# SOCIO ECONOMIC ANALYSIS OF EFFECTS OF METEOROLOGICAL DROUGHT ON RICE CULTIVATION IN PALAKKAD DISTRICT

**By**

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**(2013-20-122)**

## THESIS

**Submitted in partial fulfilment of the requirement for the degree of**

## B.Sc.-M.Sc. (Integrated) Climate Change Adaptation

**Faculty of Agriculture**
**Kerala Agricultural University, Thrissur**

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**VELLANIKKARA, THRISSUR – 680656**

**KERALA, INDIA**

**2018**

# DECLARATION

I hereby declare that the thesis entitled **"Socio economic analysis of meteorological drought in rice cultivation in Palakkad district"** is a bonafide record of research work done by me during the course of research and the thesis has not been previously formed for the award to me any degree, diploma, fellowship or other similar title, of any other University or Society.

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Certified that this thesis entitled "**Socio economic analysis of effect of meteorological drought on rice cultivation in Palakkad district**" is a record of research work done independently by **Ms. Adheena Vijay** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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# *ACKNOWLEDGEMENT*

*I would like to express my sincere gratitude to* **Dr. Chitra Parayil**, *Assistant Professor, Agricultural Economics, Regional Agricultural Research Station, Pattambi, for her exceptional guidance and support throughout the period of my M.Sc project work. It was a great honor and privilege working under her guidance. I shall be grateful to her forever.*

*I would like to thank* **Mr. B. Shanmugaundaram**, *Professor(Agricultural Extension), Division of Social Science, College of Agriculture, Padanakkad, and member of my advisory committee for his scrupulous guidance, advices, valuable and timely suggestions given during my work.*

*I express my thanks to* **Dr. Sindu. P. V**, *Assistant Professor(Agronomy), AICRP on MAP and B, College of Horticulture, Vellanikkara, for her constant help and valuable suggestions from beginning to the end of this study.*

*I express my gratitude and indebtedness to* **Dr. P. O. Nameer**, *Special officer, Academy of Climate Change Education and Research and member of my advisory committee for his guidance, advices, valuable and timely suggestions given during my work.*

*I express my gratitude to* **Dr. S. Krishnan**, *Professor and Head, Dept.of Agricultural Statistics, for his valuable assistance, immense help and guidance during the statistical analysis of the data.*

*I respectfully thank* **Dr. Sunil Mukundan**. *Professor, Krishi Vikjana Kendra, Pattambi, for his scrupulous guidance, advices, valuable and timely suggestions given during my work.*

*I sincerely acknowledge the service rendered by the* ***staff and other members of Regional Agriculture Research Station, Pattambi***.

*My special thanks to* ***Mr. Haidas. K, Mr. Swaminathan, Mr. Muhammad, Mr. Kuttikrishnan. Mr. Neelakandan, Mr. Shanmuga Chettiyar, Mr. Sankaran Chetiyar, Mr. Mahalingam, Mr. Unnikrishnan, Mrs. Dhakshayani,*** *for their* immense help and cooperation during the field survey. I express my deep gratitude to the **farmers** whom I interviewed for my course of action for helping me in the completion of my study.

My heartfelt thanks and love to all my classmates of **Kauravas-2013** for their support given to me during the whole college days. Let me place on my record my sincere thanks to my dear friends, **Anju, Sudhamani, Surabhi, Vishnumaya, Haritha, Aarathy, Vishnu** for their moral support and sincere help and cooperation throughout my research work

I am in dearth of words to express my love towards my parents **Mr. K. P. Vijayan** and **Mrs. Sujatha Vijayan,** my brother **Anokh. V** and also my uncles **Mr. Sreedharan** and **Mr. Damodharan** for their moral support, deep concern, prayers and personal sacrifices which sustain peace in my life.

I am sincerely thank full to all the teaching staff and non teaching staffs especially **Saju Sir, Saritha miss, Krishnapriya miss** and **Sajitha miss** of **Academy of Climate Change Education and Research** for their support.

I am deeply indebted to without whose constant encouragement this would not have been a success. A word of apology to those I have not mentioned in person and a note of thanks to one and all who worked for the successful completion of this endeavor. I once again express my heartfelt thanks to all those who helped me in completing this venture in time.

**Adheena Vijay**

*Dedicated to my beloved parents & my brother*

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## ABBREVIATIONS AND SYMBOLS

| | | |
|---|---|---|
| IRRI | - | International Rice Research Institute |
| mm | - | Millimetre |
| kg | - | Kilogram |
| GOK | - | Government of Kerala |
| GOI | - | Government of India |
| % | - | Per cent |
| DEA | - | Data Envelopment Analysis |
| Mt | - | Metric tonne |
| OLS | - | Ordinary Least Square |
| ENSO | - | El-Nino Southern Oscillation |
| SST | - | Sea Surface Temperature |
| $CO_2$ | - | Carbon dioxide |
| DSR | - | Direct Seeded Rice |
| Rs | - | Rupees |
| GHGs | - | Greenhouse Gases |
| RARS | - | Regional Agricultural Research Station |
| SE | - | Scale Efficiency |
| CRS | - | Constant Returns to Scale |
| VRS | - | Variable Returns to Scale |
| *i.e,* | - | That is |
| CACP | - | Commission on Agricultural Cost and Prices |
| ha | - | Hectare |
| ton | - | Tonnes |
| TE | - | Technical Efficiency |
| $^0C$ | - | Degree Celsius |

| | | |
|---|---|---|
| IPCC | - | Inter-governmental Panel on Climate Change |
| *et al* | - | And other people or things |
| viz | - | That is to say |
| cm | - | Centimetre |
| TE | - | Triennium Ending |

# INTRODUCTION

# CHAPTER 1

# INTRODUCTION

Global warming and climate change is the major concern of mankind in the $21^{st}$ century. Under the changing climatic scenario, crop failures, reduction in yields, reduction in quality and increasing pest and disease problems are common and they render the cultivation unprofitable. Global simulation studies indicated that between 2080 and 2100, temperature increase may lead to 10 - 40 per cent of loss in crop production in India (IPCC, 2007).

Drought is a recurring climatic event and an important constraint to rainfed rice production in all over the world. The impact of drought in terms of human suffering, economic loss and environmental effects is alarming. Severe drought can result in starvation and even death of the affected population. The impact of drought can be categorized into physical, economic and environmental. Employment and income fall, price rise, poor health, food security, production loss are the major economic effects of drought (Pandey and Bhandary, 2008).

Agricultural production is the main source of income and employment in rural areas and there is reduction in income and employment in the agricultural sector due to drought. Agricultural production losses, which are often used as a measure of the impact of drought, are only a part of the overall socio-economic impact.

Rice is the most important cereal and staple food produced and consumed in Kerala. Rice cultivation in Kerala has witnessed a steady decline since 1980s. In Kerala, rice was cultivated an area of about 6.64 lakh ha in 1987-88 and it has decreased to around 1.97 lakh ha in 2016-17 and the production decreased from 11.34 lakh tonnes in 1987-88 to 5.49 lakh tonnes in 2016-17 (Appendix 2). Palakkad and Alappuzha are the major rice producing districts in Kerala (Economic Review, GOK, 2017).

**Table 1. Rice area, production and productivity of Kerala from 2012-16**

| Year | Area (lakh ha) | Production (lakh tonnes) | Productivity (kg $ha^{-1}$) |
|---|---|---|---|
| 2012-13 | 2.08 | 5.68 | 2733 |
| 2013-14 | 1.97 | 5.08 | 2577 |
| 2014-15 | 1.99 | 5.64 | 2827 |
| 2015-16 | 1.98 | 5.62 | 2837 |
| 2016-17 | 1.96 | 5.49 | 2790 |

Source: Economic Review, GOK, 2017

Palakkad, the rice bowl of Kerala, has about 0. 65 lakh ha (38.2 per cent of total rice area in the state) under rice cultivation and the production was 1.44 lakh tonnes during the year 2016-17 and in the year 2015-16 it was about 0.81 lakh ha and the production was 2.28 lakh tonnes (Appendix 3). The sharp decline in the area, production and productivity of rice was due to the severe drought experienced in the state during 2016-17. It was estimated that drought affected a total area of 50917.62 ha of rice cultivation including crop damage in 36927.62 ha in various districts (Economic Review, GOK, 2017). Season-wise trend also showed that there has not been much of a decline in *virippu* (first crop season), but a drastic decline in *mundakan* (second crop season) and *puncha* (third crop season) crop seasons (Economic Review, GOK, 2016).

**Table 2. Rice area, production and productivity of Palakkad district**

| Year | Area (lakh ha) | Production (lakh tonnes) | Productivity (kg $ha^{-1}$) |
|---|---|---|---|
| 2012-13 | 79201 | 189229 | 2389 |
| 2013-14 | 82896 | 238065 | 2872 |
| 2014-15 | 82912 | 236398 | 2851 |
| 2015-16 | 81120 | 228459 | 2816 |
| 2016-17 | 65513 | 144275 | 2202 |

Source: Economic Review, GOK, 2017

In 2016-17, there was a drastic reduction in production compared to the previous years due to the adverse effect of drought. The other major reasons for reduction in area and production of rice cultivation are labour shortage, lack of government support, reduction in irrigation water, and lack of interest of youth in rice cultivation along with rising cost of production (Shiji, 2016).

The average cost of production of rice in Kerala is relatively higher as compared to the other states in India (Kumari, 2011). The agricultural economy in the state is undergoing structural transformation from the mid of the seventies by switching over a large proportion of its traditional cropped area which was devoted to subsistence crops like rice and tapioca to more remunerative crops like banana, rubber and other plantation crops (Economic Review, GOK, 2016).

In order to make rice farming profitable, need drought resistant varieties. Breeding work at Regional Agricultural Research Station (RARS), Pattambi, Onattukra, and Kayamkulam have identified two rice varieties 'Harsha' for Palakkad and 'Chingam' for Onattukara respectively, and for *mundakan* (second crop) season need to use drought resistant or tolerant varieties such as 'Suvarnamodan', 'Annapoorna', 'Swarnaprabha', 'Vaisakh', 'Uma', 'Aiswarya', 'Rohini' (Kumari, 2011). Awareness programmes for the farmers to use drought tolerant or semi tolerant varieties make paddy cultivation a profitable and remunerative activity. Due to the lack of awareness about modern high yielding varieties, resistant or tolerant varieties and other inputs of cultivation, a good percentage of farmers still resort to conventional cultivation practices. This results in lower productivity, production and thereby low income. This, to a certain extent distracts the farmers from rice cultivation.

Hence, the present study is formulated to assess the socio-economic impact of drought on rice cultivation in Palakkad district

The specific objective of the study were

1. To analyse the nature and extent of drought in Palakkad district.
2. To study the economic cost of drought on rice in the district

3. To determine the coping mechanisms followed by the farmers and recommended by extension functionaries to withstand drought.

**Scope and importance of the study**

The results from the study are expected to provide a multidimensional view into the status of rice cultivation, cost of cultivation of rice, economic loss experienced by small, marginal and large farmers and also to point out the socio-economic challenges faced by the rice farmers due to effect of drought and the coping strategies adopted by the farmers. This would help to formulate efficient policy recommendations and targeted interventions in rice production along the right direction in the face of climate change events.

**Limitation of the study**

The study has been restricted to five panchayats of Palakkad district and has been conducted for a limited period of time as a part of M.Sc. project, hence the results of the study can represent only a part of the state, so the results need to be carefully applied to the other situations. The results of the study are based on primary data collected through pretested interview schedules from farmers, who were not maintaining any field records. However, data were collected based on their memory and thus could suffer from recall bias but has been cross checked to minimize the errors and misconceptions.

**Plan of thesis**

The entire thesis is divided into five different sections. The first section covers an introduction about the topic, research problem background, objective of the research and limitations of the research. In the second section, detailed review of earlier works related to proposed research has been presented. In the third section, a detailed description of the study area surveyed has been given. The methodology followed in the conducted research has also been described in the third section. In the fourth section, results of the research work are discussed, and summary of the work undertaken and the conclusions drawn from the research are presented.

# REVIEW OF LITERATURE

# CHAPTER 2

# REVIEW OF LITERATURE

A brief review of studies, which have a direct or indirect bearing on the objectives of the present study, is attempted in this chapter. Commensurate with the objectives of the present study, the available literature was scanned and is briefly reviewed and presented under following heads.

**2.1 Effect of climate change on agriculture**

**2.2 Effect of climate change on rice cultivation**

**2.3 Drought and the socio economic condition of rice farmers**

**2.4 Mitigation and adaptation measures used by rice farmers**

## 2.1 Effect of climate change on agriculture

Latha *et al.*, (2012) observed that the yield of rainfed crops were highly affected due to climatic variation such as occurrence of drought. The study revealed that occurrence of drought had significant impact on the production of rainfed crops. The study suggested that the climate change impact is intensifying day by day, it should be addressed through a policy perspective at the earliest to avoid long term effects such as quitting agricultural profession and short term effect such as yield and income by the rainfed farmers.

Khajuria and Ravindranath (2012) found that climate plays a significant role in the economic development of India. India has a number of reasons to be concerned about the impacts of climate change. Feeding of a billion people in a changing climatic and economic scenario are the challenges faced by Indian agriculture. Even agriculture is the main source of income and livelihood for almost 60% of the country's total population. In India cereal production was increased from 50 Mt to 212 Mt during the period of Green Revolution (1951) to 2002 and the mean cereal productivity increased from 500 kg per ha to almost 1800 kg per ha.

The Intergovernmental Panel on Climate Change (IPCC, 2007) reported that mean global average surface air temperature is increased by 0.74°C (0.56°C to 0.92°C) in past 100 years.

Venkateswarlu and Shankar (2009) analysed the climate change and food security in India. The study found that the climate change would modify the global and local food security vulnerability patterns. Small-scale rainfed farming systems, pastural systems, coastal and inland fishing communities and forest based systems are very vulnerable to climate change. The study identified that zero tillage would effectively reduce the water demand for rice-wheat cropping systems in more than one million ha of area in the Indo-Gangetic Plains.

Ali and Erenstein (2017) studied the household food security and poverty in Pakistan, in association with the factors that influence the choice of climate change adaptation practices. The study revealed that the farmers in Pakistan used a variety of adaptation practices against adverse impact of climate change such as, sowing time adjustment, adoption of drought tolerant varieties and some of them were shifted to new crops. About 22 per cent household made sowing time adjustment, 15 per cent were adopted the drought tolerant varieties, and 25 per cent household were shifted to new crops. The results also showed that the younger farmers and high level educated farmers were more likely to adopt these adaptation practices.

The effects of climate change on rice production in the tropical humid climate of Kerala was studied by Saseendran *et al.*, (2000). India Meteorological Department maintained long-term five climatic stations were chosen along a north-south gradient in the state of Kerala for the climate data. The study revealed that by the middle of the next century in the state of Kerala, under rainfed conditions an increase in rice yields is possible under the projected climate change scenario adopted for the study. The study also revealed that there is a reduction in crop duration at all the locations in the state due to increase in temperature and associated with the build-up of greenhouse gases in the atmosphere.

Auffhammer *et al.*, (2011) studied the adverse impact of climate change on rice crop and found that, in India because of climate change, rice yield was decreased by about 5-10 per cent during 1996-2002 period. The study also showed that the monsoon rainfall is not only the weather variable to affect the kharif rice in India, and a greater impact is the night time temperature on rice yield at the end of growing season.

Kothawale *et al.*, (2010) compiled the meteorological data over the past century and observed that the earth is warming. The study reported that the mean annual temperature showed a significant trend in warming of 0.51 degree Celsius per 100 years during the period 1901 - 2007.

Wang *et al.*, (2017) collected the data on the effect of drought on yield. Using ordinary least squares (OLS) method, yield biased and inconsistent parameters were estimated because it assumed that adaptive irrigation to drought is exogenously determined. In the context of climate change, irrigation is a strategy for adaptive risk management in agriculture. In farm households, to reduce the food insecurity due to extreme drought this strategy can indeed a buffer and play a crucial role.

Thripathi *et al.*, (2017) studied the passive adaptation to climate change, and the study shows that both climate change affects the agriculture and the agriculture is a contribute to climate change by emitting greenhouse gases. The study revealed that adaptation was achieved by perceiving the climate change and its associated risk and responding to perceived changes to minimize the adverse effects. The adaptation technique included, changing sowing and harvesting time, inter cropping, cultivation of short duration crops, investment in irrigation and changing cropping pattern.

According to Kumar *et al.*, (2014) the effect of climate change caused many threats to agriculture and that will change the quality and quantity water resources and crop productivity. The agriculture sector is the most prone sector and it will have a direct impact on 1.2 billion people. Rising the atmospheric temperatures and changing precipitation patterns will severely affect the production patterns of different crops. Agricultural productivity will also be affected due to increased atmospheric concentration of carbon. All of these changes will increase the vulnerability of the landless and the poor.

Mahato (2014) observed that the climate is the primary determinant of agricultural productivity and which directly affect the food production across the globe. The study identified that the increase in the global mean average temperature can reduce the duration of many crops and hence reduce final yield production. Food production systems are extremely sensitive to change in temperature and precipitation pattern, which may lead to outbreaks of pests and diseases and thereby reducing harvest ultimately affecting the food security of the country.

Kumar *et al*., (2004) analyzed the crop and climate relationships in India, using historic production statistics for major crops such as rice, wheat, sorghum, groundnut and sugarcane and use of historical agricultural statistics to explore the association between agricultural production and short-term rainfall variations over India. The study suggested that there was a strong influence of ElNino Southern Oscillation(ENSO) on rice production in India. Also Indian Ocean Sea Surface Temperature(SST) showed a long lead association with the kharif rice production, but not with the rabi rice crop.

Singh *et al*., (2017) studied the risk from climate change for rainfed rice cultivation in India. The study results predicted that between 15 per cent and 40 per cent of locations where rainfed rice is currently grown may become less suitable for cultivation or even unsuitable for that method of agriculture by 2050. Predictions says that in future around 40 per cent existing rainfed rice areas in India may be at risk. This decline in rice production mostly affects eastern India states such as Odisha, Assam and Chhattisgarh. Because, these States predominantly use rainfed rice cultivation methods and contribute more than a quarter annual rice production in India.

**2.2 Effect of climate change on rice cultivation**

According to Yang *et al.*, (2018) rice is a $C_3$ plant, and therefore the increase in $CO_2$ can increase its yield and the yield is controlled by a combined effect of temperature, precipitation, and atmospheric carbon dioxide. The increase in temperature will cause shortening of the period of growth and development of rice plant and temperature stress can reduce the accumulation rate of dry materials, and both of which may lead to lowering of rice production.

Palanisami *et al.*, (2017) observed that the future rice production in India was projected to be about 104 million tons during mid of the century *i.e.*, 2021-2050 and 101 million tons during end century *i.e.*, 2071-2100. Under medium emission scenario an overall reduction in rice production from the current level by 2.5 to 5 per cent during these periods was indicated. Under high emission scenario, rice production will be reduced by about 3 to 10 per cent during these periods. Among these three regions, central region is more prone for climate change and special attention is needed for stabilizing rice production, as rice area and productivity are already showing declining growth rate in the region.

In rainfed rice cultivation, climate is the primary factor which is driving force for good rice yields. The projections say that the climate will change in future and particularly that are related to increased variability in rainfall (Meinshausen *et al.*, 2011).

Aryal (2013) studied the physiological functions of rice and it was observed that during the growing and developing stages, the rice crop needed large quantity of water for its various physiological functions. Evaporation and evapotranspiration are influenced by several climatic and non-climatic factors. It was observed that the evaporation was highest in the month of September (3.16 mm/day) and lowest in June (2.56 mm/day). The rate of evapotranspiration was increasing from June (3.43 mm/day) to September (19.57 mm/day) respectively. The crop water requirement of rice was increased in days after planting and successive developmental stage.

The total amount of rainfall in the study area over study period (23rd June, to 30th September, 2005) was observed as 549.59 mm.

In the case of rice, drought resulted in both area and yield loss, and the magnitude of loss being dependent on the land type. In land with good irrigation, losses were lowest and highest in poorly irrigated lands (Ding *et al.*, 2007).

Katalakute *et al.*, (2016) conducted a study in Maharashtra and estimated that as the severity of drought increases, the agricultural sector and also the economy would be directly affected. Drought disrupts the agricultural production system, and the equilibrium between supply and demand of agricultural products will be broken. The occurrence of hydrological drought leads to the agricultural drought and then to socioeconomic drought. The people start to migrate towards urban areas or other parts for employment due to the effect of drought.

During the flowering or grain filling stage of rice, it is more sensitive to drought and late season drought is likely to have a larger aggregate production impact than early season drought. Drought can cause harmful effect in terms of human suffering, economic loss, and adverse environmental impact. Severe drought results in starvation and even death of the affected population. And economic impact such as production shortfall, price rise, lack of employment and income fall, food insecurity and poor health arise (Pandey and Bhandary, 2008).

Drought was an economic and livelihood hazard in Kampong Speu province in Cambodia. Droughts damaged more than 1000 hectares of paddy rice in seven of the thirteen years between 1994 and 2006. The Standardized Precipitation Index (SPI) was used in many climate zones for drought monitoring. This SPI played an important role in understanding the impacts of dry spells on crop production. The study revealed that compared to early or mid-season drought, late growing season droughts are more damaging (Chhinh and Millington, 2015).

Drought is strongly related to the agricultural food production system, and it destroys the food chain, food stock, and the agro-based production systems.

Sustainable and effective use of water for agriculture are the global priorities (Smith and Munoz, 2002).

Prasanna *et al.,* (2012) examined the likelihood factors affecting farmers higher gain from paddy marketing in the North Central Province of Sri Lanka, the main paddy cultivation area of the country. The factors were assessed by the use of empirical logit model. The study, identified that the imperfections of existing paddy marketing system in the area were due to concentrated market power among few oligopolistic buyers. And also the land ownership, land size, poor accessibility in formal sector credit market and farmers' involvement in informal sector credit sources were critical to farmers' decisions to gain higher returns from paddy marketing.

