EFFECT OF SALINITY ON PADDY PRODUCTION IN ALAPPUZHA DISTRICT OF KERALA- AN ECONOMIC ANALYSIS

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KERALA, INDIA

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by

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KERALA, INDIA

2020

DECLARATION

I, hereby declare that this thesis entitled "**EFFECT OF SALINITY ON PADDY PRODUCTION IN ALAPPUZHA DISTRICT OF KERALA- AN ECONOMIC ANALYSIS**" 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.

Place: Vellayani

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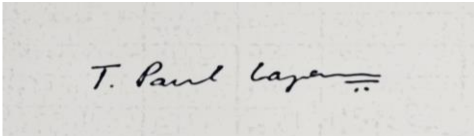

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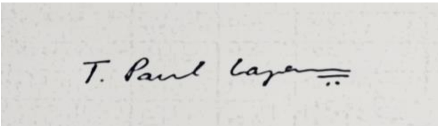

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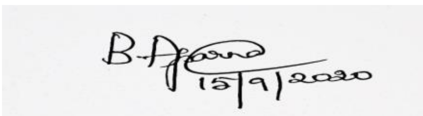

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"Dedicated to the farming community in Haripad,
who work in hectares not in hours"

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(Nithin Raj K)

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LIST OF ABBREVIATIONS

BCR	Benefit Cost Ratio
et al	Co worker
GOI	Government of India
GOK	Government of Kerala
HSC	Higher Secondary
HYV	High Yielding Variety
KAU	Kerala Agricultural University
KWS	Kuttanad Wetland System
MFC	Marginal Factor Cost
MOP	Muriate of Potash
MPP	Marginal Physical Product
MSL	Mean Sea Level
MSSRF	M.S. Swaminathan Research Foundation
MVP	Marginal Value Product
NRCS	Natural Resources Conservation Service
OLS	Ordinary Least Square
PLDA	Pokkali Land Development Agency
R^2	Coefficient of Multiple Determination
RARS	Regional Agricultural Research Station
VIF	Variable Inflation Factor

LIST OF SYMBOLS

^{0}C	Degree Celsius
ha^{-1}	Per hectare
t^{-1}	Per Tonnes
%	Per cent
₹	Rupees
<	Less than
>	Greater than
≤	Lesser than or equal to
dS	deci Siemen
ha	Hectare
kg	Kilogram
km	Kilometre
km^2	Square kilometre
mm	Millimetre
MT	Million tonnes
t	Tonnes

Introduction

CHAPTER I
INTRODUCTION

Globally, rice is the foremost and principal food crop among cereals, grown in most of the countries and feeds more than four billion people primarily in Asia**.** The refrain "Rice is love, rice is life" is apt for India since it is the most commonly consumed grain crop and it also adds to the food security of the nation. Of the total rice production in the world, India accounts for 21 per cent thus, adding largely to the global food security. Hence, enhancing rice productivity is a primary concern to the representatives and other stakeholders in the progress of agriculture sector. Among the income generating activities in India, food grain production is the most important one and provides employment to a larger section of the society.

Rice is grown in two major seasons *viz.,* Kharif and Rabi in which Kharif accounts for 90 percent of total rice area, 87 percent of total rice production and rabi accounts for 10 percent area and 13 percent production (Samal *et al.*, 2018) in India. The estimated demand for rice will be 113.3 million tonnes and 137.3 million tonnes respectively, by the year 2022 and 2050 (Kumar et al., 2009; Mohapatra *et al.,* 2013). In spite of these triumphs, productivity of rice is low in India. Since the production and area is limited, the only option left is to improve the productivity in order to meet the needs of the growing population.

Rice is the staple food of Kerala which is cultivated under wide diversity conditions extending from regions situated three meters below mean sea level as in Kuttanad to an altitude of 1400 m level as in Wayanad. Rice is occupying 7.7 per cent of the total cultivated area after coconut (29.6 %) and rubber (21.5 %). Kerala stands 18^{th} place in terms of paddy production in India. The acreage and production of paddy cultivation was 2.34 lakh ha and 5.98 lakh tonnes respectively during the year 2009-10 and, in 2019, it recorded a reduction of 15 per cent in the area and 3.5 per cent in production. However, productivity increased by 14 per cent over 2009-10. Compared to 2017-18, the acreage, production, and productivity of rice were increased by 4.7 percent (1.98 lakh ha), 10.9 percent (5.78 lakh tonnes) and 5.9 per cent (2920 kg ha-1) respectively, during 2019. (GOK, 2019)

The three major rice growing seasons of Kerala are Virippu (April-May to September-October), Mundakan (September-October to December-January) and Puncha (December-January to March-April). Even though Mundakan crop is prominent throughout the state, Puncha crop is prevalent in the Alappuzha district and Mundakan and Virippu crops are common in Palakkad district. Palakkad (39 percent), Alappuzha (19.5 per cent), Thrissur (11.1 per cent) and Kottayam districts (11.2 per cent) accounted for about 80 per cent of the total rice area and 82 per cent of the total rice production in the State. Concerning the area and production of rice, Palakkad and Alappuzha districts hold the first two positions, while in productivity, Pathanamthitta and Alappuzha hold the first and second positions in the state (GOK, 2019).

Salinity or sodicity are the major problems affecting 15 per cent of the total cultivated land around the world. Salinity induced losses in agricultural production was about US $12 billion and if necessary measures are not taken to mitigate salt stress, the losses may considerably increase in the next few decades (Shabala, 2013). Saline soils are one of the problematic soils affecting the crop production and productivity by limiting the economic usage of existing resources along the coastal line. Also, fresh water availability is a major concern to cope up with the rising salinity during rabi season (Mandal *et al*., 2013). At present, rice is the only crop cultivated in coastal saline soils of south India during rainy season. This area is left uncultivated in remaining part of the year due to high salinity and lack of good quality water for irrigation. Moreover, use of underground water for crop production is limited due to its poor quality.

Kerala state has a coastline of about 569.70 km long with nine districts viz., Kasaragod, Kannur, Kozhikode, Malappuram, Ernakulam, Kollam, Thrissur, Alappuzha and Thiruvananthapuram adjoining the Arabian Sea, which account for 65 per cent of the total geographical area and 84 per cent of ground water resource of the state. Salt water intrusion is a common phenomenon occurring in these districts and had a significant impact on the state's agriculture sector. The main salt distressed ecological units are Kuttanad, Pokkali, Kaipad and Kole lands. Estuaries and network of backwaters operates as pathways for sea water to intrude in to these areas and causes salinity (Swarajyalakshmi *et al*, 2003).

In order to compensate the losses from the occurrence of salinity and to enhance the farm income, farmers in each area follow different principles and practices based on the geographical and ecological features of the corresponding regions. For instance, paddy cultivation is practiced in the salt water filled Kaipad fields in Kannur district. In Ernakulam district, sequential fish/prawn farming with the paddy is commonly followed by the farmers in the Pokkali tracts. Farmers in some parts of the Kuttanad region of Alappuzha followed double season cropping. And they usually kept their fields under flooded conditions after the harvest in order to leach out the accumulated salts completely.

Salinity not only affected the agricultural progress but also the economic progress of the country. The effect of salinity was evident even in the production of livestock and fish species. It was found that the production of pasture and forage crops were reduced in saline areas and people resorted to other sources to compensate for the lack of minerals for livestock (Alam *et al.*, 2017). The spread of income discrepancy, variations in consumption patterns and the deficiency of drinking water were the detrimental effects of salinity on the livelihood of farmers (Haider *et al.* 2009).

Salinity induced by salt water intrusion was being frequently reported from the Kuttanad region of Alappuzha, and in turn, the rice production in the area was severely affected with increased costs of production and huge yield losses to the farmers. The impact of salinity on crop yield was accounted for about 30-50 per cent. It limits the plant growth and yield by lowering the osmotic potential, creating toxicity of ions, imbalance of ion uptake and metabolic activities of the plant (Joseph and Mohanan, 2013).

Salinity has severe influence on the input use efficiency of crop production as well. Increased salinity often resulted in the suboptimal utilization of resources and hence affected the economic efficiency of the farmers. A study conducted by Kurup and Ranjeet, (2002) concluded that resource use efficiency of paddy production in the salt affected areas was improved by finding the alternative use of existing resources. Integration of paddy farming with prawn culture or fish culture is one such feasible alternative which provided additional employment apart from increased income to the farmers.

Kerala has perceived significant changes in its land use and cropping pattern over the years. The prime change being the alteration of food crop production to non- food crops and conversion of cultivable area for non- agricultural purposes and this in turn, challenges the food security and the ecological sustainability of the state. Despite of these changes in land use patterns over the years, rice cultivation is still acting as a major source of income to the large section of population in the state.

More than salt water intrusion, paddy cultivation in Kuttanad faces several other crises. Thomas (2002) stated that prevalence of marginal size of holdings, labour shortage, frequent crop failures, lack of timely labour availability, low productivity of labours and growing revulsion in rising generation were the major problems negatively influencing paddy farming. At the same time, lack of good quality seeds, imbalanced use of fertilizers, insufficient plant protection measures, high weed problem and increased labour costs were the potential reasons for the lower returns of farmers in the northern part of Kerala (Reddy *et al.* 2001; Nair *et al.,* 2002).

Due to the severity of the issue and multiple negative impacts of salinity, enhancing the farm income by managing the agricultural fields in the saline coastal areas has become challenging for the policy makers and technology experts to improve the productivity and livelihood of deprived farmers (Mandal, 2013). In the wake of all the above, the present study aimed at identifying the effect of salinity on paddy cultivation, along with estimating its impact on farm production and income of farmers in the comparative frame work of salinity affected and unaffected fields in Alappuzha district of Kerala.

The distinct objectives of the study are as follows

1) To examine the resource use efficiency in paddy production

2) To analyse the impact of salinity on crop production and farm income

3) To study the major constraints faced by paddy farmers.

SCOPE OF THE STUDY

This study was undertaken with the goal of providing fruitful results of considerable significance in evolving, improving and implementing location specific cropping systems in the study area or in areas with similar circumstances prevailing. It will enable farmers, researchers and policy makers to determine strategies that are useful for the overall enhancement of paddy cultivation in salinity affected areas and also in areas under extreme conditions.

LIMITATIONS OF THE STUDY

The research findings are based on oral statements of the respondents which often had recall bias, therefore conditioned by the accuracy and validity. The study is restricted to

Alappuzha district and hence the results cannot be generalised for the entire Kerala state. Lack of availability of past year’s recorded data on ground water salinity levels from the study area was a limitation for improvement analysis. Common limitations of statistical analysis might also have affected the study slightly. In spite of these, maximum care has been taken to ensure that such limitations do not affect the authenticity of findings of the study.

ORGANIZATION OF THE THESIS

This thesis is mainly organised and presented in five chapters. Introduction, the first chapter highlights the objectives, scope and limitations of the study. The second chapter is review of literature devoted to the review of past research works carried out in connection with this study. The third chapter, materials and methods dealt with study area, nature and sources of data and about the analytical tools employed for evaluating the objectives. Critical analysis of results and discussions are provided in chapter four. The final chapter encompasses the brief summary and conclusions of the study along with the policy implications followed by references, abstract and appendices.

FUTURE PROSPECTS

This study was carried out only in the Alappuzha district of Kerala. Considering the importance of the research problem, similar studies can be carried out in areas where agriculture has been practiced under unfavourable conditions both inside and outside Kerala. These comparative studies can be used to provide basis for policy recommendations to increase the paddy production in the state.

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

In order to endorse the many aspects of research, every scientific study needs an excellent literature review. This helps in recognizing the research gaps and recording issues related to different research dimensions. It also makes it easier to identify the information available on the strategic objectives of the intended study and provides a framework for the explanation of outcomes.

Revisions of past research have been gathered based on impact of salinity on crop production and farm income, resource use efficiency in paddy production, adaptive measures followed by the farmers, constraints in paddy production and are discussed in the below sections:

2.1. Studies on impact of salinity on crop production and farm income

2.2. Studies on economics and status of rice farming in the problem areas of Kerala

2.3. Studies on resource use efficiency in paddy production

2.4. Studies on constraints in paddy production in salt affected areas of Kerala

2.5. Studies on adaptive measures followed by the farmers.

2.1. STUDIES ON IMPACT OF SALINITY ON CROP PRODUCTION AND FARM INCOME

Swaminathan (1999) worked out the economics of impact of seawater intrusion on agriculture in Thiruvalluvar district of Tamil Nadu. The findings from the decomposition analysis showed that salinity has resulted 26 per cent difference in gross returns between the salt affected and non- affected farms. Throughout the first season, the total decrease in rice productivity was 279 kg per hectare due to salinity, which represented 6% of the real productivity achieved. The estimated total loss in rice productivity during the second season was 137.15 kg per hectare.

Grattan *et al.,* (2002) examined the relation between salinity and yield potential of several crops. It was found that plants which were highly susceptible to electrical conductivity or salinity display a decrease in yield potential of 50 per cent or more even for a slight rise in salinity. Paddy experienced a 50 per cent decrease in yield potential as the electrical conductivity has risen from 2.0 dS / m to 4.8 dS / m, which indicated that it was extremely sensitive to salinity.

Wilson (2003) observed that, in many parts of rural Australia the dryland salinity and increasing salt water levels recognized as a serious and threatening issue, reducing the yield of agricultural crops and making detrimental effects to the natural environment.

Thoshihiro *et al.* (2008) reported that, in the coastal regions, the area under paddy had reduced significantly by converting the fields to aquaculture lands, especially in to shrimp farms. Even though the increased salinity resulted reduction in aquaculture practices, which needs brackish water to carry out. Thus in the coastal areas of Mekong delta in Vietnam the paddy cultivation was regulated by the interaction between saltwater intrusion and changes in land use patterns.

Haider *et al.* (2009) studied the impact of salinity on the livelihood patterns of farmers in the south –west regions of Bangladesh. The results of the study indicated that the spread of income disparity, changes in consumption patterns and the lack of drinking water were the major adverse effects of salinity in the area.

Jayan and Sathyanathan (2010) carried out a study on farming practices in the water-logged areas such as Kuttanad, Pokkali, Kole and Kaipad areas of Kerala. They observed that, as a result of the structural changes around the river basin and rising salinity levels, area under Kaipad cultivation had further reduced. The constraints on sustainable use of the wetlands cannot be tackled since the possibilities of any systemic improvements in agriculture with political mediations were not effective. Joint actions of people and government eliminated the existing socio-economic inequality and established a more sustainable society.

A study by Chandramohanan and Mohanan (2012) on Kaipad rice farming in north Kerala reported that rice varieties Ezhome 1 and Ezhome 2 released by Kerala Agricultural University was having an average yield of 3.5 and 3.2 tonnes per hectare respectively under close planting and zero management conditions. This is 70 and 60 per cent more yield than that of the local cultivars such as Chovverian, Kuthiru, Kuttusan and Orkazhama.

According to Natural Resources conservation service (NRCS) (2012) the extent of salt-affected soils influenced by the weather conditions and shifts in land use patterns. Soil salinity influenced crop yields by hindering the absorption of plant nutrients and water. The overall output loss relied on the quantity and type of salts present in the profile and can be calculated by means of its electrical conductivity.

Based on his study on the human impact on Kuttanad wetland system, Sreejith (2013) observed that 60 per cent of rain in Kuttanad was received during the south- west monsoon and 30 per cent during north- east monsoon. As a result the influx in to Kuttanad was higher during June to November on comparing with the influx in to Vembanad Lake. And the reverse process was occurring during the months of December to the first week of May. This lowered the water level on the lake, and allows the backward flow from sea to the inland water sources which leads to salinity throughout the lake.

Haider and Hossain (2013) carried out a study to assess the impact of salinity on livelihood strategies of farmers living in four villages from two unions in Asasuni upazila of Satkhira district of Bangladesh. Accordingly, while salinity adversely affected farmer’s income, expenditure and job prospects, it positively influenced the shrimp-based land use activities of farmers in the area.

Study conducted by Rabbani *et al.* (2013) observed that, owing to its high exposure to salt water intrusion and extreme poverty, Satkhira became one of the most vulnerable coastal district in Bangladesh. Salt water intrusion in to the soil by means of cyclones and sea level rise happened as a result of the climate changes resulted to negative impacts on paddy production in coastal Bangladesh.

Ahmed and Haider (2014) observed that, in low salt affected areas during the khorip seasons the average paddy production accounted about 4,232 kg per hectare and for medium and high saline areas 3,760 kg per hectare and 2,663 kg per hectare, respectively. The results from Cobb- Douglas production function revealed that salinity negatively influenced the rice yield. If high salinity can be lowered to the minimum levels, farmers could gain a per hectare returns of around US$685 from the increased rice production itself. And in order to maximize the benefits of increased production, salinity levels must be restricted.

Radhika (2014) analysed the production and marketing of Kaipad paddy and the study found out that the farmers growing traditional variety , High Yielding Variety (HYV) earns an average annual returns of Rs. 40,752 and Rs. 51,105/ha respectively. Farmers who were doing rice- shrimp sequential farming earned an average annual returns of Rs. 42,245 and Rs. 59241/ha from growing traditional varieties as well as from growing HYV respectively. The average income of the farmers who practiced cultivation in non-affected areas near to Kaipad was Rs. 50079/ha.

A study conducted by Sharma *et al.* (2015) revealed that the highest annual losses in agricultural production due to salinity was recorded in Uttar Pradesh (7.69 MT) and subsequently in Gujarat (4.83 MT). Whereas in terms of economic losses per annum, Gujarat (100.63 billion**)** stood first followed by Uttar Pradesh (81.29 billion).

Khanom (2016) stated that, in the course of years as a result of the rise in salinity levels a significant drop in production was experienced for Aman and Aus rice in the coastal Bangladesh.

Alam *et al.* (2017) conducted a study to analyse the effect of salinity intrusion on food Crops, livestock and fish species at Kalapara coastal belt in Bangladesh. It was found that salinity affected both the agricultural and economic development. Salinity in the coastal belt of Bangladesh produced a volatile climate for normal cultivation over the years. Reduction in agricultural production in the coastal area had a major effect on country's economy. There was a lack of pasture land and forage crops for livestock production due to the increased salt content. As a result, people became forced to use other natural resources to compensate the lack of minerals for livestock.

Raju *et al.* (2017) reported that out of the 95,765 ha salinity affected area in Haryana, cereal cultivation alone carried out in 77,061 ha (80.47 per cent). Rice and wheat were the two major crops cultivated under cereals. The estimated actual losses and potential losses per ha per annum were Rs. 9,314 and Rs. 10,807 respectively. The gross monetary loss due to salt affected soils in the study area amounted to Rs. 3.67 million.

