GENDER DISAGGREGATED ANALYSIS OF CLIMATE-CHANGE ADAPTATIONS AMONG VEGETABLE FARMERS

By

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(2020-11-083)

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KERALA AGRICULTURAL UNIVERSITY

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THESIS

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2023

DECLARATION

I hereby declare that this thesis entitled "**Gender disaggregated analysis of climate-change adaptations among vegetable farmers**" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award of any degree, diploma, fellowship or other similar title, of any other university or society.

Atheena

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Date: 27-07-2023 **(2020-11-083)**

CERTIFICATE

Certified that this thesis entitled "**Gender disaggregated analysis of climate-change adaptations among vegetable farmers**" is a bonafide record of research work done independently by **Ms. Atheena U.P.** (2020-11-083) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

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We, the undersigned members of the advisory committee of **Ms. Atheena U.P. (2017-11-083)**, a candidate for the degree of **Master of Science in Agriculture** with major field in **Agricultural Extension Education**, agree that this thesis entitled "**Gender disaggregated analysis of climate-change adaptations among vegetable farmers**" may be submitted by **Ms. Atheena U.P.** in partial fulfilment of the requirement for the degree.

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People are all we have got

(Fleabag- Phoebe Waller Bridge)

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Atheena. U.P

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Chapter 1
INTRODUCTION

"We are on a highway to climate hell with our foot on the accelerator"

-Antonio Guterres, U.N Secretary General at COP-27(2022)

According to the IPCC, a change in the state of the climate is referred to as climate change which can be determined (e.g., by statistical tests) by changes in the mean and/or variability of its attributes and if the change lasts for a significant amount of time, often decades or longer.

The threats posed by climate change are no longer a far-off phenomenon and many countries are already facing the turmoil brought on by nature due to global warming. Extreme events are happening more frequently all around the world now.

Hurricanes and superstorms in the United States, extended heat waves in Europe, and unheard-of forest fires in Australia have all been experienced by the global North. The South has experienced a variety of natural disasters, including powerful cyclones, protracted droughts, heavy rainfall, flooding, and landslides. These have led to widespread ecological deterioration, decreased agricultural productivity, incursion of saline, and soil erosion in riparian zones.

Through links among the economic, environmental, social, and political domains, climate change will have cascading consequences on livelihoods, communities, and sustainability in addition to its direct effects on output.

1.1. Impact of climate change on agriculture

Given that agriculture is a biological production process, the expected climate change will have an impact on the sustainability of agricultural production and the livelihoods of those who depend on it. Agricultural production is carried out by choosing crops that are suited to the local climate and using effective farming techniques. As a result, agriculture is a bio-industry that depends on climate and exhibits distinctive regional features. And because of this, global, regional, and local food production will all likely be impacted by climate change.

Evidence suggest that climate change is leading to a reduction in the yield of most staple crops, with the agricultural sector being one of the most vulnerable sectors to the impacts of climate change (Wheeler and Braun, 2013). For instance, the duration of crops, crop respiration rates, photosynthate partitioning to economic products, pest population survival and distribution, soil nutrient mineralization rates, fertiliser use efficiencies, and evapotranspiration rates can all be affected by temperature changes depending on the ambient temperature.

Due to a number of risk factors, including poverty, geographic exposure, reliance on rain-fed agriculture, and challenges with poor governance and social infrastructure, climate change would have major implications on food and nutritional security particularly in developing countries of the semi- arid tropics, where the need to increase and sustain food production is most urgent.

1.2. Impact of climate change on Indian agriculture

India is disproportionately more vulnerable to climatic anomalies than other countries because of its proximity to the equator and its tropical climate. It is one of the top ten nations, most impacted by climate change, according to the Global Climate Risk Index 2021.

Geographically and climatically, the nation has a variety of conditions, which results in distinct regional effects. It has been observed that both the maximum and minimum temperatures in India have been rising steadily over the past few decades. India's annual mean temperature climbed by 1.2°C between 1901 and 2017 and future projections indicate that it may rise even faster (Oldenborgh *et al*., 2018).

Regional studies suggest a shifting pattern of precipitation (Mondal *et al*., 2015). On the other hand, extended interruptions in the southwest monsoon have shown an increasing frequency of droughts, resulting in recurrent drought episodes being recorded in various parts of the subcontinent (Choudhury and Sindhi, 2017). This creates enormous challenges for both food production and livelihoods of small-scale farmers who are already unfortunate with limited financial resources and access to infrastructure to invest in appropriate adaptation measures (Patnaik and Das, 2017).

It has been predicted that in India, in the scenario of a temperature increase of 2.5°C to 4.9°C, rice yields will decrease by 32-40 per cent and wheat yields by 41-52 per cent. Climate change will result in an increase in *kharif* rainfall, which may be advantageous for *kharif* crops. Additionally, a one-degree increase in temperature may not have a significant impact on productivity for *kharif* crops. However, the yield of wheat, a vital food grain crop, will be impacted by temperature increases during the *rabi* season.

According to a study by the Indian Agricultural Research Institute (IARI), the *rabi* crop will be severely impacted and wheat production will decline by 4-5 million tonnes for every 1°C increase in temperature. Most grains would produce less as a result of rising temperatures and declining water availability, particularly in the Indo Gangetic plains. Depending on the modelling method, a loss of 10–40 per cent in crop yield is predicted by 2100.

Overall, because of the institutional and technological advancements, the nation may be able to meet the food needs of a growing population. However, it is evident that agricultural output is already being negatively impacted by climate change, which has an adverse effect on rural incomes and poverty as well as local food supplies. It had been estimated that losses related to climate change are about 4-9 per cent of the agricultural economy each year, which is an overall GDP loss of 1.5 per cent (Parliamentary Standing Committee on Agriculture,2017).

The endeavour against climate change in India is extremely difficult, because around 60 per cent of the net cultivated land is rainfed and subject to biotic and abiotic pressures brought on by climatic variability and climate change. Over 80 per cent of Indian farmers are marginal, tiny, and have limited resilience. Furthermore, the farmers in India are also disorganised and diverse (Gupta and Pathak, 2016). As a result, there is an urgent need for research on the effects of climate change on main crops at the level of agroclimatic zones so that location-specific R&D and dynamic, diverse, and flexible interventions with local settings can be carried out (Singh *et al*., 2019).

1.3. Impact of climate change on agriculture – Kerala scenario

Due to its location on a seacoast and steep gradient along the slopes of the Western Ghats, the state of Kerala is especially susceptible to the dynamics of the changing climate. In the first report of Indian Network for Climate Change Assessment (INCCA) on impact of climate change in four regions of the country, it was noted that the Western Ghats and Kerala would experience reduced rainfall, elevated atmospheric temperatures, and flooding as a result of sea level rise in the next 20 years.

In a study conducted by Centre for Water Resource Development and Management, Kozhikode reported that the range of increase in maximum temperature was 0.43°C to 1.92°C. A rise of 0.66 °C to 2.17 °C was seen in the minimum temperature. Rainfall was reported to have increased by 166 mm to 1,434 mm. It is evident that the monsoon patterns have changed as a result of climate change, as seen by shifting spatial and temporal data obtained in Kerala. It has also been noted that the size of raindrops has increased erosion and has caused damage to agriculture and infrastructure. Wetlands are adversely affected due to such altering patterns.

The torrential rain that floods a whole area and the sweltering heat that evaporates all water. These changes in the climate are also having an impact on the state's food supply. With crop yields declining by up to 33% over the past few decades. The yield of major rainfed crops cultivated in the state such as rice, bananas, rubber, coffee, black pepper, coconuts, and arecanut is found to be decreased from 0.3% to 33%.

Total crop water requirements of important crops like coconut, paddy, and banana have increased with the rise in temperature. Since agriculture is an important subsector of the primary sector in Kerala accounting for more than 80% of the state GDP generated within the primary sector and 33% of the overall state GDP, it is imperative to address climate change.

There is constant demand for eclectic mix of vegetables for home consumption in Kerala. The typical vegetables grown are beans (cowpea, cluster, broad), gourds, pumpkins, cabbage, cauliflower, cucumber, tomatoes, etc. Vegetables crops, like other agricultural crops, are sensitive to climate variability.

Vegetables are generally sensitive to environmental extremes, and thus high temperature are the major causes of low yields and will be further magnified by climate change (Bhardwaj, 2012). Under changing climatic situations crop failures, shortage of yields, reduction in quality and increasing pest and disease problems are common and they render the vegetable production unprofitable. In order to adapt to the adverse impact of climatic change on productivity and quality of vegetable crops there is need to develop sound adaptation strategies which has only been given limited attention in terms of research.

Effects of climate change on the sectors such as livestock, coastal fisheries, forests, human health and tourism are also highlighted in climate impact assessments. Further, vulnerability assessments have shown that the majority of Kerala's districts are extremely vulnerable. Kerala has encountered a variety of natural disasters, including coastal erosion, saltwater intrusion, earthquakes, floods, landslides, and sea level rise. Through the development of adaptation actions that are inclusive, participatory, and gender responsive, it is necessary to develop focused strategies for building adaptive capacity, strengthening resilience, and reducing the vulnerability of natural and socio-economic systems.

1.4. Objectives of the study

This study intends to concentrate on the following objectives:

1. Assessment of the gender differentiated perception on effect of climate change among vegetable farmers
2. Investigation of the determinants of climate change adaptation among male and female farmers
3. Analysis of the constraints with respect to climate change adaptations among the farmers

1.5. Scope and importance of the study

The impacts of a changing climate on the lives and livelihoods of the global poor become more apparent with each passing year. These effects are especially noticeable among farming community since they have to deal with ever-more unstable economic and agricultural environments. The agricultural sector is one of the most vulnerable to the effects of climate change, and evidence suggests that it is causing a decrease in the productivity of most staple crops.

Although all people who depend on agriculture for their livelihoods are affected by the effects of climate change, these effects are not perceived by all people equally. It affects men's and women's natural, physical, social, and financial capital in distinct ways. Impacts of climate change will differ by gender, age, and social class, with the impoverished more likely to experience negative effects. In order to effectively address the environmental and humanitarian challenges brought on by climate change, a gender equality viewpoint is crucial.

Also understanding how farmers view climate change and the factors influencing their local adaptation efforts is crucial for fostering successful adaptation in the agriculture sector. Therefore, assessment of farmers' views on climate change is therefore very important. Since roles, obligations, and entitlements related to various markers of social identities and power relations, such as gender, ethnicity, socioeconomic class, or caste, greatly influence adaption, it is crucial to look into the factors that affect farmers' adaptations to combat climate change and to examine the challenges posed by how people perceive it.

The results of this study will aid in understanding the perception of agrarian community on effect of climate change. Additionally, it would give a fair knowledge of the elements, such as gender, influencing this perspective. This study would also help to understand the many adaptation strategies farmers use to battle climate change, the factors that influence their choices, and the barriers that stand in the way of their adaptation.

Integrating important insights from the results of the study, some recommendations can be put forward for designing various developmental interventions. The study is expected to be useful for the state planners, policy makers, the researchers to identify areas of success and failures, thus to rethink next course of action.

1.6. Limitation of the study

Because the study region was constrained to just four blocks from Palakkad district extrapolating the results to the entire agro-ecosystem of Kerala will be challenging. The conclusions were based on the respondents' expressed views.

As a result, the objectivity would be restricted as the respondent's sincere opinion. Despite the fact that the data had been cross-checked to reduce error, the findings might only be valid to the location in which they were conducted. Like any other single student research conducted, the study's time range appears to have limitations. Due to a lack of time and resources, the study concentrated on limited number of variables. The study had financial and physical limitations as well. Despite the aforementioned limitations, every effort was made to ensure that the study was as objective and organised as possible.

1.7. Organization of the thesis

The study assembled into thesis is arranged into six chapters. It starts with the introductory section, describing the objectives, scope, importance and limitations of the study. The second chapter offers a review of the literature in line with the objective. The third chapter covers the research methodology that was used. The fourth chapter consists of the results and discussion. The study's summary, conclusion, and future directions are included in the fifth chapter, which concludes with references, appendices, and abstract.

Review of literature

Chapter 2
REVIEW OF LITERATURE

Review of literature can be defined as the search and evaluation of the available literature in the field of research. It combines the substantiative findings and the theoretical and methodological contributions to the research genre. The most recent works on the concepts, methods, variables and policy implications related to the topic have been reviewed here.

This chapter tries to systematically collate the existing information on climate change vulnerability of agriculture, farmers' perception on effect of climate change and climate change adaptations.

Review of previous studies will be helpful to be acquainted with the present conditions of the research area. Relevant studies in this area of research are presented chronologically under the following subheads.

2.1. Personal and socio-economic attributes of farmers selected for the study
2.2. Climate change vulnerability of agriculture
2.3. Impact of climate change on vegetable production
2.4. Farmers' awareness on climate change
2.5. Farmers' perception on effect of climate change
2.6. Gender and climate change
2.7. Climate change adaptation
2.8. Adaptation strategies for vegetable farming
2.9. Determinants of climate change adaptation
2.10. Constraints faced by vegetable farmers with respect to climate change adaptation

2.1. Personal and socio-economic attributes of farmers selected for the study

Since the variables chosen for the study and discussed in the review are expected to be influenced by a variety of socioeconomic and personal attributes, an extensive review of the literature on the link between these traits and dependent variables is provided below:

Smit *et al*. (2007) stated that the socioeconomic condition of the respondents has a significant impact on their behaviour and views towards climate change adaptations

Crane (2010) observed that the human dimension of agricultural adaptation includes farmers as planners, performers, and cultivators operating under specific socioeconomic, cultural, and ecological setting.

Following this Nyanga *et al*. (2011) concluded that farmers' ability to adapt to climate change is limited because the range of socioeconomic factors that can affect their options for adaptation is wide.

Belay *et al*. (2017) found that household demographics have an impact on farmers' ability to make wise adaptation decisions, as do factors like farm size, income, market access, access to climate information and extension, and livestock production.

2.1.1. Age

Antwi-Agyei *et al*. (2012) found that age influences one's ability to look for and acquire jobs and money, which could boost a farmer's revenue and assist them deal with unfavourable climate change.

This was supported by the observation of Ademola *et al*. (2012), in his study conducted at Nigeria reported that young, energetic people are more productive than too old, inactive adults.

Misganaw *et al*. (2014) stated that growing older does translate into more agricultural experience, which would boost farmers' native expertise to address hazards brought on by climatic variability.

Nganga and Crane (2020) concluded that adjusting to climate change is a contingent process that is strongly influenced by age because it affects the perspectives from which locals engage in negotiations, engage in technical adaptation practices, and evaluate them.

2.1.2. Gender

One of the most significant factors that influences the way a farmer chooses to adapt to climate change is their gender. Male farmers are more likely to learn about new technology and engage in risky enterprise than female farmers (Asfaw and Admassie, 2004).

According to Tenge *et al*. (2004), being a female farmer may have a negative impact on the adoption of soil and water conservation measures because of the limited access to information, land, and other resources as a result of conventional social barriers.

Murage (2015) also asserted that the differences in impact and the resulting adaptation interventions for both genders are defined by gender-specific roles in agriculture.

Mersha and Laerhoven (2016) concluded that gender obstacles, not preferences between men and women, are to blame for the observed differences in gendered climate adaption.

2.1.3. Education

Wamsler *et al*. (2012) indicated that people's capacity for adaptation may be more strongly influenced by their formal education.

Tazeze *et al*. (2012) showed that education is a significant factor of climate change adaptation decision in rural agricultural communities.

Ndamani and Watanabe (2016) argued that better educated farmers, have access to information on climate change and possible adaptation strategies, which makes them more knowledgeable.

According to Trinh *et al*. (2018) educational qualification is suggested as a factor promoting climate change adaptation of farmers.

2.1.4. Farming experience

Nwobodo and Agwu (2015) showed that farming experience influenced farmers' knowledge on climate change and adaptation strategies to it.

Rajendra (2017) observed that agricultural expertise had a favourable influence on the quality and extent of farmers' adaptation to the effects of climate change. This may be explained by the fact that as farming experience increases, farmers become more proficient in a variety of farming activities to combat climate change.

While studying the adaptation to climate change in rain-fed farming system in Punjab, Bakhsh and Kamran (2019) emphasized the importance of farming experience in increasing farmers' adaptation to climate change.

According to Jabbar *et al*. (2020) farm experience is crucial for adaptability because more seasoned farmers are more likely to be aware of past harsh climatic disasters and to be better able to react to them.

2.1.5. Farm size

Maddison (2006) observed that adaptation to climate change has positively and significantly increased with farm size.

In a study on smallholder farmers' adaptation strategies to climate change in Ethiopia, Kide (2014) pointed out that households with relatively large farm sizes were more likely to take up new adaptation strategies compared to farmers with small farm sizes.

Ashraf *et al*. (2014) who asserted that compared to households with small farms, those with larger farms were more likely to adapt to climate change. This can be possibly explained by the fact that small scale farms, experience greater economic loss due to climate change than large scale farms.

Atinkut and Mebrat (2016) found that the negative effects of climatic variability are less likely to be felt by households with larger farms since they are more likely to diversify their crops, especially during dry seasons.

2.1.6. Annual income

While studying the adaptation methods to climate change in the Nile basin of Ethiopia, Deressa *et al*. (2009) observed that farmers income level is associated with their adaptation decisions.

Mabe *et al*. (2014) higher-income farmers are more likely to employ more adaptation techniques, particularly the more complex and expensive ones.

According to empirical research by Masud *et al*. (2015), respondents' willingness to pay for better management and climate change adaptation programmes increases as their level of income rise.

Ndamani and Watanabe (2016) found that there are parallel associations, and that household wealth is a significant factor in supporting adaptation or the willingness to pay for the adaptation programme.

Analysing the socioeconomic and motivational factors affecting the willingness to pay for climate change adaptation in Malaysia, Al-Amin *et al*. (2020) concluded that raising household income is essential for fostering climate change adaptation.

2.1.7. Extent of farming integration

Lansigan *et al*. (2000) found that when food production becomes more dangerous due to climate change, having a variety of livelihood options aids farmers in coping with the transition. These livelihood alternatives are necessary as a safety net (Khan *et al*., 2009).

Negash (2011) demonstrated a favourable correlation between livestock ownership and the aforementioned adaption strategies.

Belay *et al*. (2017) observed that climate change adaptations such as shifting the planting season, fusing crop production with livestock rearing, and adopting practises for soil and water conservation, is positively correlated with crop and livestock productivity.

Asrat and Simane (2018) found that the ability to adapt to climate change is positively and significantly correlated with income from livestock and non-agricultural sources. This may be explained by the possibility that money from these sources will give farmers more financial flexibility to pay for adaption measures.

2.1.8. Exposure to training

Mariara and Karanja (2007) observed that farmers who received proper training are more likely to implement adaptation practises in response to climate change.

Beshir *et al*. (2012) stated that promoting the sustainable application of land-based climate change adaption strategies requires exposure to training.

Farmers participate in training are observed to be more aware about the effects of the climate change and importance of adaptation in minimising losses (Ha Tinh Provincial People’s Committee, 2014)

Trinh *et al*. (2018) identified the attendance at climate change training as a significant factor influencing farmers' decisions regarding adaptation to climate change. When compared to farmers who did not attend any training on climate change, it was discovered that these farmers were more likely to adopt adaptive practices.

Tangonyire and Akuriba (2021) the respondents received training programmes from Government or NGOs regarding climate change adaptation had a positive impact on their adaptation strategies.

2.1.9. Access to climatic information

Nhemachena and Hassan (2007) stated that farmers are more likely to adjust to climate change if they have exposure to climatic information.

Yadav and Rani (2011) while studying role of communication in climate change and sustainable development emphasised importance of various information sources in adaptation.

Abid *et al*. (2014) found that the possibility of using adaptation actions like modifying irrigation, fertiliser management, adjusting sowing dates, and other land management activities is significantly increased when timely seasonal and daily climate information is available.

Regasa and Akirso (2019) observed that adopting drought tolerant and early maturing crop varieties and practicing soil and water conservation was anticipated by access to information.

Fahad and Wang (2020) described that access to weather and climatic information helps farmers to become more adaptable.

Sardar *et al*. (2021) reported that the adoption of climate-smart agriculture (CSA) strategies is positively and strongly correlated with availability to climatic information.

2.1.10. Extension contact

Maddison (2007) stated that access to extension contact is one of the important institutional factors that influences the farmers' decision towards adaptation. Farmers are more likely to be aware of climatic conditions if they have access to extension services.

Gbetibouo (2009) found that farmers who have access to extension services are more likely to notice climate changes because they are informed about weather and climate changes.

While studying climate change adaptations implemented by farmers of Karnataka, Jamadar (2012) observed that adaptive behaviour is strongly influenced by extension participation of farmers.

Debalke (2013) emphasised that an increase in frequency of extension contact would boost farmers' chances of adopting solutions for coping with climate change, such as different farming practises to counteract its negative consequences.

Oseni *et al*. (2015) observed that consistent communication between farmers and extension agents will lead to the sharing of pertinent information on farm operations, planning, procedures, and emerging agricultural technologies to help farmers increase yields and profitability.

The significance of extension services was stressed, since they have a favourable impact on farmers' propensity to embrace climate change adaptation measures (Mihiretu *et al*., 2019).

2.1.11. Social Participation

During a study conducted on the determinants of the climate change adaptation in rural farming in Nepal Himalaya, Tiwari *et al*. (2014) observed that farmers who are members of cooperative organisations are more likely to use adaptation techniques because they can discuss issues, exchange ideas, and make choices together.

Ndamani and Watanabe (2016) found a positive relationship between participation in farmer-based organisations and climatic change adaptability.

Similarly, Ehiakpor *et al*. (2016) showed a link between participation in farmer-based organisations (FBOs) and climate change adaptation among cocoa farmers in the Suaman district of Ghana.

While studying the climate change strategies adaptation strategies among farm households in Delta state, Nigeria, Solomon and Edet (2018) found that determinants of the likelihood of adopting adaptation strategies by farmers included membership of cooperative societies.

Khanal *et al*. (2019) reported that participation in community-based organisations has been shown to be effective at promoting adaptation.

Aryal *et al*. (2021) observed that being a member of an organisation gives farmers access to contacts and knowledge-sharing resources for farm practices and risk-reduction techniques in response to climate change.

2.1.12. Financial assistance

2.1.12.1. Credit

Harris (2002) observed that availability of credit is a significant factor that frequently influences adaptation behaviour in a positive way.

According to studies on the adoption of agricultural technology, the degree of adoption and the accessibility of loans are positively correlated (Pattanayak *et al*., 2003)

Supporting this, Petrick (2004) stated that having access to credit may have an impact on farm productivity since individuals who are bound by capital constraints tend to use less advanced agricultural inputs in their production activities than those who are not.

Benhin (2006) found that having credit assistance influences farmers' financial resources, allowing them to purchase costly inputs and agromachinaries.

Bryan *et al*. (2009) concluded that farmers would be more likely to adapt to climate change if they had financial support through credit.

2.1.12.2. Crop Insurance

Dolan *et al*. (2001) discovered that farmers adjust their use of crop insurance in response to recent weather events.

Mcleman and Smit, (2006) stated that agricultural insurance can be crucial in the attempt to adapt to climate change.

Panda (2013) conducted his study on climate variability and the role of access to crop insurance as a social-protection measure in Odisha and observed that farmers, who have access to crop insurance employed alternative adaptation measures.

A study on evaluating the performance of the National Agricultural Insurance Scheme (NAIS) and the pilot Weather Based Crop Insurance Scheme (WBCIS) in the state of Odisha, by Swain (2014) found that the area covered by NAIS between 2000 and 2010 shows a roughly growing trend for both the *kharif* and *rabi* seasons.

Dale (2021) concluded that risk assessment and management are steps in the process of adaptation to climate change. In order to spread out the risk across society, insurance has traditionally adopted by people.

2.1.13. Risk bearability

Hardaker *et al*. (2015) defined risk as uncertain outcomes, particularly the potential exposure to undesirable consequences.

Pandey *et al*. (2011) observed that crop production, marketing of crops, financing and investment, as well as a category representing overall risk-taking ability, were used to characterise farmers' assessments of their capacity for risk-taking.

In a study on risk management strategies for smallholder vegetable growers in Battambang, Cambodia, Kiely (2019) found that extreme climatic conditions can be considered as a part of production risks which causes the high variability of in agriculture outcome.

Even though any other relevant studies were not available on this topic the variable was selected since the concept of risk management and adaptation have been associated for a decade, and been linked with anthropogenic climate change for two decades (Jones, 2010).

2.1.14. Market orientation

In agriculture, the term "market orientation" refers to a decision a farmer makes about their production that is influenced by both market signals and their particular production circumstances (Gebremedhin and Jaleta, 2010).

Prior research has demonstrated that market orientation is a requirement for several of the essential farmer characteristics, such as the ability to commercialise and innovate (Mirzaei *et al*., 2016; Newman *et al*., 2016; Ocampo *et al*., 2018).

It was not possible to review any closely connected studies regarding effect of market orientation on climate change adaptation. But it was agreed to take this factor into account of climate change adaptation strategies after discussion with the expert team.

2.1.15. Scientific orientation

Scientific orientation can be defined as farmer's attitude toward novel, scientific techniques that can be applied to various elements of farming.

Patel *et al*. (2017) observed that scientifically oriented farmers are always positive about their vocation and tend to apply advanced techniques in it.

Singh *et al*. (2021) found that vegetable farmers' level of knowledge on recommended vegetable production technology and the scientific orientation were positively and significantly correlated, which indicates a favourable impact of scientific orientation on knowledge of vegetable production technology.

Similarly, Aher *et al*. (2021) concluded farmers' adoption level has significantly increased along with their development in scientific orientation. Hence scientific orientation is considered as a significant variable pertaining to climate change adaptation and been studied.

2.2. Climate change vulnerability of Agriculture

Global climate change has gained the attention of governmental organisations and the academic community worldwide as a serious environmental issue that will have an impact on development of mankind and future survival. Agriculture is one of the sectors most vulnerable to changes in the climate (Field *et al*., 2014). Any amount of climate change will likely have an influence on agricultural productivity and related operations.

Scientists from all over the world have turned their attention to the vulnerability of agro-ecosystems and agricultural output to climate change as a result of the intensifying research on the impact of climate change on agriculture and adaptation since the 1990s.

The scientific literature has seen an increase in the amount of vulnerability assessments over the past ten years that examine how vulnerable various industries, particularly agriculture, are to climate change (Baca *et al*., 2014).

Climate parameters that directly impact commercial agriculture include temperature, precipitation, solar radiation, relative humidity, and carbon dioxide concentration. These conditions have an impact on plants' ability to photosynthesise and distribute dry matter (Mohanty *et al*., 2015).

According to Vos *et al*. (2016) vulnerability is the intensity to which a natural or social system is sensitive to sustain damage from climate change impacts, and is a function of exposure, sensitivity, and adaptive capability. Therefore, the combined effect of these factors on agriculture and livelihoods can be thought of as the impact of climate change.

Matiu *et al*. (2017) stated that climate variability is one of the most significant elements influencing crop output because it accounts for over 60% of yield variability.

Previous research from around the world has established a link between climate change and its impact on crop productivity, particularly in South Asia (Aryal *et al*., 2020). However, the real impact of climate change on crop production is observed to be relied on the type of crop, the region it is grown in, and its ability to adjust to climatic vagaries too.

2.3. Impact of climate change on Vegetable production

Vegetables are one of the agricultural products and a substantial source of income for most people in both rural and urban areas. All year long, they are readily available, simple to prepare, and naturally grow quickly.

Bhardwaj (2012) observed that vegetable cultivation offers farmers the chance to boost their revenue due to the exponential growth of worldwide vegetable output over the past 250 years and the fact that vegetables now command a higher global trade value than cereals.

Vegetables are regarded as protective foods because of their ability to prevent disease by supplying vitamins and minerals. Its nutritional quality is highly influenced by soil factors, temperature, light, and CO2; as a result, a small change in any one of these factors can have a significant impact on the nutritional value of the vegetables.

Datta (2013) revealed that lower precipitation and higher temperatures cause substantial crop water stress in vegetables since there is an increase in evapotranspiration and less water available for irrigation.

Ayyogari *et al*. (2014) described that due to the general sensitivity of vegetables to environmental extremes, high temperatures and insufficient soil moisture are the primary causes of low yields as they have a significant negative impact on a number of physiological and biochemical processes, including reduced photosynthesis, altered metabolism and enzymatic activity, thermal injury to the tissues, reduced pollination and fruit set, etc. These effects will be further amplified by climate change.

The changes in the distribution of existing pests, diseases, and weeds are among the effects of climate change on the production of vegetables (Deuter, 2014)

Mattos *et al*. (2014) observed that even a small increase in the average daytime or night-time temperature can have an impact on the output and quality of vegetables.

Other researches have also confirmed that high temperatures have an impact on the flavour, firmness, and physical and physiological issues that occur throughout growth (Spaldon *et al*., 2015).

Temperature changes will not only have a significant impact on crop development and cultivation, but they will also have an impact on the severity, reproduction, and spread of many plant diseases (Das *et al*., 2016).

Scheelbeek *et al*. (2018) concluded that climate trends or extreme occurrences, such as heat waves, droughts, excessive rains, and changes in seasonal patterns cause danger to both productivity and quality of vegetables

It is evident that the severity of climate change, poses a risk of increasing smallholder farmers' vulnerability and undermining their development possibilities (Williams *et al*., 2018)

2.4. Farmers awareness on climate change

Climate change awareness refers to knowledge, skills, values, attitudes, and beliefs regarding the causes, effects, and mitigation measures related to climate change of the rural population.

Adger *et al*. (2009) found that the degree to which rural farming communities are aware of effects of the current climate change affects how they respond to it.

A study conducted by Sarkar and Padaria (2010) in India revealed about the degree of public awareness of climate change, saying that even though some people were completely aware of climate change, the majority of them lacked thorough knowledge of it.

According to a study conducted by Oruonye (2011) in Jalingo Metropolis, Nigeria, over 82% of the respondents said that they were aware of climate change.

Idrisa *et al*. (2012) concluded that farmers' decisions to implement climate change adaptation techniques are closely connected with their awareness of the issue, which may minimise vulnerability and strengthen livelihoods.

Supporting this, Juana *et al*., (2013) stated that the implementation of effective climate change adaptation techniques is greatly influenced by awareness.

Mudombi (2013) found that the majority of respondents were completely aware of the effects of climate change in Seke and Mrewa Districts of Zimbabwe.

Similar observations were made by Dhanya and Ramachandran (2016) in semi-arid region of South India.

Eneji *et al*. (2021) concluded that climate change awareness as a process of education which aims to increase young people's and adults' climate literacy, urge them to take action against the effects of global warming on the local, regional, and worldwide levels.

2.5. Farmer's perception on effect of climate change

Perception of climate change, as a tremendously difficult idea for the farmers, has limited boundaries as the individual's perception differs with the past and present situation (Saarinen, 1976).

Van den Ban and Hawkins (2000) defined perception as a process of receiving information and stimuli from our surroundings and converting them into psychological responsiveness.

Leiserowitz (2005) noted that public perceptions are crucial elements of the socio-political environment in which policymakers work. They have the power to fundamentally motivate or restrain political, economic, and social action to address a specific issue, such as climate change.