Analysis of agricultural drought and its effects on productivity at different district of Nepal were conducted by Bhandari and Panthi (2014). The study mainly focused on agricultural drought. The study revealed that the variations of temperature and erratic precipitation directly affected agriculture and crops grown.

Half of the world population, use rice as a staple food. In Asia, Africa, and Americas around a million households depend on rice systems as the main source of employment and livelihood. Rice is therefore considered as the frontline in the fight against world hunger and poverty (Nguyen and Ferrero, 2006).

**2.3 Drought and the socio economic condition of rice farmers**

Akhtar *et al.,* (2007) assessed the level of economic efficiency and competitiveness in the production of rice crop and the effect of policy intervention on the production of Basmati and IRRI rice crop in Pakistan's Punjab. The study indicated a lack of competitiveness at the farm level in the production of both Basmati and IRRI rice and concluded that the prevailing incentive structure affected farmers negatively. The study showed the negative divergence between private and social profits which implied that the net effect of policy intervention reduced the farm level profitability of both rice production systems in Pakistan's Punjab. The result showed that the need for removing existing policy distortions in the structure of economic incentives to increase economic efficiency and to attain farm level competitiveness in rice production.

Economic costs of drought and rice farmers in eastern India, the study conducted by Pandey *et al*., (2007), found that the aggregate economic losses from drought was high and correlated the drought events with production. The annual value of rice output was estimated across the states and ranged from 6 per cent to 10 per cent and that the total annual loss in rice production of the study area was 1.0 to 1.3 million tons, which is about 7–9 per cent of the mean output.

To analyze the factors which are responsible for shrinking of rice field in Kerala a study was done by Shiji (2016). The study observed that during the last few decades' people who were interested and entering agriculture as an occupation in rural Kerala has reduced drastically. Labour shortage, increased labour charges, and hikes in the cost of inputs were the factors which influenced the reduction. Lack of government support for rice cultivation also seems to be a factor for the loss of interest. The incentive for rice production in the state is only Rs. 350 $ha^{-1}$, which is negligible compared to other crops. Three major factors that affect the profitability of rice were cost of cultivation, yield levels and prices. Socio cultural and economic changes in the state were the major factors that caused the depletion in rice cultivation.

A study conducted by Samarpitha *et al.,* (2016) analysed the socio-economic characteristics of rice farmers in the combined state of Andhra Pradesh. The study identified the average age of the sample farmers as 46.04 years and indicated that the majority of the farmers in the study area were middle aged. 80 per cent of the farmers were educated and thus electronic media, mobiles and e-resources could be used to educate them for improved technologies. The major irrigation sources were found to be canals and bore wells, open wells and tanks were also used. The study pointed out that the cost cultivation of rice farmers was very high and their return was very low compared to cultivation cost.

Polthanee *et al.*, (2014) studied the rainfall characteristics in northeast Thailand, and assessed the impact of drought on rice production in 2012 and adaptation to strategies of farmers relative to drought. According to them, drought was an important constraint to crop production in northeast Thailand. Farmers decided to grow cassava replacing rice before maturity when they observed that rice produced low yield due to the effect of drought.

Rohila *et al.,* (2016) studied the socio economic profile of direct seeded rice (DSR) farmers. They found that DSR was an eco-friendly and resource conservation technology to have a sustainable food production system ensuring food security and enhancement of farmer income and it offers a very exciting opportunity to improve water and environmental sustainability. Direct-seeded rice (DSR) was a feasible alternative method with good potential to save water, reduce the labour requirement, mitigate the emission of greenhouse gases (GHGs) and adaptation to climate risks.

Economic analysis and constraints of rice cultivation in Dhamtari district of Chhattisgarh, was conducted by Churpal, *et al.*, (2015). According to them Mahamaya variety of rice was profitable in the study area since it had industrial importance for preparation of flakes rice or poha. The obtained net return of rice cultivation was Rs. 50342.0 $ha^{-1}$. The farmers opined the constraints as rainfall distribution, occurrence of disease and pest, weed infestation, deficiency of soil fertility and drought.

A study was carried out to determine the economics of resource efficiency in rice cultivation in Karnataka, the cost of cultivation was Rs.30065 $ha^{-1}$ and which was lower than the traditional which is about Rs.32445 $ha^{-1}$. The gross returns of demonstrated farmers were Rs.55018 $ha^{-1}$ and in traditional farmers the amount being Rs.43639 $ha^{-1}$. The co-efficient of determination ($R^2$) value was found to be 0.89 and 0.83 in the case of demonstrated and traditional farmers respectively (Bhakthavatsalam and Mundinamani, 2015).

Rice production is highly dependent on water supply. Adaptation to a rise in the number of extreme drought events, especially through improving water supply infrastructure and its management is very important. The study concluded that increasing the agricultural production and ensuring national food security by investment in irrigation infrastructure has been proposed as the best option (Lohmar *et al.*, 2003; Huang *et al.*, 2006).

Globally, the vulnerability to drought had increased very fast, therefore greater attention is needed to reduce risks associated with the drought occurrence through the introduction of planning to improve operational capabilities like climate and water supply monitoring, building institutional capacity and mitigation measures that are aimed to reducing impact of drought. In recent decades, the impact of drought has increased in economic, social, and environmental sectors, and occurrence of similar trend exist for all natural hazards. The study used the climatic parameters for analyze the drought impacts (Wilhite *et al.*, 2014).

Selvaraj (2009) noticed that given the rainfall distribution and the availability of ground water in rainfed areas, farmers can change their cropping pattern to mitigate the effect of drought. The study revealed that in Tamil Nadu, family food security was the major and primary concern for majority of the farmers. They were willing to undertake diversification only if the rice production could provide adequate and enough food for their family. Price and technology were the major factors which affect the area allocated to rice cultivation. The study assessed that the adoption of modern varieties, technologies and improved infrastructure especially irrigation are the important factors that contributed to achieve rapid growth in the agriculture sector, particularly rice production over the past 35 years.

The study carried out by Tijani *et al.*, (2010) on the resource use efficiency in rice production in Nigeria examined the socio-economic characteristics of respondents such as age, gender, educational status, farm size, farming experience, major occupation, and annual income. The study revealed that rice farmers were technically inefficient in the use of farm resources and the inefficiency of the farmers may be directly or indirectly linked with the high cost of fertilizer, rented land, seed, hired and mechanized labour. The study concluded that the resources such as fertilizer, hired labour and rented land were under-utilized.

Uday *et al.*, (2015) analysed the economics and constraints of rice cultivation in Koriya district of Chhattisgarh. It was observed that the cost of cultivation in the study area was estimated as Rs.8472.69 $ha^{-1}$ and the average yield of paddy was 18.61 quintal $ha^{-1}$. The study revealed that lack of technical knowledge, low adoption of recommended package of practices of crops and lack of finance were the major problems faced by the paddy growers in that region. Therefore, dissemination of the technical knowledge and providing irrigation facilities to the farmers could increase their production as well as net income from the paddy cultivation.

To find out the technical efficiency in agricultural production and its determinants in district level by Shanmugam and Venkataramani (2006) conducted a study which showed that health, education, and infrastructure were powerful drivers of efficiency at the district level. International comparison indicates that in India, the agricultural productivity was relatively very low. India had the largest area under cereal cultivation *i.e*, around 99.45 million hectares. The study results show that one of the most important reasons for low rice productivity was low literacy rates and inadequate physical infrastructure and difficulties in understanding new technologies.

Nirmala and Muthuraman (2009) estimated the constraints in the cost-return aspects of rice cultivation conducted in Kaithal district of Haryana and found that the machine labour in the rice cultivation contributed a highest percentage (25.27%) followed by human labour (19.72%), fertilizers (18.9%) and pesticides (11.56%) respectively and found that the total cost of cultivation of rice as Rs.33778.68 $ha^{-1}$. Major constraints in rice production in the Kaithal district were pests and disease incidence, lack of remunerative price and labour shortage.

A study conducted by Joes (2016) concluded that about 38 per cent people prefer agriculture because of family property, 28 per cent because of traditional, and 11 per cent is because of self-interest. Nine per cent of the respondents opined that the purpose of using the agriculture products for family usage 5 per cent respondents prefer due to earning additional income, 4 per cent respondents prefer due to favorable climatic conditions, 3 per cent respondents prefer because of unemployment and 2 per cent respondents prefer for the easy marketability.

The technical efficiency in rice production in Pakistan was studied by Abedullah *et al.*, (2007). It was estimated that different variables such as irrigation hours, sowing area, and labour hours were positive and significant and the number of ploughing and fertilizers were significant but negative. It was also estimated that farmers in the study area are operating at an average of 91 per cent technical efficiency level and hence for the adoption of new technologies would improve the rice productivity in the long run.

Chidi et al., (2015) investigated the socio-economic factors and profitability of rice production among small-scale farmers in Ebonyi state. The result of analysis showed that females were the majority (58.3%) of the farmers in the study area and 41.7 per cent were males. The age of the respondents ranged between 21-30 years was ranked the highest and is around 41.7 per cent, while those who were greater than 51 years with 4.2 per cent was the least. Majority (62.5%) of the respondents were married and 4.2 per cent were single. The result of educational level showed that majority of farmers were (41.2%) completed their primary school while the least of the respondents (12.5%) complete tertiary education. The year of experience of respondents (45%) ranged between 16 and above in the study area. The study also showed that about 41.7 per cent of the respondents earned between 31,000-4,0000 naira per annual income. The major constraints limiting the rice production identified by the study were economic problems, infrastructural issue and unfavourable government policies.

Grover (2013) studied the economic profile of rice cultivation in Punjab and estimated that Rs.17657 $ha^{-1}$was the total variable cost of cultivation and Rs.54585 ha$^{-1}$was the gross return of production. Regression analysis showed that there existed scope for further increase in use of insecticides or pesticides, manures or fertilizers and irrigation for improving the rice yield in Punjab.

Ahirwar *et al.,* (2013) conducted a study in Central Narmada Valley agroclimatic region of Madhya Pradesh for estimation of cost of cultivation, cost of production, profitability and constraints of rice cultivation. It was found that the cost of cultivation was highest in large farms (Rs.33128.51 ha$^{-1}$) compared to the small farms (Rs. 26623.81 ha$^{-1}$) and medium farms (Rs.30177.59 ha$^{-1}$). The result also showed that profit in rice production could be increased by eliminating constraints like high cost of input, insect pests and, weed problems, lack of hired human labour during the operational period.

### 2.4 Mitigation and adaptation measures used by rice farmers

To assess farmers' perception of drought impact, local adaptation and administrative mitigation measures in Maharashtra, a study was conducted by Udmale *et al.*, (2014). The occurrence of drought, resulted in the failure of agriculture and there was a reduction of farming employment opportunity and it affected the household income and food security. Irrigation played a major role in mitigating the drought impact on agriculture.

A study was conducted by Sugirtharan and Venuthasan (2012) to analyze the socio economic condition of farmers which showed that, 70 per cent of farmers were aware of changing pattern and increasing trend of flood and 61 per cent of the farmers were aware about the changing pattern and the increasing trend of drought. The study revealed that 43 per cent of the farmers were adapting new agronomic practices in rice cultivation such as reuse of drainage water, increase the number of ploughing, shifting the cultivation period and use of flood and drought tolerant crop variety.

Pant (2011) conducted a study on climate change and crop production. The study revealed that the climate change would potentially increase the crop production cost. The climate change adaptation techniques include switching to more resilient and drought tolerant or resistant crop varieties and rainwater harvesting. The irrigation infrastructure development that reduced the dependence of farmers on rainfall, thus decreasing the effect of drought. In household farms, the increased food insecurity increases the costs causing food deficit. This increased food insecurity which is a major problem to smallholder farmers who were food deficit and had no secure alternate source of income. Climate change also affected the food quality because of the increasing temperature and decreasing the crop growth period.

Herath and Thirumarpan (2017) investigated the effect of climate change induced adaptation by paddy farmers. The study identified that the adaptation practices included planting new improved varieties that offer farmers higher yields instead of the traditional once, shifting to shorter cycle crop varieties, that can take short periods of time like three months from planting to harvesting, shifting to drought tolerant crops varieties, insuring farm against risk, use of supplementary reservoir for water storage, and shifting of harvesting period was also used as mitigation and adaptation measures.

In India, to meet the food demand of people, the sustainable agricultural development, poverty reduction through economic growth by creating employment opportunities in non-agricultural rural sectors are essential. Taking adaptive actions may help to overcome adverse effects of climate change on agriculture and innovative agricultural practices and technologies can play a role in mitigation and adaptation of climate change. The study suggested that some of the mitigation and adaptation measures were improvement in forecasting and early warning systems, establishing hazard and vulnerability mapping, augmenting public awareness, creating community based forest management and afforestation projects and finally improvement in irrigation Senapati *et al.*, (2013).

According to Salehin *et al.*, (2009) yearly income of farmer, food consumption expenditure had been increased due to adoption of new rice production technologies. The study was mainly focused on the farmers age, farm size, family size, educational status and annual income. At the same time housing



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environment had a significant improvement after adoption of rice production technologies. Due to the adoption of new technologies, change in the family status which was associated with income and other socioeconomic correlates of the farmer. Therefore, to reduce the over growing demand of food, nutrition and environmental problems, there is a need to enhance the adoption of rice production technologies among the farmers.

Drought is one of the major extreme event caused by climate change worldwide. The economic impact of drought was associated with agriculture crops and the income generated from crops. The study showed that due to the effect of drought, in some places the field crops were being replaced with tree crops like, timber, fuel wood and fruit trees. And also, permaculture, mulching, and traditional harrowing followed by powdering the soil to protect evaporation were being practiced in some areas. To reduce vulnerability of drought, education, research, training and technology as well as innovation of software applications to monitor and forecast droughts could be a very good option in the least developed countries. The study also showed that women and children were mostly vulnerable to drought (Miyan, 2014).

Udmale *et al.,* (2014) conducted a study in the drought affected rural livelihood in India and find out that, farmers with high education were more conscious about drought. The study results showed that farmers adopted a variety of strategies such as changing crop calendar, no sowing, using improved irrigation practices, water harvesting and minimize the wastage of water. They concluded that farmers' preference to rain water harvesting through various structures and modern irrigation practices such as drip and sprinkler irrigation technique were very less. Pangapangaa *et al.,* (2012) also reported that farmers' behavior with respect to adaptation strategies was influenced by the factors such as land holding size, household income and education.

The constraints faced by farmers were poor rural infrastructure, limited capital to increase volume of coverage, lack of availability of extension education, lack of trained man-power and low level of educational status. These constraints have been minimized in rural areas by better extension works (Ndanitsa *et al.*, 2011).

Msangya and Yihuan (2006) conducted a study on challenges of small scale farmers of Ulanga District, Tanzania. The study identified that the major challenges in small-scale farmers encountered were high cost of cultivation during ploughing, unprofitable market price, plant diseases and infestation of weeds, lack of extension services, lack of credit facilities as well as lack of improved varieties and education status. Lack of technical knowledge also affected small-scale farmers and their economic efficiency in rice production. Therefore, to increase the overall rice production, technical assistance from extension officers is very important.

# MATERIALS AND METHODS

## CHAPTER 3

## MATERIALS AND METHODS

This chapter deals with brief description about the research techniques used in this study under the following sections.

**3.1 Locale of Research**

**3.2 Selection of Respondents**

**3.3 Description of study area**

**3.4 Operationalisation of variables and their measurement**

**3.5 Collection of data**

**3.6 Method of estimation of cost**

**3.7 Statistical tools used**

### 3.1 Locale of Research

This section deals with the selection procedures followed to locate this *ex-posto-facto* study.

#### 3.1.1 Selection of District

Based on the objectives of the study cited elsewhere, it was required to select districts to study the socioeconomic impact of meteorological drought on rice cultivation .The study was undertaken in Palakkad district in Kerala. Palakkad is called the rice bowl of Kerala because it is the largest producer of rice in the state. Palakkad is popularly called *Nellara* or the grain warehouse of Kerala. In Kerala, compared to other districts, Palakkad experienced severe drought during second crop season (2016-17) because, it exists at the same sea level as Coimbatore district of Tamil Nadu. Hence the Palakkad district was selected purposely.

### 3.1.2 Selection of Blocks

In Palakkad district, out of 13 blocks, Alathur, Chittur and Pattambi blocks were purposively selected for the study.

### 3.1.3 Selection of Panchayats

Pattithara, Erimayur, Kavassery, Pallessana and Nallepilly Panchayaths were purposively selected for the study as these five Panchayats were declared as drought affected by the department of agriculture during the year 2016-17.

**Table. 3 Panchayat wise area of drought affected**

| Sl. No | Panchayat | Area of drought affected rice (ha) |
|---|---|---|
| 1 | Pattithara | 25 |
| 2 | Erimayur | 16.62 |
| 3 | Kavassery | 12.51 |
| 4 | Pallessana | 12.44 |
| 5 | Nallepilly | 7.81 |
| 6 | Kollengode | 7.59 |
| 7 | Thrikkadiri | 5.6 |
| 8 | Thrithala | 5 |
| 9 | Kongad | 4.09 |
| 10 | Pookkottokavu | 2.7 |
| 11 | Pattambi | 2 |
| 12 | Pudur | 2 |
| 13 | Koppam | 1.59 |

Source: Principal Agricultural Office, Palakkad (2016-17)

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### 3.2 Selection of Respondents

As per the study objectives, the rice growing farmers were required to be selected. The panchayats were selected based on the area affected by drought. The number of farmers were randomly selected based on the proportion of drought affected area in each panchayat. An equal number of farmers who did not suffer losses from drought were also selected randomly from each panchayat for the study purpose. The total sample included 50 drought affected farmers and an equal number who did not suffer losses due to drought. Thus, a total of 100 rice farmers were surveyed from 5 different Panchayats of Palakkad. In each Panchayat, 20 farmers were surveyed, out of this, 10 farmers who did not suffer loss due to drought and 10 farmers who suffer loss due to drought. Data were collected in line with the objectives using a pre-tested structured interview schedule.

### 3.3 Description of study area

To develop better perception about the findings and also relate them for similar conditions elsewhere, it would be necessary to know the general conditions of the study area. Hence, the description of Palakkad district is given.

### 3.3.1 Palakkad district

Palakkad district came into existence on 1st January 1957 with headquarters at Palakkad town. With an area of 4482 Sq.km, Palakkad ranks 1st in area among the districts of Kerala. The district is called the 'rice bowl' of Kerala. Palakkad is the gateway to Kerala from the rest of the country due to the presence of the Palakkad Gap, which has a width of about 32 to 40 km in the Western Ghats. At present, the district consists of 2 revenue divisions, 6 taluks and 157 revenue Villages. There are 7 municipalities, 13 block panchayats and 88 village panchayats in the district.

### 3.3.2.1 Location

It lies between 10° 20' and 11° 14' north latitude and between 76° 20' and 76° 54' east longitudes. Located in the South- West coast of India, the district is bordered by Malappuram on the north west, Thrissur on the south, the Nilgiris on the north east and Coimbatore district of Tamil Nadu on the eastern side.

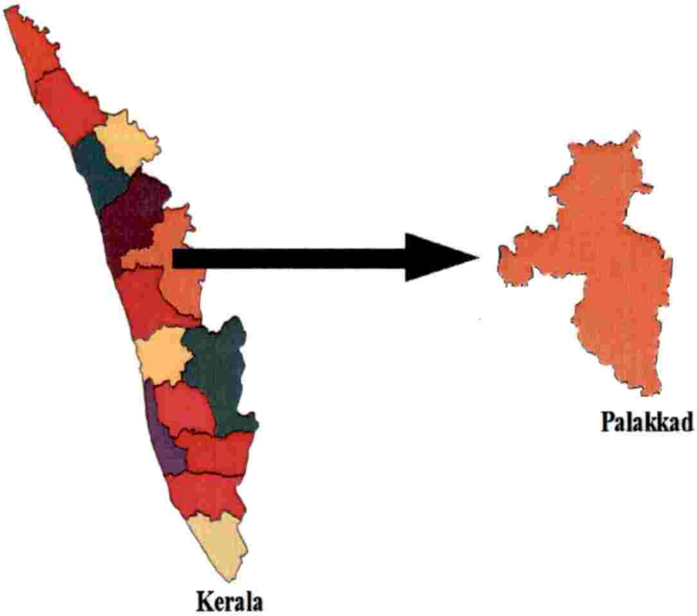


**Fig 1. Map showing the study area – Palakkad district**


**Fig 2. Palakkad district**

### 3.3.2.2 Topography and climate

Palakkad is the gateway to Kerala due to the presence of the Palakkad Gap, in the Western Ghats. Palakkad has a tropical wet and dry climate. Temperatures remain moderate throughout the year, with exception in March and April being the hottest months. A very high amount of precipitation is received in Palakkad, mainly due to the South-West monsoon. July is the wettest month, and the total annual rainfall is around 83 inches (211 cm).

### 3.3.2.3 Demographic features

As per the 2011 Census, the population of Palakkad in 2011 was 1,30,955; of which the number of males and females were 63,833 and 67,122 respectively. The total literates in Palakkad city were 112,479 of which 56,065 were males while 56,414 were females. The average literacy rate of Palakkad city was 94.20 per cent of which male and female literacy was 96.83 and 91.73 per cent.

