THE ECONOMIC IMPACT OF AN EXTREME WEATHER EVENT ON THE PRODUCTION OF CARDAMOM IN IDUKKI DISTRICT OF KERALA

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COLLEGE OF AGRICULTURE
VELLAYANI, THIRUVANANTHAPURAM – 695522
KERALA, INDIA

2020

DECLARATION

I, hereby declare that this thesis entitled **"THE ECONOMIC IMPACT OF AN EXTREME WEATHER EVENT ON THE PRODUCTION OF CARDAMOM IN IDUKKI DISTRICT OF KERALA"** is a bonafide record of research work done by me during the course of research and the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title, of any other University or Society.

Place: Vellayani

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LIST OF ABBREVIATIONS

BCR	Benefit Cost Ratio
CRS	Cardamom Research station
CSO	Central Statistical Organisation
DaLA	Damage and Loss Assessment
et al	Co worker
FAO	Food and Agriculture Organization
GOI	Government of India
GOK	Government of Kerala
IISR	Indian Institute of Spices Research
IPCC	Intergovernmental Panel on Climate Change
KAU	Kerala Agricultural University
OSDMA	Odisha State Disaster Management Authority
PAO	Principal Agricultural Office
PDNA	Post Disaster Needs Assessment
UNDP	United Nations Development Programme
WMO	World Meteorological Organization

LIST OF SYMBOLS

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

Introduction

INTRODUCTION

Extreme weather events are the extremes of atmospheric weather and climatic parameters such as temperature, precipitation and rainfall. The occurrence of these extreme can may be influenced by weather and climatic phenomena such as monsoon, El-niño and cyclones. It affects the nature in forms of floods, droughts, landslides, hurricanes and other natural disasters. (IPCC, 2012)

The disasters due to the extreme weather events may affect the man kind in many ways. It can lead to loss of life and physical destruction. Agriculture sector is highly depended on climatic variables, land and water and hence it is highly vulnerable to disasters. Natural disasters directly hit the agriculture sector resulting in reduced production and destruction of crops. It causes direct economic loss to farmers and also affecting their livelihoods. (FAO, 2017)

1.1 NATURAL DISASTERS IN INDIA

Agriculture of Indian subcontinent mainly based on south-west monsoon. In June to September months it precipitates around 70 per cent of annual rainfall. The changing climatic situation can result in extremes either heavy precipitation or drought. Around 60 per cent of total monsoon rainfall can occur within a short time period results in flooding of land. (Mall *et al*. 2006)

India is becoming more prone to natural calamities such as floods and cyclones. It is evident from the natural calamities happened in different parts of nation in the last decade. The list of natural disasters occurred in different states of India is given in Table 1.1

Table 1.1 Natural disasters in India (2010-18)

Year	Disaster	Affected states.
2010	Cloudburst	Leh, Ladakh in Jammu and Kashmir
2011	Earthquake Floods Cyclone Thane	North Eastern India 19 Districts of Odisha Tamil Nadu, Puducherry
2012	Floods Cyclone Nilam	Assam, Uttarakhand Tamil Nadu
2013	Cyclone Mahasen	Tamil Nadu

	Floods/Landslides Cyclone Phailin Floods	Uttarakhand and Himachal Pradesh Odisha and Andhra Pradesh Andhra Pradesh, Odisha
2014	Cyclone Hud Hud Floods	Andhra Pradesh and Odisha Jammu and Kashmir
2015	Cyclonic Storms Floods and Heavy Rains	West Bengal Tamil Nadu, Rajasthan, Andhra Pradesh, Gujarat
2016	Cyclonic Storm	Tamil Nadu
2017	Lightning	Odisha and Maharashtra
2018	Floods and Heavy Rains	Kerala and Uttar Pradesh

Source: Ministry of Statistics and Programme Implementation, Govt. of India.

The floods and heavy rains of Kerala in 2018 was listed as one of the five major extreme flood events during 2015-2019 period by World Meteorological Organisation. They were China flood of 2016, North-east India, Bangladesh and Nepal flood of 2017, sierra landslide of 2017, Japan flood of 2018 and Kerala flood of 2018. (WMO, 2019)

1.2 KERALA FLOODS 2018

In 2018, Kerala recorded the heaviest monsoon rain in nearly a century resulting in flood that devastated the state. In August Kerala endured the worst ever floods in its history since devastating flood of 1924. There was a continuous spell of rainfall in the state which was 42 per cent in excess of the normal average. The heaviest spell of 771mm of rain was received during 1st August to 20th August intensified the disaster. The excessive rains triggered multiple landslides and forced the discharge of excess water from 37 dams across Kerala, magnified the disaster. There were 433 human causalities and an estimated economic loss of ₹31000 crore. Around 341 landslides were reported from different regions of state. While Idukki, the worst affected district, was devastated by 143 landslides, crop loss and much more. (GOK, 2019)

In Idukki district agricultural sector experienced the maximum damages and loss due to extreme weather event. The most affected crops were spices, banana, tubers, vegetables, coconut, rice and many fruit trees. Among the spices; cardamom, pepper, clove, cinnamon & nutmeg were suffered more damages. (GOK, 2019)

1.3 CARDAMOM CULTIVATION IN IDUKKI

Cardamom (*Elettaria cardamomum*) known as the ‘Queen of spices’ native to western ghats of India. It is one of the most important spice produced and exported from India. In world, India ranks 2nd in the production of cardamom. The major states producing cardamom are Kerala, Karnataka and Tamil Nadu. In 2016-17 the area under cardamom in India was 69357 ha and the production were 17990 tonnes. Kerala contributes around 87 per cent of national production and having 56 per cent of total area under cultivation. (Spices Board, 2018) In Kerala cardamom is cultivated widely in hilly areas of western ghats. The major district producing cardamom are Idukki and Wayanad. Among them 70 per cent of cultivation and 90 per cent of production is concentrated in Idukki district (GOK, 2018). The favorable climatic conditions and suited varieties are the primary reasons for high yield. *Njallani* variety of cardamom is widely cultivated in Idukki due to its high yielding quality.

Cardamom is one of the important crops cultivated in Idukki district and major source of income for farmers and also providing employment for many rural households and the extreme weather events of 2018 had severely hit this crop also.

In Idukki district agricultural sector experienced the maximum damages and loss due to extreme weather event. The most affected crops were spices, banana, tubers, vegetables, coconut, rice and many fruit trees. Among the spices; cardamom, pepper, clove, cinnamon & nutmeg were suffered more damages. (GOK, 2019)

In the above context, the present study “The economic impact of an extreme weather event on the production of cardamom in Idukki district of Kerala” was conducted with the following objectives.

1. To assess the loss in the production of cardamom due to an extreme weather event
2. To analyse its effect on farm income
3. To examine the adaptation strategies to mitigate the loss.

1.4 SCOPE OF THE STUDY

The purview of this study was to study the loss due to extreme weather event on cardamom cultivation in the Idukki district. The study assumes significance because it examined the socioeconomic characteristics, physiographic characteristics, meteorological data and loss assessment with primary data collected from farmers. For several agencies specifically government agencies, this study would provide a source of information. The findings from this study will help to design adaptation measures that will aid in the reduction of impacts of natural disasters. The study is also significant because it examines how the rural farmers can best take advantage of the strategies for risk aversion so as to improve agricultural development. The study also identified the major constraints faced by farmers in post disaster scenario.

1.5 LIMITATIONS OF THE STUDY

Constraints on time, accessibility, finance and other resources restricted the researcher to select limited area for the study. Hence results are primarily relevant to those areas where identical conditions prevail. Moreover, the primary data was collected by means of survey method via interviewing farmers. Hence, the objectives of the study were confined to the extent that the farmers were capable of recall from their memory as they did not keep up any farm records about the damage and loss caused by the extreme weather event and their farm income. Finally, the data was collected from a small sample of respondents of Idukki district. Therefore, the generalizations have to be limited to the region where similar socio-economic and agro-climatic conditions exists. Regardless of these limitations, the researcher has made genuine efforts to conduct the study in as much detail as possible.

1.6 PRESENTATION OF THE THESIS

This thesis has been presented in the order as mentioned below:

1. Introduction: This chapter comprises detailed background of the study, objectives, scope and limitation of the research.
2. Review of literature: This chapter consist of the results and findings of the earlier studies related to the research topics.

3. Materials and methods: This include the information of study area, sources of data, methods of data collection and different statistical tools used for the analysis of collected data and different variables.
4. Results and discussion: This chapter contains the results from the analysis and interpretation of the study.
5. Summary: This chapter pointed out the result findings and policy implications.

1.7 FUTURE PROSPECTS

This study was exclusively focused on cardamom crop of Idukki. Similar studies may be taken in other crops as well as in other districts bring out the complete picture of damages and losses to agriculture due to extreme weather event. An in-depth study including different crops in the state will be useful for formulating appropriate policies and recovery measures. Future studies can also be conducted on adaptation and mitigation strategies.

Review of literature

REVIEW OF LITERATURE

The review of the past research studies helps in identifying the gaps in methodological issues relevant to the present study. Concepts and conceptualization are essential parts of any research study. Reviewing of concepts used in earlier studies help us to adopt, modify and improve the conceptual framework and provide a link with past approaches. As the reviews on economic impact of extreme weather events in spices are limited, reviews relating to the impact of extreme weather events on other crops were also collected and presented in this chapter. The reviews on past literatures are collected based on objectives of the study and are organized under the following headings.

1. Studies on assessing the loss in the production of agricultural crops due to natural disasters
2. Studies on socio-economic conditions of farmers due to extreme weather events
3. Studies on the adaptation strategies to mitigate the loss due to natural disasters
4. Studies on the cost of cultivation of cardamom
5. Studies on constraints faced by farmers in the post disaster scenario

2.1 STUDIES ON ASSESSING THE LOSS IN THE PRODUCTION OF AGRICULTURAL CROPS DUE TO NATURAL DISASTERS

De *et al.* (2005) studied extreme weather events in India over the last hundred years (1991-2004) and reported that in the first and second weeks of June 1994, severe rainstorm occurred in Kerala causing loss of 209 human lives. It also caused crop damage of worth ₹ 144.50 crores and damages to public utility worth ₹105 crores. India’s agriculture is depending on the climate and extreme weather events affects crop production seriously. Hence, considerable efforts were needed to improve the prevailing forecasting of weather and use these improved forecasts in managing extreme weather events.

Haile (2005) studied weather patterns, food security and the humanitarian response of people in sub-Saharan Africa and found that livelihood of most of the rural households mainly dependent on traditional rainfed agriculture. Rainfall has a major role in agricultural production and thereby deciding the economic and social wellbeing of people. The pattern of rainfall in this region was determined by large scale intra-seasonal and inter-annual climate variability along with El Nino events in pacific occasionally. As a result, extreme weather events such as flood and drought happened which destroyed the agriculture and in turn, caused food shortage.

Goswami *et al.* (2006) analysed rainfall data of Indian monsoon for the past century. The study reported that the rainfall pattern for the 50 years of the last century showed a stable pattern, but later on, the occurrence of moderate weather events was significantly reduced. At the same time there was a significant increase in the occurrence of extreme weather events that happened in India. The heavy rainfall, in turn, led to floods, landslides and caused severe damages to crops. It badly affects the economy, society and environment. Forecasting of such extreme events is challenging due to its uncertain nature but, assessing the trends in the occurrence of extreme events can helpful for the preparation of infrastructure prior to occurrence of an extreme event.

Mall *et al.* (2006) studied climate change in India and asserted that above 75 per cent of rainfall in India was due to southwest monsoon and, it occurred in almost four months. However, in extreme conditions rainfall distribution could change, such that more than 200-400 mm be fell over the Western Ghats region and north east regions in a short span of days, which resulted in severe flooding and loss to human, agriculture and livestock. This variation in monsoon further caused extreme hydrological events in India.

Mendelsohn (2007) examined the reasons for crop failure in America and reported that the soil and climatic parameters contributed around 39 per cent of crop loss. According to him high precipitation caused the flooding and destruction occurred in all sectors. Moreover, the rainfall caused crops field and, it in turn it delayed the planting of crops, increases the soil compaction and also resulted in anoxia and root diseases. Hence according to him variation in precipitation was the major reason for crop failure.

Jovel *et al.* (2010) introduced DaLA (Damage and Loss Assessment) methodology to estimate post disaster needs in reconstructing the livelihood of people. It stated that agricultural losses include both crop loss and loss of assets such as irrigation, drainage channels etc. It was important to reconstruct the assets immediately to continue crop production. Along with that strong storage facilities were needed to keep the crop produce.

In case of livestock, heat waves are the important climate variable that adversely affected its milk production. The study projected that the estimated yield loss would be 1.6 million tonns in 2020 and 15 million tonns in 2050, from current levels. Further, it was reported that the reduction in milk production will be higher in crossbreds (0.61%) followed by buffaloes (0.5%) and indigenous breeds (0.4%) (Srivatsava, 2010).

Saptutyningsih and Suryanto (2011) studied the market value of flood affected agricultural land in Indonesia using the hedonic price method to find the magnitude of influence of flood. They found that the flood was one of the highly significant factors in reducing the price of land area. The approximate marginal willingness to pay for lowering the flood stream level was ₹ 2.17 for average households.

An extreme weather events means the change in value of a parameter in climate or weather above or below the threshold level. An extreme weather event occurred within the timeframe of a few days or a week. However, extreme climate events can be occurred through the occurrence of many extreme weather events (IPCC, 2012).

Lassa (2011) studied the impact of disasters on agriculture in Indonesia and suggested that three different approaches for the estimation of crop loss in agriculture. In the first method, direct loss and direct damage to crops, infrastructure and land are calculated. The second method consists of an indirect assessment of losses to agricultural labour and reduced working man-days due to loss of infrastructure. Furthermore, it was used to estimate the vulnerability and risk exposure of agriculture to natural disasters. In the third method he suggested the future prediction of agricultural losses using the previous data available.

Sharma and Rai (2012) studied the sustainability of agro diversity in traditional farming of Sikkim. They found that the microclimate of crops was influenced by the excessive rain, changes in the relative humidity and occurrence of heavy dew and which in turn lead to unpredicted insect and disease incidences in crops.

Venkateswarlu and Shanker (2012) scrutinized the prospects of dryland agriculture in crop production. The study reported that the adverse effects of climate change were more in rainfed agriculture due to variation in rainfall as well as loss in the number of rainy days, which will have greater implications for farmer's choice of crops, varieties, and cropping pattern and systems.

Christidis *et al.* (2013) studied the attributes of heavy rainfall of 2012 in Eastern Australia. It had an important connection with La-nina of 2012 and it was the third largest climate extreme in the history of Australia. Heavy rainfall led to flooding of rivers and extended to cultivated lands and resulted in loss of life and agriculture. It resulted in evacuation of many people from their houses. The increase in sea surface temperature due to global warming increased the rainfall by 5-15 percent.

Imada *et al.* (2013) studied the heavy rainfall of 2012 in Japan. Four days prolonged heavy rain resulted in flood, landslides and damages with 31 deaths. Further it caused damages to many households. They also stated that this heavy rainfall was happened due to oceanic natural variability and probabilistic atmospheric variability.

Zulqarnain (2013) discussed the economic impact of floods on small farmers in terms of agriculture, livestock and poultry which showed that the flood water has washed away the standing crops, farm inputs and livestock, taking away the livelihood of the people. He also observed that small farmers had suffered more compared to large farmers during the floods. Large farmers affected during the floods had recovered very fast as compared to small farmers.

Sharma and Dobriyal (2014) studied the climatic variation in Uttarakhand. They reported that mountain regions were more at risk to natural disasters and affects livelihood of people. It adversely affected the agriculture in terms of production, consumption and trade patterns. The changes reflected from local to global markets.

Lesk *et al.* (2016) studied the influence of extreme weather events on crop production. They studied the loss of cereals across the world due to the extreme heat events that happened during 1964-2007. The results showed that about 9-10 per cent loss in production of cereals occurred due to extreme hot conditions.

A study done by Sam *et al.* (2017a) in the Puri district of Odisha showed that floods had been destructive for agriculture. It led to crop submergence and subsequent crop failure and contributed to increasing the vulnerability of farmer.

Sheng and Xu (2019) examined the impact of climate change on productivity. Evidence from Australia's millennium drought using the synthetic control method showed that the total factor productivity of agriculture was reduced by 18 percent over the time 2002 and 2010. It was very significant in Australia's slowdown in agricultural growth.

2.2 STUDIES ON SOCIO-ECONOMIC CONDITIONS OF FARMERS DUE TO EXTREME WEATHER EVENTS

Guha-sapir *et al.* (2004) studied about the natural disasters occurred over 30 years and concluded that people in south Asian nations such as India, China and Bangladesh were more prone to disasters. They further classified the factors determining vulnerability as social, economic, physical and environmental factors. Social factors were population growth, conflicts in society, discrimination based on gender, and age. Economic vulnerability was determined by the dependency on agriculture for living, availability of credits, debt position and access to basic amenities.

Brouwer *et al.* (2007) carried out a study in the flooded region of Bangladesh and analysed the socio-economic vulnerability faced by the affected families and studied the adaptation strategies taken by them. They found that low income families and families with less productive assets were more prone to disaster. The most affected communities were fishermen and farmers. There was a significant negative relationship observed between household income and vulnerable to risk, i.e., low income groups were more vulnerable and exposed to risk. A similar significant relationship found regarding the ownership of land and vulnerable to risk, i.e., ., having more owned land reduced the vulnerability of risk.

Haen and Hemrich (2007) studied the economics of natural disasters and found that people in poor economic condition was more exposed to disasters. Their livelihood was lost to the disasters and the intensity of loss varied with factors such as race, class, sex, and ethnicity. Children and women were the most vulnerable section, especially in terms of food security and health impacts.

Roy and Hirway (2007) reported that extreme drought caused a reduction of income at the household level. About 48 per cent of farmers reported the irregularity of agriculture income due to drought. Further, they added that there was a significant difference in the average income of households during the normal year and drought year. They found that the average annual income of households in a normal year was Rs.21,739, while the income of the households was reduced to Rs.8,725 in a drought year.

Sivakumar (2008) studied about the natural disasters and its mitigation strategies for developing agriculture. The study exposed that agriculture and forestry were more predisposed to natural disasters. There existed a negative relationship between farmer's income and exposure to disasters. Increased environmental degradation reduced the farmer's income and also destroyed the soil and soil nutrients in the environment. This led to the exhaustion of arable land and increased the vulnerability of agriculture.

Mottaleb *et al.* (2013) studied effect of natural disasters on the farm income of rice farmers in Bangladesh. They concluded that disasters had significant negative relation with farm income and this volatility in income created a situation in which farmers reduce their spending on health and children's education. In the long-run, it could negatively affect the manmade capital formation in nation.

Nguyen (2013) reported that Vietnam experienced a range of calamities including tropical storms, floods and drought. Further, they scrutinized the resilience of households against these natural disasters. He observed that the ability of households to face income shocks depended on their access to liquid assets, income and wealth. Moreover, the study emphasized that poor households were more vulnerable to the risk as they had less stock of liquid assets compared to rich people.

Wang *et al.* (2014) showed that assets at households and community levels had a significant role in the adaptation measures done by the people during extreme weather events. Socio-economic factors like high education, social capital and family income were increased the rate of adaptation.

Huang *et al.* (2015) studied adaptation strategies of rice farmers to extreme weather events in China. They used econometric analysis and found that the applied farm management measures were the principal adaptations to the extreme weather events and it was highly correlated with crop input levels and socio-economic characters. Only one- third of farmers were able to use farm management measures as an adaptation. Government services facilitated the improved adaptation of farmers to extreme weather events and helped to increase yield and reduced the risks.