Thus, making public the underlying values guiding preferences and behaviours could thus be a first step in enabling more communities and people to adapt to climate change (Adger *et al*., 2009).

Perceptions not only shape knowledge but knowledge also shapes perception. Therefore, farmers' views of climate change have a significant impact on how they manage risks and uncertainties related to the climate and take specific actions by using coping strategies to lessen the negative effects of climate change on agriculture (Raghuvanshi *et al*.,2017).

Ayanlade *et al.* (2017) stated that the human dimension approach of adaptation is centred on how farmers perceive climate change in light of their prior exposure to risks and uncertainties. As a result, farmers enhance their capacity for adaptation and choose regional adaptation tactics.

Understanding the community's perceptions on effect of climate change is crucial for fostering successful adaptation in the agriculture sector. Efforts has been made to comprehend this through extensive research.

Wang and Lin (2018) stated that farmers' perception about the impact of climate change on uncertainty of the season, weather and extreme events are felt to be very real.

Ajonina *et al.* (2021) reported that farmers are actually suffering from the negative impacts of climate variability, namely decreased yield of crops, increase in pest and diseases, soil erosion and floods.

Similarly, Salman *et al*. (2021) indicated that pests and plant diseases had elevated in several places due to uncertain weather. In addition, climate change had influenced the availability of water sources.

A study conducted by Talanow *et al.* (2021) in South Africa's Western Cape concluded that farmers perceived the reduction of crop yield and quality deterioration. Aryal *et al*. (2021) while studying climate change adaptations of small holding production systems, observed that farmers were perceiving calamities as an effect of climate change.

Mondal (2021) stated that the consequences of climate change can be anticipated through erosion, reduction of soil fertility, disturbances in soil structure, reduction in water holding capacity of soil,

Shrestha *et al.* (2022) concluded that farmers perceive that the rising temperatures have reduced the soil moisture and consequent decline in agricultural yield.

The rising temperatures have also negatively affected livestock rearing and the production of quality livestock derivative products. In addition, farmers opined that, pests, crop diseases, and weed infestation have increased due to the rise in temperature and irregular rainfall patterns. And this in turn leads to the increase in adoption of non-farming activities for livelihood and migration

2.6. Gender and climate change

Numerous studies have emphasised how crucial it is for climate change adaptation efforts to include gender equality in order to obtain fair results.

Early studies including Bekele and Drake (2003) stated that gender was not a statistically significant factor influencing farmers decisions to adopt adaptation measures.

But later, many researchers contend that there is various gender-based disparities in vulnerability and as a result, in adaptation and adaptive capacity also, even when the exposure to climate change may be the same for men and women in any given location (Adger *et al*., 2005).

FAO (2009); Lambrou and Nelson (2010) stated that women and men perceive and experience climate change in diverse ways because of their distinct socially constructed gender roles, responsibilities, status and identities, which result in varied coping strategies and responses.

Reducing the gender gap by promoting women's access to resources (such as land, credit, fertilisers, extension services, and other productive inputs) is expected to raise yields by 20 to 30 per cent and reduce the number of people who go hungry by 150 million people worldwide (FAO, 2009).

Skinner (2011) observed that such choices are important determinants of agricultural outcomes in the context of adaptation to climatic variability and change. Furthermore, the lack of female participation in national, regional, and international climate accords serves as a visible reminder of the pervasiveness of outdated, male-dominated power structures that frequently fail to take into account the unique climate-related concerns of women.

Quisumbing *et al*. (2012) investigated the impacts of climate-related shocks, such as floods and droughts on wives' and husbands' assets in Bangladesh and Uganda and hypothesised that the impact is dependent on participation in agricultural output and exposure to climate risk.

The unequal distribution of power is observed extends beyond the choice of what crops will be planted and when to socially constructed rules on permission to sell in markets and laws governing market travel (Weeratunge *et al*., 2012).

Gender and rural development literature shows that women are persistently underrepresented in agricultural decision-making in families at all levels and contexts, from the household to agricultural development projects and programmes (Dankelman and Jansen, 2012).

It is clear that politically, modern democratic countries are characterised by the underrepresentation of women in decision-making processes, which has resulted in largely male-favoured policies in practically every sphere of society (Bjornberg and Hansson, 2013).

Legesse *et al*. (2013) and Mulatu (2013) observed that male farmers had better opportunities to practice adaptation measures than female farmers.

Alston (2014) stated that in addition to increasing vulnerability, sociocultural and gender norms, gender division of labour, and different levels of access to money and productive resources all have an impact on how well-prepared women are to respond to and adapt to the impacts and shocks of climate change.

According to evidence, already fragile societies, people, and classes are more susceptible to the dangers and effects of climate change. For instance, Mckune *et al*. (2015) implied that particularly owing to a loss in women's economic and social rights, climate change and the shocks and disasters it causes could exacerbate already-existing gender inequality.

In a policy discussion on supporting women farmers during changing climate Huyer *et al*. (2015) stated that it is evident that rural women are particularly vulnerable to climatic concerns and will be among those most impacted by climate change. For their livelihoods and the welfare of their families, they depend more on natural resource-based occupations than do men, and women are less able to adapt when faced with limited resources.

Mamba (2016) stated that since women handle a significant part in agriculture and food production in in the majority of patriarchal developing-world nations, while males migrate in pursuit of employment, the influence of gender on perception cannot be understated.

Nyasimi and Huyer (2017) observed that women encounter obstacles that severely reduce their output and imprison them in a cycle of low productivity. These obstacles include social norms, the gender division of labour (GDOL), land access and use restrictions, no or little input utilisation (such as drought-resistant seeds), and restricted access to climate services and agro-advisories. These obstacles will make it harder for women to adapt to a changing environment, and the gender gap in agriculture will continue to grow.

Eastin (2018) reported that climate change is known to affect women more severely than it does males. This results from ingrained cultural norms and beliefs, social and political discrimination against women, and inequities in the ownership of economic resources, including labour and money. For instance, Adzawla and Kane (2019) estimated the gender welfare gap among agricultural households in northern Ghana has grown as a result of observed effects of climate change and variability.

2.7. Climate change adaptation

The knowledge that the climate has changed in the past, and is now changing as a result of rising atmospheric concentrations of greenhouse gases (IPCC 2001) requires that decisions have to be taken to exploit the potential advantages and to reduce deleterious impacts.

Fussel and Klein (2006) stated that the most effective and environmentally benign way to reduce the negative effects of climate change appears to be adaptation.

Lambrou and Piana (2006) described adaptation as changes in "processes or structures to minimise or offset possible threats or to take advantage of possibilities connected with changes in climate".

Recently, the focus of the discussion on climate change has switched from high-level campaigning on "the need to act" to regional, national, and local solutions on "how to adapt" (Schiermeier, 2007).

Kurukulasuriya and Mendelsohn (2008) noted adaptation as an alteration in natural or human systems in response to current or anticipated climatic conditions or dangers which it can be viewed as a policy option to limit the harmful effects of climate change.

It is obvious that initial concerns about climate change could result in serious effects for the wellbeing of a large number of people in the developing countries if effective adaptation is not made (Nelson *et al*., 2009).

Gandure *et al*. (2013) noted that research shows that coping with climate change through adaptation may assist in reducing its negative consequences, safeguard the livelihoods of poor farmers, and strengthen any possible benefits it might provide.

This adaptation to climate change requires decisions and actions by a wide spectrum of society, including individuals, communities, the private sector, and governments (Dixit and McGray 2013)

According to IPCC (2014) climate change adaptation, is the modification of natural or human systems in response to present or anticipated climatic stimuli, and its effects, which lessens damages or takes advantage of advantageous chances.

Later, Jain *et al*. (2015) observed that despite the fact that all farmers experience the same weather stimuli, there is a tremendous diversity in how each farmer responds to weather variability and the factors that influence adaptation decisions.

Farmers modified their farming techniques in a variety of ways as adaptation tactics, including changing the cropping calendar, crop varieties, cultivation equipment, and cultivated area. Different approaches to agriculture's adaptation to water constraint have been reported too. Farmers also developed plans of action to deal with the diminishing soil productivity. These include the use of animal manure, the creation and application of compost, crop rotation, and crop residue storage (Shrestha *et al*.,2018).

Previous studies recognise the farm-level adaptation measures done by Indian farmers to reduce the risk of crop damage from extreme events and climate change and this included soil management, crop diversification, water management, crop pest and disease management (Aryal *et al*., 2019).

Similarly, Kabir *et al*. (2021) reported that adaption measures use to lessen the adverse effects of climate change can be categorized into four groups: crop management, water management, land management, and income diversification.

Talanow *et al*. (2021) concluded the majority of farmers have adopted adaptive farming practises, including as crop rotation, changes in harvest and planting dates, and water conservation methods, on their farms. However, compared to currently implemented techniques, farmers have planned fewer climate change adaptation strategies for future. Although the effects of climate change extend beyond farms and into society, the majority of current methods are technological and target the direct effects of climate stressors.

Previous researches have noted that there is a significant difference between the gender groups. For instance, Mussema and Yirga (2020) found that female farmers have observed to be prioritizing and adopting crop rotation more than male farmers do.

Pertains to the use of organic manure also a difference is observed in adoption, between male and female farmers (Diarra *et al*. (2021).

2.8. Adaptation strategies for vegetable farming

It is undeniable that we need to create sound adaptation techniques in order to address the negative effects of climate change on the yield and quality of horticulture crops too. Farmers believe that a variety of practises, including mixed cropping, crop rotation, shade, increased use of organic manure, and altered irrigation methods, can sustain vegetable output for a full year. It is productive in stress-prone places, especially in South Asia and Africa where environmental pressures are widespread, by wisely utilising resources, such as light, space, water, and nutrients (Machado, 2009).

Kamanga *et al*. (2010) observed that due to its higher productivity and lower chance of failure, intercropping vegetables can be a viable and effective adaptation against climate change. Another adaptation strategy used by farmers to combat climate change is the shifting of planting date (Tambo and Abdoulaye, 2013).

Datta (2013) noted that altering cultivars, shifting growing regions, and altering managerial interventions are potential avenues for the vegetable business to adapt to the effects of climate change.

Singh *et al*. (2013) stated that growing tolerant varieties could help to overcome the problems brought on by climate change in addition to using modified crop management techniques. Many research institutions have developed hybrids and varieties that can withstand drought and heat stress. Depending on how well they work in a particular agro-ecological zone, they must be used very extensively to resist the effects of climate change. Efforts should be intensified to create new varieties that are appropriate for various agro-ecological locations, in light of the changing environmental conditions.

To address the predicted rise in temperature and water stress periods during the crop-growing season, methods like changing sowing or planting dates should be used (Welbaum, 2015).

Malhotra (2016) indicated that since vegetables contain a significant amount of water and many of them are eaten raw, the usage of high-quality water is still a big concern. The productivity and quality of vegetable products depend on the effectiveness and quality of water management. The two most crucial strategies are conserving soil moisture reserves and providing irrigation throughout critical stages of crop growth. Cost-effective, labour-saving, and allowing for higher plant growth per unit of water, low-cost drip irrigation helps farmers make more money while also conserving water.

Crop rotation and mixed cropping are two adaptation techniques that farmers have used to address climate change, according to a number of prior research (Adiyoga and Lukman, 2017). Both of these adaptations are observed to be keeping various vegetables readily available while lowering the hazards associated with climate change.

It has been observed that crop failures, decreased yields and crop quality, and rising pest and disease issues are frequent in climate change conditions which makes vegetable farming unprofitable. Crop productivity and yield can be increased via intercropping, mixed cropping, relay cropping, and strip cropping to combat these situations. (Koundinya *et al.*,2018).

From the research conducted among vegetable farmers in Nepal, Dahal *et al.* (2019) found that farmers were frequently using adaptation techniques such as mulching, green/plastic houses, drip irrigation, Integrated pest management, changing the crop variety and cropping patterns.

Srinivasarao *et al*. (2020) stated that in the Indian scenario, strategies like conservation agriculture, the preservation of natural resources, reforestation, controls on population growth and pollution, the reduction of greenhouse gas emissions, breeding crops that are drought resistant, tolerant to pests and diseases, mature early, etc. are the need of the hour. Additionally, to address the dynamic, ever-changing issues brought on by climate change, hi-tech horticulture techniques must be used.

In many arid and semi-arid locations of the world, water harvesting for dry land is a traditional water management technology to reduce future water scarcity. Harvesting rainwater and floodwater has the potential to boost the productivity of arable land by boosting yields and lowering the risk of crop failure in the face of climate change (FAO,2020)

Iqbal *et al.* (2020) observed that utilizing plastic mulches and crop leftovers as mulches can help keep soil moisture levels stable. Growing crops on raised beds can sometimes solve a severe problem caused by excessive soil moisture brought on by heavy rain.

Regarding insect pest management, Rashid *et al*. (2020) implementing integrated pest management while placing more of a focus on biological control is an important adaption tactics against incidence of pests and diseases. Creating pest- and disease-resistant cultivars and forecasting pest activity utilising modern technologies like simulation modelling are another potential strategy.

For the sustainability of the agricultural production process, management of pests and illnesses through the use of resistant kinds and breeds, alternative natural pesticides, bacterial and viral pesticides, pheromones for disrupting pest reproduction, etc. could be adopted. Since bio-agents play a significant role in pest management release of these predators and improve their natural habitat. Pest management techniques should also incorporate crop rotation and multiple crops.

Srinivasarao *et al.* (2020) discussed how post-harvest quality is affected by climate change. In order to fulfil the rising demand for food, it is necessary to reduce post-harvest losses and lengthen the shelf life of the collected produce.

The current system of food production, storage, and distribution and consumption patterns should be transformed by proper scientific post-harvest interventions so that the needs of the rising population may be met with the available resources (Hari *et al*., 2020).

Protected structures can also be crucial in reducing the effects of climatic change. These structures can effectively reduce the effects of temperature change, excessive or insufficient precipitation, fluctuating sun shine hour, and pest and disease infestation. To resist the climate whims and new difficulties in vegetable production, farmers are progressively employing various protective structures. Additionally, the market will value the harvested produce highly (Gruda *et al.,*2021)

Arimi (2021) reported that vegetable farmers use a combination of traditional practises (minimum tillage, building a local dam, building drainage, avoiding flood-prone areas, increasing the use of organic manure), modern technology, and adaptation measures were used by vegetable farmers (construction of a water harvester, listening to early warning information, increased use of herbicide, increased use of fertilizer, use of pumping machine, sprinkler irrigation furrow irrigation).

From the comparative study of organic and conventional vegetable farmers in Indonesia, Irham *et al*. (2022) found that change of planting and harvesting date, mixed cropping, crop rotation, shade, increasing the uses of organic manure, and changing irrigation techniques are the strategies that farmers believe to be able to support vegetable production for one year.

During extreme rainfall or temperatures, shade will protect vegetables and reduce damage caused by extreme temperature and rainfall. Organic manure will support the soil by reducing the loss of water. Change of irrigation techniques in the form of ponds as water storage for use during drought is also implemented.

Gunathilaka and Samarakoon (2022) concluded that among the numerous adaptation strategies use by vegetable producers, early or late planting, rotating crop varieties, and extensive input utilisation are observed to be the most widely used adaptive choices.

2.9. Determinants of climate change adaptation

Promoting climate change adaptation is essential for ensuring agricultural livelihoods and food production. This requires an understanding of the driving forces behind adaptive behaviour.

Several studies reported that farmers' adaptation processes vary depending on the size and types of their farms, the climatic conditions, and other environmental elements like ecological, cultural, geographic, political, institutional, and socioeconomic ones (Deressa *et al*., 2009, Reidsma *et al*., 2010, Eriksen *et al*., 2011)

Birkmann (2011) observed that investigating both internal (such as cognitive) and external (such as institutional and biophysical) influencing elements is required to better understand farmers' adaptation behaviour to climate change.

Hisali *et al*. (2011) found that farmers use a variety of adaptation techniques that are influenced by environmental elements, farming practises, and other circumstances like political, economic, and institutional issues. Another significant factor determining adaptation is the human capital specifically, regular advisory services which plays a critical role in the adoption of adaptation methods (Bryan *et al*., 2011).

Important elements influencing farmers' adaptation choices, like sociodemographic traits, were exposed by researcher. Alam *et al*. (2017) reported that farmers responses to climate change can be influenced by factors like age, education, and gender. This is supported by the findings of Islam and Paul, (2018); Asfaw *et al*.

(2019) who indicated that climate change adaptation strategies affected by the socioeconomic determinants.

Farmers' capacity for adaptation is based on their cognitive abilities, which vary across families and are influenced by demographic factors like age, educational attainment, gender, and other socioeconomic and geographic factors (Funk *et al*., 2019).

Bakhsh and Kamran (2019) emphasized the importance of farming experience in increasing farmers' adaptation probability. Khanal *et al.* (2019) stated that participation in community-based organisations has been shown to be effective at promoting adaptation

A study conducted by Marie *et al*. (2020) concluded that farmers' ability to adopt climate change adaptation measures is significantly influenced by size of land, annual farm income, access to climatic information, total, and market access variables. Farmers that have access to resources to adopt new agricultural technology and an acceptable number of farming area are more likely to make adaptation decisions.

Irham *et al*. (2022) concluded that age, education, experience, access to credit, distance to extension services, knowledge of the climate and participation in farmer organisations, as well as farmers' opinions of climate change, all have an impact on how farmers choose their adaptation options.

Determining the factors affecting farmers' adaptive behaviour is important for developing policies that foster not only short-term, temporary adjustments but also enduring adaptation in the face of environmental change.

2.10. Constraints faced by vegetable farmers with respect to climate change adaptation

Globally, adaptation to the inevitable effects of climate change has become essential. However, several impediments that prevent adaptation planning and implementation are encountered and reported on by practitioners, policymakers, and scientists.

Burton (2009) stated that the application of adaptation is falling behind the ever-increasing need which is known as the "adaptation deficit." Therefore, it is crucial to recognise and analyse adaptation-related barriers in order to find potential solutions. Main causes of these adaptation gaps are pointed out to be the barriers to adaptations.

According to the IPCC's Fifth Assessment Report (2014) Adaptation barriers are defined as the factors that make it difficult to plan and conduct adaptation efforts or that restrict options. Klein *et al*. (2014) described barriers to adaptation as difficulties, impediments, restrictions, or hurdles that impede adaptation.

Abid *et al*. (2014) and Kide (2014) found that farmers' willingness to adopt adaptation strategies in response to climate change effects was significantly hampered by lack of knowledge about the potential for climate change, lack of awareness about appropriate adaptation options, lack of access to credit services, and a lack of financial resources.

Moslehuddin *et al*. (2015) found that high production costs due to the adoption of crops with high input and labour needs, which were further exacerbated by a lack of capital, difficult access to soft credit and lack of knowledge contemporary methods limited choices for adaptation.

Costly farm inputs, untimely access to climate data, inadequate credit facilities, lack of agricultural subsidies and difficult in accessing agricultural extension offices were mentioned by Ndamani and Watanabe (2015) as additional barriers that hinder climate adaptation in Ghana.

Similarly, Mayaya *et al*. (2015) identified a number of obstacles to adaptation including lack of resources, limited institutional support, lack of necessary technical support, the high cost of adaption technologies and unknown climatic conditions in the Semi-Arid Areas of Eastern Africa.

Nancy *et al.* (2015) opiniated that the primary obstacles in coping with climate change in India are the high cost of adaptation, lack of understanding about available adaption strategies, low access to technology.

Reiterating this Singh *et al*. (2017) found that low knowledge of government programmes, particularly in areas far from the Gram Panchayat and especially among women, low utility of climatic information due to poor timing and limited practical relevance, and lack of credit facilities for investment in agriculture were the primary obstacles to coping with climate change in India.

According to Findlater *et al*. (2018) perceived external barriers to adaptation were mostly institutional and political, although they often intersect with economic barriers. For instance, a lack of government subsidies is associated to a lack of financial resources at the farm level.

Marie *et al*. (2020) observed various barriers that hinder the adaptation strategies include lack of knowledge about the possibility of climate change, a lack of information about suitable adaption choices, a lack of credit services, and a lack of financial resources.

While studying the adaptation strategies in South Africa's Western Cape, Talanow *et al*. (2020) identified institutional and political constraints, economic constraints including the lack of government subsidies, increasing input costs, lack of reliable and long-term information and lack of awareness of climate change as the major external barriers to adaptation.

Agreeing with this, Kabir *et al*. (2021) cited difficulties in implementing adaption strategies related to inadequate technological knowledge and expertise, and ineffectiveness of agricultural extension services.

According to research on climate change adaptation influences and barriers impacting the Asian agricultural industry the inability to access information and extension services, limited awareness and expertise, and having few financial options are some of the obstacles limiting adaptation (Nguyen *et al*., 2021).

To advance scientific discussions and acquire knowledge on the nature of obstacles to adaptation, it is essential to move beyond inductive and exploratory assumptions about barriers and deal with the analytical difficulties that contextuality will pose. Not only is this key for scientific progress, it will be a vital step to support policy makers in preparing for and managing barriers to enable timely and effective adaptation to climate change.

Methodology

Chapter 3
METHODOLOGY

Research methodology has been defined as the systematic and theoretical analysis of the procedures applied in the field of study. Methods and procedures followed in the study are described in this chapter. In order to accomplish the objectives of the study, appropriate data collection tools and analytical methods have been employed. Details of the methodology used presented under the following heads:

3.1. Research design of the study
3.2. Locale of the study
3.3. Sampling procedure
3.4. Nature and sources of data
3.5. Selection of variables
3.6. Operationalization of variables
3.7. Measurement of variables
3.8. Tools used for data collection
3.9. Statistical methods used to analyse the data

3.1. Research design of the study

Kothari (2017) defines research design as the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure.

Since the major objectives of the study were to assess the gender differentiated perception on effect of climate change among vegetable farmers, to investigate the determinants of climate change adaptation among male and female farmers and to analyse the constraints with respect to climate change adaptations among the farmers thereof, ex-post facto design of research was employed.

It is the systematic empirical enquiry in which the scientist does not have any direct control over the independent variables because they have already occurred or they are inherently not manipulative.

The methodology used for the study at different stages of data collection and analysis are explained below.

3.2. Locale of the study

Palakkad district is purposively selected, as it is listed as the one of the highly vulnerable districts of Kerala in climate change, due to its specific geographic locations, humid climate, high percentage of population, dependence on agriculture, a low ranking in the human development index, high social deprivation and a high degree of vulnerability to natural hazards like floods and drought (GoK, 2014). Moreover, the district possesses highest area under the vegetable cultivation in the State (GoK, 2020).

3.2.1. Brief description of the area

3.2.1.1. Palakkad

Palakkad, befittingly known as the Gateway of Kerala, gives the rest of India access to the state. It is the largest district of Kerala with a land area of 4482 km^2. It has a population of 2,809,934. The district is bordered on the northwest by the Malappuram district, on the southwest by the Thrissur district, on the northeast by Nilgiris district, and on the east by Coimbatore district of Tamil Nadu.

The district can be divided into two natural divisions; midland and highland. Most parts of the district fall in the midland region. The midland is consisting of valleys and plains, which leads up to the highland which includes high mountain peaks, long spurs, extensive ravines, dense forests and tangled jungles.

Palakkad is blessed with many small and medium rivers, which are tributaries of the Bharathapuzha River. A number of dams have been built across these rivers, the largest being Malampuzha dam (Official website, Palakkad district).

3.2.1.2. Climate

The climate of the district is greatly influenced by the 32 kms wide gap present in the uninterruptedness of the majestic Western Ghats, as it enables the north- east winds to blow spreading its wings right up to the cost throughout the breadth of the gap.

The majority of the year is found to have a tropical climate, which is hot and humid. Palakkad is considered as one of the hottest places in Kerala. According to the available climatic data maximum temperatures ranges from 28.1 ℃ to 38 ℃. Whereas minimum temperature ranges from 22.1 ℃ to 25.3 ℃. The average annual temperature in Palakkad is 25.9 °C (78.6 °F).

March is the warmest month of the year. The temperature in March averages 29.1 °C / 84.4 °F. The lowest average temperatures in the year occur in July, when it is around 24.1 °C / 75.4 °F

There is sufficient rainfall in the district and it apparently receives more rainfall than the extreme southern districts of Kerala. In a year, the rainfall is 1216 mm or 47.9 inch. The month with the highest number of rainy days is July (26.20 days) and the month with the lowest number of rainy days is January (1.07 days).

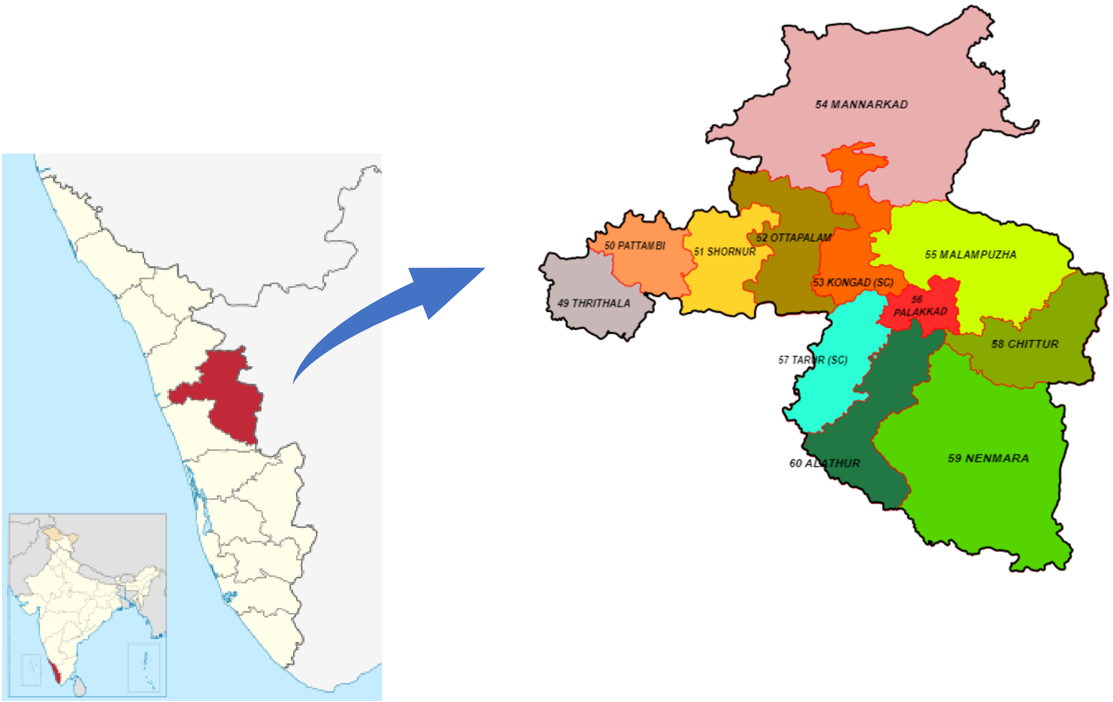
The driest month is January, with 4 mm or 0.2 inch of rain. The greatest amount of precipitation occurs in June, with an average of 223 mm or 8.8 inch.

Humidity is higher during the south west monsoon period which is from June to September which is around 90 % during this period. The month with the highest relative humidity is July (89.93 %) while February is the month with the lowest relative humidity is (47.50 %).

The average wind speed in the district is 14.4 kmph during south west monsoon and 4.5kmph during north east monsoon. The wind direction is generally westerly from January to September and easterly to north easterly during the rest of the year (Official website, Palakkad district).

Plate 1. Locale of study

Palakkad district



3.2.1.3. Cropping pattern

Agricultural products offer maximum employment potential to the population. The district has a food crop-oriented cropping pattern with major crops cultivated being paddy, vegetables, fruits and spices. Palakkad is also one of the main granaries of Kerala. Agricultural products offer maximum employment potential to the society. Area and production of important crops cultivating in the district are given below (Table 3.1).

Table 3.1. Area and production of major crops of Palakkad district

Crop	Area (Ha)	Production (Tonnes)
Paddy	76916	247655.743
Coconut	58409.77	474
Banana	13739.89	153892.892
Arecanut	8069.05	6312.541
Pepper	2807.37	1179.642
Tapioca	2081.52	117683.54
Cucumber	57.03	360.755
Bitter gourd	294.29	2515.094
Snake gourd	73.18	857.414
Green chillies	263.15	266.308
Drum stick	1697.27	3072.335
Rubber	37850	33800
Groundnut	106.4	135.2
Mango	9836.31	53853.357

(Agricultural statistics 2020-21, Department of economics and statistics, Kerala)

3.3. Sampling Procedure

Palakkad district is comprised of 13 blocks, from which four blocks, Alathur, Nenmara, Kollengode and Chittur, were randomly selected. The respondents for the study include farmers and extension personnel.

To ensure the gender-disaggregated analysis, 20 female and 20 male farmers with minimum ten years experience in vegetable cultivation from each block were randomly selected to make the total sample size of 160 in the farmers category.

The extension personnel directly involved with the vegetable farmers were identified through key informant survey and five extension personnel as Agricultural Officers, Agricultural Assistants, VFPCK managers and ATMA block technology managers were randomly selected from each selected block. Thus, a total sample size of 160 farmers and 20 extension personnel were selected for this study.

Table 3.2. Blocks and Gram Panchayaths selected for the study

District	Block	Gram Panchayath/ Krishi Bhavan
Palakkad	Alathur	Erimayur Vadakkencherry Kizhakanjeri
	Nenmara	Vithinassery Nenmara Elavancherry
	Kollengode	Kollengode town Karippode Muthalamada
	Chittur	Vadakarapathy Kozhinjampara Perumatty

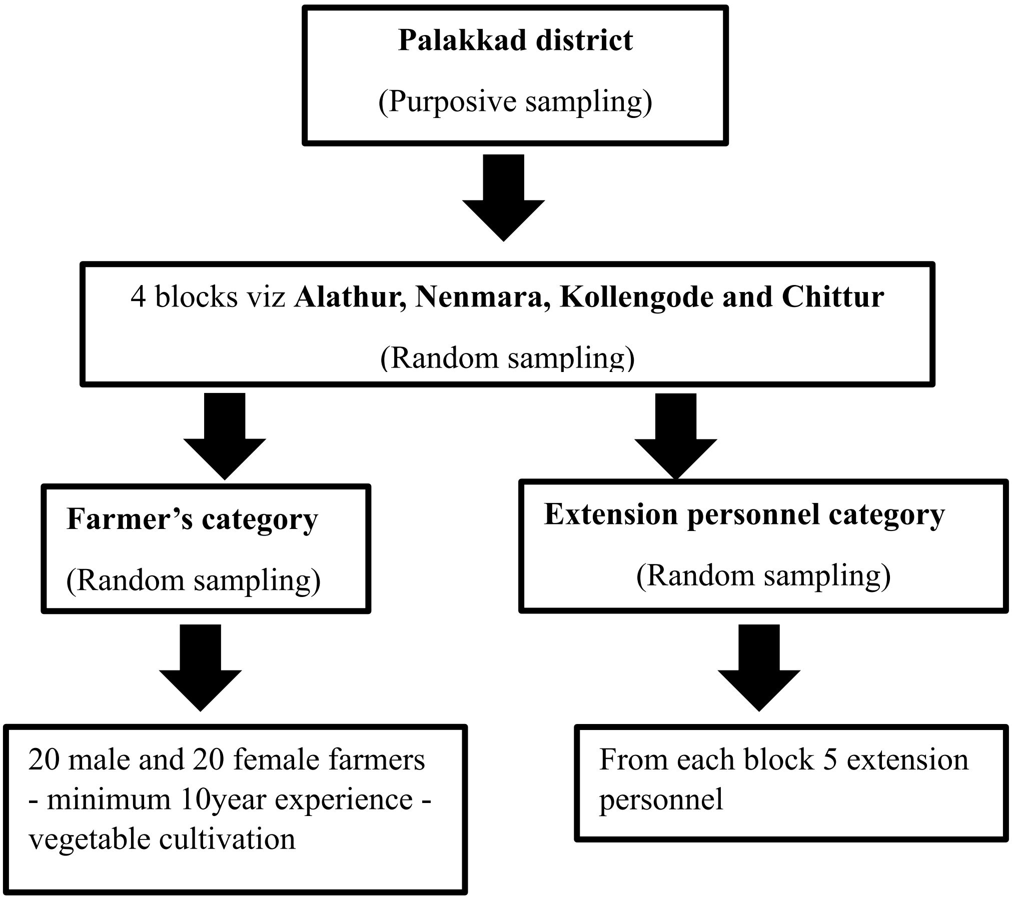


Fig 3.1. Sampling procedure

3.4. Nature and sources of data

Primary and secondary data were used for the research study. The primary data for present study was collected during 2021-2022. Primary data were collected through personal interview technique of the respondents with the help of pre-tested semi-structured interview schedule**.** Both the qualitative and quantitative data were used to address the objectives of the study.