**Table 4. Land utilization pattern of Palakkad district**

| Particulars | Area(in ha) |
|---|---|
| Forest | 136257(30.44) |
| Land put on non-agricultural uses | 49021(10.95) |
| Barren and uncultivable land | 2459(0.55) |
| Permanent pastures and other grazing land | - |
| Land under miscellaneous tree crops | 892(0.2) |
| Cultivable waste | 23641(5.28) |
| Fallow other than current fallow | 16087(3.59) |
| Current fallow | 12237(2.73) |
| Marshy land | - |
| Still Water | 15333(3.42) |
| Water logged area | - |
| Social Forestry | 380(0.09) |
| Net area sown | 191277(42.74) |
| Area sown more than once | 102163(22.83) |
| Total cropped area | 293440(65.57) |
| Geographical area | 447584(100) |

Note: Figures in parentheses indicate per cent to total geographical area

Source: Agricultural Statistics 2015-16, Department of Economics and Statistics, Government of Kerala

### 3.4 Operationalization of variables and their measurements

Independent variables relevant to the study were enlisted based on past researches. Eight variables were selected for the study. The independent variables selected for the study were age, education, experience, land holding size, area under rice cultivation, annual income, average household expenditure, source of income, inputs used for cultivation such as variety used and irrigation, cost of cultivation and coping mechanisms used by the farmers.

**Table 5. Variable studied and their measurements**

| Sl.No | Variables | Measurements |
|---|---|---|
| 1. | Age | Scale adopted from Dhruthiraj(2016) |
| 2. | Education | Scale adopted from Dhruthiraj(2016) |
| 3. | Experience | Scale adopted from Dhruthiraj(2016) |
| 4. | Area under rice cultivation | Scale adopted from Dhruthiraj(2016) |
| 5. | Farm size | Scale adopted from Dhruthiraj(2016) |
| 6. | Annual income | Scale adopted from Dhruthiraj(2016) |
| 7. | Source of income | Scale adopted from Dhruthiraj(2016) |
| 8. | Average annual household expenditure | Scale adopted from Dhruthiraj(2016) |

### 3.4.1 Age

It refers to the chronological age of the respondent at the time of investigation. The age of the respondent was recorded as mentioned by the respondents in completed years. It has been divided into four classes

a. Upto 40 years
b. 40 - 50 years
c. 50 - 60 years

d. More than 60 years

### 3.4.2 Education

Education refers to the number of years spent in formal education and academic credential acquired by the respondents at the time of investigation. The farmers were asked to put themselves in one of the following categories during the investigation

a. Illiterate
b. Lower Primary
c. Upper Primary
d. High School
e. Higher Secondary
f. College level

### 3.4.3 Experience

Farming experience refers to the number of years a farmer is involved in rice cultivation. This was quantified by asking the respondent to indicate the number of years since he has been practicing commercial rice cultivation. It is divided into three categories

a. Less than 10 years
b. 10 – 25 years
c. More than 25 years

### 3.4.4 Farm size

Land holding refers to possession of land (in hectares) by the respondent. On the basis of farm size, the farmers have been grouped into four categories such as

a. Less than 1 ha
b. 1 to 2 ha
c. More than 2 ha

### 3.4.5 Area under rice cultivation

Area under rice cultivation of the respondents refers to the extent to which the rice crop can cultivated by the respondents. The respondent has been classified on the basis of area under rice cultivation are

a. Less than 0.5 ha
b. 0.5 to 1 ha
c. More than 1 ha

### 3.4.6 Annual Income

Annual income refers to the total income in Rupees generated by the respondent in a year and is grouped into four categories

a. Rs.100000 – 200000
b. Rs.200000 – 300000
c. More than Rs.300000

### 3.4.7 Source of income

It refers to the source from which the respondents generated their income. Based on the source of income the respondents were grouped into two categories

a. Farmers with farm income alone
b. Farmers with farm income and non- farm income.

### 3.4.8 Average annual household expenditure

Average annual household expenditure refers to the average annual household spending is rupees made by the respondents to meet their everyday needs, such as: food, clothing, housing, energy, transport, durable goods, health costs, leisure, and miscellaneous services.

a. Rs.100000-200000
b. Rs.200000-300000
c. More than Rs.300000

## 3.5 Inputs used for rice cultivation

### 3.5.1 Variety used

The variety used to cultivate during the second crop season by the respondents were categorized as

a. Uma
b. Jyothi
c. Kanchana
d. Shreyas

### 3.5.2 Irrigation

Source of irrigation provided by the respondents were categorized into three

a. Canal
b. Bore well
c. Pond

## 3.6 Coping mechanisms

Coping mechanisms are the mechanisms adopted by the farmers to withstand or cope with the drought situation. Coping mechanisms practiced by the respondents in each panchayat were collected and used to analyse the farmers' ability to withstand drought in rice. The coping mechanisms used by the farmers were,

a. Irrigation: Provide irrigation from other water sources like pond, water harvesting structures, bore wells, when received rainfall is very low.
b. Insuring farm against risk: Government gave the compensation for the farmers when the adverse weather condition which affects the crop production.
c. Short duration varieties: Farmer cultivate varieties with 100 -110 days of duration.

d. Adjusting the sowing time: According to the availability of rainfall, farmers change their sowing time.
e. Reducing the use of fertilizer: In drought conditions, plant response to fertilizer declined, causing decreased rice yield.

### 3.7 Collection of data

The study is based on both primary and secondary data. The secondary data were collected from publications from Economics and Statistics Department and other online sources. Primary data regarding the profile of farmers, cost of cultivation, coping strategies and other details were collected from farmers by interview method using pre structured interview schedule. The data was collected from 2017 November to 2018 January.

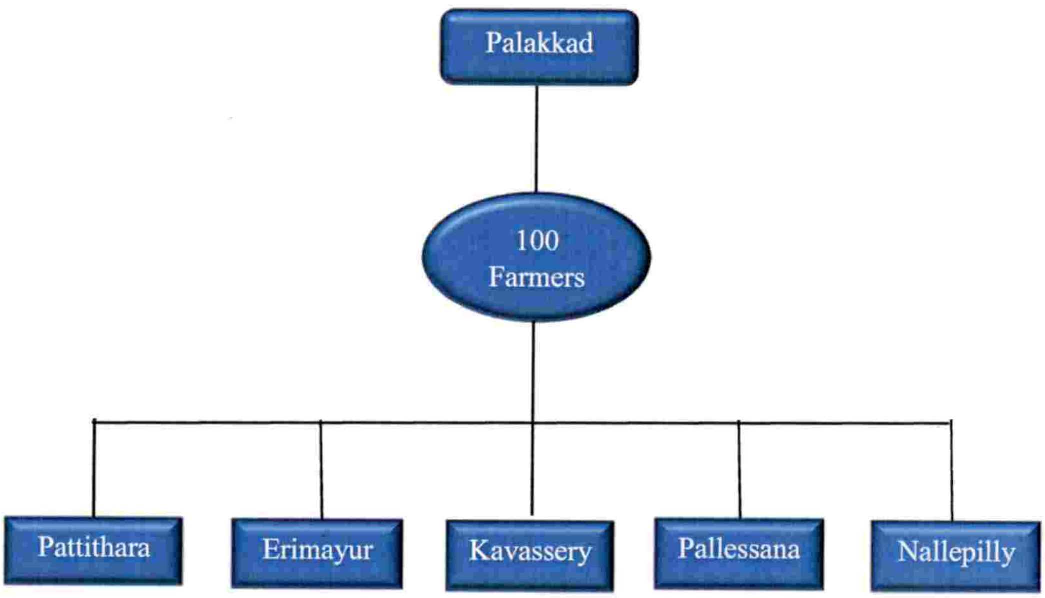


**Fig. 3 Sampling design**

### 3.7.1 Rapport building

In order to create a good rapport, preliminary visits were made to the villages. The purpose of the study was made clear to the farmers during these visits. This helped the researcher to get valid and reliable information.

## 3.8 Method of estimation of cost

### 3.8.1 Estimation of cost

**3.8.1.1 Cost concepts:** The cost concepts used by Commission on Agricultural Cost and Prices (CACP) of Government of India for farm management studies are used in the present study. Data was collected on selected indicators, physical input including value of seed (purchased or home grown), value of insecticides and pesticides, value of manure, value of fertilizer, irrigation charges, value of hired machinery, human labour (owned and hired), land revenue, rent paid for leased in land or rental value of own land, interest on working capital, depreciation of machinery and miscellaneous expenses are the indicators included the study.

The structure of different costs and their components

Cost $A_1$ includes value

i. Hired human labour

ii. Animal labour

iii. Machine labour

iv. Seed/ seedlings

v. Farm yard Manure and Chemical fertilizers

vi. Plant protection

vii. Land tax and Irrigation Cess

viii. Repair and maintenance charges of implements, machinery and buildings

ix. Interest on working capital

x. Other expenses

Cost '$B_1$': Cost 'A' + Interest on fixed assets (excluding land)

Cost 'B': Cost '$B_1$' + interest on land value

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

### 3.8.1.2 Method of measurement of various costs included in the study:

The criteria for measurement of various input costs are presented in **Table 6.**

**Table. 6 Criteria for measurement of various input cost**

| Sl.No. | Items | Criteria |
|---|---|---|
| 1. | Family Labour | On the basis of statutory wage rate or the actual market rate, whichever is higher |
| 2. | Owned Animal labour | On the basis of cost of maintenance, which includes cost of green and dry fodder and concentrates, depreciation on animal and cattle shed upkeep labour charges and other expenses. |
| 3. | Owned Machinery Charges | On the basis of cost of maintenance of farm machinery, this includes diesel, electricity, lubricants, depreciation, repairs and other maintenance expenses. |
| 4. | Implements | Depreciation and charges on account of minor repairs charged at 10% per annum. |
| 5. | Farm Produced Manure | Evaluated at rates prevailing in the village |

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| | | |
|---|---|---|
| 6. | Rent of owned land | Estimated on the basis of prevailing rents in the village for identical type of land or as reported by the sample farmers subject to the ceiling of fair rents given in the land legislation of the concerned state. |
| 7 | Farmyard Manure | If it is purchased, then the evaluation is to be done on the basis of purchase price. |
| 8 | Chemical fertilizer, pesticides, insecticides | Evaluated at purchase price |
| 7. | Interest on owned fixed capital | Interest on present value of fixed assets charged at the rate of 10% per annum. |
| 9. | Interest on working capital | Interest is charged at the rate 7.5 % per annum on the working capital for the period of crop. |
| 10. | Payments in kind | Payments in kind are evaluated at the prices prevailing in the village at the time such payments are made. |
| 11. | Main products and by-products | Imputed on the basis of post- harvest prices prevailing in the selected Panchayats. |
| Farm Assets | | |
| 12. | Owned and self-cultivated land | Evaluated at rates prevalent in the village, taking into account the differences in type of soil, distance from the village, source of irrigation available etc. |
| 13. | Farm buildings | Evaluated at rates prevailing in the village |

| | | |
|---|---|---|
| 14. | Implements and other farm machinery | Evaluated at market prices |
| 15. | Livestock | Evaluated at market prices |

## 3.9 Statistical techniques used

The following statistical methods were used in this study based on the nature of the data and relevant information required.

### 3.9.1 Percentage analysis

The percentage analysis was done to make simple comparison whenever necessary.

### 3.9.2 Regression Analysis

Regression is a statistical technique used to determine the linear relationship between two or more variables. Regression is used for forecasting, time series modelling and finding the casual effects relationship between variables.

Regression shows the relationship between the independent variable (X) and the dependent variable (Y), as in the formula below,

$$Y = \beta_0 + \beta_1 X + u$$

Where, $\beta_1$ is the slope parameter, that gives the magnitude and direction of the relation

$\beta_1$ intercept parameter, that gives the status of the dependent variable when the independent variable is absent

$u$ is the error term

The independent variable, which associated with the changes in the dependent variables.

### 3.9.3 Data Envelop Analysis

DEA is a linear programming method is a non-parametric mathematical programming approach to frontier estimation. This computer program can consider a variety of models. The three principal options are,

1. Standard CRS and VRS DEA models, which involve the calculation of technical and scale efficiencies.
2. It accounts for the cost and allocative efficiencies.
3. The application of DEA method to panel data to calculate the change of indices of total factor productivity (TFP), technological change, change in technical efficiency and scale efficiency.

Technical efficiency reflects the ability of a firm to obtain maximum output based on a given set of inputs.

The extent by which a farm lies below its production frontier, which sets the limit to the range of maximum obtainable output, can be regarded as the measure of technical inefficiency (Hota and Pradhan, 2012). There are two methods used to measure technical efficiency (TE).

a) Production frontiers estimation
b) Data envelopment analysis (DEA)

In the present study data envelop analysis was employed to measure the technical efficiency of sample farmers. The DEA frontier technology was formed as a non-parametric, piece-wise linear combination of observed "best-practice" activities. Data points were enveloped with linear segments, and efficiency scores were calculated relative to the frontier (Coelli *et al.*, 1998). Technical efficiency was estimated by employing the input oriented DEA model under VRS. Input oriented VRS DEA model for *N* decision-making units, each producing M output by using k different inputs is given below



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$$\min_{\theta,\lambda} \theta$$

$$st - y_1 + Y\lambda \leq 0$$

$$N1'\lambda = 1$$

$$\lambda \geq 0$$

where $\theta$ is a scalar $\lambda$ is a N×1 vector of constant and M is an $N \times 1$ vector of ones. The value of $\theta$ obtained will be the efficiency score for the i-th decision-making unit. It will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and hence technically efficient decision-making unit, according to the Farrell (1957) definition. Thus, the linear programming problem needs to be solved N times and a value of $\theta$ is provided for each farm in the sample. The relationship between VSR and CRS DEA score is used to calculate the scale efficiency (SE) score for a farm (Dhungana *et al.*, 2004).

$$SE_i = \frac{TE_{i,CRS}}{TE_{i,VRS}}$$

A unit is said to be scale efficient when its size of operations is optimal so that any modification on its size will render the unit less efficient.

Where SE= 1 indicates a scale efficient farm that is operating at a point of CRS. a value SE<1 indicates scale inefficiency.

### 3.9.4 Garrett ranking technique

To find out the most significant coping strategy adopted by the respondents in the study area, Garrett ranking technique was used. In the first step, coping strategies adopted by farmers in the study area were identified. As per the Garrett ranking technique, respondents had been asked to assign the rank for the identified coping strategies. The respondents were asked to rank the factors in such a way that the first rank was given for the best coping strategy adopted by them and last rank was given for the least adopted coping strategy.

In this study, data was collected from 100 respondents. The outcome of the ranking had been converted into per cent positions using the following formula

$$\frac{100(R_{ij} - 0.5)}{N_j}$$

Where,

$R_{ij}$ = Rank given for the $i^{th}$ variable by $j^{th}$ respondents

$N_j$ = Number of variable ranked by $j^{th}$ respondents

Here 0.5 is subtracted from each rank because the rank is an interval on a scale and its midpoint best represents the interval. For each percent position, the Garrett scores on a scale of 100 points were calculated with the help of Garrett's ranking conversion table given by Garrett and Woodworth in 1969. Then for each coping strategy, the scores of each individual were added and then total value of scores and mean values of score were calculated. The coping strategy having highest mean value was considered to be the most important coping strategy.

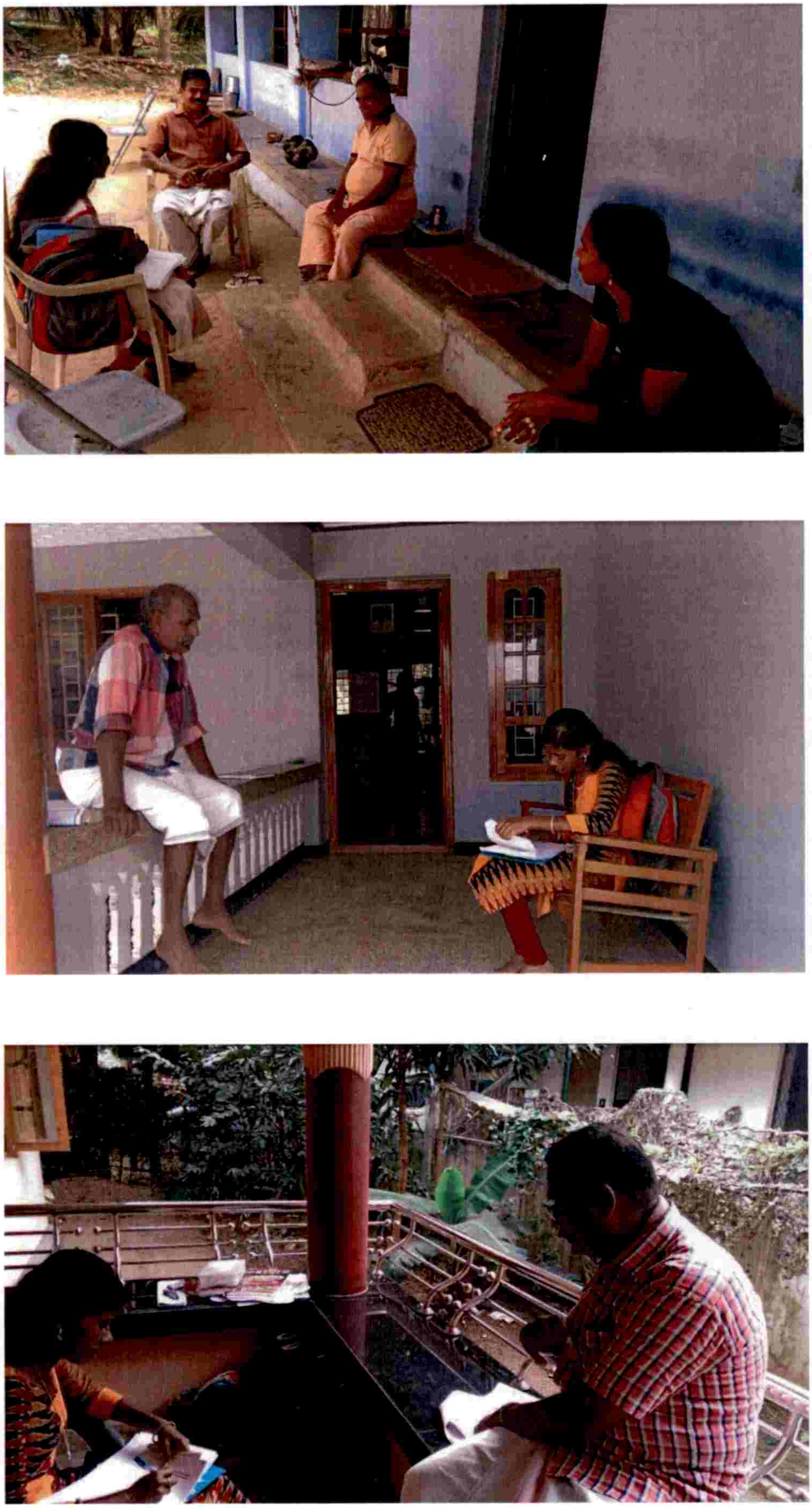

Plate 1. Student researcher with the respondents during data collection

**Plate 2**. Student researcher with the respondents during data collection

# RESULTS AND DISCUSSION

# CHAPTER 4

# RESULTS AND DISCUSSION

In this chapter, analysis of the primary data collected from the rice growers in Palakkad region have been described. The results obtained are presented under the following sub headings.

**4.1 Socioeconomic profile of respondents**

**4.2 Nature and extent of drought in Palakkad district**

**4.3 Rice production status in Kerala and Palakkad**

**4.4 Economics of rice cultivation**

**4.5 Coping mechanism adopted by the farmers**

## 4.1.Socioeconomic profile of the respondents

The socioeconome profile characteristics of the respondents are dealtwith in this section.

### 4.1.1. Age of the respondents

Age of the farmers is one of the major factors in determining their understanding about improved technologies and their behaviour towards the adoption of improved technologies. In the present study, the respondents were classified into four different categories based on the age upto 40 years, 40-50 years, 50-60 years and more than 60 years. From the **Table 7**, it is clearly evident that maximum respondents belong to more than 50 years age group. In case of upto 40 year category, only 3 per cent of the respondents belong to this category. And in case of 40-50 years category, only 23 per cent. Whereas, the highest number of farmers fall under 50-60 years category and they constitute about 50 per cent of the category. The respondents in more than 60 years category constitute only 24 per cent. These results showed that the involvement of senior farmers in paddy cultivation is higher as compared to the other age group respondents in all the Panchayats and also that the younger generation showed relatively lesser interest in paddy cultivation in the panchayats surveyed.

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### 4.1.2 Educational status

Education helps farmers for better understanding of a new or improved technology which further enables the adoption of any better technology by them (Foltz, 2003). It was observed that the literacy level is higher in the Panchayats surveyed. About 98 per cent respondents were literate and only 2 per cent respondents were illiterate. In each Panchayat, 74 per cent of the respondents had attended classes upto high school level. Seven per cent of the respondents had upper primary level education and 1 per cent respondents had lower primary level education. Farmers who had attended college level were 16 per cent of the total in the category. This result clearly showed that farmers educational status was higher in Kerala and they were capable of understanding new technologies and strategies in rice cultivation.

### 4.1.3 Experience in paddy cultivation

Experience of respondents in rice cultivation in each Panchayat had been analysed. Based on the experience in rice cultivation, the farmers were categorised into three categories. They were less than 10 years of experience category, 10-25 years' experience category and more than 25 years of experience category. The results showed that in the study area, around 77 per cent respondents had experience of more than 25 years in rice cultivation and 19 per cent respondents had an experience of 10-25 years. Only 4 per cent of the respondents had an experience of less than 10 years in rice cultivation. These results clarify that respondents in the Panchayats were highly experienced in rice cultivation.

### 4.1.4 Land holdings

It is observed that, majority of the respondents in each Panchayat belong to less than 1 ha category (76 per cent) followed by 1 to 2.5 ha (23 per cent) and more than 2.5 ha (1 per cent) of total.

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### 4.1.5 Area under rice cultivation

As evident from the table, majority of the respondents in each Panchayat fall under less than 0.5 ha category (73 per cent) followed by 0.5 to 1 ha (26 per cent) and more than 1 ha (1 per cent) of total. The result showed that, in rice cultivation, involvement of small farmers was comparatively higher than medium and large farmers.