Swaminathan and Rengalakshmi (2016) studied the impact of extreme weather events on farm families in India and reported that the form, frequency and increasing occurrence of extreme weather events such as drought, heat waves or floods are important factors causing changes on earth's climate. The socio- economic cost due to extreme events was increased sharply and it was relatively high in the last decade of the twentieth century.

A report of flood happened in Odhisha highlighted thatsocio-economic factors often played a key role in making people more vulnerable to floods. The susceptibility to flooding increased due to increased population densities in flood-prone areas and encroachment of floodplains by people. The poor socio-economic condition and their dependence on monsoon paddy aggravated the situation of people staying in these areas. (OSDMA, 2016).

A study reported that Alanda village in Puri district of Odisha had higher susceptibility to flooding compared to other villages. Due to their increased dependency ratio, illiteracy, high percentage of female-headed households and backwardness reduced adaptive ability against floods. etc. (Sam *et al.*, 2017b).

Uddin *et al.* (2017) studied the effect of climate change on coastal areas of Bangladesh and reported that socio-economic conditions of people were severely affected by climate change. They also analysed the farmer's perception regarding climate change. The majority of farmers in the study area were opined that there was an increase in temperature, rainfall and extreme climate events. Through logit analysis, they observed that socio-economic factors such as education level, size of family and farm, family income and experience in farming had significantly influenced the perception of farmers.

Chuang (2018) studied the income diversification strategies of farmers in response to heavy rainfall in India.The study stated that rainfall adversely affected the household income and around 10 per cent of decrease in income happened due to rainfall. The effect was more visible in agricultural field and 15 per cent of income is reduced. So, farmers used several off-farm activities to diversify their income and to mitigate the loss.

Patel *et al.* (2019) reviewed the livelihood of Odisha in relation to extreme weather events. They found that the impact of extreme weather events was more in developing nations due its livelihoods dependency on climate and slow adaptive ability. In areas more prone to disaster, livelihoods such as farming and fishing suffered most due to its direct dependence on weather. The study highlights that extreme weather events caused large economic loss and were more vulnerable on groups such as small and marginal farmers, backward communities, and landless labourers.

2.3 STUDIES ON THE ADAPTATION STRATEGIES TO MITIGATE THE LOSS DUE TO NATURAL DISASTERS

According to UNDP (1991), mitigation included two different types of activities *i.e.*, structural mitigations and non-structural mitigations. Structural mitigations have consisted of construction of dams, windbreaks, terracing, disaster resistant buildings, etc. Whereas, non-structural mitigations consist of educational programs and policies, for example land-use zoning, crop diversification, building codes, forecasting and early disaster warning systems, etc.

Ahemed *et al.* (1999) studied the adaptations strategies taken by the farmers against climate change in Bangladesh. The study reported that for successful adaptation, human systems required good communication within the society, innovative and cost minimizing strategies. They further added that the methods of adoption should be scientifically proven and should be acceptable to the ways of society.

Roy *et al.* (2002) studied the adaptation strategies of the poor to disasters such as drought, flood and cyclone in coastal Orissa. The adopted strategies were mostly depending on the household's perception on extreme events. Coping strategies varied according to the nature and extent of extreme events. Adaptation strategies followed by the farmers were alterations in crop practices, the adjustment in livestock management, water management, searching alternate streams of income, reducing expenditures on health, food consumption, clothes and festivals, etc.

Mirza *et al.* (2003) studied adaptations of developing nations to disasters and stated that floods were affected individuals, households and communities differently. They also asserted that people had to cope with different strategies depending on the frequency and magnitude of the disaster. Migration from flood-affected areas, flood forecasting, flood insurance of crops and livestock, providing emergency health services and building flood shelters were the major coping strategies followed in the study area.

Das (2005) studied agrometeorological impact assessment of natural disasters and extreme events and also analysed the agricultural strategies adopted in areas with high weather risks. The study informed that using windbreaks as shelterbelts helped to prevent or minimized the crop damage by winds. The shelterbelts were either be natural or artificial barriers to check the wind flow and protect the crops. Well-developed shelterbelts might be constructed in places where severe damages were caused by strong winds. It also enhanced the moisture supply in soil and, in turn reduces the soil erosion. He also mentioned that insurance could be used as a mechanism for sharing the cost of losses both over time and over a large number of similar risks. The disaster linked insurance could be promoted as it was not only covering life but also provide protection to crops, livestock and household. Insurance premiums were determined based on different factors such as location and the extent of risk. A high rate of premium could be imposed on high risk assets.

Haile (2005) studied weather patterns, food security and humanitarian response in sub-Saharan Africa and found that when an emergency hits people manage their limited resources efficiently and enable themselves to cope up with the situation. It was very effective when there was an appropriate financial support mechanism. These productive and sustainable strategies at the right time and place will help to protect themselves in the crisis of weather or other problems. Proper facilities for understanding climate variability and weather patterns will help them to be more predictable towards extreme weather events.

Reidsma *et al.* (2010) studied the adaptation strategies of farmers in Europe against extreme weather events and addressed that adaptation strategies were highly influenced by socio-economic characters and farm management practices. Farmers adapt mainly through crop rotation and change in inputs. It was observed that proper management adaptation strategies together reduce the potential impact of disasters on crops and farmers income.

A study conducted by Enete *et al.* (2011) on the topic indigenous agricultural adaptation to climate change in Imo and Enugu states in Southeast Nigeria shows that the after effects of climate changes were reduced farm income, deterioration in storage quality of crops, loss of pasture land/ vegetation and destruction of wildlife ecosystem. Major coping strategies adopted by the farmers with a relatively high profitability index include multiple/ intercropping, agro-forestry/ afforestation, mulching, purchase/ harvest of water for irrigation and use of resistant varieties. The important factors responsible for farmers investment in adaptation practices were age, literacy level and level of awareness of climate change issues. The major problems preventing them from adapting to climate change were poverty, farmland scarcity and reduced access to more efficient inputs, lack of information and poor skills, land tenure and labour constraints.

Fosu-Mensah *et al.* (2012) studied adaptation strategies of farmers in Ghana. The farmers primarily depend on rainfall for farming and decrease in rainfall caused farmers to adopt to climate change. The major adaptation strategies were diversification of crop, change in sowing time cultivating short season varieties and new species. The most important factors which determine the adaptation strategies were extension services, credit availability, land tenure and soil fertility.

Nastis *et al.* (2012) studied climate change and agricultural productivity in Greece and analysed the economic cost of climate change. He suggests that climate change has significant effects on agricultural productivity through empirical evidence. So, farmers should adapt according to climate change and follow the restructuring of crops and other suitable cultivation practices.

Selvaraju (2012) suggested that, climate risk management has an important role in long term strategies for adopting agriculture to climate change. Spatially and temporally downscaled projections of climate change were required for effective adaption. They were important in assessing climate change and planning the adaptations. However, the uncertainty in climate change was a major challenge but it cannot be an excuse for inaction.

Sharma and Rai (2012) studied climate change and sustainability of agriculture diversity in traditional farming of the Sikkim Himalaya and suggested that proper information about climate change should be given to farmers as early as possible so that they can adjust sowing and harvesting time of crop. Early warnings about heavy rainfall, hailstorm, cold and risk management system should be introduced in traditional agriculture.

Esham and Garforth (2013) studied adaptations of farming community in Sri Lanka against climate change and found that majority of them addressed climate change with adaptations from their own experiences. Major adaptations can be classified under five categories such as management of crop, land, irrigation, income and rituals. This explains that in small land holdings non climatic factors were highly influential in determining adaptation strategies. The factors significantly affecting determination of adaptation strategies were human cognition and social communication.

Le Dang *et al.* (2013) studied climate change in relation with farmers perception and adaptation in Vietnam. They enlisted a number of adaptive measures chosen by farmers in response to weather events. They were altering the calendar of planting and planting techniques, diversification of crops and use of multiple varieties, water management and finding alternative income sources as response to disasters.

Uddin *et al.* (2014) studied factors responsible for adoption strategies among farmers of Bangladesh. He states that majority of farmers adopt to extreme weather events and he analysed 14 different adoption strategies. The most utilized adoption strategy was irrigation and least was insurance to crops. The factors determining adaptation strategies were age, education, family size, farm size and income of farmers. Specific adaptation strategies consist of change in planting time, soil and water conservation, cultivating resistant varieties were practiced at farm level.

Rana and Islam (2015) studied impact of flood hazards on the agricultural production and livelihood shifting in rural Bangladesh and found that the heavy floods caused direct damage to agriculture crops and resulted in income loss to farmers forced them to shift in livelihood from agriculture to other means of non- agricultural activities. This again causes the reduction in agricultural production.

Garai (2016) did a qualitative analysis of coping strategies of cyclone disaster in coastal lands of Bangladesh reported that people living in coastal area adopted to cyclones in different ways. They changed the structure of house, migrate and search for new jobs, animal rearing, borrowing money etc. Further they can do prediction of disaster based on their traditional knowledge and take preventive measures to reduce the effect of disaster.

Swaminathan and Rengalakshmi (2016) put forward that the adaptation and mitigation practices to extreme weather events at the local body could be enhanced level by creating 'Climate Risk Management and Mitigation Centre'. These centers can work along with state departments at the block level. It can also train community level climate risk manager to run the centers.

Taraz (2017) studied the adaptation strategies of farmers to variation in monsoon in India and found that the measures adopted by farmers help to reduce the loss of profits by 14 per cent.

Climate change has remarkable effects in India as major share of its population was dependent upon agriculture, which has become increasingly unviable in recent decades especially owing to climate variability and the impact of extreme events. The study highlighted that main coping strategies undertaken by people that included taking up no-farm activities, changing of occupations and migration. (Patel *et al.,* 2019).

2.4 STUDIES ON COST OF CULTIVATION OF CARDAMOM

Korikanthimath (2000) analysed the economics of cardamom in Kodagu district of Karnataka and found that 869.8 labour days were required in one year. He worked out the cost of cultivation and 69 per cent of it was contributed by labour cost. 87.4 per cent of labourers were women and 57.8 per cent of labour required for harvesting alone.

Krishnakumar and Potty (2002) studied about the nutrition of cardamom plants in India and concluded that majority of cardamom growing hills of Kerala were acidic in nature with pH around 5 - 5.5. The status of nitrogen and potassium was high in hilly soils and its requirement was low compared to phosphorus. Organic manures were used widely in cardamom cultivation which enhances the fertility of soil and improve its physical characters.

Nair and Kutty (2004) studied cardamom (*Elettaria cardamomum*) cultivation in Kerala and reported that in cardamom cultivation around 75 percent of labourers were women. The labour such as planting, harvesting and cleaning were dominated by women and men do work such as shade control, pitting, soil conservation works, drying and rub cleaning. Seasonal labour in-migration is very common in cardamom cultivation. Due to the low population in the study area labourers were brought from neighboring areas. Cardamom cultivation required highly skilled labourers for shade control and approximately 43 percent of workers were seasonal.

Varghese (2004) analysed the trend in production and productivity of cardamom in Kerala and concluded that Kerala produced more than 60 per cent of share of cardamom production in India. In 1980-81 the share of cardamom in spice export of India was 31.30 per cent and it drastically reduced to 3.74 per cent in 2001-02. It was mainly due to the high cost of cultivation of cardamom along with disease and pest attack leads to reduced yield.

Varghese (2007) studied the economics of cardamom cultivation in Kerala and found that the cardamom is a major spice having very high cost of cultivation. The cost of cultivation of small (less than 0.5 acres), medium (0.5 to 2 acres) and large farmers (more than 2 acres) per one acre of land were ₹ 27685.67, ₹ 37371.28 and ₹ 38668.34 respectively. Small farmers were using more organic inputs in cultivation. Small and marginal farmers have much expense in cardamom cultivation if rental value of land also added to cost of cultivation.

Gopakumar (2011) studied about climate variation and its impact on various crops of Kerala from 1959-60 to 2007-08. He states that during the years of heavy rainfall the cardamom yield reduced and in low rainfall yield was relatively high.

Murugan *et al.* (2011) studied the environmental impacts of small cardamom cultivation in cardamom hills and found that the introduction of high yielding variety *Njallani* in mid-1990's and better management practices together increased the production of cardamom into three times. Shade regulation and clean cultivation also significant in increasing production. Recently the use of pesticides, fertilizers were increased several folds along with reducing the cropped area.

The recommended dose of organic manures for small cardamom cultivation is farm yard manure, cowdung or compost should be applied 5kg per plant or neem cake should be applied at 1-2 kg per plant. The time of application of fertilizers was before the onset of south west monsoon in June. Shading was essential for growth of cardamom but excess shade and inadequate shade were harmful. Shade regulation should be done properly. (KAU,2011)

Rajasenan (2016) studied the livelihood of workers in plantation crops of Kerala. Regarding the employment scenario women labourers were much more in number compared to men, constituted more than 50 per cent. It was mainly due to the less wages of women compared to men. A large number of workers were coming from Tamil Nadu to work in pepper and cardamom crops. There was a serious labour shortage faced by farmers during harvesting season. About 69 per cent of work in cardamom was done by women and it provide a way of living for them.

2.5 STUDIES ON CONSTRAINTS FACED BY FARMERS IN POST DISASTER SCENARIO

Rosenzweig *et al.* (2001) studied about extreme weather events and agriculture and found that the major problems to farming in post disaster situations were more vulnerability of crop to pest and diseases. Attack of weeds and insects may increase in certain regions of world.

Bryan *et al.* (2009) studied the adaptation strategies to climate change in Ethiopia. They found the major constraints faced by farmers were shortage of land followed by lack of credit for adaptation. Lack of knowledge about adaptation practices, limited market access, and labour shortage were important barriers of adoption.

Deressa *et al.* (2009) studied about farmers adaptations in Nile basins of Ethiopia against climate change and there were five major constraints faced by farmers to adaptations. They were lack of knowledge, lack of finance, labour shortage, limited land availability and poor irrigation facilities.

Fosu-Mensah *et al.* (2012) on his studies on adaptation strategies of farmers in Ghana found that main barriers of adoption strategy were poverty, lack of education about adaptation strategies, and lack of proper weather forecasting. Even if farmers were aware about the weather and adaption strategies lack of credit was a major constraint faced by farmers.

Ozor *et al.* (2013) studied problems of farming in Ghana with climate change and he found that floods and droughts caused problem to farmers such as high incidence of pest, weeds and diseases, variation in rainfall, declining soil fertility, and temperature variation which lead to decreased crop production.

Le Dang *et al.* (2014) studied climate change adaptations and barriers faced by farmers in Vietnam. Around 40 per cent of farmers responded such that land tenure and ownership were primary barrier to adaptations followed by maladaptation such as fatalism, denial and wishful thinking. Lack of technical knowledge about adaptations and less access to market were other constraints. However, the agricultural officers of that region perceive differently from farmers such that farmers perception regarding adaptation to climate change was the primary barrier for adaptation followed by demography and credit access.

Sathishkumar *et al.* (2013) studied constraints faced by farmers to climate change in Andhra Pradesh and concluded that major constraints were small and scattered land holdings, low education level, lack of knowledge about adaptive measures and non-availability of drought tolerant varieties. Along with these personal barriers lack of proper weather forecasting leads to more technological constraints to farmers.

Materials and methods

MATERIALS AND METHODS

Scientific study of any problem requires a systematic investigation using proper methodology in order to arrive at a reliable, unbiased and practical conclusion. Selection of suitable methodology is essential to bring out the best result for a research study. Based on the review of literature collected an appropriate methodology was selected for analysis of the data. This chapter discusses, the description of the study area, the source of the data and the analytical framework under following headings.

3.1. Description of study area

3.2. Methodology

3.3. Major observations made

3.4. Analytical framework

3.1. DESCRIPTION OF STUDY AREA

A prior briefing of physical, economic and environmental condition of the study area is required to understand the research work. So, different characters like topography, climate, soil types, land utilization pattern, land holding pattern, agriculture, demography, occupation and administrative set up are discussed in the following sub-sections.

3.1.1 Kerala State

The state of Kerala known as God's own country, located in the South West region of Indian subcontinent. Surrounded by Arabian sea to the West, Karnataka to the North and Tamil Nadu to the East. It occupies 1.18 per cent of geographical territory of India with an area of 38863 square kilometers. Kerala lies between 74° 52' and 72° 22' East longitudes and 8° 18' and 12° 48' North latitudes. Topographically Kerala is divided into three units viz, highlands, the central plains, and the coastal areas. Highland comprises of the area in and around the Western Ghats or Sahyadri which are mostly wet evergreen forests. Almost all the rivers in Kerala originate from these highlands. Western Ghats run

Figure 1: Political Map of Kerala State.

parallel to the western coastal belt. Kerala has a coastal length of 587km. The state receives heavy rainfall during southwest monsoon and north east monsoon throughout June to September and October and December respectively. Kerala receives 3107 mm average annual rainfall which is higher than national average 1,197 mm. The orographic effect created by the Western Ghats makes this tropical region one of the wettest states in India. Climatic zones of the state vary from the temperate geography of Munnar to the Savannahs of Palakkad. The Sholas, stunted tropical montane forests, which are largely found in higher elevations constitute a unique climatic vegetation of the state.

Land utilization pattern of Kerala in 2017-18 is presented in table 3.1. From the table, the total geographical area was 38.86 lakh hectares. Out of that 2579699 hectares (66.37 per cent) was total cropped area and forest area was1081509 hectares (27.8 per cent). The net sown area was 2040415 hectares and accounted for 52.5 percent, while area sown more than once was 539284 hectares *i.e.*, 13.8 per cent. Land put to non-agricultural uses was 441934 hectares (11.37 per cent) and 96491 hectares (2.48 per cent) was cultivable waste land.

Table 3.1- Land utilization pattern of Kerala in 2017-18

Particulars	Area (ha)	Percentage to total geographical area
Total geographical area	3886287	100.00
Forest	1081509	27.83
Land put to non-agricultural uses	443041	11.4
Barren and uncultivable land	10894	0.28
Land under miscellaneous tree crops	2245	0.06
Cultivable waste	96491	2.48
Fallow other than current fallow	49461	1.27
Current fallow	57522	1.48
Marshy land	14	0.00
Still water	98889	2.54
Water logged area	3235	0.08
Social forestry	2571	0.07
Net area sown	2040415	52.5
Area sown more than once	539284	13.8
Total cropped area	2579699	66.37

Source: GOK (2018), Agricultural Statistics 2017-18

Kerala is located at the southern tip of India with a unique climate. A wide variety of crops growing in this climatic condition. The major portion of agriculture comprised of food crops such as paddy and recent shift to cash crops can be clearly visible in cropping pattern. The cropping pattern of Kerala in 2017-18 is given in table 3.2. It can be seen that food crops accounts for 10.12 per cent while cash crops were cultivated over 60 per cent of total cropped area. The major food crops were rice and tapioca and cash crops were rubber, coffee, tea, and cardamom. The crops are broadly classified into seasonal crops (paddy, pulses, tapioca, vegetables, sweet potato, tubers, groundnut, ginger, turmeric, cotton, tobacco, onion, and tur), annual crops (sugarcane, banana, plantain, pineapple, and betel leaves) and perennial crops (coconut, arecanut, cashew, mango, jack, tamarind, pepper, rubber, tea, coffee, cardamom, cloves, nutmeg, cinnamon, cocoa and papaya) on the basis of life period. Oil seeds has the highest cropped area (29.56 %) in Kerala and coconut has the lion share of 99.7 per cent among this. It was followed by plantation crops (26.39%), Fresh fruits (12.65%) and spices and condiments (10.11%) respectively.