Ranjith *et al.* (2018) revealed that the semi intensive prawn production system in Kuttanad generated a gross returns of 6.49 lakhs of rupees per hectare per year with a total cost involved of 4.94 lakhs of rupees per hectare per year, with an annual net returns of Rs. 1.55 lakhs per hectare.

2.2. STUDIES ON ECONOMICS AND STATUS OF RICE FARMING IN THE PROBLEM AREAS OF KERALA

Regardless of the arduous works of the government, the performance of paddy in terms of area undertaken and production had diminished in the state of Kerala at tremendous rates ever since the mid-seventies (Thomas, 2002).

Sreedharan (2005) mentioned that during favourable climatic conditions, the average yield of paddy was about 1,125 kg per hectare. With the introduction of prawn farming, shrubs began to grow in the paddy cultivated areas and bird's inhabitation made the farm lands non profitable. The area under paddy also got reduced from 2,500 hectare in 1995 to 600 hectare by the year 2005.

Suchitra and Venugopal (2005) reported that a few decades back, the area under Pokkali rice cultivation in the coastal region of Ernakulam, Thrissur and Alappuzha districts of Kerala was about 25,000 hectares. Corresponding to the Pokkali Land Development Agency (PLDA) which was dropped to measly 8,500 ha and out of which barely 5,500 ha are strictly under rice cultivation now. The balance area is left uncultivated or used for prawn farming.

A study conducted by Balachandran (2007) on paddy cultivation in Kerala revealed that the area under paddy cultivation was rapidly decreasing at a rate of 4.3 per cent per year since mid-1970. The current area and production of rice in Kerala was 2.8 lakh ha and 6.8 lakh tonnes respectively, whereas the productivity has been increasing at a slow rate of 1.3 per cent per annum. This decline in productivity as well as profitability disappointed the farmers from practising rice cultivation. Despite the maximum efforts by the government and various other agencies to lift the cultivation of rice, it has been constantly decreasing in the state.

Kokkal *et al.* (2007) stated that the area under agriculture has been reduced significantly from the past three decades primarily due to the alteration and renovation of the low lands and other wetland areas for the construction works and other purposes which led to lower the food production. The productivity of the land was reduced due to loss of soil fertility by erosion and pollution. All these factors in turn affected the economic status of farmers, farm workers and the other people of that area. The most affected areas due to this were Kuttanad, Kole, Pokkali and Kaipad lands.

Kuttanad area elucidates the irony of concomitance of lavish natural charm and severe agrarian distress. The income obtained from the uplands diminished with the low yielding coconut palms, falling prices and lack of on-farm inputs or off-farm income generation activities. It also affected the wealth of wetland fishery system as there is no alternative for the dependant population (MSSRF, 2007).

Joseph (2008) reported that even though high yielding rice varieties viz., VTL-6 was developed by Rice Research Centre, Kochi, the native farmers of Kerala still chooses the 40 year old traditional Pokkali varieties which are of good quality, reliability and superiority.

Nambiar and Raveendran (2009) revealed the unexplored possibilities of paddy fields in the coastal zone of Kerala. Pokkali/ Kaipad/ Karikandam are unique systems of rice cultivation comprised only in the saline conditions of Coastal belt of Kerala. A total of 32 species of higher filamentous marine fungi with high degrading capacity were isolated from the fields. Due to the presence of fungi costal paddy fields were fertile and ideal for crop growth.

Nikhil and Azeez (2009) revealed that over the last few decades, people doing agriculture for their livelihood shrunk radically. Out of the total rural population in Kerala, at present only 26 per cent carry out agriculture as an occupation. The state’s agricultural setup has undergone a profound shift in various aspects by encouraging the commercial cash crops than cereals and hence the farmers were converting the low land rice fields into uplands to grow commercial perennial crops. In addition, they also disclosed that agricultural labour in the state declined to 16.1 per cent of the total by the end of 2001.

Jayan and Nithya (2010) reported that large areas under Pokkali were converted for the cultivation of coconut and other purposes, which reduced the area of rice cultivation. In about 2,000 ha of land, rice cultivation was not practiced on regular basis. The cultivated rice when favourable climatic conditions prevail. Further, the damages caused by lodging, fish, tortoise and rats reduced the potential yield by about 50 per cent.

Martin (2011) concluded that the largest area under Pokkali cultivation was recorded in Ernakulam district. Their study also noticed a munificent increase in the area under paddy in the year 2011. In the panchayats of Chellanam, Kumbalanghi, Kadamakkudy the acreage increased from less than 100, 50 and 180 hectares to 178, 240 and 200 hectares respectively. One of the significant achievements were the fields which were left fallow for about 15 years was brought under cultivation.

Srinivasan (2011) reported that in the Kole fields of Kerala state the local varieties of paddy which were cultivated few decades back was now replaced by the varieties Jyothi, Uma and Jaya. Construction of farm roads, quarrying and other practices enabled the use of Kole lands for purposes other than agriculture and which in turn led to the transformation of local environment.

Srinivasan (2012) pointed out that rice, the major food crop of Kerala, reduced its share from 32 per cent to 8.77 per cent of the total cropped area by the year 2010. The area under paddy was 8.76 lakh hectares during 1975-76 and by 2009-10, the area under paddy decreased to 2.34 lakh hectares documenting 73.28 per cent decrease in a span of about 34 years.

The Hindu (2012) reported that, as per the recent information, the area under Pokkali cultivation is only 967 hectare out of which 770 ha is in Ernakulam.

Ravikumar and Sudeesh (2013) inferred that the major causative factors for declining paddy cultivation in chittur was shortage of labour and low price for paddy.

Sreejith, (2013) recognized that the Kuttanad Wetland System (KWS) encompassing the Vembanad lake is now noticed globally because of its peculiar wetland system which allow one good rice crop, one harvest of fish and also act as a flourishing water tourism where the mother nature is at the crowning of its beauty. This Ramsar wetland site is a biodiversity paradise which provides agricultural, fish production and has an aesthetic value.

Kerala has 217 wetland areas that are located in the coastal plains and midlands, extensively occupied by rice crop (Vanaja, 2013).

Pokkali rice cultivation was practiced during the low saline phase i.e., June to mid-October and prawn farming was practiced during the high saline phase i.e., November to April.

During one season, farmer generally gets 1.2 to 1.5 tonnes of Pokkali rice and 400 to 500 kilos of prawns per hectare. (Shamna, 2014)

Joseph (2016) recognized that the Kaipad system of rice cultivation is an indigenous and integrated organic farming method in which rice cultivation and aquaculture was practiced together in the coastal areas. The saline water from the fields are withdrawn and are allowed to dry for a month for the cultivation of rice. Kuthiru and Orkayama are the traditional land races extensively grown in this area. The same study reported a unique rice production system in saline areas of central Kerala using salt tolerant varieties of rice which were cultivated solely in an organic way. It included the waterlogged acidic soils of coastal regions of Ernakulam, Alappuzha and Thrissur districts of Kerala. It was biologically diverse and has capacity to generate organic rice and shrimp alternatively. In Pokkali cultivation rice was grown during low saline phase followed by shrimp farming in high saline phase. The high yielding varieties released by KAU such as Vytilla 1 to Vytilla 8 were utilised for cultivation in Pokkali lands.

2.3. STUDIES ON RESOURCE USE EFFICIENCY IN PADDY PRODUCTION

Kurup and Ranjeet (2002) recognized that the integration of prawn/fish culture with paddy cultivation was a feasible alternative to the effective use of Kuttanad’s extensive flood plain area. Use of embankments for fish or prawn culture would not only offer better income, but also provide additional employment to the farmers. The toxic effects due to the pesticide residue accumulation has declined by the sequential cultivation of rice and fish / prawn in different seasons. In agricultural point of view, integration helped in maintaining soil fertility, avoided accumulation of waste materials, improved the pest management and thus reduced the cost of additional fertilizer applications.

Suresh and Reddy (2006) conducted an economic analysis on resource use efficiency of paddy cultivation in Peechi command area of Thrissur. Results showed that elasticity coefficients were 0.65, 0.55, 0.17 and 0.24, respectively for area under paddy cultivation, human labour, fertilizer and supplementary irrigation provided. The average technical efficiency of the farmers was found 66.18 per cent. An additional one rupee spent on fertilizer, plant protection chemicals and human labour was stated to rise the gross returns by Rs. 2.83, Rs. 1.57 and Rs. 1.17, respectively. There was a positive and significant relation between education level of farmers and supplementary irrigation provided, while the presence of water stress has a negative impact on the technical efficiency of farmers.

Nirmala and Muthuraman (2009) studied the economics and problems of rice cultivation during the period 2007-08. The primary data were collected from 80 farmers of four villages of Kaithal district in Haryana. The cost of cultivation and average annual yield of paddy cultivation were Rs. 33,779 and 4.99 tonnes/ ha, respectively along with a BC ratio of 1.27. Machine labour, human labour, fertilizers, pesticides and manures accounted for 25.27per cent, 19.72 per cent, 18.9 per cent, 11.56 per cent, and 7.31 per cent of total variable costs respectively.

In the context of efforts made by the Government of Kerala to increase paddy production in the state, Srinivasan (2012) examined the yield, input use, and net returns of paddy cultivation in Kole lands. Looking at the labour input employed in Kole lands, it was almost twice the average labour use reported for all Kerala. Roughly 176 human days per hectare were employed for Kole land paddy cultivation. Labour costs accounted for over 65 per cent of overall cultivation costs. For specific activities like land preparation, weeding, transplantation and harvesting higher labour inputs were often used. Due to the concerns over seed germination problems and plant mortality triggered by acidity and soil toxicity, farmers were forced to use more seeds. In Kole lands, usage of chemical fertilizers per hectare was twice the average of Kerala. Correlation coefficient between size of land holdings and level of margin was 0.34 and statistically significant.

Efficiency studies help to explain the current performance and potential to boost the crop production to get desirable outputs (Karthik *et al*., 2013).

Mandal *et al.* (2013) stated that tall rice varieties with low yield was preferred in the coastal saline areas during the kharif season in order to overcome the issue of waterlogging, despite of the high yielding short varieties. Availability of fresh water was of serious concern during rabi season, as it was necessary to manage the rising soil salinity. The available sources of freshwater in the area was either ground water or harvested and stored rainwater. Use of groundwater from shallow salt-affected water table often facilitated the salinity in the surface soils and thereby affected the production.

Jain and Patel (2015) conducted a study to find ways to calculate the amount of various chemical constituents in multiple irrigation water and soils of some villages of Khanpur taluk in Gujarat. The projected demands of the limited water resources and the need for sufficient food across the globe for the growing populations demanded an improved irrigation efficiency and improved crop productivity from irrigated lands.

Machado and Serralheiro (2017) found that the management strategies for fertilizer application and irrigation must take into account the effects of salinity on crop production, soil characteristics, crop resistance and impacts on water use efficiency and soil salinity. Application of bio fertilizers, use of certain nutrients such as Silicon, humic acid etc. has the potential to enhance salinity resistance in many crops. Drip irrigation and subsurface drip irrigation compared with other irrigation systems improve the water use efficiency and build an effective root zone salinity.

The use of Cobb-Douglas production function in estimating the resource use efficiency in agriculture has been proved by many researchers (Qamar, 2017; Rohith, 2018; Thulasiram *et al*., 2018).

Kalpalatha and Reddy (2018) examined the impact of advanced agricultural technologies in paddy production. The primary data was collected from 792 paddy production farms from Nellore district of Andhra Pradesh by applying the Cobb- Douglas production function. Study showed that along with fertilizers and pesticides, tillage, irrigation and threshing, reaping and winnowing have a positive and significant effect on production.

Ranjith *et al.* (2018) conducted a study on the economic and environmental perspectives of Pokkali farming system in Ernakulam and Alapuzha districts of Kerala. The results showed that the net returns obtained from Pokkali – prawn, non- Pokkali- cowpea and semi intensive prawn system were Rs. 2.80 lakhs, Rs. 0.69 lakhs, Rs. 1.55 lakhs per hectare respectively with corresponding BC ratio of 2.17, 1.45 and 1.31. The sum of values of coefficients of the fitted production function gives a nearly unitary economics of scale or a constant return to scale, suggesting that the semi intensive prawn production system is profitable. And in fact, it was not recommended to add any additional inputs to enhance the production by the farmers.

2.4. STUDIES ON CONSTRAINTS IN PADDY PRODUCTION IN SALT AFFECTED AREAS OF KERALA

Shyna and Joseph (2000) evaluated the problems of women labourers with special reference to Pokkali rice farming in Vypinkara. Even though Pokkali rice field has a unique eco-system and large capacity to produce organic rice and prawn / shrimp, farmers showed an increasing tendency to quit this age old paddy cultivation system.

Reddy *et al.* (2001) conducted a study by analysing the problem- cause relationship through farmer's participatory approach in the northern Kerala. Primary data were collected from 710 farm families selected from 3 villages in the Kasaragod district and depicted a problem- cause relationship chart. As part of study, brainstorming cum data recording sessions were performed. The key reasons for the low profitability are lack of quality seeds, unbalanced use of fertilizers, inadequate plant protection measures, excessive weed problems and huge labour costs.

Nair *et al.* (2002) studied the waning culture of integrated rice – fish farming in Kaipad. Results of the study reported the declining trend of rice production in the northern Kerala and the potential reasons for it. Farmers were no longer interested in continuing cultivation of rice due to higher wages and lack of hired as well as family labour for farming. Inefficient resource utilization had a drastic impact on the most socially deprived classes of the society.

Thomas (2002) conducted a village level study on the problems and opportunities of rice cultivation in Kuttanad, with primary data collected from the Ramankary village in Alapuzha district. Study recognized that the rice farming sector in Ramankary was currently on the cusp of a serious crisis. The main problems of paddy cultivation included a reduction in number of full time farmers, marginal and small scale land holdings, high rate of crop failure and growing aversion in the new generation on rice cultivation.

Balachandranath (2004) studied the extension approaches for the major farming systems in the background of evolving agricultural scenario. He concluded that marginal and small land size, high wage rate, lack of availability of timely labour and low productivity of labour resulted in low economic performance of paddy farmers.

Das and Stigter (2005) studied the possibilities of Pokkali rice farming and unique characteristics of Pokkali fields. From their study the estimated organic carbon content in Pokkali soils were 3-4 per cent. Researchers noted that the soil was fundamentally fertile in nature with sufficient organic carbon, potassium and beneficial microbial flora. Since the cultivation practices followed optimal use of biomass, no inputs such as fertilizers, insecticide or chemicals other than seeds were recommended for Pokkali paddy cultivation.

Ranga (2006) conducted a study on the historical and contemporary use of resources and the livelihood patterns of land owners and workers of wetland agriculture and described the roots of change in these livelihood. Study revealed that the rice- shrimp sequential farming helped to increase intake of animal proteins in the diet of local population as well as effective use of land and family labour. Due to the increased demand for shrimp on world markets and burden of economic pressure on the famers, the traditional rice-shrimp rotational cropping system is at the brink of collapse.

Shylaraj *et al*. (2006) stated that production in Pokkali tracts of Kerala faces specific challenges, such as increased salinity and saltwater intrusion from sea during the critical phases of crop growth. About 40-50 per cent of yield losses were estimated due to damages caused by fishes and rodents in the study area. In addition to the losses, farmers were suffered with acute labour shortages during the harvesting of paddy and field clearing activities for the succeeding selective prawn stocking.

Given the state government’s direct intervention rendering the monoculture of prawn as illegal, Vijesh *et al.* (2006) found that more areas under rice were slowly being put under fallow- prawn and prawn-prawn systems due to the many restrictions associated with labour intensive paddy production system in Pokkali fields. This lead to uncertainties to the in situ conservation and cultivation practices of salinity resistant native rice varieties.

Basheer (2008) pointed out that because of the tiresomeness involved in the work, agriculture labourers were reluctant to go for harvesting works. And also the higher land value offered by the real estate people often brainwashing the farmers to sell their waterlogged fields.

Joseph (2008) found that the marshy lands lying next to the mouth of rivers and close to the sea are highly prone to salinity and flooding. Soils in Pokkali fields were acidic in nature and presence of toxic elements were also reported. Such drawbacks was effectively removed by farming operations that ensure consistent drainage in the fields.

Jayan and Nithya (2010) studied the farming practices adopted in the wetlands of Kerala and reported that the low-lying areas of Kerala are under serious problems of water logging.

Inaccessibility of labour and high labour charges has taken away the faith of local farmers in Pokkali farming. The unbridled tourism promotion in the backwaters not only polluting the ecosystem but also the ethnic culture of Kuttanad, and the government is attempting to maintain both sustainable development and economic growth in area, where the equilibrium needs to be maintained.

Jayan and Sathyanathan (2010) pointed out in their study on the review of major agricultural practices in water- logged regions of Kerala that about 25 per cent of total rice production in Kerala was under water logged conditions, particularly in Kaipad, Kuttanad, Pokkali and Kole regions. The key problems faced by the famers growing paddy were related to pollution, soil degradation, encroachment, restoration, mining and biodiversity loss.

Srinivasan (2011) recognized that the construction of farm roads, quarrying and other practices enabled the use of Kole lands for purposes other than agriculture and which in turn led to the transformation of local environment.

Chandramohanan and Mohanan (2012) investigated the unique features of Kaipad paddy cultivation prevailed in Kannur district of state of Kerala. The study inferred that a further increase in deficit in rice production has been observed in recent years as a result of the large scale conversion of paddy fields in to garden lands and for residential purposes.

The Hindu (2012) reported that acute shortages of workers throughout the agricultural sector, particularly for harvesting, have forced hundreds of farmers to leave their profession in Kuttanad.

2.5. STUDIES ON ADAPTIVE MEASURES FOLLOWED BY THE FARMERS

Datta and Jong (2002) reported that in order to mitigate the detrimental effects of soil salinity on the crop yield, farmers often use canal water and ground water. Due to the variations in environmental conditions of farming system such as groundwater quality, soil types and abnormal distribution of irrigation water, increased and uneven losses in income of the famers were observed.

Nair *et al.* (2002) mentioned that Kaipad fields were low lying and usually submerged. In order to carry out the agricultural operations in the fields the tidal currents from the river has to be restricted primarily and dried conditions must be ensured in the fields. 10 feet long bunds made up of sticky mud used to regulate the tidal flow and are known as Chira or Kandi.