### 4.1.6 Annual income (in Rupees)

Income of respondents from different sources has an important role in determining the economic conditions of the respondents. It is observed that least number of respondents surveyed were under the category with annual income greater than Rs.300000 (5%). Sixty seven and 28 per cent of the farmers were in the category of annual income between Rs.100000 to 200000 and Rs.200000 to 300000 respectively. This clearly shows that farmers are earning higher annual income from farm and non-farm sources.

### 4.1.7 Source of income

Source of income refers to the source from which the respondents generated their income. The classification of selected respondents based on their income source is dealt with in this section. Among Pattithara, Erimayur, Kavassery, Pallessana and Nallepilly Panchayats, 75 per cent of respondents earned their income from farm source alone whereas 25 per cent respondents depended both on on-farm and off-farm sources for their income. This result clearly revealed that most of the respondents depended on on-farm income alone and some of the farmers depended on other off-farm occupations along with agriculture as their source of income in the study area.

### 4.1.8 Average annual household expenditure

Among the 100 respondents in the study area, about 49 per cent of farmers incurred an average annual household expenditure of Rs.100000 to 200000 followed by 44 per cent of the selected farmers who had average annual household expenditure between Rs.50000 to 100000. Seven per cent of respondents belonged to more than Rs.200000 among the total respondents.

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**Table 7. Profile characteristics of the respondents**

| Profile characters | Particulars | No. of Respondents |
|---|---|---|
| Age | Upto 40 years | 3(3.00) |
| | 40 – 50 years | 23(23.00) |
| | 50 – 60 years | 50(50.00) |
| | Above 60 years | 24(24.00) |
| Education | Illiterate | 2(2.00) |
| | Lower Primary | 1(1.00) |
| | Upper Primary | 7(7.00) |
| | High School | 74(74.00) |
| | Higher Secondary | - |
| | College level | 16(16.00) |
| Experience | Less than 10 years | 4(4.00) |
| | 10 to 25 years | 19(19.00) |
| | More than 25 years | 77(77.00) |
| Farm size | Less than 0.5 ha | 76(76.00) |
| | 0.5 to 1 ha | 23(23.00) |
| | More than 1 ha | 1(1.00) |
| Area under rice cultivation | Less than 0.5 ha | 73(73.00) |
| | 0.5 to 1 ha | 26(26.00) |
| | More than 1 ha | 1(1.00) |
| Average annual income | 1 to 2 lakh | 67(67.00) |
| | 2 to 3 lakh | 28(28.00) |
| | More than 3 lakh | 5(5.00) |
| Source of income | Farm income alone | 75(75.00) |
| | Farm income and non farm income | 25(25.00) |

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| | | |
|---|---|---|
| Average annual household expenditure | 50000 to 1 lakh | 44(44.00) |
| | 1 to 2 lakh | 49(49.00) |
| | More than 2 lakh | 7(7.00) |

Note : Figures in parentheses represent the per cent to the total

### 4.1.9 Input used by the respondents

#### 4.1.9.1. Variety used

The variety used by the respondent in each Panchayats are represented in the **Table 8.** It clearly showed that most of the farmers were used Jyothy variety, followed by Uma, Kanchana and Sreyas are also used by some of the farmers. Around 74 per cent farmers used Jyothy to cultivate. Whereas Uma is around 17 per cent. Whereas 6 per cent farmers use Sreyas and 3 per cent of Kanchana users, and it was only used in Kavassery Panchayat.

**Table 8. Variety used**

| Variety used | No. of Respondents |
|---|---|
| Jyothy | 74(74.00) |
| Uma | 17(17.00) |
| Kanchana | 3(3.00) |
| Sreyas | 6(6.00) |

Note : Figures in parentheses represent the per cent to the total

#### 4.1.9.2 Irrigation

The sample of respondents are selected based on the type of irrigation *i.e*, canal and bore well. That is 50 per cent respondents were irrigated through canal and 16 per cent respondents are irrigated through bore well and 34 per cent respondents were irrigated through pond. Canal irrigated farmers suffered mostly compared to pond and bore well irrigated once. Because of the closing of shutters of dams due to less amount of water availability. The farmers who used bore well irrigation did not experience the severe drought condition.

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**Table 9. Source of irrigation**

| Irrigation | No. of Respondents |
|---|---|
| Canal | 50(50.00) |
| Bore well | 16(26.00) |
| Pond | 34(24.00) |

Note : Figures in parentheses represent the per cent to the total

## 4.2 Nature and extent of drought in Palakkad district

### 4.2.1 Different types of drought

Drought is a weather related natural hazard and a recurrent feature of climate. It is related to a deficiency of precipitation over an extended period of time. Drought is related to the timing of precipitation. Other climatic factors such as high temperature, high wind, and low relative humidity are also associated with the drought. It has an impact on food production and it reduces life expectancy and economic performance over a large region.

Meteorological drought: Meteorological drought occurs when there is a significant decrease of normal precipitation over an area (*i.e*, more than 10 %). It usually an indicator of potential water crisis if the condition is prolonged. Meteorological drought can begin and end immediately.

Hydrological drought: Hydrological drought occurs due to prolonged meteorological drought resulting in depletion of surface and sub-surface water resources. Hydrological drought does not occur at the same time as meteorological drought.

Agricultural drought: In case of agricultural drought, the soil moisture and rainfall are inadequate to support healthy plant growth and development. Occurrence of agricultural drought which adversely affect crops and animals.

Physiological drought: Drought condition suffered by plants that occurs despite there being sufficient water in the soil. It may be occurring when the concentration of solutes in the soil water is equal to or higher than that in the root cells, so water cannot enter the plant cells by osmosis.

In this study, the main focus is on the meteorological drought. According to the Agriculture department, Palakkad district experienced meteorological drought situation during the year 2016-17. During 2016-17, Palakkad experienced a large reduction in the rainfall received and observed a higher temperature (Appendix 5).

### 4.2.2 Analysis of variation in climatic parameter in Palakkad from 1987-2016

Understanding of variation in weather parameters is important in agricultural sector. The past data on 30 years of climate parameters, mainly maximum and minimum temperatures and rainfall, of Palakkad district were analysed. From the **Fig. 4,** it was clear that the maximum and minimum temperatures of Palakkad district showed a slight increase. During the year 1987, the average maximum temperature was 33.03 $^0$C and the same temperature (33.06 $^0$C) was observed in the year 2015. A decrease in maximum temperature were observed in 1994 (31.87 $^0$C) and 1999 (31.94 $^0$C). Maximum temperature observed during 2016 were 32.69 $^0$C and the minimum temperature was 24.32 $^0$C. Whereas, the years, 2016 and 2014 witnessed a higher minimum temperature (24.32 $^0$C and 24.41 $^0$C). Lowest minimum temperatures were observed in 1988, 1990 and 1994 with a minimum temperature of 20.89 $^0$C, 20.70 $^0$C and 20.75 $^0$C respectively.

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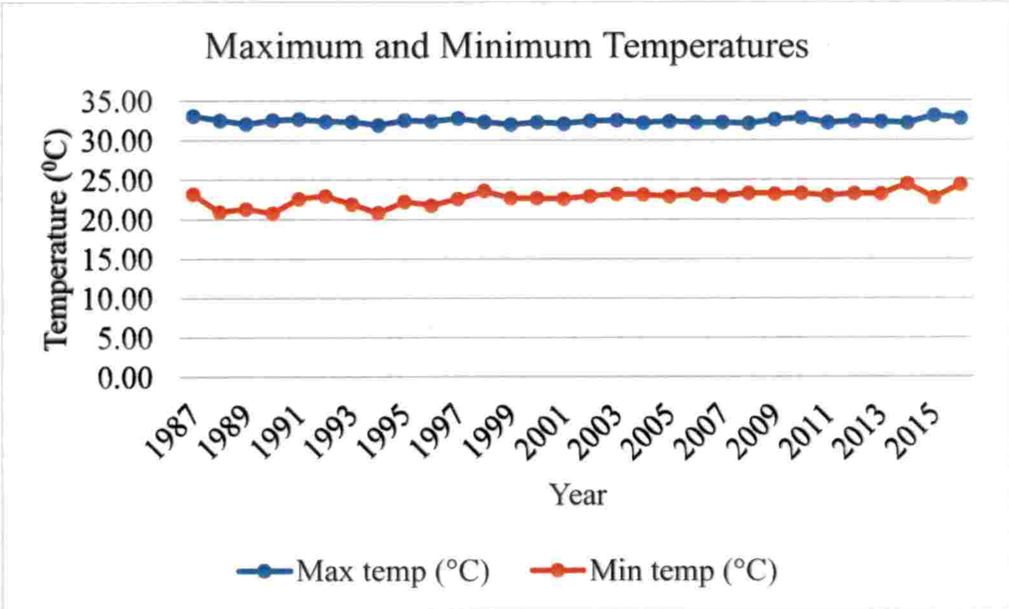


**Fig. 4 Temperature variation in Palakkad district from 1987-2016**

The regional level of rainfall pattern and trend from the past years has immense importance for agriculture based economies. The rainfall trend in the past three decades is presented in the **Fig. 5**. From the figure, it is evident that the rainfall of Palakkad showed a decreasing trend. An anomalous increase in rainfall was observed in 1989 and is about 5761.71 mm per year, which is extremely higher than the state average. And a drastic reduction in rainfall was observed in 1993 (1096 mm/year). In 2016, the rainfall received was much lesser (1292.44 mm/year) compared to previous years. This is one of the major reasons for drought in Palakkad in the year 2016. From 2013 to 2016, a declining trend in rainfall was noticed. Thus the declining rainfall was one of the major reasons for the occurrence of drought condition in 2016-17.

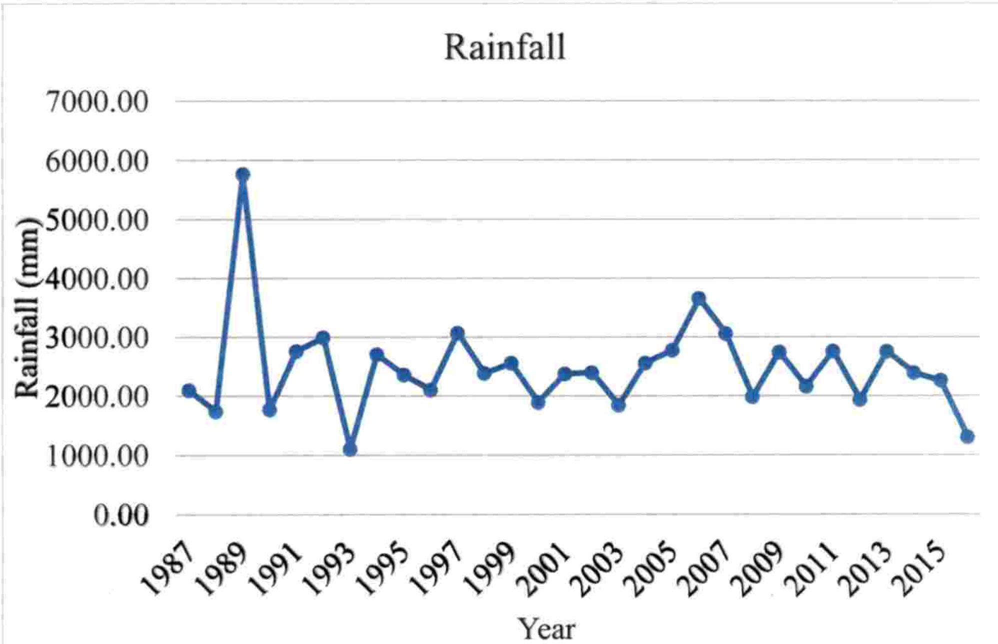


**Fig. 5 Rainfall variation in Palakkad district from 1987-2016**

### 4.2.3 Variation in climate parameter in Palakkad in the year 2016-17

Climatic condition of Palakkad district is extremely different from the other districts in the state. The summer temperature of Palakkad, is greatly influenced by the Palakkad gap and also due to the fact that it lies in the same sea level as Coimbatore in Tamil Nadu. The atmospheric temperature of Palakkad is particularly higher during the past 30 years. The average maximum temperature of Palakkad observed in 2016 was 36.99 $^0$C during April months. Almost similar maximum temperature was observed in March (36.94 $^0$C) and May (34.17 $^0$C). The lowest maximum temperature was observed during July and was around 29.78 $^0$C and August and September months witnessed 30.56 $^0$C and 30.26 $^0$C maximum temperatures respectively.

IRRI (2006) reported that rice yield was strongly correlated to night temperatures, and the increase of night temperature around 1.1 $^0$C over the past quarter century was correlated to the declining yield.

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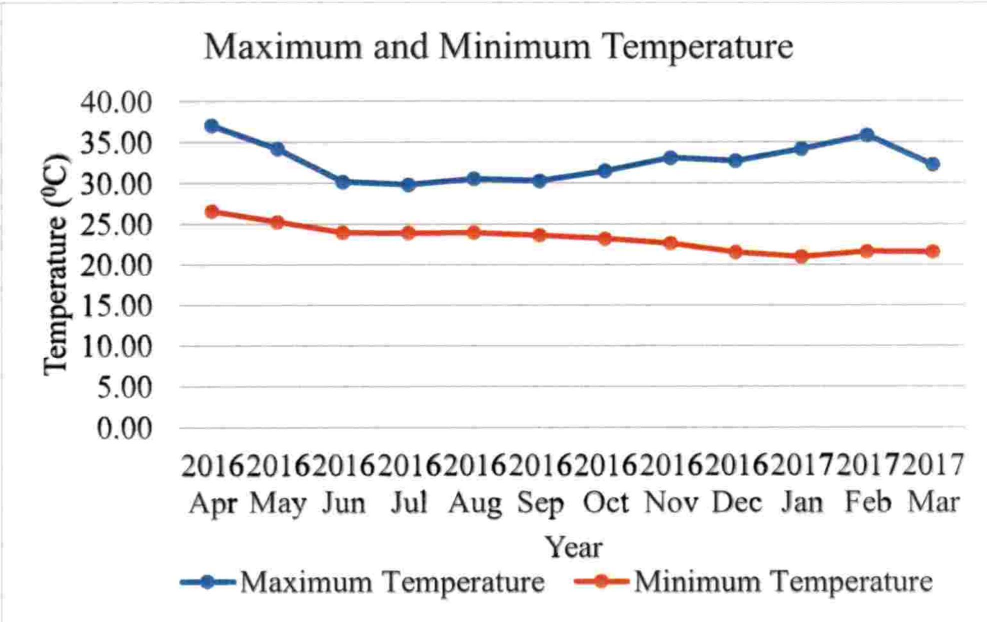


**Fig. 6 Temperature variation in Palakkad district during the year 2016-17**

Kerala is blessed with copious amount of monsoonal rainfall, but compared to the other districts of Kerala, Palakkad showed a large variation from the state average. In the year 2016-17, only 1334.74 mm of rainfall was received, which is very less compared to the state average. Maximum rainfall was received in June (480.60 mm) followed by July (344.60 mm). During the first four months, there was relatively no rainfall received and 191.70 mm was received in May. The amount of rainfall received during the month of August was 120.20 mm followed by September (92.80 mm) and October (24.14 mm). Only 4.10mm of rainfall was obtained in November and 34.30 mm was received in December. During the second crop season (winter season), relatively lesser amount of rainfall was received, which was the major reason for the drought situation during 2016-17. The study conducted by Krishnakumar *et al.*, 2009, reported that the winter rain events in the state showed an increasing trend and winter rainfall over Palakkad showed a declining trend. The study showed that the annual rainfall in the Palakkad region was comparatively less than that of the entire state.

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Kerala is one of the states which receives the most abundant rainfall in the country. But the Kerala experienced decline in annual and monsoon rainfall and an increase in temperature during the past 3 decades. The increasing temperature and decreasing rainfall in Palakkad may be due to the absence of lakes, backwaters or sea shores. And also the reclamation of rice fields for construction purpose and growing other crops like banana and rubber.

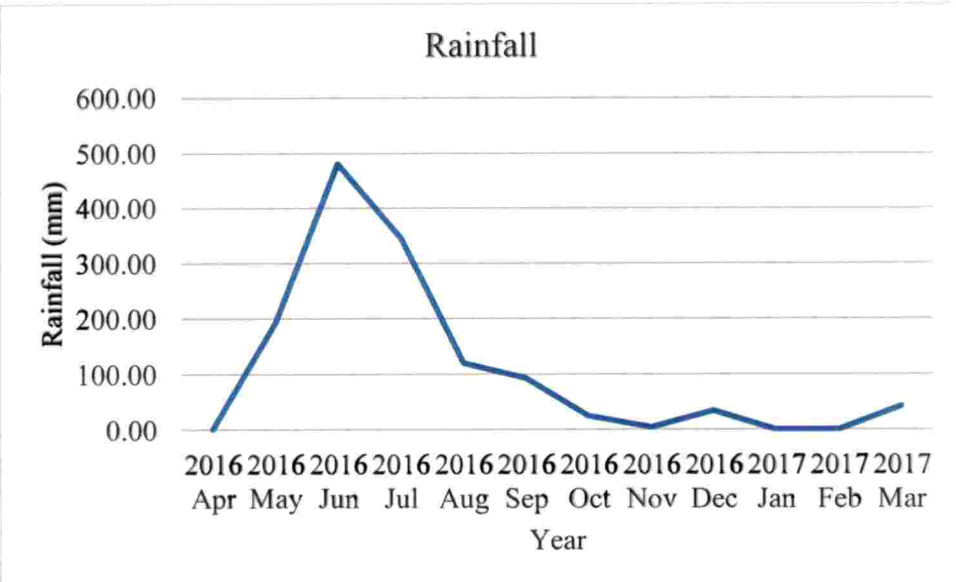


**Fig. 7 Rainfall variation in Palakkad district during the year 2016-17**

North east monsoon (Oct 1 to Dec 31) was normal with a departure of -8 per cent from the normal. The actual rainfall during the period was 441.8 mm against the normal rainfall of 480.7 mm. Excess rainfall was received in 3 districts viz. Thiruvananthapuram, Pathanamthitta and Kollam while 4 district (Alappuzha, Idukki, Ernakulam, and Kottayam) received a normal rainfall. Other district received deficient rainfall. The percentage departure from normal was highest in Palakkad district (-59 per cent), (Economic review, GOK, 2017).

### 4.2.4 Extent of drought in Palakkad district

The data on area affected by drought in rice cultivation in 2016-17 obtained from Department of Agriculture is presented in the **Table 3**. The Department of

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Agriculture observed that among 88 Panchayats, 13 Panchayats were affected by drought with an area of 104.95 ha in rice cultivation. Around 25 ha of rice fields were affected by drought in the Pattithara Panchayat. Compared to the other Panchayats, Pattithara was severely affected by drought. In Erimayur Panchayat, 16.62 ha of area was affected followed by Kavassery (12.51 ha) and Pallessana (12.44 ha) Panchayats. Whereas, in Nallepilly and Kollengode Panchayat, 7.81 ha and 7.59 ha were lost due to drought. Drought affected area of rice in Thrikkadiri and Thriithala Panchayats were 5.6 ha and 5 ha respectively. Around 4.09 ha of area in rice was affected in Kongad Panchayat. In Pookkottokavu (2.7 ha) and Pattambi and Pudur 2 ha each and in Koppam Panchayat, 1.59 ha of rice has been affected.

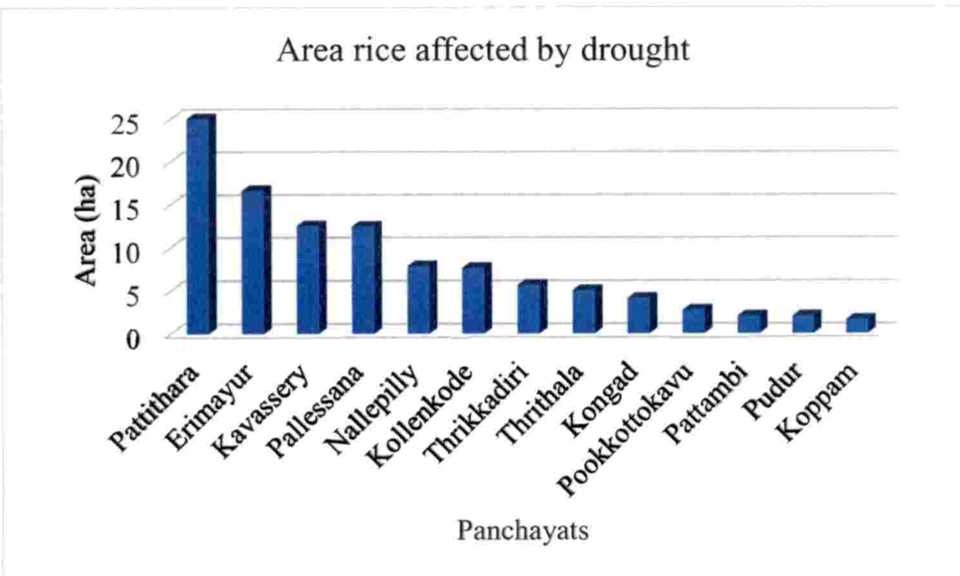


**Fig. 8 Area of rice affected by drought in Palakkad during 2016-17**

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## 4.3 Rice production status in Kerala and Palakkad

### 4.3.1 Rice area, production and productivity in Kerala

From the **Table 10,** it is clear that the rice cultivation area and the production of Kerala was decreasing from the past 30 years. But in the case of productivity, it showed an increasing trend. In triennium ending in 1989-90, the area of rice cultivation in the state was 6.15 lakh hectare and in TE 2016-17 it was about 1.98 lakh hectare. However, the production during the period was decreased to 5.5 lakh tonnes form 10.59 lakh tonnes and the productivity increased from 1723.33 kg $ha^{-1}$ to 2818 kg $ha^{-1}$ respectively. Around 4.17 lakh hectares of area and 5.00 lakh tonnes of production had been reduced and 1094.67 kg $ha^{-1}$ of productivity has been increased in these three decades. The area under rice cultivation in the state has decreased drastically from TE 1989-90 drastic reduction in area of cultivation occurred during TE 1998-99 period. Rice production also showed a decreasing trend, and a slight increase in production was recorded in TE 1989-90 from 10.59 lakh tonnes to 5.59 lakh tonnes in TE 1992-93. The productivity was increased from 1723.33 kg $ha^{-1}$ to 1952.33 kg $ha^{-1}$. Rice production during TE 2013-14 was 5.33 lakh tonnes and it increased to 5.59 lakh tonnes in TE 2016-17. This was mainly due to the increase in the productivity of rice from 2587 kg $ha^{-1}$ (TE 2013-14) to 2818 kg $ha^{-1}$ in TE 2016-17 in spite of occurrence of drought during 2016-17 (Appendix 2).