Table 3.2 Cropping pattern of Kerala during 2017-18

Crop	Area (ha)	Percentage to total cropped area
Cereals	194591	7.54
Pulses	1992	0.07
Sugar crop	3082	0.12
Spices and Condiments	260787	10.11
Fresh fruits	326516	12.65
Dry fruits	39720	1.53
Tapioca	70193	2.72
Tubers	18451	1.92
Vegetables	46363	1.79
Oil seeds	762718	29.56
Fibers, Drugs and Narcotics	563	0.02
Plantation crop	680818	26.39
Medicinal plants	1136	0.04

Other non-food crops	172763	6.69
	2579699	100.00

Source: GOK (2018), Agricultural Statistics 2017-18

3.1.2 Location of study

3.1.3 Idukki district

Idukki is the second largest district of Kerala lies in the Western Ghats having an area of 4358 square kilometers. *i.e.*, 11.21 per cent of state. The district is bordered on the East by various districts of Tamil Nadu such as Coimbatore, Dindigul, small parts of Tenkasi, Tirupur, Theni and Virudhunagar. Kerala districts, Pathanamthitta in the South, Kottayam in the South West, Ernakulam in the North West and Thrissur in the North also borders the district. It is located in between latitude 9^{0}15' and 10^{o}2' North and longitude 76^{o}37' and 77^{o}25' East. Idukki is known for its biodiversity, mountainous hills and dense forest and 97 per cent of the area is covered by mountains and forest together. It is also known as Spice garden of Kerala as the major production of spices concentrated in this district.

Land utilization pattern of Idukki district in 2017 -18 shows that total geographical area is 436328 Ha and 45.47 per cent of area is covered by forest. It accounts for 18.35 per cent of total forest area of Kerala. The net sown area in Idukki district was 47 per cent of total geographical area. Total cropped area is 62.33 per cent of total geographical area and area sown more than once is 15.24 per cent.

Table 3.3: Land utilization pattern of Idukki district in 2017 -18

Particulars	Area (ha)	Percentage to total geographical area
Total geographical area	436328	100.00
Forest	198413	45.47
Land put to non-agricultural uses	14345	3.2
Barren and uncultivable land	1404	0.32
Land under miscellaneous tree crops	162	0.03
Cultivable waste	2120	2.48
Fallow other than current fallow	1121	0.48

Current fallow	1667	0.38
Marshy land	0	0.00
Still water	10480	2.40
Social forestry	1150	0.26
Net area sown	205466	47.08
Area sown more than once	66505	15.24
Total cropped area	271971	62.33

Source: GOK (2018), Agricultural Statistics 2017-18

Principal crops cultivated were spices and plantation crops. District stands in 1st position in area of cultivation of crops such as pepper, cardamom, tea, cocoa, sugarcane, vegetables. Total area of pepper cultivation was 44533 Ha which was 52.30 per cent of state and cardamom accounts for 79.75 per cent. It has 87.6 per cent of sugarcane cultivation of Kerala. 14.43 per cent of total vegetable cultivation in Kerala was from Idukki. Area of tea cultivation was 21970 Ha *i.e.,* 73 per cent of state area. It also contributes 10.63 per cent of Kerala's fresh fruit cultivation and 9.76 per cent of tapioca cultivation.

Table 3.4 Cropping pattern of Idukki during 2017-18

Crop	Area (ha)	Percentage to total cropped area
Cereals	885	0.32
Pulses	68	0.02
Sugar crops	1084	0.39
Spices and Condiments	83440	30.68
Fresh fruits	34874	12.82
Dry fruits	1034	0.38
Tapioca	6848	2.51
Tubers	1528	0.56
Vegetables	6691	2.46
Oil seeds	15880	5.83
Fibers, Drugs and Narcotics	114	0.04
Plantation crop	85002	31.25

Other non-food crops	34523	12.69
Total	271971	100

Source: GOK (2018), Agricultural Statistics 2017-18

3.1.3.1 Climate and rainfall

The district lies in eastern highlands and it has much colder climate compared to other districts. Mist occurrence is common in high regions above 1300 mean sea level. Temperature varies between 21^{o}C to 27^{o}C with small variations. The district is rich with rainfall of South-West monsoon (Edavappathy) during June to September and North-East monsoon (Thulavarsham) during October and November with a normal rainfall of 2695.7mm.

3.1.3.2 Soil types

There are three different types of soil in Idukki district viz. laterite soil, forest soil and hilly soil. It is highly enriched with organic matter and fertile for farming. Laterite soil seen in western side while forest and hilly soil in the eastern side of district.

3.1.3.3 Demography

As per Census 2011population of district was 1108974 which contributes 3.3 per cent of total population of Kerala. Out of which, 48.95 per cent were males and 51.04 per cent were females. Sex ratio in the district is 1006 females for 1000 males and the density of population is 255 persons per square kilometer. The literacy level of district is 92.0 per cent which is higher than the national average of 74.85 per cent.

3.1.3.4 Administration

The headquarters of district is Painavu and for administrative convenience there are two revenue divisions (Idukki, Devikulam). It consist of five taluks (Devikulam, Udumbanchola, Peerumedu, Idukki, and thodupuzha) and 66 revenue villages. The district has a total of 8 block panchayats, 58 gramapanchayaths and 2 muncipalities.

For the present study Santhapara and senapathy panchayats were selected. The details about the two panchayaths is given below

3.1.4 Santhanpara Gramapanchayat

Santhanpara gramapanchayat is located about 35 Km away from the city of Nedumkandam and 75 Km away from district headquarter at Painavu. It is having a total area of 78.71 square kilometers. The boundaries are Chinnakanal gramapanchayt in the North, Senapathy gramapanchayat and Rajakumari gramapanchayt in the West, Udumbanchola gramapanchayt in the South and Tamil Nadu in the East. It comes under eastern highlands geographically. Agriculture is the major occupation and crops like cardamom, pepper, coffee is cultivated. National highway- 49 connecting Kochi to Madurai passes though Santhanpara Panchayat.

3.1.5 Senapathy Gramapanchayat

Senapathy is in the eastern edges of Western Ghats located 59 Km away from district headquarters. It is bounded by Panniyar river in North, Santhanpara gramapanchayat in the East, Udumbanchola gramapanchyath in South and Rajakkad gramapanchayat in the West. It is having a total area of 40.948 square kilometers. Panniyar river flows along the border of Senapathy gramapanchayat. Agriculture is the primary occupation and most cultivated crop is cardamom. The climate is moderately cold in this region.

3.2. METHODOLOGY

Both primary and secondary data were used for analysing specific objectives of the study.

3.2.1. Selection of study area and sampling design

Primary data for the present study was collected using a well-structured pre-tested interview schedule through a survey of 50 farmers in the Idukki district of Kerala (Appendix-I). Idukki district is purposively selected based on the loss reported due to the extreme weather event in 2018. The district was severely affected by the weather and much loss to cardamom had been also reported from the district.

Figure 2: Political map of Idukki district

Figure 3: Political map of Santhanpara Panchayat

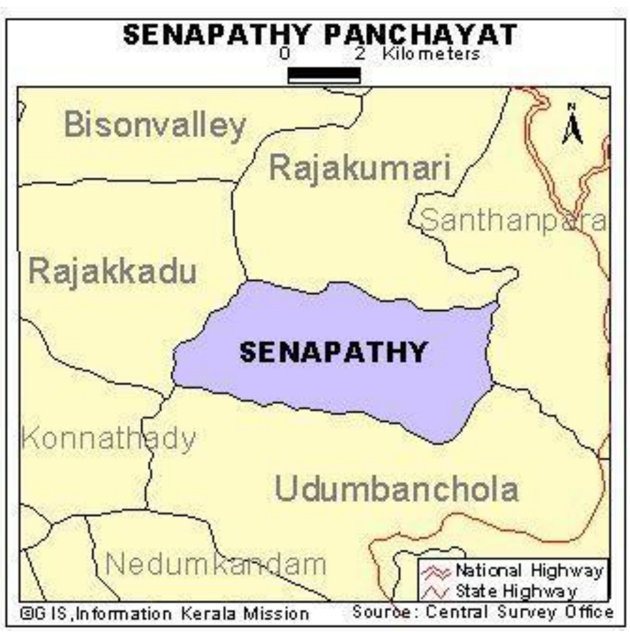

Figure 4: Political map of Senapathy Panchayat

Selection of the panchayaths for the study was made after consultation with the officials of the office of Principal Agricultural Officer of the district located at Thodupuzha. From the district, two Panchayats (Santhanpara Gramapanchayat and Senapathy Gramapanchayat) were purposively selected based on the maximum loss incurred in cardamom cultivation. Simple random sampling was used to select the samples. From the selected Panchayats twenty-five farmers each will be randomly selected and thus making the sample size as 50. The data pertaining to socio-economic parameters, land holding pattern, cropping pattern, value of damage and loss to cardamom cultivation, income particulars, cost of cultivation of cardamom in normal year, and farmer's perceptions about disasters, problems and adaptation to cropping strategies were elicited from the farmers.

Secondary data was confined to Idukki district. Idukki is the largest producer of cardamom in Kerala. Meteorological data on rainfall and temperature for the last few years was collected from Cardamom Research Station, Pampadumpara, Idukki. Data regarding area, production and productivity of cardamom in Idukki district for past 10 years from 2008 to 2018 were collected from Directorate of Economics and Statistics, Vikas Bhavan, Thiruvananthapuram.

3.2.2 Sampling frame

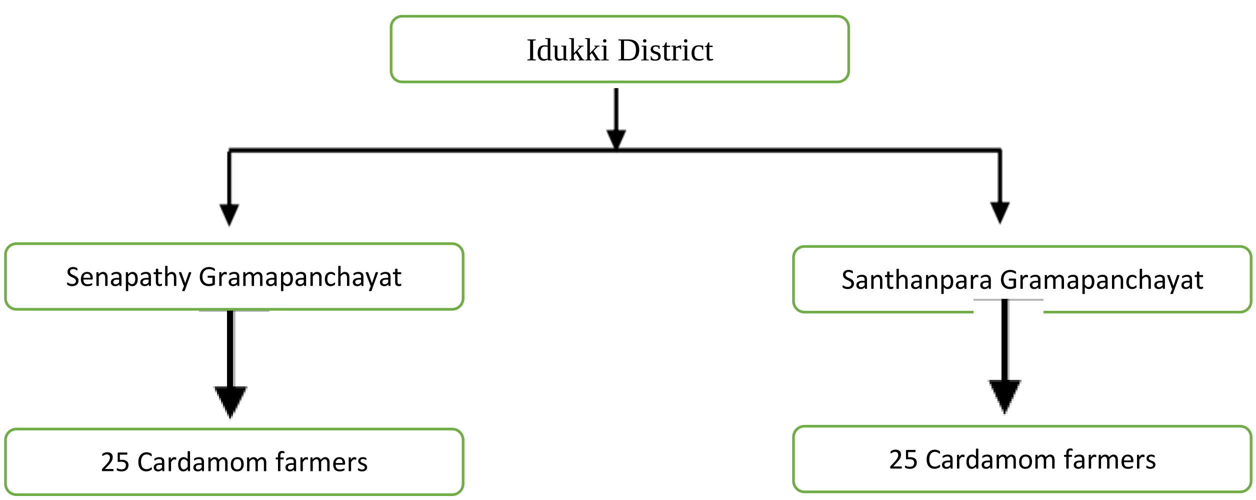

Figure 5: Sampling frame work for the study

3.2.3 Period of Study

The primary data pertains to the year 2017-18 was collected. The data collection was carried out during January to march 2020.

3.3 MAJOR OBSERVATIONS MADE

3.3.1 Socioeconomic Status of the Selected Farmers

Socio-economic characteristics of respondents such as age, educational status, gender, size of family, land ownership, annual income, annual expenses, and experience in farming were collected through structured interview schedule.

3.3.2 Quantity of Inputs

Quantity of inputs such as planting material, farm manure, poultry manure, fertilizers, insecticides, pesticides, fungicides, liming material were collected and the cost of cultivation and the annual returns were calculated.

3.3.3 Cost of Inputs

3.3.3.1. Cost of Manures, Fertilizers and Plant Protection Chemicals

The manures, fertilizers and plant protection chemicals are used in cardamom cultivation. Organic manures either purchased in bulk quantities or produced on the farm. Plant protection chemicals such as ekalux, karate, summit, metador and coragen were widely used. Liming materials and fungicides such as Bordeaux mixture, Copper Oxychloride, carbendazim were also used. These inputs are evaluated at purchase price. The organic manure produced within the farm also valued at market price. Organic manures such as cow dung, neem cake and bone meal were widely used. Farmers purchase these inputs from fertilizer shops nearby.

3.3.3.2 Cost of machinery and implements

The implements such as pump set for pesticide application and sprinklers for irrigation are used in cardamom cultivation. The cost incurred for purchase of these implements were evaluated at the market price. Use of machineries reduces the human labour to a great extent.

3.3.4 Cost of Labour

3.3.4.1 Family Labour

In majority of the farms, family members were also doing some of the farm operations So, the imputed value of family labour was calculated based on the wage rates of a hired labour in the area.

3.3.4.2 Hired Labour

Cardamom cultivation is highly laborious in nature. Men and women are equally involved in different works. Skilled workers are required for harvest in cardamom. The wages are paid to workers on a daily basis and used to calculate the hired labour cost for analysis. Trashing and harvesting are the most labour intensive and it done by women in most of the farms. Availability of labour is mainly from Tamil Nadu, North Indian states and local people. The wage rates differ among labours and average wage rate is ₹ 550 for men and ₹ 400 for women.

3.3.4.3 Machine Labour

The important machinery used for cardamom cultivation is sprayers and irrigation motors. Majority of farmers uses power sprayer. The labour cost of the hired machine was calculated on the basis of the fuel expenses, electricity charge and annual maintenance for the machine. The human labour required to operate machineries are calculated along with hired labour.

3.3.5 Cost of Adaptation Practices

In order to reduce the loss due to the extreme weather events, farmers follow various adaptation practices. Each practice requires some cost in terms of labour cost or material expenses and were calculated and summed up to get total cost of each adaptation practices

3.3.6 Land Revenue

This was taken as the actual rate paid to the Revenue Department which was ₹ 577 ha^{-1} $Year^{-1}$. It is collected from farmers.

3.3.7 Interest on Working Capital

It is common practice for farmers to take advantage of short-term loans to pay for supplies, labour and to purchase inputs in cardamom cultivation. Short term loans are availed at a rate of 7 per cent year^{-1} from credit institutions. Hence interest on working capital was computed at 7 per cent and included as an element in the cost of cultivation.

3.3.8 Interest on Fixed Capital

The present value of assets and equipment other than land constitutes fixed capital. The interest on this can be calculated as in the case of interest on working capital. It was estimated at an annual rate of 11 per cent, which is the rate of commercial bank loans for long-term loans.

3.3.9 Rental Value of the Leased in Land

It is the rent paid to the leased land. The farmers cultivate the crops throughout the year, so rental value of the leased in land was calculated as the rent paid per year.

3.3.10 Rental Value of Owned Land

It is computed by taking the rent of land prevalent in the locality

3.3.11 Harvested yield

It was the harvested yield of cardamom in disaster year.

3.3.12 Short-run expenses

It includes expenses for various works such as removal of destroyed plants, fungicide spray for diseased plants, and support for partially destroyed plants. It includes human labour and machine labour in short run maintenance.

3.4. ANALYTICAL FRAMEWORK

Appropriate statistical tools were used to analyse the collected data and draw meaningful conclusions. Tools used for analysis

3.4.1 Tabular representation of Percentages and Averages

The socio-economic characteristics of farmers, such as age, level of education, gender, family size, land tenure, annual income, have been analyzed through the use of percentages and averages.

Percentage variation is used to study the effect of extreme weather event on the farm income of cardamom farmers and percentage of adoption is used to study adaptation strategies to mitigate the loss. This is presented in tables and used for analysis.

3.4.2 Assessment of damage and loss in cardamom due to extreme weather event

FAO's methodology for damage and loss assessment in agriculture (Conforti *et al.,* 2020) is adopted in this study. This methodology can be used for studying the loss assessment in agriculture due to wide range of disasters including climate related disasters over different regions in the world. The key concepts are damage and loss which are assessed through a set of procedural and computational steps.

This assessment approach focuses mainly on damage and loss to the cardamom. From the survey it is understood that there is no production damage of stored inputs and capsules.

Cardamom plants are damaged either fully or partially due to excess heavy rain and wind. Excess rain and flooding of water around plants caused '*Azhukal*' disease and reduced the yield.

The major assumptions used for study adopted from methodology are, it assesses the damage and loss occurred to cardamom exclusively due to extreme weather event of 2018. Prices used in damage and loss assessment are farmgate price. Price of output was valued at previous year price. Assumptions regarding crop yield are yield variation and variation in harvested area assumed to be independent of each other. Crop yield is assumed to show a linear constant trend in years, prior to disaster. Assumptions regarding area of cardamom are a) fully damaged area is replanted in the same year and b) no yield until full recovery. The area harvested after the disaster is assumed to remain constant at pre-disaster levels in the counterfactual scenario of no disaster

Methodology is concentrated on damage and losses. Benefits obtained from extreme weather event are irrelevant here. All calculations are based on pre-disaster information.

3.4.2.1 Damage

It is the loss of completely destroyed crops and assets due to extreme weather event and calculated in monetary terms. It also includes the destroyed inputs and stored crop produce.

3.4.2.2 Loss

It is the difference between expected and actual value of production of crops due to extreme weather event along with the short run expenses.

3.4.2.3 Expected yield

Expected yield is the yield of cardamom that would have been harvested in the absence of extreme weather event. It is calculated as linear trend from previous years yield data. Yield of cardamom of last five years was collected and expected yield was calculated.

3.4.2.4 Reduced yield

It is the lost yield from cardamom attributed to disaster. It was calculated as the difference of expected yield and harvested yield.

3.4.2.5 Detailed computation

Model specification is given as,

$$\boldsymbol{Damage\ and\ Loss\ in\ cardamom = Production\ damage + Production\ loss}$$

3.4.2.6 Production Damage in Cardamom

Production damage in cardamom cultivation due to extreme weather event is occurred exclusively through the damage of cardamom crops. Production damage is calculated by finding the cost of replacing the completely destroyed crops.

$$\boldsymbol{Replacement\ cost\ of\ fully\ damaged\ cardamom\ = h_i * p_{t-1}}$$

The term $\boldsymbol{h_i * p_{t-1}}$ represents the replacement cost of destroyed cardamom plants expressed as the number of plants destroyed ($\boldsymbol{h_i}$) in disaster affected area valued at pre-disaster-level replanting price ($\boldsymbol{p_{t-1}}$)

3.4.2.7 Production loss in Cardamom

Production loss in cardamom occurs due to the reduced yield of crops and immediate expenses followed by extreme weather events. The sub components of production loss to cardamom is given in table 3.5.

