMANCE OF INLAND FISHERIES IN KERALA**” is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

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LIST OF ABBREVIATIONS

- CAGR - Compound Annual Growth Rate
- MVP - Marginal Value Product
- MFC - Marginal Fixed Cost
- IRR - Internal Rate of Return
- MPP - Marginal Physical Product
- HS - High School
- GVA - Gross Value Added
- TE - Triennium Ending
- NA - Not Applicable
- RFD - Result Framework Document
- NFDB - National Fisheries Development Board

LIST OF SYMBOLS

Fig. - Figure

Kg - Kilogram

Rs. - Rupees

Ha - Hectare

Ltd - Limited

Qtl - Quintal

Wt - Weight

No. - Number

Tk - Taka (Bangladesh currency)

Introduction

1. INTRODUCTION

This chapter gives a synoptic idea about the fisheries sector, research area, need for the study, its objectives and much more, which help to get an overview of the study. The chapter is divided into 7 parts. It includes

1.1 FISHERIES SECTOR

1.2 INLAND FISHERIES IN INDIA

1.3 INLAND FISHERIES IN KERALA

1.4 OBJECTIVES OF THE STUDY

1.5 SCOPE OF THE STUDY

1.6 PRESENTATION OF THE STUDY

1.7 LIMITATIONS OF THE STUDY

1.1 FISHERIES SECTOR

The global economy ultimately aims for development. For this to happen, each country should develop, in different facets by all means. Sustainable development was a well-thought-out approach for embracing progress while conserving resources like fisheries, taking into account both immediate and long-term advantages for our planet and the people who live on it.

In addition to the issue of sustainability, we also face problems of poverty and malnutrition which hinder development of economy. Priya and Premraj (2021) found out that the economic cost of malnutrition is estimated at 2 to 3 percent of GDP. Per capita consumption is directly related to malnutrition. In short, fishing sector can significantly contribute to the food, nutrition and livelihood security of people.

Fishing industry, which is considered as one of the oldest and traditional sectors also play a critical role in the socioeconomic development of the economy. Globally,

fishing industry plays a crucial role in meeting day-to-day food needs and also aids in trade. In 2017, the global fish and shellfish trade reached 150 billion US dollars marking an increase in Compound Annual Growth Rate (CAGR) by 4 per cent from 2012 data. Aside from being a foreign exchange earner, fishing sector as such is a source of healthy food, since fish is a natural source of protein (18-20 per cent) and a reservoir of eight essential amino acids including lysine, methionine and cysteine which are important for the growth and development of the human body (Mlauzi and Mzengereza, 2017). Fish is an important component of food basket, especially in developing countries, and it was found that seventy-five per cent of global production of fish was consumed in developing countries. When it comes to average consumption, Asian countries consume up to 60 kg (India low at 5-9 kg) against global average consumption of 20 kg/person/year.

Fishing has been recognized as a major source of income and employment, since it encourages creation of a number of subsidiary businesses and provides a cheap and plentiful supply of raw materials. Fish production broadly adds on both marine and inland fish production. FAO (2020) highlighted that, the fisheries sector provides full time, part time or occasional employment to the tune of 59.51 million people in the world. Rajeev in 2015 reported that there has been a tremendous increase, both in terms of quantity and value, in the share of developing nations in fish production during 2013. Global marine fish production has shown a stupendous growth trend during the period 1950-2013. As per fisheries census 2018, India's fish harvest rose from 3.80 million tonnes in 1990 to 12.59 million tonnes in 2017-18. Out of the 18 major fish producing countries, 11 are from Asia with an annual average catch of more than one million tonne. China is the major fish producing and exporting country in the world. According to Government of India, marine catch fisheries is going through colossal changes because of increased fishing. The catch of industrially significant marine fishes and shell fishes is on the decrease and result in serious asset exhaustion and joblessness of fishermen. Decrease in marine catch fishery additionally reduced the accessibility of modest protein for general society and furthermore influenced the GDP of the country. Besides all this, reports also show that climate change was affecting the overall production. Halim *et al*, 2017 observed that the pressures of climate change will

increase existing pressures on fisheries and threaten their ability to secure food and livelihoods.

Inland fish production gained momentum overtime. Inland fisheries referred to any activity conducted to extract fish and other aquatic organisms from "inland waters". The term "inland waters" is used to refer to lakes, rivers, brooks, streams, ponds, inland canals, dams, and other land-locked (usually freshwater) waters. Inland fisheries are critical for a group of developing countries in the world, providing an important source of nutrition, food security as well as micronutrients. These nutritional and food security benefits are an integral part of the agricultural landscape of the developing countries, thus inland fisheries are closely linked to food production, water and land management, biodiversity and ecosystems (Food and Agriculture Organisation (FAO), 1997).

In an expanding population, demand for fish outpaced availability. Aquaculture-based fish production offers a way to get rid-of the global problem of overfishing, which has resulted in falling stocks of natural water bodies.

1.2 INLAND FISHERIES IN INDIA

Indian fisheries industry is surrounded by a unique and diverse mix of resources. The country's fisheries sector biodiversity spans a wide range of physical and biological characteristics. Millions of people's livelihoods rely on fisheries. As the world population is expanding at a faster rate, the demand for fish protein is also on hike as always. Fisheries is a fast-growing sector in India, which provided nutrition and food security to a large population of the country. According to the Economic survey, 2020-21, India is the second largest fish producing country in the world and accounted for 7.58 per cent of the world's fish production. According to Economic Review, 2019, in India, growth rate of total fish production in 2017- 18 was 10.14 per cent and Inland fish production constituted 71 per cent of the total fish production, rest 29 per cent was from marine fisheries sector as depicted in figure 1. Fish production in India reached an all-time high of 1.16 million tonnes in 2019-20. Fisheries sector contributed 1.2 percent to Gross Value Added (GVA) and 7.28 per cent to the agricultural GVA during 2019-20. Export earnings from fisheries during the same year was around Rs. 5020 crores.

Realising the potential and importance of fisheries sector, Government also introduced flagship programmes for promoting the production in fisheries sector.

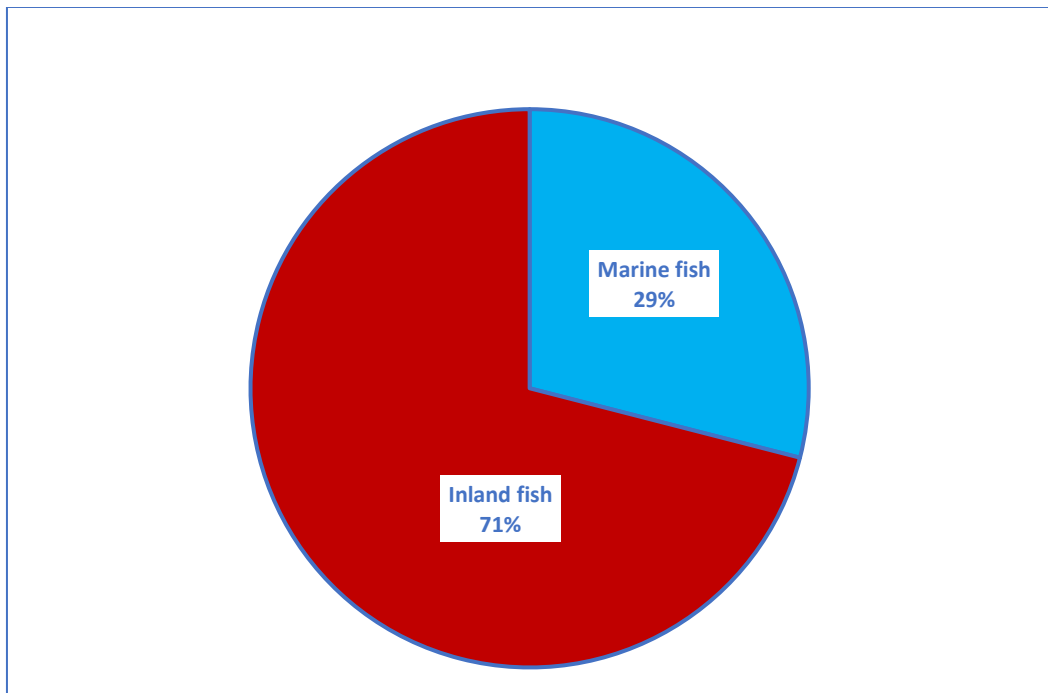
1.3 INLAND FISHERIES IN KERALA

Kerala, which is situated on the southwest coast of the Indian subcontinent with an area of about 38,863 square kilometres make about 1.27 per cent of the Indian territory. The state is separated from the rest of India by the Western Ghats in the east and the Arabian Sea in the west. Kerala has a coastline of 589.5 kilometres, which forms 10 per cent of the India's total coastline.

Kerala is blessed with a large number of water bodies which includes fresh water and brackish water rivers, interconnected backwaters (Kayal), estuaries and backwaters. The state is also endowed with vast resources in terms of ponds and tanks, rivers and canals, reservoirs, lakes and other water bodies. These water bodies make the land green and fertile and contribute a rich resource of inland production.

Fishes find a significant place in the dietary habit of 90 per cent of Kerala's population and it is assessed that 70 to 80 per cent of the fish protein necessity of the State is being met from fish. According to the project reports of Government of Kerala, 2020-21, per capita utilization of fish in the State improved from 18.71 kg in 2000 to 24.85 kg in 2015 against the national average of 3.5 kg. It showed the significance of the fishery area in the State. Fish occupies a significant position in the day-to-day meals of the Keralites. The yearly domestic necessity of fish in Kerala numbers around 7.5 lakh tonnes. However, the State has produced 8.07 lakh tonnes fish, it has exported 1.82 lakh tonnes during 2018-19 and has permitted the inflow of 1.25 lakh million tonnes fish from the adjoining States to fill the deficiency.

Figure 1: Per cent share of inland fish production in total fish production in India, 2017-18



Source: GOI, 2018

There is potential for introducing 7,000 enclosure units having a volume of 60-100 m³ each for fin fish cultivation in backwaters. It is assessed that a creation of additional 1.3 lakh million tonnes is conceivable by using the potential water bodies for aquaculture in a supportable way. The aquaculture fish production during 2018-19 was 24,511 metric tonnes (Janakiya mastyakrishi project, Government of Kerala, 2020-21).

The GVA from fishing and aquaculture factor at Triennium ending (TE) 2017-18 in India was Rs. 1,54,238 crores while that of Kerala was Rs. 9,728 crores at current prices. Share of fishing and aquaculture in agriculture and allied sector GVA at current prices in percentage during TE 2017-18 accounted to 13.88 in Kerala, while it was 6.24 per cent in India. The trend in growth rate of GVA during 2011-12 to 2017-18 at constant prices was 2.46 and 8.54 per cent in Kerala and India respectively (Parappurathu *et.al.*, 2020).

Kerala was second to Gujarat in marine fish harvest during the period 2013-14. Nonetheless, Kerala's share has declined over the period. Currently, according to CMFRI (2020), Tamil Nadu is the biggest marine fish producing state with 7,75,000 tonnes, followed by Gujarat with 7,49,000 tonnes, and Kerala with 5,44,000 tonnes in marine fish production.

A concise profile of key socio-demographic features of marine fisher folk of Kerala and India when examined shows that male literacy rate was 68.10 per cent in India in 2020 unlike 85.2 percent in Kerala. When it came to female literacy, it was 63.80 and 84.1 in India and Kerala respectively. There was almost same family size for marine fisherfolk population in Kerala and India. It accounted to 4.2 in India and 4.6 in Kerala (Source: Parappurathu, 2020).

Inland fishery resources of Kerala constituted 6.6 per cent of inland fisheries resources of India. However, the share of Kerala in India's total inland fish production was only about 1.7 per cent. Kerala has scope to improve the utilization of its resources in inland fishing. According to Government of Kerala, currently Alappuzha and Kottayam are the leading inland fish producing districts, followed by Thrissur and

Ernakulam. Leading producer is Kollam followed by Alappuzha and Ernakulam in the case of total fish production.

The total fish production in Kerala during 2018-19 was 8.01 lakh tonnes, of which Inland fish production was 1.92 lakh tonnes. It was noticed that in Kerala, the inland fish production increased from 2010 to 2015, had a drop in 2016 with 1.8 lakh tonnes and then increased to 2.05 lakh tonnes by 2020.

Pond fish farming is an important sector in inland fish farming. Pond fish farming is an artificial ecosystem created by humans. It was important to maintain balance in the ecosystem. Fish depend on water for life, food, and normal physical activity. Therefore, water quality plays an important role in determining fish growth in freshwater aquaculture. Water temperature, dissolved oxygen, pH, turbidity, and conductivity are the basic water parameters that determine the stability of a fish pond (Nayak *et al.*, 2019).

Globally, seafood products provide 15 per cent or more protein, which is consumed by nearly 3 billion people, and support the livelihoods of 520 million people, many of whom are women. Globally the need for animal protein is increasing and fisheries sector should be an important area of concern. Malnutrition issues can be controlled to a certain extent when fish production is increased and is consumed by the hungry starving population. Why are the inland resources and pond fish farming not fully exploited by Kerala? Is it feasible to start pond fish farming in Kerala?

In this scenario, the study is intended to bring forward the trend in fish production, focussing mainly on inland fish production. Also, there are very few studies related to economics of pond fish cultivation in Kerala. In this context, the present study also attempts to analyse the trend in inland fish production and to study the economics of pond fish production in Kerala.

1.4 OBJECTIVES OF THE STUDY

The specific objectives were framed based on the general objectives. This framing helped to restrain the study to a particular area and pin point the results obtained based on proper analysis.

Following were the specific objectives framed to furnish the study and to obtain results.

1. Analyse the trend in production of inland fisheries.
2. Study the economics of pond fish production in Alappuzha district.

1.5 SCOPE OF THE STUDY

The study addresses the inland fish production over the years and analyses the trend. It provides a picture of the socio-economic characteristics of fish farmers in Alappuzha district. The study also works out the total costs involved in fish cultivation and returns involved in pond fish production. This, further gives an idea on the economics of pond fish cultivation in Kerala which will help further studies. In addition, the study also helps to analyse whether pond fish farming is an economically feasible startup. An idea on the fish marketing and constraints involved are also portrayed in the study.

1.6 PRESENTATION OF THE STUDY

The study is arranged in five chapters. The chapters include Introduction, Review of literature, Materials and methods, Results and discussion and finally Summary. First chapter gives a synoptic picture about the study, its importance, objectives, scope and limitations. Second chapter deals with several studies reviewed related to the topic. Third chapter describes the methods and analytical tools employed to furnish the objectives of the study. Results obtained and further discussions are presented in the fourth chapter. The final chapter summary opens out the work done in a nut shell and further also gives the conclusion and policy implications.

1.7 LIMITATIONS OF THE STUDY

Every deed can have its own limitations. In this study, the data was obtained based on the past memory of the farmers which may not be highly accurate. The study was conducted purposefully at Alappuzha district in Kerala due to largest inland fish production, but it cannot be generalized to the case of the whole state. Personal contact was restricted while collecting data due to covid-19 issues. After all, there may be errors due to human touch. But care has been taken to minimize the errors to the extent possible.

Review of Literature

REVIEW OF LITERATURE

In this chapter, an overview of the research carried out in the field of inland fisheries is presented. The review helped to understand various concepts used by researchers for the fisheries studies, present status of inland fish farming in various study areas and it also paved path for deeper understanding of the study area. The review on inland fish farming is divided into following sections.

2.1 STUDIES RELATED TO FISHERIES AND ITS IMPORTANCE

2.2 STUDIES RELATED TRENDS IN INLAND FISH FARMING

2.3 STUDIES RELATED TO ECONOMICS OF INLAND FISH FARMING

2.1 STUDIES RELATED TO FISHERIES AND ITS IMPORTANCE

Kurien (1985), in his study based on Kerala, noted that the most valuable asset for a farmer in Kerala was his accumulated knowledge through generations about fish, fish habits, waves and currents which they have though a tradition of learning by doing, handed down from their ancestors.

For fisheries research in developing countries, fishery statistics are generally more important than developed countries. The lack of detailed information forces fishery managers to turn to other data sources as the basis for management decisions. The most easily available information comes from fishery statistics reports and similar documents (Dudley and Harris, 1987).

The importance of the fish farming industry for the economy of Kerala lies not only in its contribution to foreign exchange earnings. Fish provides about three-fourths of the animal protein intake to the state's population and for the poor it acted as the main source of animal protein. 8,00,000 people were depended on the fisheries industry for their livelihood (Meynen, 1989).

Higher carbohydrate levels lead to an increase in stored energy in the form of lipids in fish fillets and belly fat. The red color showed that it was the best option for 98 g/kg of carbohydrates in the diet. No differences in maturity were found between diets. When the Carbohydrate in the diet increased from 24 to 230 g/ kg, the digestibility of the dry matter decreased linearly by 17 per cent (Aksnes, 1995).

Korakandy (1998) worked out the demographics of inland fisherman in Kerala. In 1995-96, there were 2,23,772 fishermen of which 73,805 were adult males, and they were part of traditional fisheries in the state. In 1995 and 1996, the number of active inland fishermen was only 56,122 and the remaining were used for any of the paid employment in the sector. Many of these fishermen were attracted to the job of fish farming guides, and was employed as input providers.

Yakupitiyage (2003) on his study commented that the food nutrition supply of fish farm ponds was directly dependent on the productivity of natural foods and the supply of supplements.

Diminishing resources, the energy crisis and the resultant high cost of fish farming had led to an increased realization of the potential for and versatility of aquaculture as a viable and cost-effective alternative to capture fisheries (Ayyappan and Jena, 2001; Jana and Jena, 2004; Pillai and Katiha, 2004).

Consumer reaction in many of the fishery studies had pointed out that fish was regarded as a healthy food compared to other non-vegetarian foods (Brunso, 2003; Gross, 2003).

Dey *et al.* (2005) discussed fish consumption patterns and fish species preference based on income groups and urban-rural differences in Bangladesh, China, India, Indonesia, Philippines, Thailand and Vietnam. In India, the annual growth rate of per capita consumption was over 2.65 per cent during the 1980-2000 period, while that of freshwater fish was 4.06 per cent. This proves the importance of freshwater fish in

India's fish consumption. During the same period, growth rate of other fishes among Indian consumer and share of total annual fish consumption per capita showed a downward trend.

In aquaculture practice, probiotics have been used for years but in recent years, probiotics have become an indispensable part of aquaculture practice to improve growth and disease resistance. This strategy offers myriad advantages to overcome the limitations and the side effects of antibiotics and other medications, and can lead to high yield of fish through increased growth and disease prevention (Nayak, 2010).

India has vast inland fishery resources, including rivers, estuaries, reservoirs, floodplain wetlands, lakes, and coastal lagoons, which play an important role in fish production in the country. India's freshwater resources include 1,95,210 kilometers of rivers and canals, 2.9 million hectares of small and large reservoirs, 2.4 million hectares of ponds and lakes, and approximately 8,00,000 hectares of flood plain wetlands and water bodies. The reservoir constitutes one of the largest inland fishery resources, both in terms of resource scale and production potential. In addition, ponds and water tanks also contribute to aquaculture production. The usable area in the category of ponds and water tanks was estimated to be 2.36 million hectares, of which only 40 per cent was used for fish production (FAO, 2014).

The study of Moutopoulos and Koutsikopoulos, (2014) pointed out the need for reliable fishery data and he established a hierarchical statistical study to monitor the statistics of official fisheries to reduce the uncertainty of the reported data. Cooperation between stakeholders and research organizations, establishing an effective permit control system will beneficially improve the quality of fishery data. The available information limits the issues that can be accessed by interested parties, so the data of landings was used to cover the meta-analysis in the ecosystem. Problem-based method (ie ecological index, forecasting technology and modeling method) requires careful consideration. In addition, the use of the time series for management purposes should consider, compare and synthesize all available data to avoid misunderstandings that have serious consequences for fishermen and the ecosystem.