During 2016-17, the production of rice was very low on compared to the previous 30 years. Drought intensively affected rice cultivation in the year 2016-17, mainly in Palakkad district. The area under rice has been declining consistently since the last three decades. During 2016-17, rice crop occupies the third position in area under cultivation way behind rubber and coconut (GOK, 2017).

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**Table 10. Rice production status of Kerala from 1986-2016**

| Year | Area (lakh hectare) | Production (lakh tonnes) | Productivity (kg $ha^{-1}$) |
|---|---|---|---|
| TE 1989-90 | 6.15 | 10.59 | 1723 |
| TE 1992-93 | 5.15 | 10.96 | 1952 |
| TE 1995-96 | 5.16 | 10.22 | 1977 |
| TE 1998-99 | 4.30 | 8.63 | 2007 |
| TE 2001-02 | 3.50 | 7.50 | 2142 |
| TE 2004-05 | 3.07 | 6.54 | 2128 |
| TE 2007-08 | 2.76 | 6.46 | 2340 |
| TE 2010-11 | 2.32 | 5.72 | 2462 |
| TE 2013-14 | 2.06 | 5.33 | 2587 |
| TE 2016-17 | 1.98 | 5.59 | 2818 |

Source: Economic Review, GOK

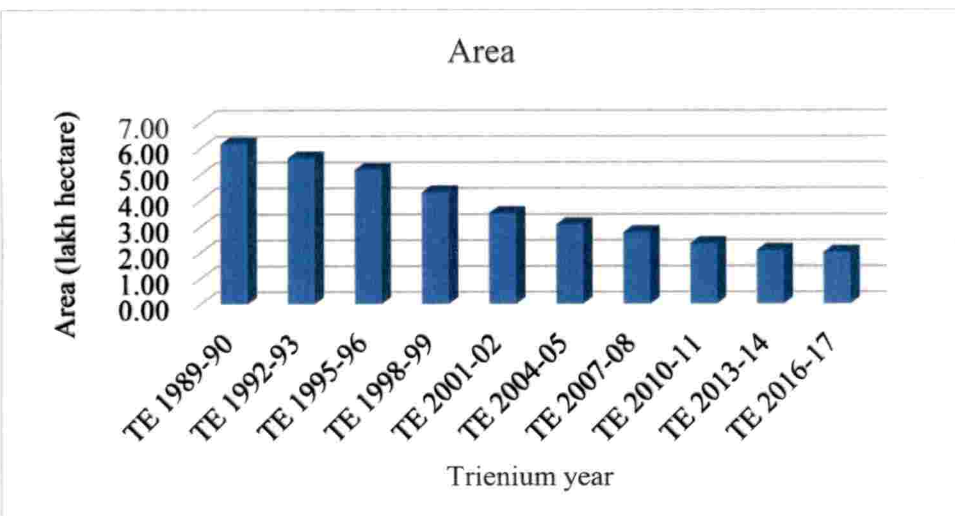


**Fig. 9 Area of rice cultivation of Kerala from 1986-2016**

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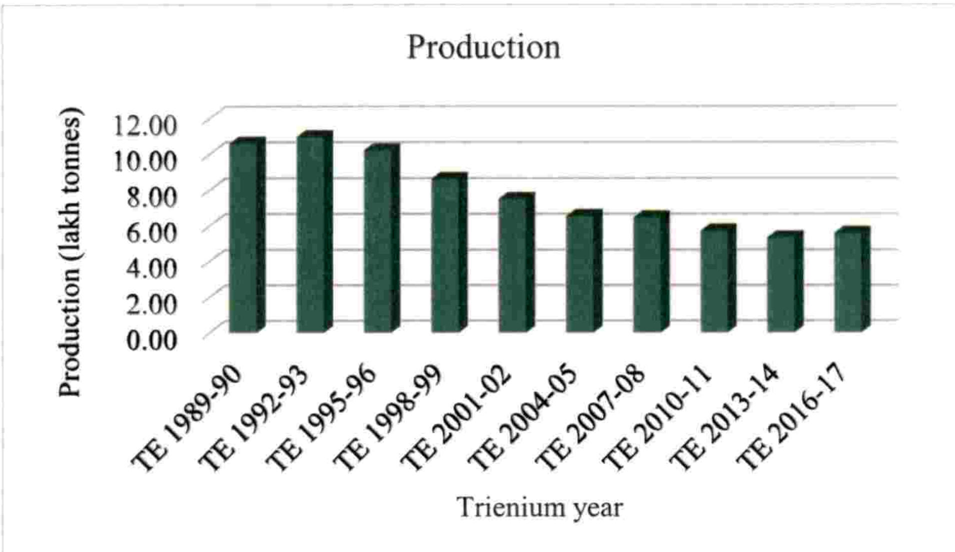


**Fig. 10 Production of rice cultivation of Kerala from 1986-2016**

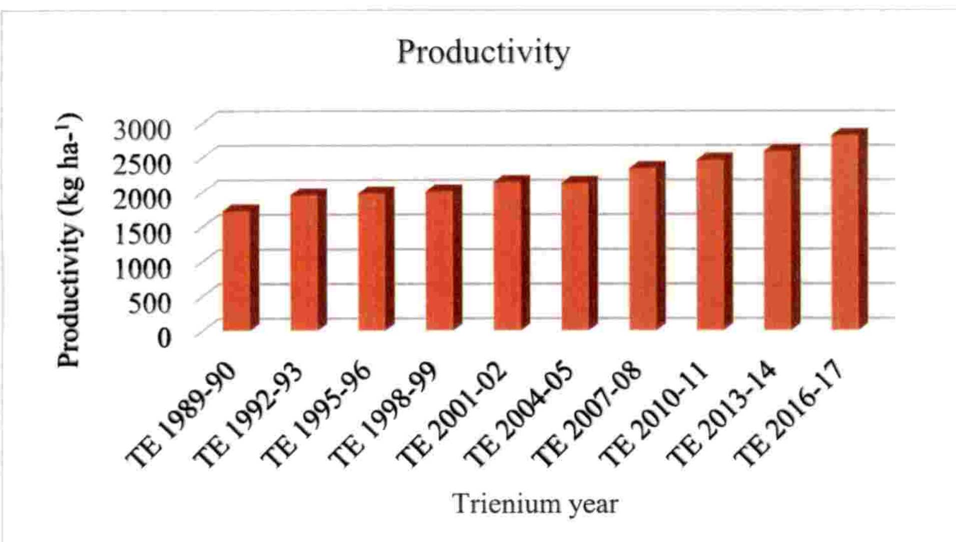


**Fig. 11 Productivity of rice cultivation of Kerala from 1986-2016**

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### 4.3.2 Rice area, production and productivity in Palakkad district

**Table 11** shows that the rice cultivation area and the production of Palakkad was decreasing from the past 24 years. Whereas, in the case of productivity, it showed an increasing trend. In TE 1995-96, the area of rice cultivation of the district was 1.39 lakh hectares and in TE 2016-17 it was about 0.76 lakh hectares. Whereas, the production during the period was decreased to 2.03 lakh tonnes from 3.09 lakh tonnes and the productivity has increased from 2215 kg $ha^{-1}$ to 2623 kg $ha^{-1}$. The area in rice cultivation was reduced by 0.63 lakh and production decreased by 1.06 lakh tonnes. Whereas in the case of productivity, there was a marked increase in productivity by around 408 kg $ha^{-1}$. This showed that new and improved technology has played a significant role in this direction (Appendix 3).

**Table 11. Rice production status of Palakkad district from 1993-2016**

| Year | Area (lakh hectare) | Production (lakh tonnes) | Productivity (kg $ha^{-1}$) |
|---|---|---|---|
| TE 1995-96 | 1.39 | 3.09 | 2215 |
| TE 1998-99 | 1.18 | 2.64 | 2226 |
| TE 2001-02 | 1.14 | 2.60 | 2273 |
| TE 2004-05 | 1.11 | 2.31 | 2083 |
| TE 2007-08 | 1.06 | 2.60 | 2426 |
| TE 2010-11 | 0.91 | 2.36 | 2576 |
| TE 2013-14 | 0.80 | 2.15 | 2657 |
| TE 2016-17 | 0.76 | 2.03 | 2623 |

Source: Economic Review(GOK)

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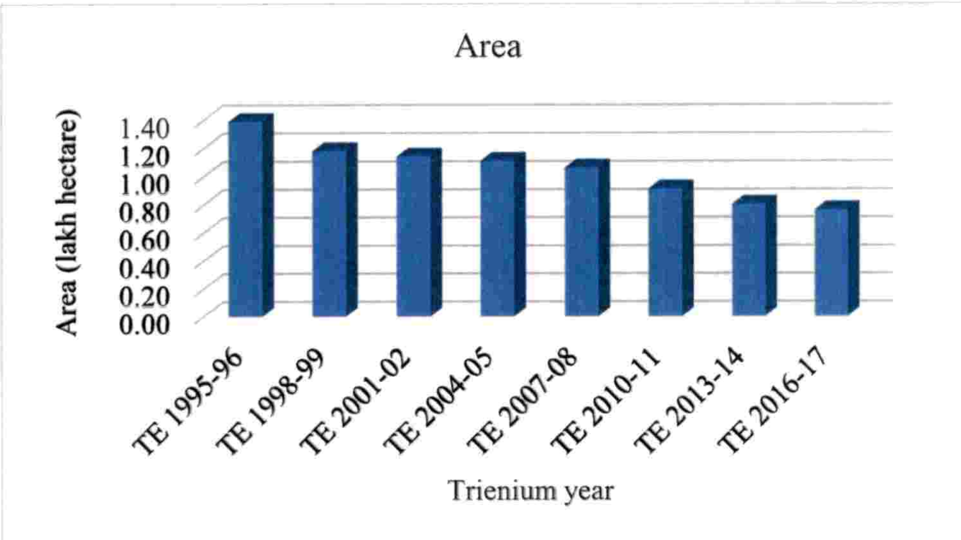


**Fig. 12 Area of rice cultivation in Palakkad from 1993-2016**

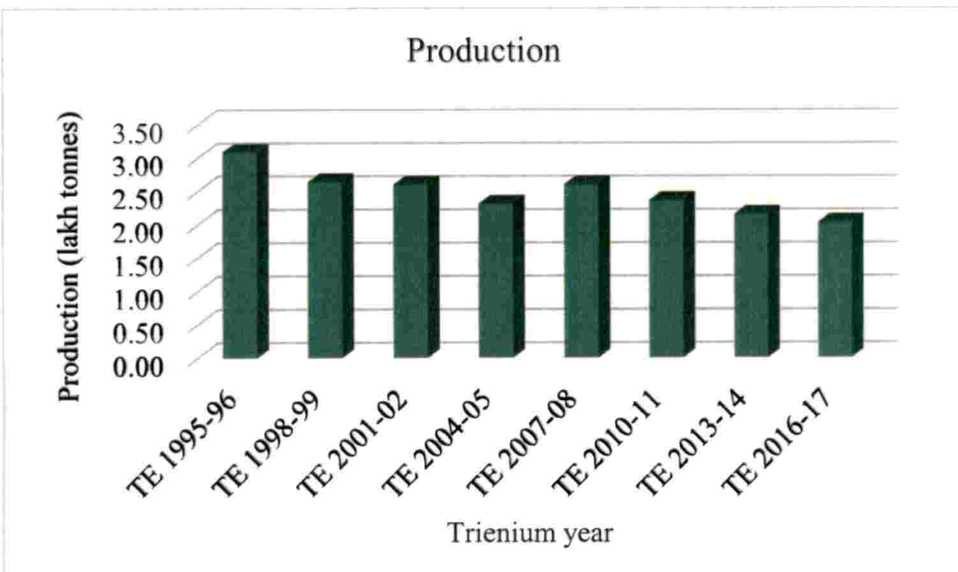


**Fig. 13 Production of rice cultivation in Palakkad from 1993-2016**

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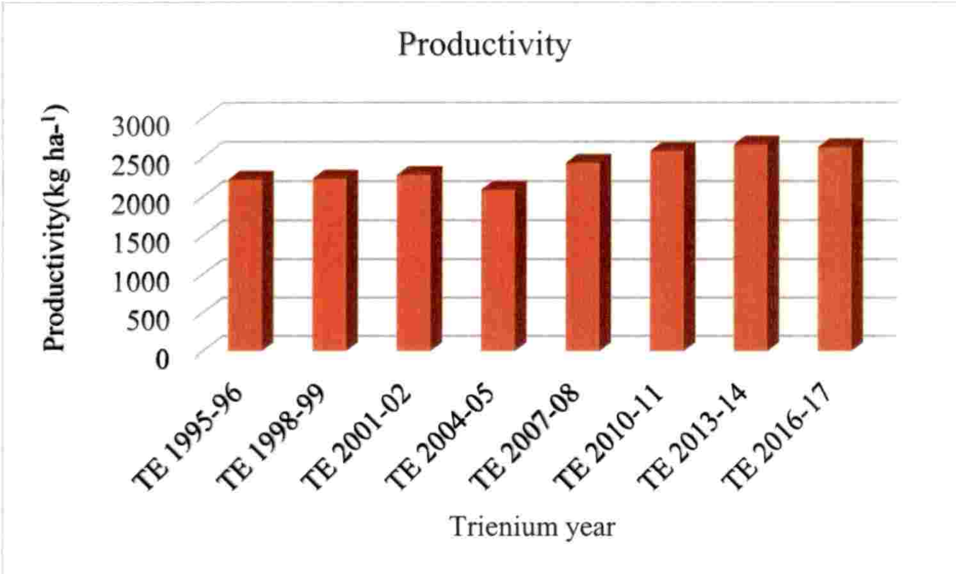


**Fig. 14 Productivity of rice cultivation in Palakkad from 1993-2016**

### 4.3.3 Per cent variation in rice area, production and productivity in Palakkad

Percentage variation in area, production and productivity of rice in Palakkad district is presented in the **Table 12,** which shows that change in area, production and productivity from 1994-95 to 2015-16. In TE 1994-95 period, there was a negative or decreased variation in area, production and productivity (-2.44, -5.72 and -3.25 respectively). Whereas, in TE 1997-98 period, the per cent variation in area was -7.42, it has been largely reduced from earlier year and per cent variation in production was -5.09. Variation in productivity showed an increase (2.5 %). During the period TE 2000-01, there was increase in area of 2.64 per cent over the TE 1997-98. Similarly, the production increased by 4.24 per cent. In TE 2003-04 period, the percentage variation in area and production showed a decrease (-0.31 and 1.84 respectively) compared to previous years. But productivity showed 5.08 per cent increase in productivity which could be due to use of new or improved technology. However, in TE 2006-07 years, area, production and productivity shows a declined variation from earlier years (-4.45, -1.92 and 1.71 respectively). In TE 2009-10 period, also indicated a decreased variation in area (-5.26), production (-4.02) and productivity (1.03). Whereas, per cent variation in area was

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increased in TE 2012-13 years, and is about -0.58. Variation in production showed a large increase (5.08) compared to the previous years. Also the productivity showed a 5.2 per cent of variation. During the period TE 2015-16, showed a large decrease in area and production and productivity. Per cent variation in area was -10.69, and in previous year, the variation was -0.58. Production reduced to a great extent during these years. Per cent variation in production and productivity are -13.63 and -7.62 respectively in TE 2015-16 as compared to TE 2012-13. Area, production and productivity showed a large decline in during the last 25 years which severely affected the self-sufficiency of rice in the state (Appendix 4).

**Table 12. Per cent variation in area, production and productivity of Palakkad district**

| Year | Percentage variation | | |
|---|---|---|---|
| | Area | Production | Productivity |
| TE 1994-95 | -2.44 | -5.72 | -3.25 |
| TE 1997-98 | -7.42 | -5.09 | 2.5 |
| TE 2000-01 | 2.64 | 4.24 | 1.69 |
| TE 2003-04 | -0.31 | 1.84 | 5.08 |
| TE 2006-07 | -4.45 | -1.92 | 1.71 |
| TE 2009-10 | -5.26 | -4.02 | 1.03 |
| TE 2012-13 | -0.58 | 5.08 | 5.2 |
| TE 2015-16 | -10.69 | -13.63 | -7.62 |

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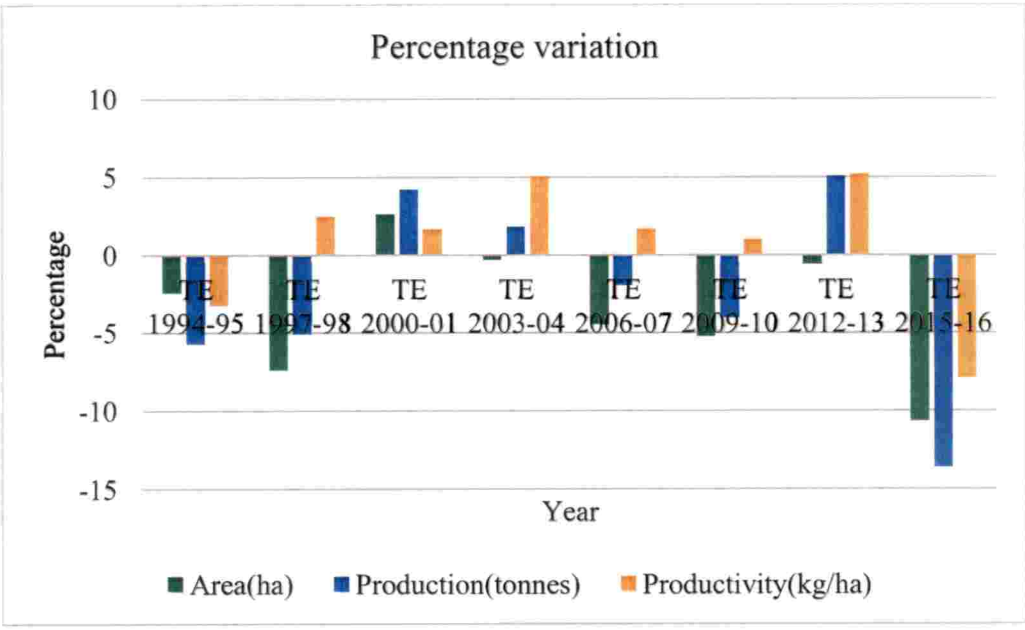


**Fig. 15 Per cent variation in area, production and productivity in Palakkad**

## 4.4 Economics of rice cultivation in Palakkad district

### 4.4.1 Input-wise cost of cultivation of rice cultivation in Palakkad districts

The input wise cost of cultivation is presented in **Table 13**. It was estimated that the hired labour cost accounts for a major share in the total cost of production. Around 51.87 per cent of the amount is spent for labour hiring charge followed by machine hiring charges (21.47%). For majority of operations such as sowing, weeding, fertilizer and manure application, farmers depended on hired labour, except for harvesting and land preparation. It was found that the hired labour cost of 630 Rs/day which is more than national average of about 277/day (GOI, 2017). Similar reports also noticed by Government of Kerala (Economic survey, GOK, 2017). While within Kerala, the labour cost share is found to be high in Palakkad compared to any other district. In Palakkad, farmers were following a transplanting method of sowing it requires relatively more labour compared to broadcasting method. Parayil (2010) also made a detailed analysis of rising labour cost, as one of the important reason for supply constraints in rice output in Kerala. Devi (2011) made an analysis of labour cost behaviour in relation to return from rice farming.

Machine hiring charges is the second highest contributor of total cost, and is accounts about 21.47 per cent. Mainly farmers depend on machine labour for land preparation and harvesting, and in some cases sowing also is done using machine labour. In Palakkad, farm machine like tractor was mainly used for land preparation. Around 10.06 per cent of cost was contributed by fertilizer and manure application. Plant protection chemicals and cost of seed contributed about 0.6 per cent and 3.63 per cent respectively. And about 12.13 per cent of cost was incurred for other expenses such as land tax, irrigation charges, maintenance cost, interest on working capital and miscellaneous expenses.