Tuong *et al.* (2003) conducted an impact assessment study on seawater intrusion control by constructing sluices in the coastal areas of Vietnam. Observations was recorded during a time period of 1994 – 2000. Farmers in Asian coastal wetlands are facing severe challenges of poverty and food insecurity. Agricultural production is often hampered by the salinity intrusion as a result of tidal fluctuations. Salt water prevention structures are constructed to reduce the intrusion of sea water as a technique to enhance the crop production.

Miah *et al.* (2004) reported that specific agricultural practices were adopted by the farmers in order to increase their yield and reduce the negative effects of salinity. For certain crops special field operations such as mulching with water hyacinth, straw and ash were performed in order to keep minimum evaporation levels. Non-use of fertilizers were observed in some salinity affected places. Fertilizers such as gypsum, urea, Triple super phosphate, Di ammonium phosphate and compost had also been used by some farmers to mitigate the problems due to soil salinity.

M. S. Swaminathan Research Foundation (MSSRF**) (**2007) evaluated the measures to mitigate agrarian distress in Alappuzha and Kuttanad wetland ecosystem. In several of the lower Kuttanad areas leading channels and a spillway at Thottappally were constructed in order to mitigate the flood impacts. Over several years due to lack of sufficient maintenance and co-ordination of functional activities, the potential flood regulation capacity in the lake zones declined drastically. Orummuttus were constructed temporarily to prevent the salinity intrusion from sea to Kuttanad through major and minor inlets, which was costly and inefficient for the timely prevention of salinity.

Vanaja *et al.* (2009) reported that introduction of new rice varieties helped to transform a wide area of Kaipad in to suitable arable land. Medium salinity tolerance, non-lodging, intermediate plant type, high yield, appropriate grain quality and pests and disease resistance are the characteristic features of the newly developed cultivars.

Haider and Hossain (2013) gathered responses of farmers on their changing livelihood strategies, who lived in the salinity affected areas of Satkhira district, Bangladesh. The study found that farmers have tried to deal with the problems of salinity in their own manner. The government had recommended for external assistance in order to achieve a long-term sustainable solution.

Mandal *et al.* (2013) stated that different approaches have made in order to enhance the farm income in the coastal regions. Adopting salinity tolerant crop varieties and following appropriate land shaping technologies were practiced in order to reduce the unnecessary costs involved in harvesting, storing and its management.

Rabbani *et al.* (2013) in their study assessed the loss and damage to farming households in coastal Bangladesh due to salinity intrusion caused by extreme weather events. And found that there was a significant increase in soil salinity in the last 20 years. The most critical adaptation was the introduction of saline tolerant rice varieties. Nevertheless, these adaptation steps were not adequate to tackle the sudden rise in salinity after cyclone hit the region back in 2009. In order to cop up with the negative impacts of salinity intrusion, farmers had taken certain non-field and field based adaptation strategies. Field based adaptation steps decreased the effect of salinity on agricultural operations and non- field based strategies reduced the too much reliance of livelihoods on agriculture.

According to Ahmed and Haider (2014), exerting tax for shrimp farming associated external costs, land zoning, property rights can be used as advisable command and control approaches to address the salinity problem in the coastal areas of the country. The adaptation strategies against the intrusion of excessive salinity were maintaining drainages, irrigation water management during dry season and encouraging cultivation and dissemination of salinity resistant rice varieties in salt prone areas.

Mandal *et al.* (2015) pointed out that occurrence of salt content in groundwater, severe and heavy withdrawals of ground water near coastal regions, vigorous as well as continuous tidal movements from sea and poor management of land and water are the prime reasons for building up of salinity. Developing salt resistant rice varieties and maintaining proper rainwater harvesting structures were considered as suitable strategies for enhancing agricultural environment in the coastal areas.

Alam *et al.* (2017) reported that different hanging vegetables can be cultivated widespread throughout the coastal belt, including country beans, cucurbitaceous vegetables such as cucumber, bottle, bitter, and sweet gourds and other creeper vegetables. Planting right types of vegetables in these areas would provide an immediate opportunity to feed the household also. This cultivation practices helps to provide the required nutrients in the undesirable salinity conditions of coastal regions.

Methodology

Chapter III

METHODOLGY

This chapter gives an insight in to the methodological aspects addressing the present research problem and helps the readers to evaluate the work performed. A detailed description of materials and methods used for the current study permits to replicate the study in future if needed. The details pertaining to area of study, sampling design, methods used for data collection, variables and their empirical measurement and the statistical tools used for analysis of data were presented under the following heads:

3.1 Area of the study

3.2 Sampling design

3.3. Sources of data

3.4 Methods of data collection

3.5 Empirical measurement of variables

3.6 Tools for analysis

3.1 AREA OF THE STUDY

The study was undertaken in Alappuzha district of Kerala, where there is large extent of area under rice cultivation and the paddy fields in the district are prone to saltwater intrusion. The agricultural activities in the district predominantly revolves around Kuttanad, known as the "Rice bowl of Kerala" which is located below the mean sea level. The present study attempts a comparative economic analysis of paddy farming in the salinity affected and non-affected fields in Alappuzha district.

3.1.1 Alappuzha District

Alappuzha is the smallest district in Kerala with a total geographical area of 1414 km^2, lies between north latitudes – 9^o 05′ and 9^o 54′ , east longitudes – 76^o 17′ 30″ and 76^o 40′. Alappuzha is the only district where there is no high land and forest area in Kerala. Water bodies make up

13 per cent of the district and Kuttanad region lies below mean sea level. There are no mountains or hills in the district except some scattered hillocks between Bharanikkavu and Chengannur blocks in the eastern part of the district. The district has a contiguous long coastline of 82 km, and thus 80 per cent of the district lies in coastal region and the rest in midland region. The district's economy is mainly depending upon agriculture and marine products. Alappuzha holds the second rank for production of rice in the state. Year wise area, production and productivity data of rice in the district is given in the table 1.

Table 1: Year wise Area, Production and Productivity of rice in Alappuzha district

Year	**Area (ha)**	**Production (tonnes)**	**Productivity (kg/ha)**
2005	28,768	71,748	2,494.02
2006	31,060	90,160	2,902.77
2007	33,335	62,270	1,868.01
2008	34,143	1,04,250	3,053.34
2009	33,440	97,976	2,929.90
2010	37,060	91,325	2,464.25
2011	36,251	1,11,980	3,089.02
2012	36,195	1,04,593	2,889.71
2013	37,403	1,06,866	2,857.15
2014	34,415	1,03,095	2,995.64
2015	31,724	89,335	2,816.01
2016	32,453	1,02,439	3,156.53
2017	40,393	1,05,676	2,616.20
2018	42,273	1,28,560	3,041.18
2019	38,623	1,28,560	3,329.00

Source: (Government of Kerala, 2019)

In contrast to the general trend in area, production and productivity of paddy in Kerala, Alappuzha district shows an increasing growth rate of 1.58, 3.16, 1.55 per cent in area, production and productivity of paddy, respectively over the year 2005-19.

3.1.2 Haripad Block

The study was conducted in Haripad block. Haripad block panchayat is located in Karthikapally taluk of Alappuzha district between the north latitudes - 9°18′0″ and the east longitudes: 76°28′0″ at an elevation of 13 meters from sea level. Haripad is spread over 9 villages, namely Cheruthana, Chingoli, Haripad, Karthikappally, Karuvatta, Kumarapuram, Pallippad, Thrikkunnapuzha, Veeyapuram with 13 divisions and a total geographical area of 112.04 km^2. Agriculture is the main occupation of the people in all these villages with rice and coconut as the major crops being cultivated in the area. Haripad is close to the Arabian sea, connecting Mavelikkara and Thrikkunnappuzha. The nine kilometre long and two kilometre wide coastal area helps in receiving heavy annual rainfall in Haripad. Veeyapuram, Cheruthana, Haripad and Pallippad villages comes under the upper Kuttanad region of Alappuzha.

3.1.3 Demographics

According to the 2011 census, Alappuzha district has a population of 2,127,789 and is ranked 216th out of a total of 640 districts in India. The district has a population density of 3,890 inhabitants per square miles (1504/sq km). Its population growth rate over the decade 2001-2011 was 0.61 per cent. Alappuzha has a sex ratio of 1100 females per 1000 males and a literacy rate of 96.26 per cent. It has the highest population density in all the districts of the state.

3.1.4 Soil types

Five types of soils mainly lateritic soil, clay loam soils, sandy loam soils, kari soils and coastal sandy soils are observed in the district. Kari soils and clay loam soils are found in major part of the district and in most parts of Haripad block.

3.1.5 Land utilization pattern

Land utilization pattern of Alappuzha district in 2017-18 is presented in table 2. The net area sown in the district was around 59.38 per cent of the geographical area and the area sown more than once was 18.72 per cent of the geographical area. While Cultivable waste accounted for 10.58 per cent of the area of the district, the share of land put to non-agricultural uses and Total cropped Area was 17.84 and 78.09 per cent respectively.

Table 2. Land utilization pattern in Alappuzha district

Particulars	Area in hectares	Percentage to total geographical area
Total Geographical area	1,41,011	100
Forest	0	0.00
Land put to non-agricultural use	25,152	17.84
Barren & uncultivable land	8	0.01
Permanent pastures	0	0.00
Land under misc. tree crops	98	0.07
Cultivable waste	14,922	10.58
Fallow other than current fallow	2,452	1.74
Current fallow	1,820	1.29
Marshy Land	1	0.001
Still Water	12,456	8.83
Water Logged Area	336	0.24
Social Forestry	40	0.03
Net area sown	83,726	59.38
Area sown more than once	26,392	18.72
Total cropped Area	1,10,118	78.09

Source: (Government of Kerala ,2018)

3.1.6 Climate and rainfall

The climate in Alappuzha is humid and hot during summer due to its close proximity to the sea. Although the average monthly temperature is 27 ^{0}C and it remains quite cool and pleasant during the months of October and November. Like in other parts of the state Alappuzha also gets the benefit of two seasonal monsoons. Since both the Southwest monsoon and Northeast monsoon influences the weather in Alappuzha, the district experiences a long monsoon season with heavy showers. During the months from June to September the south-west monsoon affects the climate and on the other hand, the north-east monsoon brings rain during October to November. The average rainfall in the region is 2763 mm. Trend in rainfall data of Alappuzha district over the year 2005-19 is given figure 2.

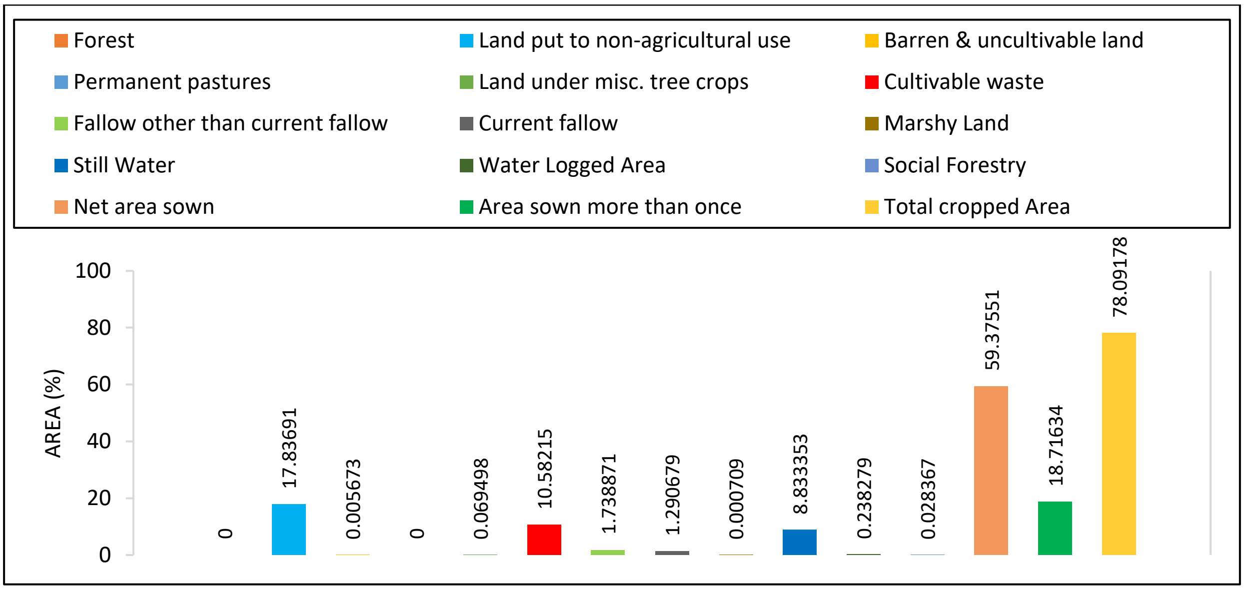


Fig.1 Land utilization pattern in Alappuzha district, 2017-18

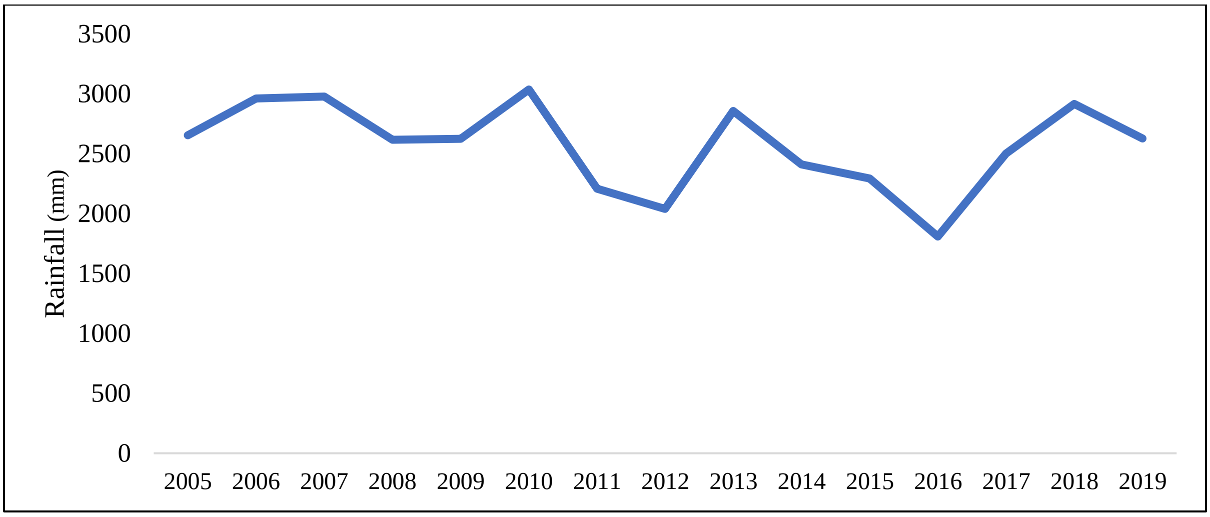
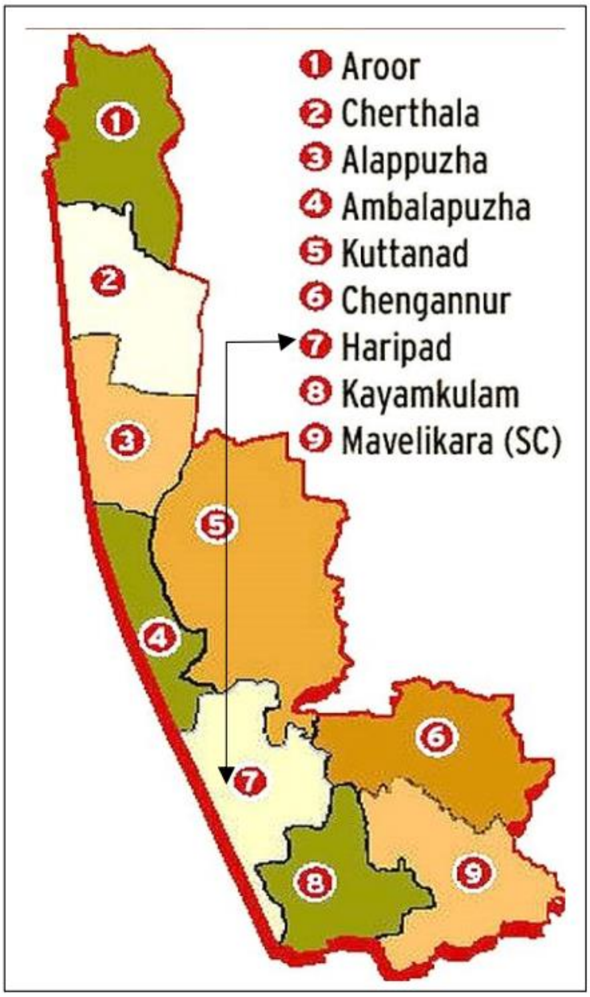


Fig 2.Trend in rainfall (2005-19), Source: (Government of Kerala, 2019)



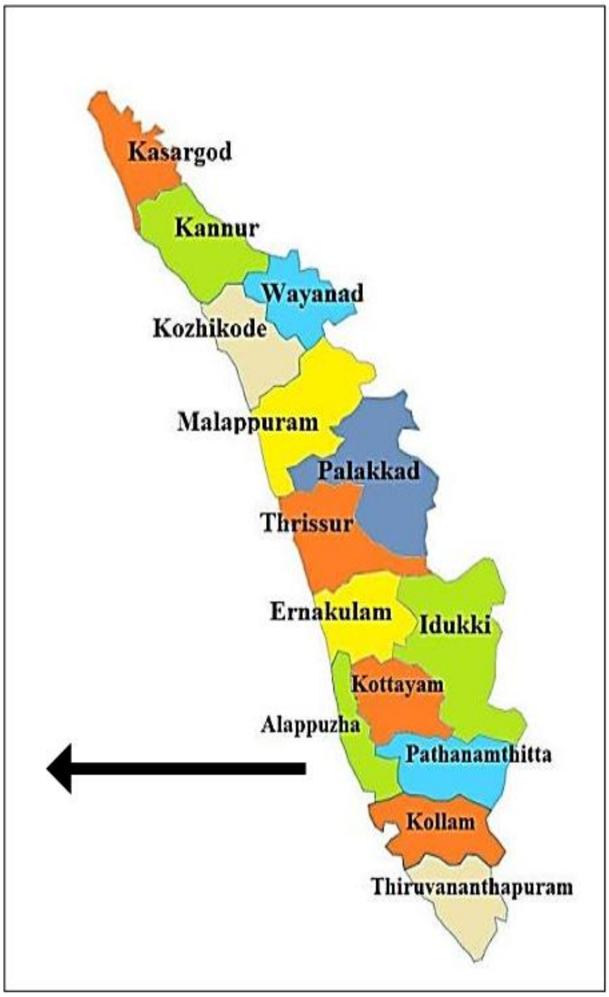


Fig 4. Political map of Alappuzha district

Fig 3. Political map of Kerala

3.2 SAMPLING DESIGN

Alappuzha district was purposively selected for the micro level study as it is one of the major districts of Kerala in cultivation of paddy. Moreover salinity problems due to salt water intrusion were frequently being reported from this district over the years. Haripad block was purposively selected as it is one among the largest producers of rice out the 12 blocks in Alappuzha district and is facing serious threats of salt water intrusion problems. For the present study paddy fields affected by salinity due to salt water intrusion and those unaffected by salinity was carefully selected. The farmers in the study area were categorised into two groups on the basis of effect of salinity. The farmers were selected based on the discussions with the officials of agriculture department as well as *Padasekharasamithis*. A pilot study was conducted. For the main study, 25 farmers each from salinity affected fields and non- affected fields were selected thus the total sample size of the study was 50. Simple random sampling was followed to collect the samples.