A study by Welcomme *et.al.* (2015) reviewed inland fish farming as a commendable source of protein-rich food and employment. Inland fisheries deliver nutritional security and income to hundreds of millions of rural households.

Aquaculture depends on a variety of natural resources including water, land, fingerlings and feed and can affect the environment by modifying natural habitats, biodiversity, soil, water and landscapes. Some forms of aquaculture production such as integrated fish farming, can positively affect the agro-environment by minimizing input use for fish or crop production or by recycling nutrients, while others result in a range of negative impacts (Jahan *et al.*, 2015).

Ghosh *et al.*, in 2016 commented that agriculture is the service industry while fisheries sector forms the bulk of the Kerala economy.

Ahmed *et al.* (2016) reported that fish consumption was significantly related to the race, age, marital status, residential area and years of education of adults in Peninsular Malaysia. The 10 most commonly consumed marine fish when arranged in descending order gives the order: Indian mackerel, anchovies, horse mackerel, tuna, sardines, torpedoes, Indian toothfish, poppet, red snapper and mackerel. Shrimp and squid were the preferred fishes for the research subjects. The most commonly eaten freshwater fishes are freshwater catfish and silver carp. The most popular cooking method for Malaysians was fried fish followed by fish cooked with thick or fine chili sauce, fish curry, and fish cooked with coconut milk mixed with other spices and seasonings.

Shafei (2016) commented that water was the breeding environment for fish, where they can perform all bodily functions. Fishes are completely dependent on water to breathe, eat and grow, excrete waste, maintain salt balance, and reproduce. Water quality focuses on various aspects of the physical and chemical parameters of water, through which the state of the water body can be easily observed. It was the first and most important limiting factor in fish farming and was generally controlled by many

parameters, including color, odor, temperature, pH, DO, BOD, TDS, EC, transparency, acidity, alkalinity, and hardness. Each of these parameters has a standard value for fish farming. Guiding Principle for fish farming was that water quality and efficient production are the direct result of good water chemistry. Therefore, maintaining good water quality was essential for healthy fish farming. Most of the fish farming in the world takes place in ponds. Pond habitats can be easily manipulated by controlling the characteristics of the water to obtain an optimal environment, resulting in high levels of fish production.

A study by Lazarus *et al.* (2016), suggested that the pressure on fully exploited fish species to over exploited species in the Western Indian Ocean can be reduced if appropriate conservation measures are adopted and implemented timely. It included more scientific and effective ban on trawling needs, modification of fish farming gears used by the fishermen and avoiding fish farming of juveniles.

According to a study by Lynch *et al.* (2017), it was reported that without properly addressing the sustainability of inland fisheries and the externalities that threatens their continued delivery of services, positive contribution of fisheries sector towards poverty alleviation, now and within the future, will likely be compromised. Replacing this lost food, employment opportunity, and revenue source would be difficult as there are very few viable alternatives within the poorest regions for the poorest segments of society.

The use of probiotics in some aquatic organisms has been shown to be beneficial, but some reports indicate that there was no significant or clear beneficial effect. Even the indiscriminate use of probiotics on commercial farms will affect both cultured and natural organisms' potential and gave negative impact on the ecosystem (Moscocco *et al.*, 2018).

Study by Handa and Datta (2019) represented a snapshot of the scientific literature on fisheries and aquaculture published in journals indexed by the Scopus database. It included quantitative evaluations of various aspects of the subject. The

results of the study indicated that the scientific literature on fisheries and aquaculture had grown almost continuously over the last decade. The trend of authors revealed a high degree of research collaboration among scientists working on the topic. India was the second and third largest fish and aquaculture producer and has carried out research cooperation with countries from different regions of the world. Oceanography/ aquatic biology, fish microbiology and health, fish hematology and carcass composition, fish growth, immune and immuno stimulant, aquatic environment health, biodiversity and integrated system, etc. were the hot topics explored by researchers/scientist times of international cooperation. Network visualization was expected to help the scientific community analyze research trends in research topics and further strengthen research cooperation.

Krupa *et al.* (2019) studied physical and chemical substances of fish pond water and analyzed the water samples, showing temperature (7 per cent), turbidity (9 per cent), pH (24 per cent), TDS (1 per cent), DO (2 per cent), total hardness (3 per cent), chloride (4 per cent), ammonia (38 per cent) and there was no iron and residual chlorine in the water samples. This showed that with the exception of ammonia and pH, most of the samples were within the normal limit of specified for pond aquaculture. Bacteriological analysis showed that the total number of coliform bacteria, the total number of *Escherichia coli* and the total number of *Streptococcus faecalis* in 86 per cent, 35 per cent and 8 per cent of the water samples exceeded the normal range, which may be due to the careless handling of the pond. Therefore, it was necessary to protect the environment near the fish pond from weeds and pollutants.

The coastal regions of Kerala are flourished with many estuaries and inland saline water networks. The inland water networks are frequently bordered with rice paddies and different forms of agriculture, which gain from seasonal flooding, that enriches the soil and that acts as a natural form of irrigation. During periods of flooding, small scale fish farming for prawn and diverse species of fish takes place in the flooded agricultural fields, developing a spatial overlap between fish farming and agriculture (Abigail, 2021).

2.2 STUDIES RELATED TRENDS IN INLAND FISH FARMING

The status of inland waters and their species need to be of large concern, although threats to freshwater fisheries and related biodiversity have obtained appreciable interest from conservation organizations and the media. The imbalance seems dangerous considering the proof that freshwater ecosystems and the species they support are, on average, greater threatened than marine ecosystems (Ricciardi and Rasmussen 1999).

During 1985-2000, the inland fisheries in India, which included both capture and culture fisheries, had witnessed tremendous growth and change. Until the mid-1980s, capture fisheries were the major source of inland fish production in India. But since then, fish production from natural water sources, such as rivers and lakes, has trended downwards, primarily due to a proliferation of water control structures, indiscriminate fish farming, and habitat degradation (Katiha, 2000).

Allan *et al.* (2005) observed that the global overall capture from the inland waters, specifically from aquaculture harvest and recreational fish farming was 8.7 million metric tons in 2002. Of this, Asia accounted for 65 per cent and Africa 24 per cent, with the rest landed in South America (4 per cent), Europe and the former USSR (4 per cent), North America (2 per cent), and Oceania (less than 1 per cent).

During 1985-2000, in India, there was a five-and-half-fold increase in freshwater aquaculture fish production. It was due to the appropriate technologies, financial investments, and entrepreneurial enthusiasm in the fisheries sector in the period (Katiha *et al.*, 2005).

Through the management of input level and the monitoring of water quality, the fisheries department still has enough room for further development (Bharatnagar and Singh, 2010).

Mohanty *et al.* (2010) reported that climate change had a profound impact on marine and inland fisheries and aquaculture in India. There was no doubt that fisheries are already a very fragile sector, facing extensive and profound changes. Developing policies and programs to improve the resilience of natural resources through risk and vulnerability assessments, raising awareness of the impacts of climate change and strengthening key institutions will help communities adapt to climate change. Food-based and other management strategies should be put in place to mitigate the impacts of climate change on fish species to ensure sustainable aquaculture and aquaculture production both for safety, nutrition and livelihood security (Mohanty *et al.*, 2017).

Bartley and Jorgensen (2010) suggested that the contribution of inland fisheries to fish production was less well known because (a) of the varied and diffused nature of inland fisheries operating in the remote areas (b) lack of awareness and policies on inland fisheries in national agendas (c) poorly defined market chains or infrastructure handling in inland waters (d) the fact that much production was consumed or traded locally and does not enter formal economy and (e) the high cost of collecting dispersed information.

In 2009, 39 per cent of the world's fish production was traded internationally, and it was estimated that 78 per cent of seafood products were exposed to international commercial competition (Tveteras *et al.*, 2012).

The fishery sector in India has been growing steadily since the first five-year plan, with an annual fish production which increased from 7,54,000 tons in 1950-51 to 9.57 million tons in 2012-13. The fisheries sector's contribution to agriculture and national GDP has steadily increased over the years. The gross domestic product of the fisheries sector reached Rs. Rs 78,000 crore in 2012-13. It was 9000 crores in 1993-94. Currently, fisheries account for 0.83 per cent of the country's GDP and 4.74 per cent of agriculture and related activities. Indian inland waters include rivers, reservoirs, aquaculture waters (ponds and tanks), estuaries and floodplain lakes. Open inland waters are distributed throughout the country which includes river reservoirs, floodplain wetlands, estuaries, and lakes. Fish farming continues to be an activity

carried out mainly by fishermen in the 36-55 age group, which represents 46.48 per cent. The distribution also showed that the representation of youth (under 35) was 35.98 per cent. The proportion of fishermen over 56 years of age was the lowest with 17.53 per cent. Elderly fishermen continued to do fish farming indicating that the operations of elderly fishermen have become increasingly complex. Considering fisheries enterprise, it has low income and high career risk, thus career changes have been observed among young people (Katiha *et al.*, 2014).

Aswathy *et al.*, (2014) tried to assess the performance and economic sustainability of Indian marine fish production by employing total factor productivity approach growth from 2000 to 2010. Total factor productivity was a measure of the productivity impact of all inputs or factors of production on production and was generally explained by technological changes or more effective production methods. The analysis was carried out using data on fish farming effort by species and equipment and average prices of marine fish by species in different states of India during 2000 to 2010. Divisia Tornqvist index method was used to estimate the growth of total factor productivity of the Indian marine fisheries sector. Research results showed that 76 per cent of the demand for fuel for the fish farming industry comes from the trawling industry, followed by trawlers (12 per cent), gillnets (9 per cent) and others (3 per cent). In 2010, India's total factor productivity increased by 1.65 per cent. State analysis showed that the growth of total factor productivity on the East Coast was positive at 8.16 per cent, while the growth of total factor productivity in the west coast of Kerala (3.69 per cent) and Maharashtra (5.83 per cent) was negative.

Saravanan (2015) examined the production of fisheries sector in India for the period of 2000-01 to 2010-11. The study found that both marine and inland fish production have grown over the years. Besides, Indian States including Andhra Pradesh, Karnataka, Kerala and Tamil Nadu, Karnataka was proved to be the leading States in marine fish production which increased at Compound Growth Rate (CGR) of 4.63 per cent during the period. On the other hand, inland fish production was found to be high in Andhra Pradesh with CGR of 9.17 per cent.

Vyashnavi and Rao (2016) explored the importance of marine fisheries in the Indian economy. They concluded that the country exported 10.51 lakh tonnes of marine products, which resulted in export earnings of 33,441.61 crores and 5,511.12 million US dollars in 2014-15. In the year 2015-16, the marine products were largely exported to South East Asia, where as exports to China were the lowest. Moreover, development programmes in five-year plans resulted in growth and expansion of marine fisheries sector in the country.

The trend of marine fisheries landings was studied by Lazarus *et.al*, in 2016 using Compound Annual Growth Rate (CAGR) by measuring the previous performance of the economic variables. Data pertaining to 10 yrs was employed for the study from 2004-2013. Exponential growth function was used for the analysis. The results showed that the catch in Kerala has increased at a faster rate in the past few years. It was cited in the study that appropriate conservation measures if developed and if it could be effectively implemented, it can reduce the pressure of fully exploited fish species in the Indian Ocean.

Jayashankar assessed the situation with freshwater aquaculture in India during the year 2018. In his study, he proposed that it was apparent that the methodologies for expanding fish production from freshwater aquaculture should be focused towards vertical and horizontal development of the sector.

Mathew and Verghese (2019) revealed that the inland fish production in Kerala was 0.36 lakh tonnes in 1990-91, 0.85 in 2000-01, 1.21 in 2010-11 and 1.88 in 2016-17.

The cumulative annual growth rate (CAGR) of inland fish production on a study based in Karnataka during 2001-2006 suggested that inland fish production grew by 5.99 and 1.77 per cent in India and Karnataka respectively. It was also suggested that fish production in pond was an economically feasible option in Karnataka to enhance the income of the fish farmer (Halli, 2019).

Mathew and Verghese (2019) estimated that the marine fish landed in India during 2012 was 3.32 million tonnes, a decrease of about 0.05 million tonnes from 2011 estimate. Within the country, Gujarat was the largest contributor in the production of marine fish, followed by Kerala. Andhra Pradesh was the largest contributor to the total fish production, with Kerala being fourth in this category. In 2012-13, 5.31 lakh tonnes of marine fish landed in Kerala, a decrease of 0.22 lakh tonnes (4.14 percent) compared to the previous year. The high-quality prominent value fish species like seer fish, prawn, ribbon fish and mackerel in total catch ultimately determines the fisherman's income.

2.3 STUDIES RELATED TO ECONOMICS OF INLAND FISH FARMING

Among the costs involved in culture fish farming, harvesting charges accounted 32 per cent of the total cost followed by maintenance, fingerlings and lease or auction amount. The net returns from fish farming ranged between Rs. 38.61 to Rs. 438.76 per acre. The benefit cost ratio was 1.57 for major tank and 1.14 for minor tank. The average cost per kg of fish worked out to Rs. 5.85 in the case of reservoirs (Anil, 1994)

Jayaraman (1999) considered the financial matters of carp culture and his findings uncovered that the carp culture was productive. Expense for a hectare was accounted to be Rs.77,950 comprising of the complete variable expense of Rs. 52,223 and fixed expense was Rs 25,727. The absolute pay and overall gain were Rs. 1,45,824 and Rs. 67,874 separately. The mean yield recorded by the carp ranchers were 4,317kg/ha/yr, as indicated by the examination.

Hapke (2001) reveals that commercialisation of fish farming had helped in increasing the prices of fish and also helped some fish farming communities to prosper. However, it has also led to the marginalisation of the women in the fisheries sector.

The international community has invested heavily through FAO to create and maintain global fish catch databases. The first step in this direction was carried out by the "Ocean Around Us" project, the fish base consortium and other groups. We hope

that these efforts will eliminate the “lack of data” as an excuse to prove the status of our fishery, and increase transparency and public understanding, resulting in an increased participation in public policies by the true owners of marine resources and future citizens of the world (Pauly and zeller, 2003).

Joseph and Sathiadas (2005) evaluated the cost and return of the crab fattening, dairy fish farming and polyculture system. The cost structure of different breeding methods was analyzed and determined. According to the study, aquaculture was the most ideal and feasible alternative for fishermen in Kerala coastal areas for productive employment. In Kerala, almost one-third of the potential brackish water area was used for one or another aquaculture practice. India's freshwater aquaculture industry has outperformed brackish water production and marine areas due to amazing technological advancements in farming, hatchery and feed manufacturing operations and strong adaptability. The development of an export market for saltwater fishes could increase their demand and prices, there by promoting their farming in the long term. Commercial production of fingerlings in hatcheries helped to gradually promote these farming methods. Although the fattening of crabs turned out to be very profitable, the lack of a stable supply of crab species limited mass adoption. Negligence and ignorance in carcass quality control was an obstacle in the promotion of other coastal aquaculture practices. It should be resolved. The geographic information system and remote sensing technology should be used to determine areas suitable for the practice of different cultures.

Dey *et al* (2005) compared the costs and returns of freshwater aquaculture among countries. In Bangladesh, both carp polyculture and Tilapia monoculture were productive and cost effective; Tilapia monoculture in ponds had a return of US 3.11 dollars for each dollar of investment in variable inputs. In India, among the polyculture methods, sewage and weed-based methods were more productive and profitable and yielded higher net return than the polyculture in ponds.

Hassan and Sathiadas (2009) reported that the average annual operating cost of a one-day trawler operating along the Kerala coast was Rs. 17,52,000. The annual catch of these units was 31,400 kg and the total annual income was Rs. 20,24,200. A capital

productivity (exploitation index) was also calculated to compare the economic efficiency of trawlers. Capital productivity is defined as the portion of total income that can cover operating expenses. The operating ratio was 0.86, indicating that 86 per cent of the total revenues generated was used to pay for your operating expenses. The higher operating costs of due to higher fuel and auction costs can be attributed to the higher operating index value.

Study by Channabasavanna *et al.*, in 2009, compared the benefit cost ratio of integrated and conventional farming system. He observed that the BC ratio was higher (1.97) in integrated system than that of conventional system (1.64). Among the diverse components in the integrated system, goat farming recorded the highest BC ratio with 2.75 accompanied by fish (2.23) because of low value of cultivation. This was followed by vegetables (2.00).

Navy and Bhattarai (2009) made an attempt to study the economic profitability and viability of small-scale capture fisheries in Cambodia. Cambodia. The variable costs of fish farming were about four times higher than the fixed costs. Variable costs alone accounted to about 25 per cent and 37 per cent of the gross returns during the open (October to May) and close (June to September) seasons respectively. The economic analysis of family fish farming in Cambodia suggests that although the profitability of family fish farming varies between communities and depend on the fish farming season, the main patterns and seasonal variations in the main economic parameters (profitability and cost structures) of family fish farming are the same in all three surveyed fish farming communities. The other causative factors are the sharp increase in the cost of inputs for fish farming activities (increases in the price of fuel and other materials used in fish farming), weak local fisheries policies and poor enforcement of fish farming rules and regulations at the local level.

According to a study based in Ghana by Asamoah *et.al.* (2012), stocking rate was the most significant input that affected production of inland fisheries, as indicated by his empirical results. Study also showed that the main factors influencing yield are labour, fertilizer, stocking rate and feed. Eventhough, these were found significant, the

input use was found inefficient. It was suggested that government should train more farmers in fingerling production with the help of extension officers of the regions concerned. Also, government should help farmers to avoid the issues of high operating and fixed capital since aquaculture was very much viable. Short-term credits and practical research in addition to effective extension should be made possible to curb the problems related to low input use efficiency by farmers.

As per an investigation by Goswami *et. al* (2013), out of the total expense incurred by fish farmer, 79.98 per cent was covered by the variable expense and rest the fixed expense. One of the primary perceptions from the examination was that the proportion of absolute variable expense that was added up went from 0.74 in class I (0.01 – 0.50 ha) lakes to 0.76 in classification VI (2.51 to 3 ha) lakes.

Another study by Rahaman *et al.* in 2013 revealed that the incidence of theft and pilferages were the most important factors causing huge loss and a potential threat against the survival of inland fish farming occupation in West Bengal.

In pond fish farming, the total cost per acre calculated by Uddin and Akhi in 2014 in Bangladesh was Tk. 2,72,266 and Tk. 2,77,179 for owner-managed and NGO-supported pond, respectively. In the case of an owner managed pond, total fixed cost and total variable cost accounted for about 8.60 and 91.40 per cent of total cost, respectively. For NGO-supported pond fish farming, total fixed cost covered 9.2 percent and total variable cost covered 90.80 percent of the total cost. Annual gross returns from this comparative study of pond fish farming were estimated to be Tk. 520,699 and Tk. 652,109 per acre for owner-managed and NGO-supported pond respectively.

Toma *et al.* (2015) in a study based on small-scale Tilapia farming in Bangladesh commented that Tilapia fish cultivation was a worthy commercial enterprise for the rural farmers. Cultivation of the Tilapia fish has an amazing ability in Bangladesh and it is going to be a top tradition species in the near future for freshwater and brackish water ecosystems. Tilapia would play greater role towards lowering

poverty through generating greater profits to the farmers, increasing employment and providing animal nutrition.

The financial matters of fish ranchers of Jammu concentrated by Kumar *et al.* (2015) uncovered that, almost about 66 per cent of fishers had lower pay of Rs 3000 and that 36 per cent of fishers fall under medium level pay bunch.