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**Table 13. Cost of Cultivation per hectare (in Rs.) of rice (*Mundakan* crop)**

**N = 100**

| **Sl.No** | **Componets** | **Cost of cultivation Rice(Rs ha$^{-1}$)** |
|---|---|---|
| 1 | Hired human labour | 28511(51.87) |
| 2 | Machine labour | 11800(21.47) |
| 3 | Seed / seedlings | 2070(3.76) |
| 4 | Farmyard manure and chemical fertilizers | 5532(10.06) |
| 5 | Plant protection | 368(0.66) |
| 6 | Land tax and irrigation cess | 133(0.24) |
| 7 | Repair and maintenance charges of implements, machinery and building | 267(0.48) |
| 8 | Interest on working capital | 2405(4.37) |
| 9 | Other expenses | 3870(7.04) |
| **10** | **Total cost 'A' (1-9)** | **54956(100)** |
| 11 | Interest on fixed capital | 391 |
| **12** | **Cost '$B_1$' (10+11)** | **55347** |
| 13 | Interest on land value | 58321 |
| **14** | **Cost 'B' (12+13)** | **113668** |
| 15 | Imputed value of household labour | 4771 |
| **16** | **Cost 'C' (14+15)** | **118439** |

Note : Figures in parentheses represent the per cent to the total

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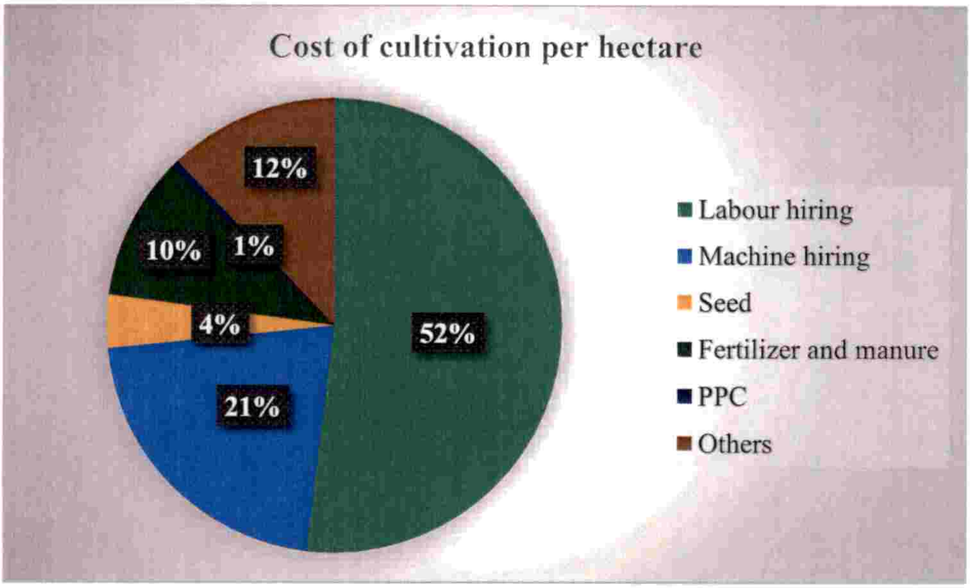


**Fig. 16 Cost of cultivation of rice (Rs ha$^{-1}$)**

### 4.4.2 Cost of cultivation among small, marginal and large farmers

Among 100 respondents in Pattithara, Erimayur, Kavassery, Pallessana and Nallepilly Panchayats, are classified into 3 classes such as, small (area less than 0.5 ha), marginal (area 0.5 to 1 ha) and large (area more than 1 ha) farmers. Input cost of cultivation among small, medium and large farmers are presented in the **Table 14**. From the table, it was observed that the cost of cultivation (Cost A) of small farmers (Rs.81443) was relatively higher than marginal (Rs.51103) and large (Rs.44670) farmer. Among small, medium and large farmers, labour hiring charge was the larger share of cost component. It constitutes 69.47 per cent, 54.77 per cent and 41.66 per cent for small, marginal and large farmers respectively. Another larger contributor of cost A is machine hiring charge and cost of fertilizer and manures. Small farmers cost of cultivation showed that machine labour constitutes 11.40 per cent of cost and 7.70 per cent costs was incurred for fertilizer and manure costs. In case of marginal farmer, it accounts 20.81 per cent and 10.89 per cent respectively. Whereas, 27.14 per cent of cost was incurred by large farmer for machine hiring charge and 9.71 per cent for fertilizer and manures. Seed cost accounts 2.20 per cent for small, 3.57 per cent for marginal and 7.43 per cent for large farmers respectively. However, plant protection chemicals constitute 0.59 per

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cent, 0.76 per cent and 0.68 per cent for small, marginal and large farmers. Other share of Cost A including land taxes, irrigation charges, repair and maintenance charge of machines, implements, buildings, interest on working capital and other miscellaneous expense. However, the variable cost or operational costs, Cost A were higher (Rs.81443) for small farmers and for marginal and large farmer, it was about Rs.51103 and Rs.44670 respectively. Therefore, the small farmer always suffers more loss due to scale of cultivation.

Whereas Cost $B_1$ of small farmers were Rs.82347, marginal farmers were Rs.51450 and large farmers were Rs.44910 respectively. Cost $B_1$ includes, Cost A and interest on fixed capital. And Cost B contains Cost $B_1$ and interest on land value, and the Cost B were Rs.207384, Rs.117269 and Rs.722238 for small, marginal and large farmers. However, the Cost C of small farmers were Rs.217359, marginal farmer was Rs.122025 and Rs.75104 for large farmers respectively. The Cost C contains the imputed value of household labour.

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**Table 14. Cost of cultivation among small, marginal and large farmers**

| Sl.No | Components | Holding size | | |
|---|---|---|---|---|
| | | Small (< 0.5 ha) | Marginal (0.5 to 1 ha) | Large (>1 ha) |
| 1 | Hired human labour | 56577(69.47) | 27994(54.77) | 18610(41.66) |
| 2 | Machine labour | 9286(11.40) | 10638(20.81) | 12126(27.14) |
| 3 | Seed / seedlings | 1650(2.02) | 1828(3.57) | 3320(7.43) |
| 4 | Farmyard manure and chemical fertilizers | 6277(7.70) | 5567(10.89) | 4338(9.71) |
| 5 | Plant protection | 483(0.59) | 389(0.76) | 307(0.68) |
| 6 | Land tax and irrigation cess | 227(0.27) | 134(0.26) | 99(0.22) |
| 7 | Repair and maintenance charges of implements, machinery and building | 751(0.92) | 251(0.49) | 103(0.23) |
| 8 | Interest on working capital | 3803(4.66) | 2331(4.56) | 1952(4.36) |
| 9 | Other expenses | 2389(2.93) | 1971(3.85) | 3815(8.54) |
| **10** | **Total cost 'A' (1-9)** | **81443(100)** | **51103(100)** | **44670(100)** |
| 11 | Interest on fixed capital | 904 | 347 | 240 |
| **12** | **Cost '$B_1$' (10+11)** | **82347** | **51450** | **44910** |
| 13 | Interest on land value | 125037 | 65819 | 27328 |
| **14** | **Cost 'B' (12+13)** | **207384** | **117269** | **72238** |
| 15 | Imputed value of household labour | 9975 | 4756 | 2866 |
| **16** | **Cost 'C' (14+15)** | **217359** | **122025** | **75104** |

Note : Figures in parentheses represent the per cent to the total

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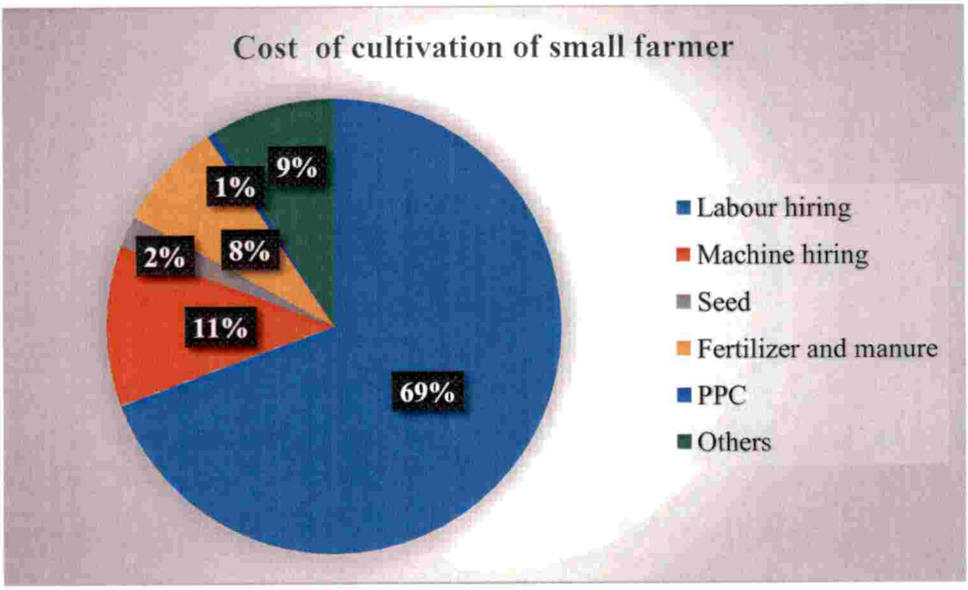


**Fig. 17 Cost of cultivation of small farmer**

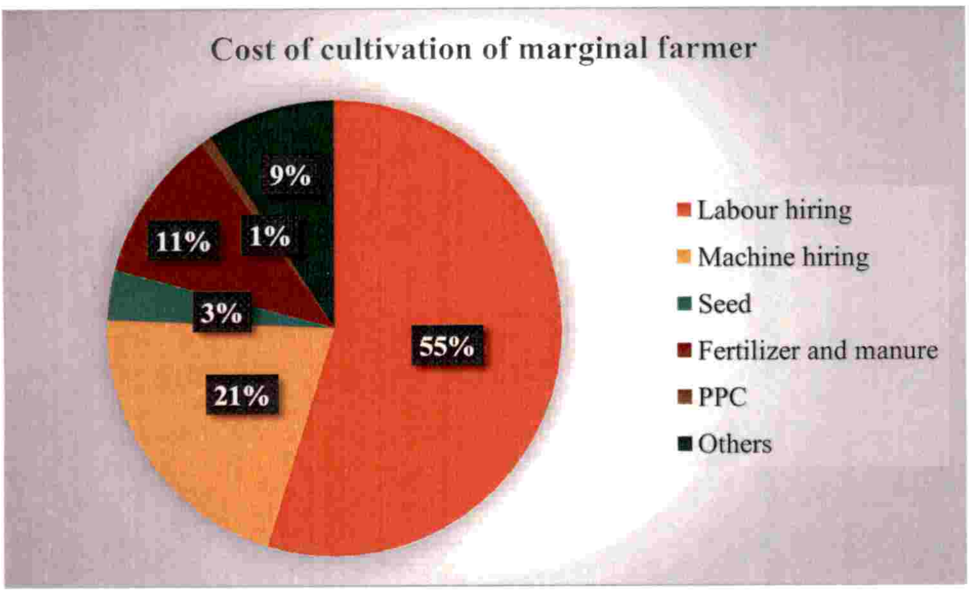


**Fig. 18 Cost of cultivation of marginal farmer**

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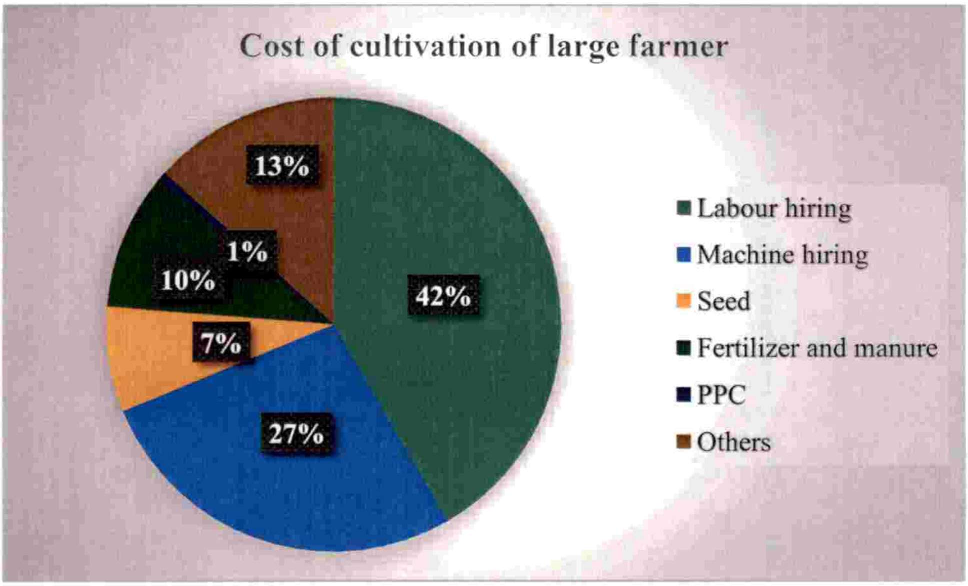


**Fig. 19 Cost of cultivation of large farmer**

### 4.4.3 Financial loss and production loss in rice cultivation during the year 2016-17

#### 4.4.3.1 Average financial loss in rice cultivation

Cost of cultivation (includes labour charge, machine charge, fertilizer and manure rate, seed rate and plant protection chemicals) of drought affected and drought not affected farmers in Pattithara, Erimayur, Kavassery, Pallessana and Nallepilly Panchayats are presented in the **Table 15**. The cost of cultivation of drought affected responents in Nallepilly (Rs. 49731 $ha^{-1}$) and Erimayur (Rs. 49235 $ha^{-1}$) Panchayat is comparatively higher than Kavassery (Rs. 47849 $ha^{-1}$), Pallessana (Rs. 48269 $ha^{-1}$) and Pattithara (Rs. 47094 $ha^{-1}$) Panchayats.

Return obtained by the drought affected farmer in Nallepilly Panchayat were Rs. 31020 $ha^{-1}$ followed by Pallessana Panchayat (Rs. 29845 $ha^{-1}$) and Erimayur Panchayat (Rs. 28200 $ha^{-1}$). In Kavassery and Pattithara Panchayat, the return obtained by drought affected farmers were Rs. 28200 $ha^{-1}$ and Rs. 21150 $ha^{-1}$ respectively. And also Rs. 13500 $ha^{-1}$ as a compensation given by the government for the affected farmers. Farmers sell the rice to Supplyco with a price of Rs. 23.5 $kg^{-1}$.

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In all Panchayat, the net return of drought affected farmers were negative, means that the drought affected farmers experience financial loss. Farmers in Pattithara Panchayat suffer more financial loss, because the yield reduction was more in the Panchayat. Around Rs. 25944 $ha^{-1}$ of loss occurred in Pattithara Panchayat. In Kavassery Panchayat, the loss occurred was Rs. 21529 $ha^{-1}$ followed by Erimayur Panchayat (Rs. 21035 $ha^{-1}$). About Rs. 18711 $ha^{-1}$ and Rs. 18424 $ha^{-1}$ of loss was incurred farmers of Nallepilly and Pallessana Panchayat.

The cost benefit ratio was very low in Pattithara Panchayat (0.45). In Kavassery and Erimayur Panchayat, the cost benefit ratio was 0.55 and 0.57 respectively. Cost benefit ratio of farmers in Nallepilly and Pallessana Panchayat were 0.62.

**Table 15. Cost of cultivation and Return obtained by drought affected farmers**

| **Panchayat** | **Cost of cultivation (Rs. $ha^{-1}$)** | **Return obtained (Rs. $ha^{-1}$)** | **Net returns (Rs. $ha^{-1}$)** | **Benefit Cost ratio** |
|---|---|---|---|---|
| Pattithara | 47094 | 21150 | -25944 | 0.45 |
| Erimayur | 49235 | 28200 | -21035 | 0.57 |
| Kavassery | 47849 | 26320 | -21529 | 0.55 |
| Pallessana | 48269 | 29845 | -18424 | 0.62 |
| Nallepilly | 49731 | 31020 | -18711 | 0.62 |

Cost of cultivation of unaffected farmers is lower than that of cost of cultivation of drought affected farmers. Cost of cultivation of unaffected farmers in Kavassery Panchayat were Rs. 47997 $ha^{-1}$ followed by Pattithara Panchayat (Rs. 47911 $ha^{-1}$). Cultivation cost of unaffected respondents in Erimayur Panchayat were Rs. 546041 $ha^{-1}$ and for Pallessana and Nallepilly Panchayats were Rs.45885 $ha^{-1}$ and Rs. 45798 $ha^{-1}$ respectively.

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The return obtained by unaffected farmers in Pallessana Panchayat were Rs. 60112.50 $ha^{-1}$ and in Kavassery Panchayat were Rs. 59995 $ha^{-1}$. In Pattithara Panchayat, the return obtained was Rs. 59760 $ha^{-1}$ followed by Erimayur (Rs. 58975 $ha^{-1}$) and Nallepilly (Rs. 58350 $ha^{-1}$) respectively.

A higher net return was observed in Pallessana Panchayat, about Rs. 14227.50 $ha^{-1}$. In Erimayur and Nallepilly Panchayat, the net return obtained was Rs. 12934 $ha^{-1}$ and Rs. 12552 $ha^{-1}$ respectively. The net returns obtained by unaffected farmers in Kavassery was Rs. 11998 $ha^{-1}$ and Pattithara Panchayat were Rs. 11849 $ha^{-1}$.

The cost benefit ratio of Pallessana Panchayat was observed as a higher (1.31) compared to other Panchayat. In Erimayur and Nallepilly Panchayat, the cost benefit ratio was 1.28 and 1.27 respectively. Cost benefit ratio of Kavassery and Pattithara Panchayat were 1.25 in each.

**Table 16. Cost of cultivation and Return obtained by drought unaffected farmers**

| Panchayat | Cost of cultivation (Rs. $ha^{-1}$) | Return obtained (Rs. $ha^{-1}$) | Net returns (Rs. $ha^{-1}$) | Benefit Cost ratio |
|---|---|---|---|---|
| Pattithara | 47911 | 59760 | 11849 | 1.25 |
| Erimayur | 46041 | 58975 | 12934 | 1.28 |
| Kavassery | 47997 | 59995 | 11998 | 1.25 |
| Pallessana | 45885 | 60112.5 | 14227.5 | 1.31 |
| Nallepilly | 45798 | 58350 | 12552 | 1.27 |

From the above two table, it was clear that the return obtained from affected farmer was very less compared to unaffected farmers. In the case of drought affected farmer, the net return was negative. Because of the attained yield was less. Average cost of cultivation of drought affected farmer is Rs. 48435.6 $ha^{-1}$ and average return was found that Rs. 27307 $ha^{-1}$. Average net return was Rs. -21128.6

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$ha^{-1}$ that is, 43.62 per cent of reduction in total returns. And also the cost benefit ratio is very less, the average B:C ratio were 0.63.

In the case of unaffected farmer, net return is positive, *i.e*, the farmers got profit from rice production during the drought condition. Average cost of cultivation Rs. 46726.4 $ha^{-1}$, average return was Rs. 59438.5 $ha^{-1}$, average net return was Rs.12712.1 $ha^{-1}$. The cost benefit ratio of unaffected farmers were1.27. About 27.20 per cent of benefit attained by unaffected farmers.

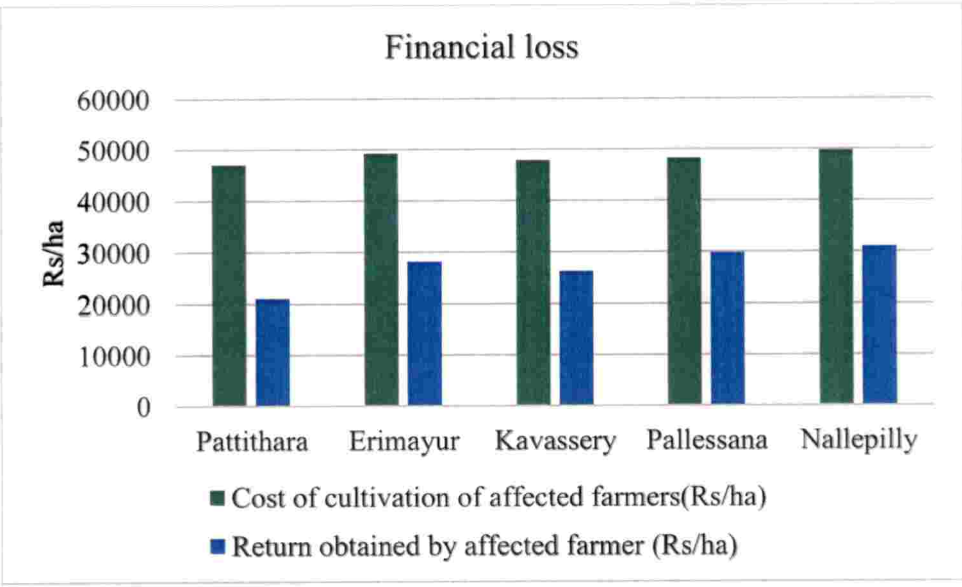


**Fig. 20 Financial loss and gain of drought affected farmers**

**4.4.3.2 Average production loss in rice cultivation**

Yield obtained in each Panchayat is presented in the **Table 17**. In the case of drought affected farmer, they attained a very smaller amount of yield compared to normal yield. The yield obtained in Pattithara Panchayat were very low (900 kg $ha^{-1}$) compared to other Panchayats. The reduction of yield was mainly due to the severity of drought in Pattithara Panchayat. Among drought affected farmers, comparatively a higher yield was obtained in Nallepilly Panchayat (1320 kg $ha^{-1}$). Because of the severity of drought was relatively less in Nallepilly Panchayat. The yield obtained in Pallessana were 1270 kg $ha^{-1}$ followed by Erimayur and Kavassery Panchayat (1200 kg $ha^{-1}$ and 1120 kg $ha^{-1}$ respectively). Whereas in the case of

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unaffected farmers, they attained the normal yield. Higher yield obtained in Erimayur Panchayat (2430 kg $ha^{-1}$) and low yield obtained in Nallepilly Panhayat (2300 kg $ha^{-1}$). In Pattithara, Kavassery and Pallessana Panchayat, the yield obtained were 2360 kg $ha^{-1}$, 2370 kg $ha^{-1}$ and 2375 kg $ha^{-1}$ respectively. Compared to previous year, the productivity of Palakkad district was 2816 kg $ha^{-1}$ and in 2016-2017 it was 2202 kg $ha^{-1}$ (Economic Review, GOK, 2017).