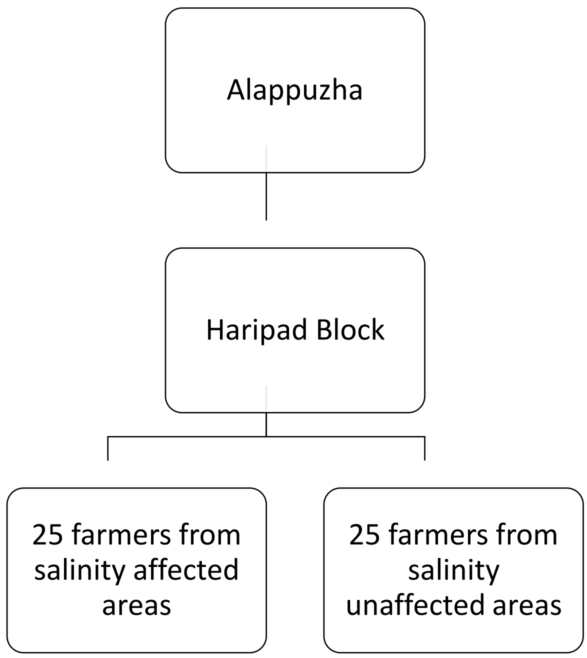


Fig 5. Sampling framework of the study

3.3. SOURCES OF DATA

3.3.1 Primary data

For evaluating the specific objectives of the study, necessary primary data were obtained from the sample farmers through personal interview with the help of a pre-tested and well-structured questionnaire. Information was collected on socioeconomic status of the selected farmers, total yield, costs and returns from paddy, adaptation measures followed by the farmers and problems faced by the farmers in paddy production. The data so collected were pertained to the agricultural year 2019-20.

3.3.2 Secondary data

Secondary data were also used for the present study. For identification and selection of the study location, secondary data pertaining to ground water salinity, salinity of irrigation water and soil salinity levels were collected from the State ground water authority, Thiruvananthapuram, Kerala Centre for Pest Management, Moncombu and Department of Soil Survey & Soil Conservation, Alappuzha respectively. Data related to land use pattern, cropping pattern, area, production, productivity of paddy and other major crops were collected from the annual reports of Department of Economics and Statistics. Data related to area, demographic features, administration were collected from the reports of Government of Kerala. The annual rainfall data of Alappuzha district were collected from Regional Agricultural Research Station (RARS), Onattukara.

3.4 METHODS OF DATA COLLECTION

The survey was conducted during May month of 2020. Data was collected by personally interviewing the respondents using a pretested structured interview schedule. The information regarding rice cultivation by the respondents, yield of paddy, costs and returns involved, impact of saltwater intrusion in the fields, constraints faced for paddy cultivation, adaptation strategies followed and current status of rice cultivation in the area were collected.

3.5 EMPIRICAL MEASUREMENT OF VARIABLES

The data pertaining to the study were collected under the following headings and analysed using various statistical tools.

3.5.1 Socio economic profile of farmers

Socio economic status of the respondents were assessed by collecting details regarding Name of respondents, Age, Gender, Source of income, Annual income of the farmer, Experience in paddy farming and Land holdings of sample farmers.

3.5.2 Quantity of inputs

Quantity of inputs such as quantity of seed, fertilizers, soil ameliorants and plant protection chemicals were collected and used for the analysis of resource use efficiency.

3.5.3 Cost of inputs

3.5.3.1 Cost of seed

Farmers from the selected area was using Uma D-1 variety of rice for cultivation and was provided free of cost by the government with a fixed quantity of 40 kg per acre. Costs incurred by the farmers for purchasing the extra seeds from local dealers were calculated on the basis of purchase price.

3.5.3.2 Cost of manures, fertilizers and plant protection chemicals

Cost of chemical fertilizers, organic manures, herbicides, pesticides and fungicides was calculated on the basis of its prevailing market prices in the area.

3.5.3.3 Cost of soil ameliorants

Slaked lime and Dolomite were the important soil ameliorants used in the selected area. Costs incurred for the purchase of these soil ameliorants have also been calculated for the analysis of input costs.

3.5.4 COST OF LABOUR

3.5.4.1 Family labour

Family labour costs were estimated on the basis of existing wage rates of hired labour in the selected locality.

3.5.4.2 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 and female labours in the selected block was ₹ 750-850 and ₹ 450-500 respectively. Even though wage rates paid to the labours were different for different agricultural operations.

3.5.4.3 Machine labour

The labour costs incurred for tractor and combined harvester were worked out separately. The machine labour paid for the work of tractor and combined harvester was estimated based on the number of working hours and area of operation respectively. The cost of harvesting paddy in the selected locality was between ₹ 1900 and ₹2100 per hectare.

3.5.5 LAND REVENUE

Farmers have to pay a fixed monetary value as tax to the revenue department for the land they own. The real rate paid by them was estimated ₹ 250 per acre per year in that locality.

3.5.6 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 for the period of crop.

3.5.7 INTEREST ON FIXED CAPITAL

Fixed capital refers to the present value of equipment and assets except land value. Interest on fixed capital was worked out in the same way as interest on working capital. Banking institutions offer long term loans at an interest rate of 11 per cent per annum. Hence the interest on fixed capital was measured at 11 per cent per year.

3.5.8 RENTAL VALUE OF LEASED IN LAND

Since single season paddy cultivation was followed by the farmers in the study area, rent was charged for a single crop season. The current lending rate in the selected area was between ₹ 8000 and ₹10000 per acre.

3.5.9 RENTAL VALUE OF OWNED LAND

It was estimated based on the prevailing lease rates for the particular crop lands in the selected locale.

3.5.10 DEPRECIATION

Over the period of time due to wear and tear, the value of an asset get declined. This annual depreciation of working assets owned by paddy farmers was estimated individually by using straight line method. Subsequently the total annual depreciation was worked out of this.

3.5.11 MISCELLANEOUS EXPENSES

Expenses incurred for transporting of harvested paddy in to loading sites, filling of paddy in to the rice sacks and loading were apportioned as miscellaneous expenses.

3.5.12 QUANTITY OF OUTPUTS

Quantity of paddy is indicated in tonnes per hectare.

3.6 TOOLS FOR ANALYSIS

Various statistical tools were employed for the analysis of collected data in order to draw meaningful conclusions. Simple tabular analysis, percentage analysis, arithmetic averages, functional analysis, Regression analysis, Chow test and constraint analysis (Garrett ranking method) were mainly used for the statistical analysis.

3.6.1 Percentage and Average

The socio- economic characteristics of the respondents such as age of farmers, gender, educational status, family size of the respondents, land holdings, occupational status, annual income and experience in rice farming were examined using percentages and averages. In order to document the status of rice farming 15 statements were prepared with a five point continuum of ‘No change’, ‘Slightly increased’, ‘Highly increased’, ‘Slightly decreased’ and ‘Highly decreased’. The results were expressed in terms of frequencies and percentages.

3.6.2 Method of Estimation of Cost

Cost concepts used by Raju and Rao (2015) for farm management studies classified costs as cost A_1, A_2, B and C. These concepts were used in the present study in order to estimate the cost of cultivation and returns from paddy cultivation. The important cost concepts are elaborated as follows:

Cost A_1 includes

1. Cost of seeds

2. Cost of hired labour

3. Cost of machine labour

4. Cost of bullock labour

5. Cost of manures and fertilizers

6. Cost of plant protection chemicals

7. Value of soil ameliorants

8. Land revenue

9. Depreciation on machineries & farm implements used

10. Interest on working capital

11. Miscellaneous expenses

Cost A_2: Cost A_1 + Rental value of leased-in land

Cost B: Cost A_2 + Interest on the fixed capital (excluding land) + rental value of owned land

Cost C: Cost B + Imputed value of the family labour

3.6.3 Returns

3.6.3.1 Gross return

It was worked out as the product of total quantity of paddy produced per year by the respondents with its unit price. The government procurement price for paddy during the study period was ₹ 26.95 per kg.

3.6.3.2 Net return

Net return was calculated by deducting the annual maintenance cost of paddy from the estimated gross returns

3.6.4 Benefit- cost ratio

It was worked out as the ratio of the total benefits to total expenditure incurred for paddy production in the selected locale.

3.6.5 Cost of production

The average annual cost incurred for production of unit quantity of paddy was worked out as the ratio of total expenditure incurred for paddy production to total yield.

3.6.6 Production Function analysis

Among the different types of production functions, Cobb-Douglas production function was chosen to examine the resource use efficiency in paddy production due to its relative advantage over other production functions. Cobb-Douglas production function was used to assess how efficiently the scarce resources are allocated in the cultivation process of rice and also how various inputs and outputs produced in the selected locale are related to each other. Ordinary Least Square (OLS) method was considered to evaluate the factors influencing paddy production by taking yield as dependent variable and the different inputs used as independent variables. The function was fitted separately for farmers from both salinity affected and non-affected areas.

Algebraic form of Cobb- Douglas production function is represented as

$$Y = a\prod_{i=1}^{6}\left(X_i^{bi}\right)e$$

Fitted production function for this study is

$Y = a.\ X_1^{b1}\ X_2^{b2}\ X_3^{b3}\ X_4^{b4}\ X_5^{b5}\ X_6^{b6}\ e$

Above fitted function can be written in its log-log form as

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

Where,

Y = Quantity of output (kg)

a = Intercept

X_1 = Hired labour (man days)

X_2 = Family labour (man days)

X_3 = Quantity of manures and fertilizers (kg)

X_4 = Quantity of soil ameliorants (kg)

X_5 = Quantity of plant protection materials (kg)

X_6 = Machine and bullock power (hours)

$b_1, b_2, b_3, b_4, b_5, b_6$ = Regression coefficients of corresponding independent variable.

e = base of natural logarithm

3.6.7 Marginal Productivity Analysis

The ratio between Marginal Value Product (MVP) and Marginal Factor Cost (MFC) of each individual input gives the efficiency of resource use.

$$MPPi = bi \times \frac{\bar{Y}}{\bar{X}i}$$

Where,

MPP_i = Marginal Physical Product

$\bar{Y}$ = Geometric mean of production.

$\bar{X}_i$ = Geometric mean of the i^{th} independent variable.

bi = Regression coefficient of the i^{th} independent variable.

The formula used for the MVP calculation was:

$$\text{MVP of } Xi = P\,y\ \left(bi \times \frac{\bar{Y}}{\bar{X}i}\right)$$

Where,

Py = per unit price of paddy

Allocative efficiency (K_i) is calculated by the formula:

$$Ki = \frac{MVPi}{MFCi}$$

Where,

Ki = Allocative efficiency of ^{ith} resource.

MVPi = Marginal Value Product of i^{th} resource.

MFC = Marginal Factor Cost

3.6.8 Chow test

A Chow test was performed to get the parameter stability of the fitted regression models. For this production functions of salt water affected farmers, unaffected farmers and pooled function was used. F* was calculated by the given equation,

$$F^* = \frac{[\sum e_p^2 - (\sum e_1^2 + \sum e_2^2)]/K}{(\sum e_1^2 + \sum e_2^2)/(n_1 + n_2 - 2K)}$$

(Koutsoyiannis, 1977)

Where,

$\sum e_p^2$ = Sum of square of error term of pooled regression function of salinity affected and unaffected paddy farmers with ($n_1 + n_2 - 2K$) degrees of freedom

$\sum e_1^2$ = Sum of square of error term of regression function of salinity unaffected paddy farmers with ($n_1 - K$) degrees of freedom

$\sum e_2^2$ = Sum of square of error term of regression function of salinity affected farmers with ($n_2 - K$) degrees of freedom

n_1 = Number of salinity unaffected farmers

n_2 = Number of salinity affected farmers

K = Number of regression coefficients including constant

H_0 : **T**here is no significant difference in regression coefficients of the production functions of salt water unaffected and affected farmers

H_1 : The regression coefficients of the production functions of salt water unaffected and affected farmers differ significantly

Compare the observed F* with the theoretical value of $F_{0.05}$ with $v_1 = K$ and $v_2 = (n_1 + n_2 - 2K)$ degrees of freedom.

If $F^* > F_{0.05}$, we reject null hypothesis. *i.e* we accept that the two functions differ significantly

If $F^* < F_{0.05}$, accept null hypothesis. *i.e* there is significant difference between the two functions

3.6.9 Constraint Analysis

In order to analyse the constraints faced by paddy farmers from each salt water unaffected and affected areas, Henry Garrett's ranking technique was used. Several constraints were noted and enlisted in tabular form based on preceding literature and prevailing conditions in the selected area. During the survey, respondents were requested to rank those constraints without any bias. Using the formula shown below, the obtained ranks were then converted to the per cent position.

$$\text{Per cent position} = \frac{100 \times (R_{IJ} - 0.5)}{N_j}$$

Where,

R_{ij} = Rank given for the i^{th} factor by j^{th} person.

N_j = No. of constraints ranked by the j^{th} person.

(Garrett and Woodworth, 1969)

Using Garrett's conversion table, the calculated per cent positions were converted to Garrett score. 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 constraints were arranged in the ascending order and the constraint with the maximum mean score was identified as the serious problem faced by the paddy farmers in selected area.

Results and Discussions

Chapter IV

RESULTS AND DISCUSSION

The overall objective of the present study was to analyse the effect of salinity on paddy production in the Alappuzha district of Kerala. The results from the analysis of data collected for achieving this objective of the study were presented and neatly described in this chapter. As a detailed elaboration of information is highly essential to understand the problem and to arrive suitable policy suggestions, each of them is discussed under the following headings.

4.1 Socio economic characteristics of the sample respondents

4.2 Economics of paddy cultivation

4.3 Resource use efficiency

4.4 Effect of salinity on rice production and farm income

4.5 Major constraints faced by paddy farmers in Haripad block

4.6 Perception of farmers on the status of rice farming in Haripad block

4.1 SOCIO ECONOMIC CHARACTERISTICS OF THE SAMPLE RESPONDENTS

An elaborate description regarding socio-economic characteristics of the sample respondents comprising age of farmers, gender, educational status, family size of the respondents, experience in rice farming, occupation, annual income and land holding pattern were included in this section as follows.

4.1.1 Age

Based on the data collected from the sample farmers regarding the age group, they were classified into four different categories based on Newman and Newman (1999) classification of age groups. The results of the different age groups *viz.*, <30 years (youth), 30-45 years (adulthood), 45-60 years (middle adulthood) and >60 years (old age) are given in Table 3.

Table 3. Age wise classification of the sample farmers

Category of farmers	Age profile (Years)				Total	Average
	< 30	30 – 45	45 - 60	> 60		
Growing paddy in unaffected area	0 (0.0)	1 (4.0)	13 (52.0)	11 (44.0)	25 (100)	58.76
Growing paddy in affected area	0 (0.0)	2 (8.0)	13 (52.0)	10 (40.0)	25 (100)	57.48
Total	0 (0.0)	3 (6.0)	26 (52.0)	21 (42.0)	50 (100)	58.12

Note: Figures in parentheses denote percentage to row total

It was observed from the table that, out of the total 50 respondent farmers, no farmer belonged to the age group of <30 years. Majority of the farmers (94.0 %) were in the age group of middle adult hood and old age, indicating the refutation of young farmers in paddy farming. The average age groups of farmers growing paddy in salt water unaffected and affected areas were 58.76 and 57.48 per cent, respectively. This clearly indicated the aversion of younger generation towards paddy farming in the area.

4.1.2 Gender

The classification of farmers based on gender was presented in Table 4. It was observed that more than three-fourth of the total sample respondents were male both in unaffected and affected areas. Of the total respondents, only 14 per cent of farmers were female, occupying 12 per cent in non-saline and 16 per cent in saline areas, respectively.

Table 4. Gender wise distribution of the sample farmers

Category of farmers	Gender		Total
	Male	Female	
Growing paddy in unaffected area	22 (88.0)	3 (12.0)	25 (100)
Growing paddy in affected area	21 (84.0)	4 (16.0)	25 (100)
Total	43 (86.0)	7 (14.0)	50 (100)

Note: Figures in parentheses denote percentage to row total

The drudgery in cultivation, participation in MNREGS and Kudumbasree may be the reason for the lower participation of females in paddy cultivation

4.1.3 Educational status

It is imperative to know about the educational status of sample respondents in order to determine the efficiency in any field of activity. According to the level of education, the farmers were classified into illiterate, primary, secondary, pre-degree/HSC, diploma and graduation as presented in Table 5.

Table 5. Educational status of the sample farmers

Category of farmers	Education						Total
	Illiterate	Primary	Secondary	Pre-degree/HS	Diploma	Graduation	
Growing paddy in unaffected area	0 (0.0)	2 (8.0)	17 (68.0)	2 (8.0)	4 (16.0)	0 (0.0)	25 (100)
Growing paddy in affected area	0 (0.0)	0 (0.0)	20 (80.0)	3 (12.0)	1 (4.0)	1 (4.0)	25 (100)
Total	0 (0.0)	2 (4.0)	37 (74.0)	5 (10.0)	5 (10.0)	1 (2.0)	50 (100)

Note: Figures in parentheses denote percentage to row total

All the farmers were literates and majority (74%) acquired secondary level of education followed by HSC and diploma of 10 per cent each. Sixteen per cent of the farmers growing paddy in unaffected areas were had a diploma, where as it was only four per cent in the case of farmers growing paddy in affected areas. Farmers growing paddy in affected areas had a minimum of secondary level of education and also comprised graduated farmers to the extent of four per cent. Out of the total respondents, only two per cent of the paddy farmers were graduated in the area, which indicated the refutation of graduated persons entering in to paddy farming.