Especially in terms of consumption, small groups of weed fishes considered as a weed in scientific carp culture such as moca, putit, botia, chanda, etc have high demand and high market price in Tripura compared to carps (Debnath *et al.*, 2015).

Income from fish farming and allied works was found to be lower than other sectors and this may be due to seasonal nature of the work (Radhakrishnan *et al.* 2017).

There are many sources for loan, including banks, private lenders, friends, self-help groups, private companies, cooperatives, and cooperative banks for fishermen population. There are different institutional arrangements for providing credit to fishermen. Private moneylenders and friends are informal sources, while others are formal sources of credit supply. From the fish farmers surveyed, 70.7 per cent mainly rely on bank loans. Respondents in Assam and Punjab rely solely on banks to obtain loans. Interestingly, 61.2 per cent of Andhra Pradesh respondents rely on private lenders to provide loans. Among the people surveyed in Orissa Province and West Bengal, SHG was also a good source of loans (Barik *et al.*, 2018).

Madan *et al.* (2018) attempted to calculate the economics and marketing of the dried fish in Thoothukudi district, Tamil Nadu, India. The results showed that sardines and anchovies represented 50 per cent of the total dried fish produced in terms of quantity. Dried fish marketing was found to be a profitable business, by the study with an Internal Rate of Return (IRR) of 75 per cent, a simple rate of return (SRR) of 43.48 per cent, and a net profit margin of ₹ 2,258.83 per week. The research also showed that dried fish reached consumers through three marketing channels, namely channel I (producer to consumer), channel II (producer, intermediary and consumer) and channel

3 (producer, wholesaler, intermediary and consumers). Channel I was considered the most effective marketing channel than channel II. It was found that the cost of raw materials, transportation, packaging and marketing profits were the key factors significantly affecting and determining the income of producers of dried fish.

Aswathy and Joseph (2018) studied the efficiency of resource use based on selected variables. Cage fish culture used by farmers in Kerala coastal waters was proven to be a profitable endeavor. The feed and fingerlings used had a positive and significant impact in fish production, while the scale of the farm was not significant in the study.

Materials and Methods

3. MATERIALS AND METHODS

The authenticity of the study is highly dependent on the methodology followed to obtain the results. In this chapter, the details regarding the methods and materials employed to fulfill the specific objectives are discussed. The chapter is explained under the following headings

3.1 DESCRIPTION OF THE STUDY AREA

3.2 SAMPLING DESIGN

3.3 NATURE AND SOURCES OF DATA

3.4 VARIABLES AND THEIR MEASUREMENT

3.5 TOOLS FOR ANALYSIS

3.1 DESCRIPTION OF THE STUDY AREA

The study was primarily on the inland fisheries in Kerala and thus area selected purposively for fulfilling the purpose of study was Alappuzha district as the district secured a major position in inland fish production during 2019-20. Among the various grama panchayats in Alappuzha district: - Puliyoora, Budanoor, Purakkad, Thekkekara, Ala, Venmony, Mannar, Thiruvandoor, Mulakuzha and Palamel were selected for the purpose of study due to relatively greater number of respondents in these areas.

3.1.1 Alappuzha

The name Alappuzha is derived from Aal (sea) + Puzhai (river-mouth) ie. the joining place of a river and the sea. Alappuzha, nick named as 'Venice of the East' is located at 9.54 ° N and 76.40 ° E. The mean height is 1 meter (3.3 feet). It covers an area of 1,414 square kilometers (546 square miles) and is flanked by 2,195 square kilometers (847 square miles) of Lake Vembanad, where six major rivers run before joining the country's 80 km long shoreline. The city of Alappuzha is crossed by a canal system which is part of the National Canal 3.

The district is a strip of sandy land crossed by lagoons, rivers and canals. There are no mountains or hills in the district, except for a few scattered hills that lie between the Bharanikkavu and Chengannur blocks in the eastern part of the district. There are no forests in this district.

Alappuzha is bordered on the west by the Laccadive sea. The city has a network of many freshwater lakes, ponds and rivers. The richness of the coastal waters of Alappuzha is expressed annually in the blooming and resulting deposition of a large number of fish and shrimp on the coast of Alappuzha, which is called "Chakara". This annual sandbank change occurs during the post-monsoon season and adds to the local economy and is a festive season for the people of Kerala. *Etroplus* and *Tilapia* are the two main categories of fish, which had the dominant share in total fish production. *Etroplus suratensis*, popularly known as Karimeen, is an endemic species highly valued for its delicacy (Krishnakumar and Dharmarajan, 2011).

Annual floods rejuvenate and purify soil and water, creating an abundance of marine life such as shrimp, lobsters, fish, turtles, and other plants in the ocean.

The backwaters and wetlands of the district are home to thousands of teals, ducks and cormorants that come here from great distances each year. An important feature of the area is the Kuttanad region, the "granary of Kerala". Also known as the Kerala Rice Bowl, Kuttanad is one of the few places in the world where agriculture is practised below sea level. Rice fields are between 0.6 and 2 m below mean sea level. Alappuzha is known for its inland fish cultivation and its various traditional fish cuisines. Table 3 provides data on the inland fish production in Alappuzha during 2004-05 to 2019-20.

3.1.2 Demographics of Alappuzha

Alappuzha is occupied by a population of 21,27,789 which constitutes 6.61 per cent of the total population of India according to 2011 census. Alappuzha stands 216th in population status. The population density of 1504 per square kilometres makes the district with highest population density in Kerala. There is literacy rate of 95.72 per

cent. For every 1000 males there are 1100 females in the district. The district has 6 taluks: - Cherthala, Ambalappuzha, Kuttanad, Karthikapally, Chengannur and Mavelikara which have further been subdivided into 12 Community Development Blocks and 73 Grama Panchayats. Five municipalities in Alappuzha includes Chengannur, Alappuzha, Kayamkulam, Mavelikara and Cherthala.

3.1.3 Climate, Rainfall and Soil Type of Alappuzha

The climate is moist and hot in the coast and slightly cool and dry in the district. The average monthly temperature is 25⁰ C. The district also gets the benefit of two monsoons as in the case of other parts of the state. The district has 8 reporting rain gauge stations namely at Arookutty, Cherthala, Alappuzha, Ambalapuzha, Harippad, Kayamkulam, Mavelikkara and Chengannur. The average rainfall in the district is 2763 mm. Demographic and geographic profile of Alappuzha is summarized in table 1. Alappuzha has sandy, Peaty, kari and alluvial soils. Crops mainly grown include Coconut, arecanut, paddy, sugarcane, fruit trees and vegetables.

Table 1: Demographic and geographical profile of Alappuzha district

Sl.no	Particulars	Value
1	Geographical area (sq.km)	1,415
2	Population	21,27,789
3	Literacy rate (%)	95.7
4	Population density (per sq.km)	1,504
5	Child population	1,92,046
6	Actual rainfall (mm)	2,763
7	Main agricultural labourers	39,491
8	Net area irrigated (ha)	35,841
9	Forest cover (sq.km)	80
10	Gross cropped area (ha)	1,11,743
11	Net cropped area (ha)	83,602
12	Land put to non-agricultural uses (ha)	25,271
13	Fallow land (ha)	4,747
14	Cultivable waste	14,458

Source: GOK, 2020

3.1.4 Inland Fish Production in Alappuzha District

Alappuzha is one of the most important tourist centers of the state, with a large network of inland canals, earning the sobriquet "Venice of the East". These large networks of canals are Alleppey's lifeline. The total inland fish production during 2019-20 was 0.50 lakh tonnes while that of marine fish production was 0.17 lakh tonnes. The Inland fisherfolk population of Alappuzha constituted 25508 males and 24424 females. A synoptic overview is given in table 2.

Table 2: Fisheries data in Alappuzha during 2019-20

Sl. No.	Particulars		Value
1	Marine fish production (lakh tonnes)		0.17
2	Inland fish production (lakh tonnes)		0.50
3	Marine fisherfolk population	Male	53,601
		Female	48,964
4	Inland fisherfolk population	Male	25,508
		Female	24,424

Source: GOK, 2020

Inland fish production comprises of inland culture and capture production. Capture fisheries is more compared to culture fisheries in Kerala and so in Alappuzha too. During 2019-20, the capture fisheries accounted to 40,459 tonnes while culture production was 9,672 tonnes. Table 3 provides detailed data of Alappuzha district in terms of culture and capture inland fish production.

3.2 SAMPLING DESIGN

Alappuzha was purposively selected as the district secured a major position in inland fish production during 2019-20. Farmers were selected by random sampling from purposively selected grama panchayats. Ten grama panchayats from Alappuzha district namely Puliyoor, Budanoor, Purakkad, Thekkekara, Ala, Venmony, Mannar, Thiruvandoor, Mulakuzha and Palamel, were purposively selected as they hosted majority of pond fish farmers from Alappuzha. From each grama panchayat, 6 farmers were selected randomly for the purpose of study thus making the total sample size to 60.

Table 3: Inland fish production in Alappuzha district from 2004-05 to 2019-20

Sl. No.	Year	Inland fish production (tonnes)		Total inland fish production (tonnes)
		Culture	Capture	
1	2004-05	NA	NA	12,725
2	2005-06	NA	NA	13,021
3	2006-07	NA	NA	13,265
4	2007-08	NA	NA	13,579
5	2008-09	NA	NA	14,027
6	2009-10	NA	NA	15,272
7	2010-11	NA	NA	15,988
8	2011-12	NA	NA	18,284
9	2012-13	NA	NA	20,290
10	2013-14	NA	NA	24,828
11	2014-15	NA	NA	31,081
12	2015-16	10,397	24,533	34,930
13	2016-17	6,638	25,754	32,378
14	2017-18	2,683	29,521	32,204
15	2018-19	1,668	49,539	51,207
16	2019-20	9,672	40,459	50,131

(NA-Not Available)

Source: GOK, 2020

3.3 NATURE AND SOURCE OF DATA

Both primary and secondary data was collected and analyzed from various sources for getting desired results for the objectives framed.

3.3.1 Primary Data

There were mainly two specific objectives for the study. Primary data was collected from the respondents of Alappuzha district for accomplishing the second objective of study. The data was collected from 60 sample respondents selected from various grama panchayats of Alappuzha district. The farmers were personally interviewed and the data regarding the pond fish production was collected using a pre-tested well-structured interview schedule. The information was collected regarding details such as land holdings, asset position, educational status, assets involved, fish production and marketing, price of inputs etc which were mandatory for the study. Further data was also collected on the constraints faced by farmers in production and marketing of inland culture fish.

3.3.2 Secondary Data

Secondary data was also collected as it was necessary for the fulfillment of the specific objective and making of the thesis. The data regarding the land use pattern and demographics were collected from the annual reports of Directorate of Economics and Statistics, Government of Kerala. Data pertaining to inland fish production of India were collected from the annual reports of the Department of Fisheries, Government of India. Data related to inland fish production in Kerala were collected from the Directorate of Fisheries, Vikas Bhavan, Thiruvananthapuram.

3.4 VARIABLES AND THEIR MEASUREMENT

The data pertaining to the study were collected under the following headings and analysed using various statistical tools. The analytical techniques used to evaluate are also given below. Initially the variables used and the concepts are described followed by the analytical techniques used in the estimation.

3.4.1 Socio-Economic Features of Pond Culture Fish Farmers

Socio economic status of the inland fresh water culture fish farmers were assessed by collecting details regarding name of respondents, age, gender, education, primary and secondary occupation of the farmers, experience in fish farming, land holding size and pond size of the sample farmers.

3.4.2 Quantity of Inputs

Quantity of inputs such as quantity of fingerlings, feed, manure, lime and solution kit were collected and used for the calculation of economic performance in pond fish cultivation.

3.4.3 Cost of Inputs

3.4.3.1 Cost of Fingerlings

Fish farmers from the selected area used fingerlings of Tilapia, Anabus and Pangassius for fish farming. They purchased the fingerlings either from the Dept. of Fisheries or from private dealers.

3.4.3.2 Cost of Manures and Lime

Cost of manures and lime were calculated on the basis of the prevailing market price in the study area.

3.4.3.3 Cost of Feed

The price of the fish feed varies with the size of the fishes fed. The feed contained ingredients like groundnut oilcake, rice bran, maize, and other millets. The feed cost was estimated by multiplying quantities of each of them used with their respective unit price. Unit price of feed sack was recorded from the farmers. An average amount was calculated per kg of feed considering the market price prevailing at the time of study.

3.4.3.4 Cost of Solution Kits

Farmers used solution kits for testing the pH variation in water and for finding the ammonia content in the pond. This is usually done monthly or when there is a discoloration in the water in the ponds. The cost of the kit is taken based on the market price prevailed in the study area.

3.4.3.5 Cost of Medicines and Hormones

Farmers from the selected study area did not use hormones or medicines.

3.4.4 Cost of Fixed Assets

Cost of pond digging, tarpaulin, pipes, motors, net and other accessories used in fish cultivation were calculated on the basis of the data collected from the farmers during survey. Miscellaneous expenses incurred for incidental and supplementary needs in fish production are also included in the fixed costs.

3.4.5 Cost of Labour

Labour cost was calculated based on the labour charges prevailed in the study area for various activities involved in pond fish production.

3.4.5.1 Family Labour

Family labour costs were estimated on the basis of existing wage rates of hired labour in the selected locality. Human labour utilized in various activities was calculated in terms of man days per acre and is estimated in terms of eight hours work per Day and is called labour man days.

The specification of the formula is as follows,

Labour man days =

$$\frac{\text{No. of working days} \times \text{No. of working hours per day} \times \text{No. of labour working per day}}{8 \text{ hrs}}$$

3.4.5.2 Hired Labour

It is the existing wage rate that is paid to the hired labour for the different works performed in the farm. The standard wage rate for male labour was selected, even though wage rates paid to the labours were different for different operations carried at initial stages.

3.4.5.3 Machine Labour

The labour costs incurred for initial digging of pond was collected and they mainly hired JCB for work.

3.4.6 Interest on Working Capital

Interest on working capital was determined at the rate at which institutional agencies provide short term loans to the farmers. Loans were availed by the farmers from the banking institutions at 7 per cent per annum.

3.4.7 Interest on Fixed Capital

Fixed cost is the cost which does not change with the level of fish production and rearing activities. Banking institutions offer long term loans at an interest rate of 14 per cent per annum and it is taken for calculation.

3.4.8 Depreciation

Depreciation on each capital equipment, fishing nets and machinery owned by the farmers were calculated using straight-line method. The average life of the asset as indicated by each farmer was used in the computation of the depreciation.

The formula used is,

$$\text{Depreciation} = \frac{\text{Original value} - \text{Salvage value}}{\text{Economic life period}}$$

3.4.9 Repair and maintenance cost

The actual annual cost of repairs and maintenance of capital items such as motors etc used in fish production and rearing was used.

3.4.10 Quantity of output

Quantity of fish harvested is indicated in kg per acre.

3.5 TOOLS FOR ANALYSIS

Several statistical tools were utilised for the analysis of collected data in order to draw meaningful conclusions. Simple tabular analysis, percentage analysis, arithmetic averages, economic analysis and constraint analysis were mainly used for the statistical analysis.

3.5.1 Analysis of Socio- Economic Features of Sample Respondents

3.5.1.1 Percentages and Averages

The data collected were presented in tabular form to facilitate the process of analysis. Percentages and averages were used to analyse the socio-economic features of sample respondents. The socio- economic characteristics of the respondents analysed were age of farmers, gender, educational status, family size of the respondents, land holding size, occupational status, pond size and experience in pond fish farming.

3.5.2 Trend in Inland Fish Production

Generally, in economic studies, we analyse the trend of a particular factor over a period of time in its growth rate (Kumar and Singh, 2014). Timsina *et al* further summarized in their study in 2015 that growth analysis indicates the performance of the variable under consideration, and it can further be used to make interpretations to evolve policy implications. In the present study, secondary data which were collected regarding the quantity of inland fish production in Kerala and in India and were analysed using Compound Annual Growth Rate (CAGR) to determine the trend.

The compound annual growth rate was estimated using the exponential function of the following form

$$y = a b^t e$$

Take the logarithm, it becomes $\log y = \log a + t \log b + \text{error}$,

and it can be written as $\ln(Y) = \ln(b_0) + b_1 t$

Where, t is used to represent the time variable,

Y - variable for which growth rate is calculated and

b_1 - regression coefficient of Y on t .

The Compound Annual Growth Rate (CAGR) is obtained as

$$\text{CAGR (\%)} = (\text{Antilog } b_1 - 1) \times 100$$

3.5.3 Economic Performance of Inland Pond Fish Production

3.5.3.1 Method of Estimation of Cost

Capital Investment

In the present study, the capital cost is defined as an initial investment on land, pond construction, building, machinery and equipment, and tanks, fencing and electrical installations.

Fixed cost

Fixed cost is the cost which does not change with the level of fish production and rearing activities. Fixed cost include depreciation on investment and capital assets like equipment and farm implements, interest on fixed capital, repairs and maintenance.

Fixed costs includes

- a) Pond digging cost
- b) Tarpaulin cost
- c) Cost of motors and pipes
- d) Electrification charges
- e) Cost of net, sacks
- f) Cost of frame
- g) Cost of CCTV
- h) Cost of weighing balance, name board, utensils
- i) Miscellaneous cost

Variable cost

Cost of inputs used viz., labour cost, fingerlings cost, manuring cost, feed cost, lime cost, solution kit cost and interest on working capital @ 7% per annum and other incidental expenses constituted variable cost.

Total costs and returns incurred for the fish cultivation were calculated and analysis was performed based on the concept used by Halli in 2019. Capital investment made for the preparation of pond was found out after collecting the data from the respondents. The investment of each respondent was converted to per acre basis. The average of total costs from all respondents was taken to find the final investment costs.

Cost of cultivation was found out by adding the annual fixed and variable costs. The annual fixed costs included depreciation and interest on fixed costs.

Variable costs includes

1. Labour costs
2. Material costs
 - a. Fingerlings costs
 - b. Manure costs
 - c. Feed costs
 - d. Lime

- e. Solution kit
3. Maintenance costs
 4. Interest on working capital

3.5.3.2 Estimation of Returns

Gross return was calculated by multiplying the total amount of production by their respective market prices (Dillon and Hardakar, 1993). In this study for the estimation of returns from fish production, total production from the three fish species was calculated separately according to the data collected and then multiplied with the market price of the fish species to get the total returns.

3.5.3.3 Economic Feasibility Analysis

To analyse the economic feasibility following measures were used.

3.5.3.3.1 Net Return

The net income is the difference between total income and total cost.

$$\text{Net return} = \text{TR} - \text{TC}$$

Where, TR = Total revenue

TC = Total cost

3.5.3.3.2 Cost of Production

Cost incurred in production of 1 kg of fish.

3.5.3.3.4 Benefit Cost Ratio

It is the ratio of value of future cash benefits discounted at required rate of return to the initial cash outflows of the investment.

3.5.4 Marketing of Inland Fish

The marketing channels were identified and values calculated using percentages and averages. The quantity marketed and the price involved for different species were collected from the study area.

3.5.5 Resource Use Efficiency

Regression analysis was worked out for studying the resource use efficiency of pond fish production. Cobb Douglas production function was used, as used by Kingsley *et al* (2014) in a fisheries study based in Nigeria. Resource use efficiency was computed using the concept explained by Mugabo *et al* (2014).