**Table 17. Yield obtained from drought affected and unaffected farmers**

| Panchayat | Average yield obtained by affected farmers (kg $ha^{-1}$) | Average yield obtained by unaffected farmers (kg $ha^{-1}$) |
|---|---|---|
| Pattithara | 900 | 2360 |
| Erimayur | 1200 | 2430 |
| Kavassery | 1120 | 2370 |
| Pallessana | 1270 | 2375 |
| Nallepilly | 1320 | 2300 |

### 4.4.4 Regression Analysis

In regression analysis yield is taken as dependent variable and fertilizer, human labour and machine hours are taken as independent variable. It could be observed from the **Table 18**, Regression analysis of affected farmers shows that most significant contributor to yield were human labour and machine hours. The coefficient value of human. labour and machine hours were -16.31 and 50.99 respectively. $R^2$ which explains the proportion of the variation in dependent variable (Y) explained by the independent variables and it is a non-decreasing function of the number of explanatory variables present in the model. Labour use in rice cultivation had an elasticity of -16.31 which shows that one per cent increase in labour use would decrease the total yield by -16.31 per cent. In Palakkad, farmers incur higher labour cost. Machine use in rice cultivation had an elasticity of 50.99 which shows that one per cent increase in machine use would increase the total yield by 50.99 per cent. Thus, it can be concluded from the regression that

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mechanisation in rice cultivation can make a huge difference in yield in rice. The obtained $R^2$ value for affected farmer was 0.772, which implies that the included independent variables could explain 77.2 per cent of variation in the yield.

**Table 18. Regression model for drought affected farmer**

| Variables | Co-efficient | Standard error | 't' value |
|---|---|---|---|
| Fertilizer quantity | -0.08 | 0.13 | -0.61 |
| Human labour** | -16.31 | 1.35 | -12.02 |
| Machine hours** | 50.99 | 22.9 | 2.22 |
| Constant | 1586.18 | 163.16 | 9.72 |
| $R^2$= 0.772 , N= 50 | | | |

Note: ** denotes the significant variable

It could be observed from the **Table 19**, regression analysis of unaffected farmers shows that most significant contributor to yield were human labour and machine hours. The coefficient value of human labour and machine hours were -20.74 and 34.17 respectively. Labour use in rice cultivation had an elasticity of -20.74 which shows that one per cent increase in labour use would decrease the total yield by -20.74 per cent. Machine use in rice cultivation had an elasticity of 34.17 which shows that one per cent increase in machine use would increase the total yield by 34.74 per cent. $R^2$ value was 0.734 which implies that included independent variables in the model could explain 73.4 per cent of the variation in the total yield.

**Table 19. Regression model for drought unaffected farmer**

| Variables | Co-efficient | Standard error | 't' value |
|---|---|---|---|
| Fertilizer quantity | 0.57 | 0.25 | 2.26 |
| Human labour** | -20.74 | 3.09 | -6.69 |
| Machine hours** | 34.17 | 37.01 | 0.92 |
| Constant | 2300.86 | 409.65 | 5.61 |
| $R^2$= 0.734 , N= 50 | | | |

Note: ** denotes the significant variable

### 4.4.5 Efficiency Analysis

The producer performance was assessed using on output and three inputs using DEA model. The output variable was yield (kg $ha^{-1}$) and input variables were quantity of fertilizer and manure, human labour (mandays) and Machine labour (machine hours). The result plotted and presented in **Fig 21** to **Fig 25**. In case of unaffected farmers, technical efficiency was higher compared to affected farmer. Average technical efficiency of unaffected farmer were 72 per cent and affected farmers were 51 per cent. The average scale efficiency was observed that 75.2 per cent and 56.8 per cent.

**Table 20. Mean technical efficiency and mean scale efficiency**

| Panchayat | Mean Technical Efficiency | | Mean Scale Efficiency | |
|---|---|---|---|---|
| | Unaffected farmer | Affected farmer | Unaffected farmer | Affected farmer |
| Pattithara | 0.68 | 0.58 | 0.72 | 0.63 |
| Erimayur | 0.75 | 0.67 | 0.76 | 0.71 |
| Kavassery | 0.69 | 0.48 | 0.75 | 0.51 |
| Pallessana | 0.74 | 0.49 | 0.76 | 0.59 |
| Nallepilly | 0.75 | 0.37 | 0.77 | 0.4 |

In the case of unaffected farmers in Erimayur and Nallepilly Panchayat show higher technical efficiency (75 per cent) and Pattithara Panchayat (68 per cent) showed low technical efficiency. This showed that there is a scope for improvement in the usage of inputs like, fertilizer, human labour and machine labour. Whereas in the case of drought affected farmers, a higher technical efficiency was observed in Erimayur Panchayat (67 per cent) and lower technical efficiency observed in Nallepilly Panchayat. From the result it implied that producers, *i.e,* affected farmers there is scope for improvement in technical efficiency.

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The scale efficiency results showed that 75.2 per cent of scale efficiency for unaffected farmer and 56.8 per cent in case of affected farmer. Fragmentation of land holding may be the reason for scale inefficiency in rice production in the Panchayat where the study was undertaken.

Most of the studies reported that the uneconomic level of use of human labour and reported it as the highest single item of expenditure. Muraleedharan (1982), studied the resource use efficiency in rice cultivation. By analysing the production function approach, he found that the inputs like human labour, animal labour, fertilizer and manure are not efficient at both aggregate and individual farm level.

Khai and Yabe (2011) revealed that the intensive labour in rice land is the most important factor in helping farmers increase the technical efficiency of rice production.

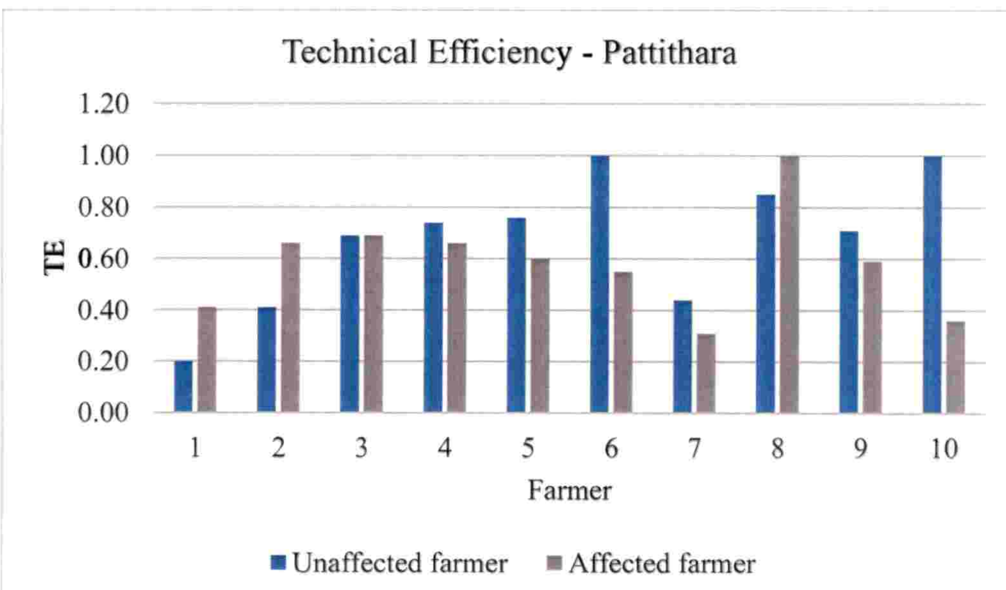


**Fig. 21 Technical efficiency of respondents in Pattithara Panchayat**

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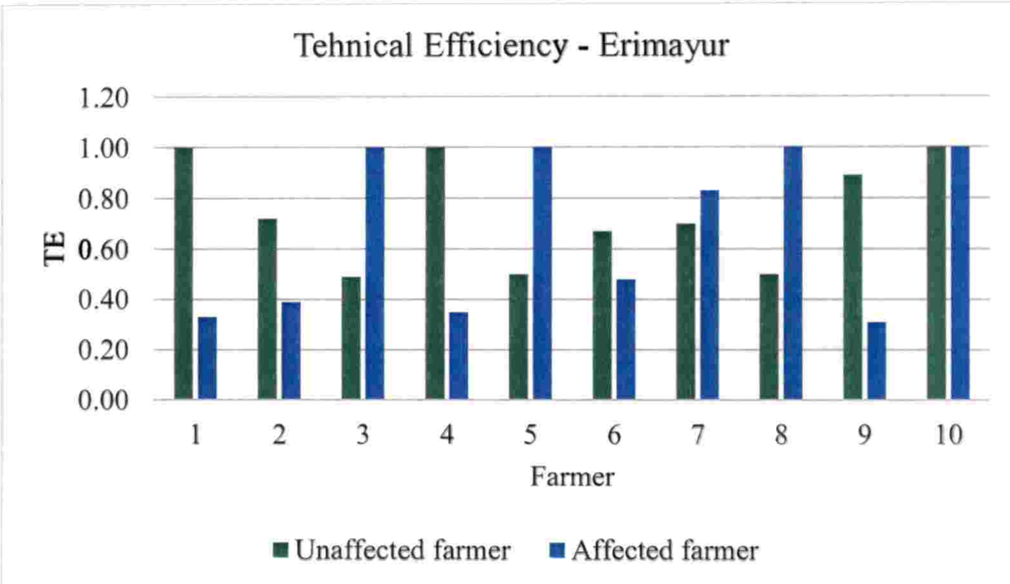


**Fig. 22 Technical efficiency of respondents in Erimayur Panchayat**

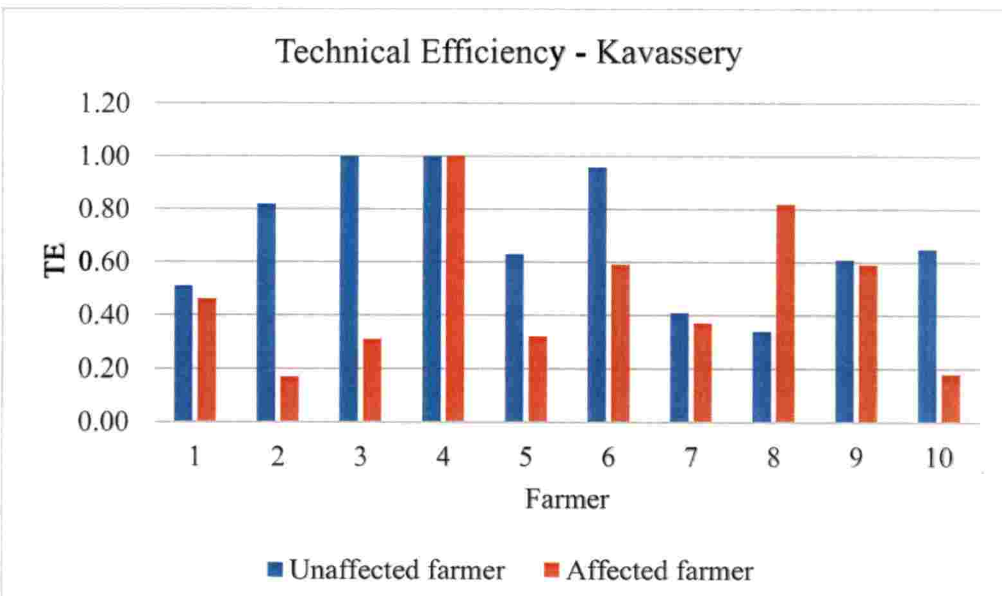


**Fig. 23 Technical efficiency of respondents in Kavassery Panchayat**

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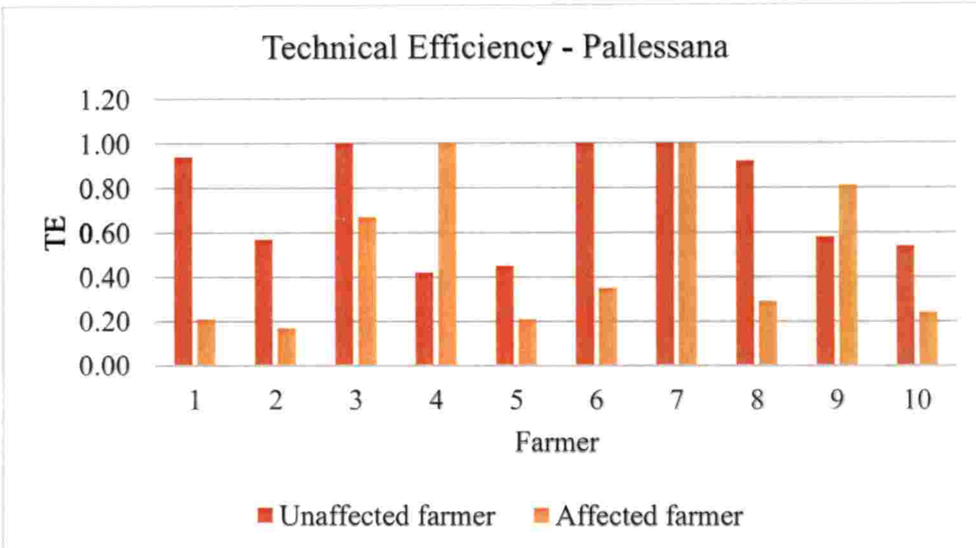


**Fig. 24 Technical efficiency of respondents in Pallessana Panchayat**

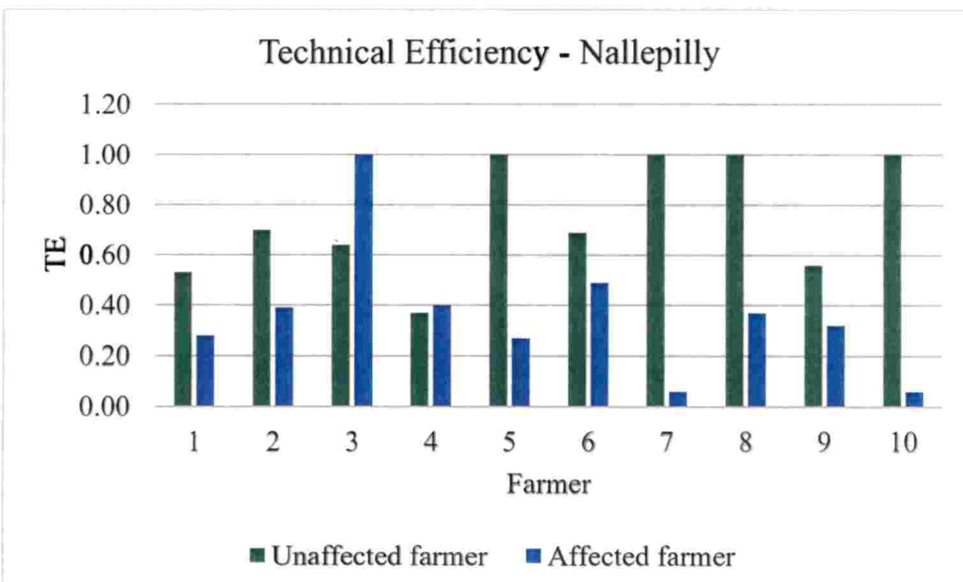


**Fig. 25 Technical efficiency of respondents in Nallepilly Panchayat**

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## 4.5 Coping mechanisms used by the farmers

Drought is one of the main constraints in rain-fed rice production. According to Garrity et al. (1986), 50 per cent of rainfed low land and rainfed upland are drought prone. Due to the changing climatic and environmental conditions, modification in agricultural have been made. Coping mechanisms followed by the farmers against drought are represented in the **Table 21**. In each of the Panchayats, most of the farmers adopted irrigation as their coping strategy. This is because rice is a crop which requires 5 cm of standing water for growth and development. Canal irrigation was usually done in the study area during normal conditions. Malampuzha and Aliyar dam were the main source of irrigation water in the area. But in the drought situation, bore well and ponds are usually used by the farmers for the irrigation purpose. The farmers who had no irrigation facility, usually used short duration varieties. Shifting cultivation is another coping strategy followed by insuring farm against risk, and reduction in the use of fertilizer.

**Table 21. Coping mechanism used by the farmers**

| Sl. No | Coping Mechanisms | Score | Rank |
|---|---|---|---|
| 1 | Irrigation | 74.25 | 1 |
| 2 | Insuring farm against risk | 60.46 | 4 |
| 3 | Short duration varieties | 53.55 | 2 |
| 4 | Adjusting the sowing time | 66.61 | 3 |
| 5 | Reducing the fertilizer usage | 63.28 | 5 |

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Based on the rainfall distribution, availability of ground water and temperature, rain fed farmers can change their cropping pattern to mitigate the effect of drought on their yields. However, family food security is the primary concern of majority of the farmers. High temperature during the flowering stage of rice causes spikelet sterility. Peng *et al.*, (2004) suggested that the adjustment in planting time so that the reproductive and grain filling stage fall into those months with relatively low temperature. Kumary (2011) reported that the delayed sowing or selection of appropriate planting date so as to escape from high temperature during flowering of the crop. Rainfall is the most important weather parameter for the profitable rice production. Sridevi and Chellamuthu (2015), also studied the impact of rainfall on rice, and revealed that minimum of 200-300 mm of water per month is required to get good rice production in rain fed systems. The deviation in weather can be used by resorting to optimum time of planting or sowing.

Challinor *et al.,* (2004) suggested that the cultivation of rice varieties with great tolerance or resistance to stresses such as heat, drought, flood, salinity and varieties which respond positively to high $CO_2$ can be adopted as an effective technological option. Most of the respondent in the study area cultivate the variety Jyothi, because of the high yield and relatively shorter duration (100-110 days). Other short duration varieties used by farmers are Kanchana, Rohini, Annapoorna, Suvarnamoden, etc. Majority of farmers used Jyothi variety as short duration variety, and Uma, Kanchana and Shreyas were also cultivated by the farmers. Some of the respondents shift the cultivation period according to the rainfall availability. Some of the farmers insuring the farm against risk, and the government gave the compensation of the rice farmers. Drought tolerant or semi tolerant varieties like Uma, Kanchana, and Annapoorna are cultivated by some of the farmers.

Fertilizer use in rainfed areas was reduced due to shortage of rainfall. Under water scare environment, plants are unable to absorb fertilizer from soil. In drought conditions, plant response to fertilizer declined, causing decreased rice yield. Selvaraj (2009) studied the rice yield in response to fertilizer input declined the yield during drought period.

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### 4.4.1 Coping strategies of farmers to overcome the drought condition - Suggested solutions

Coping with the impact of climate change events on the agriculture sector will require careful management of resources such as soil, water and biodiversity. Making agriculture production sustainable is key and is achieved only through the production systems that make the most efficient use of environmental goods and services without damaging these assets.

Most of the farmers use irrigation as the main coping mechanism used to overcome the adverse effect of drought. Because, rice crop is strongly influenced by water supply. Rice required 5 cm of standing water throughout its growth period.

Awareness programmes should be conducted for adoption of technologies and government schemes that provides financial support to rice farmers.

Local knowledge is important for taking the adaptation strategies against climate change at regional and community level. Thus, local knowledge traditions could be added to adaptation process to Climate change. The combination of local knowledge and science in creating new knowledge about climate change should be undertaken.

Development of drought resistant varieties with high yield is one of the method to reduce the production risk.

Selection of planting material is an important factor which influences the crop productivity. Planting material should be of good quality, high yield, drought tolerant varieties. Variety selected should be suitable to the particular region. High yielding varieties having biotic and abiotic stress tolerance should be selected for maximizing the production.

High yielding varieties and drought tolerant varieties like Suvarnamoden, Kunjukunju Varna, Sornaprabha, Jyothy, Uma, and Annapoorna should be cultivated to ensure maximum profit.

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Multiple enterprise agriculture consisting of crop, livestock, poultry, fish farming and trees in a single unit of land will ensure protection against projected loss due to climate change and is also benefit from farm resource use (Salinger and Stigter, 2000). They are willing to undertake diversification only if rice production can provide adequate food for their family. Therefore, it is necessary to increase the productivity of rice-based production systems to successfully promote crop diversification.

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# SUMMARY

# CHAPTER 5

# SUMMARY

The present study entitled "Socioeconomic analysis of effect of meteorological drought on rice cultivation in Palakkad district" was conducted in drought affected areas of Palakkad district. The objectives of the study were to analyze the nature and extent of drought in Palakkad district, to study the economic costs of drought on rice in the district and to determine the coping mechanisms followed by farmers and recommended by extension functionaries to withstand drought.

The Panchayats of Pattithara, Erimayur, Kavassery, Pallessana and Nallepilly of Palakkad district were purposively selected for the study as these Panchayats in the district were most affected by drought in the year 2016-17. The present study was mainly based on primary data collected from a sample of 100 farmers in five Panchayats and also weather data was used to analyze the drought situation. Fifty farmers each of drought affected and unaffected were randomly selected and surveyed in each Panchayat making a total sample size of 100 respondents. The primary data were obtained from the selected sample farmers by personal interview method using a pre tested interview schedule. Data related to the socioeconomic condition of the farmers, yield, costs and returns from rice, adoption of coping mechanisms were collected.

The analysis of secondary data referring to the weather characteristics of Palakkad district which included maximum and minimum temperature and rainfall was also done. The analysis of temperature showed an increasing trend in minimum temperature for the past 3 decades. Analysis showed that compared to the last decade, this decade showed an increase of about 1.18$^0$C in minimum temperature, and the year 2016 recorded the highest minimum temperature (24.32$^0$C). The rainfall in the district showed a decreasing trend, and the year 2016-17 received the lowest rainfall (1334.74mm) compared to previous years. The situation of low rainfall was the major reason for drought occurrence during the second crop season

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in the year 2016-17. The nature and extent of drought in Palakkad district was also analyzed based on the data collected from the Principal Agricultural Office, Palakkad. According to PAO, about 104.95 ha of rice in the district was severely affected by drought. Trends in area, production and productivity of Kerala and Palakkad district were analyzed and it was observed that the area and production was on a decreasing trend in Kerala and Palakkad. Compared to the previous years, the production in the year 2016 alone showed a large reduction in productivity (2202 kg $ha^{-1}$). Drought may be the reason for the sudden decrease in productivity compared to the year 2015 (2816 kg $ha^{-1}$).