4.1.4 Family size

Based on the information collected from the sample respondents, the family size was categorised into nuclear (≤ 4 members) and joint family (5 to 8 members) as given in Table 6.

Table 6. Family size of the respondents

Category of farmers	Family size		Total	Average size
	≤ 4 (Nuclear)	5-8 (Joint)		
Growing paddy in unaffected area	14 (56.0)	11 (44.0)	25 (100)	4.61
Growing paddy in affected area	15 (60.0)	10 (40.0)	25 (100)	4.39
Total	29 (58.0)	21 (42.0)	50 (100)	4.50

Note: Figures in parentheses denote percentage to row total

About 58 per cent of the total respondents belonged to nuclear family and 42 per cent of total were living as joint families. The average family size of the farmers growing paddy in unaffected areas was 4.61 and for the farmers growing paddy in affected areas was 4.39.

4.1.5 Experience in rice farming

The distribution of respondents based on their experience in farming is presented in Table 7. The respondents were grouped according to their experience in paddy farming into ≤10 years, 11 to 20 years and > 20 years.

Table 7. Classification of respondents based on farming experience

Category of farmers	Experience in Rice farming			Total	Average year of experience
	≤10	11 to 20	>20		
Growing paddy in unaffected area	4 (16.0)	4 (16.0)	17 (68.0)	25 (100)	25.64
Growing paddy in affected area	0 (0.0)	8 (32.0)	17 (68.0)	25 (100)	28.28

Total	4 (8.0)	12 (24.0)	34 (68.0)	50 (100)	26.96

Note: Figures in parentheses denote percentage to row total

More than two third of respondents (68%) were having an experience of >20 years. Of the total farmers in each area, 16 per cent farmers were having less than ten years of experience in unaffected areas while it was zero in the case of affected areas. The average years of experience was higher for the respondents growing paddy in the affected area (28.28) compared to the farmers growing paddy in unaffected area (25.64).

4.1.6 Occupation

The occupational status was classified into agriculture as main occupation and agriculture as a subsidiary component of occupation based on the data collected from the sample farmers. Agriculture as a subsidiary was further classified into public, private and self-employment as shown in Table 8.

Table 8. Classification of farmers based on occupational status

Category of farmers	Agriculture as main	Agriculture as subsidiary			Total
		Public	Private	Self employed	
Growing paddy in unaffected area	18 (72.0)	1 (4.0)	1 (4.0)	5 (20.0)	25 (100)
Growing paddy in affected area	23 (92.0)	0	1 (4.0)	1 (4.0)	25 (100)
Total	41 (82.0)	1 (2.0)	2 (4.0)	6 (12.0)	50 (100)

Note: Figures in parentheses denote percentage to row total

The majority of the farmers (82%) were doing agriculture as their main occupation. Farmers doing agriculture as a subsidiary constituted about 18 per cent of the total (12 % self-employed, 4% in private sector and 2% in public sector). The percentage of sample farmers chosen agriculture as their main occupation was higher in affected area (92%) than in unaffected area (72 %).

4.1.7 Annual income

Based on annual income respondents were categorised into four categories: below ₹50,000, ₹50,000 - ₹1,00,000, ₹1,00,000 - ₹2,50,000, and > ₹ 2,50,000. Grouping of farmers according to their annual income was presented in Table 9.

Table 9. Classification of the sample respondents according to average annual income

Category of farmers	Annual income (₹)				Total	Average annual income (₹)
	< ₹50000	₹50000-₹100000	₹100000-₹250000	> ₹250000		
Growing paddy in unaffected area	4 (16.0)	7 (28.0)	12 (48.0)	2 (8.0)	25 (100)	135200
Growing paddy in affected area	6 (24.0)	9 (36.0)	9 (36.0)	1 (4.0)	25 (100)	114200
Total	10 (20.0)	16 (32.0)	21 (42.0)	3 (6.0)	50 (100)	124700

Note: Figures in parentheses denote percentage to row total

About 80 per cent of the total respondents were having an annual income of more than ₹ 50,000. Sixteen per cent of the sample farmers in unaffected area and 24 per cent of farmers in affected were receiving less than ₹ 50,000 per year. The average annual income of the sample respondents growing paddy in unaffected area (₹1,35,200) was higher than the respondents in affected area (₹1,14,200).

Average annual income of respondents were categorised in to on-farm income and off-farm income, respectively based on the sources of income. Annual income worked out for the affected and unaffected farmers is presented in Table.10

Table 10. Source wise average annual income distribution of respondents

Category of farmers	On-farm income (₹)	Off-farm income (₹)
Growing paddy in unaffected area	82,400	14,266
Growing paddy in affected area	64,200	16,666
Average income	73,300	15,466

On- farm income earned by the paddy farmers in the unaffected area (₹ 82,400) was more than that of the affected farmers (₹ 64,200). Off-farm income of the affected farmers (₹ 16,666) was higher than the unaffected farmers (₹ 14,266). Which indicated the diversion of farmer’s interest from paddy cultivation to other off- farm activities in the salt water affected areas.

4.1.8 Land holdings

Table 11 depicts the distribution of sample respondents according to the size of land holding. Based on the size of land holdings, sample respondents were classified into marginal (below 1 acre), small (1.0-2.5 acres), medium (2.5-5.0 acres) and large (above 5 acres). About half (52%) of the sample respondents were small farmers followed by medium (20%), large (18%) and marginal farmers (10%). The average size of land holdings for the marginal, small, medium and large farmers was 0.32, 1.95, 3.47 and 9.25, respectively. The average size of land holdings was higher for the farmers in affected area (3.54 acres) than farmers in the unaffected area (3.14 acres).

4.1.9 Ownership

The particulars on the ownership of holdings of the sample respondents were given in Table 12. According to the ownership of land holdings, respondents were classified into doing cultivation in owned land, leased in land and in both the lands together. Majority of the sample farmers (64 %) were cultivating in their own land followed by cultivation in both owned, leased in lands together (30 %) and leased in land (6.0 %) with an average size of 2.28 acres, 4.17 acres and 5.83 acres respectively. The percentage of sample farmers cultivating in leased land in affected areas were zero and is 12 per cent in unaffected areas. The percentage of owned land was higher for the farmers growing paddy in unaffected area compared to farmers in affected area.

Table 11. Classification of farmers based on size of land holdings

Category of farmers	Classes of holdings (in Acres)								Total	Average size of holdings (in Acres)
	Marginal < 1.0		Small 1.0-2.5		Medium 2.5-5.0		Large >5.0			
	Number	Size (in Acres)	Number	Size (in Acres)	Number	Size (in Acres)	Number	Size (in Acres)		
Growing paddy in unaffected area	5 (20.0)	0.65	11 (44.0)	1.80	3 (12.0)	3.5	6 (24.0)	7.5	25 (100)	3.14
Growing paddy in affected area	0 (0.0)	0.0	15 (60.0)	2.09	7 (28.0)	3.43	3 (12.0)	11	25 (100)	3.54
All categories	5 (10.0)	0.65	26 (52.0)	1.97	10 (20.0)	3.45	9 (18.0)	8.66	50 (100)	3.34

Note: Figures in parentheses denote percentage to row total

Table 12. Details on the ownership of holdings of the sample farmers

Category of farmers	Owned land (in Acres)		Leased in land (in Acres)		Cultivation in both lands (in Acres)		Total
	Number	Average size	Number	Average size	Number	Average size	
Growing paddy in unaffected area	17 (68.0)	1.92	3 (12.0)	4.17	5 (20.0)	7.90	25 (100)
Growing paddy in affected area	15 (60.0)	2.53	0 (0.0)	0	10 (40.0)	4.79	25 (100)
Total	32 (64.0)	2.28	3 (6.0)	4.17	15 (30.0)	5.83	50 (100)

Note: Figures in parentheses denote percentage to row total

4.2 ECONOMICS OF PADDY CULTIVATION

Economics of paddy cultivation was used in order to compare the relative performance of the salt water unaffected and the affected farmers in the study area. Cost of cultivation of paddy for the salt water unaffected and affected farmers were estimated using the ABC cost concepts *viz.*, cost A_1, cost A_2, cost B and cost C are presented in Table 13 and 14.

4.2.1 Cost of cultivation of paddy for the salt water unaffected farmers

The average annual cost of cultivation for the salt water unaffected farmers was found to be slightly lesser when compared to that of salt water affected farmers. The average annual cost of cultivation for the salt water unaffected farmers is furnished in Table 13. The difference in the costs was mainly due to the comparatively lower usage of inputs in the salt water unaffected areas. The total cost of cultivation at cost C worked out for unaffected farmers was ₹ 1,03,322.85 per hectare. Cost A_1 constituted ₹ 72,389.79 per hectare, of which cost incurred for the hired labour stood highest and accounted for more than one fourth of cost A_1. It was estimated at ₹ 23,380.22 ha^{-1} and was 32.30 per cent of cost A_1. Since paddy cultivation is labour intensive cost incurred for wages was also more. Wages paid to the labourers for each farm operations was different in the area and it included the rent paid for implements also. Many farmers have used their own farm implements in the fields. Following the labour cost, cost incurred for machine labour (20.99%), cost of manures and fertilizers (13.70%) occupied in the second and third positions respectively. Costs of plant protection chemicals accounted for 10.49 per cent of cost A_1. Cost of seeds, cost of bullock labour, value of soil ameliorants, land revenue, depreciation, and interest on working capital all together constituted 8.74 per cent of cost A_1 and the remaining costs were classified under miscellaneous cost.

The diagrammatic representation of components of cost A1 for the unaffected farmers is given in Figure 6. Cultivation in the leased in lands was predominant in the study area resulting in demand for leased in lands was more. Consequently, the rental value of land in the unaffected areas was higher when compared to affected areas. Cost A_2 and cost B was found to be ₹ 82,923.14 and ₹ 99,037.91 ha^{-1}, respectively.

4.2.2 Cost of cultivation of paddy for the salt water affected farmers

The average annual cost of cultivation for the salt water affected farmers is given in Table 14. The total cost C estimated from the affected area was more than that of unaffected farmers and was ₹ 104145.13 ha^{-1}. Cost A_1, cost A_2, cost B accounted to ₹ 75,873.25, ₹ 82,788.65 and ₹ 1,00,426.77 ha^{-1}, respectively. Among the components of cost A1, the cost incurred for hired labour was the maximum, constituting 33.76 per cent followed by cost of machine labour (20.99 %). The cost incurred for fertilizers and for plant protection chemicals together constituted 31.48 per cent of cost A_1. A significant increase in cost of soil ameliorants (4.70 %) was observed in the affected areas, but it remained to be of very less amount in the unaffected areas. Cost of seeds (3.01%), cost of bullock labour (0.86%), land revenue (0.59%), depreciation (0.71%) and interest on working capital (2.29%) accounted for minor shares in the total cost A_1. The rental value of leased in land was comparatively lesser in the affected areas comparing to the unaffected areas. As a result cost A_2 was less in the affected area. The rental value of leased in land was found out to be ₹ 6,915.40 per hectare. Pictorial representation of components of cost A_1 for the affected farmers is given in Figure 7.

From the analysis it was found that the cost of cultivation of paddy in salt water affected area was slightly higher than that of the unaffected area. The major share of the cost was incurred for the hired labour, machine labour, manures and fertilizers, respectively for both affected and unaffected farmers. Miscellaneous expenses were higher in the unaffected area compared to the affected areas. It was mainly due to the higher expenses incurred for transportation of harvested paddy, filling of paddy in to the rice sacks and loading charges in the unaffected areas.

The result of the study conducted by the Government of Kerala (2016) regarding the cost of cultivation of paddy in Alappuzha district was in close proximity with the results of the current study. As per the report the average annual cost of cultivation incurred for the paddy farmers was ₹ 95,929 ha^{-1}.

Table 13. Cost of cultivation of paddy for the salt water unaffected farmers

Sl. No	Item	Cost (Rs/ha)	Percentage to cost A_1
1	Cost of seeds	2,022.50	2.79
2	Cost of hired labour	23,380.22	32.30
3	Cost of machine labour	15,196.47	20.99
4	Cost of bullock labour	781.57	1.08
5	Cost of manures and fertilizers	9,916.15	13.70
6	Cost of plant protection chemicals	7,593.81	10.49
7	Value of soil ameliorants	942.75	1.30
8	Land revenue	657.70	0.91
9	Depreciation	492.62	0.68
10	Interest on working capital	1,433.26	1.98
11	Miscellaneous expenses	9,972.74	13.78
	Cost A_1	72,389.79	-
12	Rental value of leased in land	10,533.35	-
	Cost A_2	82,923.14	-
13	Interest on owned fixed capital excluding land	1,500.14	-
14	Rental value of owned land	14,614.63	-
	Cost B	99,037.91	-
15	Imputed value of family labour	4,284.94	-
	Cost C	1,03,322.85	-

Table 14. Cost of cultivation of paddy for the salt water affected farmers

Sl. No	Item	Cost (Rs/ha)	Percentage to cost A_1
1	Cost of seeds	2,283.00	3.01
2	Cost of hired labour	25,611.83	33.76
3	Cost of machine labour	15,199.03	20.03
4	Cost of bullock labour	649.86	0.86
5	Cost of manures and fertilizers	11,013.08	14.52
6	Cost of plant protection chemicals	7,931.79	10.45
7	Value of soil ameliorants	3,567.33	4.70
8	Land revenue	446.29	0.59
9	Depreciation	541.27	0.71
10	Interest on working capital	1,735.66	2.29
11	Miscellaneous expenses	6,894.09	9.09
	Cost A_1	75,873.25	-
12	Rental value of leased in land	6,915.40	-
	Cost A_2	82,788.65	-
13	Interest on owned fixed capital excluding land	1,119.98	-
14	Rental value of owned land	16,518.14	-
	Cost B	1,00,426.77	-
15	Imputed value of family labour	3718.35	-
	Cost C	1,04,145.00	-