The analysis was performed using the Cobb-Douglas production and the form is as follows

$$Y = a X_1^{b_1} X_2^{b_2} X_3^{b_3} X_4^{b_4} X_5^{b_5} X_6^{b_6} X_7^{b_7} e$$

Where,

Y = Quantity of output (kg)

X₁ = Family labour (labour man days)

X₂ = Quantity of feed (kg)

X₃ = Quantity of manure (kg)

X₄ = Quantity of lime (kg)

X₅ = No. of solution kits

X₆ = No. of fingerlings

X₇ = Pond area (cents)

e = base of natural logarithm

Taking log, we obtain the equation as,

$$\log Y = \log a + b_1 \log X_1 + b_2 \log X_2 + b_3 \log X_3 + b_4 \log X_4 + b_5 \log X_5 + b_6 \log X_6 + b_7 \log X_7 + \log e$$

a = intercept

$b_1, b_2, b_3, b_4, b_5, b_6, b_7$ = Regression coefficients of corresponding explanatory variables

Regression was fitted to the data collected and significance noted using the t value and p value obtained.

3.5.6 Marginal Productivity Analysis

Allocative use efficiency was analysed using marginal productivity analysis. The marginal value product (MVP) is divided by the cost of one unit of the factor of production or the marginal factor cost (MFC) to get the relative efficiency of resource use.

$$r_i = MVP_i / MFC_i$$

r_i = relative efficiency of resource i (also known as the allocative efficiency)

MVP_i = Marginal Value Product of factor i

MFC_i = Marginal Factor Cost of factor i

Marginal Value product is calculated as follows

$$MVP_i = MPP_i * P_y$$

Where, MPP_i = Marginal Physical Product of resource i and P_y corresponds to the unit price of fish.

The marginal physical product is computed by the equation below.

$$MPP_i = b_i * Y_m / X_{m_i}$$

Where, MPP_i = Marginal Physical Product of input i ($i = 1, 2, 3, 4, 5, 6, 7$)

b_i = The coefficient associated with the input i ;

Y_m = Geometric mean of total fish yield

X_{mi} = Geometric mean of the input i used in pond fish production.

3.5.7 Constraint Analysis

Every new project or a production process will have its own constraints at different stages. Fish production is of no exception. Both marketing and production constraints were present in the study area.

Henry Garrett's ranking technique was used to perform the constraint analysis in this study. Several constraints were noted and enlisted in tabular form based on the referred studies and farmers' response. The data was then recorded in the table and analysed. Constraints were ranked initially.

Using the formula shown below, the obtained ranks were then converted to the per cent position (Garrett and Woodworth, 1969).

$$\text{Per cent position} = 100 \times (R_{mn} - 0.5) / N_n$$

Where, R_{mn} = Rank given for the m th factor by n th person.

N_n = No. of constraints ranked by the n th person.

The calculated per cent positions were then converted to Garrett score using Garrett's conversion table. The sum and mean value of Garrett scores were worked out from the scores attributed to each constraint by the individual respondents. Mean score obtained for each constraint calculated and the constraint with the maximum mean score was identified as the major problem faced by the fish farmers in selected study area.

Results and Discussion

4. RESULTS AND DISCUSSION

The study entitled “Capture production and economic performance of inland fisheries in Kerala”, conducted at Alappuzha district focused mainly on the objectives such as the trend analysis of inland fish production and the economics of pond fish cultivation. After proper data collection; careful and prompt analysis was performed to yield the following results. Results thus obtained are arranged into sections as listed below

4.1 SOCIO-ECONOMIC CHARACTERISTICS OF POND FISH FARMERS

4.2 TREND IN INLAND FISH PRODUCTION

4.3 ECONOMICS OF POND FISH PRODUCTION

4.4 ECONOMIC EFFICIENCY OF POND FISH PRODUCTION

4.5 MARKETING OF POND FISH

4.6 CONSTRAINTS INVOLVED IN POND FISH PRODUCTION

4.1 SOCIO-ECONOMIC CHARACTERISTICS OF POND FISH FARMERS

The data regarding the basic socio-economic details were collected during the course of the survey. This included information on age, gender, education, occupation, family size, land holding size, pond size and experience in inland pond fish production. This helped to understand the nature of households to which the farmers belonged and their living standards.

4.1.1 Age

Based on the response from the farmers, the respondents were classified into four different categories, viz., 20-30, 31-40, 41-50 and more than 50 years. It was observed from table 4, that 50 per cent of the farmers who undertook fish production belonged to the category of more than 50 years of age. Many of the farmers in this age group were those who started pond fish farming with their savings after retirement or those who lost their jobs abroad due to various reasons. There were very few farmers (5%) in the age group of 20-30 years. Lack of interest among the youth towards fish farming activities and high initial investment cost discouraged the young generation

from inland fish farming. A similar study from Assam by Gupta and Dey (2014) also showed comparable results where more than 50 per cent of the farmers belonged to the old age group followed by middle and young farmers.

Table 4: Classification of pond fish farmers based on age

Sl. No.	Age group (years)	Respondents	
		Number	Per cent
1	20-30	3	5.00
2	31-40	15	25.00
3	41-50	12	20.00
4	More than 50	30	50.00
	Total	60	100.00
	Mean age	49	

4.1.2 Gender

The study revealed that the majority of the farmers undertaking inland fish production activity were males and this constituted around 67 per cent. A study by Olasunkanmi, 2012 on socio- economic characteristics of fish farmers in Osun state of South-Western Nigeria revealed that most fish farmers (58.3 %) in the state were males, aged between 31-50 years old. In the present study, even though, the fish farming was mainly taken care by males, females actively took part in the day-to-day management of the ponds. A lot of physical labour was carried out by men for digging construction and for the maintenance of the electrical appliances involved in pond fish cultivation. The percentage share of male and female pond fish farmers are reported in table 5.

Table 5: Classification of pond fish farmers based on gender

Sl. No.	Gender	Respondents	
		Number	Per cent
1	Male	40	67.00
2	Female	20	33.00
	Total	60	100.00

4.1.3 Education

The data was collected on the educational background of the fish farmers and it was found that 33 per cent of the farmers had pre-degree/ Higher Secondary (HS) level of education. None of the farmers were found illiterate and a good chunk of them i.e., 30 per cent were graduates. Detailed data on the farmers' educational status was compiled and summarized in table 6. Ninety-five per cent of the farmers had secondary education and above in the study area. Literacy level was very important in the scientific and technological management of the farm. It was observed that educated farmers are better at management compared to others. A study conducted by Pandey and Upadhayaya (2012) in Kulubari, West Tripura noticed that the graduates had more collaborated in fish farming practices.

Table 6: Classification of pond fish farmers based on education

Sl. No.	Education	Number	Per cent
1	Illiterate	0	0.00
2	Primary	3	5.00
3	Secondary	9	15.00
4	Pre-degree/HS	20	33.00
5	Diploma	10	17.00
6	Graduation and above	18	30.00
	Total	60	100.00

4.1.4 Occupation

In the study area, 26.67 per cent of the selected farmers primarily practised pond fish farming and considered inland fish farming as their prime source of income. While, a majority of the farmers (73.33%) in the study area took fish farming as their secondary source of income as depicted in table 7. Among the farmers who considered fish farming as their secondary source of income 21.66 per cent of farmers were working in the public sector, 25 per cent farmers were working in the private sector and the remaining 26.67 per cent of farmers were self-employed. Majority of the farmers took inland fish

farming as their secondary occupation, since it had a lot of risk factors such as loss of produce through disease incidence, intermittent heavy rainfall etc. In addition, farmers did not consider the possibility of widening the pond area or expansion of production due to hectic initial investment and lack of adequate incentives. The results were contrary to the study conducted by Islam *et al* (2014) in Bangladesh, where 51 per cent of the farmers were involved solely in fish farming, 22 per cent in fish farming along with agriculture and 27 per cent in fish farming with other professions.

4.1.5 Family size

Generally, family size is directly related to family consumption. The survey on family size data in the study area revealed that 80 per cent of the farmers belonged to nuclear families whereas 12 farmers from a total of 60 were part of joint families. Table 8 summarizes the classification based on family size. It was noticed that even though some families were joint with more than 4 members, they did not retain a proportionate quantity of fish harvested for family consumption. It was observed that elders and children were also involved in various pond related activities from joint families.

Table 7: Classification of pond fish farmers based on occupational status

Sl. No.	Primary occupation	Secondary occupation(s)	Number of respondents	Per cent
1	Inland fish farming	Agriculture	16	26.67
2	Public sector	Inland fish farming	13	21.66
3	Self-employed	Inland fish farming, agriculture	16	26.67
4	Private sector	Inland fish farming	15	25.00
Total			60	100.00

Table 8: Classification of pond fish farmers based on family size

Sl. No.	Family size	Number	Per cent
1	Nuclear (4 or less)	48	80.00
2	Joint (more than 4)	12	20.00
	Total	60	100.00

4.1.6 Land holding size

Total land holding survey of the sample farmers revealed that 55 per cent of the farmers owned less than 1 acre of land whereas 28 per cent of farmers owned between 1-2 acres. Seventeen per cent of farmers owned more than 2 acres of land area. The values are noted in table 9. The mean land area of farmers was found to be 1.3 acres.

Table 9: Classification of pond fish farmers based on land holding size

Sl. No.	Land holding size (in acres)	Number	Per cent
1	Less than 1 acre	33	55.00
2	1-2 acres	17	28.00
3	More than 2 acres	10	17.00
	Total	60	100.00
Mean area = 1.3 acres			

4.1.7 Pond size

Hossain *et al* (2002) stated that multiple pond ownership became a prime factor for pond aquaculture, where multiple fish farmer operated 66 per cent ponds. Also, Zaman *et al* in his study had noted that the very best numbers of fish farmers (52 per cent) had 1 pond, while 7, 7 and 8 per cent of fish farmers had 4, 5 and above five ponds

respectively. In the present survey, it was found that both the studies hold good. Ninety per cent of the farmers had less than 20 cents of pond area, among which majority of the farmers fall under 2 cents of pond area category. While 10 per cent of farmers had more than 20 cents of pond area and each pond been managed by a group of 2 or three farmers so as to reduce the burden of more financial investment. Farmers having small pond area also maintained 2 or 3 ponds unlike opting for a single one so that the risk due to loss of fish by means of incidence of diseases and other factors could be reduced. Efforts were not observed from the farmers to expand the pond area even though land area was available. This was mainly because of lack of proper incentives to the farmers. The farmers were having the mean pond size area of 6.7 cents as shown in table 10.

Table 10: Classification of pond fish farmers based on pond area

Sl. No.	Pond area (in cents)	Number	Percentage
1	Less than 10	42	70.00
2	10 – 20	12	20.00
3	More than 20	6	10.00
	Total	60	100.00
Mean pond area = 6.7 cents			

4.1.8 Experience in pond fish farming

Experience was an additional earning factor required for any business. In this study, it was noticed that farmers with less experience faced more constraints when compared to experienced and trained farmers. Sampled farmers had experience of between 2-4 years with a mean value of 2.4 years.

4.2 TREND IN INLAND FISH PRODUCTION

4.2.1 Trend in inland fish production in India

To analyse the trend in fish production 20 years data from 2000-01 to 2019-20 was used. It was observed from the result that there was a steady increase in the inland fish production attaining a Compound Annual Growth Rate (CAGR) of 4.89 per cent

and was found to be significant. The CAGR calculated for total fish production and marine fish production from 2000-01 to 2019-20 was 4.90 and 1.80, respectively and was found to be significant. The total fish production jumped from 56.56 lakh tonnes in 2000-01 to 141.64 lakh tonnes by 2019-20 (GOI, 2019). The data for the past 20 years is summarized in table 11. According to the Government of India 2018, India's fish harvest rose from 38.36 lakh tonnes in 1990 to 125.9 lakh tonnes in 2017-18. The production data showed that only 36.8 lakh tonnes was constituted by marine sector from the total 125.9 lakh tonnes. This implies that the production from inland sector was 71 per cent in 2017-18. It is very well clear from the table that the percentage share of inland fish production increased from 50.3 per cent in 2000-01 to 73.69 per cent in 2019-20.

Zafar (2021), evaluated the total fish harvest within the country and reported that India's marine fish sector has already reached a plateau and can able to forecast only a marginal growth in the future. However, inland fish production has depicted rapid boom because of untapped water and fish sources and thriving investments.

Although, started as a livelihood activity, inland fisheries economy in India had made speedy changes and converted the sector to the reputation of an industrialized industry, contributing immensely to employment generation, food and nutrition security and overseas exchange earner to the country. Inland fish production in India from 2000-01 to 2019-20 is shown in figure 2. According to Sathiadas *et al.*, (2014), inland fish production increased due to various initiatives by government during the XIth plan under Result Framework Document (RFD) programme of National Fisheries Development Board (NFDB). Large number of reservoirs were stocked with fish fingerlings as part of the programme. It resulted in significant enhancement in fish yield (yield from small reservoirs increased from 50 to 174 kg/ha).

Table 11: Fish production in India during 2000-01 to 2019-20 (in lakh tonnes)

SL. No.	Year	Inland fish production (lakh tonnes)	Marine fish production (lakh tonnes)	Total fish production (lakh tonnes)
1	2000-01	28.45 (50.30)	28.11 (49.70)	56.56
2	2001-02	31.26 (52.48)	28.30 (47.52)	59.56
3	2002-03	32.10 (51.77)	29.90 (48.23)	62.00
4	2003-04	34.58 (54.04)	29.41 (45.96)	63.99
5	2004-05	35.26 (55.92)	27.79 (44.08)	63.05
6	2005-06	37.56 (57.15)	28.16 (42.85)	65.72
7	2006-07	38.45 (55.98)	30.24 (44.02)	68.69
8	2007-08	42.07 (59.03)	29.20 (40.97)	71.27
9	2008-09	46.38 (60.90)	29.78 (39.10)	76.16
10	2009-10	48.94 (61.19)	31.04 (38.81)	79.98
11	2010-11	49.81 (60.52)	32.50 (39.48)	82.31
12	2011-12	52.94 (61.09)	33.72 (38.91)	86.66
13	2012-13	57.19 (63.26)	33.21 (36.74)	90.4
14	2013-14	61.36	34.43	95.79

		(64.06)	(35.94)	
15	2014-15	66.91 (65.21)	35.69 (34.79)	102.6
16	2015-16	71.62 (66.55)	36.00 (33.45)	107.62
17	2016-17	78.06 (68.29)	36.25 (31.71)	114.31
18	2017-18	89.02 (70.07)	37.56 (29.57)	127.04
19	2018-19	97.20 (71.61)	38.53 (28.39)	135.73
20	2019-20	104.37 (73.69)	37.27 (26.31)	141.64
	CAGR	6.85	1.80	4.90

(Note: Figures in parentheses denote percentage to row total)

Source: GOI, 2020

4.2.2 Trend in inland fish production in Kerala

Inland fish production data in Kerala from 2000-01 to 2019-20 is shown in table 12. Analysis of the data for the last 20 years found that the CAGR value for the inland fish production was 6.74 per cent. Mathew and Verghese (2019) in a similar study also obtained matching results. They also opined that the movement in inland fish production was showing a tremendous increase unlike in the case of marine fish production in Kerala.

Table 12: Inland fish production in Kerala 2000-01 to 2019-20 (tonnes)

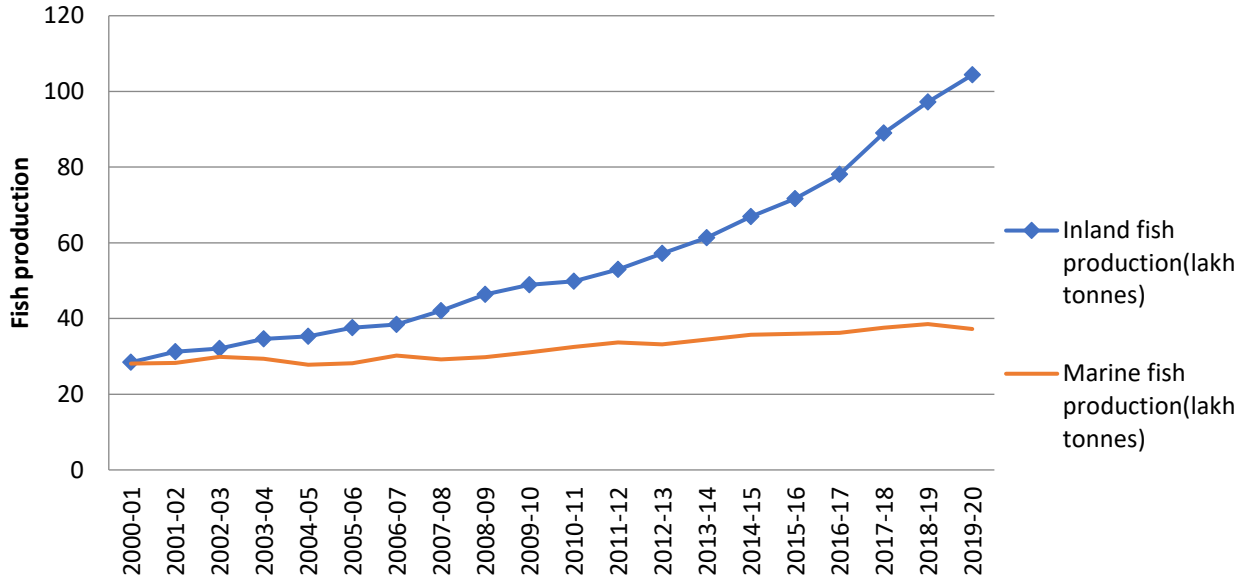
Sl. No.	Year	Kerala
1	2000-01	85,234
2	2001-02	78,039
3	2002-03	75,036
4	2003-04	76,279
5	2004-05	76,451
6	2005-06	77,980
7	2006-07	79,647
8	2007-08	91,085
9	2008-09	1,02,842
10	2009-10	1,16,836
11	2010-11	1,21,215
12	2011-12	1,40,031
13	2012-13	1,49,098
14	2013-14	1,86,337
15	2014-15	2,01,545
16	2015-16	2,10,763
17	2016-17	1,88,130
18	2017-18	1,89,081
19	2018-19	1,92,027
20	2019-20	2,05,430
	CAGR	6.74

Source: GOK, 2020

Gowsalya *et al.* (2019) in her study based in Tamil Nadu found that during 2006-07 to 2016-17 period, Average Annual Growth Rate (AAGR) of inland fish production was 1.87 percent whereas in the case of inland seed production, it was 10.21 percent.

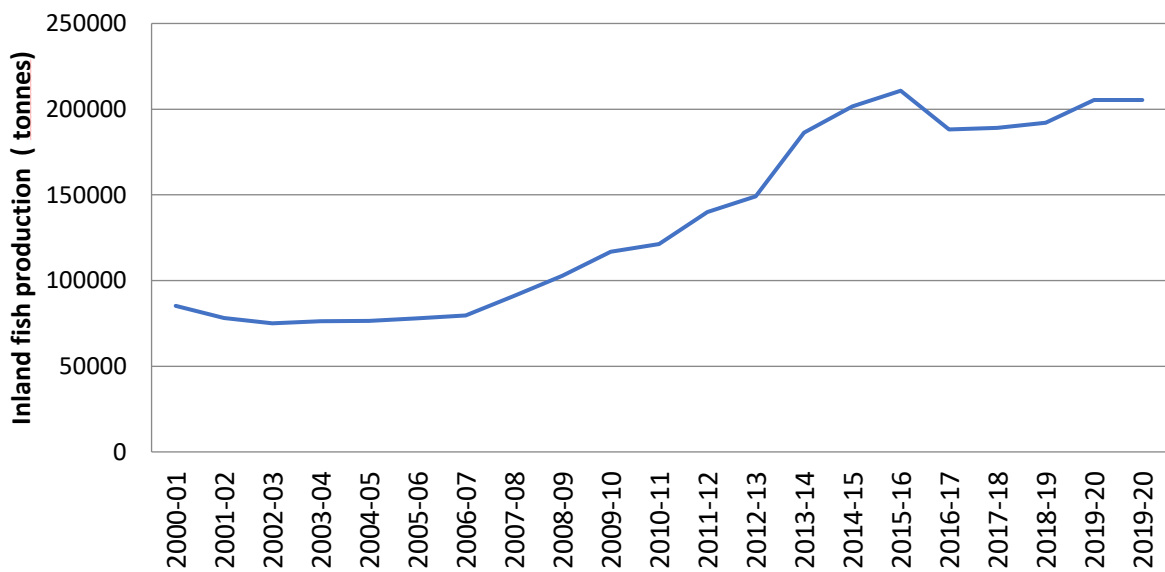
Growth rate of inland seed production was higher than the inland fish production in Tamil Nadu. Maurya *et al.*, (2018) in her study at Uttar Pradesh, for the time period

Figure 2: Trend in inland fish and marine fish production in India during 2000-01 to 2019-20



Source: GOI, 2020

Figure 3: Inland fish production in Kerala during 2000-01 to 2019-20 (in tonnes)



Source: GOK, 2020

2001-02 to 2016-17 reported that AAGR in fish production was 7.56 per cent. Figure 3 represents the trend in inland fish production in Kerala from 2000-01 to 2019-20.