3.4.1. Observation method

In the research study, direct observation was also used to study the existing climate change adaptations and environmental factors affecting the adaptation.

3.4.2. Interview and discussion with key informant

Key informants are the people anticipated to have particular opinion about the topic under study. Key informants among the vegetable farmers were utilized for identifying the key stakeholders. Systematic discussion and interview technique was conducted with the key informants to identify the different stakeholders directly and indirectly involved in climate change adaptation.

The secondary data pertaining to climatic variables including average maximum and minimum temperature, average maximum and minimum precipitation, number of rainy days, evaporation, windspeed in the study area were collected from Regional Agriculture Research Station, Pattambi. Secondary data on area and production of major crops including vegetables were collected from Department of Agriculture, in either published or unpublished documents of the institution in the form of data base, annual reports, statistics and photos.

3.5. Selection of variables

In accordance with the objectives, review of the literature, and expert recommendations, the variables and the measurements that were recommended for them were chosen. The chosen dependent and independent variables, as well as the procedures used to measure them, are as follows:

Table 3.3. List of variables and their measurement

Sl. No.	Variables	Method of measurement
Independent variables		
1	Age	Classified based on the Government of India census report (2011)
2	Gender	Arbitrary scores
3	Educational status	Scale used by Jayasree (2004) with suitable modifications for the study
4	Farming experience	Scoring procedure developed for the study
5	Farm size	GOK (2011)
6	Annual income	Scoring procedure developed for the study
7	Extend of farming integration	Scale developed by Joseph (2016)
8	Access to climatological information	Scoring procedure developed for the study
9	Exposure to training	Scale developed by Shivacharan (2014)
10	Extension contact	Scoring procedure developed for the study
11	Social participation	Scoring procedure developed for the study
12	Financial assistance	Procedure followed by Sobha (2014), Athira (2017) and Anseera (2018) with suitable modifications for the study
13	Risk bearability	Procedure followed by Gajendra (2011) with suitable modifications for the study
14	Market orientation	Procedure followed by Sajeev (1989) with suitable modifications for the study
15	Scientific orientation	Procedure developed by Supe and Singh (1969) with suitable modifications for the study

Sl. No.	Variables	Method of measurement
Dependent variables		
1	Farmers awareness on climate change	Adopted from Gopal *et al*. (2014) and modified in line with the objectives
2	Farmers perceptions on effect of climate change	Adopted from Dhanya and Ramachandran (2016) and modified
3	Climate change adaptation strategies	Adopted from Talanow *et al*. (2021) and modified

3.6. Operationalization of variables

According to Kerlinger (2004), a definition that assigns meaning to a construct or variable by identifying the actions or 'operations' necessary to measure it, is known as an operational definition. As an alternative, an operational definition specifies the tasks. After a thorough and in-depth analysis of the pertinent literature and consultation with experts, relevant variables were chosen for the current study. A brief list of the independent variables that were chosen for the study is given below:

3.6.1. Age

It refers to chronological age of the respondents at the time of investigation and it is determined by direct questioning. Respondents were classified into the following categories in accordance with the procedure used by the Government of India (GOI) in the Census Report, 2011 as following.

Sl. No.	Category and scale
1	Young (less than 35)
2	Middle aged (35-55)
3	Aged (more than 55)

3.6.2. Gender

Gender is the state of being male or female in relation to the social and cultural roles. It was categorized into male and female, and under each category frequency and percentage were calculated.

3.6.3. Educational status

It was operationalized as the total number of years that the respondent had attended formal school. The categories were formed following by Jayasree (2004) and Anseera (2018) with modifications. The categorization along with scores are given below.

Sl. No.	Education	Score
1	Illiterate	1
2	Primary education	2
3	Upper primary education	3
4	Secondary	4
5	Higher secondary	5
6	Graduate and above	6

3.6.4. Farming experience

Farming experience was operationally defined as the respondent's duration of involvement in farming at the time of data collection. It is determined by direct questioning. Respondents were classified into different categories in accordance with the values of mean and standard deviation.

3.6.5. Farm size

The total area of cultivable land possessed by the respondents was used as the operational definition of farm size. The categorization developed by Government of Kerala (GOK, 2011) was used to group farmers according to the size of their farms as following.

Sl. No.	Classification of farmers
1	Marginal farmers (<1 ha)
2	Small farmers (1-1.99 ha)
3	Semi- medium farmers (2-3.99 ha)
4	Medium farmers (4-9.99 ha)
5	Large farmers (≥10 ha and above)

3.6.6. Annual Income

It was operationalized as the summation of income in rupees of the respondent from all the agricultural sources on annual basis. It is determined by direct questioning. Respondents were classified into different categories in accordance with the values of mean and standard deviation.

3.6.7. Extend of farming integration

Extend of farming integration refers to the frequency of integrating different non-crop components with the cultivation of crops. The scoring procedure developed by Joseph (2016) is used to measure the extend of farming integration.

Sl. No.	Category	Scores
1	No components	0
2	Livestock/Poultry/Pisciculture	1
3	Livestock + Poultry	2
4	Livestock+ Poultry+ Pisciculture	3

3.6.8. Access to climatological information

Access to climatological information is operationalized as the degree to which respondents are using informal, formal and mass media information sources for acquiring awareness and knowledge on various aspects of climatic information. Respondents were asked to indicate their preference on a three-point continuum as given below. Rank was assigned to each source of information based on mean score.

Sl. No.	Access to climatological information	Scores
1	Never	0
2	Occasionally	1
3	Regularly	2

3.6.9. Exposure to training

Exposure to training is operationalized and measured as the attendance of farmers in training programs on climate change and adaptation attended by the respondents. The respondents were categorized based on their exposure to training as given below.

Sl. No.	Exposure to training	Scores
1	Not attended	0
2	Attended	1

3.6.10. Extension contact

Extension contact refers to the amount of interaction farmers have with different extension agencies as well as his/her participation in various activities conducted by these agencies including meetings, field visits, demonstrations, exhibitions and so on. The respondents were asked to indicate their preference on a three-point continuum as given below. Rank was assigned to each agency and programme based on mean score.

3.6.10.1. Extension agency contact

Sl. No.	Frequency of contact	Score
1	Never	0
2	Occasionally	1
3	Regular	2

3.6.10.2. Extension Participation

Sl. No.	Frequency of participation	Score
1	Never	0
2	Occasionally	1
3	Regular	2

3.6.11. Social participation

Social participation in this is operationalized as the extent of involvement of the farmers in any social organizations including local self-government institutions, cooperative societies, self-help groups or any farmer-based organization either as a member or as an office bearer.

Sl. No.	Institution/Organization	Score
1	No membership in any organization	0
2	Member in one organization	1
3	Member in more than one organization	2
4	Office bearer	3

3.6.12. Financial assistance

Financial assistance is operationally defined as the financial services availed by farmer respondents which are provided by either public sector agencies or private sector agencies. It is quantified according to the frequency of availing credit and insurance. The scoring procedure used by Sobha (2014) and followed by Athira (2017) and Anseera (2018) with suitable modifications is adopted for measuring financial assistance and it is given below:

Sl. No.	Category	Availed (2)	Not availed (1)
1	Credit		
2	Insurance		

3.6.13. Risk bearability

Risk bearability is defined as the degree to which vegetable farmers were oriented toward risk and uncertainty as well as the courage to confront issues in the production and sale of vegetables in the background of climate change. The risk bearability of farmers were measured with the help of the scale developed by Gajendra (2011) with necessary modifications required for the study. The scale consisted of six statements, out of which, statements number 1, 2, 5 and 6 were positive and statement number 3 and 4 were negative.

The responses from the farmers were obtained against each item of their degree of agreement or disagreement expressed on five-point continuum. The positive statements were scored as 5, 4, 3, 2 and 1 for strongly agree, agree, undecided, disagree and strongly disagree, whereas negative statements were scored as 1,2,3,4 and 5 for strongly agree, agree, undecided, disagree and strongly disagree. The total score ranges from 0 to 30. The total score was computed and the respondents were classified into low, medium and high based on the mean and standard deviation.

3.6.14. Market orientation

It refers to the degree with which the farmer respondent is focused on the market in terms of the demand and price of his produce. In this research the scale followed by Sajeev (1989) was adopted with appropriate modification. The scale consisted of six statements, out of which, statements number 1, 2, 4 and 6 were positive and statement number 3 and 5 were negative.

The responses from the farmers were obtained against each item of their degree of agreement or disagreement expressed on five-point continuum. The positive statements were scored as 5, 4, 3, 2 and 1 for strongly agree, agree, undecided, disagree and strongly disagree, whereas negative statements were scored as 1,2,3,4 and 5 for strongly agree, agree, undecided, disagree and strongly disagree. The total score ranges from 0 to 30. The total score was computed and the respondents were classified into low, medium and high based on the mean and standard deviation.

3.6.15. Scientific orientation

Scientific orientation was operationalized as the degree to which farmer respondent is oriented to adopt scientific methods in agriculture related decision making. The scientific orientation of farmers was measured with scale developed by Supe and Singh (1969) which was followed by Kumari (2020) with necessary modifications for the study. The scale consisted of five statements, out of which, statements number 1, 2, 3 and 4 were positive and statement number 5 was negative.

The responses from the farmers were obtained against each item of their degree of agreement or disagreement expressed on five-point continuum. The positive statements were scored as 5, 4, 3, 2 and 1 for strongly agree, agree, undecided, disagree and strongly disagree, whereas negative statements were scored as 1,2,3,4 and 5 for strongly agree, agree, undecided, disagree and strongly disagree. The total score ranges from 0 to 25. The total score was computed and the respondents were classified into low, medium and high based on the mean and standard deviation.

3.7. Operationalization and measurement of dependent variable

The dependent variables selected for the study includes 'farmers awareness on climate change', 'farmers perceptions on effect of climate change' and 'climate change adaptation strategies'. Details of the methodology adopted to measure each of them are explained below:

3.7.1. Farmers awareness on climate change

Awareness is operationally defined as the degree to which the farmers had information regarding climate change. It was analysed using a structured schedule developed, following the method used by Gopal *et al*. (2014) with suitable modifications for the study. The schedule consisted of 10 items related to climatic variables like temperature, precipitation and wind. To prevent ambiguity and uncertainty in interpreting the intended meaning, each statement was carefully edited.

Awareness of farmer respondents were noted as 'aware', and 'not aware' with corresponding scores of '2' and '1' respectively. The indicators included in the schedule are reflective of the changes occurs in various climatic variables during climate change. Extent of awareness of a farmer on climate change was obtained by summing the scores obtained for each item.

Table 3.4. Farmers awareness on climate change

Sl. No.	Climate change indicators	Awareness	
		Aware (2)	Not aware (1)
1	Change in average temperature		
	Minimum temperature		
	Maximum temperature		
2	Change in average precipitation		
	Minimum precipitation		
	Maximum precipitation		
3	Increase in number of rainy days		
4	Fluctuations in onset of monsoons		
5	Uneven distribution of rainfall		
6	Occurrence of more and longer dry spells as compared to the past		
7	Increased frequency of heatwaves		
8	Increase in windspeed		
9	Increase in duration of wind		
10	Prolonged cold weather		

3.7.2. Farmers' perception on effect of climate change

Many researchers have hypothesized the existence of links between farmers' and other stakeholders' climate change perceptions and valuation, as well as their adaptation responses with climate records (Cannon and Muller- Mahn*,* 2010 and Mertz *et al.,* 2010). The Cambridge Dictionary describes the meaning of perception as "a belief or opinion, often held by many people and based on how things seem". Nwakile *et al*. (2020) narrated perception as an act of being conscious of one's surroundings through sensory experiences, and it indicates a person's ability to understand. In this study, farmers perception of effect of climate change is operationalized as the farmers consciousness about the changing climate and its impact/consequences on vegetable farming over the years.

An index-based approach is followed to measure the farmers perception on the effect of climate change. An index developed by Dhanya and Ramachandran (2016) is adopted with suitable modification. Identification of major components on the effect of climate change in line with the objective of the study were done through exhaustive literature survey and expert consultation.

A total 35 indicators were collected covering different aspects on the effect of climate change. Most relevant and appropriate indicators were selected for the final study by consulting fifteen experts from different domains as vegetable science, agricultural entomology, agronomy, soil science, animal husbandry, agricultural extension. The developed framework identified those six major components and 28 indicators. The components and the indicators are detailed below (Table 3.5)

The respondents were asked to indicate their perception on the effect of climate change on different aspects with the severity with which they perceive. These were given a four-point continuum of severe, moderate, mild and nil with corresponding weights of three, two, one and zero respectively.

Table 3.5. Farmers perception on effect of climate change

Sl. No	**Effects**	**Indicators/ way as experienced**	**Severity as perceived by farmer**				**Source**
			Nil (0)	**Mild (1)**	**Moderate (2)**	**Severe (3)**	
1	Water related	Water shortage					Acquah and Frempong (2011)
		Quality issues (salinity, heavy metal)					Acquah and Frempong (2011)
2	Crop related	Increase in growing period					Mahuta (2014)
		Reduction in crop yield					Ajonina *et al.* (2021)
		Quality deterioration					Acquah and Frempong (2011)
		Decreased shelf life					Srinivasarao *et al.* (2020)
		Pest and disease outbreak					Manandhar *et al*. (2015)
		Emergence of new weeds					Shrestha *et al.* (2022)
		Increased crop weed competition					Shrestha *et al.* (2022)

		Increased water stress					Anseera (2018)
		Decrease in fertilizer use efficiency					Shrestha *et al.* (2022)
		Others (Specify)					
3	Calamity related	Heavy rain					Aryal *et al.* (2021)
		Drought					Elum *et al.* (2017)
		Hailstorm					Elum *et al.* (2017)
		Flood					Pandey (2019)
		Landslide					Pandey (2019)
		Others (Specify)					
4	Soil related	Reduced soil fertility					Mondal (2021)
		Depletion of ground water					Taylor *et al.* (2013)
		Disturbed soil structure					Mondal (2021)
		Increased soil erosion					Oriakhi *et al.* (2016)
		Reduced water					Mondal (2021)

		holding capacity					
5	Animal husbandry related	Low productivity of livestock					Naqvi *et al.* (2015)
		Emergence and transmission of pest and diseases					Lacetera (2019)
		Increased mortality					Ali *et al.* (2020)
6	Others	Presence of new animal or bird species and straying od wild animals (Eg: Peacock)					Root and Schneider (2002)
		Increase in cost of cultivation					Nelson *et al.* (2009)
		Increase in adoption of non-farming activities for livelihood					Shrestha *et al.* (2022)
		Increase in urban					Nguyen and Sean (2021)

		migration of framers/ rural youth from rural areas					

3.7.3. Climate change adaptation strategies

Adaptation refers to adjustment in ecological, social or economic systems in reaction to present or anticipated climate stimuli and effects or impacts. Adaptation strategies were operationalized as the steps taken and/or implemented by the farming community to address the negative effects of climate change on their farming.

3.7.3.1. Prioritization of climate change adaptation strategies by the vegetable farmers

Adaptation represents the alterations made in processes, practices and structures in order to limit possible harm or take advantage of opportunities brought on by climate change. (Smit and Pilifosova, 2003).

From identification of an issue to search for alternative solutions, followed by decision making and execution, decision making is discerned and performed as a linear activity.

The Analytical Hierarchy Process (AHP) is a structured method based on mathematics and psychology for organising and analysing complex decisions. It was developed by Thomas L. Saaty in 1980, as a useful tool for handling complex decisions, and to help the decision-maker establish priorities and come to the ideal decision.

The AHP aids in capturing both subjective and objective components of a decision by breaking down complex decisions into a series of pairwise comparisons and then synthesising the results. Additionally, AHP incorporates a helpful method for evaluating the consistency of the decision maker's assessments, which minimises bias in the decision-making process.

Operation researchers and decision scientists have employed this strategy extensively over the past 20 years, especially in developed countries. However, it has also received criticism for several of its operational flaws (Zopounidis and Doumpos, 2002).

The AHP procedure was used among 40 key farmers (20 male and 20 female farmers) to prioritize the climate change adaptation strategies in the present study.

3.7.3.1.2. Step-wise procedure of Analytic Hierarchy Process (AHP)

Step I: Problem modelling

A precise operational definition of the construct is required in order to develop a more extensive understanding of it. This is used to determine what has to be accomplished and what elements needs to be taken into account for this. The results of prior research as well as expert opinion can be helpful in identifying the factors. Criteria will be derived under each factor. These are the fundamental components of 'problem modelling' in AHP. Index developed by Talanow *et al*. (2021) is adopted with suitable modification for this purpose.

Less number of criteria should be used in the problem structure whilst addressing a wide range of topics. The chosen criteria and factors ought to be relevant to the construct. In order to do so the judges who are experts in the related fields will be approached to rate the relevance of the selected factors and the criteria under each element.

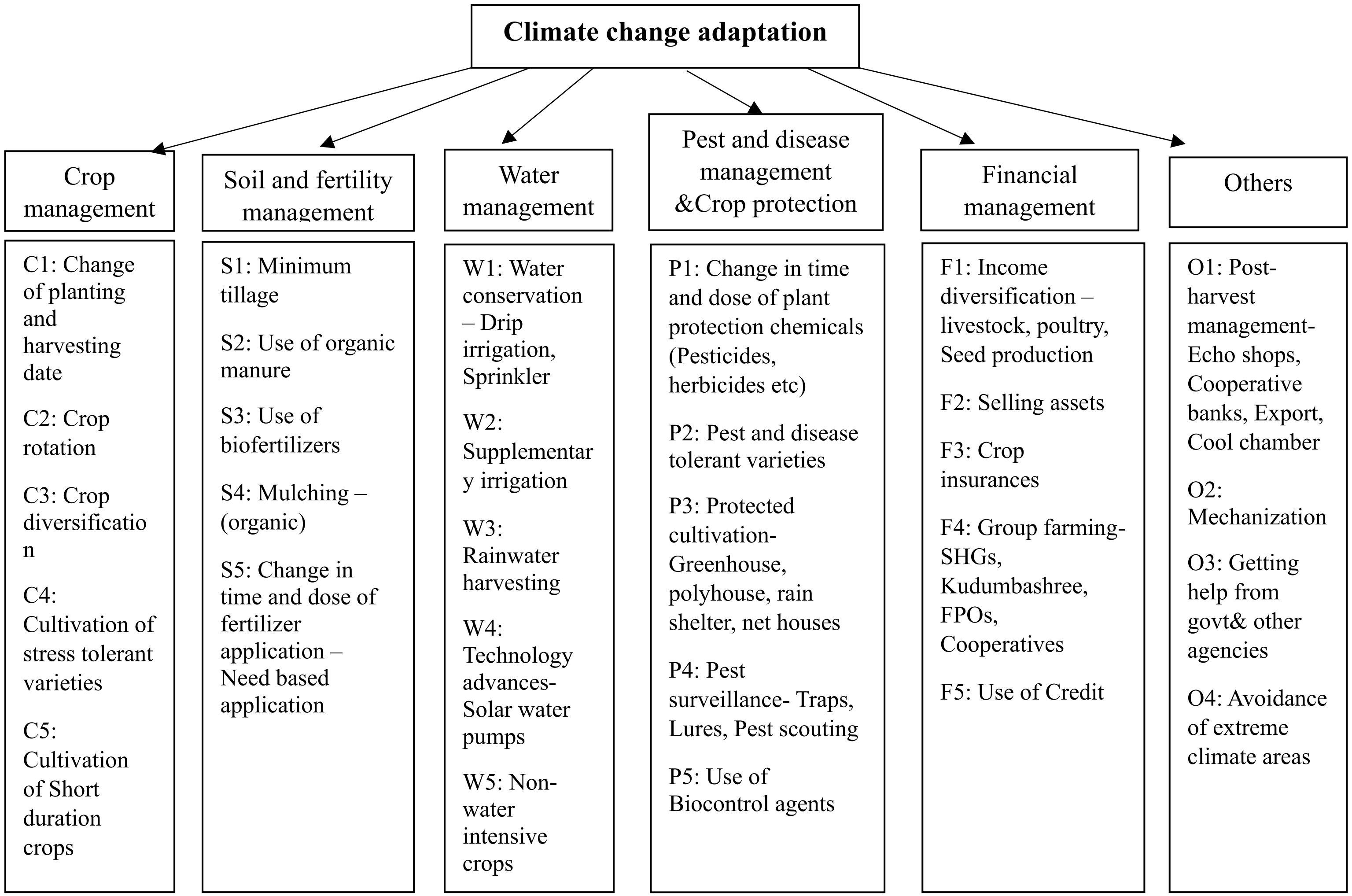


Fig 3.2. Problem modelling for prioritising the climate change adaptation strategies

Under component “crop management”, alternatives were “change of planting and harvesting date”, “crop rotation”, “crop diversification”, “cultivation of stress”, “tolerant varieties” and “cultivation of short duration crops”.

Under component “soil and fertility management”, “minimum tillage”, “use of organic manure”, “use of biofertilizers”, “mulching” and “change in time and dose of fertilizer application” were considered as alternatives.

Component “water management”, consisted of alternatives, “water conservation”, “supplementary irrigation”, “rainwater harvesting”, “technology advances” and “non-water intensive crops”.

Under component “pest and disease management”, alternatives were “change in time and dose of plant protection chemicals”, “pest and disease tolerant varieties”, “protected cultivation”, “pest surveillance” and “use of biocontrol agents”.

Component “financial management” consisted of alternatives “income diversification”, “selling assets”, “crop insurances”, “group farming” and “use of credit”.

Under component “others”, alternatives were “post- harvest management”, “mechanization”, “getting help from govt& other agencies” and “avoidance of extreme climate areas”.

Step II: Pair-wise comparison

The next stage involves the pair-wise comparison of various factors, and the following stage comprises of the pair-wise comparison of criteria. based on the comparison a ‘comparison matrix’ can be developed in each case (both factor and criteria).

$$M = (a_{ij}) = \begin{array}{c} \\ D_1 \\ D_2 \\ \vdots \\ D_n \end{array} \begin{pmatrix} D_1 & D_2 & \dots & D_n \\ 1 & a_{12} & \dots & a_{1n} \\ 1/a_{12} & 1 & \dots & a_{2n} \\ .. & .. & .. & .. \\ 1/a_{1n} & 1/a_{2n} & \dots & 1 \end{pmatrix}$$

M= Pair-wise Comparison matrix

Step III: Judgemental scale

The ability to compare qualitative and quantitative criteria and alternatives using the same preference scale is known as the key strength of AHP. The response can be turned into a cardinal measurement whether it is numerical, verbal, or graphical.

Saaty (2008) proposed a nine-point scale (Table 3.6) to compare various factors and criteria pair-wise. According to the relative relevance of each vocal remark, they will be converted into numbers ranging from one to nine in Saaty's AHP.

Table 3.6. The fundamental scale of absolute numbers

Intensity of importance	**Definition**	**Explanation**
1	Equal importance	Two activities contribute equally to the objective
2	Weak or Slight	
3	Moderate importance	Experience and judgement slightly favour one activity over another
4	Moderate plus	
5	Strong importance	Experience and judgement strongly favour one activity over another
6	Strong plus	

7	Very strong or demonstrated importance	An activity is favoured very strongly over another; its dominance demonstrated in practice
8	Very, very strong	
9	Extreme importance	The evidence favouring one activity over another is of the highest possible order of affirmation

(Adopted from Saaty, 2008)

Step IV: Aggregation of judgment

In AHP, a number of procedures are employed to aggregate the opinions of the decision-makers. The following two are the most common methods: 'Aggregation of Individual Judgments' (AIJ), and the 'Aggregation of Individual Priorities' (AIP).

Aggregation of Individual Judgments (AIJ) is done by aggregating individual judgments regarding each set of pair-wise comparisons to produce an aggregate hierarchy.

Aggregation of Individual Priorities (AIP) is performed by synthesizing each of the individual hierarchies and aggregating the resulting priorities (Forman and Peniwati, 1998).

According to Forman and Peniwati (1998) the optimal mathematical method for aggregation, depends on whether the group is considered of as a synergistic unit or as a collection of individuals. Aggregating Individual Judgement' (AIJ) with geometric mean in case of former and 'Aggregating Individual Priorities' (AIP) with either geometric mean or arithmetic mean should be used in the later scenario, respectively. Wu *et al*. (2008) compared several aggregating techniques and unequivocally asserted that the aggregation techniques had no impact on the outcomes.

Step V: Determination of Consistency Ratio

Consistency check must be used since only priorities resulting from consistent matrices would be useable and valid. A consistency index (CI), related to the eigenvalue method, was proposed by Saaty (1977). The 'Eigen value' ($\lambda_{\max}$) may be calculated by adding the products of each element of the 'Eigen vector' multiplied by the sum of the columns of the reciprocal matrix.

Additionally, he demonstrated that the largest 'Eigen value' ($\lambda_{\max}$ = n) is equal to the number of comparisons.

'Consistency Index' can be calculated by the following formula

$$CI = \frac{(\lambda_{\max} - n)}{(n-1)}$$

Where, n= dimension of the matrix
λ_{max}= maximal eigenvalue

The consistency ratio, the ratio of CI and RI, is given by:
CR = CI/RI,
Where RI is the random index

Table 3.7. Random Indices

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

(Adopted from Saaty and Forman, 1992; actual calculation made by Saaty, 1977)

As a general rule for the consistency of the matrix, consistency ratio should be smaller than 0.1.

Step VI: Calculation of priorities

Identification of the scaling factor is crucial since it will indicate how important a certain factor is in relation to the overall aim. Local priority refers to the priority or scaling factor inside a specific factor, while global or overall priority refers to the priority or scaling factor in connection to the overall aim. As a result, these priorities would indicate the critical relevance of each criterion or factor on the whole. Priority or local weights can be determined by dividing each element of row by the sum of each column in 'comparison matrix'.

To identify scaling factors or priority vectors, normalise the "Eigen vectors" by averaging the value of the factors/criteria across the new rows. It is possible to determine the relative importance of each factor to the overall goal and the local priority of the criterion in this way. However, the priority vector of the factors must be multiplied by the local priorities of the respective criteria within that particular factor in order to obtain the global priority of the criteria toward the overall aim.

3.7.3.2 Climate change adaptation index

A list of prioritized adaptation strategies followed among vegetable farming were prepared using the results AHP. Then an interview schedule was developed with a three-point continuum viz. full adoption, discontinued the adoption and non-adoption with the score of 2, 1, and 0. In order to quantify the adaptation strategies and to determine differential level of adoption of adaptation strategies, ***'Climate Change Adaptation Index (CCAI)'*** was calculated with the following formula:

$$\text{Climate change adaptation index (CCAI)} = \frac{\text{Obtained score}}{\text{Maximum obtainable score}}$$

3.7.4. Constraints faced by vegetable farmers with respect to climate change adaptation

Constraints experienced by farmers against adapting to climate change were examined using Garrett ranking method. Various difficulties or problems faced by farmers while adapting to climate change were identified while reviewing previous studies and collecting data from respondents. These barriers were listed out and asked them to rank each barrier according to their preferences. Then the rank given by the farmer respondent to each barrier was converted into the per cent position using the following equation of Garrett ranking: -

$$\text{Percent position} = \frac{100(R_{ij}-0.5)}{N_j}$$

Where, R_{ij} is the rank for i^{th} constraint experienced by the j^{th} individual

N_j is the number of constraints ranked by the j^{th} individual

Here the obtained rank was on an interval scale and its midpoint indicates the interval, thus 0.5 was subtracted from every rank obtained. Finally with the use of Garrett table the percent position obtained was reformed into score (Garrett and Woodworth, 1969). Then the mean score was calculated and ranked by using the obtained score for each constraint.

3.8. Tools used for data collection

By analysing prior research studies and consulting with experts in the field of agricultural extension, a semi structured interview schedule was developed. The interview schedule was examined using a pretesting. Based on the results a final interview schedule was prepared after the required modifications, additions, and omissions.

Additionally, information on agency roles and policies was gathered from primary and secondary sources. Review of reports, literature authored by different government and non-government organisations, and online resources were used to gather secondary data.

3.9. Statistical methods used to analyze data

Both descriptive and analytical statistics were used in the study. Wherever required, the data were further analyzed with specific analytical tools for testing the significant effects of the parameters under the study.

3.9.1. Percentages and frequency

The socio-economic profile characteristics of farmers, *viz*., age, education, farming experience, farm size, annual income, extend of farming integration, exposure to training, extension contact, social participation and financial assistance have been scrutinized with the statistical tools of percentages and frequency.

3.9.2. Arithmetic Mean

Mean values of the scores of the variables selected for the study were used to compare different groups and categorize respondents. Mean is the measure of central tendency and is calculated by dividing the sum of values of all observations by total number of observations.

$$\text{Mean} = \frac{\sum_{i=1}^{n} X_i}{n}$$

Where X_i is the value of i^{th} observation and n is the total number of observations.

3.9.3. Standard deviation

Standard deviation is the measure of dispersion and is calculated by taking square root of mean of squared deviations taken from arithmetic mean.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \mu)^2}{N}}$$

Where σ is the standard deviation, X_i is the i^{th} observation, μ is the arithmetic mean of all the observations, and N is the total number of observations

3.9.4. Categorization using mean and standard deviation

Simple frequencies and percentages were worked out to find the distribution of respondents based on the scores for different variables. Results of the independent variables selected for the study were interpreted using this analysis.

Category	Range (score)	Values
High	(≥ Mean+ S.D.)	≥ Mean
Medium	(≥ Mean+ S.D.) + (≤ Mean – S.D.)	Between
Low	(≤ Mean – S.D.)	≤ Mean

With regard to dependent variables, frequencies, percentages were found out and ranked accordingly.