Figure 6. Per cent share of each component at cost A_1 of the unaffected farmers

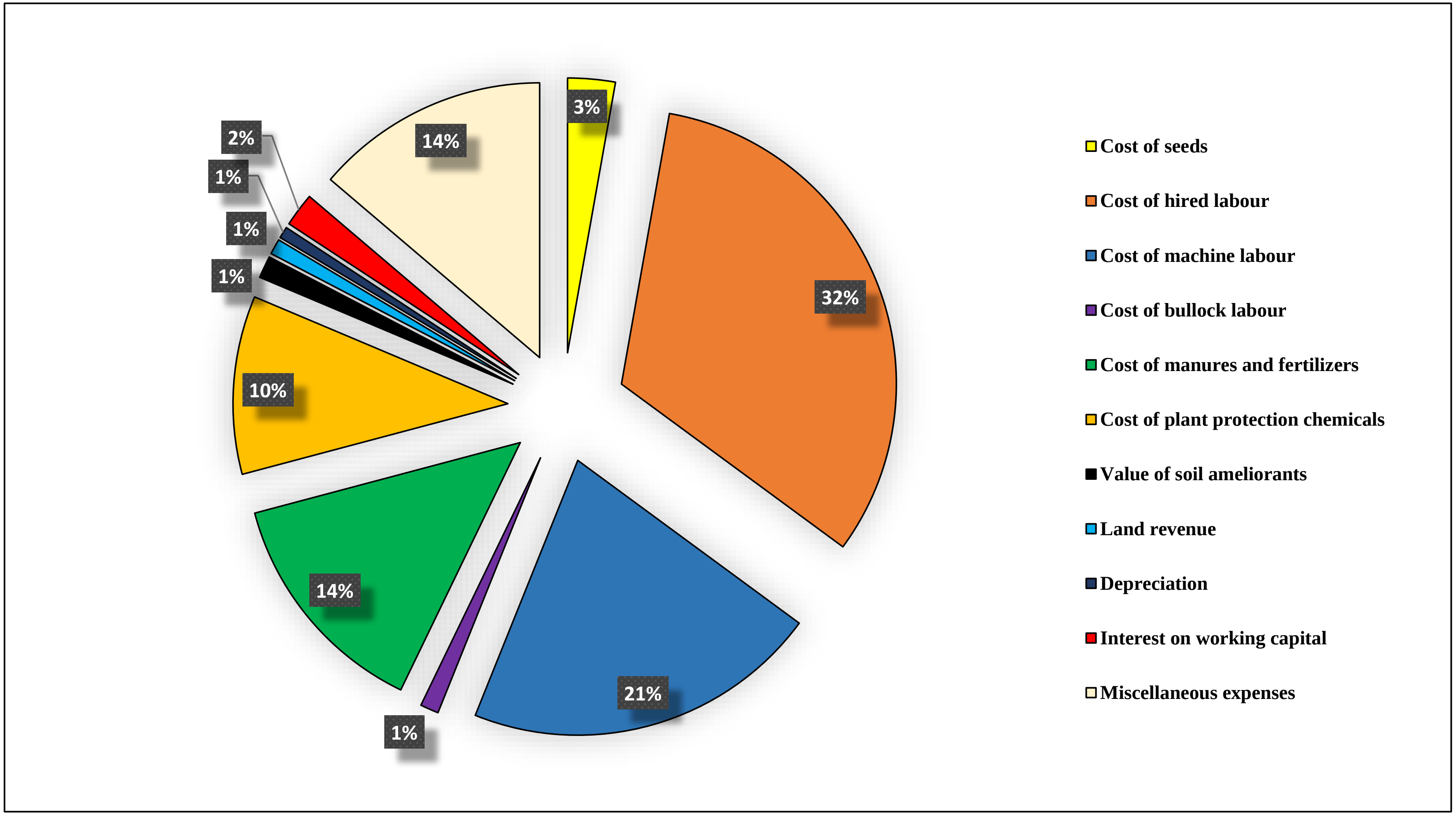


Figure 7. Per cent share of each component at cost A_1 of the affected farmers

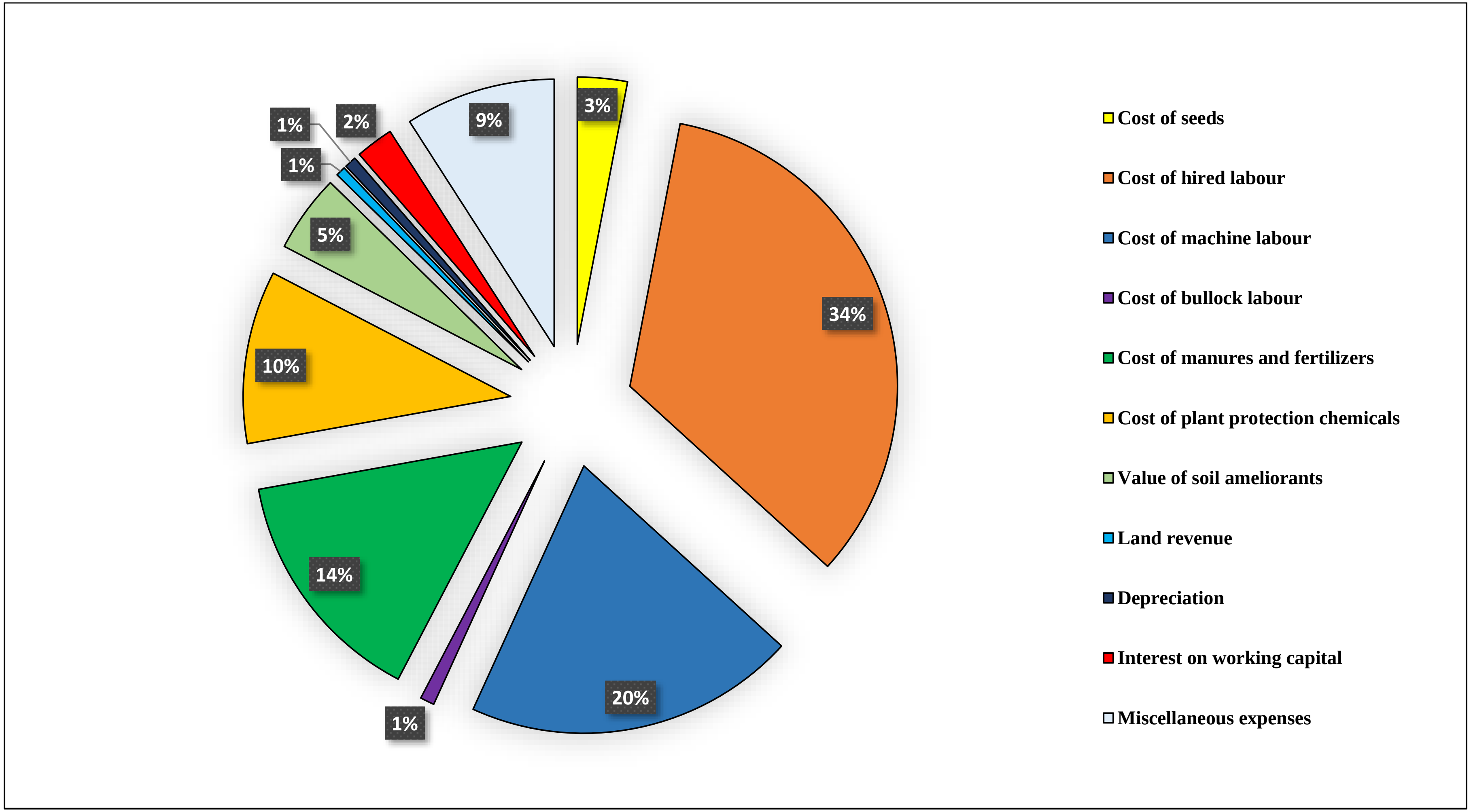


Table 15. Cost of production of paddy by the unaffected and the affected farmers

Sl No.	Particular	Unaffected farmers	Affected farmers
1.	Cost A_1 (₹ /t)	12,051	19,960
2.	Cost A_2 (₹ /t)	13,805	21,780
3.	Cost B (₹ /t)	16,488	26,420
4.	Cost C (₹ /t)	17,200	27,398

The average cost of production per tonne of paddy by the salt water unaffected and the affected farmers is given in Table 15. The average cost of production of respondents from the unaffected area was less when compared to that of affected farmers. The average cost of production at cost C for the unaffected and the affected farmers was ₹17,200 and ₹27,398 t^{-1}, respectively. Even though the cost of cultivation was almost close in both the areas, the yield realised from the affected areas was remarkably lesser than that of unaffected areas and, in turn, led to the increased cost of production of paddy in the affected areas. The cost of production of paddy for the unaffected and the affected farmers showed a difference of around ₹ 10,000 t^{-1} at cost B and cost C. This could be attributed to the enhanced yield potential of paddy in unaffected areas.

4.3 RESOURCE USE EFFICIENCY

4.3.1 Resource use efficiency in paddy production by the salt water unaffected and the affected farmers

Efficiency studies helps to explain the current performance and potential to boost the crop production. In order to examine the resource use efficiency for rice cultivation, Cobb- Douglas production function was used. The production function was fitted separately for the salt water affected farmers as well as the unaffected farmers. Physical quantities of the dependent variable and independent variables were taken for the regression analysis. Multicollinearity between the independent variables were checked by estimating the Variance Inflation Factor (VIF). Resource use efficiency in paddy production by the salt water unaffected and the affected farmers along with resource use efficiency in their pooled data were estimated and furnished in tables 16, 17 and 18 respectively.

Urea, Factamfos and Muriate of potash were the popular fertilizers used by the farmers. Lime and Dolomite were used as soil ameliorants in order to manage acidity in the fields. The R^2 value obtained from regression analysis of the unaffected farmers was 0.90, which defines that, 90 per cent of the changes in yield was explained by quantity of hired labour, family labour, manures and fertilizers, soil ameliorants, plant protection chemicals, machine and bullock power.

Among the independent variables, quantity of manures and fertilizers, machine and bullock power significantly influenced the yield of paddy at 1 per cent level of significance. One per cent increase in quantity usage of manures and fertilizers, machine and bullock power were found to enhance the yield of paddy by 0.59 and 0.64 per cent, respectively. Quantity of hired labour, soil ameliorants and plant protection chemicals were found significant at 5 per cent level of significance with positive coefficient. Quantity of family labour in the analysis was observed non-significant with positive coefficient.

$\sum bi$ value represents the returns to scale of the production function. It was observed from the analysis that, a simultaneous increase in all the independent variables by one per cent will increase the yield of paddy by 2.24 per cent. So the function was having an increasing returns to scale. The VIF value for independent variables was less than 5, indicating negligible multicollinearity between the selected independent variables.

Table 16. Estimated production function of rice production by the salt water unaffected farmers

Particulars	**Coefficients**	**Standard Error**	**P value**	**VIF**
Intercept	0.335	1.908	0.862	
Quantity of hired labour	0.563**	0.226	0.023	4.75
Quantity of family labour	0.044	0.161	0.788	1.8
Quantity of manures and fertilizers	0.594***	0.202	0.009	4.4
Quantity of soil ameliorants	0.098**	0.038	0.020	2.02
Quantity of plant protection chemicals	0.285**	0.136	0.050	2
Quantity of machine and bullock power	0.640***	0.150	0.000	2.8
R^2	0.90			
Adjusted R^2	0.87			
Calculated F	27.33			
$\sum bi$	2.24			
No. of observations	25			

** Significant at 5 per cent level, *** Significant at 1 per cent level

Note: Coefficients were obtained with log values

Results of resource use efficiency tabulated for the salt water affected farmers were presented in table 16. R^2 value obtained for the salt water affected farmers was 0.89 with an adjusted R^2 value of 0.86. The R^2 value represents that 89 per cent of variation in yield was explained by the independent variables used for analysis. The quantity of hired labour, manures and fertilizers were significant at 1 per cent level with coefficients 0.474 and 0.258. Quantity of plant protection chemicals had a positive coefficient and it was significantly influencing the yield of paddy at 5 per cent level. One per cent increase in use of plant protection chemicals will result in 0.19 per cent increase in yield. Quantity of soil ameliorants, machine and bullock power was observed to be significant at 10 per cent level of significance with positive coefficients. As in the case of unaffected farmers, family labour was found to be non-significant with positive coefficient for affected farmers.

$\sum bi$ value for the production function analysis was obtained as 1.31, which indicated an increasing returns to scale. Thus a simultaneous increase in all the independent variables by one per cent will increase the yield of paddy by 1.31 per cent in the salt water affected area. VIF was estimated to detect multicollinearity and observed within a range of 1.24 to 2.1 indicating negligible presence of correlation between the independent variables.

Table 17. Estimated production function of rice production by the salt water affected farmers

Particulars	**Coefficients**	**Standard Error**	**P value**	**VIF**
Intercept	2.860	0.596	0.000	
Quantity of hired labour	0.474***	0.103	0.000	2.1

Quantity of family labour	0.094	0.068	0.186	1.44
Quantity of manures and fertilizers	0.258***	0.079	0.004	1.44
Quantity of soil ameliorants	0.174*	0.087	0.060	1.89
Quantity of plant protection chemicals	0.190**	0.089	0.046	1.44
Quantity of machine and bullock power	0.123*	0.066	0.078	1.24
R^2	0.89			
Adjusted R^2	0.86			
Calculated F	25.16			
$\sum bi$	1.311			
No. of observations	25			

* Significant at 10 per cent level, ** Significant at 5 per cent level, *** Significant at 1 per cent level

Note: Coefficients were obtained with log values

Results of production function analysis of pooled data of salt water affected farmers and unaffected farmers is shown in table 18. The R^2 value obtained was 0.70 with an adjusted R^2 value of 0.66 indicating that 70 per cent of variation in yield was explained by the independent variables used for the analysis. The quantity of family labour, plant protection chemicals, machine and bullock power were significant at 1 per cent level with coefficients 0.314, 0.383 and 0.450, respectively. Quantity of manures and fertilizers was significantly influencing the yield at 5 per cent level. One per cent increase in use of manures and fertilizer resulted in 0.27 per cent increase in yield of paddy. Quantity of hired labour was observed to be significant at 10 per cent level of significance with a positive coefficient of 0.213. Coefficient of soil ameliorants was positive and non-significant.

The returns to scale ($\sum bi$) for the production function analysis was found to be 1.64, which indicated an increasing returns to scale of overall paddy farmers in the area. Thus a simultaneous increase in all the independent variables by one per cent will increase the yield of paddy by 1.64 per cent in the selected area in Alappuzha district. VIF values lie within a range of 1.24 to 1.51 indicating negligible presence of multicollinearity between the independent variables.

Table 18. Estimated production function of pooled data of the salt water affected and the unaffected farmers

Particulars	**Coefficients**	**Standard Error**	**P value**	**VIF**
Intercept	3.404	0.894	0.000	
Quantity of hired labour	0.213*	0.122	0.088	1.51
Quantity of family labour	0.314***	0.111	0.007	1.26
Quantity of manures and fertilizers	0.271**	0.100	0.010	1.24
Quantity of soil ameliorants	0.010	0.032	0.763	1.61
Quantity of plant protection chemicals	0.383***	0.108	0.001	1.24
Quantity of machine and bullock power	0.450***	0.104	0.000	1.45
R^2	0.70			
Adjusted R^2	0.66			
Calculated F	17.04			
$\sum bi$	1.64			
No. of observations	50			

* Significant at 10 per cent level, ** Significant at 5 per cent level, *** Significant at 1 per cent level; Note: Coefficients were obtained with log values

Similar studies conducted by Suresh and Reddy (2006), Kalpalatha and Reddy (2018) on the resource use efficiency in rice revealed that the quantity of human labour, manures and fertilizers and plant protection chemicals used have a positive and significant effect on rice production and the findings of current study are in agreement with these results.

4.3.2 Marginal productivity analysis

Ratio of Marginal Value Product (MVP) and Marginal Factor Cost (MFC) of each inputs were calculated to study the efficiency of resource use in paddy cultivation. MVP of each inputs was worked out from the corresponding geometric means and regression coefficients. Allocative efficiency explains how resources in a farm are efficiently utilized and is examined by the value of K. The results of marginal productivity analysis done for the salt water unaffected and the affected farmers are mentioned in Table 19, 20 respectively.

The K value obtained for each independent variable from the analysis showed that, all variables except manures and fertilizers were having a K value of more than one for the unaffected farmers. This indicated the suboptimal or underutilization of resources by farmers in the salt water unaffected area. An optimal utilization of resources can improve the allocative efficiency and hence production of paddy in the area. K value for quantity of manures and fertilizers were obtained as 0.61. This represented the overutilization of manures and fertilizers by the farmers.

Likewise for the unaffected farmers, the K value obtained for all variables except manures and fertilizers for the affected farmers was more than one. This indicated the underutilization of these resources by farmers in salt water affected area. K value obtained for quantity of manures and fertilizers was 0.90. This represented the overutilization of manures and fertilizers by the farmers and can be reduced to improve the allocative efficiency.

Efficiency of resources varies from place to place due to the changes in fertilizers used, availability of inputs, financial conditions, extent of adoption of agricultural operations. A similar study on resource use efficiency of rice production carried out by Devi and Singh (2014) in the state of Manipur revealed that the allocative efficiency worked out for all the inputs was less than one, except for fertilizer. This represented the over utilization of other inputs and under-utilization of fertilizer in the area. And results of the current study run contrary to this study.

Table 19. Economic efficiency of input use for the salt water unaffected farmers

S No.	Particular	Geometric mean	MVP	MFC	K = MVP/MFC
1	Yield	4617.88			
2	Quantity of hired labour	30.98	1346.78	725.27	1.86
3	Quantity of family labour	6.36	11004.2	716.22	15.36
4	Quantity of manures and fertilizers	510.56	10.72	17.54	0.61
5	Quantity of soil ameliorants	267.74	275.99	5.44	50.77
6	Quantity of plant protection chemicals	6.06	2012.01	1206.11	1.67
7	Quantity of machine and bullock power	11.17	3180.65	1251.51	2.54

Table 20. Economic efficiency of input use for salt water affected farmers

S No.	Particular	Geometric mean	MVP	MFC	MVP/MFC=K
1	Yield	4526.04			
2	Quantity of hired labour	43.95	7937.75	680.01	11.67
3	Quantity of family labour	6.20	9316.42	703.74	13.24
4	Quantity of manures and fertilizers	809.87	14.11	15.68	0.90
5	Quantity of soil ameliorants	731.88	42.94	5.50	7.81
6	Quantity of plant protection chemicals	8.33	2546.85	1140.45	2.23
7	Quantity of machine and bullock power	13.44	1720.99	1303.69	1.32

4.4 EFFECT OF SALINITY ON RICE PRODUCTION AND FARM INCOME

4.4.1 Effect of salinity on rice production

The average rice yield obtained from paddy cultivated in the salt water unaffected (6.01 t/ha) and the affected area (3.80 t/ha) showed a remarkable difference. Chow test was used to examine the existence of significant difference in regression coefficients of independent variables used in regression analysis of rice production by the salt water unaffected and the affected farmers. The null hypothesis and alternate hypothesis of the test were as given below.

H_0 : There is no significant difference in regression coefficients of the production functions of the salt water unaffected and the affected farmers

H_1 : The regression coefficients of the production functions of salt water unaffected and affected farmers differ significantly.

The observed value of F was worked out by the given equation and sum of squares of error terms of salt water unaffected, affected and their pooled regression is shown in Table 21.

$$F^* = \frac{[\sum e_p^2 - (\sum e_1^2 + \sum e_2^2)]/K}{(\sum e_1^2 + \sum e_2^2)/(n_1 + n_2 - 2K)}$$

Table 21. Sum of square of error term of regression analysis

S No.	Groups	$\sum e^2$
1	Unaffected farmers $\sum e_1^2$	1838389398.0
2	Affected farmers $\sum e_2^2$	809239983.3
3	Unaffected farmers + Affected farmers (Pooled regression) $\sum e_p^2$	3446402683.0

F* calculated from the Chow test was 5.14, which was compared with the table value of F at 5 per cent level of significance with $v_1 = K$ and $v_2 = (n_1 + n_2 - 2K)$ degrees of freedom. And if $F^* > F_{0.05}$, we reject null hypothesis. The $F_{0.05}$ at $v_1 = 7$ and $v_2 = 36$ degrees of freedom was found to be 2.28 and hence the null hypothesis was rejected and concluded that there is a significant difference in regression coefficients between the salt water unaffected and the affected farmers. The result of chow test is given in Table 22.

Table 22. Results of Chow test showing impact of salinity on rice production

F*	F-tab	Decision	Remark
5.14	2.28	If F* > $F_{0.05}$; then there is a significant difference in coefficients between the salt water unaffected and the affected farmers	The two production functions differ significantly between the salt water affected and unaffected area.

4.4.2 Effect of salinity on farm income of farmers

4.4.2.1 Net returns

Net returns obtained by the farmers from paddy production was worked out to evaluate the profit from rice cultivation. The procurement price of paddy fixed by the state government was ₹ 26.95 per kg. The gross returns obtained by both the salt water unaffected and affected farmers were worked out and net returns at cost A_1, cost A_2, cost B and cost C were found out separately. A remarkable difference was observed in average returns between salt water unaffected and affected farmers and is shown in Table 23.

Average yield obtained by the unaffected and affected farmers was 6.01 and 3.80 t/ha. Salt water intrusion had caused a drastic impact in yield obtained by the farmers. A significant difference of 2.21 t/ha of average rice yield and ₹ 59,440.31 per hectare in gross returns existed between the salt water unaffected farmers and the affected farmers. Even though the cost incurred for inputs and agricultural operations of both farmers was marginally different, the salt water affected farmers faced major downfall in returns due to decreased yield and poor quality of the grains. Five kilogram per quintal of paddy was considered as *Kizhivu* (reduction in weight) in the salt water affected areas. As a result, in order to obtain the returns from one quintal of paddy farmers from the affected areas had to forego 105 kg of paddy. Hence the average price obtained by the farmers from 1kg of paddy was ₹25.66. This attributed to the lower returns from paddy for the salt water affected farmers.

Table 23. Returns from paddy cultivation in the salt water unaffected and the affected areas.

Sl No.	Particular	Returns	
		Unaffected farmers	Affected farmers
1	Yield (t/ha)	6.01	3.80
2	Price (₹ /kg)	26.95	26.95
3	Gross returns (₹/ha)	1,61,883.36	102443.05
4	Net returns at cost A_1 (₹ /ha)	89,493.57	26569.80
5	Net returns at cost A_2 (₹ /ha)	78,960.22	19654.40
6	Net returns at cost B (₹ /ha)	62,845.45	2016.27
7	Net returns at cost C (₹ /ha)	58,560.51	-1702.08

The gross returns obtained by the salt water affected farmers was ₹1,02,443.05 per hectare. The net returns at cost A_1, cost A_2, and cost B were ₹26,569.80, ₹19,654.40, ₹2,016.27 per hectare respectively. There was no net returns for farmers in the saltwater affected area at cost C and also they faced a monetary loss of ₹ 1,702.08 per hectare.