A Study by Garg and Gupta in 2019 revealed that the fish farming area, fish production and the production of fish seed in Haryana had raised over the years. Fish farming areas in Haryana have increased from 8,882 ha in 2004-05 to 18,550 ha in 2017-18 at the CAGR of 5.13 per cent. Similarly, the total fish production has increased from 42,052 tonnes in 2004-05 to 1,90,000 tonnes in 2017-18 and recorded a CAGR of 9.64 per cent. While fish seed production obtained a high CAGR of 16.183 per cent during the same period.

Inland fish production data among various districts in Kerala were analysed and results are presented in table 13. Kottayam district has been found to have the highest inland fish production in 2019-20, followed by Alappuzha and Ernakulam in second and third positions respectively. Table 13 shows the production of inland fish among various districts of Kerala along with their TE 2019-20 average. The TE 2019-20 values among various districts shows that Kottayam had highest average value of 45,669.67 followed by Alappuzha (44,514), Ernakulam (26,670) and Thrissur (22,371.33). Production data of Kottayam district when analysed, it was observed that the production increased from 11,474 to 34,972 tonnes from 2016-17 to 2017-18 and further increased to 51,760 tonnes during 2018-19. As per the officials from various districts, this was due to the increased production of clam fish in Kottayam district during 2017-19. Alappuzha and Ernakulam districts are also known for its increased clam fish availability. This increase in clam production was also the reason for the hike in production of inland fish in Alappuzha district during 2018-19 (51,207) from 2017-18 (32,204). Alappuzha had an appreciable hike in inland fish production from 12,725 tonnes in 2004-05 to 50,131 tonnes in 2019-20. Kasargod district, eventhough had TE 2019-20 average value of 21,339.67, the data from 2004-05 to 2006-07 shows that Kasargod has very less inland fish production. It was observed that the production jumped from 75 tonnes in 2006-07 to 7884 tonnes during 2007-08. This tremendous hike was majorly contributed by the mussel and oyster fish production data that were added to the inland fish production from 2008 onwards. After 2008, Kasargod showed

increased production since, the mussel and oyster production data were added to the list. After 2017, decreased production from some of the districts such as Kollam, Thrissur and Kozhikode were due to the influence of COVID-19 on the fisheries sector. The graph representing the inland fish production among various districts such as Kollam, Kottayam, Alappuzha, Ernakulam, Thrissur and Kasargod is shown in Figure 3.

Table 13: Inland fish production in various districts of Kerala 2004-05 to 2019-20 (tonnes)

Sl. No.	Year	Alappuzha	Ernakulam	Idukki	Kannur	Kasargod
1	2004-05	12,725	23,591	598	1,635	71*
2	2005-06	13,021	23,163	624	1,691	73*
3	2006-07	13,265	24,164	627	1,710	75*
4	2007-08	13,579	24,855	639	2,179	7,884
5	2008-09	14,027	25,777	660	2,308	16,027
6	2009-10	15,272	27,903	737	2,137	20,840
7	2010-11	15,988	29,611	752	2,179	21,561
8	2011-12	18,284	31,284	825	2,306	21,670
9	2012-13	20,290	35,038	979	2,601	19,905
10	2013-14	24,828	41,449	1,344	3,139	22,505
11	2014-15	31,081	37,674	2,946	3,991	25,376
12	2015-16	34,930	38,951	3,536	4,786	23,333
13	2016-17	32,378	37,580	3,144	4,087	10,488
14	2017-18	32,204	24,645	1,882	4,531	35,942
15	2018-19	51,207	21,589	1,373	2,687	8,114
16	2019-20	50,131	33,776	1,922	2,009	19,963
TE 2019-20 average		44,514	26,670	1,725.67	3,075.67	21,339.67

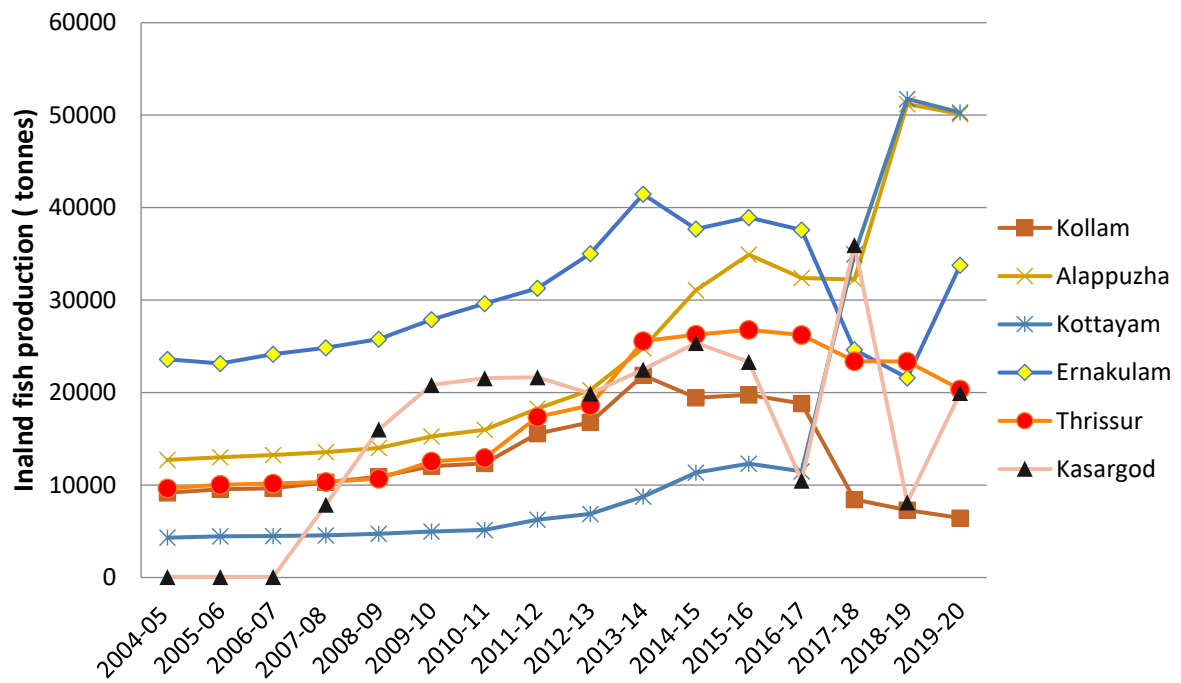
***Note :** During 2005-07, the data on inland fish production in Kasargod did not include the mussel and oyster production. Hence, the production is shown to be less during this period.

Kollam	Kottayam	Kozhikode	Malappuram	Palakkad	Pathanamthitta
9,156	4,310	1,916	1,329	8,488	1,137
9,532	4,446	1,996	1,379	8,967	1,163
9,636	4,498	2,015	1,391	9,000	1,184
10,297	4,574	2,886	1,546	9,149	1,203
10,892	4,720	3,317	1,742	9,437	1,243
12,046	4,968	3,384	2,121	11,110	1,286
12,354	5,139	3,499	2,099	11,194	1,306
15,577	6,250	3,676	2,647	15,345	1,467
16,787	6,865	3,905	2,778	16,156	1,640
21,877	8,756	4,561	4,561	3,543	2,025
19,447	11,345	5,264	6,517	21,833	2,888
19,757	12,308	6,124	6,831	22,064	3,525
18,817	11,474	5,090	6,476	21,883	3,173
8,446	34,972	4,434	3,826	7,427	1,990
7,313	51,760	998	8,406	10,132	2,882
6,441	50,277	2,057	5,170	2,656	6,558
7,400	45,669.67	2,496.33	5,800.67	6,738.33	3,810

Thiruvananthapuram	Thrissur	Wayanad
1,516	9,656	283
1,605	10,020	300
1,614	10,167	301
1,641	10,348	305
1,693	10,685	314
1,954	12,567	511
1,974	12,930	629
2,565	17,387	748
2,720	18,621	813
3,705	25,564	1,005
4,944	26,251	1,988
5,562	26,781	2,274
5,233	26,220	2,087
4,914	23,391	477
1,449	23,372	746
2,815	20,351	1,326
3,059.33	22,371.33	849.67

Source: GOK, 2020

Figure 4: Trend in inland fish production among major districts in Kerala from 2004-05 to 2019-20



Source: GOK, 2020

Table 14: Inland capture and culture fish production among various districts in Kerala from 2015-16 to 2019-20

Sl. No.	District	2015-16			2016-17		
		Inland			Inland		
		Culture	Capture	Total	Culture	Capture	Total
1	Thiruvananthapuram	2,166	3,396	5,562	1,223	4,010	5,233
2	Kollam	2,417	17,339	19,756	1,370	17,468	18,838
3	Pathanamthitta	1,434	2,091	3,525	810	2,363	3,173
4	Alappuzha	10,397	24,533	34,930	6,638	25,754	32,392
5	Kottayam	4,103	8,205	12,308	2,334	9,149	11,483
6	Idukki	1,844	1,692	3,536	1,045	2,100	3,145
7	Ernakulam	2,278	36,673	38,951	1,312	35,854	37,166
8	Thrissur	7,392	19,390	26,782	4,643	20,734	25,377
9	Palakkad	5,086	16,978	22,064	2,871	19,111	21,982
10	Malappuram	3,016	3,815	6,831	2,757	4,828	7,585
11	Kozhikode	1,524	4,600	6,124	861	4,232	5,093
12	Wayanad	1,126	1,148	2,274	637	1,450	2,087
13	Kannur	1,518	3,269	4,787	867	3,248	4,115
14	Kasargod	1,964	21,369	23,333	1,109	9,352	10,461
	Total	46,265	1,64,498	2,10,763	28,477	1,59,653	1,88,130
	Percentage to total	21.95	78.05		15.14	84.86	

Sl. No.	District	2017-18			2018-19		
		Inland			Inland		
		Culture	Capture	Total	Culture	Capture	Total
1	Thiruvananthapuram	418	519	937	342	1,107	1,449
2	Kollam	311	8,134	8,446	1,428	5,885	7,313
3	Pathanamthitta	14	1,976	1,990	439	2,443	2,882
4	Alappuzha	2,683	29,520	32,204	1,668	49,539	51,207
5	Kottayam	3,973	30,999	34,972	945	50,814	51,759
6	Idukki	985	897	1,882	143	1,230	1,373
7	Ernakulam	2,334	22,311	24,645	530	21,060	21,590
8	Thrissur	8,626	14,765	23,391	7,773	15,599	23,372
9	Palakkad	2,674	4,756	7,427	9,303	829	10,132
10	Malappuram	145	3,680	3,826	89	8,317	8,406
11	Kozhikode	18	4,414	4,434	65	932	997
12	Wayanad	8	469	477	657	89	746
13	Kannur	755	3,776	4,531	395	2,292	2,687
14	Kasargod	1,254	34,688	35,942	734	7,380	8,114
	Total	24,198	1,60,906	1,85,104	24,511	1,67,516	1,92,027
	Percentage to total	13.07	86.93		12.76	87.24	

Sl. No.	District	2019-20		
		Inland		
		Culture	Capture	Total
1	Thiruvananthapuram	1,813	1,002	2,815
2	Kollam	2,309	4,132	6,441
3	Pathanamthitta	1,518	5,039	6,558
4	Alappuzha	9,672	40,459	50,131
5	Kottayam	552	49,725	50,277
6	Idukki	760	1,162	1,922
7	Ernakulam	1,788	31,988	33,776

8	Thrissur	903	19,447	20,351
9	Palakkad	1,912	724	2,636
10	Malappuram	515	4,655	5,170
11	Kozhikode	315	1,741	2,057
12	Wayanad	1,166	160	1,326
13	Kannur	1,033	976	2,009
14	Kasargod	831	19,132	19,963
	Total	25,088	1,80,342	2,05,432
	Percentage to total	12.21	87.79	

Source: GOK, 2020

Table 14 shows the capture and culture inland fish production in Kerala from 2015-16 to 2019-20. It can be observed that in all the periods, inland capture fish production was more compared to inland culture fish production. The capture fish production contributed 78.05 per cent to total inland fish production in Kerala in 2015-16. The share increased to 87.79 per cent by 2019-20.

CAGR values for the inland fish production for the past 16 years is computed for different districts and recorded in table 15. The table revealed that highest growth rate was obtained for Kottayam district with a CAGR of 17.92 which was found to be significant. Highest growth rate of Kottayam district was due to increased inland capture fish production in the district. Further, Malappuram with a CAGR of 13.40, followed by Wayanad (12.40) and Idukki (11.62). Alappuzha, holding the fifth position was having a CAGR of 10.40 and was found to be significant. The Palakkad district alone had negative growth rate with a CAGR value of -0.61 and was found to be insignificant with time. Parappurath *et al.* in 2020 in his study analysed the growth performance of inland fisheries in Kerala from 2012-13 to 2017-18 and mentioned that the decline in inland fish production in three major inland fish production districts of Palakkad, Ernakulam and Kollam was not known and the investigations should be further proceeded to find the reason for the same.

Table 15: CAGR for inland fish production in various districts of Kerala during 2004-05 to 2019-20

Sl. No.	District	CAGR (per cent)
1	Thiruvananthapuram	6.92
2	Kollam	0.53
3	Pathanamthitta	10.07
4	Alappuzha	10.40
5	Kottayam	17.92
6	Idukki	11.62
7	Ernakulam	2.06
8	Thrissur	7.94
9	Palakkad	-0.61
10	Malappuram	13.40
11	Kozhikode	1.96
12	Wayanad	12.40
13	Kannur	5.27
14	Kasargod (from 2007-08 to 2019-20)	1.43

Computed using the data obtained from the Directorate of Fisheries, Government of Kerala, 2020

4.3 ECONOMICS OF POND FISH PRODUCTION

In this session, the cost and returns associated with the pond fish production was analysed and details are presented.

4.3.1 Digging of Fish Pond in Kerala

The digging cost of the pond was the major component in the fixed cost. The pond preparation process was such that; once the location of the pond is confirmed, it will be dug and cleaned. After this, a tarpaulin is laid so that the pond is completely covered. High-quality tarpaulin with high Grams per Square Metre (GSM) is utilized for this purpose. Sand bags filled with soil were then placed above the tarpaulin sheet along the four sides of the pond to keep the tarpaulin intact. The sand bags were packed tightly so that sand inside do not drop out. Four sides of the pond were very well covered using the nets and given a frame. The frame was made of pipes or strong poles. The top portion was also well covered with the net so that the litter fall is controlled. A stiff net fixed in the side prevented the fishes from jumping off the pond. Lime and cow dung were added based on the needs. After cleaning, water is filled and the pH of water was tested. Fingerlings were then released into the pond and taken care of.

4.3.2 Investment involved in establishing the fish pond

The total investment required for establishing the fish pond in one acre was estimated to be Rs 35,18,705. The detailed investment pattern is shown in table 16. In the establishment cost, the major investment item was tarpaulin which cost Rs. 11,56,015 and accounted for 33 per cent of the total investment cost. Farmers used high-quality tarpaulin which overweighed the cost of digging of ponds which is contradictory to that of other states such as West Bengal, Karnataka and Tamil Nadu where they do not use tarpaulin to line the ponds (Kumar *et al.*, 2013). Farmers spent around Rs. 45,000 for tarpaulin (more than 250 GSM) for 2 cents pond area. Digging of pond also incurred a sizeable share in the total cost and it accounted for 31 per cent of total investment cost, followed by cost of net (14%), cost of frame and cost of motor (8% each). Other items such as frame, sand bags, input-output pipes, weighing balance, CCTV, utensils, etc. which were necessary for establishing of pond fish production unit shared the remaining 8 per cent of the total investment cost (Figure 4).

Table 16: Investment pattern for establishing fish pond (Rs/acre)

Sl. No.	Particulars	Fixed Cost (Rs.)
1	Digging of pond	10,89,266
2	Farm building	45,833
3	Frame	2,74,399
4	Sand bags	25,612
5	Net	4,99,173
6	Tarpaulin	11,56,015
7	Input Output Pipes	40,270
8	Motor pump	2,65,500
9	Weighing balance	5,987
10	Name Board	375
11	CCTV	32,000
12	Utensils	1,789
13	Fishing net	32,892
14	Miscellaneous	49,594
15	Total	35,18,705

Box plot for the fixed cost in Rs. /acre is shown in Figure 5. From the figure, it can be observed that most of the farmers were concentrated below the median value. Table 17 provides the mean, maximum value, minimum value and standard deviation of fixed cost. The mean value of fixed cost per acre was found to be Rs. 33,27,445 per acre ranging between Rs. 8,72,483 and Rs. 70,52,633.

Figure 5: Pie chart showing the per cent share of cost involved in the fixed cost.