3.9.5. Two sample t test

The two-sample t test was used to find out the difference between adoption of climate change adaptations between male and female vegetable farmers

3.9.6. Binary Logistic Regression

For the evaluation of qualitative dependent variables that have dichotomous groups while the independent variables are categorical, continuous and dummy binary logistic regression is used. It is calculated using the equation: -

$$Y = \text{Ln}\, \frac{P(X)}{1-P(X)} = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki}$$

Where, Y= Dependent variable

$X_1, X_2, X_3 \ldots, X_n$ = Explanatory variable inserted into the model for testing

$\beta_1, \beta_2, \beta_3 \ldots, \beta_n$ = Regression coefficients

β_0 = Intercept

Plate 2. Data collection from vegetable farmers and officials at Palakkad district

Farmer interview at Alathur

Farmer interview at Nenmara

Interviewing officials at Nenmara Krishi Bhavan

Interviewing official at Alathur VFPCK office

Plate 3. Field visits conducted at Palakkad district

Field visit at Alathur

Field visit at Kollengode

Field visit at Nenmara

Results & Discussion

Chapter 4
RESULTS AND DISCUSSION

This chapter explains the findings of the study based on the data gathered from the field and other sources. The results are based on data on farmer's perception on effect of climate change in vegetable farming, determinants of climate change adaptation behaviour of vegetable farmers and constraints with respect to climate change adaptations among the farmers. The context and previously studies have been discussed in relation to the results.

The findings of the study have been presented under the following sub headings:

4.1. Personal and socio-economic attributes of farmers selected for the study
4.2. Farmers' awareness on climate change
4.3. Farmers' perception on effect of climate change
4.4. Prioritization of climate change adaptation strategies by the vegetable farmers
4.5. Adaptation strategies adopted by the vegetable farmers
4.6. Adoption of climate change adaptations among male and female farmers
4.7. Determinants of climate change adaptations
4.8. Constraints with respect to climate change adaptation

4.1. Personal and socio-economic attributes of farmers selected for the study

Since adaptation to climate change is found to be greatly influenced by the socio-economic characteristics of the farmer, an analysis was done to draw out the profile of the farmers for the study and to find out whether these characteristics significantly influenced climate change adaptation shown by them. The socio-economic profile of the respondents is described below.

4.1.1. Age

Respondents were categorized into groups *viz.* young (up to 35 years), middle aged (36-45 years) and old aged (>45 years). Groups and their respective frequency and percentage are given below (Table 4.1).

Table 4.1 Distribution of respondents based on their age (n=160)

Category	Male farmers (n=80)		Female farmers (n=80)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Young age (up to 35)	6	7.5	11	13.75
Middle aged (36-55)	47	58.75	51	63.75
Old age (above 55)	27	33.75	18	22.5
Total	**80**	**100**	**80**	**100**

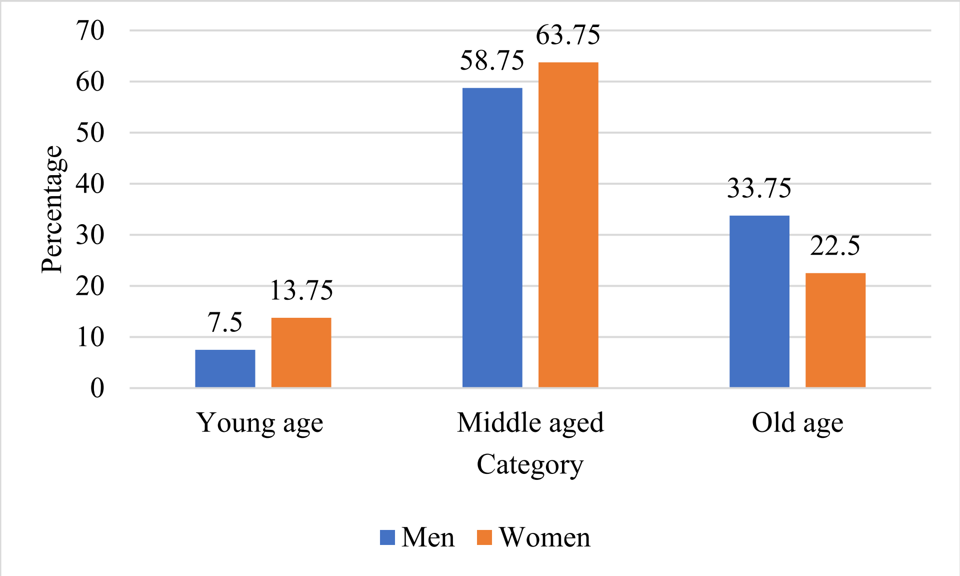


Figure 4.1. Distribution of respondents based on their age

Categorization of farmers based on their age showed considerable difference in the proportion of young and old age farmers, with majority of the respondent farmers coming under the middle-aged category. (See Table 4.1). The average age of the male farmers was found to be 51. About three fifth of the respondents (58.75%) and one third (33.73%) of the farmers belonged to 'middle age' and 'old age' groups respectively. Young age category comprised only 7.5 per cent of the male respondents. The average age of the female farmers was found to be 48. More than three fifth (63.73%) of the respondent women were belonged to 'middle age' and 22.5 per cent in 'old aged' category respectively. 13.75 per cent of respondent women farmers belonged to the young age category. These findings are found to be in agreement with the findings of Agyei *et al*. (2012) and Misganaw *et al*. (2014).

The above findings might be due to the fact that young generation are more inclined towards other livelihood sources than agriculture. Some traditional middle aged and old farmers have also expressed their indifference to pursue farming as their livelihood option. This might be explained by the long time it takes for agriculture to produce returns, its vulnerability to climatic change, and its unpredictable potential to provide lucrative rewards.

4.1.2. Gender

It was observed that women's participation in agriculture was influenced by the socio-economic status of the family. It is observed that women were working on the land owned by them. Better educational status and social network are found to be influencing the participation of women in vegetable farming. These findings were in line with the observations of Asfaw and Admassie (2004) and Mersha and Laerhoven (2016).

4.1.3. Education

According to the educational level, the respondents were classified into 6 categories, as shown in the Table 4.2 given below.

Table 4.2 Distribution of respondents based on their education (n=160)

Category	**Male farmers (n=80)**		**Female farmers (n=80)**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Illiterate	-	-	-	-
Primary education	6	7.5	10	12.5
Upper primary education	13	16.25	17	21.25
Secondary	41	51.25	30	37.5
Higher secondary	14	17.5	15	18.75
Graduate and above	6	7.5	8	10
Total	**80**	**100**	**80**	**100**

Based on the survey results, the slightly above half (51.25%) of the male vegetable farmers had secondary level of education, followed by those with higher secondary (17.5%), upper primary (16.25%), primary and graduate levels of education.

Whereas a lower percentage of female vegetable farmers (37.5%) had secondary level of education compared to male farmers. Followed by those with higher upper primary (21.25%), higher secondary (18.75%), primary (12.5%) and graduate (10%) levels of education. None of the farmers in both genders were found illiterate.

Thus, we could conclude that all the farmers in the sample were found literate and more than half of them (75% male and 71.25% female) were educated at least up to secondary level. The probable reason for this result may be the high literacy rate prevalent in the state (GOI, 2011). Furthermore, the results are consistent with the findings of Trinh *et al*. (2018).

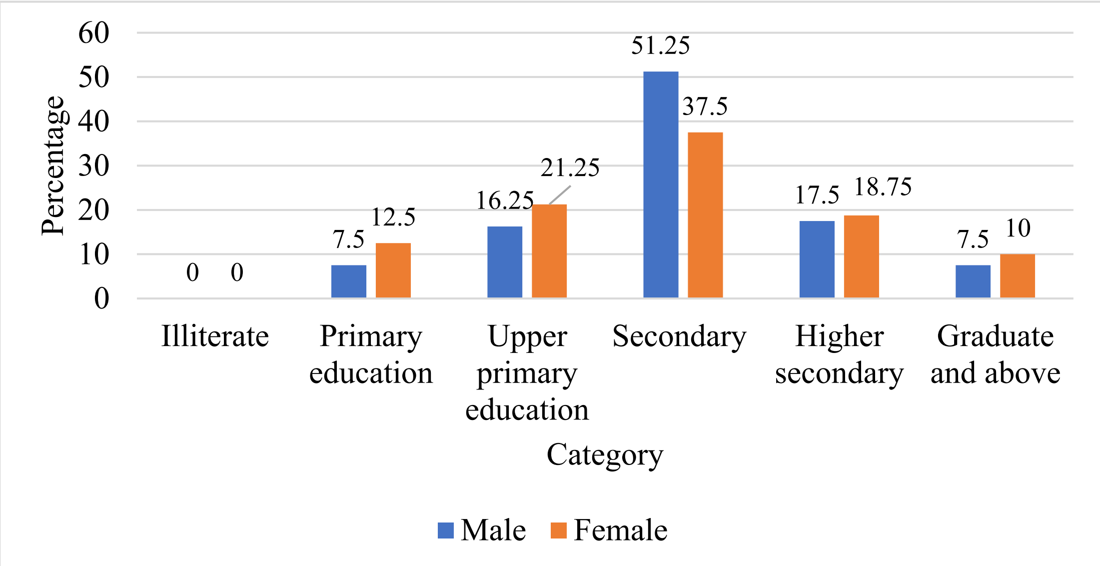


Figure 4.2. Distribution of respondents based on their education

4.1.4. Farming experience

Experience of the farmers was measured in terms of the number of years their engagement in vegetable farming. Considering the years of farming experience of the respondents they were classified into 3 categories. Distribution of respondents based on their experience is presented below in Table 4.3.

Table 4.3. Distribution of respondents based on their experience (n=160)

Category	Male farmers (n=80)		Female farmers (n=80)	
	Frequency	Percentage	Frequency	Percentage
<12 years	12	15	22	27.5
12-26 years	56	70	50	62.5
>26 years	12	15	8	10
	Mean= 19.37 S.D.= 7.28			

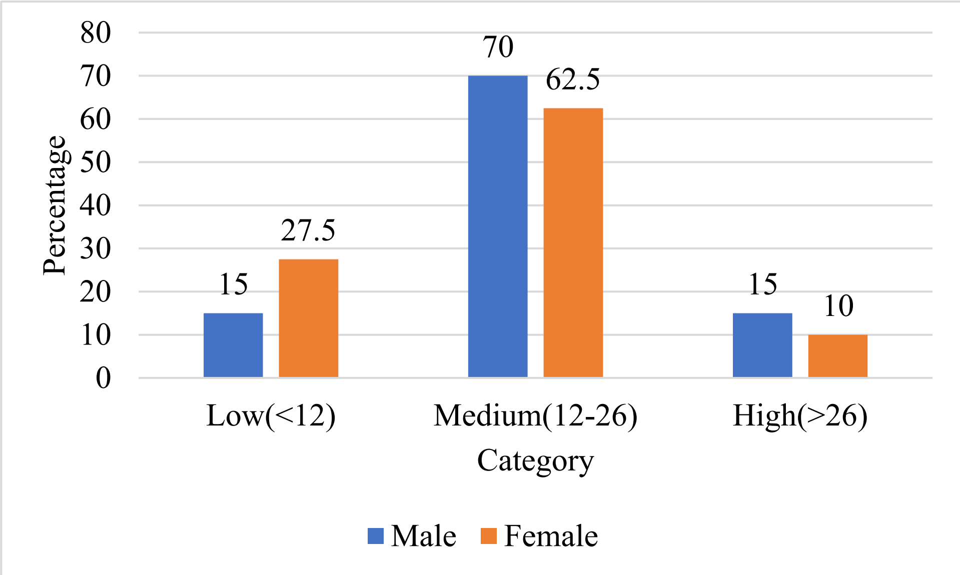


Figure 4.3. Distribution of respondents based on their experience

More than half of the respondent male farmers (70%) and female farmers (62.5%) had medium range of farming experience (12-26 years), followed by farmers with more than 26 years of experience (15% male farmers and 10% female farmers). 27.5 per cent female farmers have low farming experience of less than 12 years compared to 15 per cent of male farmers. Based on the results it can be inferred that the majority of the respondents (66.25%) had a medium range of farming experience. This might be because more than half of the respondents were middle aged. The results are in agreement with Nwobodo and Agwu (2015) and Bakhsh and Kamran (2019).

4.1.5. Farm size

Based on the cultivable land holding, farmers were categorized into marginal, small, semi-medium, medium and large. Frequency and percentage distribution of the farmers across these categories are listed below (Table 4.4).

Table 4.4. Distribution of farmers based on farm size (n=160)

Category	Male farmers (n=80)		Female farmers (n=80)	
	Frequency	Percentage	Frequency	Percentage
Marginal farmers (<1 ha)	52	65	63	78.75
Small farmers (1-1.99 ha)	21	26.25	14	17.5
Semi- medium farmers (2-3.99 ha)	6	7.5	2	2.5
Medium farmers (4-9.99 ha)	1	1.25	1	1.25
Large farmers (≥ 10 ha	-	-	-	-
Total	**80**	**100**	**80**	**100**

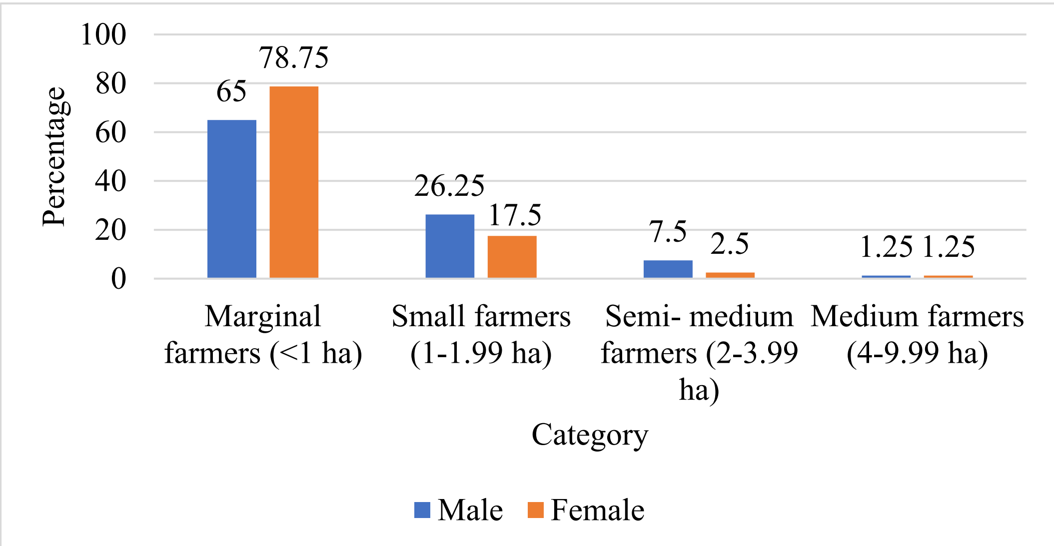


Figure 4.4. Distribution of farmers based on farm size

Majority of farmers belonged to marginal farmers (65% male and 78.75% female) with farm size less than 1 hectare land followed by small farmers (26.25% males and 17.5% females) with farm size between 1-1.99. It is evident from the results that majority of the farmers were marginal and small holders. This may be attributed to the fact that the state has smallest average size of the holdings and majority of the farmers falls under the small to marginal categories. Furthermore, these results are in agreement with the Kide (2014) and Ashraf *et al*. (2014).

4.1.6. Annual income

Farmers were categorized in to different income categories based on their income from agriculture and other sources on yearly basis. The frequency and percentage of farmers under each category are listed below (Table 4.5).

Table 4.5. Distribution of farmers based on their annual income (n=160)

Category	Male farmers (n=80)		Female farmers (n=80)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Low (<1.30 lakhs)	17	21.25	26	32.5
Medium (1.30-3.74 lakhs)	48	60	41	51.25
High (>3.74 lakhs)	15	18.75	13	16.25
	Mean= 2.52 S. D= 1.21			

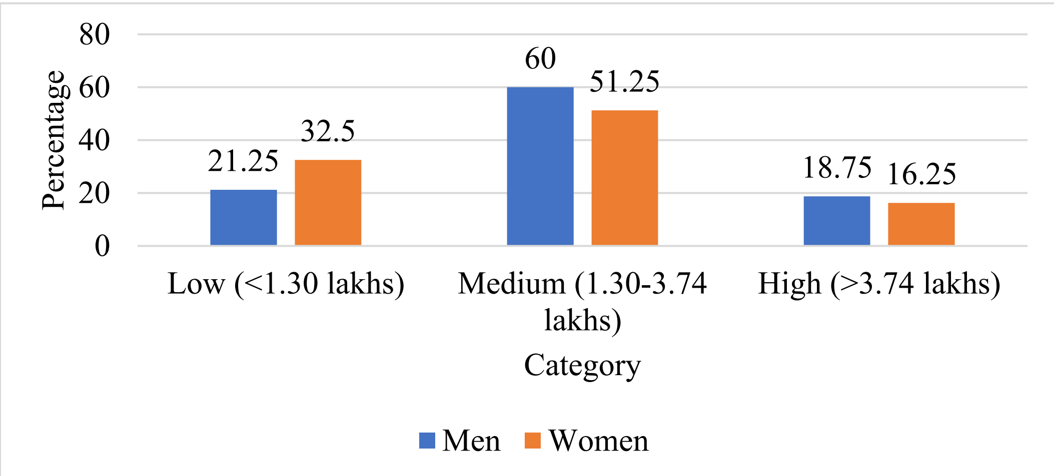


Figure 4.5. Distribution of farmers based on their annual income

More than half of the respondent male farmers (60%) and female farmers (51.25%) had medium range of annual income (1.30- 3.74 lakhs), followed by farmers with annual income of less than 1.30 lakhs (21.25% male farmers and 26.25% female farmers). 18.75 per cent male farmers have annual income of more than 3.74 lakhs compared to 16.75 per cent of female farmers. Based on the results it can be inferred that the more than half of the respondents (55.62%) had a medium range of annual income.

The average annual income of the farmer respondents was found to be 2.52 lakhs. This analysis showed the real plight of farmers and the low profitability of farming as a mean of livelihood. Majority of the respondents were found to have medium range of income, which has implications on their adaptation to climate change. These findings concur with the observations of Mabe *et al*. (2014) and Masud *et al*. (2015).

4.1.7. Extend of farming integration

Since climate change adaptation is possible only with the integration of farming with various allied activities, extent of integration was assessed based on frequency of farming integration with livestock (See Table 4.6)

Table 4.6. Distribution of farmers based on farming integration

Category	**Male farmers (n=80)**		**Female farmers (n=80)**	
	Frequency	**Percentage**	**Frequency**	**Percentage**
No components	49	61.25	52	65
Livestock	25	31.25	28	35
Pisciculture	4	5	-	-
Livestock+ Poultry	1	1.25	-	-
Livestock + Pisciculture	1	1.25	-	-
Total	**80**	**100**	**80**	**100**

More than half (61.25% of males and 65% of females) of the respondents in both gender groups were found to have not integrated any of the components. While 31.35 per cent male farmers and 35 per cent female farmers had integrated their farming with livestock. 5 per cent of male respondents were found to have integrated pisciculture with vegetable farming.

The results clearly showed that integration of various allied activities with farming is not widely practiced by farming community. Farmers reported that due the ill effects of climate change on farm animals, including disease outbreaks and decrease in productivity, most of them had discontinued farm integration. These observations were consistent with the observations made by Belay *et al*. (2017).

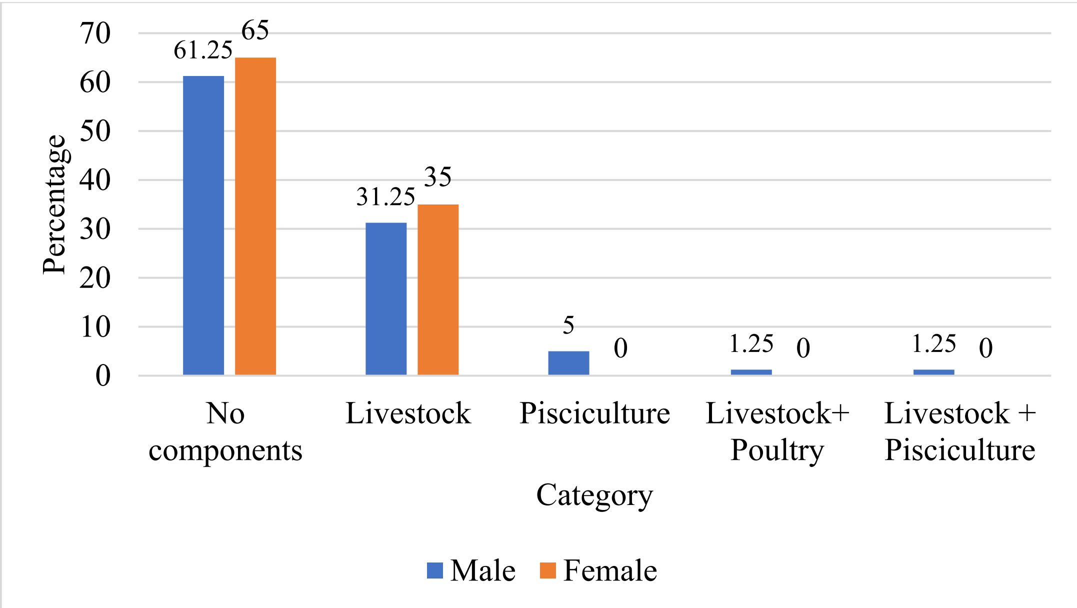


Figure 4.6. Distribution of farmers based on farming integration

4.1.8. Access to climatological information

The degree of utilization of different forms of media for acquiring awareness and knowledge on climatic information is observed to be varying among respondents. Distribution of farmers based on their frequency of access to climatological information is as follows.

Table 4.7. Distribution of farmers based on their access to climatological information through informal sources

Information source	Male (%)			Female (%)		
	Never	Occasionally	Regularly	Never	Occasionally	Regular
Fellow farmers	1.25 (1)	5 (4)	93.75 (75)	-	8.75 (7)	91.25 (73)
Neighbours	1.25 (1)	6.25 (5)	92.5 (74)	-	6.25 (5)	93.75 (75)

(Values within parentheses indicates frequencies)

From table 4.7, it is evident that with regard to informal sources, majority of male respondents (93.75%) acquired climatological information through fellow farmers regularly followed by their neighbours (92.75%). Majority (93.75%) of the female respondents were found to acquire climatological information from their neighbours followed by their fellow farmers (91.25%). The results indicates that fellow farmer and neighbours are more accessible and regarded as reliable by the farmers.

Table 4.8. Distribution of male farmers according to frequency of contact with mass media

Sl.No.	Source	Frequency of contacts			TS	MS	Rank
		Regularly (2)	Occasionally (1)	Never (0)			
1	Print	39	25	16	103	1.28	II
2	Radio	3	14	63	20	0.25	IV
3	Television	50	27	3	127	1.58	I
4	Social media	39	14	27	92	1.15	III

Table 4.9. Distribution of female farmers according to frequency of contact with mass media

Sl.No.	Source	Frequency of contacts			TS	MS	Rank
		Regularly (2)	Occasionally (1)	Never (0)			
1	Print	44	25	11	113	1.41	II
2	Radio	-	14	66	14	0.17	IV
3	Television	54	25	1	133	1.66	I
4	Social media	32	23	25	87	1.08	III

From table 4.8 and 4.9, it is evident that with regard to mass media sources, television was the most preferred source of information because most of the respondents had television at their houses and the programmes providing climatic information such as Krishi Darsan were concurrent with their free time. Print media was the second most preferred source of information because of the accessibility. And radio was the least preferred source of information and was replaced by other mass media. Despite the increasing penetration and influence of internet and social media, farmers are reluctant to use it due to various constraints such as high cost of data service, inadequate service of network and speed and difficulty to find relevant information. The results are found to be in line with the findings of Abid *et al*. (2014) and Regasa and Akirso (2019).

4.1.9. Exposure to training

Since climate change has been playing major role in changing the agricultural scenario in Kerala, it is imperative that our farming community gets adapted to the effects it causes. It is evident that department of agriculture had provided farmers with different training programs on various dimensions of climate change adaptation. Distribution of farmers based on the frequency of exposure to training programmes that facilitated awareness and adoption of climate resilient practices are categorized and provided below.

Table 4.10. Distribution of farmers based on the frequency of exposure to training programmes

Category	Male farmers (n=80)		Female farmers (n=80)	
	Frequency	**Percentage**	**Frequency**	**Percentage**
Not attended	10	12.5	9	11.25
Attended	70	87.5	71	88.75
Total	**80**	**100**	**80**	**100**

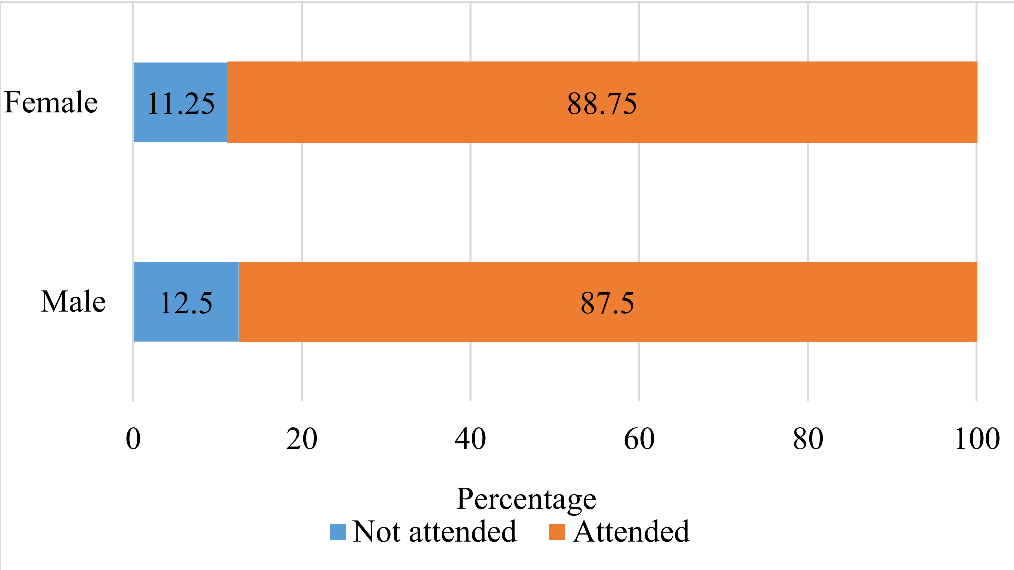


Figure 4.7. Distribution of farmers based on the frequency of exposure to training programmes

The results showed that a large number of farmers (87.5% male and 88.75% female) have attended training programmes. It implies that farmers were aware about the importance of training, as it provides an opportunity to imply necessary skills along with gain in theoretical knowledge. Remaining farmers (12.5% male and 11.25% female) have not participated in any of the training programmes on climate change. Farmers unattendance in the training programmes might be because of their round the clock work schedule as they have to work in the field, lack of time awareness and location of the training institutes. The respondents generally attended training programmes organized by VFPCK in self-help groups. The findings are in accordance with the observations of Trinh *et al*. (2018) and Tangonyire and Akuriba (2020).

4.1.10. Extension contact

Mainstreaming climate change adaptation require regular contact with different extension agencies and officials as well participation in various activities conducted by these agencies including meetings, field visits, demonstrations, exhibitions and so on. The distribution observed is given in Tables 4.11, 4.12, 4.13 and 4.14.

4.1.10.1. Extension agency contact

Table 4.11. Distribution of male farmers according to frequency of contact with extension agencies and officials

Sl.No.	**Extension official**	**Frequency of contacts**			**TS**	**MS**	**Rank**
		Regularly (2)	Occasional (1)	Never (0)			
1	Agricultural Officer	57	19	4	133	1.66	II
2	Agricultural Assistant	55	21	4	131	1.63	III
3	VFPCK Officers	74	6	-	154	1.92	I
4	ATMA BTM’s	4	24	52	32	0.4	IV

Table 4.12. Distribution of female farmers according to frequency of contact with extension agencies and officials

Sl.No.	Extension official	Frequency of contacts			TS	MS	Rank
		Regularly (2)	Occasional (1)	Never (0)			
1	Agricultural Officer	47	30	3	124	1.55	II
2	Agricultural Assistant	44	32	4	120	1.5	III
3	VFPCK Officials	71	7	2	149	1.86	I
4	ATMA BTM's	6	17	57	29	0.36	IV

From table 4.11 and 4.12, it is evident that with regard to extension agency/official, VFPCK officials were most preferred because the agency was active in bringing about overall development of fruit and vegetables. In the selected area of study agencies and officials were easily accessible at village level. Agricultural Officers were the second most preferred extension officials. And ATMA BTM's were the least preferred due to difficulty in accessing them personally. These results are found to be in line with the observations of Gbetibouo (2009).

4.1.10.2. Extension participation

Table 4.13. Distribution of male farmers according to frequency of participation in extension programmes

Sl. No.	Programme	Frequency of participation			TS	MS	Rank
		Regularly (2)	Occasional (1)	Never (0)			
1	Group meetings	67	11	2	145	1.81	I

2	Educational visits	21	51	8	93	1.16	II
3	Kisan mela and exhibitions	17	29	34	63	0.78	IV
4	Demonstration	31	42	7	104	1.3	III
5	Seminar	12	29	34	53	0.66	V

Table 4.14. Distribution of female farmers according to frequency of participation in extension programmes

Sl.No.	Programme	Frequency of participation			TS	MS	Rank
		Regularly (2)	Occasional (1)	Never (0)			
1	Group meetings	69	10	1	148	1.85	I
2	Educational visits	6	39	35	51	0.63	III
3	Kisan mela and exhibitions	2	8	70	12	0.15	V
4	Demonstration	22	47	11	91	1.13	II
5	Seminar	3	20	57	26	0.32	IV

From table 4.13 and 4.14, it is evident that with regard to extension participation, despite the gender group meeting were most participated programme because these were easy to conduct among the farmers. Educational visits were the second most participated programme among male vegetable farmers due to their better social exposure. Demonstrations were the second most participated extension programme among female farmers because these were conducted at their own vegetable fields. Seminars and exhibitions were the least participated programmes due to difficulty in reaching the places these were conducted at. It is observed that male farmers more regularly participated in extension programmes compared to female farmers except for group meetings. These observations are in agreement with findings of Jamadar (2012).

4.1.11. Social participation

The involvement of respondents in organizations like cooperative societies, self-help groups, farmer organizations etc. either as a member or as an office bearer were assessed and the results obtained is given in Table 4.15.

Table 4.15. Distribution of farmers based on their social participation (n=160)

Sl. No.	**Category**	**Male farmers (n=80)**		**Female farmers (n=80)**	
		Frequency	Percentage	Frequency	Percentage
1.	No membership in any organization	-	-	2	2.5
2.	Member in one organization	30	37.5	63	78.5
3.	Member in more than one organization	39	48.75	8	10
4.	Office bearer	11	13.75	7	8.75
Total		80	100	80	100

From the above Table 4.15, it is clear that all the male vegetable farmers had membership in at least one organization, with 13.75 per cent of them held official position in the organizations and 48.75 per cent of the respondents had membership in more than one organization. Majority of the female vegetable (78.5%) farmers too had membership in at least one organization, with 8.75 per cent of them held official position in the organizations and one tenth of respondents had membership in more than one organization. Most of the respondents had membership in the VFPCK- Self Help Groups. They are maintaining the membership to facilitate access to assured market, information, input and credit. These results are on par with the observations made by Khanal *et al*. (2019).