The gross returns obtained by the salt water unaffected farmers was ₹1,61,883.36 per hectare. The net returns at cost A_1, cost A_2, cost B and cost C for salt water unaffected farmers were worked out to be ₹89,493.57, ₹78,960.22, ₹62,845.45, ₹58,560.51 per hectare respectively. Two kilograms per quintal of paddy was considered as *Kizhivu* in the salt water unaffected areas. Thus the average price obtained by the farmers for 1 kg of paddy was ₹ 26.42.

4.4.2.1 B-C Ratio

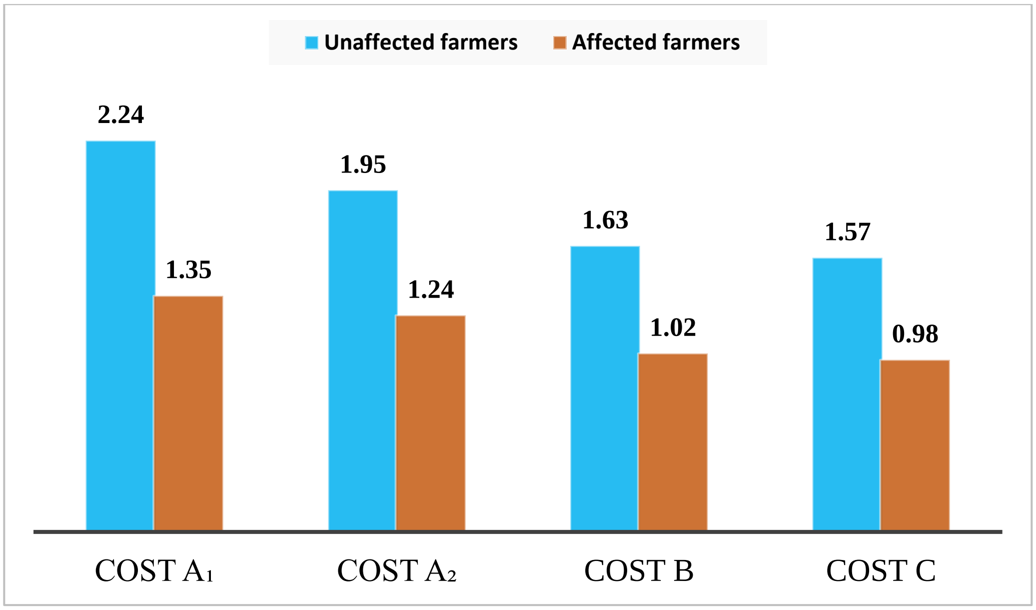
The returns generated by farmers per rupee invested in paddy cultivation was worked out for salt water unaffected and affected areas in order to evaluate the profitability. B-C ratio of unaffected and affected farmers from paddy cultivation is given in Table 24. From the results, B-C ratio of salt water unaffected farmers at cost A_1, cost A_2, cost B and cost C was 2.24, 1.95, 1.64 and 1.57, respectively. The B-C ratio of affected farmers at cost A_1, cost A_2 and cost B was 1.35, 1.24 and 1.02 0.98 respectively. Also the results clearly showed that the unaffected farmers got more profit relative to the affected farmers. The B-C ratio at cost C for affected farmers was 0.98 which indicated the occurrence of slight losses from production.

Table 24. B-C ratio of salt water unaffected and affected farmers

Sl. No	**Cost**	**Unaffected farmers**	**Affected farmers**
1	Cost A_1	2.24	1.35
2	Cost A_2	1.95	1.24
3	Cost B	1.64	1.02
4	Cost C	1.57	0.98

A similar study conducted by Radhika (2014) revealed that the relative profitability from saline affected Kaipad area of Kannur district was much less than the non-saline areas. The diagrammatic representation of B-C ratio of unaffected and affected farmers at different cost levels are depicted in Figure 8.

Fig 8. B-C ratio of salt water unaffected and affected farmers at different cost levels.



4.4 PERCEPTION OF FARMERS ON THE STATUS OF RICE FARMING IN HARIPAD BLOCK

The data pertaining to the perception of farmers on current status of rice farming in Haripad block over the past 10 years were given in Table 25. Majority of the respondents (52.0%) expressed that, there was no change in the area under rice cultivation and about 38 per cent of the respondents stated a slight increase in the area. About 66 per cent of the sample respondents expressed high large increase in the cost of cultivation. This was mainly due to the increased wage rates of labourers and prices of inputs. No change in the yield was expressed by 52 per cent of the sample farmers, whereas 20 per cent of the respondents expressed slight increase in the yield. This was due to the increased usage of machines and implements as well as high yielding varieties of rice. And 20 per cent of respondents expressed slight decrease in yield over the years. 100 per cent of the farmers opined increase in market price of their produce in the last 10 years. Nearly 66 per cent of the farmers expressed, over the years there has been increase in the procurement price of rice. The increase was due to price policies followed by central and state governments. In addition to the minimum support price the state government was paying state incentive bonus in order to help the farmers. More than half of the respondents vented a slight reduction in labour availability. The labour wages per day as expressed by the sample farmers increased in the area. Sixty per cent of the respondents vented the difficulty in getting good quality seeds is getting reduced over the years. Which might due to the increased seed production and market possibilities of distribution units.

About half of the respondents expressed that the emergence of new weeds was posing problems. The continuous usage of same herbicides without rotation might be the reason for emergence of new weeds. Some of the farmers opined that new weeds mainly entered the fields through the seeds they procured from outside districts. Application of micro nutrients and soil test based fertilizer recommendation increased mainly due to the increased awareness about their importance in farming. Mechanisation and general interest in rice farming had also increased. This was due to the welfare schemes implemented by the government to the paddy farmers. This was due to the increased aid provided by the government to the paddy farmers. But the involvement of younger generation in paddy farming decreased due to their lack of interest in farming and tendency in acquiring white collar jobs.

The sample farmers also expressed slight increase in the adoption of mitigation strategies followed for salt water intrusion. A study conducted by M. S. Swaminathan Research Foundation (MSSRF**) (**2007) evaluated the measures to mitigate agrarian distress in Alappuzha and Kuttanad wetland ecosystem. *Orumuttu* or temporary salt exclusion barriers were constructed to prevent the salinity intrusion from sea to Kuttanad through major and minor inlets. Even though, it was costly and inefficient for the timely prevention of salinity. But now the construction expenses of *Orumuttu* is solely undertaken by the state irrigation department.

Table 25. Distribution of sample farmers according to their view on the current status of rice farming compared to past 10 years

S No	Particular	No change	Slightly increased	Highly increased	Slightly decreased	Highly decreased
1.	Area under rice cultivation	26 (52.0)	19 (38.0)	5 (10.0)	0 (0.0)	0 (0.0)
2.	Cost of cultivation/ acre (in Rs.)	0 (0.0)	17 (34.0)	33 (66.0)	0 (0.0)	0 (0.0)
3.	Yield/acre (in Kg)	26 (52.0)	10 (20.0)	0 (0.0)	10 (20.0)	4 (8.0)
4.	Procurement price of rice (in Rs.)	0 (0.0)	17 (34.0)	33 (66.0)	0 (0.0)	0 (0.0)
5.	Labour availability	5 (10.0)	5 (10.0)	0 (0.0)	35 (70.0)	5 (10.0)
6.	Labour wages/day	0 (0.0)	18 (36.0)	32 (64.0)	0 (0.0)	0 (0.0)
7.		4	30	16	0	0

	Availability of seeds	(8.0)	(60.0)	(32.0)	(0.0)	(0.0)
8.	Emergence of new weeds	17 (34.0)	28 (56.0)	0 (0.0)	5 (10.0)	0 (0.0)
9.	Micro nutrient application	0 (0.0)	38 (76.0)	12 (24.0)	0 (0.0)	0 (0.0)
10	Soil test based fertilizer recommendatio ns	0 (0.0)	34 (68.0)	16 (32.0)	0 (0.0)	0 (0.0)
11	Mechanization	0 (0.0)	11 (22.0)	39 (78.0)	0 (0.0)	0 (0.0)
12	Interest of farmers in paddy farming	5 (10.0)	33 (66.0)	8 (16.0)	4 (8.0)	0 (0.0)
13	Aid provided by government to paddy farmers	0 (0.0)	33 (66.0)	17 (34.0)	0 (0.0)	0 (0.0)
14	Involvement of younger generation in paddy farming	0 (0.0)	2 (4.0)	0 (0.0)	17 (34.0)	31 (62.0)

15	Use of adaptation / mitigation measures for salt water intrusion	0 (0.0)	33 (66)	17 (34.0)	0 (0.0)	0 (0.0)

Note: Figures in parentheses denote percentage to row total

4.5 MAJOR CONSTRAINTS FACED BY PADDY FARMERS IN HARIPAD BLOCK

4.5.1 Constraints faced by the paddy farmers in the salt water unaffected area

A lot of constraints were being faced by the farmers cultivating paddy in the salt water unaffected area of Haripad block. Farmers from the salt water unaffected areas of Haripad, Pallipad and Kumarapuram villages were surveyed for obtaining information. Detailed assessment and interpretation of the constraints was required to improve the productivity, income and thereby livelihood of the farmers. A total of 19 general constraints of paddy cultivation were enlisted and the farmers were asked to rank based on its severity. From which the most important 10 constraints ranked by majority of farmers were tabulated and presented in Table 26. And the constraint analysis was done using Garrett's ranking method.

The results revealed that weed problem was the most severe constraint faced by most of the farmers with a garret's score of 95.68 followed by the non-availability of hired labour having a score of 65.72. The next major problem was the increased cost of inputs (63.08) and followed by pest related problems (62.16). Apart from this, the climatic constraints such as uneven distribution of rainfall affected the paddy farmers with a Garret's score of 59.84. Subsequently, problems related to harvesting, such as non-availability of harvester in time, extra losses and difficulties faced during the delayed harvesting came in sixth position with a Garett's score of 56.52. Micronutrient deficiencies (55.80) and delay in disbursing the price of procured paddy (53.80) were also prominent among paddy farmers. Attack of birds and rodents (51.48) and the construction of bunds and their maintenance (50.88) were also some of the constraints faced by the paddy farmers in the salt water non-affected area.

Table 26. Constraints faced by paddy farmers in the salt water unaffected area

Sl. No	**Constraints**	**Garrett's score**	**Rank**
1	Weed problem	95.68	1
2	Non availability of hired labour in time	65.72	2
3	High cost of inputs	63.08	3
4	Pest problems	62.16	4
5	Uneven distribution of rainfall	59.84	5
6	Problems related to harvesting	56.52	6
7	Micronutrient deficiencies	55.80	7
8	Delay in disbursing the price of paddy procured	53.80	8
9	Attack of birds and rodents	51.48	9
10	Construction and maintenance of bunds	50.88	10

4.5.2 Constraints faced by paddy farmers in the salt water affected area

The paddy farmers in the salt water affected area of Haripad block were facing a number of constraints and are given in Table 27. Farmers were surveyed from the Veeyapuram and Cheruthana villages of Haripad block. The major constraint was the salt water intrusion with a Garrett's score of 77.68. This affected the productivity as well as average returns from rice. According to the farmers, major reason for salt water intrusion into rice fields was due to the improper construction and maintenance of bunds by the irrigation department. The farmers also pointed out that there was lack of co-ordination of irrigation department and other line departments in taking necessary precautionary actions against salt water intrusion. As a result of the floods in 2018 in Kerala, three shutters of Thottapally spillway were damaged and repair work is still underway. It also resulted in inadequate and inefficient management of salt water intrusion into the region. The next major constraint pointed out by the farmers was decrease in quality of produce due to salinity (71.36). Based on the quality and moisture content of produce, a certain amount for paddy was reduced from the total procured paddy (*Kizhivu*). This reduction was solely made by the rice mills and it often lead to conflicts between rice mill agents and farmers (69.04). The other major constraints included weed problems (66.48), non-availability of hired labour in time (62.20), high cost of inputs (59.00), pest problems (56.56), delay in disbursing the price of paddy procured (56.40) and uneven distribution of rainfall (45.08). Micronutrient deficiencies (44.64) were also affecting the paddy farmers by making their livelihood in distress.

Similar studies conducted by various researchers revealed that the main problems of paddy cultivation included a reduction in number of full time farmers, marginal and small scale land holdings, high rate of crop failure, lack of availability of farm hands for harvesting, growing aversion in the new generation on rice cultivation and the higher land value offered by the real estate people often brainwashing the farmers to sell their waterlogged fields. (Thomas, 2002; Suchitra and Venugopal 2005; Basheer, 2008).

Table 27. Constraints faced by paddy farmers in the salt water affected area

Sl No.	Constraints	Garrett's score	Rank
1	Salt water intrusion	77.68	1
2	Decrease in quality of paddy due to salinity	71.36	2
3	Conflicts between rice mill agents and farmers in determination of Kizhivu.	69.04	3
4	Weed problem	66.48	4
5	Non availability of hired labour in time	62.20	5
6	High cost of inputs	59.00	6
7	Pest problems	56.56	7
8	Delay in disbursing the price of paddy procured	56.40	8
9	Uneven distribution of rainfall	45.08	9
10	Micronutrient deficiencies	44.64	10

4.5.3 Adaptation measures followed by the farmers

Adaptation measures existed in the region were of two types namely permanent salt exclusion barriers and temporary salt exclusion barriers or "*Orumuttu*". Thannermukkom Bund and Thottappally Spillway were the permanent salt exclusion barriers constructed in Alappuzha. Thanneermukkom bund was constructed under the

Kuttanad Development Scheme to prevent tidal movements and salt water intrusion into the lowlands of Kuttanad through Vembanad lake. Thottappally spillway was built in order to spill the excess water over the Lower and Upper Kuttanad regions via Manimala river, Achancovil river and Pamba river.

Temporary salt exclusion barriers called 'Orumuttu' were constructed across different parts of the rivulets and canals by the irrigation department and as well as by the farmers themselves. And this was the only adaptation measure practised by the farmers for preventing salt water intrusion in to their fields. It was observed that many of the Padasekharams expenses incurred for the construction of *orumuttu* were also included in the *Nermma* (Amount paid as advance to the Padashekarasamithi for common requirements of the farmers).

4.5.4 Suggestions to improve paddy cultivation

Suggestions were asked from the respondents in order to know the future requirements of farmers to reduce the yield loss and enhance their returns from paddy production. They are enlisted below,

- Since farmers in the area strongly believed that the effect of salinity on the yield of paddy would have been too less if they were to start the sowing on first week of November itself. They suggested an assured and timely completion of bund maintenance works and construction of "*Orumuttu*" in the respective areas, so that they can start their farm operations in the predetermined time.

- Quantity of seeds provided by government under subsidy was 40kg per acre. Since the average quantity of seeds used by an individual farmer in the area was around 60-65kg per acre, farmers suggested an increment in quantity of seeds provided.
- Ensure sufficient availability of quality soil ameliorants to the farmers on time.

- Quantity of paddy decided as "*Kizhivu"* by the mill agents each year lead to conflicts between the farmers and mill agents since there was less transparency in the process of determination of *Kizhivu*. Hence many of the farmers suggested to make measures to improve the transparency in determination of *Kizhivu* of paddy by the mill agents.

Plate 1a. Salt water unaffected paddy field

Plate 1b. Salt water unaffected paddy field

Plate 2a. Salt water affected paddy field

Plate 2b. Salt water affected paddy field

Plate 2c. Salt water affected paddy field

Plate 3. Salt water affected rice seedling

Plate 4. Harvesting in salt water affected paddy field

Plate 5. Temporary salt exclusion barrier (*Orumuttu*)

Summary

Chapter V
SUMMARY

The present study entitled "Effect of salinity on paddy production in Alappuzha district of Kerala- An economic analysis" was carried out in the salt water affected and unaffected paddy fields of Alappuzha district. The specific objectives of the study was to examine the resource use efficiency in paddy production, to analyse the impact of salinity on crop production and farm income and to study the major constraints faced by paddy farmers.

The study was based on both primary and secondary data. Alappuzha district was purposively selected for the micro level study as it is one of the major districts of Kerala in cultivation of paddy. Moreover salinity problems due to salt water intrusion were frequently being reported from this district over the years. Haripad block was purposively selected since researches on salinity was mostly concentrated in other blocks and a research gap was felt in this area. The farmers were categorised into two groups on the basis of effect of salinity *viz* 25 farmers each from salinity affected fields and non- affected fields, thus the total sample size was 50. For identification and selection of the study location, secondary data pertaining to ground water salinity, salinity of irrigation water and soil salinity levels were collected from the State ground water authority, Thiruvananthapuram, Kerala Centre for Pest Management, Moncombu and Department of Soil Survey & Soil Conservation, Alappuzha respectively. Data regarding socio economic status and physiographic factors were collected from the official websites and government annual reports.

The socio economic characteristics of the sample respondents were analysed. Out of the total respondent farmers, majority of the farmers (94.0%) were in the age group of middle adult hood and old age, indicating the refutation of young farmers in paddy farming. The average age group of farmers growing paddy in unaffected area was 58.76 and in affected area 57.48. It was observed that more than three-fourth of the total sample respondents were male both in unaffected and affected areas. All the farmers were literates with majority of them (74%) had secondary education. The average family size of the farmers growing paddy in both unaffected areas and in affected areas was four. More than two third of respondents (68 %) were having an experience of >20 years in both unaffected and affected areas. The percentage of sample farmers who chose agriculture as their main occupation was higher in affected area (92 %) than in unaffected area (72 %). The average annual income of the sample respondents growing paddy in unaffected area (₹1,35,200) was higher than the respondents in affected area (₹1,14,200). The average size of land holdings was higher for the farmers in affected area (3.54 acres) than farmers in the unaffected area (3.14 acres).

The average annual cost of cultivation of paddy incurred by the salt water unaffected and the affected farmers was found to be ₹ 1,03,322.85 ha^{-1} and ₹ 104145.13 ha^{-1} respectively. A significant increase of percentage share in the cost of soil ameliorants (4.70 %) was observed for salt water affected farmers. In both the cases, per cent share of hired labour in cost A_1 was the highest followed by machine labour. The average cost of production of paddy were ₹ 17,200 and ₹ 27,398 per tonne for salt water unaffected and affected farmers respectively. The reason for this increased cost of production was that the yield realised from the affected areas was remarkably lesser than that of unaffected areas even though the cost of cultivation was almost similar in both areas.