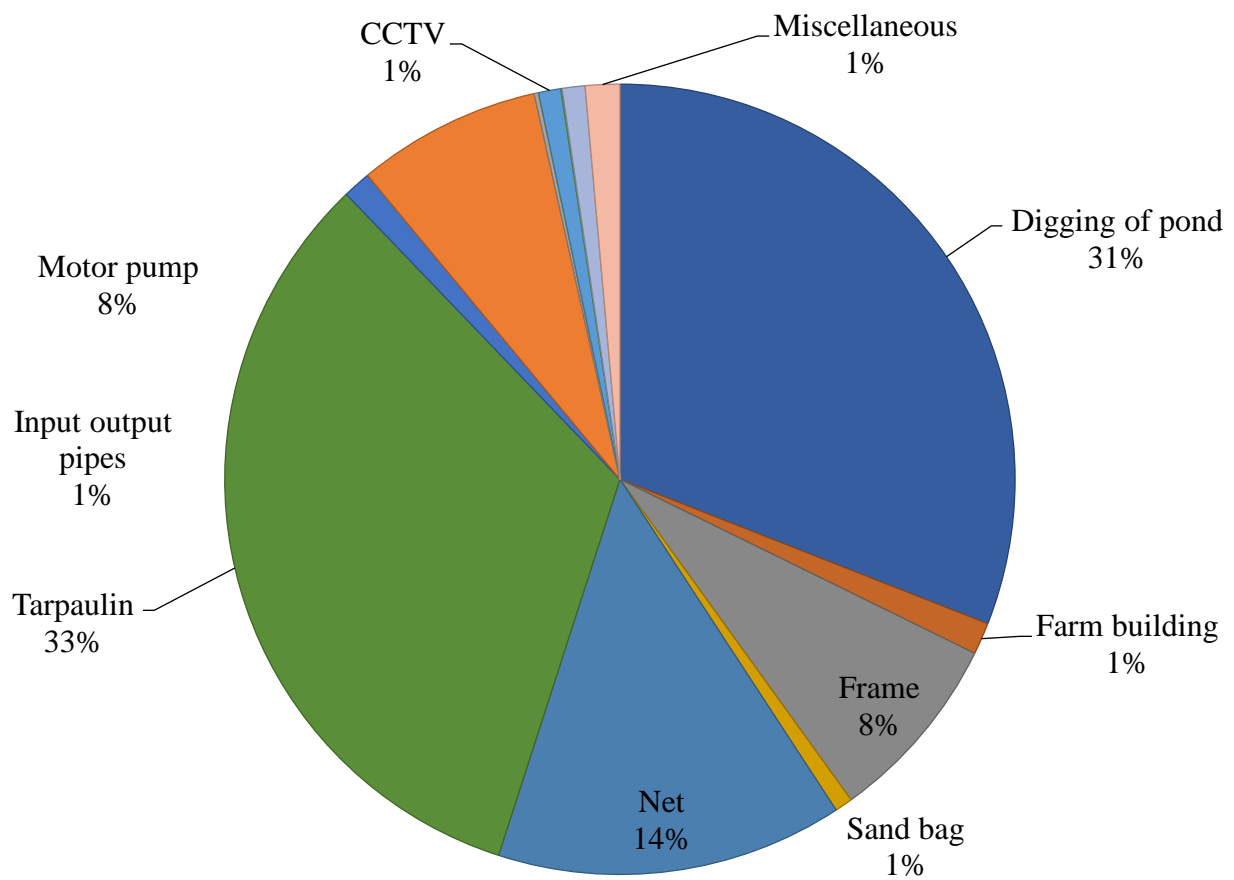


Figure 6: Box-plot showing fixed cost (Rs./acre)

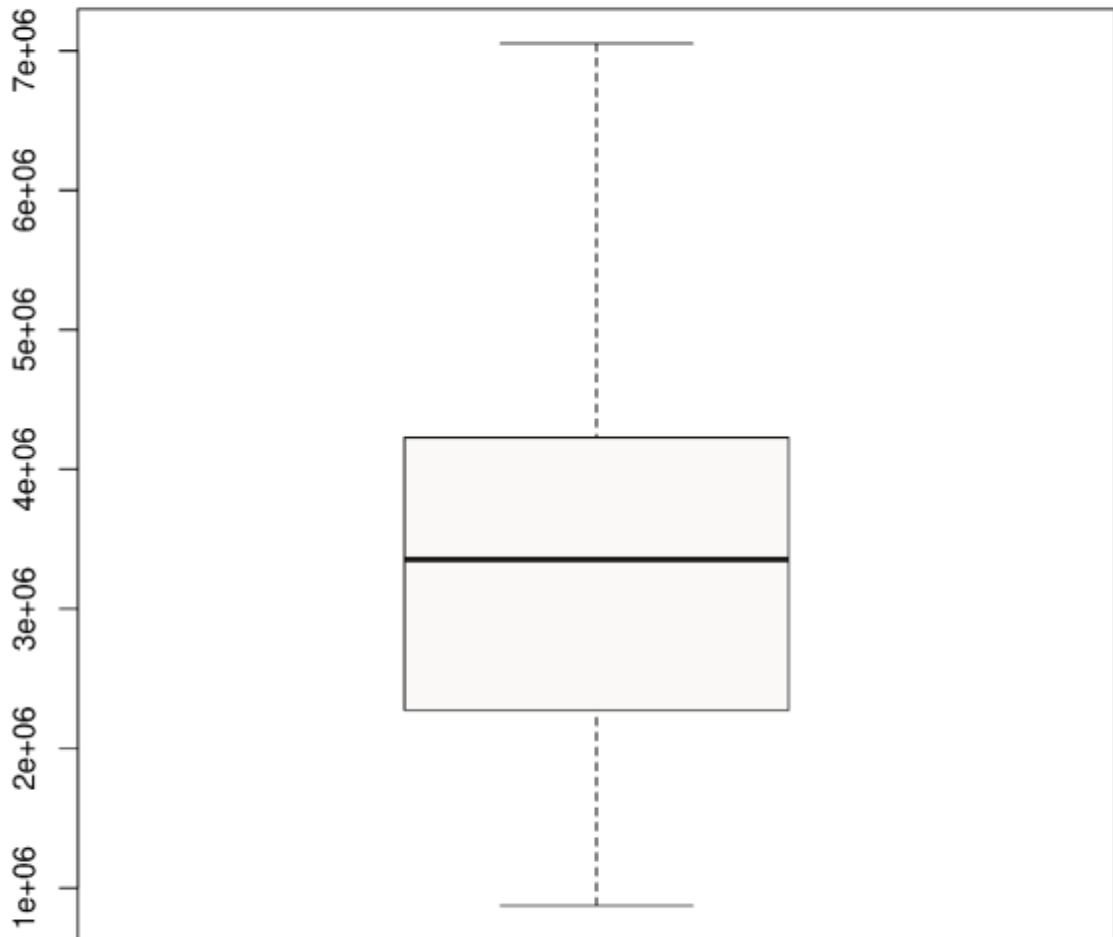


Table 17: Descriptive statistics for Fixed cost (Rs. /acre)

Variable	Mean	Standard deviation	Minimum value	Maximum value
Fixed cost (Rs.)	33,27,445	15,52,022	8,72,483	70,52,633

4.3.3 Costs and returns of pond fish production

The costs involved in pond fish production were presented in table 18. The total annual cost incurred by the farmers for rearing fish in the pond was Rs.16,85,631 per acre. The variable cost was Rs. 15,20,863 and it accounted for 90.20 per cent of the total cost, while the fixed cost was Rs. 1,64,768 and it accounted for 9.7 per cent of the total cost. Figure 6 shows the per cent share of variable costs incurred by various inputs. Among the operational cost, the cost of feed was the major item of expenditure which worked out to be Rs. 6,49,675 and accounted for 38.50 per cent of the total cost. Feed given to the fishes varied according to the stage of production. Initially, starter feed was given, which is more expensive when compared to the later feeds. The price ranged from Rs. 40-110 per kg with an average of Rs 75/kg. Farmers mainly used feeds such as Growfin (Growel feeds Pvt. Ltd) rated Rs 1800 per 40 kg sack and Spark (Godrej agrovet) rated Rs 1510 per 40 kg sack. Feed cost is followed by family labour cost which was Rs. 5,39,734 per acre and accounted for 32 per cent of the total cost. A study conducted by Ideba *et al.* (2013) in Nigeria also found that the amount spent on seed stock accounted for the major portion of the variable cost (32.27%), followed by amount spent on water (30.21 %), feed (16.51 %) and total labour (14.84 %). In this study, no amount was spent on water as every farmer had wells which supplied sufficient quantity of water.

Table 18: Cost of pond fish production (Rs/acre/yr)

Sl. No.	Particulars	Cost	Percentage
A	Variable cost		
1	Family labour cost	5,39,734	32.01
2	Material cost		
	a) Fingerling cost	1,07,785	6.39
	b) Manure cost	3,389	0.20
	c) Feed cost	6,49,675	38.54
	d) Lime	1703	0.10
	e) Solution kit	66,515	3.94
3	Maintenance	52,567	3.18
4	Interest on working capital (@7%)	99,496	5.90
	Sub total	15,20,863	90.22
B	Fixed cost		
1	Depreciation	1,49,789	8.88
2	Interest on fixed cost (@ 7 %)	14979	0.88
	Sub total	1,64,768	9.77
C	Grand total (cost of cultivation)	16,85,631	100.00

Apart from the labour used in initial digging of pond, labour was employed for repair and maintenance activities. If we analyse the labour utilization pattern, the involvement of family labour is very high, and the members were fully engaged in the activities like feeding of fish, checking the water quality, etc.

Figure 7: Per cent share of variable costs involved in pond fish production in Alappuzha

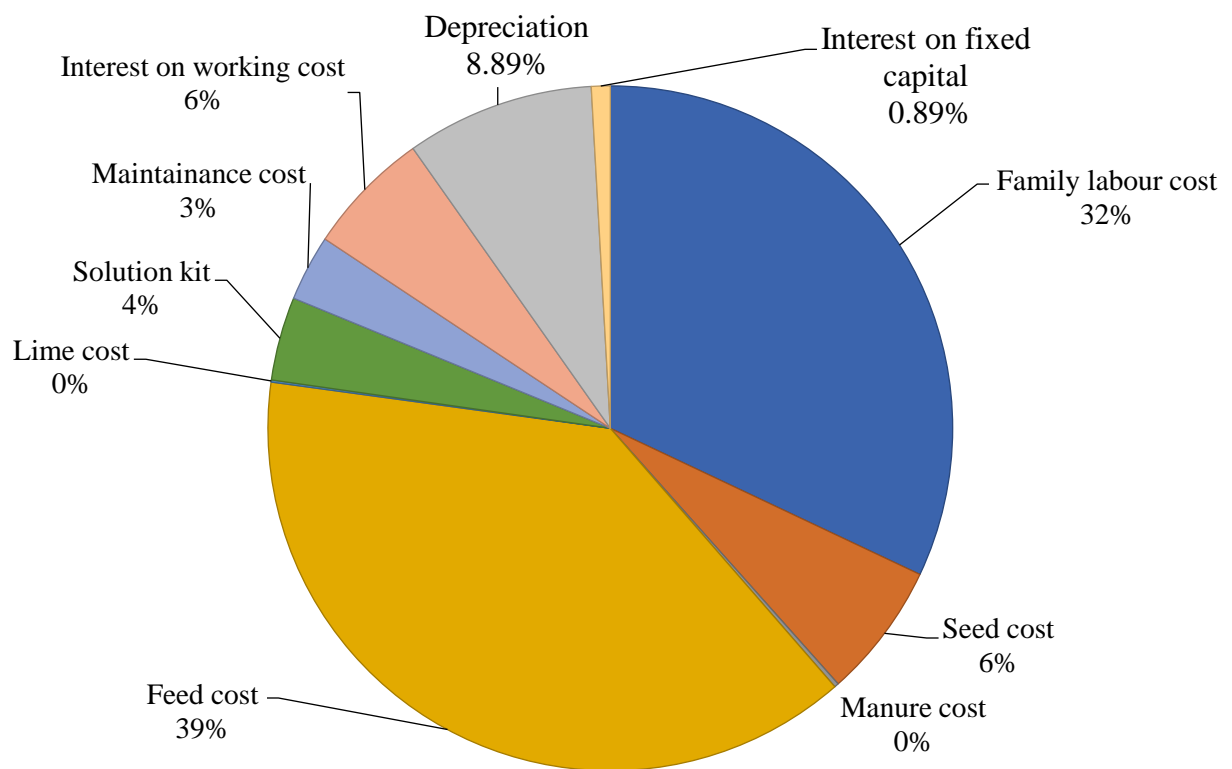


Table 19: Per cent share of family and hired in pond fish production

Sl. No.	Particulars	Number of labour (man days/acre)	Percentage
1	Family labour	603	83.75
2	Hired labour	117	16.25
	Total	720	100

When the total labour involved in pond fish farming was considered, it was observed that 83.75 per cent of total labour was contributed by the family members and the rest 16.25 per cent by the hired labourers. The split-up of the total labour is shown in table 19. Fingerling cost ranked next to labour cost. The fish seed or fingerling cost was Rs. 1,07,785 per acre and accounted for 6.39 per cent of the total cost. Farmers in Alappuzha mainly reared three fresh water fish species *viz.*, Anabus, Pangassius and Tilapia. All the three species, the fingerling cost was four rupees.

Farmers used solution kits to test the pH of the water and maintain it at 6.5-8.5 as optimum level. Liming has a large influence where the soil pH is above seven or total alkalinity is above 50 mg/L (Boyd, 1995). Agricultural limestone reacts quickly and increases the total alkalinity and overall hardness of the pond water (Julio *et al.*, 2004). Some farmers also used ammonia test kits to maintain ammonia level and maintain it at 0.02-.05 mg/L as optimum level. Maintenance charges and repairs accounted for Rs. 52,567 (3.18 per cent) per acre. The cost of cow dung manure and lime were the least and constituted only 0.3 per cent of the total cost. Cow dung was added to the pond water to enhance the phytoplankton growth that act as an additional feed for the fishes. Farmers did not use any kind of fertilizers in their ponds.

The interest on working capital was also included in the total variable cost and was Rs. 99,496, and it accounted for 5.90 per cent of the total variable cost. The total fixed cost was Rs. 1,64,770, and it constituted merely 9.77 per cent of the total cost. The major item in fixed cost was depreciation which was 8.80 per cent of the total cost.

The depreciation cost was worked out on capital expenditure such as farm house, motors, input-output pipes, frame, tarpaulin, etc., and is included under fixed cost. Among the fixed cost, the interest on fixed capital was 0.8 per cent of the total cost.

Returns from fish were estimated by multiplying average productivity with the market price that prevailed during the survey period. Table 20 shows the number of respondents involved in the cultivation of various fish species. Majority of farmers i.e. 36 out of 60 were cultivating Pangassius, Tilapia, and Anabus together. It was found that 14 farmers were engaged in the farming of Pangassius and Anabus only and 10 farmers were engaged in the farming of Pangassius and Tilapia only. The quantity of fish harvested and returns calculated from each fish species is summarized in table 21. It was found that from the total total quantity of 19,763.52 kg of fish produced per acre, the major contribution was from Pangassius. The quantity harvested of Pangassius species was 13,135 kg/acre. Harvest of Tilapia and Anabus were 4,210 and 2,417 kg per acre respectively. Pangassius attains its harvest size by 8 months whereas, Tilapia and Anabus by 6 months. Eventhough their maturity period is 6-8 months; fishes are harvested at different times between 6-12 months based on consumer demand. On an average, one cent pond has 500 fingerlings of Pangassius, 90 of Tilapia and 50 of Anabus fingerlings.

Total returns from fish production were estimated to be Rs. 35,84,446.40 per acre per year. Table 21 reveals that the returns from Pangassius, Tilapia and Anabus were Rs. 21,01,638.20, 8,42,064.20 and 6,40,764 per acre per year respectively. A study by Toma *et al.*, (2015) revealed that Tilapia fish production is profitable for marginal, small and medium farmers. He calculated the per hectare yield of Tilapia and found it to be 19,432 kg, 23,234 kg, 27,993 kg for marginal, small and medium farmers respectively.

Figure 8: Box-plot for yield(kg/acre) in the study area

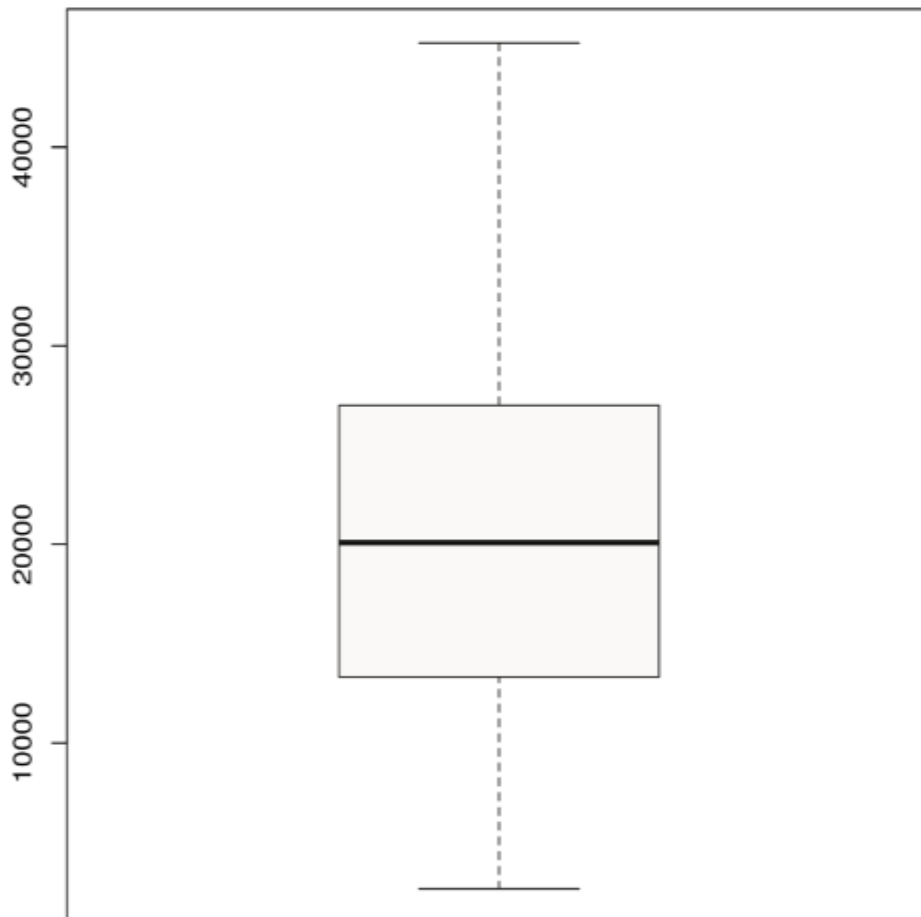


Table 20: Number of respondents involved in farming of various fish species

Sl. No.	Fish species	Number of respondents involved
1	Pangassius and Tilapia together	10
2	Pangassius and Anabus together	14
3	Pangassius, Tilapia and Anabus together	36

Table 21: Returns from different fish species

Sl. No.	Fish species	Quantity produced (kg/acre)	Unit price (Rs. /kg)	Total returns (Rs/acre)
1	Pangassius	13,135.23	160.00	21,01,638.20
2	Tilapia	4,210.32	200.00	8,42,064.20
3	Anabus	2417.97	265.00	6,40,764.00
	Total	19,763.52		35,84,446.40

Box plot for the yield obtained in the study area by the farmers is shown in figure 7. It can be observed from the figure that the farmers were concentrated almost equally above and below the median. Minimum value, maximum value, first quartile (Q1), third quartile (Q3) and median of all the three fish species can be seen in the figure. Table 22 gives the mean, standard deviation, median, Q1, Q3, minimum and maximum values of yield in kg/acre. It was revealed from the table that the mean value of yield was 19,776 kg/acre and median value is 20,077 kg/acre.

Table 22: Descriptive statistics for yield (kg /acre)

Variable	Mean	Standard Deviation	Minimum value	Q1	Median	Q3	Maximum value
Yield (kg/acre)	19,776.15	9,046.97	2,650	13,312.5	20,077	27,000	45,250

Cost of production for various fish species was calculated based on the total cost incurred in production and yield obtained from each fish species. Table 23 provides a synoptic picture of the cost of production involved in the production of various fish species with and without including family labour. It was inferred from the table that the cost of production for Pangassius was Rs. 145.80/kg. When the family labour charges were excluded, the cost reduced to Rs. 104.97/kg. Similarly, in the case of Tilapia, the cost of production was Rs. 202.34/kg and Rs. 145.68/kg (excluding the family labour charges). The cost of production for Anabus with and without adding family labour charges were Rs. 311.85 and Rs. 224.53 per kg, respectively. When the cost of production included the family labour expenses, the market price of Tilapia and Anabus was less than the cost of production, while it was more than the cost of production in case of Pangassius. When the cost of production excluded family labour expenses, the market price of all the three species of fish was more than their cost of production.

Table 23: Cost of production for various fish species

Sl. No.	Fish species	Cost of production (Rs. /kg)	Cost of production (Rs. /kg) (Excluding family labour)
1	Pangassius	145.80	104.97
2	Tilapia	202.34	145.68
3	Anabus	311.85	224.53

Kerala government provides subsidy for the farmers raising Pangassius fish in 2 cents of land area under Subiksha Keralam project. Only Pangassius species is subsidized under this project. As per the project, farmers can avail a subsidy amount of Rs 49,200 which is 40 per cent of the total cost involved in Pangassius farming as calculated by the Department of Fisheries. The details of the project are given in table 24. Out of the total amount of Rs. 49,200, major portion is contributed by the local self-government (Rs. 32800). Department of Fisheries provides an amount of Rs. 16,400. According to this study the average cost incurred for 2 cents of Pangassius farming was Rs. 1,24,500, whereas according to the study conducted by the Department of Fisheries, the cost was Rs. 1,23,000 per 2 cents.