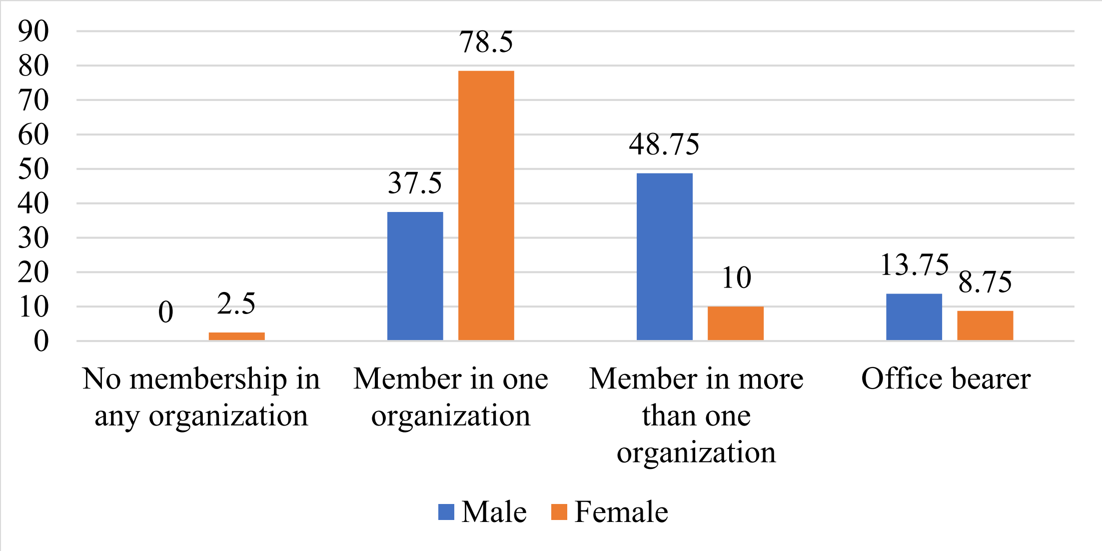


Figure 4.8. Distribution of farmers based on their social participation

4.1.12. Financial assistance

Financial assistance availed by farmer respondents is known to have an imperative effect on climate change adaptation. The result of the distribution of farmers based on credit availing and insurance is as follows (Table 4.16).

Table 4.16. Distribution of farmers based on availing credit and insurance (n=160)

Financial assistance	Male (%)		Female (%)	
	Availed	Not availed	Availed	Not availed
Credit	70 (56)	30 (24)	75 (60)	25 (20)
Insurance	63.75 (51)	36.25 (29)	60 (48)	40 (32)

(Values within parentheses indicates frequencies)

Among farmers of both gender groups, more than half (70% male and 75% female) were found to be availed credit. Remaining 30 per cent male farmers and 25 per cent female farmers were observed to be not availed credit. The results are found to be concur with the findings of Bryan *et al*. (2009).

A greater number of farmers (63.75% males and 60% females) were noted to be availed insurance. Remaining 36.25 per cent males and 40 per cent females found to be not availed insurance. The results are line with the observations of Swain (2014).

The avail of financial assistance among the farmer respondents implies to their readiness to invest into agricultural practices for improving production and to reduce the negative impact of climate change.

4.1.13. Risk bearability

Risk bearability of the farmers is reported to be very important in adopting new practices and evolving new ways of adaptation. Risk bearability is measured by a scoring technique, which elicited the degree to which farmers were oriented toward risk and uncertainty to confront issues in the production and sale of vegetables in the background of climate change. The results are given in Table 4.17.

Table 4.17. Distribution of male farmers based on their risk bearability

Category	**Percentage of farmers (n=160)**	
	Male (n =80)	**Female (n=80)**
Low (<15.86)	8.75 (7)	5 (4)
Medium (15.86-22.88)	67.5 (54)	87.5 (70)
High (>22.88)	23.75 (19)	7.5 (6)
	Mean= 19.38 S.D.= 3.5	

(Values within parentheses indicates frequencies)

More number of male farmers were found to be in category of low risk bearability as they tend to migrate to other places than be more dependent on vegetable cultivation.

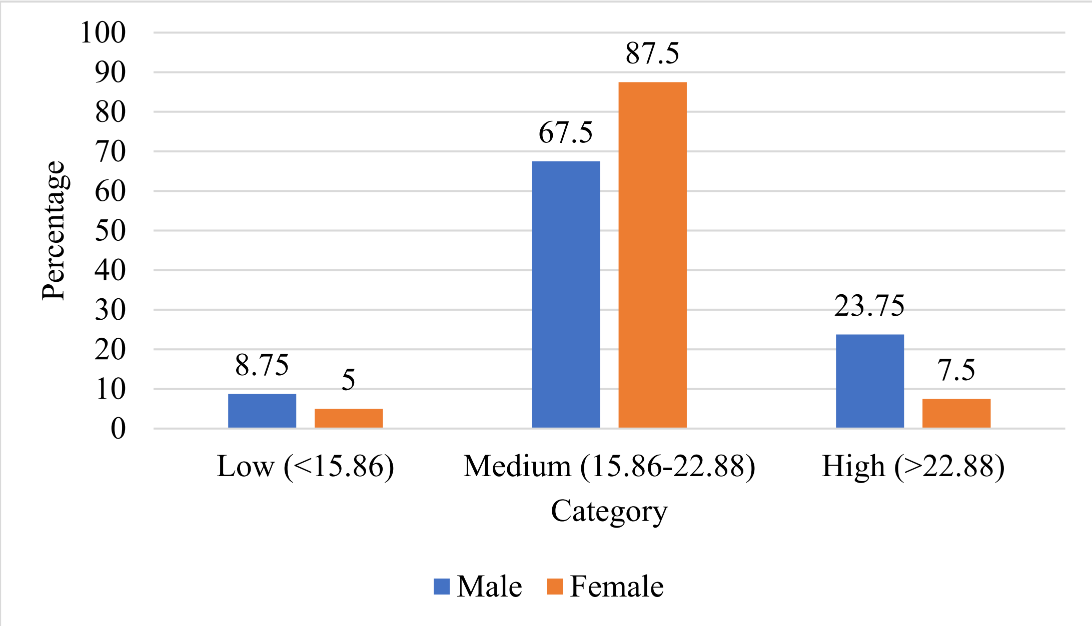


Figure 4.9. Distribution of male farmers based on their risk bearability

The distribution showed that majority of the respondents (67.5% male and 87.5% female farmers) were found to be having medium risk bearability. The proportion farmers with high risk bearability were only 23.75 per cent among male farmers and 7.5 per cent among female farmers. The medium level of risk bearability among the farmer respondents implies their readiness to accept and adopt new practices or technologies, to word off the loses and to ensure expected returns in farming.

4.1.14. Market orientation

Market orientation of the farmers is reported to be very important because it is the degree with which the farmer is focused on the market in terms of the demand and price of the produce. Market orientation is measured by a scoring technique and the results are given in Table 4.18.

Table 4.18. Distribution of farmers based on their market orientation

Category	Percentage of farmers (n=160)	
	Male (n =80)	**Female (n=80)**
Low (<15.48)	8.75 (7)	20 (16)
Medium (15.48-21.3)	72.5 (58)	72.5 (58)
High (>21.31)	18.75 (15)	7.5 (6)
	Mean= 18.4 S.D.=2.91	

(Values within parentheses indicates frequencies)

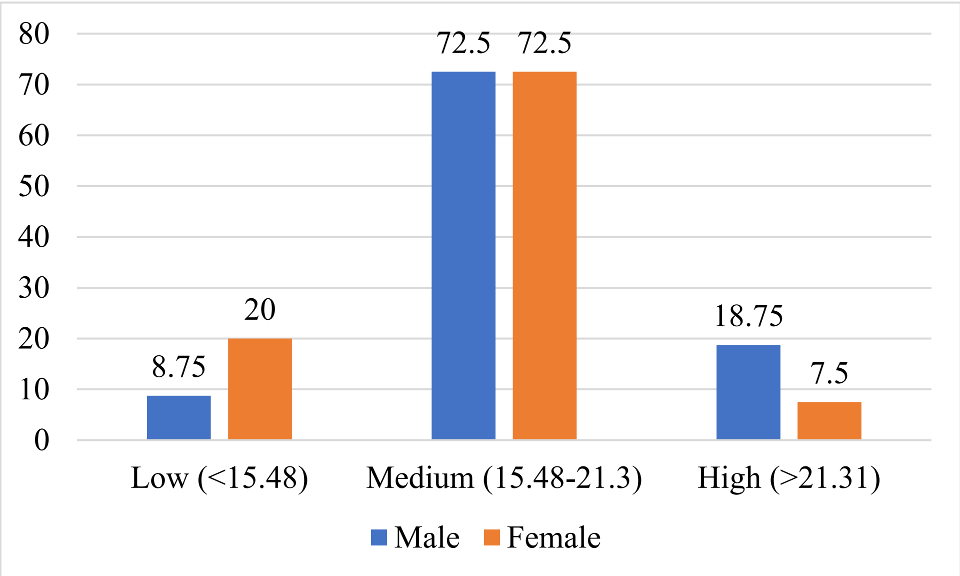


Figure 4.10. Distribution of farmers based on their market orientation

The distribution showed that majority (72.5% male and female farmers) of the respondents were found to be having medium level market orientation. Followed by 18.75 per cent among male farmers and 7.5 per cent female farmers were having high market orientation. The medium level of market orientation among the farmer respondents implies their readiness to focus on the market in terms of the demand and price of the produce in the background of climate change.

4.1.15. Scientific orientation

Scientific orientation is found to be crucial to climate change adaptation because it refers to the degree to which farmer respondent is oriented to adopt scientific methods in agriculture and related decision making. Scientific orientation is measured using scoring procedure and the results are given in Table 4.19.

Table 4.19. Distribution of male farmers based on their scientific orientation

Category	Percentage of farmers (n=160)	
	Male (n =80)	Female (n=80)
Low (<13.83)	13.75 (11)	17.5 (14)
Medium (13.83-20.40)	68.75 (55)	67.5 (54)
High (>20.40)	17.5 (14)	15 (12)
	Mean= 17.11 S.D.= 3.28	

(Values within parentheses indicates frequencies)

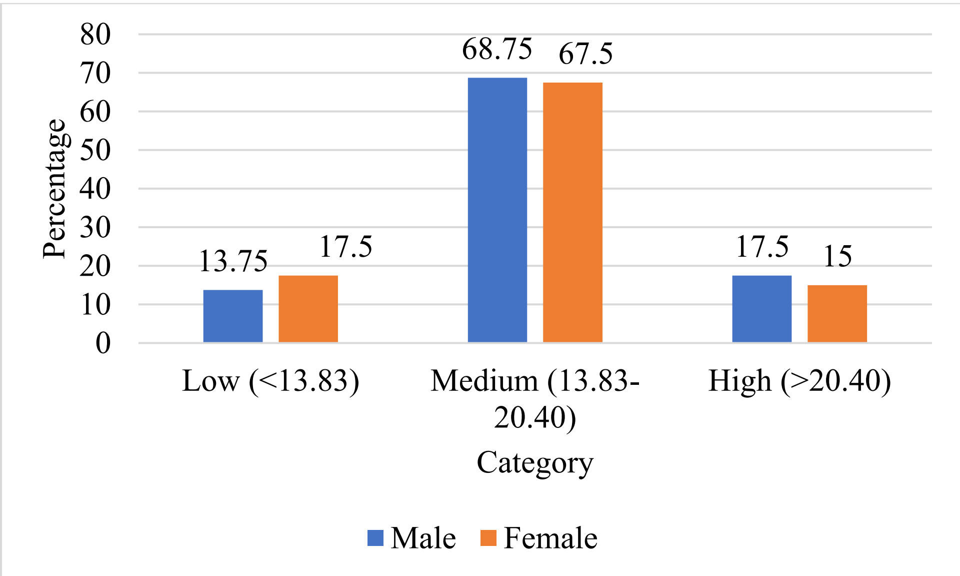


Figure 4.11. Distribution of male farmers based on their scientific orientation

Majority (68.75% male and 67.5% female) of the vegetable farmers were found to have medium scientific orientation. Followed by 17.5 per cent male and 15 per cent female respondents were found to have high scientific orientation. 13.75 per cent male farmers and 17.5 per cent female farmers were observed to have low scientific orientation. The medium level of scientific orientation among the farmer respondents implies to their readiness to adopt scientific methods in agriculture related decision making to combat climate change.

4.2. Farmers awareness on climate change

In this study we have analysed the awareness of farmers on climate change from their responses to various climatic indicators and is presented in Table 4.20. This was primarily used to assess the level of awareness among vegetable farmers on different climatic indicators so as to identify the information gap present among the vegetable growers.

The results indicated that most of the farmers who were constituted the sample of respondents had cognizance of the important climatic indicators. More than 90 per cent of the farmers were found to be aware of change in average temperature and precipitation, fluctuation in onset of monsoon, uneven distribution of rainfall occurrence of dry spells, increase in windspeed and prolonged cold weather. Majority of the farmers (71.875 %) were unaware of the increase in number of rainy days. Farmers opinionated that number of rainy days has decreased in the past decade.

The results were validated using the climatic data collected from Regional Agriculture Research Station, Pattambi. It was found that farmers cognizance was in line with this data except for the indicator - change in number of rainy days. In farmers' opinion, number of rainy days has decreased, but from the climatic data it was clear that there is an increase in the number of rainy days in the past decade.

Table 4.20. Distribution of farmers based on their awareness on climate change

Sl. No.	Climate change indicators	Awareness	
		Aware (2)	Not aware (1)
1	Change in average temperature		
	Minimum temperature	98.125 (157)	1.875 (3)
	Maximum temperature	98.75 (158)	1.25 (2)
2	Change in average precipitation		
	Minimum precipitation	100 (160)	-
	Maximum precipitation	100 (160)	-
3	Increase in number of rainy days	28.125 (45)	71.875 (115)
4	Fluctuations in onset of monsoons	100 (160)	-
5	Uneven distribution of rainfall	95.625 (153)	4.375 (7)
6	Occurrence of more and longer dry spells as compared to the past	99.375 (159)	0.625 (1)
7	Increased frequency of heatwaves	83.125 (133)	16.875 (27)
8	Increase in windspeed	92.5 (148)	7.5 (12)
9	Increase in duration of wind	86.25 (138)	13.75 (22)
10	Prolonged cold weather	95.625 (153)	4.375 (7)

(Values within parentheses indicate frequencies)

It has been observed that environmental communication occurs when socioeconomical, institutional, and geographical factors interact with humans. This helps in accumulating the environmental knowledge with addition to past erratic climate changes. It is evident in the result that personal attributes of respondents including education, framing experience, extension contact, exposure to training, access to climatic information social participation and financial assistance have a positive significant effect on their understanding on climate change. These results are in line with the findings of Sujit and Padaria (2010).

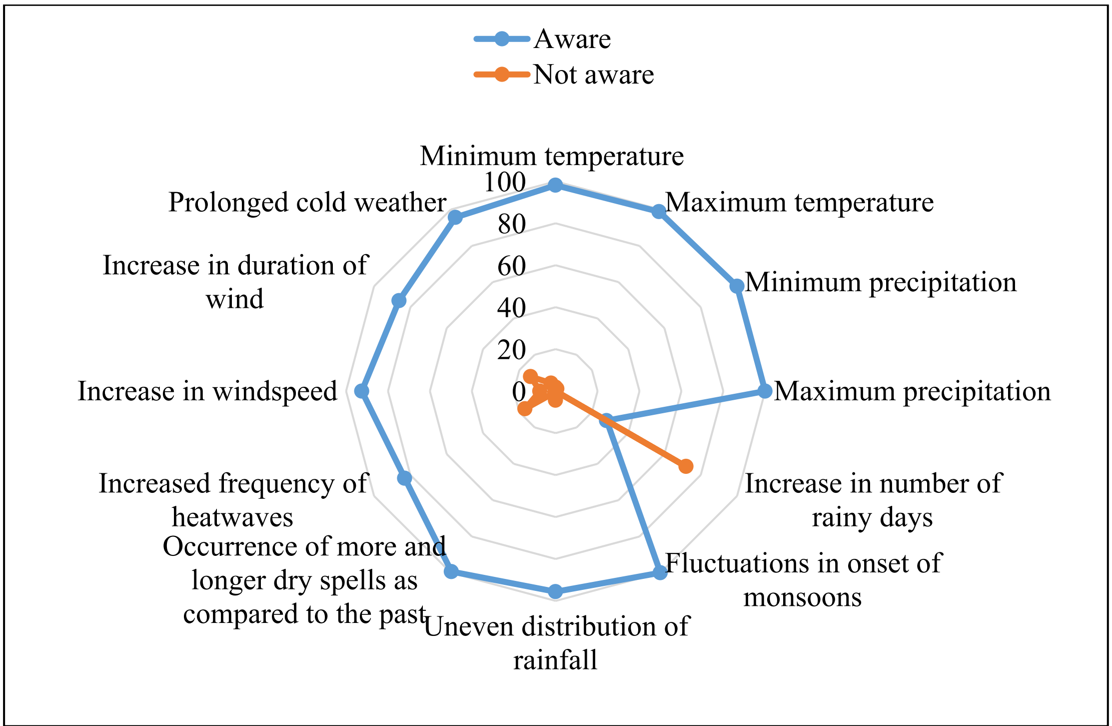


Figure 4.12. Distribution of farmers based on their awareness on climate change

4.3. Farmers' perception on effect of climate change - Gender disaggregated analysis

Gendered perceptions of climate variability are critical to understanding and interpreting the disparate impacts of climate variability on male and female farmers largely due to their social construction of gender roles and relations. Furthermore, gender-based perceptions of climate variability will have weight on male and female farmers' decisions to implement adaptation practices thereby reducing their vulnerabilities to the threats of the changing climate (Ahmed *et al*., 2016).

Distribution of vegetable farmers based on their perception on effect of climate change as estimated from their responses to various indicators related to water, crop, calamities, soil, animal husbandry and others is presented in tables. This was assessed to find the impact of climate change on vegetable farming. Farmer's perception on effects of climate change have been captured distinctively through four categories i.e., nil, mild, moderate, and severe.

4.3.1. Farmers perception on water related effects

Table 4.21 shows the farmer's perception on water related effects of climate change.

Table 4.21. Farmers perception on water related effects

Indicators/way as experienced	Percentage of male farmers (N=80)				Percentage of female farmers (N=80)			
	N	MI	MO	S	N	MI	MO	S
Water shortage	20 (16)	36.25 (29)	28.75 (23)	15 (12)	15 (12)	56.25 (45)	18.75 (15)	10 (8)
Quality issues (salinity, heavy metal)	66.25 (53)	25 (20)	8.75 (7)	-	76.25 (61)	21.25 (17)	2.5 (2)	-

(Values within parentheses indicate frequencies, N-Nil, MI-Mild, MO-Moderate, S-Severe)

Table 4.21 indicates that majority (65%) male farmers perceived mild to moderate level of water shortage, while three forth (75%) of the female farmers perceived mild to moderate water shortage. 15 per cent of male farmers reported severe water shortage, and 20 per cent felt no water shortage for farming activities.10 per cent and 15 per cent respondent female farmers observed severe water shortage and no water shortage for their farming activities respectively. It is noticeable from the table that more number of female farmers have experienced shortage of water. This can be explained by their role in collection of water in a farming household.

Majority of the male (66.25%) and female (76.25%) farmers haven't perceived water quality issues. About 33.75 per cent of the male and 23.75 per cent female vegetable farmers found to be experienced mild to moderate level quality issues related to water in the past 10 years. None of the respondents reported severe quality issues.

It is clear from the table that male vegetable farmers who possess important role in irrigation and water management has perceived more quality issues related to water as an effect of climate change more.

A larger number of the farmers were depending on open well as a source of irrigation water and under persistent dry weather conditions, the water level of these wells is found to be dropping, causing shortage of water. This is evidently the reason for farmers perceiving water shortage as an effect of climate change. The results are in line with inferences made by FAO (2011) and Salman *et al*. (2021).

4.3.2. Farmers perception on crop related effects

Distribution of male and female vegetable farmers based on their perception on effect of climate change as estimated from their responses to indicators related to crop is provided in Table 4.22.

It has been observed that majority (57.5% male and 68.75%) of the vegetable farmers from both genders have anticipated the mild to moderate increase in growing period of crops. Remaining 31.25 per cent male respondents and 28.75 per cent female farmers were found to be not perceiving the effect yet.

Table 4.22. Farmers perception on crop related effects

Indicators/ way as experienced	Percentage of male farmers (N=80)				Percentage of female farmers (N=80)			
	N	**MI**	**MO**	**S**	**N**	**MI**	**MO**	**S**
Increase in growing period	31.25 (25)	36.25 (29)	21.25 (17)	11.25 (9)	28.75 (23)	50 (40)	18.75 (15)	2.5 (2)
Reduction in crop yield	1.25 (1)	25 (20)	31.25 (25)	42.5 (34)	1.25 (1)	12.5 (10)	55 (44)	31.25 (25)
Quality deterioration	10 (8)	33.75 (27)	26.25 (21)	30 (24)	2.5 (1)	21.25 (17)	52.5 (42)	23.75 (19)
Decreased shelf life	6.25 (5)	45 (36)	36.25 (29)	12.5 (10)	6.25 (5)	25 (20)	60 (48)	8.75 (7)
Pest and disease outbreak	6.25 (5)	45 (36)	36.25 (29)	12.5 (10)	-	3.75 (3)	23.75 (19)	72.5 (58)
Emergence of new weeds	21.25 (17)	18.75 (15)	55 (44)	5 (4)	17.5 (14)	25 (20)	56.25 (45)	1.25 (1)
Increased crop weed competition	38.75 (31)	28.75 (23)	31.25 (25)	1.25 (1)	42.5 (34)	43.75 (35)	13.75 (11)	-
Increased water stress	10 (8)	52.5 (42)	36.25 (29)	1.25 (1)	13.75 (11)	61.25 (49)	23.75 (19)	1.25 (1)
Decrease in fertilizer use efficiency	6.25 (5)	47.5 (38)	46.25 (37)	-	2.5 (2)	67.5 (54)	30 (24)	-

(Values within parentheses indicate frequencies, N-Nil, MI-Mild, MO-Moderate, S-Severe)

Majority (56.25% male 67.5% female) farmers have found to be experienced mild to moderate reduction in crop yield. It is observed that 42.5 per cent male farmers and 31.25 per cent female farmers have reported severe reduction in the yield. It has been found from the table that equal number of farmers were experiencing the effect, but a greater number of male farmers have experienced it in a severe way.

In terms of crop quality deterioration 60 per cent of male respondents and 73.75 female respondents reported mild to moderate effect. It is observed that about 30 per cent male and 23.75 per cent female farmer have perceived severe deterioration in crop quality. One tenth of the male farmers were not experienced the effect in the last 10 years.

Majority of the male farmers (81.25% and 73.75% female) have noted to be perceiving mild to moderate decrease in shelf life of vegetables. It is found that 12.5 per cent male and 8.75 female perceived severe decrease in shelf life.

It is observed that majority (81.25%) of the male vegetable cultivators have perceived mild to moderate pest and disease outbreaks in the last 10 years. While only 27.5 per cent female farmers have perceived the same. It is found that 12.5 per cent male farmers and 72.5 per cent female farmers have reported the occurrence of severe outbreaks. It is noticeable that all the female farmers have perceived this effect of climate change on their farming and majority of them experienced this in a severe level.

Most of the respondents (73.75% male and 81.25% female) perceived mild to moderate increase in emergence of new weeds in the fields. A greater part (60% male and 57.5% female) of the farmers have reported mild to moderate increase in crop weed competition. None of the female farmers perceived severe increase in crop weed competition. It is observed that 38.75 per cent of the male respondents and 42.5 per cent female respondents were found to be not experienced the effect.

Majority of the farmers (88.75% male and 85% female) were observed to be experienced mild to moderate increase in water stress among vegetable crops in the last decade.

Major part of the vegetable farming community (93.75% males and 97.5% of females) perceived mild to moderate level decrease in fertilizer use efficiency among vegetable crops. None of the respondents were perceived a severe level change.

It is evident from the table that female farmers found to have better perception on crop related indicators except for crop weed competition and increase in water stress. The negative effects of climate change on crop will impact women farmers the hardest as they work under the most perilous circumstances in the sector with tougher conditions and poorer livelihood opportunities.

Most of the vegetable farmers have perceived effects of climate change on their vegetable crops. These results are in line with the findings of Lambrou and Nelson (2010) Talanow *et al.* (2021).

4.3.3. Farmers perception on calamity related effects

Distribution of male and female vegetable farmers based on their perception on calamity related effects of climate change as estimated from their responses to indicators is provided in table 4.23.

Table 4.23. Farmers perception on calamity related effects

Indicators/ way as experienced	Percentage of male farmers (N=80)				Percentage of female farmers (N=80)			
	N	MI	MO	S	N	MI	MO	S
Heavy rain	2.5 (2)	31.25 (25)	38.75 (31)	27.5 (22)	-	45 (36)	32.5 (26)	22.5 (18)
Drought	2.5 (2)	33.75 (27)	43.75 (35)	20 (16)	3.75 (3)	53.75 (43)	33.75 (27)	8.75 (7)
Hailstorm	100 (80)	-	-	-	100 (80)	-	-	-
Flood	21.25 (17)	28.75 (23)	41.25 (33)	8.75 (7)	17.5 (14)	50 (40)	21.25 (17)	11.25 (9)
Landslide	90 (72)	5 (4)	3.75 (3)	1.25 (1)	86.25 (69)	7.5 (6)	2.5 (2)	3.75 (3)

(Values within parentheses indicate frequencies, N-Nil, MI-Mild, MO-Moderate, S-Severe)

Majority (70% males and 77.5% females) have found to be perceived occurrence of heavy rains in mild to moderate level. It is observed that 27.5 per cent male and 22.5 per cent female farmers experienced severe heavy rains in the last decade as an effect of climate change. It is evident from the results that all the female farmers were experiencing occurrence of heavy rain as an after effect of climate change.

A large part (77.5% males and 87.5% females) of the farmers anticipated drought as an effect of climate change in mild to moderate level. It is found that 20 per cent males and 8.75 per cent females perceived this in severe level.

It is evident from the table that none of the farmer respondents have perceived hailstorm as an aftermath of climate change which indicates that the location of the study has not faced this calamity in the last decade.

It is observed that 78.75 per cent of the male and 82.25 per cent female respondents were noticed to be anticipated floods as an effect of climate change on mild to severe level in the last 10 years. It is found that one block in the study area was affected by the floods occurred in 2018 and 2019. Farmers were found to be anticipating the indicator since the area is susceptible to this calamity.

Majority of the farmers (90% males and 86.25% females) were not experienced landslides in their fields indicating the non-occurrence of the calamity in the study area in the last decade.

A large part of female farmers perceived calamities at severe levels especially flood and landslide as an effect of climate change because of the greater risk to survival and recovery. While severe effect of heavy rain and drought was more perceived by male farmers due to their higher participation in the vegetable production.

It is apparent that most of the farmers have perceived calamities as an effect of climate change. These results are found to be in agreement with the findings of Adger *et al*. (2005) Aryal *et al*. (2021).

4.3.4. Farmers perception on soil related effects

Distribution of male and female vegetable farmers based on their perception on soil related effects of climate change as estimated from their responses to indicators is provided in table 4.24.

Table 4.24. Farmers perception on effects of climate change on soil

Indicators/ way as experienced	Percentage of male farmers (N=80)				Percentage of female farmers (N=80)			
	N	MI	MO	S	N	MI	MO	S
Reduced soil fertility	15 (12)	30 (24)	42.5 (34)	12.5 (10)	10 (8)	23.75 (19)	56.25 (45)	10 (8)
Depletion of ground water	16.25 (13)	46.25 (37)	27.5 (22)	10 (8)	10 (8)	62.5 (50)	26.25 (21)	1.25 (1)
Disturbed soil structure	17.5 (14)	56.25 (45)	17.5 (14)	8.75 (7)	23.75 (19)	61.25 (49)	11.25 (9)	3.75 (3)
Increased soil erosion	53.75 (43)	23.75 (19)	13.75 (11)	8.75 (7)	43.75 (35)	45 (36)	8.75 (7)	2.5 (2)
Reduced water holding capacity	51.25 (41)	28.75 (23)	11.25 (9)	8.75 (7)	53.75 (43)	36.25 (29)	7.5 (6)	2.5 (2)

(Values within parentheses indicate frequencies, N-Nil, MI-Mild, MO-Moderate, S-Severe)

Pertains to the effects of climate change on soil, majority (72.4% of the males and 80% females) of the vegetable farmers perceived mild to moderate reduction in soil fertility. Majority (73.75% male and 88.75% female) of the farmers reported mild to moderate depletion of ground water. One tenth of male respondents perceived severe ground water depletion.

It is clear from the data that female farmers have experienced the depletion of ground water more, compared to male farmers. This can be because of the household role women possess related to the collection of water.

A large part (73.75% male and 72.5% female) of the respondents perceived mild to moderate disturbance in the soil structure in the past 10 years. While 17.5 per cent males and 23.75 per cent females were not experienced any effect. It is observed that 37.5 per cent male and 53.75 per cent female vegetable cultivators had mild to moderate perception on increased soil erosion. While 53.75 per cent of the male respondents and 43.75 per cent female respondents found to be not perceived the increase in soil erosion.

It is observed that 40 per cent of the male respondents and 43.75 per cent female respondents were observed to experience mild to moderate reduction in the water holding capacity of soil as an effect of climate change. Slightly more than half (51.25% males and 53.75 % females) not perceived this effect. Farmers seems to perceive effect related to soil erosion and reduction in water holding capacity because these effects are more anticipatable.

It is noticeable from the results that male farmers have experienced severe effects of climate change on soil more because of their title role on the land preparation during vegetable cultivation. Most of the farmers have experienced the effect of climate change on soil. These results were consistent with the findings of Lambrou and Nelson (2010) and Mondal (2021).

4.3.5. Farmers' perception on animal husbandry related effects

Distribution of the farmers respondents based on their perception on animal husbandry related effects of climate change as estimated from their responses to indicators is provided in table 4.25.

Table 4.25. Farmers perception on animal husbandry related effects

Indicators/ way as experienced	Percentage of male farmers (N=80)				Percentage of female farmers (N=80)			
	N	**MI**	**MO**	**S**	**N**	**MI**	**MO**	**S**
Low productivity of livestock	11.25 (9)	20 (16)	47.5 (38)	21.25 (17)	3.75 (3)	26.25 (21)	57.5 (46)	12.5 (10)
Emergence and transmission of pest and diseases	11.25 (9)	17.5 (14)	53.75 (43)	17.5 (14)	3.75 (3)	25 (20)	58.75 (47)	12.5 (10)
Increased mortality	17.5 (14)	37.5 (30)	38.75 (31)	6.25 (5)	17.5 (14)	58.75 (47)	21.25 (17)	2.5 (2)

(Values within parentheses indicate frequencies, N-Nil, MI-Mild, MO-Moderate, S-Severe)

Majority (67.5% male and 83.75% female) of the vegetable farmers perceived mild to moderate decrease in the productivity of the livestock in the past 10 years as an aftermath of climate change. It is found that 21.25 per cent male farmers and 12.5 per cent female farmers were experienced severe reduction in the productivity of livestock.