Table 3.5: Sub components of production loss to cardamom

Sl. no	Particular	formula
1	Value of reduced yield of cardamom in affected areas	$\boldsymbol{P_{t-1} * \Delta Y_t}$
2	Short-run expenses	$\boldsymbol{P_{short-run(lumpsum)}}$

$$\boldsymbol{Production\ loss\ in\ cardamom = (P_{t-1} * \Delta Y_t) + P_{short-run}}$$

The term $\boldsymbol{P_{t-1} * \Delta Y_t}$ represents the value of crop production that has been reduced as a consequence from the weather event. In cardamom, disaster impacted the crop land partially and harvest of the crop was done after the event. So, the crop yield was reduced (ΔY_t). The overall reduction in harvest is then valued at pre-disaster price P during the time period (t-1).

The term $\boldsymbol{P_{short-run(lumpsum)}}$ captures any short-run disaster-related expenses that have been incurred by farmers in the short period after the disaster in order to maintain production activities or to restore activities to pre-disaster level. This could include activities such as hiring JCB, expenses for clearing up after landslides, short-run hire of machinery, hire of irrigation services, immediate spraying etc.

$$\boldsymbol{Damage\ and\ Loss\ in\ cardamom = Production\ damage + Production\ loss}$$

$$\boldsymbol{Damage\ and\ loss\ in\ cardamom = (h_i * p_{t-1}) + (P_{t-1} * \Delta Y_t) + P_{short-run}}$$

3.4.4 Annual maintenance cost

The cost of cultivation of cardamom was calculated as the total sum of the cost incurred in various inputs that were used in production. In this study, the cost concept was used to calculate the cost of cultivation of cardamom for the year 2017-18.

3.4.4.1 Cost Concept

The Cost A1 includes

a) Cost of hired labour
b) Cost of machine labour
c) Cost of manures, fertilizers and soil ameliorants
d) Cost of plant protection chemicals
e) Cost of irrigation
f) Land revenue
g) Depreciation on machineries and implements
h) Interest on working capital

Cost A2

Cost A1 + rent paid for leased-in land.

Cost B

Cost A2 + rental value of owned land & interest on owned fixed capital excluding land.

Cost C

Cost B + imputed value of family labour.

(CSO, 2008)

3.4.5. Returns

3.4.5.1. Gross returns

The gross returns were calculated as the total value of the products at the 2017-18 market price. Market price was the average of wholesale price over the year.

Gross returns = Quantity of product * unit price

3.4.5.2. Net returns

Net returns were obtained by deducting the total cost from gross returns.

Net returns = Gross returns- cost of cultivation

3.4.6 Benefit-Cost Ratio (BC Ratio)

It was calculated as the ratio of the total benefits to total expenditure incurred for production of cardamom.

BC ratio = Gross returns / cost of cultivation

3.4.7 Depreciation

Depreciation means decrease in the value of the asset over the period of time, due to the wear and tear. In cardamom cultivation most of the farmers are using machineries for farming. Annual depreciation on machineries of fixed capital can be worked out by using straight line method and then aggregated to get the total annual depreciation.

$$\text{Amount of depreciation} = \frac{\text{original cost of the asset} - \text{junk } value}{useful\ life\ of\ asset}$$

(Reddy *et al.*, 2016)

3.4.8 Constraint Analysis

Garrett's ranking technique was used to analyse the constraints faced by farmers in the post disaster scenario. Several constraints have been listed in different groups based on the literature, experts' suggestions and conditions prevailing in the area. They were classified into production constraints, marketing constraints and adaptation constraints. During the survey, respondents were asked to rank these constraints. These ranks were then converted to the percentage position using the formula.

Percentage position = 100 X (R_{ij} – 0.5) / N_j

Where,

R_{ij} = Rank given for i^{th} factor by j^{th} individual

N_j = No. of factors ranked by the j^{th} individual

(Garrett, 1969)

With the help of Garrett's table, the estimated percentage position becomes a Garrett score. Therefore, for each constraint, the scores of different respondents were added and the mean value was calculated. The mean scores obtained for each of the restrictions were sorted in descending order. The attribute with the highest mean value was considered to be the most important constraint.

Results and discussion

RESULTS AND DISCUSSION

The collected data were tabulated and analysed to find meaningful results. This chapter explains the findings along with discussions. The results were presented under the following sub-headings.

4.1 Cardamom production in Kerala

4.2 Extreme weather event of 2018

4.3 Socio economic profile of the respondents

4.4 Economics of cardamom cultivation

4.5 Damage and loss assessment of cardamom

4.6 Effect of loss on farm income of the respondents

4.7 Weather forecasting and crop insurance in cardamom cultivation

4.8 Adaptation strategies to mitigate the loss in cardamom cultivation

4.9 Constraints faced by the farmers in post disaster scenario.

4.1 Cardamom production in Kerala

Cardamom, known as the queen of spices is widely cultivated in the high ranges of Kerala. The climatic condition of Kerala makes it more suitable for cardamom cultivation. State- wise production details of cardamom are given in table 4.1. The three states cultivating small cardamom are Kerala, Karnataka and Tamil Nadu. Among these, 56.3 per cent of the area is cultivated in Kerala while Karnataka and Tamil Nadu own 36.2 per cent and 7.4 per cent respectively. Kerala alone accounts for 87 per cent of the total production of cardamom in India. Karnataka and Tamil Nadu together contribute to 13 per cent of production. When comparing the productivity Kerala is far ahead of other states with a productivity of 400 kg ha^{-1} while Karnataka has 57.6 kg ha^{-1} and Tamil Nadu has 172 kg
ha^{-1}.

Table 4.1: State-wise production of cardamom in India (2016-17)

Sl No.	State	Area (ha)	Production (tonnes)	Productivity (kg ha^{-1})
1	Kerala	39080 (56.3)	15650 (87)	400
2	Karnataka	25117 (36.2)	1449 (8.05)	57.6
3	Tamil Nadu	5160 (7.4)	891 (4.9)	172
	Total	69357	17990	

Source: Spices Board, 2018

Per cent to total is given in parentheses

Coming to the Kerala scenario, cardamom is mainly cultivated in Idukki and Wayanad districts. Area, production and productivity of cardamom in Kerala from 2008-09 to 2018-19 are studied. Area, production and productivity of cardamom in Kerala and Idukki are shown in Figure 4.1. 4.2 and 4.3 respectively. Idukki accounts for more than 70 per cent of cardamom cultivation in Kerala and around 90 per cent of cardamom production. The average area under cardamom cultivation is 40350.5 ha in of which 32160.5 ha is in Idukki district. The productivity of cardamom in the Idukki district is higher than that of Kerala. The average production of cardamom in Kerala is 12841.9 tonnes and in Idukki, it is 12142.7 tonnes. (GOK, 2018). The cardamom cultivated lands of Udumbanchola, Peerumade and Devikulam taulks of Idukki district are known as cardamom hills having high productivity and suitability to cardamom cultivation. The weather parameters such as precipitation and number of rainy days significantly affect the production of cardamom (Murugan *et al.*, 2000)

The area of cardamom cultivation is showing a constant trend while production is showing an increasing trend. However, there was a sudden decrease in production in the year 2018 after the extreme weather event which caused heavy rains and flooding which severely affected the agricultural production of state. The production of cardamom declined to 11535 tonnes from 18350 tonnes in Kerala and 6671 tonnes of cardamom production was lost in Idukki district. (GOK, 2019).

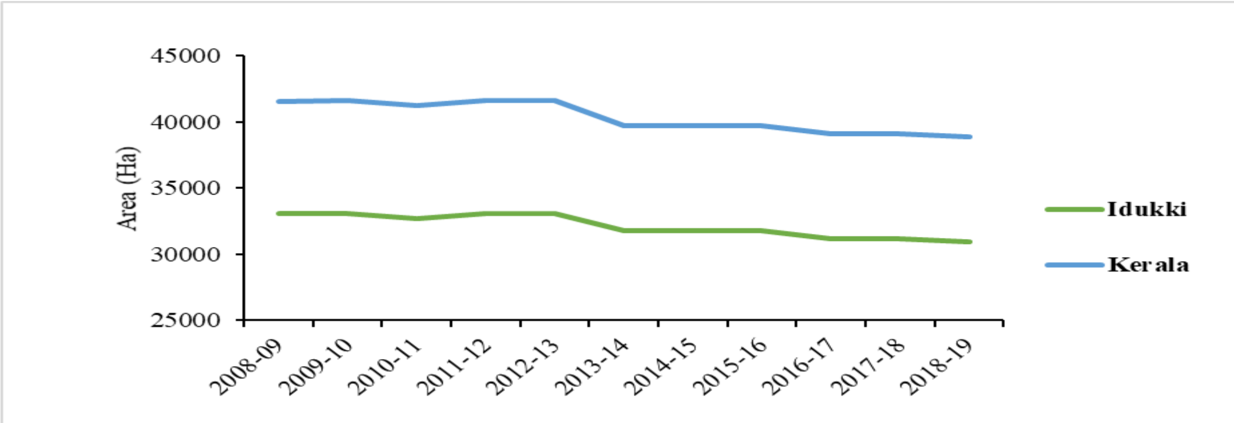

Figure.4.1 Trend in area of cardamom in Kerala and Idukki (2009-2019)

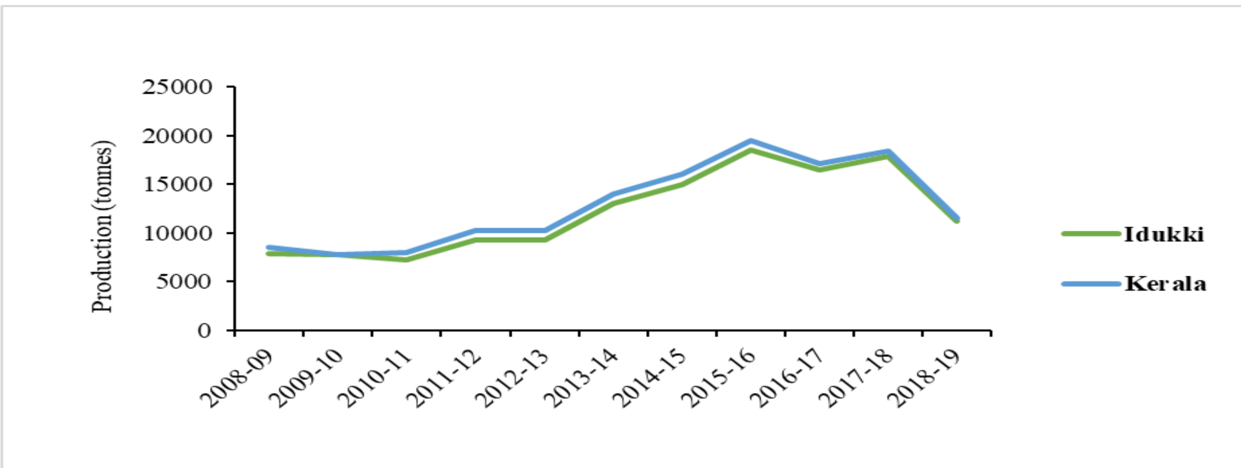

Figure 4.2 Trend in production of cardamom in Kerala and Idukki (2009-2019)

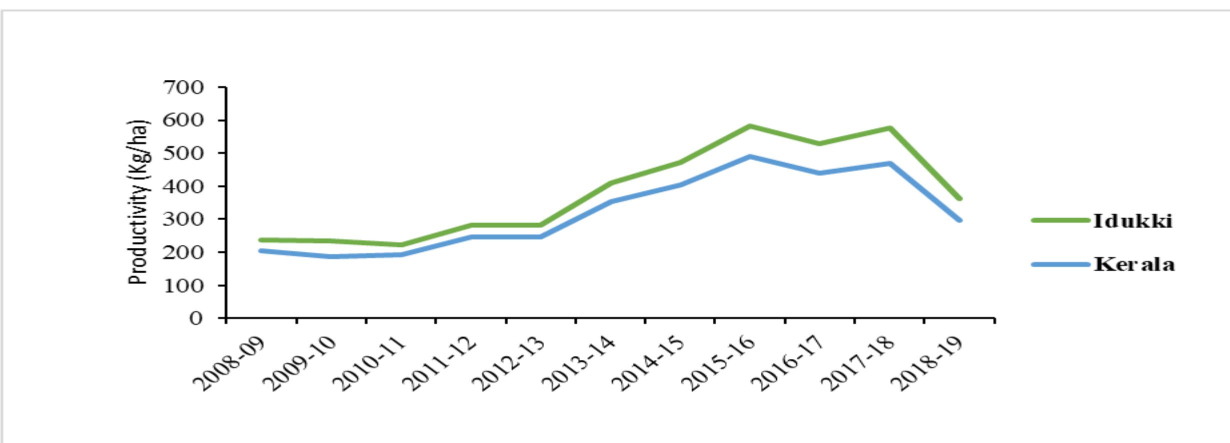

Figure 4.3: Trend in productivity of cardamom in Kerala and Idukki (2009-2019)

4.2 Extreme weather event of 2018

In 2018, Kerala recorded the heaviest monsoon rain in nearly a century resulting in flood that devastated the state. This was listed as one among the largest extreme weather events in the world between 2015 and 2019 (WMO, 2019). There were 433 human casualties and an estimated total economic loss of ₹ 31,000 crores. In August, there was continuous spell of rain which was 164 per cent above normal rainfall. Within 20 days, state received 771mm rain which led to the occurrence of landslides, mudslides in Western Ghats. Idukki was the worst affected district with a total of 143 landslides (GOK, 2018).

The largest dam in Kerala, the Idukki arch dam was opened for the first time in 26 years and along with that shutters of 35 dams were opened which added to the depth of disaster. Rain water entering the soil and rocks destabilised it, resulting in landslides. It caused damages to entire constructions, flora and fauna in its path. The topsoil was removed and trees were uprooted and most of the habitats were destroyed. The worst affected crops in Idukki were cardamom, pepper, banana, nutmeg, tubers and vegetables. The phenomena of sand piping and sand bar formation triggered the loss of biodiversity. Many cultivated areas deposited with the debris of landslides came from up hills. Due to heavy rain and flooding, plants were affected with secondary fungal infections. Removal of fertile soil and sedimentation by landslides made cropping unfavorable. This showed that the restoration of cropping into its previous condition requires many years (GOK, 2019).

Rainfall data and temperature data of Idukki district for the last 25 years were collected from Cardamom Research Station, Pampadumpara and graphically analysed in figure 4.4. In the year 2018 rainfall was 2717.30 mm which was higher than the average annual rainfall of district. The monthly rainfall of the year 2018 is depicted in figure 4.5. It shows that majority of annual rainfall precipitation were distributed over two months. As far as the distribution of rainfall is concerned, 52.57 per cent of annual rainfall was received in July and August months, which led to the extreme weather event. The continuous heavy rainfall resulted in flooding the state.

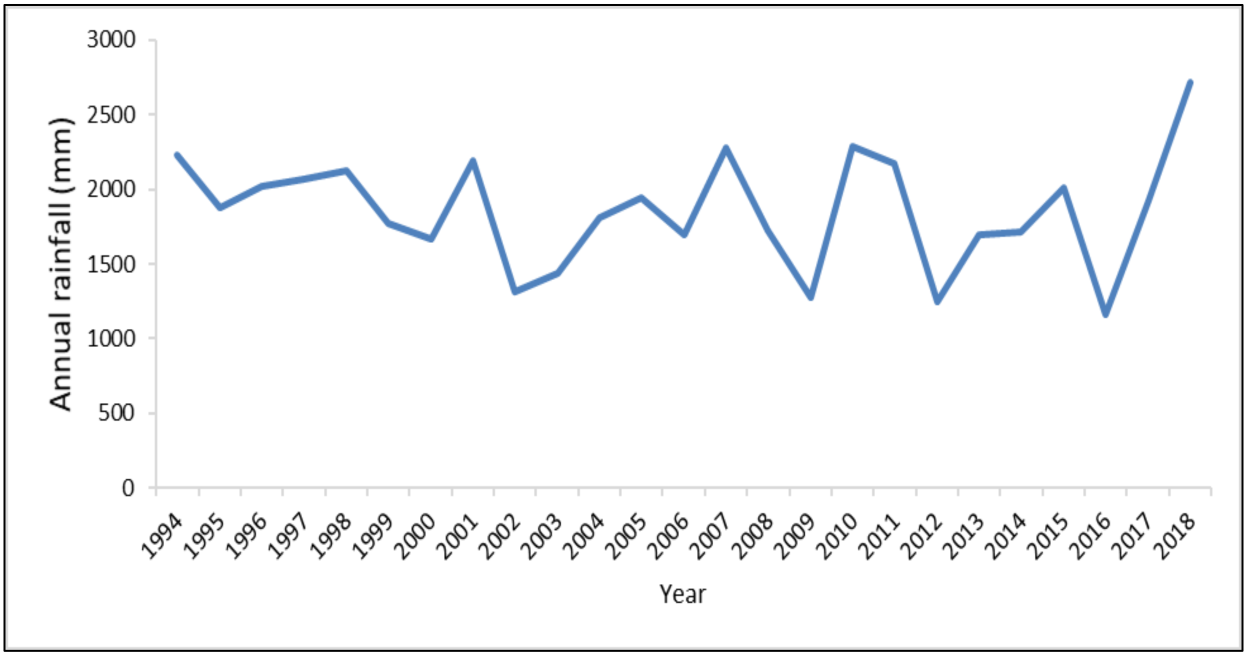

Figure 4.4: Annual rainfall of Idukki district (1994-2018)

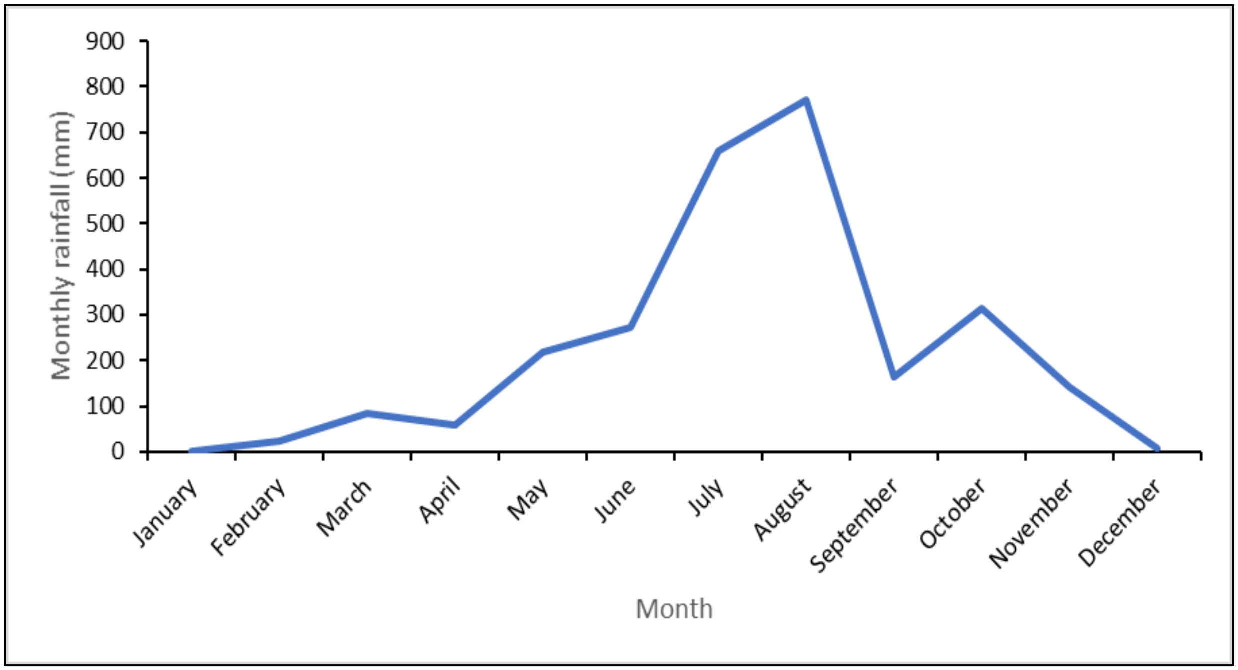

Figure 4.5: Monthly rainfall in Idukki (2018)

Primary data were collected from Santhanpara and Senapathy gramapanchyats of Idukki district with a pre-tested well-structured survey schedule. From each gramapanchayat twenty five cardamom farmers were selected and the total sample size was fifty.