The analysis of socioeconomic characteristics of the farmers included age, educational status, experience in rice cultivation, land holding size, area under rice cultivation, source of income, annual average income, annual average expenditure. It was evident that maximum respondents belonged to more than 50 years age group and farmers' literacy level was relatively high. Majority of the farmers had more than 25 years of experience and they were small farmers with an area of less than 0.5 ha. Farm income was the main source of income measure for majority farmers and their average annual income and expenditure was about 1 to 2 lakhs. Inputs used by the respondents were analyzed and it was observed that Jyothi variety was used by most of the farmers and canal irrigation was the main source. Canal irrigated farmers suffered most due to the drought situation because of lack of availability of water in dams and rivers. Malampuzha and Aliyar dams were the source of irrigation water in the study area.

The cost of cultivation of rice in Palakkad district was found as Rs. 54956 $ha^{-1}$. Labour hiring charge contributed the major share of total cost followed by machine hiring charges which accounted for 52 per cent and 21 per cent respectively. Cultivation cost is higher for small farmer (Rs. 81443 $ha^{-1}$) compared to marginal (Rs. 51103 $ha^{-1}$) and large (Rs. 44670 $ha^{-1}$) farmers respectively. It was also observed that around 43.62 per cent of financial loss was incurred by drought affected farmers. The yield reduction was 49.09 per cent and the average yield

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obtained by drought affected farmer was 1162 kg $ha^{-1}$ and for unaffected farmer it was 2367 kg $ha^{-1}$.

Regression analysis showed that human labour and machine hours were the most significant variables in case of both affected and unaffected farmers.

Efficiency analysis was done and shows that input efficiency of drought affected farmers was lower than the unaffected farmers. The average technical efficiency of drought affected farmers was found as 51 per cent which showed that the efficiency in use of inputs like, fertilizer, human labour and machine labour was relatively low. The average technical efficiency of unaffected farmers was found as 72 per cent.

Coping strategies adopted by farmers in the study area were irrigation, use of short duration varieties, adjusting the sowing time, insuring the farm against risk, and reducing the use of fertilizers.

**Policy suggestions:**

The rate of decline in area and production of rice in Palakkad district was found to be more rapid. Hence there should be region specific programmes to sustain the rice farming in the areas.

The change in weather parameters was significant across the region, within the state, and the weather extremes are region specific. So investment on weather based agro advisory services can, to a large extent, help the farmers to manage and adapt to climate change impacts. This naturally necessitates establishment of weather stations in these regions.

Farmer education on the potential impact and adaptation strategies on climate change can be done through extension programmes.

Research and development to develop new strategies on the adaptation and mitigation of climate change impacts should be initiated.

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**Future line of work**

This study has concentrated on the impact of drought on rice cultivation in Palakkad district. It may be extended to other districts. Further the economic impact of drought on the major crops like coconut, banana, vegetables, spices of Kerala is to be conducted.

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# APPENDIX

## APPENDIX I

## KERALA AGRICULTURAL UNIVERSITY
## ACADEMY OF CLIMATE CHANGE EDUCATION AND RESEARCH, VELLANIKARA, THRISSUR

### Socio-economic Analysis of Effect of Meteorological drought on rice cultivation in Palakkad district

SOCIO-ECONOMIC PROFILE OF FARMERS

1. Name & Address of the farmer:
2. Gender : Male/Female
3. Age : 20-30/30-40/40-50/>50
4. Religion : Hindu/Muslim/Christian/Others
5. Caste : SC/ST/OBC/OEC/Others
6. Education : Illiterate/LP/UP/HS/SSLC/HSS/Degree/PG
7. Marital Status : Married/Unmarried/Widower/Widow/Divorced/Separator
8. Economic Status : BPL/APL
9. Employment Status :Self Employed/Wage Empt/Unemployed
10. No. of earing members of family: 1/2/3 & above
11. Monthly Income : <15000/15000-20000/20000-25000/25000-30000/ Above 30000
12. Source of income : Agri/Salary/Rent/Wages/Profit/Lease/Royalty/others
13. Land ownship : Below 50 cents/50-1acres/ 1-2/2-4/4-6/Above 6 acres
14. Farming or experience in rice cultivation: <10years/ 10-25years / >25 years
15. Type of House: Tiled/Concrete/others
16. Size of House : Small/Medium/Large/Extra large
17. Employed servant at house : Y/N

If yes a) No. of servants: - 1/2/>2

b) Type of empt. - Full time/part-time

18. Do you own other house/other building than the living one : Y/N

If yes a) No. of building - 1/2/>2

b) Is it given on rent - Y/N

19. No. of Bank Account : 1/2/3 & above

20. Do you have a PAN : Y/N

21. Do you pay income tax : Y/N

If yes, how much per year- <10000/10000-20000/20000-40000/40000-60000/>60000

22. Do you have Debt : Yes/No

If Yes, a) approx. amount - <1 lakh/1-3lakh/3-6lakh/6-10lakh/>10 lakhs

b) Appox. Term of debt - <3yrs/3-5yrs/5-10yrs/10-15yrs/>15 years

Family particulars:

| Sl.No | Particulars | Relation-ship | M/F | Age | Edn | Occupa-tion | Monthly Income | Earning member |
|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | |
| 2 | | | | | | | | |
| 3 | | | | | | | | |
| 4 | | | | | | | | |
| 5 | | | | | | | | |
| 6 | | | | | | | | |
| 7 | | | | | | | | |
| 8 | | | | | | | | |

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Land holding Details:

| Sl. No | Type of land | Owned (in acres) | Leased in | | Leased out | | Total area (in acres) | Total value (Rs ) |
|---|---|---|---|---|---|---|---|---|
| | | | Area (in acres) | Value (Rs) | Area (in acres) | Value (Rs) | | |
| 1. | Dry | | | | | | | |
| 2. | Irrigated | | | | | | | |
| | Garden | | | | | | | |
| | Total | | | | | | | |

Details of irrigation

| Sl. No | Sources | Area irrigated (in acres) | Market value | Remarks |
|---|---|---|---|---|
| 1. | Bore well | | | |
| 2. | Canal | | | |
| 3. | Tank | | | |
| | Total | | | |

| Season | Crop | Area | Age & variety | Main Yield /ha | Value (Rs) | By product yld /ha | Value | Total value (Rs) | Dry/ Irrigated |
|---|---|---|---|---|---|---|---|---|---|
| Kharif | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Rabi | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Summer | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

Cropping pattern : Dry /Irrigated

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ASSETS POSITION

**a. Farm assets**

| PARTICULARS | No. | Purchase value | Present value |
|---|---|---|---|
| **A. Farm buildings** | | | |
| 1.farm house | | | |
| 2.cattle shed | | | |
| 3.pump house | | | |
| 4.poultry shed | | | |
| **B. Farm machinery & equipments** | | | |
| **1.** Tractor | | | |
| 2. Power Tiller | | | |
| 3. Cultivator | | | |
| 4. Disc Plough | | | |
| 5. Transplanter | | | |
| 6. M.B Plough | | | |
| 7. Submersible Pump Set | | | |
| **C. Intercultural implements.** | | | |
| 1.Spade | | | |
| 2. Sickle | | | |

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**b. Live stock enterprises.**

| Enterprises | No. | Purchase value | Present value | Maintenance cost | Income |
|---|---|---|---|---|---|
| 1. Bullock | | | | | |
| 2. Cow | | | | | |
| 3. Buffalo | | | | | |
| 4. Sheep | | | | | |
| 5. Goat | | | | | |
| 6. Poultry | | | | | |
| 7. Others | | | | | |
| **Total** | | | | | |

**c). Household assets**

| Particulars | No. | Purchase value | Present value | Source of funding |
|---|---|---|---|---|
| 1. T.V | | | | |
| 2. Refrigerator | | | | |
| 3.Fan | | | | |
| 4. Furniture | | | | |
| 5.Transport Vehicles | | | | |

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**d). Financial status**

| Particulars | Amount | Remarks |
|---|---|---|
| 1. Cash on hand | | |
| 2. Savings in bank | | |
| 3. Chit funds | | |
| 4. Advances made to others | | |
| 5. Others(specify) | | |

AVERAGE MONTHLY FAMILY EXPENDITURE (Amount in Rs.)

| Description | Weekly | Monthly | Yearly |
|---|---|---|---|
| Food (W) | | | |
| Clothing (Y) | | | |
| Education (Y) | | | |
| Medical (Y) | | | |
| Entertainment (M) | | | |
| Fuel (M) | | | |
| Electricity (M) | | | |
| Phone (M) | | | |
| Donation (Y) | | | |
| Loan repayment (M) | | | |
| Liquor/Tobacco (M) | | | |
| Travel (M) | | | |
| Newspaper (M) | | | |
| Rent (M) | | | |
| Internet (M) | | | |
| Other (M) | | | |
| **Total** | | | |

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6.Whether you are cultivating KAU rice variety (jyothy or uma) or local non KAU variety :

a. From when onwards you started the rice cultivation: year

b. If you are cultivating the KAU rice variety any specific reason is there for the adoption of these variety. YES/ NO
If it is YES give the reasons :

c. The rice variety used is drought resistant/tolerant/not

d. How many areas of field is affected by drought in previous years

e. How many rupees of compensation is given by the government per hector

f. If this compensation is sufficient or not

g. The copying mechanism followed by you to avoid drought

h. Whether the copying mechanisms used is based on the recommendation of the extension functionaries

i. The TPFM bacteria is used or not

j. The source of irrigation for the rice field during summer period : River/Pond/Canal/Others

k. Water conservation techniques used/not

l. Do you have any agricultural loan, if yes, how many rupees

7.Costs and Returns

a. Crops:
Crop season: ---------------------, Variety: --------------------. Area (Acres) ---------
Wage rate (Rs./day) a) Men-------, b) Women------ c) Bullock Pair-------
c) Machine power:---------- Rs/hr

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| SL.No. | Particulars | Unit | Qty. | Rate | Value (Rs.) |
|---|---|---|---|---|---|
| **I. Costs**<br>**A) Variable Cost** | | | | | |
| 1 | Seed/ Seedlings | | | | |
| 2 | FYM | | | | |
| 3 | Fertilizers<br>a)<br>b)<br>c)<br>d) | | | | |
| 4 | Plant protection chemicals<br>a)<br>b)<br>c)<br>d) | | | | |
| 5 | Labour<br>a)Men<br>b)Women<br>c)Bullock Pair<br>d)Tractor Hours | | | | |
| **B).Fixed cost** | | | | | |
| 1 | Land revenue | | | | |
| 2 | Irrigation charges | | | | |
| 3 | Rental value of land | | | | |
| 4 | Electricity charges | | | | |
| 5 | Others | | | | |
| **II. Returns** | | | | | |
| 1 | Main Product Yield | | | | |
| 2 | By-Product Yield | | | | |
| **III Quantity Retained for home consumption** | | | | | |
| | Main product | | | | |
| | By product | | | | |

**8. Information on input use and costs**

Crop: Variety: Acres: Season:

| Operations | Material input | | | Labour | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Human labour (No) | | | Machinery labour (No) | | | Total cost |
| | Qty | Unit value | Cost 1 | Family | Hired | Cost 2 | Family | Hired | Cost4 | 1+2+3+4 |
| Ploughing | | | | | | | | | | |
| Harrowing | | | | | | | | | | |
| Clad crushing | | | | | | | | | | |
| Farm yard manure & applications | | | | | | | | | | |
| Fertilizers & applications | | | | | | | | | | |
| Cost of seeds | | | | | | | | | | |
| Planting cost/sowing | | | | | | | | | | |
| Irrigation | | | | | | | | | | |
| Weeding | | | | | | | | | | |
| Earthing up | | | | | | | | | | |
| PP measures & application | | | | | | | | | | |
| Watch and ward | | | | | | | | | | |
| Harvesting | | | | | | | | | | |
| Threshing & Packing | | | | | | | | | | |

# APPENDIX 2

## Rice production status of Kerala

| Year | Area(lakh ha) | Production(lakh tonnes) | Productivity(Kg/Ha) |
|---|---|---|---|
| 1987-1988 | 6.63 | 11.33 | 1708 |
| 1988-1989 | 6.04 | 10.32 | 1709 |
| 1989-1990 | 5.77 | 10.11 | 1753 |
| 1990-1991 | 5.83 | 11.41 | 1956 |
| 1991-1992 | 5.59 | 10.86 | 1942 |
| 1992-1993 | 5.41 | 10.60 | 1959 |
| 1993-1994 | 5.37 | 10.84 | 2018 |
| 1994-1995 | 5.07 | 10.03 | 1977 |
| 1995-1996 | 5.03 | 9.78 | 1937 |
| 1996-1997 | 4.71 | 9.53 | 2023 |
| 1997-1998 | 4.30 | 8.71 | 2022 |
| 1998-1999 | 3.87 | 7.64 | 1975 |
| 1999-2000 | 3.52 | 7.26 | 2061 |
| 2000-2001 | 3.49 | 7.70 | 2203 |
| 2001-2002 | 3.47 | 7.51 | 2162 |
| 2002-2003 | 3.22 | 7.03 | 2182 |
| 2003-2004 | 3.10 | 6.88 | 2218 |
| 2004-2005 | 2.87 | 5.70 | 1984 |
| 2005-2006 | 2.89 | 6.67 | 2301 |
| 2006-2007 | 2.75 | 6.29 | 2285 |
| 2007-2008 | 2.63 | 6.41 | 2435 |

| | | | |
|---|---|---|---|
| 2008-2009 | 2.28 | 5.28 | 2308 |
| 2009-2010 | 2.34 | 5.90 | 2520 |
| 2010-2011 | 2.34 | 5.98 | 2557 |
| 2011-2012 | 2.13 | 5.22 | 2452 |
| 2012-2013 | 2.08 | 5.68 | 2733 |
| 2013-2014 | 1.97 | 5.08 | 2577 |
| 2014-2015 | 1.99 | 5.64 | 2827 |
| 2015-2016 | 1.98 | 5.62 | 2837 |
| 2016-2017 | 1.96 | 5.49 | 2790 |

Source: Economic Review, GOK

## APPENDIX 3

**Rice production status of Palakkad district**

| Year | Area(lakh ha) | Production (lakh ton) | Productivity(kg/ha) |
|---|---|---|---|
| 1991-1992 | 1.47 | 3.44 | 2344 |
| 1992-1993 | 1.46 | 3.35 | 2297 |
| 1993-1994 | 1.43 | 3.34 | 2337 |
| 1994-1995 | 1.40 | 3.13 | 2240 |
| 1995-1996 | 1.35 | 2.80 | 2067 |
| 1996-1997 | 1.28 | 2.94 | 2291 |
| 1997-1998 | 1.20 | 2.60 | 2173 |
| 1998-1999 | 1.07 | 2.37 | 2213 |
| 1999-2000 | 1.09 | 2.50 | 2287 |
| 2000-2001 | 1.18 | 2.62 | 2209 |
| 2001-2002 | 1.15 | 2.69 | 2323 |
| 2002-2003 | 1.15 | 2.43 | 2104 |
| 2003-2004 | 1.05 | 1.89 | 1802 |
| 2004-2005 | 1.13 | 2.60 | 2343 |
| 2005-2006 | 1.11 | 2.66 | 2341 |
| 2006-2007 | 1.09 | 2.70 | 2473 |
| 2007-2008 | 0.99 | 2.44 | 2463 |
| 2008-2009 | 0.96 | 2.40 | 2497 |
| 2009-2010 | 0.94 | 2.56 | 2703 |
| 2010-2011 | 0.84 | 2.12 | 2527 |
| 2011-2012 | 0.80 | 2.18 | 2711 |
| 2012-2013 | 0.79 | 1.89 | 2389 |
| 2013-2014 | 0.82 | 2.38 | 2872 |
| 2014-2015 | 0.82 | 2.36 | 2851 |
| 2015-2016 | 0.81 | 2.28 | 2816 |
| 2016-2017 | 0.65 | 1.44 | 2202 |

Source: Economic Review, GOK

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## APPENDIX 4

**Weather data of Palakkad**

| Year | Max temp (°C) | Min temp (°C) | Rainfall (mm) |
|---|---|---|---|
| 1987 | 33.03 | 23.14 | 2089.60 |
| 1988 | 32.50 | 20.89 | 1730.50 |
| 1989 | 32.03 | 21.26 | 5761.70 |
| 1990 | 32.51 | 20.70 | 1764.22 |
| 1991 | 32.63 | 22.55 | 2756.00 |
| 1992 | 32.34 | 22.89 | 2986.00 |
| 1993 | 32.29 | 21.87 | 1096.00 |
| 1994 | 31.87 | 20.75 | 2698.30 |
| 1995 | 32.46 | 22.16 | 2352.40 |
| 1996 | 32.35 | 21.69 | 2097.70 |
| 1997 | 32.71 | 22.53 | 3064.60 |
| 1998 | 32.26 | 23.54 | 2377.60 |
| 1999 | 31.94 | 22.61 | 2550.60 |
| 2000 | 32.23 | 22.61 | 1887.00 |
| 2001 | 32.04 | 22.53 | 2366.40 |
| 2002 | 32.39 | 22.88 | 2391.40 |
| 2003 | 32.47 | 23.15 | 1837.80 |
| 2004 | 32.17 | 23.06 | 2555.00 |
| 2005 | 32.33 | 22.84 | 2767.90 |
| 2006 | 32.19 | 23.11 | 3650.10 |
| 2007 | 32.18 | 22.87 | 3055.80 |
| 2008 | 32.07 | 23.23 | 1976.20 |

| | | | |
|---|---|---|---|
| 2009 | 32.56 | 23.15 | 2740.60 |
| 2010 | 32.76 | 23.21 | 2154.00 |
| 2011 | 32.15 | 22.91 | 2754.90 |
| 2012 | 32.38 | 23.20 | 1929.90 |
| 2013 | 32.27 | 23.13 | 2749.60 |
| 2014 | 32.13 | 24.41 | 2385.50 |
| 2015 | 33.06 | 22.68 | 2253.10 |
| 2016 | 32.69 | 24.32 | 1292.44 |

Source: RARS, Pattambi

## APPENDIX 5

**Weather data of Palakkad during 2016-17**

| Year | Maximum Temperature($^0$C) | Minimum Temperature($^0$C) | Rainfall(mm) |
|---|---|---|---|
| 2016 Apr | 36.99 | 26.50 | 0.00 |
| 2016 May | 34.17 | 25.18 | 191.70 |
| 2016 Jun | 30.14 | 23.88 | 480.60 |
| 2016 Jul | 29.78 | 23.83 | 344.60 |
| 2016 Aug | 30.51 | 23.88 | 120.20 |
| 2016 Sep | 30.26 | 23.56 | 92.80 |
| 2016 Oct | 31.46 | 23.14 | 24.14 |
| 2016 Nov | 33.04 | 22.58 | 4.10 |
| 2016 Dec | 32.67 | 21.47 | 34.30 |
| 2017 Jan | 34.13 | 20.93 | 0 |
| 2017 Feb | 35.8 | 21.58 | 0 |
| 2017 Mar | 32.21 | 21.51 | 42.3 |

Source: RARS, Pattambi

# SOCIO ECONOMIC ANALYSIS OF EFFECTS OF METEOROLOGICAL DROUGHT ON RICE CULTIVATION IN PALAKKAD DISTRICT


By

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**(2013-20-122)**


## ABSTRACT OF THE THESIS

**Submitted in partial fulfilment of the requirement for the degree of**

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**2018**

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# ABSTRACT

Climate change is the major concern of mankind in the $21^{st}$ century. Under changing climatic scenario, crop failures, reduction in yield, reduction in quality and increasing pest and disease problems are common and they render the cultivation unprofitable. Climate change has both direct and indirect effects on agriculture productivity including changing rainfall pattern, drought, flood, pest and disease outbreaks, etc. The impact of drought can be categorized into physical, economic and environmental. The present study was undertaken with the objectives viz., to analyse the nature and extent of drought in Palakkad district; to study the economic costs of drought on rice in the district; to determine the coping mechanism followed by farmers and recommended by extension functionaries to withstand drought. As per the study objectives, the rice growing farmers (100 no's) were required to be selected from 5 panchayats. The panchayats were selected based on the area affected by drought. An equal number of farmers who did not suffer losses and suffer losses from drought were also selected randomly from each panchayat for the study purpose. Data were collected in line with the objectives using a pre-tested structured interview schedule. In this study, the main focus is on the meteorological drought. According to the Agriculture department, Palakkad district experienced meteorological drought situation during the year 2016-17. During 2016-17, Palakkad experienced a large reduction in the rainfall received and observed a higher atmospheric temperature. In 2016-17, Palakkad experienced extreme shortage of rainfall (1334.74 mm), which is less than the state average. The cost of cultivation was found that Rs. 54956 $ha^{-1}$. Hired labour cost accounts for a major share in the total cost of production followed by machine charge, fertilizer and manure charge, seed charge and other expenses. It was found that the cost of cultivation was higher for small (Rs. 81443 $ha^{-1}$) farmer compared to marginal (Rs. 51103 $ha^{-1}$) and large (Rs. 44670 $ha^{-1}$) farmer. Small farmers were suffered more financial loss due to drought. Around 49.09 per cent of yield reduction and 43.6 per cent of financial loss occurred. Regression analysis showed that the most significant variables which contributed to the yield were human labour and machine labour. Technical efficiency analysis showed that the input efficiency of drought affected

farmers was lower than the unaffected farmers and was found as 51 per cent. This shows that the farmer has a scope for improving the use of inputs like, fertilizer, human labour and machine labour. Irrigation is the one of the most important coping strategy adopted by the farmer followed by using short duration varieties, adjusting the sowing time, insuring the farm against risk and reducing the usage of fertilizer. Thus, it can be concluded that the occurrence of drought, severely affected the farmers' economic condition. It was found that the small farmers suffered most compared to marginal and large farmers in terms of financial loss.