A greater number (71.25% male and 83.75% female) of respondents were found to have perception on emergence and transmission of pest and diseases among livestock. They reported mild to moderate effect. It is observed that17.5 per cent males and 12.5 per cent females have experienced severe outbreaks of livestock pests and diseases.

It is found that 76.25 per cent male farmers and 80 per cent female farmers were noticed to be perceived mild to moderate increase in mortality of livestock as an effect of climate change.

It is apparent from the results that more female farmers perceived mild to moderate on effects related to animal husbandry. This can be explained by their role in taking care of the livestock in an agricultural household. Severe level effects were perceived by male farmers who were possessing the economical ownership of farm animals. This result is supported by the observations made by Lambrou and Nelson (2010) and Shrestha *et al.* (2022).

4.3.6. Farmers perception on other effects

Distribution of the farmers respondents based on their perception on other effects of climate change as estimated from their responses to indicators is provided in table 4.26.

Indicators/ way as experienced	Percentage of male farmers (N=80)				Percentage of female farmers (N=80)			
	N	MI	MO	S	N	MI	MO	S
Presence of new animal or bird species (Eg:Peacock), wild animals straying into villages.	1.25 (1)	6.25 (5)	68.75 (55)	23.75 (19)	-	6.25 (5)	68.75 (55)	25 (20)
Increase in cost of cultivation	-	3.75 (3)	61.25 (49)	35 (28)	-	2.5 (2)	66.25 (53)	31.25 (25)
Increase in adoption of non-farming activities for livelihood	7.5 (6)	16.25 (13)	67.5 (54)	8.75 (7)	7.5 (6)	36.25 (29)	50 (40)	6.25 (5)
Increase in urban migration of framers/ rural youth from rural areas	12.5 (10)	20 (16)	61.25 (49)	6.25 (5)	15 (12)	38.75 (31)	45 (36)	1.25 (1)

Table 4.26. Farmers perception on other effects of climate change

(Values within parentheses indicate frequencies, N-Nil, MI-Mild, MO-Moderate, S-Severe)

Three quarters of respondents from both genders perceived presence of new animals and birds and wild animal straying into villages in mild to moderate level. It is found that 23.75 per cent male and 25 per cent female respondents have noted to be perceiving this on a severe level.

It is observed from the field study that despite the gender all the farmers experienced mild to severe increase in the cost of cultivation of vegetable farming. As already mentioned, there is an increase in the pest and diseases, due to this the cost of inputs including plant protection chemicals and labour charges are increased which has contributed to the increase in total cost of cultivation.

A large part (83.75% male and 86.25% female) of the vegetable cultivators perceived mild to moderate increase in adoption of non-farming activities for livelihood in the last 10 years. Above four-fifth (81.25% male and 83.75% female) respondents perceived mild to moderate increase in urban migration of farmers and rural youth in the last decade. It is noticeable that male farmers perceived the effects at severe level given their role in the socio-economic system. These Inferences are found to be in line with the findings of Skinner (2011) and Shrestha *et al*. (2022).

4.4. Prioritization of climate change adaptation strategies among vegetable farmers

In this study, adaptation strategies were measured under four components namely, crop management, soil and fertility management, water management, pest and disease management, financial management and others. Using prior research, expert opinion and observations of pre-testing alternatives were specified under each component.

4.4.1. Priority Weights of the Criteria in relation to the decision making on the adoption of different adaptation strategies

Using the Analytical Hierarchy Process (AHP), the multiple criteria for decision making regarding adaption strategies were examined.

The quantitative significance of each component to the decision-making among vegetable farmers was assessed and is presented in the Table 4.27.

Table 4.27. Priority weights of the components in relation to the decision making on the adoption of different adaptation strategies (n=40)

Component	Priority Weights	λ MAX	Consistency Index (CI)	Consistency Ratio (CR)
Crop management	0.33	6.34	0.06	0.055
Soil and fertility management	0.21			
Water management	0.20			
Pest and disease management	0.20			
Financial management	0.07			
Others	0.03			

The consistency ratio is clearly less than 0.1, demonstrating the consistency of the data. It also shows that preference was given to crop management, with a priority weight of 0.33, in comparison to other components. This is because the crop management practices are considered as easy, economical and effective by farmers.

4.4.2. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of different adaptation strategies among male vegetable farmers

Tables 4.28 to 4.33 details which alternatives were more significant, their respective contributions to the component, as well as their overall importance or global priority among male farmers. Alternatives were ranked and quantitative importance of each alternative under the selected components as well as overall decision making on the adoption of different adaptation strategies were determined imperatively in the table.

Tables 4.28 to 4.33 shows that most important alternative for component "crop management" was "crop rotation" with local priority of 0.40 and "use of organic manures" in the "soil and fertility management" strategy with local priority of 0.61.

Supplementary irrigation was chosen as the most important strategy of “water management”, (local priority-0.40) and pest surveillance in the “pest and disease management” component with local priority of 0.35 Income diversification (local priority-0.48) was preferred as the financial management strategy, whereas in other activities, most important alternative was “post- harvest management” with a local priority of 0.38.

It is clearly visible from Tables 4.28 to 4.33 that based on the intensity of importance of one over another alternatives, the most substantial strategy among male farmers was “use of organic manure” because this promotes greater soil organic matter content and improve soil structure. It is also considered as an easy and economical practice among male farmers, given that a large number of them own farm animals. Male farmers were able to prepare organic manure by themselves at their own farms. The result also supports the findings of Niggli *et al*. (2008) and Diarra *et al*. (2021).

Table 4.28. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of crop management adaptation strategies among male vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Crop management	0.31	C1: Change of planting and harvesting date	0.06	0.23 (II)	0.07	IV
		C2: Crop rotation		0.40 (I)	0.124	II
		C3: Crop diversification		0.22 (III)	0.07	IV
		C4: Cultivation of stress tolerant varieties		0.11 (IV)	0.03	VII
λ_{MAX}= 5.28	CI= 0.07	C5: Cultivation of Short duration crops		0.05 (V)	0.02	VIII

Table 4.29. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of soil and fertility management adaptation strategies among male vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Soil and fertility management	0.22	S1: Minimum tillage	0.03	0.06 (V)	0.01	IX
		S2: Use of organic manure		0.61 (I)	0.13	I
		S3: Use of biofertilizers		0.10 (III)	0.02	VIII
		S4: Mulching		0.09 (IV)	0.02	VIII
λ_{MAX}=5.15	CI=0.04	S5: Change in time and dose of fertilizer application		0.13 (II)	0.03	VII

Table 4.30. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of water management adaptation strategies among male vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Water management	0.19	W1: Water conservation	0.026	0.24 (II)	0.05	VI
		W2: Supplementary irrigation		0.40 (I)	0.08	III
		W3: Rainwater harvesting		0.10 (IV)	0.02	VIII
		W4: Technology advances		0.09 (V)	0.02	VIII
λ_{MAX}= 5.11	CI= 0.03	W5: Non-water intensive crops		0.17 (III)	0.03	VII

Table 4.31. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of pest and disease management adaptation strategies among male vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Pest and disease management &Crop protection	0.18	P1: Change in time and dose of plant protection chemicals	0.025	0.30 (II)	0.05	VI
		P2: Pest and disease tolerant varieties		0.25 (III)	0.05	VI
		P3: Protected cultivation		0.05 (IV)	0.009	X
		P4: Pest surveillance		0.35 (I)	0.06	V
λ_{MAX}= 5.11	CI= 0.03	P5: Use of Biocontrol agents		0.05 (IV)	0.009	X

Table 4.32. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of financial management adaptation strategies among male vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Financial management	0.07	F1: Income diversification	0.06	0.48 (I)	0.03	VII
		F2: Selling assets		0.05 (IV)	0.003	XII
		F3: Crop insurances		0.13 (III)	0.009	X
	CI=0.07	F4: Group farming- SHGs, Kudumbashree, FPOs, Cooperatives		0.21 (II)	0.01	IX
λ_{MAX}=5.28		F5: Use of Credit		0.13 (III)	0.009	X

Table 4.33. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of other adaptation strategies among male vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Others	0.03	O1: Post- harvest management	0.009	0.38 (I)	0.01	IX
		O2: Mechanization		0.23 (III)	0.007	XI
		O3: Getting help from govt& other agencies		0.29 (II)	0.009	X
λ max=4.00	CI=0.0008	O4: Avoidance of extreme climate areas		0.11 (IV)	0.003	XII

4.3.5. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of different adaptation strategies among female vegetable farmers

Tables 4.34 to 4.39 details which alternatives were more significant, their respective contributions to the component, as well as their overall importance or global priority among female farmers. Alternatives were ranked and quantitative importance of each alternative under the selected components as well as overall decision making on the adoption of different adaptation strategies were determined imperatively in the table.

Tables 4.34 to 4.39 shows that most important alternative for component "crop management" was "crop rotation" with local priority of 0.38 and "use of organic manures" in the "soil and fertility management" strategy with local priority of 0.59. "Supplementary irrigation was chosen as the most important strategy of "water management" and pest surveillance in the "pest and disease management" component with local priority of 0.37. "Income diversification" was preferred as the financial management strategy, with local priority of 0.48 whereas in other activities, most important alternative was "getting help from govt& other agencies" with a local priority of 0.43.

It is clear from Tables that based on the intensity of importance of one over another alternatives, the most substantial adaptation among female farmers was "crop rotation". It is considered as an easy and economical adaptation strategy. Crop rotation was known to offer better crop residue management and higher soil nutrient. And since it has been practiced traditionally it was widely accepted among women farmers. This result comes in line with the findings of Mussema and Yirga (2020).

Table 4.34. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of crop management adaptation strategies among female vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Crop management	0.32	C1: Change of planting and harvesting date	0.07	0.27 (II)	0.09	III
		C2: Crop rotation		0.38 (I)	0.12	I
		C3: Crop diversification		0.20 (III)	0.06	V
	CI= 0.08	C4: Cultivation of stress tolerant varieties		0.09 (IV)	0.03	VIII
λ_{MAX}= 5.31		C5: Cultivation of Short duration crops		0.06 (V)	0.02	IX

Table 4.35. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of soil and fertility management adaptation strategies among female vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Soil and fertility management	0.18	S1: Minimum tillage	0.06	0.06 (V)	0.01	X
		S2: Use of organic manure		0.59 (I)	0.11	II
		S3: Use of biofertilizers		0.12 (III)	0.02	IX
		S4: Mulching		0.07 (IV)	0.01	X
λ_{MAX}=5.26	CI=0.07	S5: Change in time and dose of fertilizer application		0.16 (II)	0.03	VIII

Table 4.36. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of soil and water management adaptation strategies among female vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Water management	0.20	W1: Water conservation	0.03	0.30 (II)	0.06	V
		W2: Supplementary irrigation		0.36 (I)	0.07	IV
		W3: Rainwater harvesting		0.11 (IV)	0.02	IX
		W4: Technology advances		0.08 (V)	0.02	IX
λ_{MAX}= 5.14	CI=0.04	W5: Non-water intensive crops		0.16 (III)	0.03	VIII

Table 4.37. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of pest and disease management adaptation strategies among female vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Pest and disease management &Crop protection	0.20	P1: Change in time and dose of plant protection chemicals	0.04	0.28 (II)	0.06	V
		P2: Pest and disease tolerant varieties		0.24 (III)	0.05	VI
		P3: Protected cultivation		0.06 (IV)	0.01	X
	CI=0.04	P4: Pest surveillance		0.37 (I)	0.07	IV
λ_{MAX} = 5.18		P5: Use of Biocontrol agents		0.04 (V)	0.008	XII

Table 4.38. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of financial management adaptation strategies among female vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Financial management	0.08	F1: Income diversification	0.08	0.48 (I)	0.039	VII
		F2: Selling assets		0.05 (V)	0.004	XIV
		F3: Crop insurances		0.12 (IV)	0.01	XI
	CI=0.09	F4: Group farming- SHGs, Kudumbashree, FPOs, Cooperatives		0.18 (II)	0.01	XI
λ_{MAX}=5.35		F5: Use of Credit		0.17 (III)	0.01	XI

Table 4.39. Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of other adaptation strategies among female vegetable farmers (n=20)

Component	Priority of the criteria (Scaling factor)	Alternative	Consistency Ratio (CR)	Priority of the alternative within criteria and rank	Globally or overall priority of the alternatives	Overall Rank
Others	0.03	O1: Post- harvest management	0.001	0.27 (II)	0.008	XII
		O2: Mechanization		0.18 (III)	0.005	XIII
		O3: Getting help from govt& other agencies		0.43 (I)	0.01	XI
λ max=4.00	CI=0.0009	O4: Avoidance of extreme climate areas		0.12 (IV)	0.004	XIV

4.5 Adaptation strategies adopted by the vegetable farmers

Distribution of farmers across different levels of adoption for each adaptation strategy within each component is given as the tables.

4.5.1. Crop management

Distribution of farmers across different levels of adoption for each adaptation strategy within crop management component is given as table 4.40

Table 4.40. Degree of adoption of the adaptation strategies followed by vegetable farmers under crop management (n=160)

Sl. No	Adaptation strategies	Adopted		Not adopted
		Continued	Discontinued	
		Percentage	Percentage	Percentage
1	Change of planting and harvesting date	83.75 (134)	14.375 (23)	1.875 (3)
2	Crop rotation	91.875 (147)	4.375 (7)	3.75 (6)
3	Crop diversification	75 (120)	15.625 (25)	9.375 (15)
4	Cultivation of stress tolerant varieties	13.125 (21)	50.625 (81)	36.25 (58)
5	Cultivation of Short duration crops	8.125 (13)	21.875 (35)	70 (112)

(Values within parentheses indicate frequencies)

Table 4.40. vividly describes the adoption status of 5 adaptation strategies pertains to crop management practiced among the vegetable farmers of the study area.

It was found that majority (83.75%) of the farmers adopted change of planting and harvesting date as an adaptation strategy, while 14.38 per cent discontinued the practice. Vast majority (92.00%) farmers continued practicing crop rotation, followed by 75.00 per cent of them practicing crop diversification as an adaptation strategy to climate change. It is observed that cultivation of stress tolerant varieties and short duration crops have highest rate of non-adoption (36.25% and 70.00%) and discontinuance, (50.63 % and 21.88%) respectively. Even though cultivation of stress tolerant varieties and cultivation of short duration varieties are effective adaptation strategies to cope with climate change adversities, respondents are reluctant to adopt them. High input cost and labour cost was cited as the major reason for this non-adoption by farmers. The results presented above are supportive of the findings of Srinivasarao *et al. (*2020) and Irham *et al* (2022).

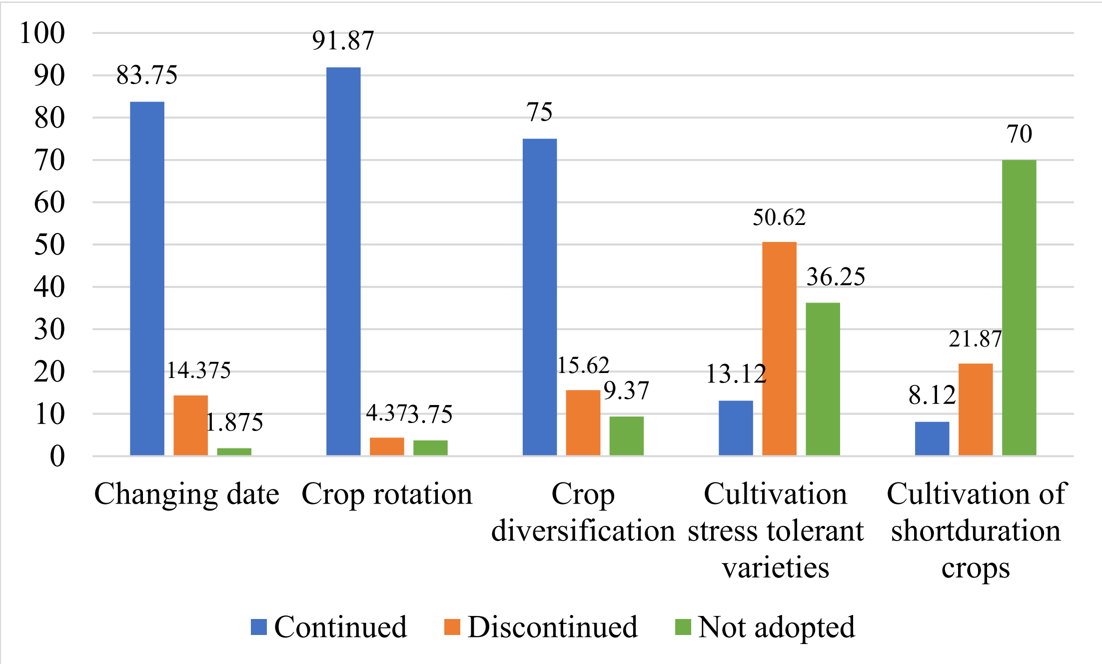


Figure 4.13. Degree of adoption of the adaptation strategies followed by vegetable farmers under crop management

4.5.2. Soil and fertility management

Distribution of farmers across different levels of adoption for each adaptation strategy within the soil and fertility management is given in table 4.41

Table 4.41. Degree of adoption of the adaptation strategies followed by vegetable farmers under soil and fertility management (n=160)

Sl. No	Adaptation strategies	Adopted		Not adopted
		Continued	Discontinued	
		Percentage	Percentage	Percentage
1	Minimum tillage	5.625 (9)	5 (8)	89.375 (143)
2	Use of organic manure	99.375 (159)	0.62 (1)	-
3	Use of biofertilizers	18.75 (30)	25 (40)	56.25 (90)
4	Mulching – (organic)	20.625 (33)	10.625 (17)	68.75 (110)
5	Change in time and dose of fertilizer application – Need based application	61.875 (99)	23.75 (38)	14.375 (23)

(Values within parentheses indicate frequencies)

Table 4.41. vividly describes the adoption status of 5 adaptation strategies pertains to soil and fertility management practiced among the vegetable farmers of the study area.

It was found that almost all farmers (99.37%) adopted use of organic manure as an adaptation strategy. Majority (61.87%) of the farmers continued to change time and dose of fertilizer application, while 14.37 per cent has not adopted the practice. It is observed that use of biofertilizers has highest rate of discontinuance (25%). Followed by change in time and dose of fertilizer application (23.75%). Minimum tillage

(89.38%), mulching (68.75%) and use of biofertlizers (56.25%) have highest rate of non-adoption. Even though these practices have been recommended as effective adaptation strategies, farmers are reluctant to switch from the prevailing traditional practices. High input cost was also cited as a major reason for the non-adoption. This result is supported by the findings of Iqbal *et al.* (2020) and Arimi (2021).

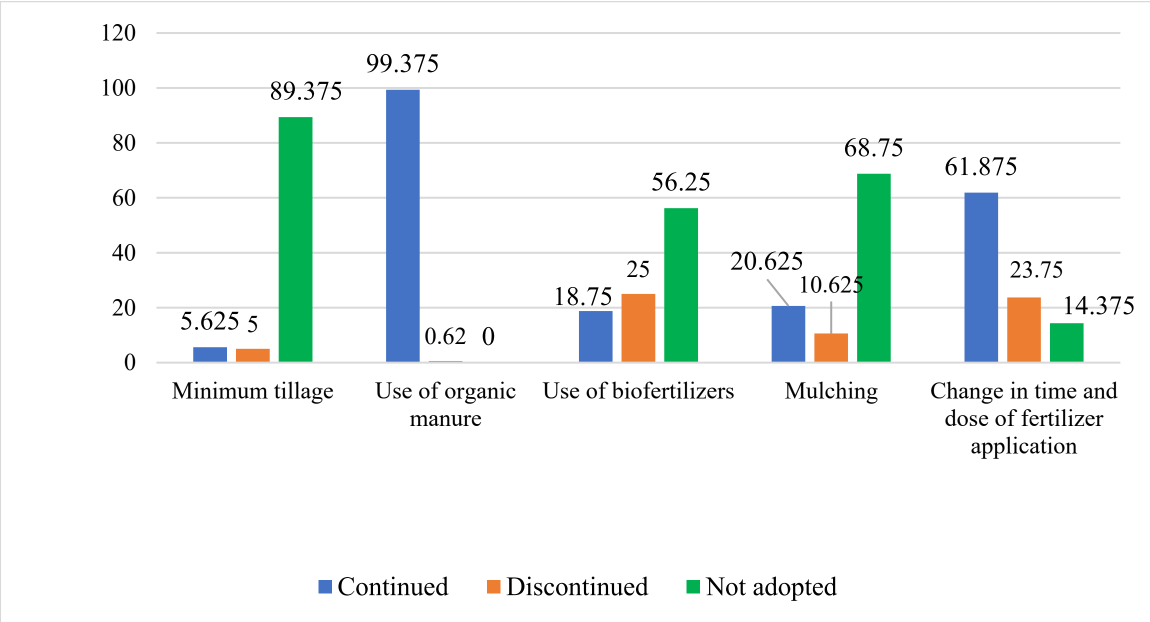


Figure 4.14. Degree of adoption of the adaptation strategies followed by vegetable farmers under soil and fertility management

4.5.3. Water management

Distribution of farmers across different levels of adoption for each adaptation strategy within the water management is given in table 4.42.

Table 4.42 evidently describes the state of adoption of the 5 adaptation strategies practiced among the vegetable farmers under water management.

Table 4.42. Degree of adoption of the adaptation strategies followed by vegetable farmers under water management (n=160)

Sl. No.	Adaptation strategies	Adopted		Not adopted
		Continued	Discontinued	
		Percentage	Percentage	Percentage
1	Water conservation – Drip irrigation, Sprinkler	50.625 (81)	13.75 (22)	35.625 (57)
2	Supplementary irrigation	76.25 (122)	5 (8)	18.75 (30)
3	Rainwater harvesting	1.25 (2)	3.125 (5)	95.625 (153)
4	Technology advances- Solar water pumps	1.25 (2)	-	98.75 (158)
5	Non-water intensive crops	38.75 (62)	6.875 (11)	54.375 (87)

(Values within parentheses indicate frequencies)

It was observed that majority (76.25%) of the farmers adopted supplementary irrigation as an adaptation strategy, while 18.75 per cent not adopted the practice. About half (50.62%) farmers continued practicing water conservation strategies, followed by 38.75 per cent farmers adopting cultivation of non-water intensive crops as an adaptation strategy. It was found that water conservation and cultivation of non-water intensive crops have highest rate of discontinuance (13.75% and 6.87% respectively). It was observed that vast majority have not adopted technology advances (98.75%) and rainwater harvesting (95.62%). High input cost and the reluctancy to change traditional practices could be cited as the reasons for non-adoption of water management technologies by vegetable farmers. The results are in line with observations of Dahl *et al*. (2019).

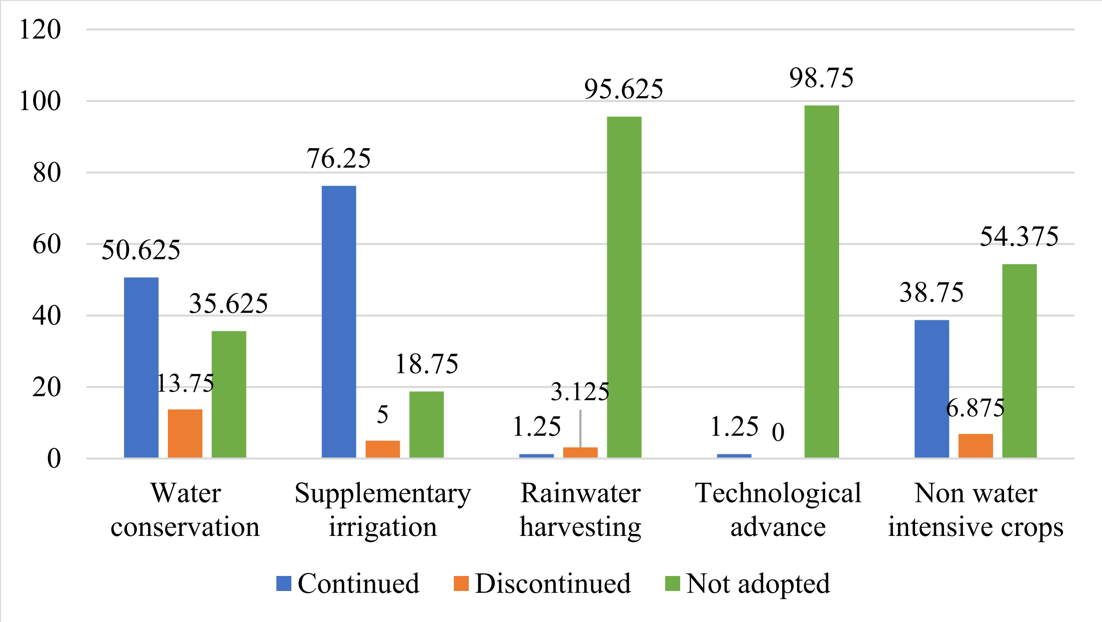


Figure 4.15. Degree of adoption of the adaptation strategies followed by vegetable farmers under water management

4.5.4. Pest and disease management

Distribution of farmers across different levels of adoption for each adaptation strategy within the pest and disease management is given in table 4.43.

Table 4.43 vividly describes the state of adoption of the 5 adaptation strategies practiced among the vegetable farmers under pest and disease management. It was found that majority of the farmers adopted pest surveillance (65.62%), while 11.25 per cent not adopted the practice. Change in time and dose of plant protection chemicals was the adopted by 61.88 per cent of the farmers as an adaptation practice. It is found that 35 per cent of the farmers adopted pest and disease tolerant varieties as an adaptation strategy.

Table 4.43. Degree of adoption of the adaptation strategies followed by vegetable farmers pest and disease management (n=160)

Sl. No	Adaptation strategies	Adopted		Not adopted
		Continued	Discontinued	
		Percentage	Percentage	Percentage
1	Change in time and dose of plant protection chemicals	61.875 (99)	17.5 (28)	20.625 (33)
2	Pest and disease tolerant varieties	35 (56)	31.875 (51)	32.5 (52)
3	Protected cultivation	3.75 (6)	1.25 (2)	95 (152)
4	Pest surveillance	65.625 (105)	23.125 (37)	11.25 (18)
5	Use of Biocontrol agents	2.5 (4)	4.375 (7)	93.125 (149)

(Figures within parentheses indicate frequencies)

It was found that cultivation of pest and disease tolerant varieties and pest surveillance have the highest rate of discontinuance (31.88% and 23.12% respectively). Protected cultivation and use of biocontrol agents have highest rate of non-adoption (95% and 93.12% respectively). Expensive inputs, lack of knowledge on the practices and high maintenance were cited as reasons behind this non-adoption. This observation is supported by the findings of Rashid *et al*. (2020) and Gruda *et al.* (2021).

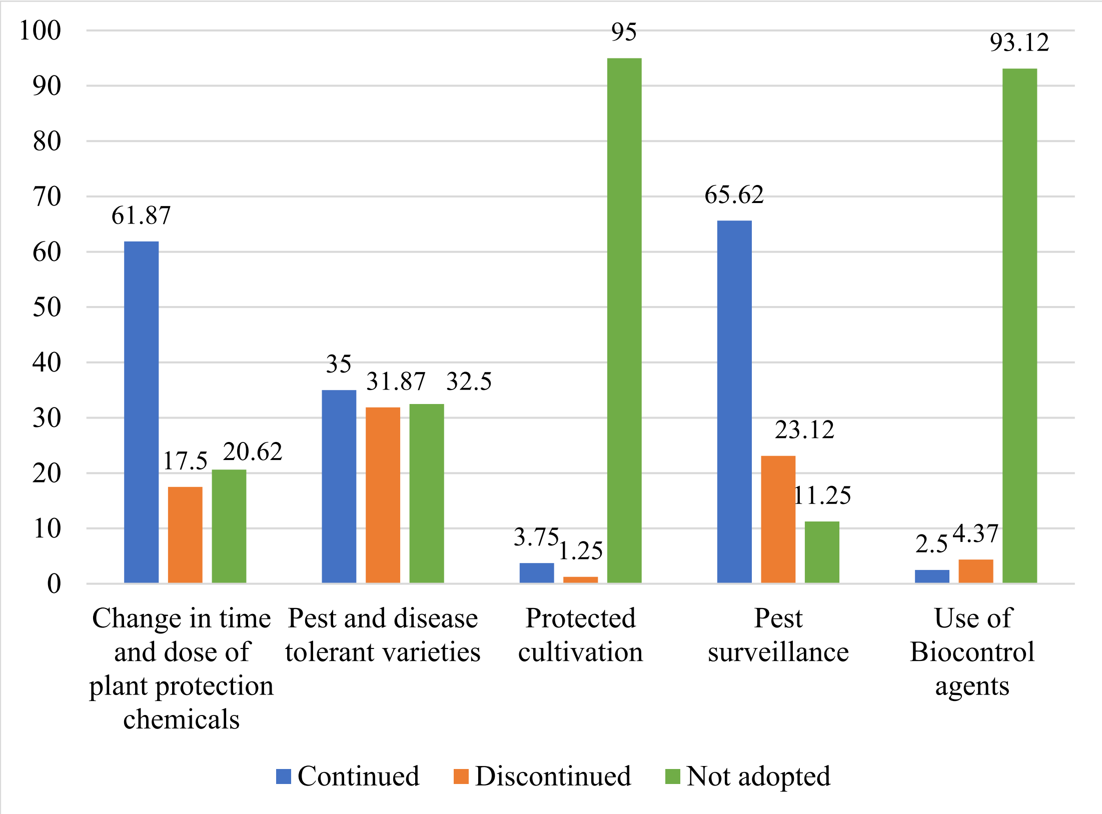


Figure 4.16. Degree of adoption of the adaptation strategies followed by vegetable farmers under pest and disease management

4.5.5. Financial management

Distribution of farmers across different levels of adoption for each adaptation strategy within the financial management is given in table 4.44.

Table 4.44 clearly describes the state of adoption of the 5 adaptation strategies practiced among the vegetable farmers under financial management.

It was observed that majority (72.5%) of the farmers adopted income diversification as an adaptation strategy, while 15.62 per cent discontinued the practice. It is found that 38.75 per cent farmers adopted crop insurances as an adaptation. It was found that crop insurances and group farming have highest rates of discontinuance (22.5% and 20% respectively). The long and tedious procedure and the lack of coordination among members are the reasons for this respectively.

Table 4.44. Degree of adoption of the adaptation strategies followed by vegetable farmers under financial management (n=160)

Sl. No	Adaptation strategies	Adopted		Not adopted
		Continued	Discontinued	
		Percentage	Percentage	Percentage
1	Income diversification	72.5 (116)	15.625 (25)	11.875 (19)
2	Selling assets	-	5.625 (9)	94.375 (151)
3	Crop insurances	38.75 (62)	22.5 (36)	38.75 (62)
4	Group farming- SHGs, Kudumbashree, FPOs, Cooperatives	18.75 (30)	20 (32)	61.25 (98)
5	Use of Credit	24.375 (39)	10.625 (76)	47.5 (76)

(Values within parentheses indicate frequencies)

Selling assets has the highest rate of non-adoption (94.37%) followed by group farming (61.25%) and use of credit (47.5%). Small landholding and lower annual income can point as the major reason for this non-adoption by farmers. This result comes line with the observation made by Kabir *et al*. (2021).