4.3 Socio-economic profile of the respondents

Socio-economic profile of the selected respondents was studied and analysed. The distribution of various socio-economic characters such as the age of the respondents, gender, educational status, family size, occupational status and farming experience were collected. The results were analysed and presented under the following sub-headings.

4.3.1 Age

The respondents were classified based on age into below 40 years, 40 to 50 years, 50 to 60 years, 60 to 70 years and above 70 years (table 4.2). The average age of respondents was 53 years and 44 per cent of the respondents were belonged to the age group 50-60 years. Eight per cent belonged to below 40 years category, 13 per cent belonged to 40-50 years category, 18 per cent belonged to 60-70 years category while only 4 per cent belonged to above 70 years category.

Table 4.2 Age-wise distribution of the respondents in the study area

Sl No.	Particulars	Below 40 years	40-50 years	50-60 years	60-70 years	Above 70 years
1	No.of Respondents	4	13	22	9	2
2	Percentage to total (%)	8	26	44	18	4
	Average (years)	53				

This shows that 70 per cent of farmers were aged between 40 and 60 years. The number of farmers above 70 years is only two and below 40 years of age is only four. This shows a clear evidence of the interest of middle-aged farmers (40-60 years) in farming.

A similar kind of result was found by Kumar (2017) on the economic impact of climate change adaptations in pepper in Kerala which showed 63.75 per cent of farmers belong to the age group of 40 to 60 years.

4.3.2 Gender

The respondents were classified on the basis of gender in table 4.3 below. Study shows that out of 50 respondents 47 were male which constitutes 94 per cent of sample and remaining 6 per cent were female.

Table 4.3 Gender wise classification of the respondents

Sl No.	Particulars	No. of respondents	Percentage to total (%)
1	Male	47	94
2	Female	3	6
	Total	50	

4.3.3 Educational status

The educational status of the respondents was classified into different categories such as below secondary, secondary, higher secondary, graduation and post-graduation. It is presented in table 4.4 and 42 per cent of respondents have educational qualification of higher secondary, 40 per cent of respondents have secondary education and 12 per cent have below secondary education. Four per cent of respondents were graduates and 2 per cent have post-graduation.

Table 4.4 Educational status of the respondents

Sl No.	Particulars	No. of respondents	Percentage to total (%)
1	Below secondary	6	12
2	Secondary	20	40
3	Higher secondary	21	42
4	Graduation	2	4
5	Post-graduation	1	2
	Total	50	

This revealed that farmers are literate and the majority had basic education but, highly educated young people are not much interested in agriculture as their primary occupation. The study conducted by Maina and Maina (2012) about the engagement of youth in agriculture in Kenya also has the similar result.

4.3.4 Family size

The respondents were classified on the basis of the number of members in family (table 4.5). Forty per cent of households have 4 members followed by 5 membered households with 36 per cent. Seven households have 6 or more members. Family with 3 members and 2 or fewer members was 4 per cent each. The average family size of respondents was 4.5.

Table 4.5 Family size of the respondents in the study area

Sl No.	Family size	No. of respondents	Percentage to total (%)
1	≤2	2	4
2	3	2	4
3	4	20	40
4	5	19	38
5	≥6	7	14
	Total	50	
	Average	4.5	

The average number of family members among farmers is 4.5. The results were in consistent with the result obtained by Varghese (2012) in her study about economics of pepper cultivation in Idukki district. She found that the farming households in Idukki had average family size of 4.4.

4.3.5 Occupational status

The respondents were classified based on their primary source of income (table 4.6). Majority (92 %) of the respondents had agriculture as the main source of income without any other subsidiary sources of income. Eight percent of them were running some enterprises along with farming.

Table 4.6 Classification of the respondents based on occupation

Sl No.	Occupation	No. of respondents	Percentage to total (%)
1	Agriculture as main	46	92
2	Agriculture as a subsidiary	4	8

It shows that most of the households depend on agriculture for living since it was the major source of income.

4.3.6 Size of land holding

The respondents were classified based on the size of land holding (table 4.7). They were classified into marginal farmers (< 1 ha), small (1-2 ha) and semi- medium (≥ 2 ha) (FIB, 2019). Forty per cent of the farmers had marginal land holdings, while 38 per cent had small and 22 per cent had semi-medium land holdings.

Table 4.7: Classification of the respondents on the basis of size of land holding

Sl No.	Size of land holding	No. of respondents	Percentage to total (%)
1	Marginal (< 1 ha)	20	40
2	Small (1-1.99 ha)	19	38
3	Semi - medium (2 – 3.99 ha)	11	22
	Average	1.30 ha	

The average size of land holdings was 1.30 ha. A good number of small and marginal farmers were engaged in agriculture.

4.3.7 Farming experience

The farming experience of respondents was collected and tabulated (Table 4.8). It was classified into different categories such as less than 10 years, 10-20, 20-30, 30-40, 40-50, and above 50 years. Thirty-six per cent of respondents had an experience of 30-40 years followed by 20 per cent of farmers in the category of 20- 30 years and 40-50 years. Twelve per cent of respondents had an experience of 10 – 20 years and 10 per cent of respondents had above 50 years of experience. Remaining had less than 10 years of experience. The average farming experience of respondents was 32 years.

Table 4.8: Classification of the respondents based on farming experience

Sl No.	Farming experience (years)	No. of respondents	Percentage to total (%)
1	Less than 10	1	2

2	10-20	6	12
3	20-30	10	20
4	30-40	18	36
5	40-50	10	20
6	Above 50	5	10
	Average	32 years	

It could be observed the majority of respondent farmers had a rich experience of 30-40 years. This finding was in consistent with the results of Varghese (2012) in her study about pepper farmers in Idukki district. It revealed that, conventional farmers of the district had an average farming experience of 31 years.

4.3.8 Farming system

The farming systems followed by the farmers are given in table 4.9. Majority of them (72%) had crop production as the main enterprise without any allied activities. Twenty-eight per cent of the respondents had livestock rearing, cattle farming, poultry and goat farming along with crop production.

Table 4.9 Classification of the respondents based on the farming system

Sl No.	Particulars	Crop production only	Crop production and livestock		
			Cattle farming	poultry	Goat farming
1	No. of respondents	36	12	2	1
2	Percentage to total (%)	72	28		

4.3.9 Annual income

The respondents were classified on the basis of their annual income and tabulated under categories such as less than 1 lakh rupees, 1- 3 lakh rupees, 3-5 lakh rupees, 5- 10 lakh rupees and above 10 lakh rupees (table 4.10). Forty-six per cent of respondents had an annual income between 1 lakh to 3 lakh and 18 per cent had annual income between 3 lakhs to 5 lakhs followed by less than 1 lakh category with 16 per cent, 5 lakhs to 10 lakh annual income with 12 per cent and above 10 lakhs with 8 per cent respectively. The average annual income of respondents was 3.13 lakhs.

Table 4.10: Classification of the respondents based on annual income

Sl No.	Annual income (₹)	No. of respondents	Percentage to total (%)
1	< 1 lakh	8	16
2	1lakh - 3 lakh	23	46
3	3 lakh -5 lakh	9	18
4	5 lakh -10 lakh	6	12
5	≥10 lakh	4	8
	Average	₹ 3,13,100	

4.3.11 Area under cardamom

The respondents were classified based on the area of cardamom cultivated and presented in table 4.11. It was classified into different area groups such as less than 1 ha, 1-2 ha and greater than 2 ha. From the table 4.11, it can be seen that 50 per cent of respondents have an area less than 1 ha of cardamom cultivation. Thirty-two per cent of respondents have 1-2 ha of cardamom cultivation followed by greater than 2 ha with 18 per cent. The average area under the cardamom of respondents was 1.2 ha.

Table 4.11: Classification of the respondents based on the area under cardamom

Sl No.	Area (ha)	No. of respondents	Percentage to total (%)
1	Less than 1	25	50
2	1-2	16	32
3	Greater than 2	9	18
	Average area	1.2 ha	

The average land holding size of the farmers were found to be 1.3 ha and out of which 1.2 ha of average area was under cardamom cultivation shows that the major crop cultivated was cardamom.

4.3.12 Type of cropping

The respondents were classified on the basis of the type of cropping (table 4.12). Cropping in cardamom can be either sole cropping or intercropping with pepper. Fifty-six per cent of farmers intercropping with pepper and 44 per cent following sole cropping.

Table 4.12: Classification of respondents based on the type of cropping

Sl. No	Type of cropping	No. of respondents	Percentage to total (%)
1	Sole crop	22	44
2	Intercrop with pepper	28	56
	Total	50	

Farmers who were practiced growing pepper with cardamom used the shade trees in cardamom plantation as standards for pepper. It gave an additional income to the farmers.

4.4 Cost of cultivation of cardamom

The information on cost of cultivation of cardamom is useful for farmers for a proper understanding of expenses and returns from the crop. It also helps them to reallocate the resources and how much variation in cost is caused by alternative resources. It is worked out on a per hectare basis including all the expenses incurred in cultivation.

4.4.1 Annual maintenance cost of cardamom cultivation

Cardamom plants normally start bearing capsules from eighteen months of planting. The regular cultural operations in a cardamom plantation include activities such as weeding and trashing, shade regulation, forking of soil, application of fertilizers and plant protection chemicals, mulching and irrigation. Harvesting of cardamom capsules is carried out at an interval of 45 days. After harvest, cardamom capsules are processed (KAU, 2011). The plantations at harvesting stage were selected for study

The annual maintenance cost of cardamom for the year 2017-18 was calculated from the primary data collected. Cost A_1, cost A_2, cost B, cost C were calculated using cost concepts.

Table 4.13 Cost of cultivation of cardamom in Idukki

Sl. No.	Item	Cost (₹/ha)	Percentage to cost A1 (%)
1	Hired labour	2,04,492.50	43.21
2	Manures and fertilizers	106195.13	22.44
3	Plant protection chemicals	59816.95	12.64
3	Machine power	52,367.84	11.07
4	Soil ameliorants	13,259.65	2.80
5	Land revenue	577.00	0.12
6	Depreciation	5,564.73	1.18
7	Interest on working capital	30,959.17	6.54
	Cost A1	4,73,232.97	100.00
9	Rental value of leased in land	12,433.00	
	Cost A2	4,85,665.91	-
10	Rental value of owned land and Interest on owned fixed capital	17,4803.51	-
	Cost B	6,60,469.42	-
11	Imputed value of family labour	22,896.63	-
	Cost C	6,83,366.06	-

The cost of cultivation of cardamom is presented in table 4.13. Cost A_1 is ₹ 4,73,232.97 ha^{-1}. Nearly 43.21 per cent of this accounted for hired labour. In cardamom, labour cost is the factor responsible for the high cost of cultivation. Harvesting of cardamom is skilled work and it is done generally by women. The average green cardamom harvested by a woman is 15-20 kg/day.

Trashing and weeding of cardamom which is the process of removing the dead, dried and old leaves, panicles and shoots. It was done before the harvest of cardamom in June – July months. It helps to increase pollination and decrease the spread of diseases (KAU, 2011). Most of the small and marginal farmers were using family labour which reduces the expense on hired labour.

The operations such as forking of soil and shade regulation were done once in a year to facilitate ideal condition for growth of cardamom plants. For the growth of high yielding varieties of cardamom, 55 – 60 per cent shade was maintained. It helped increased production and reduced the pathogenicity of disease causing organisms (Murugan *et al.*, 2009). The major shade trees used in cardamom plantations were *Vernonia arborea,* and *Toona ciliate* (KAU, 2011).

Manures and fertilizers contributed 22.44 per cent of cost A_1. Different types of organic manures such as cow dung, neem cake, bone meal, ground nut cake were used in cardamom cultivation. The farmers purchase these inputs from Tamil Nadu since it is cheaper and easily available there.

The plant protection chemicals contributed 12.64 per cent of cost A_1. Cardamom is a crop which is highly prone to pest and diseases. To protect them, farmers used plant protection chemicals. Every month pesticide spray is given to protect from stem borer which is a major pest of cardamom.

Machine power accounted for 11.07 per cent of cost A_1. Every farmer had their sprayer for fertilizer and plant protection chemical applications. Fuel used was either petrol or kerosene and the use of machinery reduced labour and time to a large extent. For drying of harvested capsules, dryers were used by the farmers which accounted for ₹10 per kg of green cardamom. Soil ameliorants accounted for 2.80 per cent share of cost A_1. The soil was acidic in nature, so ameliorants such as lime were applied before the onset of monsoon according to the requirement. For land revenue, the cost was 0.12 per cent and the depreciation of assets were 1.18 per cent to cost A_1. Interest on working capital was 6.54 per cent of cost A_1. cost A_2, cost B and cost C were ₹ 4,85,665.91, ₹6,60,469.42 and ₹6,83,366.06 ha^{-1} respectively.

The cost of cultivation of Santhanpara gramapanchayat and Senapathy gramapanchayat are given in table 4.14 and 4.15 respectively. Percentage share of each component of cost A1 of Idukki, Santhanpara and Senapathy were worked out and represented in the form of pie- chart in figures 4.6,4.7 and 4.8.

Table 4.14 Cost of cultivation of cardamom in Santhanpara gramapanchayat

Sl. No.	Item	Cost (₹/ha)	Percentage to cost A1 (%)
1	Hired labour	189491.82	40.53
2	Manures and fertilizers	119474.31	25.56
3	Plant protection chemicals	58710.60	12.56
4	Machine power	52296.14	11.19
5	Soil ameliorants	10536.86	2.25
6	Land revenue	577.00	0.12
7	Depreciation	5829.02	1.25
8	Interest on working capital	30584.12	6.54
	Cost A1	467,500.00	100.00
9	Rental value of leased in land	10123.00	
	Cost A2	477,623.00	-
10	Rental value of owned land and Interest on owned fixed capital	17,4425.90	-
	Cost B	652048.90	-
11	Imputed value of family labour	22563.10	-
	Cost C	674,612	-

Table 4.15 Cost of cultivation of cardamom in Senapathy gramapanchayat

Sl. No.	Item	Cost (₹/ha)	Percentage to cost A1 (%)
1	Hired labour	219434.77	45.82
2	Manures and fertilizers	92967.66	19.41
3	Plant protection chemicals	60918.98	12.70
4	Machine power	52439.25	10.95

5	Soil ameliorants	15971.84	3.33
6	Land revenue	577.00	0.12
7	Depreciation	5301.46	1.11
8	Interest on working capital	31332.75	6.54
	Cost A1	478,944.00	100.00
9	Rental value of leased in land	14734.00	
	Cost A2	493,678.00	-
10	Rental value of owned land and Interest on owned fixed capital	175179.15	-
	Cost B	668857.15	-
11	Imputed value of family labour	23228.85	-
	Cost C	692,086	-

The cost incurred for hired labour in Santhanpara gramapanchayat is less than that of Senapathy gramapanchayat. This was mainly due to the prevailing low labour cost in Santhanpara gramapanchayat. The labour cost varied among labours of native and northern states of India.