Table 24: Details of Government scheme for providing subsidy to farmers raising Pangassius

Sl. No.	Particulars	
1	Name of the scheme	Homestead pond fish farming
2	Duration of scheme	1 year
3	Total cost estimated	Rs. 1,23,000/-
4	Contribution by local self-government	Rs. 32,800/-
5	Contribution by Department of Fisheries	Rs. 16,400/-
6	Contribution by the beneficiary/Loan	Rs. 73, 800/-
7	Scheme implementation	Department of Fisheries
8	Scheme supervision	Local self-government and Department of Fisheries
9	Expected yield	1 tonne
10	Fish species	Pangassius

4.3.4 Economic Feasibility of Fish Production

The discounted costs and returns were worked out for an acre for 2 years based on the data collected from the farmers. The discount rate selected was 12 per cent. The discounted cost was Rs. 57,88,669.41 and discounted returns was Rs. 63,05,076.36 with

net discounted returns of Rs. 5,16,406.95. The discounted benefit cost ratio was found to be 1.08. Since the value is more than one, it can be concluded that fish farming is economically feasible. It can be inferred that for every 1 rupee invested, the farmers obtained a return of Rs. 1.08. The benefit cost ratio on variable cost was found to be 2.13, which also showed that the pond fish farming to be an economically feasible project. The economic feasibility of the project is summarized in table 25. Magada *et al*, 2014 reported that the BC ratio of catla was 1.59, rohu 2.91, common carp 2.05 and grass carp 3.4 in a study based in Mandya district of Karnataka.

Results from the study of Dey *et al.* in 2005 suggested that both gross and net returns from monoculture of carnivorous species such as prawn, snakehead, and walking catfish were higher, but resource poor fish farmers in Asia may not be able to adopt the technologies such as cage and pen culture due to the high capital intensity. Polyculture of omnivorous and herbivorous species such as carp and Tilapia, and monoculture of these species appear more suitable for poor farmers in Asia.

Table 25: Economic feasibility of pond fish cultivation

Sl. No.	Particulars	Value
1	Discounted cost (Rs.)	57,88,669.41
2	Discounted benefit (Rs.)	63,05,076.36
3	Discounted benefit cost ratio	1.08
4	Benefit cost ratio on variable cost	2.13

4.4 ECONOMIC EFFICIENCY OF POND FISH PRODUCTION

The resources are scarce and farmers sometimes have limited access to these resources due to unstable fund availability. Thus, efficient utilization of resources is very important in any production process to obtain the optimum production. In this section, an attempt is made to analyse the productivity of various resources used in the fish production process. The study was done on per- acre basis.

4.4.1 Input Use Pattern in Pond Fish Production

It was observed that the various inputs used in the pond fish cultivation were fingerlings, labour, feed, lime, manure and solution kit. The details of inputs used per acre in pond fish production in Alappuzha were recorded during the survey and were reported in table 26. It was found that the farmers used 26,914 fingerlings on average for a one-acre pond. The fingerlings of fish were bought from various sources such as The office of the Department of Fisheries, private dealers and local farmers.

The fish species mainly reared by the farmers were Pangassius (*Pangassius bocourti*), Tilapia (*Oreochromis niloticus*) and Anabus (*Anabus testudineus*). Pangassius gained more weight at harvest than other fish species. Average weight of Pangassius, Tilapia and Anabus during harvest was 540.64, 350.07 and 258.33 gms respectively. The labour use pattern comprising both family and hired labour which accounted to 720-man days per acre per year. Family labour was engaged in feeding, harvesting and maintenance of ponds. Hired labour was employed for initial digging, repair and maintenance work, and harvesting. Hence, pond fish production is not only considered as a source of income, but also as a good employment generator. Feed included a definite proportion of rice bran, vitamins, minerals, micronutrients and feed probiotics, and it supplemented 40-45 per cent of the protein to the fish.

Table 26: Input use pattern in pond fish cultivation

Sl. No.	Particulars	Quantity used per acre	Average price (Rs. per kg or piece or man days)
1	Family labour (labour man days)	720	750
2	Quantity of feed (kg)	8,577	75
s3	Quantity of manure (kg)	480	6
4	Quantity of lime (kg)	284	6
5	Number of solution kits (No.)	400	165
6	Number of fingerlings (No.)	26,914	4

Farmers used an average of 8,577 kg of feed per acre of pond per year. Farmers did not use any fertilizers to rear the fish in the study area. Lime was used in negligible quantities, and it purifies the water and regulates the pH level of the pond water. During the preparation of the pond, farmers used 284 kg of lime per acre. Very few farmers used a considerable amount of lime in their ponds. Farmers also used a solution kit to check the pH and ammonia levels in the water. On average, 400 kits per year were used by the farmers for checking of water quality. Solution kits were used when there was a change in water quality or once in a month according to water status of the ponds. Cow dung was sometimes used in the pond for increasing the growth of phytoplankton which acts as food for fishes. Around 480 kg of cow dung was used per acre to stimulate their growth. Most of the farmers won't consider this factor and use a meager amount of manure.

4.4.2 Resource use efficiency of fish production

The Cobb Douglas production function was used to study resource use efficiency in fish production.

The independent variables used for the study were quantity of family labour, quantity of feed, quantity of manure, quantity of lime, number of solution kits, number of fingerlings and pond area. The mean, minimum value, maximum value and standard deviation of the variables that were used in the study of resource use efficiency calculation are shown in table 27. It was revealed from the table that the mean values of quantity of family labour, quantity of feed, quantity of manure, quantity of lime, number of solution kits, number of fingerlings and pond area were 18.18 man days, 494.72 kg, 16.94 kg, 14.45 kg, 15.76, 3085.42 and 6.72 cents, respectively. Production function analysis on table 28 showed that the coefficient of labour was positive and found to be significant at a one per cent level. The significant influence between labour used and net income showed the importance of labour in pond fish production. The low-cost component of labour in catfish farm enterprises suggests that farmers depended more on family labour which was not sustainable in the long term as family members settle outside the family households and eventually family labour will decline

(Oluwasola and Ele, 2015). The coefficient of feed and fingerlings were 0.17 and 0.57, respectively and found to be significant at a five per cent level, indicating that one per cent increase in the usage of these inputs would increase the yield by 0.17 and 0.57 per cent, respectively. While, the coefficient of lime was -0.10 and is found to be significant at a ten per cent level, indicating that one per cent increase in the usage of lime would decrease the yield by 0.10 per cent. It was mainly due to the improper usage of lime in the fish ponds. A similar result was obtained by Tunde in 2015, where the coefficient of lime was negative, and it showed the inverse relationship between the usage of lime and the yield of fish due to improper usage.

The coefficient of multiple determination (R^2) was found to be 0.90, and it depicted that 90 per cent variations in the pond fish yield were contributed by all the independent variables together in the model. The adjusted R^2 value was 0.88. The sum of co-efficient values was found to be 1.30, and it inferred that the pond fish farming showed an increasing returns to scale i.e., if all the resources in the fitted model increased by one per cent, output increased by about 1.3 per cent. In similar line Chandra *et al.* (2010) observed an increasing return to scale in flood plain fish culture. VIF values were found for the variables and they were less than 10. This confirmed the absence of serious multicollinearity between the variables.

Table 27: Descriptive statistics for various inputs and output

Sl. No.	Variable	Mean	Standard deviation	Minimum value	Maximum value
1	Yield (kg)	990.78	941.93	53.00	4190.00
2	Family labour (labour man days)	18.18	2.57	14.75	27.75
3	Quantity of feed (kg)	494.72	610.65	20.00	2800
4	Quantity of manure (kg)	16.94	23.43	2.00	167.00
5	Quantity of lime (kg)	14.45	38.39	2.00	300.00

6	Number of solution kits (No.)	15.76	10.43	6.00	60.00
7	Number of fingerlings (No.)	3085.42	3200.75	300.00	14500.00
8	Pond area (cents)	6.72	7.90	0.50	30.00

Table 28: Resource use efficiency of pond fish cultivation

Sl. No.	Variable	Co-efficient	p value	VIF
1	Intercept	2.17	0.00	
2	Family labour (labour man days)	0.50***	0.00	3.15
3	Quantity of feed (kg)	0.17**	0.038	5.86
4	Quantity of manure (kg)	0.004	0.90	1.21
5	Quantity of lime (kg)	-0.10*	0.10	1.59
6	Number of solution kits (No.)	0.02	0.88	2.94
7	Number of fingerlings (No.)	0.57**	0.04	7.21
8	Pond area (cents)	0.14	0.63	6.19
	R ²	0.90		
	Adjusted R ²	0.88		
	Σbi	1.304		

Note: * indicates significance at 10 %, ** indicates significance at 5% and *** indicates significance at 1%

4.4.3 Allocative efficiency of fish production

The allocative efficiency analysis has greater importance in ascertaining whether production at the farm level could be increased profitably to an optimum level by making reallocation of existing resource use patterns. The Cobb Douglas

production function was used to test the efficiency of different inputs used in the pond fish farming. The Marginal Value Product (MVP), Marginal Factor Cost (MFC) and profitability ratio (MVP/MFC) were calculated at the geometric mean level of various production inputs and output levels.

It was evident from table 29 that the MVP to MFC ratios for family labour, feed and fingerlings had values greater than unity, and it indicated the sub-optimal usage of these inputs in the pond fish production. The MVP/MFC ratios of labour, feed and fingerlings were 5.04, 1.28 and 37.09, respectively, indicating that each additional rupee spent on these inputs added ₹5.04, ₹1.28 and ₹37.09, respectively to the returns from the pond fish. Contradictory to the present findings, Agbamu and Fabusoro (2001) and Akanni and Adeokun (2004) opined that as family labour is a readily available pool of labour, it was over-utilised in farm operations. Inoni (2007), analysed the fish farming in the Delta State of Nigeria and observed that except size of pond, all other inputs were over- utilized in the pond fish farming.

Table 29: Allocative efficiency of inputs used in pond fish cultivation

Inputs	Parameter	Geometric mean	MVP	MFC	MVP/ MFC	Allocation
Family labour (labour man days)	0.50	18.51	3783.11	750	5.04	Under utilized
Feed (kg)	0.17	252.70	96.15	75	1.28	Under utilized
Lime (kg)	-0.10	8.49	-1683.22	6	-280.53	Overutilized
Fingerlings (No.)	0.57	1927.27	42.27	4	10.56	Underutilized
Yield (kg)		687.22				

4.5 MARKETING OF POND FISH

It is very important to find a market for the output that is being produced. Perishable items, which are of great concern, should be marketed soon after the harvest. Fish, being a highly perishable commodity care should be taken during transportation and its marketing stages. Farmers in the study area have taken good steps to market the produce on demand basis. For yielding maximum income, farmers should be aware of peak demand and high price periods. The selection of marketing channels depended upon the quantity of marketable surplus available with the farmers, withholding capacity of the farmer, prevailing market price, availability of infrastructure facilities, etc.

4.5.1 Marketing channels in the study area

Mostly harvested fishes were directly sold to the consumers in the study area. Very few farmers sold their produce through retailers. This was largely due to the price variation that prevailed in the markets. There were mainly two marketing channels in the study area. These were:

- 1) Channel I: Producer —→ Consumer
- 2) Channel II: Producer —→ Retailer—→ Consumer

The details of farmers' preferences towards various marketing channels are shown in table 30. It was observed that all the farmers mostly preferred channel-I as it gives them more share of consumer's money. In addition to channel-1, 28 per cent of the farmers marketed their harvest through channel II. It was observed that all the farmers were selling the harvested fish directly to the consumers near their homes. There was a large demand for pond fish, so consumers were readily available once the fish attained the harvest size. Farmers do not harvest unless the demand rises, and they would not harvest the whole produce at a stretch. The retailers in channel II are the vendors and other sellers who were involved in the local sale. Thus, the marketing is localized to the area where the fish is produced.

Table 30: Marketing channels for pond fish in the study area

Sl. No.	Marketing Channel	Number of respondents	Percentage to total respondents
1	Channel I (Producer → Consumer)	60	100
2	Channel II (Producer → Retailer → Consumer)	17	28
		n=60	

Price received for various fish species differed in the two channels and are summarized in table 31. It could be observed from the table that there was a large price variation between the producer's price received for the same species through channels I and II. Price also varies over time on the same marketing channel. In channel I, the average price of Pangassius, Tilapia and Anabus was Rs.178.33, 211.80 and 318.12 per kg, respectively. Similarly, in marketing channel II, the average price of Pangassius, Tilapia and Anabus was Rs.103.75, 132.50 and 210 per kg, respectively. This price difference discourages the producer from selling through channel II.

Table 31: Average producer price of pond fish in different marketing channels in the study area

Sl. No.	Type of fish	Average producer price in Channel I (Rs/kg)	Average producer price in Channel II (Rs/kg)
1	Pangassius	178.33	103.75
2	Tilapia	211.80	132.50
3	Anabus	318.12	210.00

Table 32: Average quantity of pond fish sold in different channels of marketing

Sl. No.	Marketing channel	Average quantity sold	Percentage
1	Channel I (Producer → Consumer)	13,885.84	70.26
2	Channel II (Producer → Retailer → Consumer)	5,877.67	29.74
	Total	19,763.52	100

Seventy per cent of the farmers marketed their produce through channel I as shown in table 32. Of the total 19,763.52 kg marketed, the average quantity marketed through Channel I was 13,885.84 kg. The remaining 5,877.67 kg was marketed through channel II.

Although most of the farmers preferred channel I for marketing, farmers are forced to market through channel II when adverse situations such as heavy rains and floods arise. Table 32 summarizes the average quantity of fish species marketed through various channels. It was found that 8,449 kg of Pangassius (60.84 %), 3,233 kg of Tilapia (23.28 %) and 2,203 kg of Anabus (15.86 %) were marketed through channel I. Out of the total 5877 kg marketed through channel II, 4,685.76 kg was Pangassius (79.72 %), 976 kg was Tilapia (16.62 %) and 214 kg was Anabus (3.65 %). Percentage contribution by each fish species is also depicted in table 33.

Table 33: Average quantity of fish species marketed through different marketing channels

Sl. No.	Marketing channel	Average quantity of fish sold (kg/acre)			Total (kg/acre)
		Pangassius	Tilapia	Anabus	
1	Marketing channel I	8,449.47 (60.84)	3,233.34 (23.28)	2,203.04 (15.86)	13,885.84 (100.00)
2	Marketing channel II	4,685.76 (79.72)	976.98 (16.62)	214.93 (3.65)	5,877.67 (100.00)
	Total	13,135.23 (66.46)	4,210.32 (21.30)	2,417.97 (12.23)	19,763.52 (100.00)

Note: Figures in parentheses denote percentage to grand total

4.6 CONSTRAINTS INVOLVED IN POND FISH PRODUCTION

There are a lot of constraints that have to be overcome in any production activity. The limitations can be observed during the pre-production stages, production stages, and also during the marketing stages. Similarly, pond fish farmers are facing many constraints in fish production. The limitations faced by the farmers are summarized in table 34 and 35.

4.6.1 Production constraints

Various constraints were listed based on the farmer's response in the preliminary survey. Among 15 constraints listed from a detailed examination of the production process, the most relevant six constraints were ranked using Garrett's ranking technique. The analysis showed that the most severe constraint faced by the farmer was the high cost of feed which had a Garrett score of 76.66. Inadequate supply of quality

fingerlings was the second most important constraint with Garrett's score of 60. Most of the farmers in the study area opined that there was 25 per cent mortality with the fingerlings purchased. Apart from this, lack of timely support from the government (Garret's score 47.5), intermittent and heavy rainfall (Garret's score 45.66), lack of technical knowledge (Garret's score 37.45) and incidence of diseases (Garret's score 32.13) were the constraints faced by the farmers. The Garrett's score and ranks of each production constraint are summarized in table 34. Vignesh *et al.* (2017) found out that the inadequate availability of quality fingerlings was the main constraint among the 14 constraints affecting freshwater aquaculture in Thanjavur District of Tamil Nadu, followed by shortage of water, excessive price of supplementary feed, high price of electricity, non-availability of professional labour, incidence of disease outbreak, etc.

Table 34: Production constraints faced by the farmers in the study area

Sl. No.	Production constraints	Garrett's Score	Rank
1	High cost of feed	76.76	1
2	Inadequate supply of fingerlings and its quality	60.00	2
3	Lack of timely support from government	47.05	3
4	Intermittent and heavy rainfall	45.66	4
5	Lack of technical knowledge	37.45	5
6	Incidence of diseases	32.13	6

Jayasankar (2018) also opined that the availability of right quality fingerlings and feed availability were the prominent constraints of freshwater aquaculture improvement in India. In addition to these constraints, Uddin *et al* (2021) also pointed out that farmers are deprived of adequate farm information and have low access to extension services in the some of the Tilapia farms in Bangladesh.

4.6.2 Marketing constraints

Marketing constraints are those constraints observed during the marketing activity. Among the six listed constraints, two were found to be most relevant in the study area. The important marketing constraints are given in table 35, along with its Garrett's score and their respective ranks.

The study showed that price fluctuation was the major constraint among the farmers with Garrett's score of 63. There was a large price difference noticed between the two marketing channels and also within the marketing channel. This was mainly because of the perishable nature and the variation in demand and supply of fish in the market. Lack of demand for Pangassius fish was found to be the second most important constraint. The availability of poor quality (inferior taste) Pangassius fish at a cheaper rate in the market adversely affected the demand for Pangassius cultivated by the farmers with good quality feeds. Although domestic fish marketing plays an important role, it is still highly unorganized and unregulated (Kumar *et al.*, 2008). In a similar line (Pongener and Sharma (2018) found that low marketable surplus and price uncertainty were the prime constraints faced by the fishery enterprise in Nagaland. Nisar *et al.*, 2018 also studied the constraints involved in the marketing of exotic carps by wholesale fish dealers in Jammu and Kashmir and reported that lack of specific market, lack of cold storage facility, non-availability of ice, high transportation cost, low demand for fish in the market, low availability of local species, etc. were the important constraints faced by the fish dealers. Shakti and Vahoniya (2016) studied the inland fish marketing in Gujarat and found that major constraint for the wholesaler was the perishability of fish followed by huge competition in the market.

Table 35: Marketing constraints in the study area

Sl. No.	Marketing constraints	Garrett's score	Rank
1	Price fluctuation	63.00	1
2	Less demand for Pangassius	36.00	2



Plate 1: Fish pond lined with tarpaulin and covered by net



Plate 2: Fish pond installed with inlet and outlet pipes



Plate 3: Pond with filters for filtering water



Plate 4: Fish feed and Fish feed sack



Plate 5: Pangassius fish species cultivated by farmers



Plate 6: Tilapia fish species cultivated by farmers



Plate 7: Solution for water quality check



Plate 8: Anabus fish species cultivated by farmers

Summary

5. SUMMARY

The present study entitled “Capture production and economic performance of inland fisheries in Kerala” was carried out in the Department of Agricultural Economics, College of Agriculture, Vellayani during the period 2019-21 to study the trend in the production of inland fish and to study the economics of pond fish production in Alappuzha district. The socio-economic characteristics of farmers were also studied during the time period. An attempt was also made to identify the marketing channels and to analyse the constraints faced by the farmers in pond fish production.