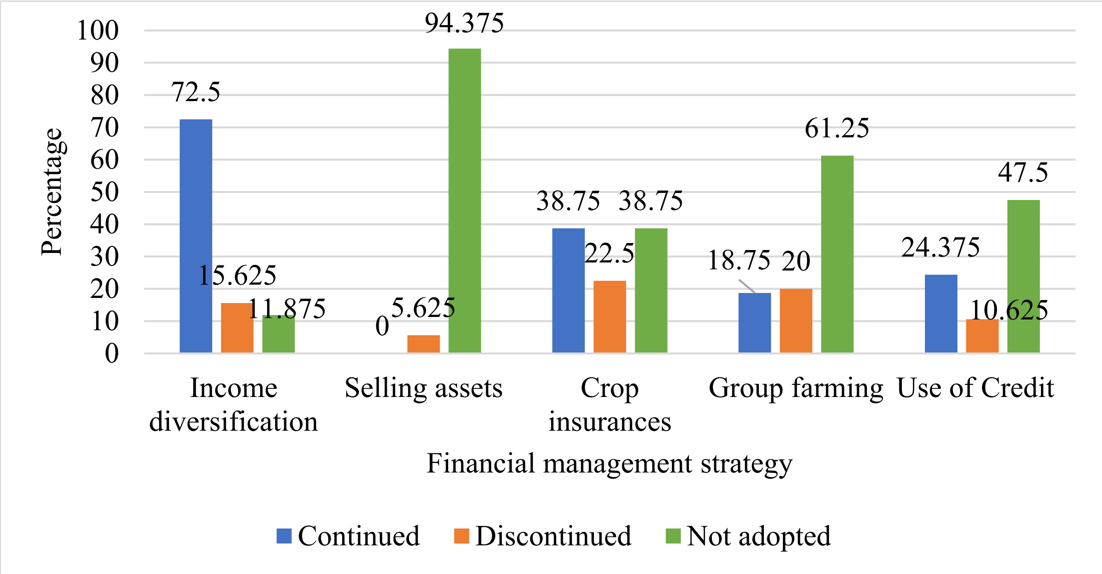


Figure 4.17. Degree of adoption of the adaptation strategies followed by vegetable farmers under financial management

4.5.6. Other adaptation strategies

Distribution of farmers across different levels of adoption for other adaptation strategies is given in table 4.45.

Table 4.45. Degree of adoption of the adaptation strategies under other practices

Sl. No	Adaptation strategies	Adopted		Not adopted
		Continued	Discontinued	
		Percent	Percent	Percent
1	Post- harvest management-	26.25 (42)	22.5 (36)	51.25 (82)
2	Mechanization	48.125 (77)	20 (32)	31.875 (51)
3	Getting help from government& other agencies	71.25 (114)	-	28.75 (46)
4	Avoidance of extreme climate areas	12.5 (20)	10.625 (17)	76.875 (123)

(Values within parentheses indicate frequencies)

Table 4.45 vividly describes the state of adoption of the 4 other adaptation strategies practiced among the vegetable farmers.

It was found that majority (71.25%) of the farmers continued getting help from government and other agencies. Farmers reported getting supports through various schemes and programmes. About half (48.12%) of the farmers adopted mechanization as an adaptation strategy while 22.5 per cent discontinued the practice. It is observed that post-harvest management followed by mechanization has the highest rates of discontinuance (22.5% and 20% respectively). Avoidance of extreme climate areas has the highest rate of non-adoption (76.87%) followed by post-harvest management (51.25%).

Even though avoidance of extreme climate areas and post-harvest management are recommended as effective adaptation strategies, small holder farmers are not ready to adopt them because of the lack of alternate lands to cultivate vegetables. High input cost, non-availability of labour and high labour cost was cited as the major reason for non-adoption of post-harvest management by farmers.

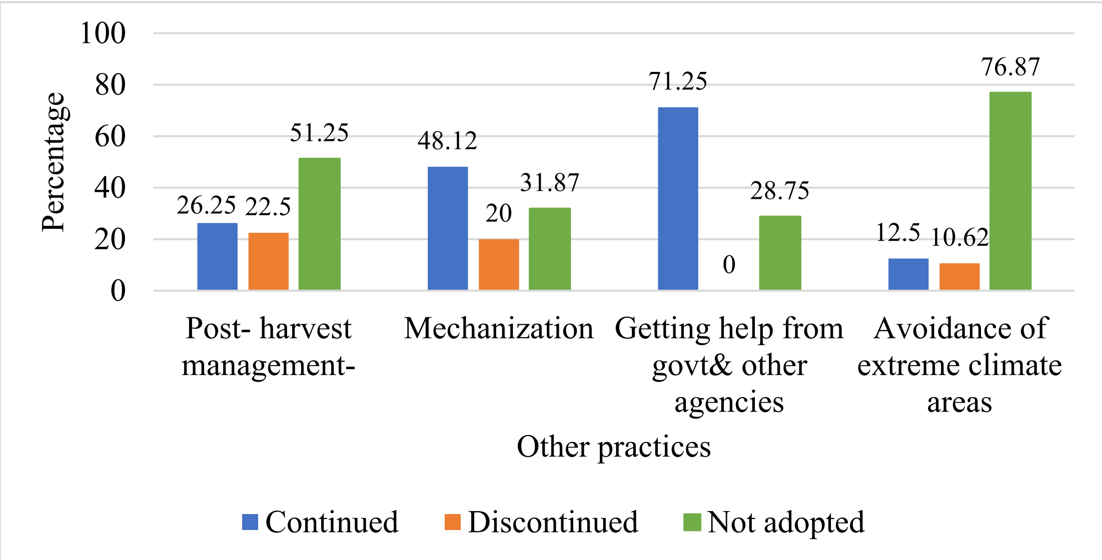


Figure 4.18. Degree of adoption of the adaptation strategies followed by vegetable farmers under other practices

4.5.7. Distribution of vegetable farmers according to their differential level of climate change adaptation

Male and female vegetable farmers of the sample were categorized into three differential level of adoption *i.e.,* low, medium and high on the basis of obtained climate change index score by the respective farmers.

Table 4.46. Distribution of vegetable farmers based their differential level of climate change adaptation

Category	Percentage of farmers (n=160)	
	Male (n=80)	**Female (n=80)**
Low (<21.17)	10 (8)	25 (20)
Medium (21.7-32.6)	65 (52)	70 (56)
High (>32.6)	25 (20)	5 (4)
	Mean= 26.88 S.D.= 5.71	

(Values within parentheses indicate frequencies)

Majority (65% male and 70% female) of the vegetable farmers are having medium level of adoption, while 25 per cent of male farmers and 5 per cent of female farmers have higher level of adoption. 25 per cent of females have low adoption of selected adaptation strategies to cope with climate change compared to 10 per cent of male farmers. It is evident from the table that there is a gendered difference in adoption of climate change adaptation strategies among vegetable farmers, which may be due to the disparities between men's and women's abilities to purchase inputs for implementing adaptation strategies, as well as inequalities in access to information and financial assistance. These results are line with the findings of Adger *et al*. (2005).

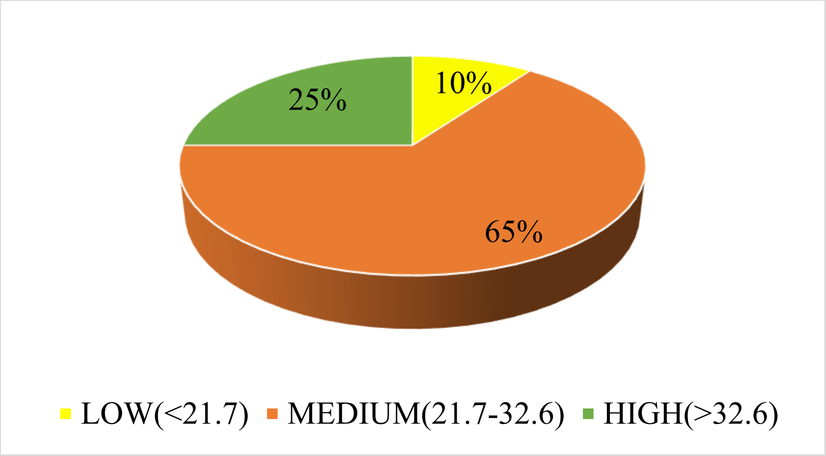


Figure 4.19. Distribution of male farmers according their differential level of adoption of adaptation strategies.

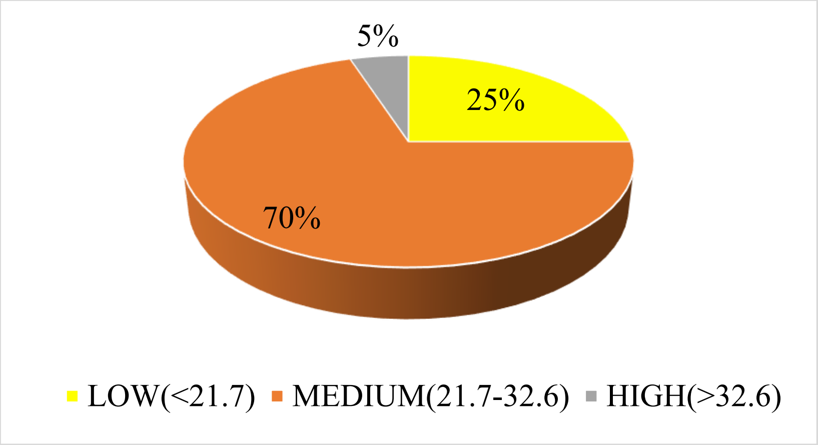


Figure 4.20. Distribution of female farmers according their differential level of adoption of adaptation strategies.

4.6 Adoption of climate change adaptations among male and female farmers

As adoption of climate change adaptation is observed to be influenced by gender, an attempt was made to find out whether there had been any difference between male and female vegetable farmers in terms of adoption of different climate change adaptation strategies. The mean climate change adaptation index of farmers was calculated for each adaptation and two sample t test was employed to find out the difference.

Table 4.47. Adoption of climate change adaptations among male and female farmers

Adaptation	Mean climate change adaptation index		p value of t-statistic
	Male	Female	
Crop management	0.897	0.708	0.225646
Soil and fertility management	0.470	0.462	0.749524
Water management	0.381	0.349	0.258999
Pest and disease management	0.410	0.401	0.725194
Financial management	0.486	0.404	**0.003151****
Other adaptations	0.410	0.246	**0****
Total climate change adaptation	0.500	0.428	**0.000002****

**significant at 1% level

As seen from the table 4.47, probabilities of t-statistic obtained indicates significant difference in the adoption of financial management and other strategies by male and female farmers. It is clear that significant gender difference is only observed related to the adoption of financial management and other strategies. This supports the findings of Bekele and Drake (2003) who found that gender was not a statistically significant factor influencing farmers decisions to adopt adaptation measures.

Since the mean adaptation index of male farmers was higher than that of female farmers, related to financial management and other strategies, it could be concluded that climate change adaptation of male farmers is higher than that of female farmers regarding these components. It is also seen from the table that the probabilities of t-statistic obtained indicates significant difference in the total climate change adaptation by male and female farmers. Since the mean of total adaptation index of male farmers was higher than that of female farmers, it could be concluded that adoption of climate change adaptation strategies by male farmers is higher than that of female farmers. The results were observed to be consistent with the findings of Legesse *et al.* (2013) and Mulatu (2013) who observed that male farmers had better opportunities to practice adaptation measures than female farmers.

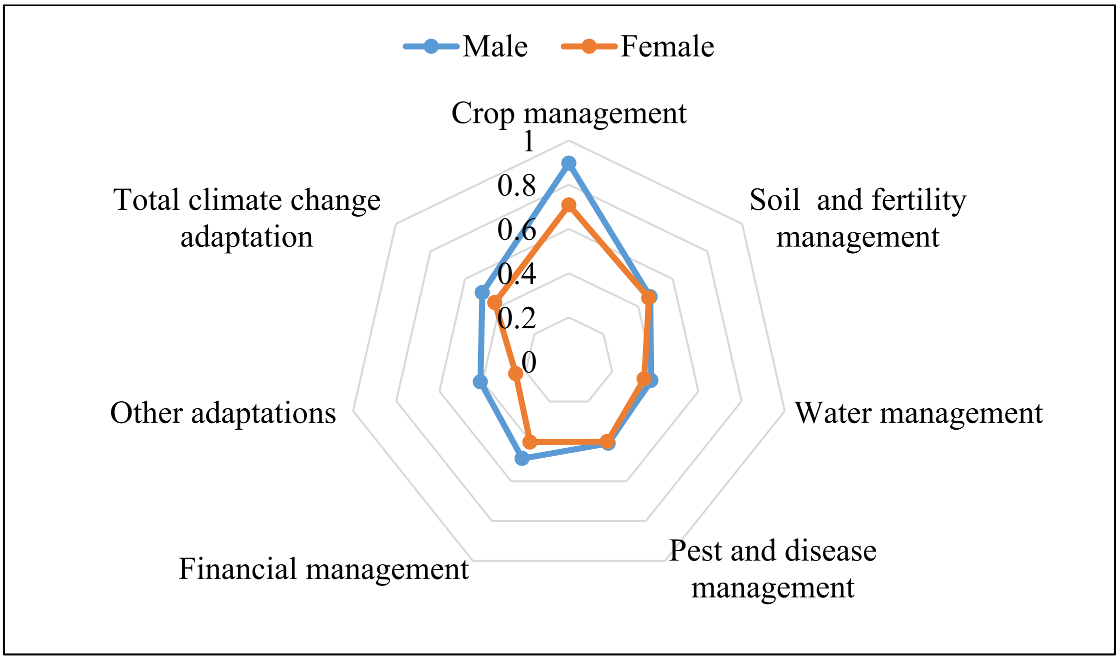


Figure 4.21. Adoption of climate change adaptations among male and female farmers

4.7 Determinants of climate change adaptation among vegetable farmers

In order to study the determinants influencing adoption of climate change adaptation strategies among vegetable farmers, binary logistic regression is employed between profile characteristics and adoption status of the farmers. Binary logistic regression is used to predict the odds of being a case based on the values of the independent variables. The odds are defined as the probability that a particular outcome is a case divided by the probability that it is a non-case, which is specified in the following tables.

4.7.1. Crop management

Table 4.88 shows the binary logistic regression of crop management strategies practiced by vegetable farmers with their profile characteristics.

Table 4.48. Determinants of crop management strategies

Sl. No.	Variable	B	Sig.	Odds ratio
1	Gender	-0.407	0.301	0.666
2	Age	-0.024	0.350	0.976
3	Education	-0.272	0.168	0.762
4	Farming Experience	0.010	0.762	1.010
5	Farm size.	-0.236	0.446	0.790
6	Annual income	0.169	0.221	1.184
7	Mass media exposure	0.165	0.154	1.179
8	Access to climatological information	-0.076	0.552	0.927
9	Extension contact	0.150	0.141	1.162
10	Social participation	0.117	0.483	1.124
11	Risk bearability	0.082	0.164	1.085
12	Market orientation	-0.004	0.962	0.996
13	Scientific orientation	-0.026	0.714	0.974

It could be observed from the Table 4.48 that, changes in none of the variables could lead to a change in adaptation behaviour pertains to the crop management strategies.

4.7.2. Soil and fertility management

Table 4.49 shows the binary logistic regression of soil and fertility management strategies practiced by vegetable farmers with their profile characteristics.

Table 4.49. Determinants of soil and fertility management strategies

Sl. No.	Variable	B	Sig.	Odds ratio
1	Gender	-0.336	0.487	0.715
2	Age	-0.010	0.741	0.990
3	Education	-0.419	0.095	0.658
4	Farming Experience	-0.048	0.213	0.953
5	Farm size.	-0.628	0.163	0.534
6	Annual income	-0.034	0.847	0.966
7	Mass media exposure	0.240	0.107	1.272
8	Access to climatological information	-0.033	0.822	0.968
9	Extension contact	**0.349**	**0.007****	1.417
10	Social participation	0.328	0.099	1.388
11	Risk bearability	0.127	0.063	1.135
12	Market orientation	-0.118	0.255	0.889
13	Scientific orientation	0.140	0.134	1.150

** significant at 1% level

It is observed from the Table 4.49 that, changes in extension contact variable could lead to a change in adaptation behaviour pertains to the soil and fertility management strategies. The calculated value of odds ratios showed that a change in the level of extension contact could bring a corresponding chance of 14.17 per cent for a farmer to adopt a soil and fertility management adaptation strategy. It is evidently clear that the extension contact could promote farmers adoption of adaptation strategies related to soil and fertility by providing proper technical knowledge to farmers. These findings support the observations of Bryan *et al*. (2011).

4.7.3. Water management

Table 4.50 shows the binary logistic regression of water management strategies practiced by vegetable farmers with their profile characteristics.

Table 4.50. Determinants of water management strategies

Sl. No.	Variable	B	Sig.	Odds ratio
1	Gender	-0.407	0.301	0.666
2	Age	-0.024	0.350	0.976
3	Education	-0.272	0.168	0.762
4	Farming Experience	0.010	0.762	1.010
5	Farm size.	-0.236	0.446	0.790
6	Annual income	0.169	0.221	1.184
7	Mass media exposure	0.165	0.154	1.179
8	Access to climatological information	-0.076	0.552	0.927
9	Extension contact	0.150	0.141	1.162
10	Social participation	0.117	0.483	1.124
11	Risk bearability	0.082	0.164	1.085
12	Market orientation	-0.004	0.962	0.996
13	Scientific orientation	-0.026	0.714	0.974

It could be observed from the Table 4.50 that, changes in none of the variables could lead to a change in adaptation behaviour pertains to the water management strategies.

4.7.4. Pest and disease management

Table 4.51 shows the binary logistic regression of pest and disease management strategies practiced by vegetable farmers with their profile characteristics.

Table 4.51. Determinants of pest and disease management strategies

Sl. No.	Variable	B	Sig.	Odds ratio
1	Gender	-0.225	0.684	0.798
2	Age	-0.005	0.871	0.995
3	Education	-0.152	0.586	0.859
4	Farming Experience	-0.005	0.898	0.995
5	Farm size.	0.522	0.177	1.686
6	Annual income	-0.287	0.145	0.750
7	Mass media exposure	0.321	0.071	1.378
8	Access to climatological information	-0.038	0.819	0.963
9	Extension contact	0.151	0.287	1.163
10	Social participation	0.077	0.734	1.080
11	Risk bearability	0.145	0.068	1.156
12	Market orientation	-0.010	0.929	0.990
13	Scientific orientation	0.026	0.810	1.026

It could be observed from the Table 4.51 that, changes in none of the variables could lead to a change in adaptation behaviour pertains to the pest and disease management strategies.

4.7.5. Financial management

Table 4.52 shows the binary logistic regression of financial management strategies practiced by vegetable farmers with their profile characteristics.

Table 4.52. Determinants of financial management strategies

Sl. No.	Variable	B	Sig.	Odds ratio
1	Gender	**-1.577**	**0.000****	**0.207**
2	Age	-0.006	0.823	0.994
3	Education	0.064	0.757	1.066
4	Farming Experience	-0.034	0.301	0.966
5	Farm size.	-0.478	0.152	0.620
6	Annual income	0.100	0.466	1.105
7	Mass media exposure	0.086	0.468	1.090
8	Access to climatological information	-0.102	0.424	0.903
9	Extension contacts	0.127	0.225	1.135
10	Social participation	0.197	0.248	1.218
11	Risk bearability	**-0.134**	**0.032***	**0.875**
12	Market orientation	-0.077	0.373	0.926
13	Scientific orientation	0.100	0.199	1.106

*significant at 5% level **significant at 1% level

It is observed from the Table 4.52 that, gender and risk bearability variables could affect change in adaptation behaviour pertains to the financial management strategies. The calculated value of odds ratios showed that being a male and decrease in level of risk bearability could bring a corresponding chance of 20 per cent and 87.5 per cent for a farmer to adopt a financial management adaptation strategy respectively. It can be concluded that male farmers have more opportunities to adopt financial management adaptations due to the prevailing power relations in the society. Results also implies that farmers with less risk bearabilty seems to adopt more financial management practices due to their low readiness to accept and adopt adaptation practices pertains to crop management, soil and fertility management, water management and pest and disease management. These observations are in agreement with the findings of Funk *et al*. (2019).

4.7.6. Other strategies

Table 4.53 shows the binary logistic regression of other adaptation strategies practiced by vegetable farmers with their profile characteristics.

Table 4.53. Determinants of other strategies

Sl. No.	Variable	B	Sig.	Odds ratio
1	Gender	**-1.577**	**0.000****	0.207
2	Age	-0.006	0.823	0.994
3	Education	0.064	0.757	1.066
4	Farming Experience	-0.034	0.301	0.966
5	Farm size.	-0.478	0.152	0.620
6	Annual income	0.100	0.466	1.105
7	Mass media exposure	0.086	0.468	1.090
8	Access to climatological information	-0.102	0.424	0.903
9	Extension contact	0.127	0.225	1.135
10	Social participation	0.197	0.248	1.218
11	Risk bearability	**-0.134**	**0.032***	0.875
12	Market orientation	-0.077	0.373	0.926
13	Scientific orientation	0.100	0.199	1.106

*Significant at 5% level **Significant at 1% level

It is observed from the Table 4.53 that, gender and risk bearability variables could affect change in adaptation behaviour pertains to the other strategies. The calculated value of odds ratios showed that being a male and reduction in the level of risk bearability could bring a corresponding chance of 20 per cent and 87.5 per cent for a farmer to adopt other adaptation strategies. It can be concluded that male farmers have more opportunities to adopt climate change adaptations such as mechanization and post-harvest management due to the prevailing power relations in the society. Results also implies that farmers with less risk bearability seems to adopt practices including post-harvest management and mechanization more, due to their low readiness to accept and adopt other adaptation practices related to crop management, soil and fertility management, water management and pest and disease management. These observations are in line with the findings of Funk *et al*. (2019).

4.8. Constraints faced by vegetable farmers with respect to climate change adaptation

The study also made an attempt to look into the major constraints faced by vegetable farmers, associated with the climate change adaptation. The farmers were personally interviewed with the help of semi-structured interview schedule to enlist the constraints faced by them in climate change adaptation. For this purpose, Garrett's ranking technique was used to rank the constraints. The major constraints were identified and prioritized as follows;

Table 4.54. Constraints faced by vegetable farmers with respect to climate change adaptation

Sl. No	Constraints	Mean score	Rank
1	Lack of government support	62.22	1
2	High cost of the agricultural inputs needed for adaptation strategies	59.71	2
3	Inadequate credit facilities and lack of agricultural subsidies	51.77	3
4	Lack of access to awareness programmes on climate change adaptation	38.33	4
5	Lack of information about long term climate change and appropriate adaptations	35.89	5

Table 4.54 shows the per cent score values and the various constraints were ranked based on that. The major constraint faced by vegetable farmers with respect to climate change adaptations were lack of government support (62.22 Garrett score). Farmers reported the lack of government support through schemes and subsidies. Lack

of policy guidance, the limited coordination between levels, and the lack of available governmental resources reduces the adaptation at all administrative levels. It is pertinent that supportive institutional mechanisms should be proposed to promote farmers adaptation decision.

High cost of the agricultural inputs needed for adaptation strategies was the second major constraint felt by the farmers (59.71 Garrett score). Adaptation to climate change is a costly affair and requires costly resources like fertilizer, pesticides, improved varieties. Therefore, small land holding farmers facing acute shortage of income are not able to opt for adaptation. Inputs should be made available through extension agencies or through subsidized cost, which will be more supportive for the farmers.

Inadequate credit facilities and lack of agricultural subsidies was the third perceived constraint by the farmers (51.77 Garrett score). Farmers are identified as one of the most disadvantaged groups where lack of productive resources such as credit and subsidies is dominant. Since assistance like these may ease liquidity constraints faced by farmers in accessing production resources, it is critical in helping farmers adapt to climate change. This implies that both government and private institutions are to intensify efforts on increasing credit facilities and agricultural subsidies to help farmers to adopt adaptation strategies.

Lack of access to awareness programmes on climate change adaptation was another important constraint faced by the vegetable farmers (38.33 Garrett score). The lack of adaptive capacity due to constraints on resources such as the lack of/inadequate access to awareness programmes creates serious gaps between the farmers and useful information that should help them in their farm work. However, farmers face the lack of access to these facilities due to distance to the programme location and their round the clock work schedule. This will undoubtedly make the farmers become ignorant of the adaptation strategies and hence become vulnerable to the impact of climate change. It is clear that government and non-government organization should conduct more accessible awareness programmes to guide farmers on climate change adaptation so that they can make informed decisions and useful farm plans.

Another problem raised by the farmers was the lack of information about long term climate change and appropriate adaptations (35.82 Garret score). The smallholder farmers viewed a dearth of knowledge about long term climate change and appropriate adaptations. Farmers lacked information about long term climate change and suffered a knowledge gap in appropriate adaptation responses. Farmers' friendly information systems should be developed as effective measures to guide climate change adaptation policies.

No gender disparity was observed in the barriers faced by the farmers. The results are line with the findings of Mayaya *et al*. (2015) and Singh *et al*. (2017).

Summary & Conclusion

Chapter 5
SUMMARY AND CONCLUSION

5.1. Introduction

The impacts of a changing climate have particularly pronounced among agrarian populations, as they contend with ever-more uncertain conditions in which to raise food and earn a living. Climate change as 50 per cent of the net sown area is rainfed, which is contributes to 60 per cent value of agriculture GDP of India. Kerala, because of its location is also susceptible to the dynamics of the changing climate. Due to the general sensitivity to environmental extremes, vegetable crops have been noted facing both productivity and quality issues. While the impacts of climate change have different impacts on women's and men's natural, physical, social, and financial capital. Understanding this has enhanced the need to build resilience in the agricultural production systems across the globe. This requires awareness building, creation and promotion of sound adaptation strategies, with a gender equality perspective, all of which call for focussed extension delivery, support packages, action research programmes and participatory problem solving. In this context the present study entitles "Gender disaggregated analysis of climate-change adaptations among vegetable farmers" was undertaken with following specific objectives.

5.2. Specific objectives

1. Assessment of the gender differentiated perception on effect of climate change among vegetable farmers
2. Investigation of the determinants of climate change adaptation among male and female farmers
3. Analysis of the constraints with respect to climate change adaptations among the farmers

5.3. Research Methodology

Ex-post-facto research design was used for the study. Palakkad district was purposively selected as it is listed as the one of the highly vulnerable districts of Kerala in climate change. Four blocks (Alathur, Nenmara, Kollengode and Chittur) were randomly selected from the 13 blocks in Palakkad district. The respondents for the study include farmers and extension personnel. From each selected block 20 female and 20 male farmers with minimum ten years experience in vegetable cultivation from each block were randomly selected to make the total sample size of 160 in the farmers category. Through key informant survey five extension personnel as Agricultural Officers, Agricultural Assistants, VFPCK managers and ATMA block technology managers were randomly from each selected block. Thus, a total sample size of 160 farmers and 20 extension personnel were selected for this study.

Primary data was collected through personnel interviews using pretested semi-structured schedules, interview and discussion with key informants and direct observation. Secondary data was collected from Regional Agriculture Research Station, Pattambi and Department of Agriculture in either published or unpublished documents of the institution. Appropriate descriptive and inferential statistical tools were used to analyze the data.

5.4. Major findings

5.4.1 Personal and socio-economic attributes of farmers selected for the study

- **Age**: Majority of the farmers (58.75% male and 63.75 female farmers) belonged to middle age groups. This might be due to the fact that young generation are more inclined towards other livelihood sources than agriculture
- **Education:** Slightly above half (51.25%) male farmers and 37.5 per cent female farmers had secondary level of education. The probable reason for this result may be the high literacy rate prevalent in the state
- **Farming experience:** More than half of the respondent male farmers (70%) and female farmers (62.5%) had medium range of farming experience (12-26 years), followed by farmers with more than 26 years of experience (15% male farmers and 10% female farmers). This might be because more than half of the respondents were middle aged.