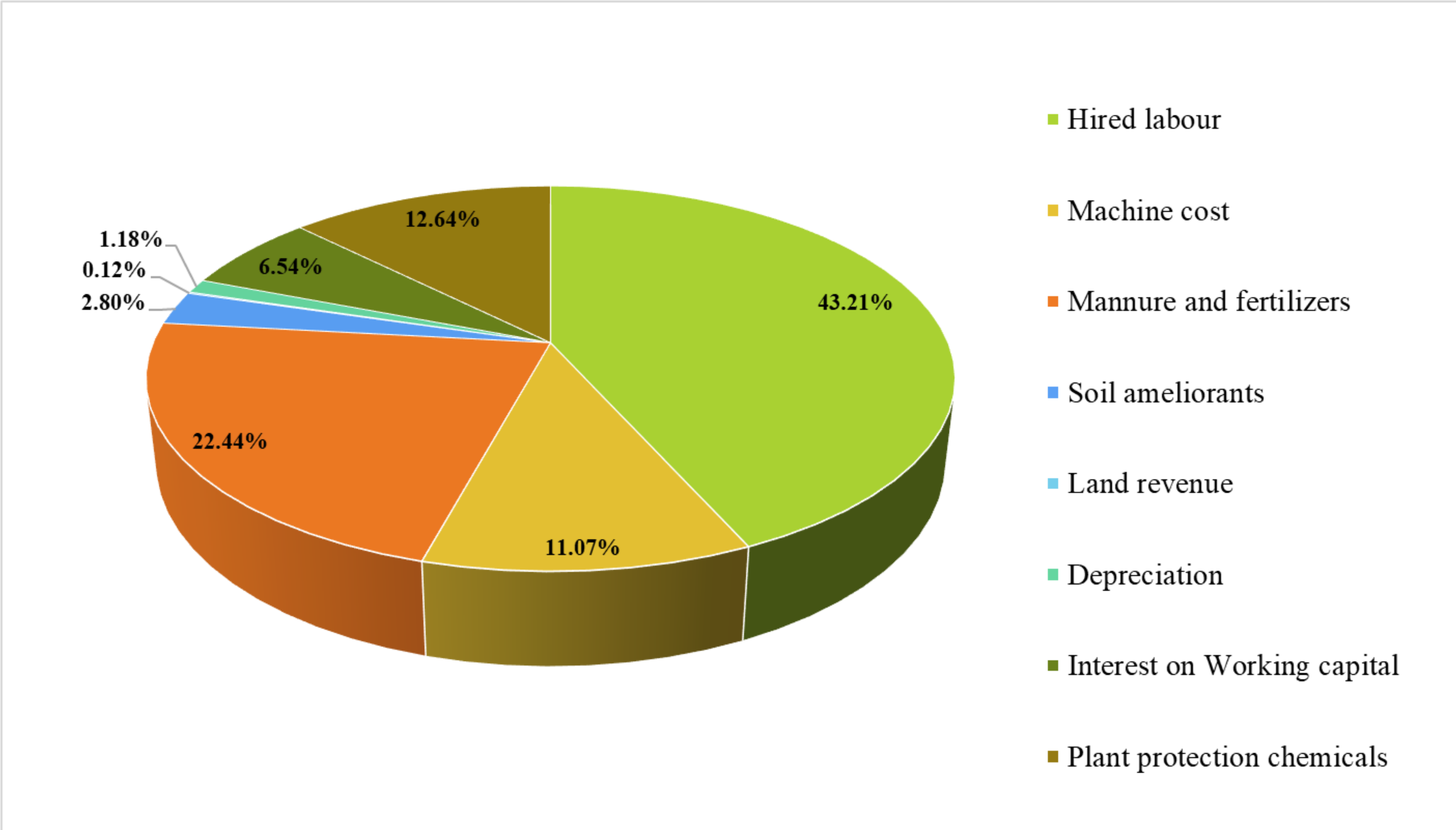

Figure 4.6: Percentage share of each component to cost A_1- Idukki district

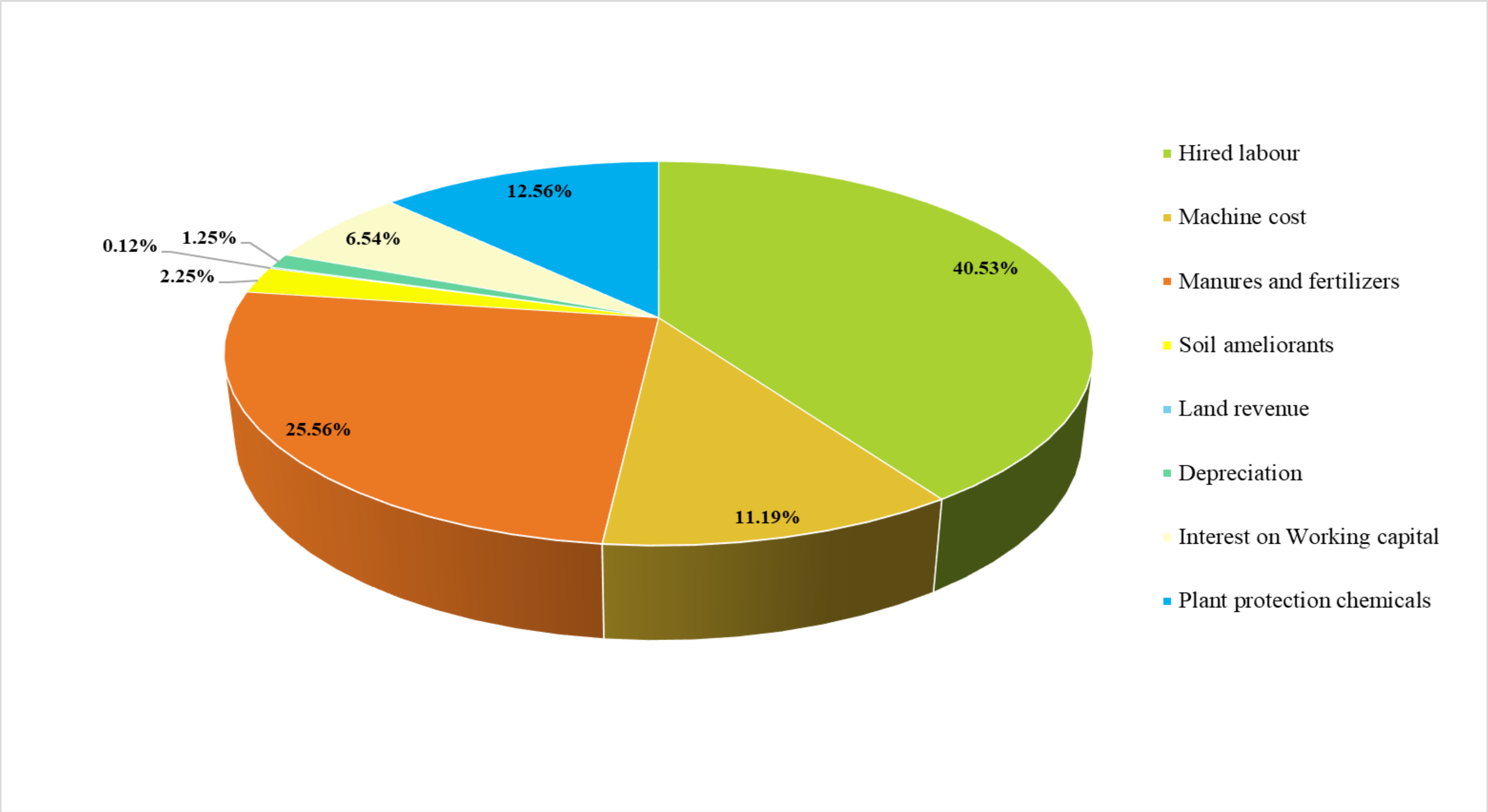

Figure 4.7: Percentage share of each component to cost A_1 - Santhanpara gramapanchayat

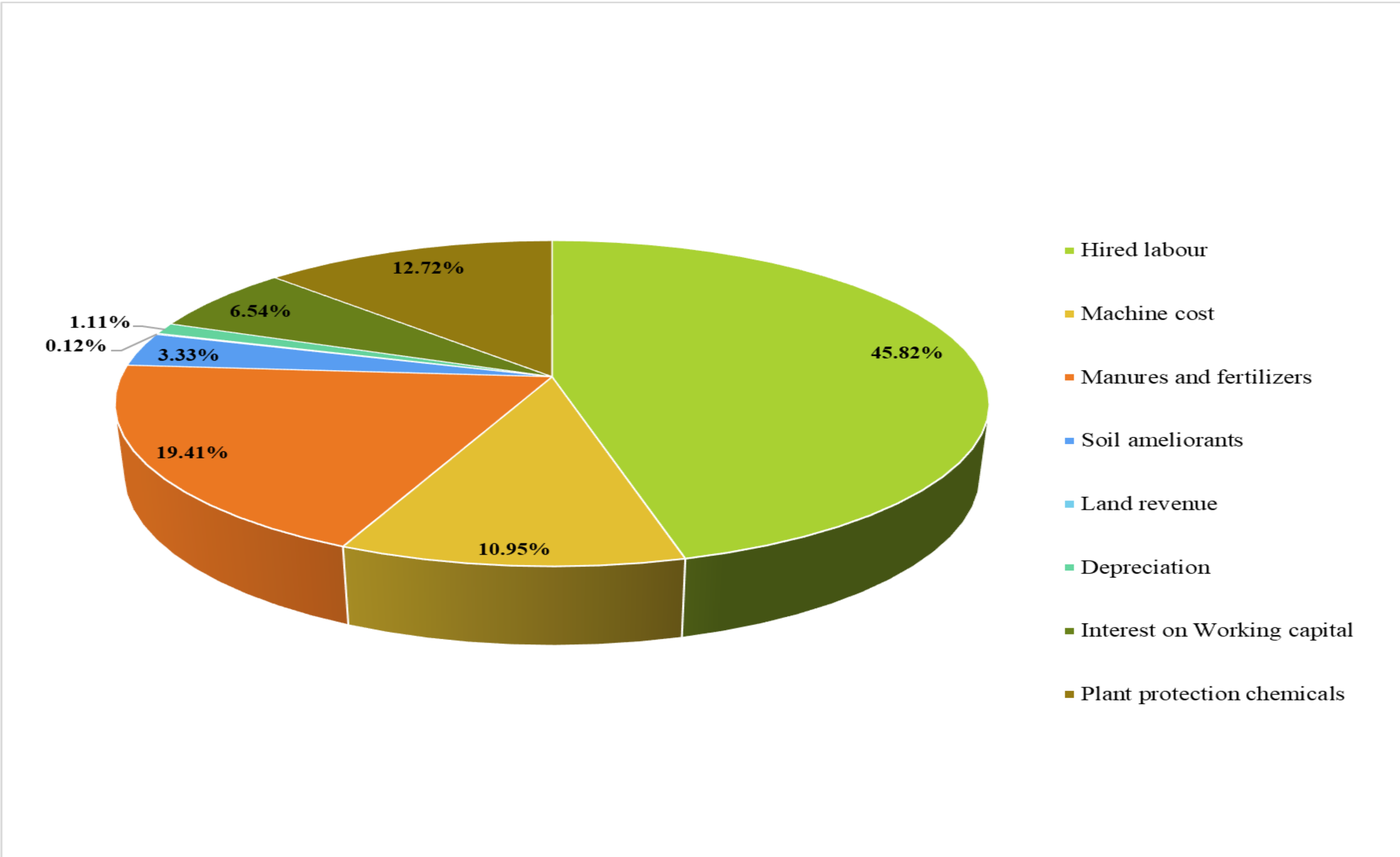

Figure 4.8: Percentage share of each component to cost A_1- Senapathy gramapanchayat

This result is in line with cost of cultivation of small cardamom from Spices Board (2015) which revealed that the major cost involved in cardamom cultivation was labour cost followed by cost of inputs. The results are also in conformity with the Cost of cultivation of cardamom published by the Government of Kerala in which the percentage distribution of hired labour to cost A_1 was 41.29 per cent. (GOK, 2018)

4.4.2 Net Returns

Net returns is a tool used to analyse the profit of crop cultivation. It is calculated as the difference between returns and costs. The average yield per ha was calculated as 895.34 kg and the average price of processed cardamom for the year 2017 was ₹ 982.45 /kg (GOI, 2019). It is presented in table 4.16

Table 4.16: Net returns of cardamom cultivation per hectare

Sl No.	Particulars	Value		
		Santhanpara gramapanchayat	Senapathy gramapanchayat	Average
1	Yield (kg/ha)	883.13	907.51	895.34
2	Price (₹/kg)	982.45	982.45	982.45
3	Gross returns(₹/ha)	867434.21	891583.62	8,79,632.28
4	Net returns at Cost A_1(₹/ha)	400134.00	412640.00	4,06,399.31
5	Net returns at Cost A_2(₹/ha)	390011.00	397906.00	3,93,966.40
6	Net returns at Cost B(₹/ha)	215585.31	222726.47	2,19,162.86
7	Net returns at Cost C(₹/ha)	193022.00	199498.00	1,96,266.22

The gross returns were ₹8,79,632.28 ha^{-1}. Net returns at Cost A_1, Cost A_2, cost B and Cost C is ₹ 4,06399.31, ₹393966.40, ₹ 219162.86 and ₹ 1,96266.22 respectively. Net returns of Santhanpara and Senapathy gramapanchayats were calculated and it was the higher in Senapathy gramapanchayat as in case of cost of cultivation. The graphical comparison of cost of cultivation and net returns of Santhanpara and Senapathy gramapanchayts to total is given in figures 4.9, 4.10 respectively.

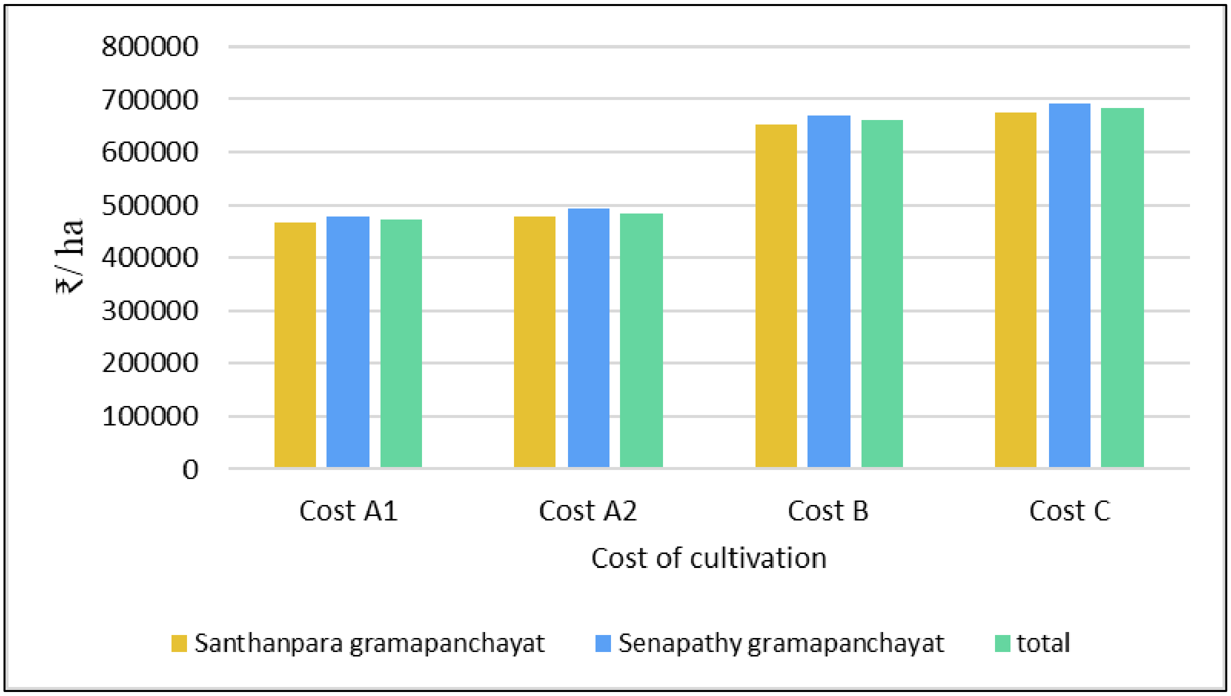

Figure 4.9: Cost of cultivation of cardamom in the study area

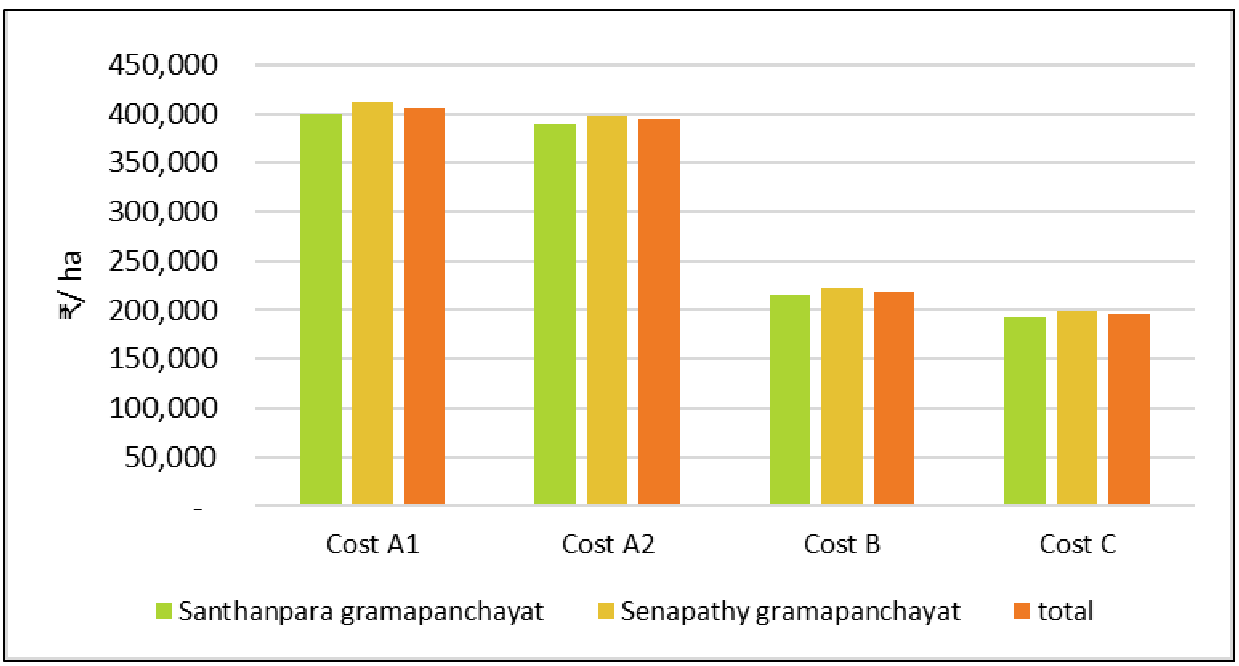

Figure 4.10: Net returns from cardamom cultivation in the study area

4.4.3 Benefit – Cost ratio

Benefit – Cost ratio is the analysis tool which determines the efficiency of cardamom cultivation. It is presented in table 4.17.

Table 4.17 Benefit cost ratio of cardamom in the study area

Sl No	Particulars	B:C Ratio		
		Santhanpara gramapanchayat	Senapathy gramapanchayat	Average
1	BCR at cost A1	1.86	1.86	1.86
2	BCR at Cost A2	1.82	1.81	1.81
3	BCR at Cost B	1.33	1.33	1.33
4	BCR at Cost C	1.29	1.29	1.29

B:C ratio at Cost A1, Cost A2, Cost B and Cost C were 1.86, 1.81, 1.33 and 1.29 respectively. The value was greater than 1 and hence cardamom cultivation is profitable at Cost C. There was not much difference among the two gramapanchayats.

4.5 Damage and loss assessment of cardamom

During the year 2018, there was unprecedented heavy rainfall and the state received 42 per cent more rainfall than usual from 1st June to August 18, 2018 (GOK, 2019). The majority of Idukki district lies in Western Ghats with hilly terrain. The anthropogenic activities over the years had considerably damaged this fragile ecosystem. The heavy rainfall during 2018 had resulted in severe landslides and erosion causing the death of several people and considerable damage to dwellings and the crops cultivated. The topsoil of the affected fields was washed away and the fields were filled with debris

Cardamom is highly prone to *azhukal* disease caused by *Phytophthora sp.* which affects shoots, capsules, leaves and panicles. Infected capsules become brown in colour due to decay and prolonged water logging in the soil (KAU, 2011). Most of the cardamom plantations were completely or partially destroyed. The farmers suffered severe loss and damages. In this context, the present study attempted to assess the loss and damage to the crop due to the extreme weather event in 2018.

The completely destroyed crops were to be replanted and the partially destroyed crops suffered from yield loss. Farmers had borne short run expenses to continue proper cultivation. The study employed the loss assessment methodology of Conforti *et al.* (2020).

Table 4.18: Yield of cardamom per hectare in 2018 in the study area

Sl No	Particulars	Yield (kg/ha)		
		Santhanpara gramapanchayat	Senapathy gramapanchayat	Average
1	Expected yield	901.21	889.57	895.38
2	Harvested yield	496.96 (55.14)	539.95 (60.69)	518.49 (57.91)
3	Reduced yield	404.25 (44.86)	349.61 (39.30)	376.88 (42.09)

Per cent to expected yield is given in parentheses

Expected yield is the yield of cardamom that should be harvested in the absence of extreme weather event. It was calculated as linear trend from previous five years yield data. The harvested yield was the yield of cardamom in disaster year. Harvested yield data was collected from farmers. The loss in yield due to the complete and partial destruction of plants was the reduced yield and it was calculated as the difference between the expected yield and the harvested yield (Conforti *et al.,* 2020). It is given in table 4.18. There was a huge loss of 404.25 kg/ ha of cardamom in Santhanpara gramapanchayat and 349.61 kg/ha in Senapathy gramapanchayat to an expected yield of 901.21 kg/ha and 889.57 kg/ha cardamom respectively. It was revealed that due to extreme weather event 42.09 per cent of expected yield was lost to farmers and only 518.49 kg/ha of cardamom was the harvested yield.

The results are in line with the study of Gopakumar (2011) on the relationship between climate variability and crops of Kerala which showed reduction in the yield of cardamom due to heavy rainfall incidence.

In monetary terms, the damage and loss were tabulated in table 4.19. For the completely destroyed plantation, the cost of replanting and destroyed yield were estimated and used as a proxy for damage. For the partially destroyed standing crops, the reduced yield was assessed.

Table 4.19: Damage and loss of cardamom in monetary terms in Idukki district

Sl No	Particulars	Value (₹ lakhs)		
		Santhanpara gramapanchayat	Senapathy gramapanchayat	Total
1	Observed area of cardamom	28.64 ha	28.76 ha	57.41 ha
2	Replacement cost	5.90 (4.43)	6.79 (5.77)	12.7 (5.06)
3	Loss due to reduced yield	113.72 (85.36)	98.74 (83.88)	212.46 (84.67)
4	Short run expenses	13.58 (10.19)	12.17 (10.34)	25.75 (10.26)
5	Total loss	133.21	117.71	250.92
6	Loss per ha (₹/ha)	4.65	4.09	4.37
7	Loss per farmer (₹/ farmer)	5.32	4.71	5.02
8	Total area of cardamom in Idukki		31166 ha	
9	Total loss of cardamom in Idukki (₹ crores)		1,362	

Note: Per cent to total loss is given in parentheses

The total loss that occurred to these farmers was ₹ 2.50 crores. Out of which 84.67 per cent was due to the yield loss. Short run expenses and replacement costs were 10.26 per cent and 5.06 per cent respectively.