In order to examine the resource use efficiency for rice cultivation, Cobb-Douglas production function was fitted separately for the salt water affected farmers, unaffected farmers and for their pooled data. In case of the unaffected farmers R^2 value obtained was 0.90. All the independent variables were positive, among which quantity of manures and fertilizers, machine and bullock power was significant at 1 per cent level of significance. Urea, Factamfos and Muriate of potash were the popular fertilizers among paddy farmers. The returns to scale obtained for the unaffected farmers was 2.24, which represented an increasing returns to scale. For the affected farmers, the obtained R^2 value was 0.89. Quantity of family labour was found to be non-significant for both the unaffected and affected farmers. The quantity of hired labour, manures and fertilizers were significant at 1 per cent level of significance. The value for returns to scale was obtained 1.31 and hence showed an increasing returns to scale.

The resource use efficiency of pooled data revealed that the quantity of family labour, plant protection chemicals, machine and bullock power were significant at 1 per cent level of significance with coefficients 0.314, 0.383 and 0.450, respectively. The R^2 value thus obtained from the regression analysis was 0.70. Coefficient of all the independent variables except quantity of soil ameliorants was positive and significant. Soil ameliorants was obtained positive and non-significant. $\sum bi$ value of the production function analysis was found to be 1.64, which indicated an increasing returns to scale of overall paddy farmers in the area.

Allocative efficiency was examined to know how resources in the farm were efficiently utilized in terms of economic aspects. Marginal productivity analysis showed that, all the variables except manures and fertilizers were having a K value more than one, which indicated the suboptimal or underutilization of resources by farmers in both salt water unaffected and affected areas. Allocative efficiency of these inputs can be improved only by the enhanced utilization. K value obtained for quantity of manures and fertilizers in salt water unaffected and affected areas were 0.61 and 0.90 respectively. This represented the over utilization of resource and thus the allocative efficiency can be improved by the reduced usage.

The average rice yield obtained from paddy cultivation in the salt water unaffected and affected area was 6.01 t/ha and 3.80 t/ha respectively. Chow test was used in order to analyse the effect of salinity on rice production by examining significant difference in coefficients of independent variables used in regression analysis of rice production among the salt water unaffected and the affected farmers. The $F_{0.05}$ at $v_1 = 7$ and $v_2 = 36$ degrees of freedom was found to be 2.28 and is lesser than F*. Hence the null hypothesis was rejected and concluded that there is a significant difference in coefficients between rice production by the salt water unaffected and the affected farmers.

Effect of salinity on farm income of farmers was examined by calculating the gross income of farmers. Highest average gross income of ₹ 1,61,883 per hectare was obtained by farmers cultivating rice in the salt water unaffected areas, while it was lowest for paddy farmers in salt water affected areas (₹ 1,02,443/ha). The net income at cost A_1, cost A_2, cost B and cost C were found out separately and it showed that farming in salt water unaffected areas were highly profitable. At the same time it was not much profitable in the affected areas especially when the family labour, rental value of owned land and interest on fixed capital were accounted in the cost. The estimated monetary loss of salt water affected farmers at cost C was ₹ 1,702 per hectare. B-C ratio of salt water affected farmers at cost C was 0.98 and for unaffected farmers it was 1.57.

The perception of farmers on current status of rice farming in Haripad block over the past 10 years was documented. Majority of the farmers perceived as, there was no change in the area under rice cultivation (52.0%). 66 per cent of the sample respondents expressed high increase in the cost of cultivation, no change in the yield (52.0%) and 66 per cent of the farmers opined high increase in procurement price of paddy. Seventy per cent of respondents vented a slight reduction in labour availability and high increase in labour wages (70.0%). Availability of seeds (60.0%), emergence of new weeds (56.0%), micro nutrient application (76.0%), soil test based fertilizer application (68.0%), use of adaptation / mitigation measures (66%) and interest of farmers in paddy farming (66.0%) have slightly increased over the past 10 years.

Detailed assessment and interpretation of the constraints faced by rice farmers were required to improve the productivity, farm income and also to find policy implications. Garrett's ranking method was used for the constraint analysis. Since the major constraints faced by farmers in salt water unaffected and affected areas were different, the ranking procedure was performed separately for both the unaffected and affected farmers. Weed problem was the severe constraint faced by most of the farmers from salt water unaffected areas followed by the scarcity of hired labour. In the case of salt water affected farmers, the major constraint was the salt water intrusion itself. Followed by decrease in quality of produce due to salinity. According to the farmers, major reason for salt water intrusion in to rice fields was the improper construction and maintenance of bunds.

Policy suggestions

- In order to avoid the problem of quality deterioration of paddy in the salt water affected areas, more researches may be directed towards the development of location specific, high yielding, salinity tolerant rice varieties in the years envisaged.
- The present study can be extended to the problematic areas of other districts in order to formulate sustainable policies.
- Usage of majority of the inputs were under suboptimal levels, this component needs to be further improved by educating or training the farmers with respect to the economic efficiency of inputs.

- Soil test based fertilizer recommendation can be suggested for the paddy farmers in Haripad. The optimum utilization of all the resources can be insisted in order to increase the production and reduce cost of cultivation
- Timely construction and proper maintenance of bunds are the most efficient measures to refrain salt water intrusion to the farmer’s fields. Opening and closing of Thottapally spillway and Thannermukkom bund has a major role in managing the salt water intrusion. The conflicting needs by paddy farmers and fish farmers in the case of salt water intrusion needs to be addressed properly. Institutional measures may be made more effective, which is the most important factor to address the issue of salt water intrusion.

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Chapter VI

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Appendix I

APPENDIX- I

KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF AGRICULTURE

DEPARTMENT OF AGRICULTURAL ECONOMICS

Vellayani , Thiruvananthapuram- 695522

SURVEY SCHEDULE FOR PRIMARY DATA

EFFECT OF SALINITY ON PADDY PRODUCTION IN ALAPPUZHA DISTRICT OF KERALA – AN ECONOMIC ANALYSIS

Block: Panchayat:

I. Socio economic profile of farmers:

1. Name of the farmer :
2. Age :
3. Gender :
4. Address :
5. Phone no :
6. Experience in paddy farming:

II. Family Details

Name	Gender (M/F)	Age	*Education	**Occupation		Annual income	
				Primary	Secondary	Primary	Secondary

*01-Primary,02-Secondary, 03-Pree- degree/HSC, 04-Diploma, 05-Graduate, 06-Post Graduate
**1-Agriculture & allied activities, 2-Public sector, 3-Private sector, 4-Self employed

III.A Details of land holdings

Particulars	Owned (ha)	Leased in(ha)	Leased out (ha)	Total (ha)
Wet land				
Garden land				
Permanent fallow				
Total (ha)				

Rental value of leased in land (Rs. / ha for 1 year):

Land revenue of leased out land (Rs./ha for 1 year):

Value of land (Rs./ ha):

III. B Details of fixed assets (except land)

S. No	Particulars	Nos.	Year of construction	Present value (Rs)	Remarks
1	Farm house				
2	Store house				
3	Cattle shed				
4	Pump shed				
5	Others (specify)				

III.C Machineries/ Implements

Sl. No.	Particulars	Number	Year of purchase	Purchase price (Rs)	Expected life (Years)
1	Spades				
2	Sprayers				
3	Vaakathi/ Knife				
4	Others 1. 2. 3.				

IV. Crop particulars:

Season	Crop	Variety	Area (ha)	Main product		By-product	
				Qty (Kg)	Value (Rs)	Qty (Kg)	Value (Rs)
Wetland	<u>Season I</u>						
	<u>Season II</u>						
	<u>Season III</u>						
Garden land							

V. Details of non-crop activities:

Sl No	Activities	Area/No.	Annual maintenance expenses	Gross returns
1	Shrimp farming			
2	Livestock activities			
3	Poultry			
4	Self-employment			
5	Others			

VI. Source of seeds:

Sl. no	Source	Variety	Quantity	Price (Rs/kg)

VII. Cropping pattern

Cropping pattern: Sole cropping
Mixed cropping
Relay cropping
Crop rotation

S. No.	Crops	Variety	Area (Cents)	Irrigated /rainfed	Yield (kg)	Income (Rs)
1						

VIII. Cost of cultivation:

Crop: Bullock power cost (Rs/pair/day): Yield:

Season: Machine power cost (Rs/hr/ha) :

Variety: Wage rate (Rs/day): Main product
(Kg):

Area: (1) Male: (2) Female By product
(Kg):

VIII A. Input and Operation – wise expenses

Variable inputs	Quantity	Rate/unit	Total cost
Seed(Kg/ ha)			
FYM (Kg/ha)			
Urea (Kg/ha)			
SSP (Kg/ha)			
MOP (Kg/ha)			
Other fertilizers (Kg/ha)			
1.			
2.			
3.			
Plant protection chemicals (unit)			
1.			
2.			
Soil ameliorants (unit)			
1.			
2.			
Irrigation cost (Rs)			
Total input cost			

VIII B. Input and Operation – wise expenses

Operations	Machine labour		Human labour (No's)		Total labour cost	Total cost (Machine + Human)
	Hours	Cost	M	F		
Land preparation						
Liming material						
Sowing						
Fertilizer application						
Organic manure application						
Weeding & Gap filling						
Plant protection operation						
Intercultural operation						
Harvesting						
Loading						

- Are you practicing mechanization in the fields?

- If Yes, for which all operations:

S.No	Operation	Cost involved (Rs)
1	Land preparation	
2	Harvesting	

IX. Constraints in Production

(i) Ranking of production constraints:

****1-YES, 2- NO, 3- Previously reported but not present now**

Sl no	Problem	Occurrence of problem (yes / no)	Rank
1.	High wage cost		
2.	Scarcity of hired labour		
3.	Weed problem		
4.	Problems related to harvesting		
5.	Conflicts between rice mill agents and farmers		
6.	Attack of birds and rodents		
7.	Rice farming threatened by deteriorating soil.		
8.	Increase in salinity		
9.	Young generation of traditional farm workers prefer other jobs		
10.	Lack of encouragement from the government		
11.	Non- availability of labours on time.		
12.	Pest problems		
13.	Decrease in quality of paddy due to salinity		
14.	Uneven distribution of rainfall		
15.	Poor quality irrigation water		
16.	High cost of inputs		
17.	Changing governments and policies		
18.	Frequent outbreak of diseases		
19.	Lack of technical knowledge		
20.	Micronutrient deficiencies		

X. DOCUMENTATION OF THE STATUS OF RICE FARMING
(Compared to 10 years back)

****1- No Change, 2- Slightly Increased, 3- Highly Increased, 4 – Slightly Decreased, 5- Highly Decreased**

Sl. No.	Particular	Occurrence of change
1.	Area under rice cultivation	
2.	Cost of cultivation/ acre (in Rs.)	
3.	Yield/acre (in Kg)	
4.	Market Price of rice (in Rs.)	
5.	Labour availability	
6.	Labour wages/day	
7.	Availability of seeds	
8.	Emergence of new weeds	
9.	Micro nutrients application	
10.	Soil test based fertilizer recommendations	
11.	Usage of Machineries for agricultural operations	
12.	Interest of farmers in paddy farming	
13.	Aids provided by government to paddy farmers	

14.	Involvement of younger generation in paddy farming	
15.	Use of adaptation / mitigation measures in case of occurrence of salt water intrusion	

- What are all the salinity problems faced by you?
- What are the main factors affecting yield (in order of preference):
- Adaptive measures taken by the farmers

Appendix II

APPENDIX - II

GARRETT RANKING CONVERSION TABLE

The conversion of orders of merits into units of amount of "socres"

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		

Appendix III

APPENDIX –III

Salinity range of irrigation water in Haripad Block (as on 03.03.2020)

Date of sampling	Location / Address	EC Range (dS/m)
Cheruthana Village		
28.01.2020	Cheruthana Narayanchira	1.90
28.01.2020	Cheruthana river	15.50
30.01.2020	Cheruthana Narayanchira	1.90
30.01.2020	Cheruthana ,Kannanchery	3.00
14.02.2020	Cheruthana	3.90
14.02.2020	Cheruthana	4.20
14.02.2020	Theveri Thandapra (Vadakku)	1.20
14.02.2020	Thandapra (Padinjaru)	2.00
20.02.2020	Cheruthana Thevery (Padinjaru)	1.29
20.02.2020	Cheruthana Karuvatta Border	1.90
25.02.2020	Pothanaody	4.10
25.02.2020	Narayanchira	3.90
03.03.2020	Kannachery (River)	4.60
03.03.2020	Kannachery (Padam)	2.60

Haripad Village		
02.03.2020	Harippad - Vazhuthanam vadakku	4.30
03.03.2020	Vazhuthanam Vadakku	3.60
03.03.2020	Vazhuthanam Vadakku (River)	4.20
03.03.2020	Vazhuthanam Thekku (River)	4.30
03.03.2020	Kizhakke parambikkary A- Block	1.20
03.03.2020	Kizhakke parambikkary B- Block	2.10
03.03.2020	Kattakuzhy (Pamba River)	0.14
03.03.2020	Kareepadam	2.40
03.03.2020	Kareeli (River)	5.10
03.03.2020	Vettikkal River	0.89
20.02.2020	Thrikkunnapuzha Cheeppu aduth	18.36
20.02.2020	Thrikkunnapuzha vadakku	12.10
20.02.2020	Thrikkunnapuzha Cheeppu	15.00

Appendix IV

APPENDIX IV

Ground water salinity in Alappuzha district (Champakulam Block)

Block : Champakulam, Village : Moncombu				
Well ID	Sampling date	pH	EC	TDS
19 Moncombu	11/02/2009	8.1	357	214
19 Moncombu	05/06/2009	8.2	578	342
19 Moncombu	06/10/2009	8.3	413	248
19 Moncombu	21/04/2010	8.3	480	288
19 Moncombu	13/09/2010	8.1	413	248
19 Moncombu	27/01/2011	8.3	398	239
19 Moncombu	06/05/2011	8.5	548	329
19 Moncombu	24/12/2012	8.3	538	323
19 Moncombu	10/01/2014	8.5	542	325
19 Moncombu	29/05/2014	8.4	682	409
19 Moncombu	02/04/2015	8.4	745	447
19 Moncombu	28/04/2016	8.5	482	289
19 Moncombu	07/01/2016	8.6	490	294
19 Moncombu	11/12/2016	8.7	670	402
19 Moncombu	16/05/2017	8.3	646	388
19 Moncombu	26/08/2017	8.3	978	587
19 Moncombu	27/09/2018	8.4	565	339
19 Moncombu	17/04/2018	9.0	674	404
Block : Champakulam, Village : Nedumudy				
OW-19 Chambakulam	11/02/2009	8.7	699	419
OW-19 Chambakulam	21/04/2010	8.3	480	288

Abstract

EFFECT OF SALINITY ON PADDY PRODUCTION IN ALAPPUZHA DISTRICT OF KERALA- AN ECONOMIC ANALYSIS

by
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(Admn No. 2018-11-110)

Abstract of the thesis
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ABSTRACT

The present study entitled "Effect of salinity on paddy production in Alappuzha district of Kerala- An economic analysis" was conducted during 2019-20, with specific objectives of examining the resource use efficiency in paddy production, to analyse the impact of salinity on crop production and farm income and to study the major constraints faced by paddy farmers.

The current study was focused on both primary as well as secondary data. The study was conducted in the salt water affected and unaffected paddy fields of Alappuzha district. Primary data was collected from the farmers through formal interviews. Farmers in the study area were grouped in to salt water affected and unaffected farmers based on the extent of salinity levels in the area. From each of the two groups, 25 salt water affected and 25 unaffected farmers were selected. Thus the total sample size was 50. Secondary data pertaining to water salinity, socio economic status and physiographic factors were collected from various sources.

Average annual cost of cultivation of paddy by the salt water unaffected farmers was almost similar to that of salt water affected farmers and was found to be ₹ 1,03,322.85 and ₹ 1,04,145.13 per hectare respectively. In both the case of the unaffected and affected farmers, per cent share of hired labour in the total cost A_1 was highest followed by machine labour. The average cost of production of paddy by the salt water unaffected and the affected farmers were ₹ 17,200 and ₹ 27,398 per tonne respectively.

Cobb-Douglas production function was fitted separately for rice production among salt water affected and unaffected farmers to examine the resource use efficiency. The results showed that R^2 value for salt water unaffected and affected paddy cultivation was 0.90 and 0.89 respectively and it indicated good fit of both the regression models. Marginal productivity analysis for examining the allocative efficiency showed that, all the variables except manures and fertilizers were having a K value of more than unity, indicated the suboptimal utilization of the resources.

The average rice yield obtained from paddy cultivation in the salt water unaffected and affected area was 6.01 and 3.80 tonnes per hectare respectively. Chow test was used to analyse the effect of salinity on rice production. The test revealed significant differences in regression coefficients and hence concluded that the two groups differ significantly. Farmers in salt water unaffected areas obtained a gross income of ₹ 1,61,883.36 per hectare while farmers in salt water affected area obtained ₹ 1,02,443.05 per hectare. Farming in salt water unaffected areas were highly profitable at cost C with a B-C ratio of 1.57, but it was not much profitable for the unaffected farmers (0.98).

Weed problems and scarcity of hired labour was the severe constraint faced by most of the farmers from salt water unaffected areas. But the major constraint for paddy production in the salt water affected area was salt water intrusion. According to the farmers, main reason behind the salt water intrusion in to their paddy fields was the improper construction and maintenance of bunds. Majority of the farmers perceived that, there was an increase in cost of cultivation, usage of machines, market price of paddy, availability of seeds, labour wages, emergence of new weeds and use of adaptation or mitigation strategies for preventing salt water intrusion in Haripad over the past ten years.

In order to avoid the problem of quality deterioration of paddy in the salt water affected areas, more researches may be directed towards the development of location specific high yielding salinity tolerant rice varieties in the years envisaged. Usage of majority of the inputs were under suboptimal levels, this component needed to be further improved by educating or training the farmers with respect to the economic efficiency of inputs. It was found from study that there was overutilization of fertilizer in the study area. Hence, soil test based fertilizer recommendation could be suggested for farmers in Haripad. The conflicting needs by paddy farmers and fish farmers in the case of salt water intrusion need to be addressed properly. Institutional measures may be made more effective, which is the most important factor to address the issue of salt water intrusion.