It was observed from the socio-economic analysis that 50 per cent of the farmers who have taken up fish production are in the age group of more than 50 years. Least participation was found in the younger generation under 30 years of age. Lack of interest of the youth towards the pond fish farming sector and high initial investment cost deprived the young generation from inland fish farming and related activities. Gender-based classification showed that the majority of the farmers who undertook production activity were males. It was also observed that 95 per cent of the pond fish farmers had education above the secondary level and, educated farmers were managing their field in a better way compared to that of others. Of the total farmers, only 27 per cent of the farmers primarily practised pond fish farming and considered it as their major source of income. The majority of the farmers took inland fish farming as their secondary occupation as it has a lot of risks such as loss of produce due to disease, heavy rainfall, etc.

The majority of the sample farmers were from nuclear families, so family participation in pond fish farming activities was much lower when compared to that by joint families. Land holding survey of the sample farmers revealed that 55 per cent of the farmers had less than one acre of land and 28 per cent of farmers had 1-2 acres of land. It was found that farmers with a large land area did not have a proportional pond area. Sample farmers had 2-4 years of experience, with a mean value of 2.4 years, which shows that farmers had only limited experience in pond fish farming.

There was a steady increase in the inland fish production during 2000-01 to 2019-20 in India attaining a Compound Annual Growth Rate (CAGR) of 4.89 per cent.

The CAGR of total fish production and marine fish production during 2000-01 to 2019-20 was 4.90 and 1.80 per cent, respectively, and was found to be significant at one per cent level. The total fish production in India jumped from 56.56 lakh tonnes in 2000-01 to 141.64 lakh tonnes by 2019-20. In Kerala, except for a few years, a gradual increase in the production of inland fish was noticed during the study period, and production has increased from 85,234 tonnes in 2000-01 to 2,05,430 tonnes in 2019-20 attaining a CAGR of 6.74 per cent. Among various districts, Kottayam district has been found to have the highest inland fish production in 2019-20, followed by Alappuzha and Ernakulam district. The TE 2019-20 values for inland fish production among various districts showed that Kottayam had the highest average value of 45,669.67 tonnes followed by Alappuzha (44,514 tonnes), Ernakulam (26,670 tonnes) and Thrissur (22,371.33 tonnes). Palakkad district had a negative CAGR value of -0.61 and was found to be insignificant. The reasons for the decrease in inland fish production in major fish producing districts may be considered as an area of future line of research.

Analysis of the economics of inland pond fish farming revealed that the total investment required for establishing the fish pond in one acre was estimated to be Rs 35,18,705. In the establishment cost, the major investment item was the cost of tarpaulin which accounted for 33 per cent of the total investment cost. The total yearly cost incurred by the farmers for rearing fish in the pond Rs.16,85,631 per acre. In the operational cost, the cost of feed was the major item of expenditure, and it accounted for 38.50 per cent of the total cost. While analysing the labour utilisation pattern, it was observed that 83.75 per cent of total labour was contributed by the family members and the rest 16.25 per cent by the hired labourers. Farmers mainly reared three fish species *viz.*, Pangassius, Tilapia and Anabus. Of the total 19,763.52 kg of fish produced per acre, the major portion of the contribution was from Pangassius. The quantity of fish harvested from Pangassius species was 13,135 kg/acre. Harvest from Tilapia and Anabus were 4210 and 2417 kg per acre, respectively. Total returns from fish production were estimated to be Rs. 35,84,446.40 per acre.

The production cost of Anabus was found to be higher than that of Tilapia and Pangassius. The discounted costs and returns were worked out for an acre for 2 years

and found that discounted cost was Rs. 57,88,669.41 and discounted returns was Rs. 63,05,076.36 with net discounted returns of Rs.5,16,406.95. The discounted benefit-cost ratio was found to be 1.08. Since the value is more than one, it can be concluded that fish farming is economically feasible. The benefit-cost ratio on variable cost was found to be 2.13, which showed that pond fish farming is an economically feasible project.

The economic efficiency of the pond fish farming was studied using the Cobb Douglas production function and observed that the factors such as labour, feed and fingerling were significantly and positively influenced the yield of fish. Lime has negatively affected the yield of fish mainly due to the improper usage of lime in the fish ponds. The coefficient of multiple determination (R^2) was found to be 0.90, and the adjusted R^2 value was 0.88. The sum of co-efficient values was found to be 1.30, and it inferred that the pond fish farming showed an increasing returns to scale. The MVP to MFC ratios for labour, feed and fingerling had values greater than unity, and it indicated the sub-optimal usage of these inputs in pond fish production.

Mostly harvested fishes were are directly sold to the consumers. Very few farmers sold their produce through retail traders. There were only 2 marketing channels in the study area *viz.*, channel-I (Producer \longrightarrow Consumer) and channel II (Producer \longrightarrow Retailer \longrightarrow Consumer) and almost 70 per cent of the farmers marketed their produce through channel I. Of the total 19,763.52 kg marketed, the average quantity marketed through Channel I was 13,885.84 kg. The remaining 5,877.67 kg was marketed through channel II. It was also observed that 8,449 kg of *Pangassius*, 3,233 kg of *Tilapia* and 2,203 kg of *Anabus* were marketed through channel I.

Analysis of constraints in the study area showed that the most severe constraint in pond fish production faced by the farmer was the high cost of feed which had a Garrett score of 76.66. Inadequate supply of quality fingerlings was the second most important constraint, followed by lack of timely support from the government, intermittent and heavy rainfall, lack of technical knowledge and incidence of diseases, etc. The study on the marketing constraints showed that price fluctuation was the major

constraint among the farmers with Garrett's score of 63. Lack of demand for *Pangassius* fish was the second most important marketing constraint faced by the farmers in the study area.

In the light of analysis made from the study, it was observed that if the government provides adequate incentives for feed to all inland fish farmers, it may attract more young people to inland fish farming. In addition, the initial construction costs also deprived the youth from entering the business. If the government increases the subsidy amount, more farmers will enter the arena, and existing farmers may choose to extend their ponds, and thereby inland fish production can be increased in that area. Further, if the farmers are provided timely advice regarding the optimum usage of inputs, it may help the farmers to earn more profit from fish farming. If the fisheries department takes the initiative to collect fish from the farmers and give them a profitable price, the farmers will be able to harvest twice and it will increase the profit margin. The major issue of inadequate supply of quality fingerlings can be tackled to a certain extent by initiating timely action to supply quality fingerlings from various sources. The government may obtain quality fingerlings from large fish farmers in and around the Alappuzha district. Furthermore, the government may promote fish hatcheries in the district so that it can supply quality fingerlings to the fish farmers. The government may also ensure that the fingerlings distributed are healthy and can survive in the farmers' pond conditions. Unlike agricultural products, the state government has not yet provided any insurance coverage for fish. Certain private companies such as New India Assurance and Oriental Insurance companies provide insurance for inland fishes. Steps may be taken by the concerned authorities to provide insurance schemes so that farmers can insure the fishes as the producers are facing huge losses due to several factors like diseases and adverse climatic conditions. Despite all these constraints, the study observed that pond fish farming was an economically feasible project. Policy suggestions cited based on the present study may help to improve the pond fish farming even better with improved production and better profits.

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Appendices

*01-Primary,02-Secondary, 03-Pre-degree/HSC, 04-Diploma, 05-Graduate, 06-Post Graduate

**1-Fishery with agriculture, 2-Public sector, 3-Private sector, 4-Self employed

2. INVENTORY OF RESOURCES: LAND

Sl. No.	PARTICULARS	
1.	Total owned area (ha)	
2	Leased in land (ha)	
3	Leased out land (ha)	
4	Total land (ha)	
5.	Net farming area (ha)	
6.	Area under pond (cent)	
7.	Value of owned land (Rs)	
8.	Land revenue (Rs)	
9.	Miscellaneous	

3. ASSET POSITION

Sl. No	Particulars	Quantity (No.)/ area (cents)	Value (₹)	Year of construction/ purchased	Present value (₹)	Subsidy (₹)	Main tenance cost (Rs)
1	Farm Building						
2	Main pond						
3	Nursery pond						
4	Brood stock pond						
5	Bio-floc tank						

6	Nets – Bird cover net						
	Stiff side fencing net						
7	Tarpaulin						
8	Sacks						
9	PVC pipes						
10	Rope						
11	Frame						
12	Pump set: electric						
	diesel						
	solar						
13	Boat						
14	Aerator						
15	Solution kit						
16	Electrification and fuel						
17	Name board						
18	CCTV						
19	Generator/invertor						
20	Utensils						
21	Others						

4. Fishes

Sl. No.	Type of fish	Feeder (Top/middle/bottom)	Reason for Selection	Time period for harvesting	Total Number	Weight during harvest (kg)
1						
2						
3						
4						
5						

5. Fish Farming Details

Sl. No.	Particulars		
1.	Total area under pond (ha)		
2.	Purpose of farming		
3.	Variety		
4.	Lime (Kg/ha)		
5.	Dolomite (Kg/ha)		
6.	Cow dung (manure) (Kg/ha)		
7.	Fertilizers (Kg/ha)		
8.	Fingerlings Source:		
9.	Feed (Kg/ha)		
10.	Medicines		

11.	Probiotic		
12.	Hormones		
13.	Miscellaneous		
14.	Harvest season		
15.	No. of harvests per year		
16.	Wt (g)/fish		
17.	Total harvest (Kg)		
18.	Price (Rs/kg)		

7. Water Source

a. Quantity of water required/ Pumping: -

b. No. of pumpings required/ season: -

Sl. No.	Source	Yes/No
	Canal	
	Tanks/ Ponds	
	Wells/ Bore wells	
	Pump set: - Electric Diesel Solar	

Probiotic															
Medicines															
a.															
b.															
Hormones															
Chemical application															
Contingency															
Miscellaneous															
Total															

9. Production constraints

Sl. No.	Constraints/ Problems	Rank
1	Non availability of labourers when needed	
2	Incidence of diseases	
3	High wage rate	
4	High cost of input	
5	Intermittent rainfall	
6	Low productivity	
7	Animal and bird attack	
8	Lack of adequate finance	
9	Lack of timely support from the government	
10	Lack of technical knowledge	
11	Lack of power supply	
12	Non availability of medicines	
13	Inadequate supply of fingerlings	
14	Lack of infrastructure supply scheme from the government	
15	Difficulty in breeding	

Marketing schedule

Marketed products:

- Fish (yes/no)
- Fingerlings (yes/no)

1. Details of marketing of fish

Sl. No.	Type of fish	Year	Total quantity produced (Kg)	Quantity retained for family consumption (Kg)	Quantity retained for other purpose (Kg)	Total marketed quantity (Kg)	Price (Rs/kg)	Total returns
1		1 st yr						
		2 nd yr						
		3 rd yr						
2		1 st yr						
		2 nd yr						
		3 rd yr						
3		1 st yr						
		2 nd yr						
		3 rd yr						

- a. Name of the nearest primary market:
- b. Distance (km)
- c. Name of the nearest wholesale or secondary market:
- d. Distance (km):

2. Details of marketing of fingerlings

Sl. No.	Fingerling variety	Year	Quantity supplied (Kg)	Price (Rs/fingerling)	Total returns (Rs)
1		1 st yr			
		2 nd yr			
		3 rd yr			
2		1 st yr			
		2 nd yr			
		3 rd yr			
3		1 st yr			
		2 nd yr			
		3 rd yr			

3. Method of sale:

Sl. No	Method of sale	Quantity (Kg)	Price (Rs/kg)	Total cost (Kg)
1	Village fishermen			
2	Commission agent			
3	Primary/ retail market			
4	Secondary/wholesale			
5	Direct sale to consumers			
6	Government			
7	Other			

4. Cost incurred in marketing per kg of fish

Sl. No.	Particulars	Cost (Rs /kg)
1	Loading charge	
2	Cleaning	
3	Storage	
4	Packaging	
5	Rent	
6	Transport cost	
7	Sales tax	
8	Unloading charges	
9	Miscellaneous	

10	Profit margin	
----	---------------	--

5. Are you aware of price prevailing for fish in local and international markets? Per kg price

a. Source of such information?

b. Price received per unit:

c. Mode of payment:

6. Do you know the consumer price for 1 kg fish?

7. Are you member of any producer organization / Cooperative?

8. Any contractual agreement of selling of the produce?

a. If yes, since which year?

b. How the price is determined?

c. Is there any incentive/bonus?

9. Suggestions for improvement of fish farming

10. What support do you expect from the institutions to withstand price volatility?

11. Marketing constraints

Sl. No.	Constraints/ Problems	Rank
1	Price fluctuation	
2	Exploitation by middle men	
3	Inadequate storage facilities	
4	Inadequate transportation facility	
5	Lack of market information	
6	Lack of demand	
7	Delayed payments	
8	Due to covid-19 pandemic	

APPENDIX II**GARRETT RANKING CONVERSION TABLE****The conversion of orders of merits into units of amount of “soces”**

Percent	Score	Percent	Score	Percent	Score
0.09	99	22.32	65	83.31	31
0.20	98	23.88	64	84.56	30
0.32	97	25.48	63	85.75	29
0.45	96	27.15	62	86.89	28
0.61	95	28.86	61	87.96	27
0.78	94	30.61	60	88.97	26
0.97	93	32.42	59	89.94	25
1.18	92	34.25	58	90.83	24
1.42	91	36.15	57	91.67	23
1.68	90	38.06	56	92.45	22
1.96	89	40.01	55	93.19	21
2.28	88	41.97	54	93.86	20
2.69	87	43.97	53	94.49	19
3.01	86	45.97	52	95.08	18
3.43	85	47.98	51	95.62	17
3.89	84	50.00	50	96.11	16
4.38	83	52.02	49	96.57	15
4.92	82	54.03	48	96.99	14
5.51	81	56.03	47	97.37	13
6.14	80	58.03	46	97.72	12
6.81	79	59.99	45	98.04	11
7.55	78	61.94	44	98.32	10
8.33	77	63.85	43	98.58	9
9.17	76	65.75	42	98.82	8
10.06	75	67.48	41	99.03	7
11.03	74	69.39	40	99.22	6
12.04	73	71.14	39	99.39	5
13.11	72	72.85	38	99.55	4
14.25	71	74.52	37	99.68	3
15.44	70	76.12	36	99.80	2
16.69	69	77.68	35	99.91	1
18.01	68	79.17	34	100.00	0
19.39	67	80.61	33		
20.93	66	81.99	32		

**CAPTURE PRODUCTION AND ECONOMIC PERFORMANCE
OF INLAND FISHERIES IN KERALA**

by

MEERA RAJ R R

(Admn. No. 2019 - 11 - 170)

Abstract of the thesis

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Kerala Agricultural University**



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ABSTRACT

The present study entitled “Capture production and economic performance of inland fisheries in Kerala” was carried out in the Department of Agricultural Economics, College of Agriculture, Vellayani during the period 2019-21 to study the trend in production of inland fish and to study the economics of pond fish production in Alappuzha district. The socio-economic characteristics of farmers were also studied during the time period. An attempt was also made to identify the marketing channels and to analyse the constraints faced by the farmers in pond fish production.

The study was mainly done in Kerala using secondary data collected from the Directorate of Fisheries, Vikas bhavan, Thiruvananthapuram, Kerala and annual reports of the Department of Fisheries, Government of India, while the primary data was collected from Alappuzha district as the district secured a major position in inland fish production during 2019-20. Alappuzha had 4 fisheries units, out of which Mannar unit witnessed higher inland pond fish production. Ten grama panchayats from Mannar unit were selected for study which included Puliyoor, Budanoor, Purakkad, Thekkekara, Ala, Venmony, Mannar, Thiruvandoor, Mulakuzha and Palamel due to greater number of pond fish farmers in these grama panchayats. From each of the grama panchayats, 6 farmers were selected at random for the purpose of study.

The socio-economic characteristics of the farmers were studied based on age, gender, education, occupation, family size, land holding size, experience in inland pond fish production and pond area. The analysis showed that 50 per cent of the farmers who undertook fish production belonged to the category of old age with more than 50 yrs. Least participation was found to be from the young generation within 30 yrs of age. Majority of the farmers undertaking pond fish farming were males and this constituted about 67 per cent. Females constituted only 33 per cent but they took part in the day-to-day activities involved such as feeding fishes, pond maintenance etc in the ponds. The analysis of educational status of the farmers revealed that 33 per cent of them had pre-degree/Higher Secondary level. None of them were found to be illiterate and a good chunk of them ie. 30 per cent were graduates. In the surveyed area, 27 per cent of the farmers primarily practised pond fish farming and considered it as a primary source of

income. The survey revealed that 80 per cent of the farmers belonged to nuclear families whereas 12 farmers from a total of 60 were part of joint families. Ninety per cent of the farmers had less than 20 cents of pond area, and 10 per cent had more than 20 cents and each pond was managed by a group of 2 or three farmers so as to reduce the burden of more financial investment.

Total land holding survey of the sample farmers revealed that 55 per cent of the farmers owned less than 1 acre whereas 28 per cent owned between 1-2 acres and the rest owned more than 2 acres. Sample respondents had experience of 2-4 yrs of pond fish farming with a mean value of 2.4 yrs.

The data obtained for 20 yrs from 2000-01 to 2019-20 of India when analysed, it was observed that there was a steady increase in the inland fish production attaining a Compound Annual Growth Rate (CAGR) of 6.85 per cent. When the data pertaining to inland fish production in Kerala was analyzed for 20 yrs from 2000-01 to 2019-20, it was revealed that CAGR was 6.74 per cent showing an increasing trend over the years. CAGR obtained for Alappuzha district from 2004-05 to 2019-20 was 10.40 per cent and was found that Alappuzha showed increasing inland production over the time period compared to other districts in Kerala. Kottayam showed highest CAGR with 17.92 per cent and Palakkad is lowest with -0.61 per cent.

The economics of pond fish cultivation when studied, it was observed that the initial investment accounts to a total amount of Rs. 35,18,705 per acre; 33 percent was contributed by the purchase of tarpaulin followed by pond construction (31 per cent). Rest of the cost were involved for farm building construction, frame, input-output pipes, CCTV, weighing balance etc. The variable cost involved in the pond fish production amounted to Rs. 16,85,631 per acre. Feed cost contributed to 39 per cent of the total variable cost followed by labour cost which was 32 per cent. Other variable cost contributing factors included seed, manure, lime, solution kit, maintenance, depreciation, interest on working capital and fixed capital. Family labour contributed to 80 per cent of total labour requirement. Average returns when calculated accounted to 19,763.52 kg from three fish species cultivated namely Pangassius, Tilapia and Anabus. The cost of production of Pangassius, Tilapia and Anabus was worked out to be Rs.145.80, 202.34 and 311.85 respectively. The total returns obtained was Rs.

35,84,446.40 per acre attaining a discounted benefit cost ratio of 1.08 and variable cost benefit cost ratio of 2.13 which showed that pond fish production is economically feasible.

The resource use efficiency of pond fish production revealed that labour, seed and feed were significantly contributing to the yield with an R^2 value of 0.90. Usage of lime was found negatively affecting the yield. It was found that other than solution kit, all resources were underutilized in the production process.

There were two marketing channels in the marketing of inland fish in the study area of which 80 per cent of the produce was marketed through channel 1 ie. through producer – consumer and the rest through producer-retailer-consumer. High cost of feed and inadequate supply of quality fingerlings were the major constraints found in the production side whereas price fluctuation and less demand for *Pangassius* were found to be the important constraints in the marketing side of inland fish production.

The study observed that pond fish farming was an economically feasible project. In the light of analysis made from the study, it was observed that if the government provides adequate incentives for feed to all inland fish farmers, it may attract more young people to inland fish farming. Furthermore, the government may promote fish hatcheries in the district so that it can supply quality fingerlings to the fish farmers. Steps may be taken by the concerned authorities to provide insurance schemes so that farmers can insure the fishes as the producers are facing huge losses due to several factors like diseases and adverse climatic conditions.