In Santhanpara gramapanchayat 85.36 per cent of total loss was due to the loss from reduced yield. They had also spent ₹ 5.90 lakhs to replace the destroyed crops whereas 83.88 per cent of total loss in Senapathy gramapanchayt accounted for loss from reduced yield and ₹ 6.79 lakhs were spent on replanting. The short run expenses of farmers in Santhanpara gramapanchayat and Senapathy gramapanchayat were ₹ 13.58 lakhs and ₹ 12.17 lakhs respectively.

An attempt was made to estimate the effect of extreme weather event in the district based on the loss computed for the respondents in the study area. The loss incurred per hectare in cardamom was ₹ 4.37 lakhs and loss accounted per farmer was ₹ 5.02 lakhs. There was a total of 31166 ha of cardamom in Idukki district. (GOK, 2019) The disaster loss per hectare was attributed to total area of cardamom in Idukki district, it was a whopping sum of around ₹1362 crores.

Similar studies were carried out by the government of Kerala (2019) using Post Disaster Needs Assessment (PDNA) methodology about extreme weather event on whole agricultural sector and reveled that it was affected badly. The damage and loss happened to crops all over the state was estimated to be ₹ 6280.70 crores and recovery needs were ₹ 4193.50 crores.

In addition to this an impact study was carried out by IISR Kozhikode (2018) on spices due to extreme weather event having a similar result. They found that the crop loss of cardamom across 15655 ha of area was 6600 tonnes valued at ₹ 6795 million. This contributed to 38.50 per cent of total loss to spice crops in extreme weather event.

4.6 Effect on the farm income of the respondents

The principal source of income for all the respondents was agriculture and a large proportion of farm income was contributed by cardamom. Most of the farmers were practicing intercropping pepper with cardamom. Crops such as coffee, nutmeg, clove and cocoa were also cultivated by farmers. Livestock and poultry rearing were another source of income to the farmers.

Table 4.20: Distribution of total farm income in 2017-18 of the respondents

Sl No.	Particulars	Value (₹)		
		Santhanpara gramapanchayat	Senapathy gramapanchayat	Total respondents
1	Cardamom	2,48,44,600 (87.64)	2,56,30,200 (92.6)	5,04,74,800 (90.10)
2	Other crops	26,76,500 (9.44)	16,13,000 (5.82)	42,89,500 (7.66)
3	Livestock	8,27,000 (2.91)	4,29,000 (1.55)	12,56,000 (2.24)
4	Total farm income	2,83,48,100	2,76,72,200	5,60,20,300

Note: Per cent to total farm income is given in parentheses

The extreme weather event resulted in outbreak of diseases. This has led to crop loss and yield reduction from cardamom which reflected in the farm income of respondents. The distribution of the total farm income of the respondents during previous year is shown in table 4.20. Cardamom contributed to more than 90 per cent of farm income whereas other crops and livestock contributed to 7.66 per cent and 2.24 per cent respectively.

The income from cardamom of all respondents in Santhanpara gramapanchayat and Senapathy gramapanchayath in 2017-18 was ₹ 2.4 crores and ₹ 2.5 crores respectively which formed a total of ₹ 5.04 crores. The total farm income from cardamom during disaster year was ₹ 2.92 crores. The loss of farm income from cardamom was presented in table 4.21.

Table 4.21: Loss in farm income from cardamom due to extreme weather event in study area

Sl No	Particulars	Santhanpara gramapanchayat	Senapathy gramapanchayat	Total
1	Previous year farm income from cardamom (₹)	2,48,44,600	256,30,200	5,04,74,800
2	Farm income from cardamom during disaster year (₹)	1,39,80,734	1,52,49,478	2,92,30,212
3	Loss of farm income due to disaster (₹)	1,08,63,866	1,03,80,722	2,12,44,588
4	Percentage reduction in farm income from cardamom	43.72 %	40.50 %	42.08 %

After the incidence of extreme weather event, farmers faced 42.08 per cent of reduction in farm income from cardamom. The income from cardamom in 2017-18 was ₹ 5.04 crores, whereas the disaster reduced it to ₹ 2.92 crores in the following year. Loss of farm income of cardamom accounted for ₹1.08 crores in Santhanpara gramapanchayat and ₹1.03 crores in Senapathy gramapanchayat. The per cent reduction in income from cardamom in both the panchayats was 43.72 and 40.50 respectively.

Studies were conducted by Roy and Hirway (2007) on the impact of drought on agriculture and the study by Israel *et al.* (2012) regarding the impact of natural disasters on agriculture in Philippines share similar results. Their studies reveal that the income of households reduced by more than 50 per cent in disaster year compared to normal years.

4.7 Weather forecasting and crop insurance in cardamom cultivation

Weather plays an important role in determining the success of agricultural activities**.** Cardamom is highly dependent on weather conditions prevailing in cardamom hills. In earlier times there was limited access to detailed weather forecast. However, the growth in technology carried out weather predictions to advanced levels resulted in more accurate predictions and increased the reliability of forecast.

Table 4.22: Access and sources of weather forecasting to the respondents

Sl. No	Particulars	Percentage of respondents		
1	Timely reception of extreme weather event forecast	Yes (60 %)		No (40%)
2	Use of weather information in farming activities	Yes (96 %)		No (4%)
3	Sources of weather information	Mobile App (72 %)	TV/ Newspaper (20 %)	Own experience (12 %)

Sources of weather information was collected from farmers during the survey (table 4.22). When the extreme weather event occurred, people did not realize the gravity of the catastrophe in advance. They felt like a heavy monsoon season since most of them received a heavy rainfall warning. Even though a weather warning regarding heavy rains was issued a few days before, there was nothing special farmers could do to protect crops in such a short span of time. Even with a proper warning, the measures that could be adopted in a short period was limited. Proper following of weather updates by majority of the respondents showed the importance of weather in cardamom cultivation. The sources varied from mobile applications, television, newspaper and their own experience in farming according to their access to resources.

4.7.1 Crop insurance and natural calamity assistance

Through crop insurance scheme, natural calamity affected cardamom plantations received an assistance of ₹ 60,000/ha. Natural calamity assistance was given by the government of Kerala through Krishi Bhavans and farmers suffered crop loss were received a compensation of ₹ 25,000/ha. Farmers have to submit the request for natural calamity assistance through Krishi Bhavan in order to avail compensation. The details of crop insurance against natural calamities and natural calamity assistance were collected from farmers. (table 4.23)

Table 4.23: Crop insurance and natural calamity assistance received by the respondents

Sl. No	Particulars	Percentage of respondents	
1	Insured cardamom plants against natural calamities	Insured (nil)	Not insured (100 %)
2	Farmers received natural calamity assistance	Yes (66 %)	No (34 %)

One of the most important observations was that none of the farmers insured their crops against natural calamities. The primary reason was the lack of awareness about crop insurance scheme against natural calamities. Other reason was the minimum requirement of an area of 1 ha productive cardamom cultivation which limited the access to crop insurance by marginal farmers. About 66 per cent of farmers received natural calamity assistance through Krishi Bhavan.

4.8. Adaptation strategies to mitigate loss in cardamom cultivation

Adaptation strategies were followed by farmers in order to reduce the vulnerability to extreme weather events. Adaptation strategies were studied based on farmers perception and their response to disaster. The adoption of different strategies followed in cardamom cultivation by the farmers are given in table 4.24.

Table 4.24. Adaptation strategies followed by respondents in study area

Sl No	Adaptation strategies	No. of farmers	Percentage (%)
1	Prophylactic spraying of fungicide	31	62
2	Mulching	10	20
3	Cultivation of different varieties	4	8
4	Construction of shallow ditches	8	16
5	No adaptation	11	22

About 62 per cent of the farmers practised prophylactic spraying of fungicide as an adaptation strategy. It was interesting to note that around 22 per cent of farmers did not follow any adaptation strategy. The adoption of strategies may differ based on different factors such as its effectiveness, cost of adaptation and resource allocation. The different adaptation strategies followed by respondents are discussed below.

4.8.1 Prophylactic spraying of fungicide

The occurrance of *azhukal* disease after heavy rain is prevalent in cardamom cultivation. This is a fungal disease caused by *phytophthora sp.*. It affects the different plant parts such as leaves, shoots, panicle and capsules of cardamom (KAU,2011). Farmers used fungicides such as Bordeaux Mixture or Copper Oxychloride before rains which helped in preventing the incidence of *azhukal* disease. Some farmers followed 2 or 3 prophylactic sprays to protect the standing crop. The cost for one round of spray was approximately ₹ 8000 / ha. Plants that are more prone to disease were protected with selective spraying of fungicides. The major factors determining the number of sprays were the cost of spraying and the vulnerability of plants to diseases. Around 62 per cent of farmers did prophylactic spraying of fungicides to protect their crops.

4.8.2 Mulching

Farmers practised mulching around cardamom plants to reduce the effect of heavy rain and soil run-off. Mulching was practised by farmers to prevent top soil erosion due to heavy rain and they used leaves, straw, hay, shredded plant parts as mulch. Mulching prevents weed growth and also helps to hold moisture which is good for cardamom. Twenty per cent of farmers mulched their cardamom fields. The cost of mulching was about ₹ 4000/ ha.

4.8.3 Cultivation of different varieties

The most commonly cultivated variety of cardamom in Idukki is *Njallani*. It is a high yielding variety in cardamom hills. Since the variety is more prone to *azhukal* disease some farmers were cultivating other varieties of cardamom along with *Njallani* to reduce disease occurrence. Other varieties of cardamom cultivated were *Thiruthali* and *Pavizhakodi* by a few farmers, only about 8 per cent. The majority of farmers prefer *Njallani* over other varieties due to its high yield and high grade of capsules. The average cost of a planting material was ₹70-100.

4.8.4 Construction of shallow ditches

The construction of shallow ditches along the sloppy and low-lying areas acts as a channel for water flow. It reduced the stagnation of water in the field. It was cost effective and around 16 per cent of farmers adopted this method. The labour cost involved in this method was about ₹ 3000/ ha.

4.8.5 Risk management strategies

Risk is an important element in agriculture. Uncertainties in weather, yield and prices affect farming and can result in ample variation in farm income. Risk management is about choosing alternatives that reduce the financial losses that may result due to such uncertainties. Major source of income of the respondents was cardamom during the time of extreme weather event. After the extreme weather events, farmers had thought more about the risk and uncertainty of depending on cardamom alone. Farmers were practising farm diversification as risk management strategy (table 4.25).

Table 4.25: Risk management strategies followed by the cardamom farmers of the study area

Sl No	Risk aversion strategies	No. of farmers	Percentage (%)
1	Crop diversification	26	52
2	Livestock rearing	14	28
3	Aquaculture	4	8
4	Migration	8	16

From the survey, it could be seen that crop diversification was practiced by 52 per cent of the farmers. The cultivation of pepper, coffee, cocoa, nutmeg and other crops along with cardamom were practised by farmers and around 28 per cent of farmers were rearing livestock along with cardamom cultivation. Nearly 8 per cent of farmers had turned to aquaculture as an alternative source of income. Another risk aversion strategy was migration. The young generation of family were moving out to cities or to abroad in search of job which gave a secure source of income.

Similar results were reported by study of Patel *et al.*, (2019) regarding coping mechanisms in flood affected paddy farmers in Odisha.

4.9 Constraints faced by the farmers in post disaster scenario

The study investigated the problems faced by farmers of cardamom cultivation in the post disaster scenario. The constraints faced by the farmers were classified into three categories such as production constraints, marketing constraints and adaptation constraints. The important constraints were collected from the farmers. These constraints were ranked using Garrett's ranking technique.

4.9.1 Production constraints

Constraints for production of cardamom faced by farmers were the variation in rainfall, pest and diseases, high cost of plant protection chemicals, high labour cost, shortage of labour, cost of replanting and availability of planting material with quality. These constraints were ranked by farmers according to the extent of difficulty they face and analysed using the Garrett ranking technique (table 4.26). The high cost of plant protection chemical was the major constraint faced by the cardamom farmers with a Garrett score of 70.02 followed by high incidence of pests and diseases (64.24).

Table 4.26: Production constraints faced by the cardamom farmers of the study area

Sl. No	Constraint	Garrett's score	Rank
1	High cost of plant protection chemicals	70.02	I
2	High incidence of pest and disease	64.24	II
3	High labour cost	60.28	III
4	Variation in rainfall	52.28	IV
5	Labour shortage	44.36	V
6	High cost of replanting	34.74	VI
7	Less availability of quality planting material	23.08	VII

High cost of plant protection chemicals was the major problem faced by cardamom farmers. Pesticides were mainly used to control stem borer in cardamom plants. The steady increase in prices of plant protection chemicals without a simultaneous increase in cardamom price was adding more to the burden of farmers.

The incidence of pest attacks and diseases were increased in the area. Diseases such as fusarium wilt, rhizome rot, *azhukal* and mosaic can be seen in cardamom plants. Major pests were stem borer and thrips. Farmers faced difficulty in identifying the pests and diseases in early stages and in turn, this was contributing more to the losses.

The other constraints faced by the farmers were high labour cost (60.28) variation in rainfall (52.28), shortage of labour (44.36), high cost of replanting (34.74) and availability of quality planting material (23.08).

Cardamom cultivation is highly laborious and harvesting requires skilled labour. Less availability and high labour wage demanded by local workers have forced the farmers to bring cheaper workers from Tamil Nadu and other states. There was a sharp increase in labour cost and a decrease in working time in post disaster period.

Variation in rainfall and changes in weather patterns severely affected farming practices and plants were more prone to drying in summer. To reduce the intensity of summer, farmers were giving irrigation from February to May and also providing shade nets to the crops.

Planting material should be of good quality and disease free. It is usually uprooted from existing mother plants. Hence the availability of planting material was the least important constraint faced by farmers.

4.9.2 Marketing constraints

The marketing constraints faced by farmers were anlaysed using Garrett's ranking and presented in table 4.27. The major constraints were high transportation cost, delay in payment of sale proceeds, fluctuation in market price, lack of storage facilities, and unorganized marketing channels.

Table 4.27: Marketing constraints faced by the cardamom farmers of the study area

Sl. No	Constraint	Garrett's score	Rank
1	Fluctuation in the market price	75	I
2	Delay in payment of sale proceeds	52.2	II
3	Lack of storage facilities	41.2	III
4	High transportation cost	40.9	IV
5	Unorganized marketing channel	40.7	V

The data revealed that fluctuation in market price was ranked first by respondents and thus considered as primary marketing constraint. Delay in payment of sale proceeds ranked at second position while lack of storage facilities was ranked at third place in the order of constraints. The fourth rank was assigned to high transportation cost followed by unorganized marketing channel at fifth rank.

The price of cardamom increased from ₹1000 kg^{-1} to 4000 kg^{-1} within a year of disaster and this fluctuation in price affected the marketing of cardamom. Farmers were unable to make decisions based on price and there was no guaranteed sale price for cardamom.

The marketing of cardamom in Idukki district is mainly through auction centres. Auction fetches a higher price than local markets but the problem faced by farmers was the delay of about 20 days for the payment of sale proceeds. It forced the farmer to sell the produce in local markets to meet the urgent needs.

Lack of proper storage facilities for keeping cardamom free from moisture was another constraint faced by farmers. Degradation in the quality of capsules can occur if it is not properly stored. Farmers were using a plastic bag inside gunny bags to keep it airtight. But once it is opened quality gets deteriorated.

The transportation cost of taking produce to auction centers was another constraint faced by farmers. Cardamom fetches highest price in auction and market price was calculated as the average price of the auction. The small farmers found it difficult to take their produce to auction centres and so they sell their produce to the local markets.

4.9.3. Adaptation constraints

Adaptation strategies were followed by the farmers inorder to mitigate the post flood disasters**.** The adaptation constraints faced by farmers were anlaysed using Garrett's ranking and presented in table 4.28. The major adaptation constraint faced by the farmers were high cost of adaptation, lack of disease resistant varieties of cardamom, lack of knowledge about adaptation, difficulty in availing credit and lack of practical training on adaptation practices.

Table 4.28: Adaptation constraints faced by the cardamom farmers of the study area

Sl. No	Constraint	Garrett's score	Rank
1	Lack of knowledge about adaptation	63.22	I
2	Lack of disease resistant varieties	60.5	II

3	High cost of adaptation practices	46.6	III
4	Difficulty in availing credit	46.5	IV
5	Absence of practical training on adaptation practices	33.2	V

The major barriers to adaptation among respondents were ranked and lack of knowledge about adaptation practices was ranked first. Second rank is attributed to 'lack of disease resistant varieties' and 'high cost of adaptation practices' at third position. 'Difficulty in availing credit and absence of practical training on adaptation practices' were secured fourth and fifth ranks respectively.

Most of the farmers pointed out that 'lack of knowledge about adaptation practices' was the major constraint faced by them. 'Lack of disease resistant high yielding varieties of cardamom' is another major constraint faced by farmers. Every year they have to spend a large quantity of inputs for plant protection activities. The high cost of adaptation practices cannot be afforded by most of the marginal farmers.

The findings of Chetan (2011) regarding the constraints faced by cardamom farmers shares results having similarity to these findings.

Summary

SUMMARY

Cardamom, known as the queen of spices is one of the most expensive spices in the world. India is the second-largest producer of cardamom around the world. The major states cultivating cardamom are Kerala, Karnataka and Tamil Nadu. In the year 2018, Kerala recorded heavy monsoon rain resulting in floods and landslides that devastated the state. Agriculture sector was no exception with the worse damages in Idukki district. The district which lies in western ghats witnessed143 landslides causing unprecedented damages. The topsoil was removed and trees were uprooted and most of the habitats were destroyed. The worst affected crops in Idukki were cardamom, pepper, banana, nutmeg, tubers and vegetables. In this context the study entitled 'the economic impact of an extreme weather event on the production of cardamom in Idukki district of Kerala' was carried out with objective to assess the loss in production of cardamom due to extreme weather event, to analyse its effect on farm income, and to examine the adaptation strategies to mitigate the loss.

Kerala is the largest producer of small cardamom in India. Seventy per cent of cardamom cultivation in Kerala is in Idukki district. Hence Idukki district was purposively selected for the study. The study was based on both primary and secondary data. Primary data were collected from Santhanpara and Senapathy gramapanchyats of Idukki district with a pre-tested well-structured survey schedule. From each gramapanchayat twenty five cardamom farmers were selected and the total sample size was fifty. Secondary data was collected from various sources. Data on area, production and productivity of cardamom for the period 2009 – 2019 and other relevant data regarding cardamom cultivation was collected from the department of agriculture development and farmers welfare (GOK) and from Principal Agricultural Office (PAO), Idukki. Secondary data regarding climate variables were collected from Cardamom Research station (CRS) Pampadumpara, Idukki for the period 1994 - 2018. Various websites were referred to collect other relevant data regarding the district.

The study followed damage and loss assessment methodology given by FAO to assess the major objective. It also followed standard cost concepts, percentage analysis, Garrett's ranking technique to find meaningful results.

The annual maintenance cost of cardamom for the pre disaster year 2017-18 was calculated using ABC cost concept. The total cost (Cost C) of cultivation incurred by farmers was ₹6,83,366.06 ha^{-1}. In both panchayats share of Cost A_1 for hired labour was highest, followed by manures and fertilizers. The plant protection chemicals contributed 12.64 per cent of cost A_1 which reflects the increased use of pesticides. Machine power accounted for 11.07 per cent of cost A_1. The gross returns from cardamom in 2017-18 was ₹8,79,632.28 ha^{-1}. The net return at Cost C was ₹ 1,96,266.22 ha^{-1}. B:C ratio at Cost A1, Cost A2, Cost B and Cost C were calculated as 1.86, 1.81, 1.33 and 1.29 respectively which indicated that the cardamom cultivation is profitable at Cost C.

The majority of the Idukki district lies in western ghats with hilly terrain. The anthropogenic activities over the years had considerably caused damage to this fragile ecosystem. The heavy rainfall during 2018 had resulted in severe landslides and erosion causing the death of several people and considerable damage to dwellings and the crops cultivated. The topsoil of the affected fields was washed away and the fields were filled with debris. Cardamom crops are highly prone to azhukal disease caused by *Phytophthora sp.*. In cardamom, production damage and production loss were observed. The study employed the loss assessment methodology of Conforti *et al.* (2020) given by FAO. The completely destroyed crops were replanted and the partially destroyed crops had yield loss. Farmers had borne short run expenses to continue proper cultivation.

Expected yield is the yield of cardamom that should be harvested in the absence of extreme weather event. It was calculated as linear trend from previous five years yield data. The harvested yield was the yield of cardamom in disaster year. Harvested yield data was collected from farmers. The loss of yield due to the complete and partial destruction of plants was the reduced yield and it was calculated as the difference between expected and harvested yield (Conforti *et al.,* 2020).

There was a huge loss of 404.25 kg per ha of cardamom in Santhanpara gramapanchayat and 349.61 kg per ha in Senapathy gramapanchayat to an expected yield of 901.21 kg per ha and 889.57 kg per ha cardamom respectively. It was revealed that due to extreme weather event 42.09 per cent of expected yield was lost to farmers and only 518.49 kg per ha of cardamom was the harvested yield.

In monetary terms, the damage and loss were assessed and for the completely destroyed plantation, the cost of replanting and destroyed yield were estimated and used as a proxy for damage. For the partially destroyed standing crops, the reduced yield was assessed and price of output was valued at previous year price.

The total loss that occurred among the respondents were ₹ 2.50 crores. Out of which 84.67 per cent was due to the yield loss. Short run expenses and replacement costs were 10.26 per cent and 5.06 per cent respectively. In Santhanpara gramapanchayat 85.36 per cent of total loss was due to the loss from reduced yield. They had also spent ₹ 5.90 lakhs to replace the destroyed crops whereas 83.88 per cent of total loss in Senapathy gramapanchayat accounted for loss from reduced yield and ₹ 6.79 lakhs were spent on replanting. The short run expenses of farmers in Santhanpara gramapanchayat and Senapathy gramapanchayat were ₹ 13.58 lakhs and ₹12.17 lakhs respectively.

An attempt was made to estimate the effect of extreme weather event in the district based on the loss computed for the respondents in the study area. The loss incurred per hectare in cardamom was ₹ 4.37 lakhs and loss accounted per farmer was ₹ 5.02 lakhs. The disaster loss per hectare was extrapolated to the total area of cardamom in Idukki district, it was a whooping sum of around ₹1362 crores.

The extreme weather event and followed diseases led to crop loss and yield reduction from cardamom reflected in the farm income of respondents. Cardamom contributed more than 90 per cent of farm income during previous year. The income from cardamom of respondents in Santhanpara gramapanchayat and Senapathy gramapanchayat in 2017-18 were ₹ 2.4 crores and ₹ 2.5 crores respectively which formed a total of ₹ 5.04 crores. After the incidence of extreme weather event farmers faced about 42.08 per cent of shortage in farm income from cardamom. The total farm income from cardamom during disaster year was ₹ 2.92 crores. Loss of farm income of cardamom accounted for ₹1.08 crores in Santhanpara gramapanchayat and ₹1.03 crores in Senapathy gramapanchayat. The per cent reduction in income from cardamom in both the panchayats were 43.72 and 40.50 respectively.

The role of weather forecasting and sources of weather information were collected from farmers during the survey. When the extreme weather event occurred, people did not realize the gravity of catastrophe in early days. It felt like a heavy monsoon season since most of them received a heavy rainfall warning. Proper following of weather updates by majority of respondents showed the importance of weather in cardamom cultivation. Though the sources varied from mobile applications, television, newspaper to their own experience in farming.

One of the most important observation was none of the farmers had insured their crops against natural calamities. The primary reason was the unawareness of farmers about crop insurance scheme against natural calamities. Secondary reason was the minimum requirement of 1 ha productive cardamom cultivation limits the access to crop insurance for marginal farmers. Through crop insurance scheme, natural calamity affected cardamom plantations get an assistance of ₹ 60000 per hectare. Natural calamity assistance was given by government of Kerala through Krishi bhavans and those who suffered were got a compensation of ₹ 25000 per hectare.

Adaptation strategies were followed by farmers in order to reduce the vulnerability to extreme weather events. Adaptation strategies were studied based on farmers perception and their response to disaster. Most of the farmers were practiced prophylactic spraying of fungicides as an adaptation strategy. Around 22 per cent of farmers were not following any adaptation strategies. The adoption of strategies may differ based on different factors such as its effectiveness, cost of adoption and resource allocation. The other adaptation strategies such as mulching, cultivation of different varieties and construction of shallow ditches to facilitate water flow were followed.

After the extreme weather events, farmers there had been a change in the attitude of farmers towards risk aversion strategies. Most of them followed crop diversification, livestock rearing, aquaculture to avert risk.

The study examined the problems faced by farmers of cardamom cultivation in the post disaster scenario. It was classified into three categories such as production constraints, marketing constraints and adaptation constraints. These constraints were ranked using Garrett’s ranking technique.

Constraints for production of cardamom faced by farmers were the variation in rainfall, pest and diseases, high cost of plant protection chemicals, high labour cost, shortage of labour, cost of replanting and availability of planting material with quality. High cost plant protection chemicals and high incidence of pest and diseases were the major problem faced by cardamom farmers. The marketing constraints were high transportation cost, delay in payment of sale proceeds, fluctuation in market price, lack of storage facilities, and unorganized marketing channels. Fluctuation in market price and delay in payment of sale proceeds were identified as the major marketing constraints. The adaptation constraint faced by farmers were high cost of adaptation, lack of disease resistant varieties of cardamom, lack of knowledge about adaptation, difficulty in availing credit and lack of practical training on adaptation practices. The major barriers to adaptation were lack of knowledge about adaptation practices, lack of disease resistant varieties and high cost of adaptation.

Suggestions and policy interventions

- In order to avail the benefit of crop insurance to the marginal farmers, the government may consider revising the existing minimum requirement of one-hectare productive cardamom land as a precondition for crop insurance.
- Encourage farmers to reduce the risk through diversification of crops and mixed farming. It reduces the effect of loss at times of disaster.
- Farmers may be made aware to identify pests and diseases at early stage and also latest technologies in farming
- Delayed payment for the produce and high volatility in prices is a matter of concern which point outs the need for urgent institutional interventions in cardamom marketing.
- Farmers need varieties resistant to pest and diseases without compromising with high yield. Future researches can be directed towards this aim.

Plate 1: Partial destruction of cardamom

Plate 2: Flooding in the cardamom field

Plate 3: Complete destruction of cardamom

Plate 4- Secondary fungal infection - capsules

Plate 5- Secondary fungal infection- pseudo stem

Plate 6 - Decayed capsule

Plate 7 – Decayed panicle

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Appendix-I

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KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF AGRICULTURE, VELLAYANI

DEPARTMENT OF AGRICULTURAL ECONOMICS

TITLE: ECONOMIC IMPACT OF EXTREME WEATHER EVENT ON THE PRODUCTION OF MAJOR SPICE CROPS IN IDUKKI DISTRICT OF KERALA

INTERVIEW SCHEDULE

Date: Name of the interviewer:

Category of Farmer: S/L

District: Panchayath:

1. Name of Farmer:
2. Address, Phone Number:
3. Age:
4. Educational Level:
5. Experience in farming (Years/ crop):
6. Annual Income:
7. Family Details:

Sl. No.	Relation with head (code)	Age	Education	Occupation		Annual Income	
				Primary	Secondary	Primary	Secondary
1							
2							
3							
4							
5							

8. Number of members engaged in agriculture as fulltime / part time occupation:

9. Alternate sources of income

10. Land particulars

Sl. No.	Particulars (Cents)	Wet land (Cents)	Garden land (Cents)	Rainfed (Cents)	Irrigated (Cents)	Total (Cents)
1	Area owned					
2	Area leased in					
3	Area leased out					
4	Net cropped area					
5	Area under cardamom					

11. Details of non-crop / allied activities

Sl. No.	Animal	Number	Annual Maintenance Expenses (Rs)	Gross returns (Rs)
1	Cow			
2	Goat			
3	Hen			
4	Pig			
5	Others 1. 2. 3.			

12. Implements

Sl. No.	Particulars	Number	Year of purchase	Value (₹)	Expected life (Years)	Depreciation (₹)
1	Sprinklers					
2	Drip system					
3	Spades					
4	Sprayers					
5	Greenhouse / Polyhouse					
6	Brush cutter					
7.	Knife					
7	Others 1. 2. 3.					

13. . Buildings and machineries owned by farmer

Sl. No.	Particulars	Number	Year of purchase	Value	Expected life (Years)	Depreciation	Maintenance cost
1							
2							
3							
4							

14. . Family expenditure pattern

Sl. No.	Purpose	Expenditure / month
1	Food expenditure	
2	Education expenses	
3	Medical expenses	
4	Recreation	
5	Transportation	
6	Others	

15. Cropping pattern (Sole cropping/ intercropping)

Sl no.	Crop	Area/ No	Crop expenditure (₹)	Yield (in kg)	Price of the product (₹/kg)	Net Return (₹)
	Cardamom					
	Pepper					
	Nutmeg					
	Cocco					
	Coffee					
	Coconut					
	Rubber					
	Clove					
	Arecanut					
	Others.					

	Banana					
	Ginger					
	Tapioca					

16. Production of spices

Crop	2013	2014	2015	2016	2017	2018
Cardamom 1. Area (ha) 2. Quantity produced (kg)						

17. Input costs- cardamom

Sl. No.	Input used	Quantity applied	Unit	Total expenses
		2017	2017	2017
1	Planting material			
3	Fertilizer Application 1. 2. 3.			
4	Manures 1. Cow dung 2. Neem cake 3.			
5	Soil ameliorants 1. Lime 2. Others			

6	Weedicides 1.			
7	Pesticides 1. 2. 3.			
8	Fungicides 1. 2. 3.			
9	Total			

18. Labour cost

2017: Wage rate: Men (/ day) ______ Women (/ day) ______ Machinery rent (/ hour) ______

Sl.No.	Particulars		Family labour (man days)	Hired labour (man days)	Machine Labour (hours)
			Men /Women	Men/Women	2017
			2017	2017	
1	Clearing of land				
2	Digging pits				
3	Organic manure				
4	Fertilizers				
5	Liming materials				
6	Plant protection operations	Bio control			
		Chemical			

7	Weeding			
8	Irrigation			
9	Shading			
10	Planting/Staking/ Mulching			
11	Other intercultural operations			
12	Harvesting			
13	Post-harvest operations			
14	Transport			

19. Damage and loss assessment

Sl. No	Particulars	Units	Yield	Value
1	Total Area affected			
2	Total number of plants			
3	Completely destroyed plants			
4	Partially destroyed plants			
5	Destroyed/ Damaged assets			
6	Destroyed /Damaged inputs			
7	Destroyed/ Damaged stored produce			
8	No. of plants replanted			

9	Additional cost inquired			

20. Major cause of damage

a) Flooding
a) Heavy rain
b) Heavy wind
c) Landslide
d) Other

21. Source of farm income - 2017

Sl no.	Particulars	Yield	Gross Returns
1	Cardamom		
2	Livestock		
3	Other crops		
4			

22.

23. Climate Change - Flow of climate information to farmers

Sl. No	Particular	
1	Did you receive a warning about flood before it happened?	Y / N / Don't know
2	What are the sources of weather information? 1. Own experience 2. Radio / TV / Newspaper / SMS 3. Government officials 4. Community leaders 5. Friends and relatives	
3	Are you using the weather information in your farming activities? If Yes. How? If No. Reason?	Y / N

24. Crop insurance and compensation details

a) Have you insured your cardamom against natural calamities? Y/N

b) If no, Why?

c) Have you got any compensation from Government? Y/N

d) If yes, How much?

25. Adaptation strategies taken by the farmers

Sl. No.	Adaptation	Opinion (Y / N)	Cost of adaption	Benefits of adaption ()
1	Prophylactic spraying of fungicide			
2	Mulching			
3	Cultivation of different varieties			
4	Construction of shallow ditches			
5	No adaptation			
6	others			
7				

26. Risk aversion strategies adopted by the cardamom farmers

Sl No	Risk aversion methods	Opinion (Y/N)
1	Crop diversification	
2	Livestock rearing	
3	Aquaculture	
4	Migration	
5	others	

27. Constraints faced by farmers

Sl. No.	Constraints	Rank
I	**Production constraints**	
1	High labour cost	
2	Labour shortage	
3	High cost of plant protection chemicals	
4	Variation in rainfall	
5	Less availability of quality planting material	
6	High cost of replanting	
7	High incidence of pest and disease	
8	Others	
9		

II	**Marketing constraints**	Rank
1	High transportation cost	
2	Unorganized marketing channel	
3	Delay in payment of sale proceeds	
4	Fluctuation in market price	
5	Lack of storage facilities	
6	Others (specify)	
7		

III	**Adaptation constraints**	Rank
1	Absence of practical training on adaptation practices	
2	Lack of knowledge about adaptation practices	
3	Lack of disease resistant varieties	
4	High cost of adaptation practices	
5	Difficulty in availing credit	
6	Others (specify)	

Questions asked to meteorology officer of Cardamom Research Station, Pampadumpara, Idukki

Data on Maximum Temperature, Minimum Temperature, Rainfall, for the past 25 years.

Sl. no	Year	Month	Rain fall (mm)	Max. temperature (°C)	Min. temperature (°C)

Questions asked to Directorate of Economics and Statistics, Thiruvananthapuram: Data on area, production and productivity of cardamom for the past 10 years.

Kerala				
Sl No.	Year	Area	Production	Productivity

Idukki				
Sl No.	Year	Area	Production	Productivity

Appendix - II

GARRETT RANKING CONVERSION TABLE

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

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

Abstract

THE ECONOMIC IMPACT OF AN EXTREME WEATHER EVENT ON THE PRODUCTION OF CARDAMOM IN IDUKKI DISTRICT OF KERALA

by

ELIZABETH BENNY
(Admn No. 2018-11-062)

Abstract of the thesis
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MASTER OF SCIENCE IN AGRICULTURE
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2020

ABSTRACT

The study entitled 'the economic impact of an extreme weather event on the production of cardamom in Idukki district of Kerala' was carried out with objective to assess the loss in production of cardamom due to extreme weather event of 2018, to analyse its effect on farm income, and to examine the adaptation strategies to mitigate the loss. Primary data were collected from Santhanpara and Senapathy gramapanchyats of Idukki district with a pre-tested well-structured survey schedule. From each gramapanchayat twenty five cardamom farmers were selected and the total sample size was fifty. The relevant secondary data regarding climatic variables, area, production and productivity of cardamom in Idukki district were collected from the concerned institutions.

The study followed damage and loss assessment methodology given by FAO to assess the major objective. It also followed ABC cost concepts, percentage analysis, Garrett's ranking technique to find meaningful results.

The annual maintenance cost of cardamom for the pre disaster year 2017-18 was calculated using ABC cost concept. The total cost (Cost C) of cultivation incurred by farmers was ₹6,83,366.06 ha^{-1}. B:C ratio at Cost C was calculated as 1.29 which indicated that the cardamom cultivation is profitable.

The heavy rainfall during 2018 had resulted in severe landslides and erosion causing the death of several people and considerable damage to dwellings and the crops cultivated. There was a huge loss of 404.25 kg per ha of cardamom in Santhanpara gramapanchayat and 349.61 kg per ha in Senapathy gramapanchayat to an expected yield of 901.21 kg per ha and 889.57 kg per ha cardamom respectively. It was revealed that due to extreme weather event 42.09 per cent of expected yield was lost to farmers and only 518.49 kg per ha of cardamom was the harvested yield.

The total area covered by respondents were 57.41 ha. The value of total loss that occurred among the respondents were ₹ 2.50 crores. Out of which 84.67 per cent was due to the yield loss. Short run expenses and replacement costs were 10.26 per cent and 5.06 per cent respectively. The loss incurred per hectare in cardamom was ₹ 4.37 lakhs and loss accounted per farmer was ₹ 5.02 lakhs. The disaster loss per hectare was extrapolated to the total area of cardamom in Idukki district, it was a whooping sum of around ₹1362 crores.

Cardamom contributed more than 90 per cent of farm income during year 2017-18. The income from cardamom of respondents in Santhanpara gramapanchayat and Senapathy gr mapanchayat in 2017-18 were ₹ 2.4 crores and ₹ 2.5 crores respectively which formed a total of ₹ 5.04 crores. After the incidence of extreme weather event farmers faced about 42.08 per cent of shortage in farm income from cardamom. The total farm income from cardamom during disaster year was reduced to ₹ 2.92 crores.

Most of the farmers regularly follows weather updates. However, none of the farmers insured their crops against natural calamities. Through crop insurance scheme, natural calamity affected cardamom plantations get an assistance of ₹ 60000 per hectare. Natural calamity assistance was given by government of Kerala through Krishi bhavans and farmers who suffered crop loss were got a compensation of ₹ 25000 per hectare.

Adaptation strategies were followed by farmers in order to reduce the vulnerability to extreme weather events. Most of the farmers practiced prophylactic spraying of fungicides as an adaptation strategy. Around 22 per cent of farmers were not following any adaptation strategies. The other adaptation strategies such as mulching, cultivation of different varieties and construction of shallow ditches to facilitate water flow were followed. Most of them followed crop diversification, livestock rearing, aquaculture to avert risk.

The study examined the problems faced by farmers of cardamom cultivation in the post disaster scenario. Constraints for production of cardamom faced by farmers were high cost plant protection chemicals and high incidence of pest and diseases. Fluctuation in market price and delay in payment of sale proceeds were identified as the major marketing constraints. The major barriers to adaptation were lack of knowledge about adaptation practices, lack of disease resistant varieties and high cost of adaptation.

Marginal farmers were not eligible to receive crop insurance there exists a ceiling of one hectare productive cardamom land to receive the indemnity amount. Hence as a policy matter the government may consider reducing the existing ceiling of one hectare productive cardamom land. The farmers can reduce the risk through diversification of crops and mixed farming. It reduces the extent of loss at times of disaster. Better maintenance of farm with proper phyto sanitary measures will help the farmers in reducing the incidence of pests and disease and therefore the cost on plant protection chemicals can be reduced. Delayed payment for the produce and high volatility in prices is a matter of concern which point outs the need for urgent institutional interventions in cardamom marketing. Farmers need more varieties of cardamom resistant to pest and diseases without compromising on high yield. Future researches can be directed towards this goal. Thus, the study can be a reference for planners and policy makers.