- **Farm size:** Majority of farmers belonged to marginal farmers (65% male and 78.75%female) with farm size less than 1 hectare land. This may be attributed to the fact that the state has smallest average size of the holdings and majority of the farmers falls under the small to marginal categories
- **Annual income:** More than half of the respondent male farmers (60%) and female farmers (51.25%) had medium range of annual income (1.30- 3.74 lakhs). Majority of the respondents were found to have less income, which has implications on their adaptation to climate change.
- **Extend of farming integration:** Majority (61.25% of males and 65% of females) of the respondents in both gender groups were found to have not integrated any of the components. The farmers need to be mobilized towards the farming integration.
- **Access to climatological information:** majority respondents (93.75% male and 91.25% female farmers) acquired climatic information through fellow farmers regularly followed by their neighbours. This is because fellow farmer and neighbours are more accessible and regarded as reliable by the farmers. with regard to informal sources, television was the most preferred source of information.
- **Exposure to training:** A large number of farmers (57.5% male and 46.25% female) have been attending training programmes regularly. Farmers low attendance in the training programmes might be because of their round the clock work schedule as they have to work in the field, lack of time awareness and location of the training institutes.
- **Extension contact:** VFPCK officials followed by Agricultural Officers were most preferred extension officials. despite the gender group meeting were most participated programme because these were easy to conduct among the farmers. Educational visits were the second most participated programme among male vegetable farmers due to their better social exposure. Demonstrations were the second most participated extension programme among female farmers because these were conducted at their own vegetable fields.
- **Social participation:** all the male vegetable farmers had and majority of the female vegetable farmers had membership in at least one organization. 13.75

per cent males and 8.75 per cent females held official position in the organizations respectively

- **Financial assistance:** Among farmers of both gender groups, more than half (70% male and 75% female) were found to be availed credit. A greater number of farmers (63.75% males and 60% females) were noted to be availed insurance
- **Risk bearability**: majority of the respondents (67.5% male and 87.5% female farmers) were found to be having medium risk bearability
- **Market orientation:** majority (72.5% male and female farmers) of the respondents were found to be having medium level market orientation
- **Scientific orientation:** Majority (68.75% male and 67.5% female) of the vegetable farmers were found to have medium scientific orientation

5.4.2. Farmers awareness on effect of climate change

- Distribution of vegetable farmers based on their awareness on climatic indicators showed all of the farmers were aware of climate change indicators on change in average temperature, change in average precipitation and Fluctuations in onset of monsoons
- Majority of the farmers were aware of climate change indicators on uneven distribution of rainfall, occurrence of more and longer dry spells compared to the past, increased frequency of heatwaves, increase in windspeed, increase in duration of wind and prolonged cold weather
- Only 28 per cent of the farmers had awareness on increase in number of rainy days
- It can be concluded that most of the vegetable farmers had awareness on indicators of climate change

5.4.3. Farmers perception on effect of climate change – Gender disaggregated analysis

- Gender disaggregated distribution of vegetable farmers based on their perception on effect of climate change as estimated from their responses to various indicators related to water, crop, calamities, soil, animal husbandry and others showed that there are gendered differences in the perception of farmers pertains to the effect of climate change. The inferences on each indicator are detailed below

5.4.3.1. Water related effects

- Majority of the farmers (65% male and 75% female) perceived mild to moderate level of water shortage. This can be explained by their role in collection of water in a farming household
- 33.75 per cent of the male and 23.75 per cent female vegetable farmers found to be experienced mild to moderate level quality issues. Male vegetable farmers who possess important role in irrigation and water management observed to have better perception on quality issues related to water as an effect of climate change

5.4.3.2. Crop related effects

- A greater part of the vegetable farmers has anticipated the mild to moderate level effect of increase in growing period of crops, reduction in crop yield, crop quality deterioration, decrease in shelf life of vegetables and increase in crop weed competition
- It is observed that majority (81.25%) of the male vegetable cultivators have perceived mild to moderate pest and disease outbreaks in the last 10 years, while majority of the female perceived this at severe level

- Majority of the farmers experienced mild to moderate level effect of increase in emergence of new weeds in the fields and increase in water stress
- A vast majority of farmers (93.75% males and 97.5% of females) perceived mild to moderate level decrease in fertilizer use efficiency among vegetable crops
- Most of the vegetable farmers have perceived effects of climate change on their vegetable crops. Female vegetable farmers observed to have better perception on crop related indicators except for crop weed competition and increase in

water stress. The negative effects of climate change on crop seems to affect women farmers the hardest as they work under the most perilous circumstances in the sector with tougher conditions and poorer livelihood opportunities

5.4.3.3. Calamity related effects

- A vast majority of vegetable farmers perceived mild to moderate level effects related to calamities including heavy rains, drought, floods and landslides. Few farmers reported severe effects of calamities in the last decade
- None of the farmer respondents have perceived hailstorm as an effect of climate change which implies that the location of the study has not faced this calamity in the last decade
- A large part of female farmers experienced calamities at severe levels especially flood and landslide as an effect of climate change because of the greater risk to survival and recovery. Severe effect of heavy rain and drought was more perceived by male farmers because of their higher role in the vegetable production

5.4.3.4. Soil related effects

- Majority of farmers anticipated mild to moderate level effects of reduced soil fertility, depletion of ground water, disturbed soil structure
- Farmers observed to perceive effect related to soil erosion, reduction in water holding capacity at severe level since these effects are more anticipatable
- It is noticeable that male farmers have experienced severe effects of climate change on soil more because of their title role on the land preparation during vegetable cultivation

5.4.3.5. Animal husbandry related effects

- Majority of farmers have perceived animal husbandry related effects including low productivity, emergence and transmission of pest and diseases and increased mortality at mild to moderate level
- Female farmers seem to perceive mild to moderate on effects related to animal husbandry. This can be explained by their role in taking care of the livestock in

an agricultural household. Severe level effects were perceived by male farmers who were possessing the economical ownership of farm animals

5.4.3.6. Other effects

- Majority of the respondents perceived mild to moderate level effect of presence of new animals and birds and wild animal straying into villages, increase in cost of cultivation, increase in adoption of non-farming activities for livelihood and increase in urban migration of farmers and rural youth
- It is noticeable that male farmers had perceived these effects at severe levels, given their role in the socio-economic system

5.4.4. Prioritization of climate change adaptation strategies among vegetable farmers

- Adaptation strategies were measured under four components namely, crop management, soil and fertility management, water management, pest and disease management, financial management and others. Using the Analytical Hierarchy Process (AHP), the multiple criteria for decision making regarding adaption strategies were examined
- Preference was given to crop management, with a priority weight of 0.33, in comparison to other components. This is because the crop management practices are considered as easy, economical and effective by farmers

Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of different adaptation strategies among male vegetable farmers

- Most important alternative for component “crop management” was “crop rotation” with (local priority-0.40) and “use of organic manures” (local priority -0.61) in the “soil and fertility management”
- Supplementary irrigation was chosen as the most important strategy of “water management”, (local priority-0.40) and pest surveillance in the “pest and disease management” (local priority of 0.35)

- Income diversification (local priority-0.48) was preferred as the financial management strategy, whereas in other activities, most important alternative was "post- harvest management" (local priority of 0.38)
- Based on the intensity of importance of one over another alternatives, the most substantial strategy among male farmers was "use of organic manure" because this promotes greater soil organic matter content and improve soil structure. It is also considered as an easy and economical practice among male farmers, given that a large number of them own farm animals. Male farmers were able to prepare organic manure by themselves at their own farms

Local and Global priorities of criteria under each alternative in relation to the decision making on the adoption of different adaptation strategies among female vegetable farmers

- Most important alternative for component "crop management" was "crop rotation" (local priority-0.38) and "use of organic manures" (local priority-0.59) in the "soil and fertility management"
- "Supplementary irrigation was chosen as the most important strategy of "water management" and pest surveillance in the "pest and disease management" component with local priority of 0.59
- "Income diversification", was preferred as the financial management strategy with local priority of 0.48, whereas in other activities, most important alternative was "getting help from govt& other agencies" with a local priority of 0.43
- Based on the intensity of importance of one over another alternatives, the most substantial adaptation among female farmers was "crop rotation". It is considered as an easy and economical adaptation strategy. Crop rotation was known to offer better crop residue management and higher soil nutrient. And since it has been practiced traditionally it was widely accepted among women farmers

5.4.5 Adaptation strategies adopted by the vegetable farmers

- Distribution of farmers across different levels of adoption for each adaptation strategy within each component is assessed

5.4.5.1. Crop management

- Majority (83.75%) of the farmers adopted change of planting and harvesting date as an adaptation strategy, while 14.38 per cent discontinued the practice. Vast majority (92 %) farmers continued practicing crop rotation, followed by 75 per cent of them practicing crop diversification as an adaptation strategy to climate change
- Cultivation of stress tolerant varieties and short duration crops have highest rate of non-adoption (36.25% and 70%) and discontinuance, (50.63 % and 21.88%) respectively. Even though cultivation of stress tolerant varieties and cultivation of short duration varieties are effective adaptation strategies to cope with climate change adversities, respondents are reluctant to adopt them. High input cost and labour cost was cited as the major reason for this non-adoption by farmers

5.4.5.2. Soil and fertility management

- It was found that almost all farmers (99.37%) adopted use of organic manure as an adaptation strategy
- Majority (61.87%) of the farmers continued to change time and dose of fertilizer application, while 14.37 per cent discontinued the practice. It is observed that this practice has highest rate of discontinuance (23.75%). Followed by mulching (10.62%)
- Minimum tillage (89.38%), mulching (68.75%) and use of biofertilizers (56.25%) have highest rate of non-adoption
- These practices have been recommended as effective adaptation strategies. But, farmers are reluctant to switch from the prevailing traditional practices. High input cost was also cited as a major reason for the non-adoption

5.4.5.3. Water management

- Majority (76.25%) of the farmers adopted supplementary irrigation as an adaptation strategy, while 18.75 per cent discontinued the practice. About half (50.62%) farmers continued practicing water conservation strategies, followed by 38.75 per cent farmers adopting cultivation of non-water intensive crops as an adaptation strategy
- Water conservation and cultivation of non-water intensive crops have highest rate of discontinuance (13.75 % and 6.87% respectively). It was observed that vast majority have not adopted technology advances (98.75%) and rainwater harvesting (95.62%)
- High input cost and the reluctancy to change traditional practices could be cited as the reasons for this non-adoption by vegetable farmers

5.4.5.4. Pest and disease management

- Majority of the farmers adopted pest surveillance (65.62%), while 20.62 per cent not adopted the practice
- Change in time and dose of plant protection chemicals was the adopted by 61.88 per cent of the farmers as an adaptation practice. 35 per cent of the farmers adopted pest and disease tolerant varieties as an adaptation strategy
- Cultivation of pest and disease tolerant varieties and pest surveillance have the highest rate of discontinuance (31.88%and 23.12% respectively)
- Protected cultivation and use of biocontrol agents have highest rate of non-adoption (95%and 93.12% respectively)
- Expensive inputs, lack of knowledge on the practices and high maintenance were cited as reasons behind this non-adoption

5.4.5.5. Financial management

- It was observed that majority (72.5%) of the framers adopted income diversification as an adaptation strategy, while 15.62 per cent discontinued the practice

- 38.75 per cent farmers continued crop insurances as an adaptation
- It was found that crop insurances and group farming have highest rates of discontinuance (22.5% and 20% respectively)
- Selling assets has the highest rate of non-adoption (94.37%) followed by group farming (61.25%) and use of credit (47.5%)
- Small landholding and lower annual income can point as the major reason for this non-adoption by farmers

5.4.5.6. Other adaptation strategies

- About half (48.12%) of the farmers adopted reducing hired labour through mechanization as an adaptation strategy while 22.5 per cent discontinued the practice
- 41.25 per cent farmers continued getting help from government and other agencies and 31.87 per cent have not adopted this as an adaptation
- Getting help from government and other agencies and post-harvest management has the highest rates of discontinuance (30% and 22.5% respectively)
- Avoidance of extreme climate areas has the highest rate (76.87%) followed by post-harvest management (51.25%)
- Even though avoidance of extreme climate areas is are recommended as effective adaptation strategies, because of the lack of alternate lands to cultivate vegetables, farmers are not ready to adopt them
- High input cost and labour cost was cited as the major reason for non-adoption of post-harvest management by farmers

5.4.6. Distribution of vegetable farmers according their differential level of climate change adaptation

- Male and female vegetable farmers of the sample were categorized into three differential level of adoption *i.e.,* low, medium and high on the basis of obtained climate change index score by the respective farmers
- Majority (65% male and 70% female) of the vegetable farmers are having medium level of adoption

- 25 per cent of male farmers and 5 per cent of female farmers have higher level of adoption
- 25 per cent of females have low adoption of selected adaptation strategies to cope with climate change compared to 10 per cent of male farmers
- There is a gendered difference in adoption of climate change adaptation strategies among vegetable farmers, which may be due to the disparities between men's and women's abilities to purchase inputs for implementing adaptation strategies, as well as inequalities in access to information and financial assistance

5.4.7. Adoption of climate change adaptations among male and female farmers

- The mean climate change adaptation index of farmers was calculated for each adaptation and two sample t test was employed to find out the difference between male and female vegetable farmers in terms of adoption of different climate change adaptation strategies
- Probabilities of t-statistic obtained indicates significant difference in the adoption of financial management and other strategies by male and female farmers
- Since the mean adaptation index of male farmers (0.486) was higher than that of female farmers (0.404), related to financial management it could be concluded that climate change adaptation of male farmers is higher than that of female farmers regarding this
- Mean adaptation index of male farmers (0.410) was higher than that of female farmers (0.246), related to other strategies, it could be concluded that climate change adaptation of male farmers is higher than that of female farmers regarding this
- Since the mean of total adaptation index of male farmers (0.5) was higher than that of female farmers (0.428), it could be concluded that adoption of climate change adaptation strategies by male farmers is higher than that of female farmers

5.4.8. Determinants of climate change adaptation among vegetable farmers

- Binary logistic regression is employed between profile characteristics and adoption status of the farmers to find out the determinants influencing adoption of climate change adaptation strategies among vegetable farmers
- The results implied that change in the level of extension contact could bring a corresponding chance of 14.17 per cent for a farmer to adopt a soil and fertility management adaptation strategy
- This is because extension contact could promote farmers adoption of adaptation strategies related to soil and fertility by providing proper technical knowledge to farmers
- Being a male and decrease in level of risk bearability found to bring a corresponding chance of 20 per cent and 87.5 per cent respectively for a farmer to adopt a financial management and other strategies
- This is because of more opportunities male farmers have to adopt financial management adaptations due to the prevailing power relations in the society
- Also, farmers with less risk bearabilty seems to adopt more financial management practices due to their low readiness to accept and adopt adaptation practices pertains to crop, soil and fertility, water, pest and disease management

5.4.9. Constraints faced by vegetable farmers with respect to climate change adaptation

- Garrett's ranking technique was used to rank the constraints faced by vegetable farmers, associated with the climate change adaptation
- The major constraint faced by vegetable farmers with respect to climate change adaptations were lack of government support (62.22 Garrett score)
- Lack of policy guidance, the limited coordination between levels, and the lack of available governmental resources constrain adaptation at all administrative levels
- High cost of the agricultural inputs needed for adaptation strategies was the second major constraint felt by the farmers (59.71 Garrett score)

- Inadequate credit facilities and lack of agricultural subsidies (51.77 Garrett score), Lack of access to awareness programmes on climate change adaptation (38.33 Garrett score), lack of information about long term climate change and appropriate adaptations (35.82 Garrett score) were the other problems faced by farmers

5.5 Conclusions

- The farming community in Kerala are becoming increasingly aware of climate change
- Differences are observed in farmer perceptions on effect of climate change due largely to their social construction of gender roles and relations
- Furthermore, these gender-based perceptions of effect of climate change found to have weight on male and female farmers' decisions to prioritize and implement adaptation practices
- Institutional and financial support mechanism should be strengthened to transfer technology in the domain of climate change adaptation to cut back on the constraints faced by farmers

5.6. Suggestions for future research

- The study was carried out under limitations of time and resources available with researcher, covering only Palakkad district of Kerala. It is true that the finding of a single study is not adequate to make any generalized conclusion. Therefore, it is necessary to replicate the same study in other districts of the state and country
- An impact study on climate change adaptations could be conducted to bring out the extent to which it has influenced the socio-economic and environmental domains of farming
- Study on the institutional innovations in dissemination and promotion of climate change adaptations could add more to the domain

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Appendices

APPENDIX – I

KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF AGRICULTURE

VELLANIKKARA

DEPARTMENT OF AGRICULTURAL EXTENSION EDUCATION

SCHEDULE FOR DATA COLLECTION FROM FARMERS

Gender disaggregated analysis of climate-change adaptations among vegetable farmers

Serial No: Date:

I. General Information

1. Name of the farmer
2. Address:
3. Mobile number:
4. Village:
5. Block:
6. Area of residence: Rural/ Urban

I. Personal, socio-economical characteristics

1. Age:
2. Gender: Male/Female
3. Education

Illiterate	Lower primary education	Upper primary education	Highschool	Higher secondary	Degree	Masters and above

4. Occupation:

Farming	Government job	Business	Others

5. Farming experience (No. of years):
6. Land holding (in acres)

Type of land	Owned	Leased	Leased out	Total
Rainfed				
Irrigated				
Wasteland				
Total				

7. Irrigation

Source	Number	Ownership details		
Well		Owned	External	External + Owned
Tube well				
Farm pond				
Others (Specify)				

8. Farm Details

Crop component

Sl. No	Crop cultivated	Variety	Area (acre)	Season	Production
1.					
2.					
3.					
4.					

Animal component

Sl. No	**Crop cultivated**	**Breed**	**Number**	**Productivity (Milk, meat, egg, honey)**
1.	Cow			
2.	Goat			
3.	Poultry			
4.	Honey bee			
5.	Fish			
6.	Honey bee			

Value addition, if any

Sl.No.	**Item**	**Product**	**Additional Income**
1.			
2			

9. Annual income

Sl.No.	**Source of income**	**Annual income (Rs)**
1.	Crops	
2.	Animal Husbandry	
3.	Value Addition	
4.	Other sources (specify)	
	Total	

10. Sources of information

a) Formal sources

Sl. No.	**Source**	**Institution providing/ agency involved**	**Frequency**		
			Regular	Occasional	Never
1.	Training				
2.	Exposure visit				
3.	Demonstration				
4.	Seminars				
5	Exhibitions				

b) Informal sources

Sl. No.	**Source of income**	**Frequency of contact**		
		Regular	**Occasional**	**Never**
1	Fellow farmers			
2	Neighbors			

c) Mass media sources

Sl. No	**Source of income**	**Frequency of contact**		
		Regular	**Occasional**	**Never**
1	Printed media (Newspaper, Magazines, books, leaflets)			
2	Radio			
3	Television			
4	Internet and social media (Websites, Facebook pages, WhatsApp groups)			

10. Extension contacts

Sl.No.	Extension worker	Frequency of contact		
		Regular	**Occasional**	**Never**
1.	Agricultural Assistant			
2.	Agricultural Officer			
3.	VFPCK Officers			
4.	ATMA BTM's			

12. Extension participation

a) Do you participate in extension activities? Yes/No

b) If yes, give details

Sl.No.	Extension Activities	Frequency of participation		
		Regular	**Occasional**	**Never**
1.	Training program			
2.	Demonstration			
3.	Field days			
4.	Field visit			
5.	Group meetings			
6.	Agricultural Exhibitions			
7.	Kisan mela			
8.	Educational tours			
9.	Plant clinics			

13.Institutional assistance

a) Credit

Have you availed any agricultural credit support? Yes/No

Sl. No	Crops	Purpose for which credit availed	Amount	Credit criteria	Rate of interest	Institution from which credit availed
1.						
2.						
3.						

b) Insurance

Have you insured your crops or livestock? Yes/No

If yes, specify

14. Risk bearibility

Please indicate whether you agree or disagree with the following statements

Sl. No.	Statements	Response				
		Strongly Agree	Agree	Undecided	Disagree	Totally disagree
1	Farmers should work for activities associated with more risk and profit rather than low risk and low profit to combat climate change (+)					
2	Farmer who takes risk found					

	economically better than the rest in adapting to climate change (+)					
3	Farmers take risk only when see better chance to succeed (-)					
4	It is appropriate not to adopt improved technology when it has not been used by others successfully (-)					
5	Adopting climate change adaptation activities is risky but profitable (+)					
6	Amidst uncertainty in the era of climate change farmers should diversify					

	agriculture activities (+)					

15. Market orientation

Sl.No.	Statements	SA	A	UD	DA	SDA
1	Do you like to grow crops which have more market demand (+)					
2	Do you find market news as useful to farmers (+)					
3	Do you like to sell produce to the nearest market irrespective of price (-)					
4	Do you find grading the produce, helps the farmer to get a high price (+)					
5	Do you think market intermediaries are necessary for marketing a product (-)					
6	Do you think produce should be stored until a farmer get a high price for it (+)					

16.Scientific orientation

Sl.No.	Statements	SA	A	UD	DA	SDA
1	I prefer scientific techniques of crop production (+)					
2	Profitable agriculture production is possible through scientific techniques during climate change (+)					
3	Quality crop production is possible through using scientific techniques related to adaptation strategies (+)					
4	Application of scientific techniques saves money for farming (+)					

5	Scientific methods of agriculture always confuse me (-)					

II.Farmers awareness on climate change

Sl.No.	Climate change indicators	Awareness	
		Aware	Not aware
1. Climate related			
1	Change in average temperature		
	Minimum temperature		
	Maximum temperature		
2	Change in average precipitation		
	Minimum precipitation		
	Maximum precipitation		
3	Increase in number of rainy days		
4	Fluctuations in onset of monsoons		
5	Uneven distribution of rainfall		
6	Occurrence of more and longer dry spells as compared to the past		
7	Increased frequency of heatwaves		
8	Increase in windspeed		
9	Increase in duration of wind		
10	Prolonged cold weather		

III. Farmers' perception on effect of climate change

Details of effects perceived due to climate change

Sl. No.	**Effects**	**Indicators/ way as experienced**	**Severity as percieved by farmer**			
			Nil	Mild	Moderate	Severe
1	Water related	Water shortage				
		Quality issues (salinity, heavy metal)				
2	Crop related	Increase in growing period				
		Decrease in growing period				
		Reduction in crop yield				
		Quality deterioration				
		Decreased shelf life				
		Pest and disease outbreak				
		Emergence of new weeds				
		Increased crop weed competition				
		Increased water stress				
		Decrease in fertilizer use efficiency				
		Others (Specify)				
3	Calamity related	Heavy rain				
		Drought				
		Hailstorm				
		Flood				
		Landslide				

		Others (Specify)				
4	Soil related	Reduced soil fertility				
		Depletion of ground water				
		Disturbed soil structure				
		Increased soil erosion				
		Reduced water holding capacity				
5	Animal husbandry related	Low productivity of livestock				
		Emergence and transmission of pest and diseases				
		Increased mortality				
6	Others	Presence of new animal or bird species (Eg: Peacock)				
		Increase in cost of cultivation				
		Increase in adoption of non-farming activities for livelihood				
		Increase in urban migration of framers/ rural youth from rural areas				

Barriers to climate change adaptation – Garret Ranking

Sl.No.	Barriers to climate change adaptation	Rank
1	Lack of information about long term climate change and appropriate adaptations	
2	Lack of access to awareness programmes on climate change adaptation	
3	Higher cost of the agricultural inputs needed for adaptation strategies	
4	Inadequate credit facilities and lack of agricultural subsidies	
5	Lack of governmental support	

Prioritization of Climate change adaptation strategies by farmers

Component	Sl. No	Pairs	Equally prioritized	If not equally prioritized, then which one has more priority in each pair and how much? (Give tick mark)								
				Which has more priority?	How much							
					Slightly prioritized	Moderately prioritized	Moderate plus prioritized	Strongly prioritized	Strongly plus	Very strongly prioritized	Very very strongly prioritized	Extremely prioritized
Crop management	1	Change of planting &harvesting date			2	3	4	5	6	7	8	9
		Crop rotation										
	2	Change of planting &harvesting date			2	3	4	5	6	7	8	9
		Crop diversification										
	3	Change of planting &harvesting time			2	3	4	5	6	7	8	9
		Cultivation of stress tolerant varieties										

	4	Change of planting &harvesting time			2	3	4	5	6	7	8	9
		Cultivation short duration crops										
	5	Crop rotation			2	3	4	5	6	7	8	9
		Crop diversification										
	6	Crop rotation			2	3	4	5	6	7	8	9
		Cultivation of stress tolerant varieties										
	7	Crop rotation			2	3	4	5	6	7	8	9
		Cultivation of short duration crops										
	8	Crop diversification			2	3	4	5	6	7	8	9
		Cultivation of stress tolerant varieties										
	9	Crop diversification			2	3	4	5	6	7	8	9
		Cultivation of short duration crops										
	10	Cultivation of stress tolerant varieties			2	3	4	5	6	7	8	9
		Cultivation short duration crops										
Soil management	1	Minimum tillage			2	3	4	5	6	7	8	9
		Use of organic manure										
	2	Minimum tillage			2	3	4	5	6	7	8	9

		Use of biofertilizers										
	3	Minimum tillage			2	3	4	5	6	7	8	9
		Mulching (Organic)										
	4	Minimum tillage			2	3	4	5	6	7	8	9
		Change in time and dose of fertilizer application (Need based application)										
	5	Use of organic manure			2	3	4	5	6	7	8	9
		Use of biofertilizers										
	6	Use of organic manure			2	3	4	5	6	7	8	9
		Mulching										
	7	Use of organic manure			2	3	4	5	6	7	8	9
		Change in time and dose of fertilizer application (Need based application)										
	8	Use of biofertilizers			2	3	4	5	6	7	8	9
		Mulching										
	9	Use of biofertilizers			2	3	4	5	6	7	8	9

		Change in time and dose of fertilizer application (Need based application)										
	10	Mulching			2	3	4	5	6	7	8	9
		Change in time and dose of fertilizer application (Need based application)										
Water management	1	Water conservation – Drip irrigation, Sprinkler			2	3	4	5	6	7	8	9
		Supplementary irrigation										
	2	Water conservation – Drip irrigation, Sprinkler			2	3	4	5	6	7	8	9
		Rainwater harvesting										
	3	Water conservation – Drip irrigation, Sprinkler			2	3	4	5	6	7	8	9
		Technology advances- Solar water pumps										
	4	Water conservation – Drip irrigation, Sprinkler			2	3	4	5	6	7	8	9

		Non-water intensive crops										
	5	Supplementary irrigation			2	3	4	5	6	7	8	9
		Rainwater harvesting										
	6	Supplementary irrigation			2	3	4	5	6	7	8	9
		Technology advances- Solar water pumps										
	7	Supplementary irrigation			2	3	4	5	6	7	8	9
		Non-water intensive crops										
	8	Rainwater harvesting			2	3	4	5	6	7	8	9
		Technology advances- Solar water pumps										
	9	Rainwater harvesting			2	3	4	5	6	7	8	9
		Non-water intensive crops										
	10	Technology advances- Solar water pumps			2	3	4	5	6	7	8	9
		Non-water intensive crops										
	1	Change in time and dose of plant protection chemicals (Pesticides, herbicides etc)			2	3	4	5	6	7	8	9

Pest and disease management & Crop protection		Pest and disease tolerant varieties (Development using Grafting)										
	2	Change in time and dose of plant protection chemicals (Pesticides, herbicides etc)			2	3	4	5	6	7	8	9
		Protected cultivation- Greenhouse, polyhouse, rain shelter, net houses										
	3	Change in time and dose of plant protection chemicals (Pesticides, herbicides etc)			2	3	4	5	6	7	8	9
		Pest surveillance- Traps, Lures, Pest scouting										
	4	Change in time and dose of plant protection chemicals (Pesticides, herbicides etc)			2	3	4	5	6	7	8	9
		Use of Biocontrol agents										

	5	Pest and disease tolerant varieties (Development using Grafting)			2	3	4	5	6	7	8	9
		Protected cultivation- Greenhouse, polyhouse, rain shelter, net houses										
	6	Pest and disease tolerant varieties (Development using Grafting)			2	3	4	5	6	7	8	9
		Pest surveillance- Traps, Lures, Pest scouting										
	7	Pest and disease tolerant varieties (Development using Grafting)			2	3	4	5	6	7	8	9
		Use of Biocontrol agents										

	8	Protected cultivation- Greenhouse, polyhouse, rain shelter, net houses			2	3	4	5	6	7	8	9
		Pest surveillance- Traps, Lures, Pest scouting										
	9	Protected cultivation- Greenhouse, polyhouse, rain shelter, net houses			2	3	4	5	6	7	8	9
		Use of Biocontrol agents										
	10	Pest surveillance- Traps, Lures, Pest scouting			2	3	4	5	6	7	8	9
		Use of Biocontrol agents										
Financial management	1	Income diversification – livestock, poultry, seed production			2	3	4	5	6	7	8	9
		Selling assets										
	2	Income diversification – livestock, poultry, Seed production			2	3	4	5	6	7	8	9

		Use of credit										
	3	Income diversification – livestock, poultry, Seed production			2	3	4	5	6	7	8	9
		Crop insurances										
	4	Income diversification – livestock, poultry, Seed production			2	3	4	5	6	7	8	9
		Group farming- SHGs, Kudumbashree, FPOs, Cooperatives										
	5	Selling assets			2	3	4	5	6	7	8	9
		Use of credit										
	6	Selling assets			2	3	4	5	6	7	8	9
		Crop insurances										
	7	Selling assets			2	3	4	5	6	7	8	9
		Group farming- SHGs, Kudumbashree, FPOs, Cooperatives										

	8	Use of credit Crop insurances			2	3	4	5	6	7	8	9
	9	Use of credit Group farming- SHGs, Kudumbashree, FPOs, Cooperatives			2	3	4	5	6	7	8	9
	10	Crop insurances Group farming- SHGs, Kudumbashree, FPOs, Cooperatives			2	3	4	5	6	7	8	9
Others	1	Post- harvest management - Processing, Cool chamber, Echo shops, Cooperative banks, Export Reduce hired labour- Mechanization			2	3	4	5	6	7	8	9
	2	Post- harvest management - Processing, Cool chamber,			2	3	4	5	6	7	8	9

		Echo shops, Cooperative banks, Export										
		Getting help from govt& other agencies – Linkage with marketing facilities- VFPCK, Horti Corp, Contract farming										
	3	Post- harvest management - Processing, Cool chamber, Echo shops, Cooperative banks, Export			2	3	4	5	6	7	8	9
		Avoidance of extreme weather (drought/flood) prone areas										
	4	Reduce hired labour- Mechanization			2	3	4	5	6	7	8	9
		Getting help from govt& other agencies – Linkage with marketing facilities-										

		VFPCK, Horti Corp, Contract farming										
	5	Reduce hired labour- Mechanization			2	3	4	5	6	7	8	9
		Avoidance of extreme weather (drought/flood) prone areas										
	6	Getting help from govt& other agencies – Linkage with marketing facilities- VFPCK, Horti Corp, Contract farming			2	3	4	5	6	7	8	9
		Avoidance of extreme weather (drought/flood) prone areas										

Adoption of climate change adaptation strategies

Please read the statement below and express which adaptation strategies, discontinued and never adopted.

Put tick (✓) mark in appropriate box.

Sl.No.	Adaptation Strategies	AC	AD	NA
	Crop Management			
1	Change of planting and harvesting date			
2	Crop rotation			
3	Crop diversification			
4	Cultivation of stress tolerant varieties			
5	Cultivation of Short duration crops			
	Soil and fertility management			
1	Minimum tillage			
2	Use of organic manure			
4	Use of biofertilizers			
5	Mulching – (organic)			
6	Change in time and dose of fertilizer application – Need based application			
	Water management			
1	Water conservation – Drip irrigation, Sprinkler			
2	Supplementary irrigation			
3	Rainwater harvesting			
4	Technology advances- Solar water pumps			
5	Non-water intensive crops			
	Pest and disease management & Crop protection			
1	1. Change in time and dose of plant protection chemicals (Pesticides, herbicides etc)			

2	Pest and disease tolerant varieties (Development using Grafting)			
3	Protected cultivation- Greenhouse, polyhouse, rain shelter, net houses			
4	Pest surveillance- Traps, Lures, Pest scouting			
5	Use of Biocontrol agents			
	Financial management			
1	Income diversification – livestock, poultry, Seed production			
2	Selling assets			
3	Crop insurances			
4	Group farming- SHGs, Kudumbashree, FPOs, Cooperatives			
5	Use of Credit			
	Others			
1	Post- harvest management- Echo shops, Cooperative banks, Export, Cool chamber			
2	Reduce hired labour Mechanization			
3	Getting help from govt& other agencies			
4	Avoidance of extreme climate areas			

AC-Adaption Continued **AD**-Adaption Discontinued **NA**-Never Adopted

APPENDIX – II

KERALA AGRICULTURAL UNIVERSITY

COLLEGE OF AGRICULTURE

VELLANIKKARA

DEPARTMENT OF AGRICULTURAL EXTENSION EDUCATION

SCHEDULE FOR DATA COLLECTION FROM OFFICIALS

Gender disaggregated analysis of climate-change adaptations among vegetable farmers

Serial No: Date:

1. Name of the respondent:
2. Designation:
3. Age:
4. Gender: male / female
5. Education: (VHSE/ Degree/ Post graduate/ Doctoral degree)
6. Experience: (No. of years):
7. Are there any climate change related issues reported by farmers? Yes/No
8. What aspect of issues they are reporting?

   Crop loss ☐ Reduction in the yield ☐ Pest and diseases ☐

9. Does climate change have impact on vegetable production? Yes/ No
10. Source of information you are using to update knowledge on climate change and adaptation strategies

Source	**Daily**	**Once in a week**	**Fortnightly**	**Monthly**	**Occasionally**
Contact with farmers					
Subject experts					
Field vets/staff					
Extension staff					

Mass media (Electronic)					
Various Literature					
Any other source					

11. Details of Trainings/ Seminars/conferences attended related to climate change and adaptation strategies

Sl. No.	**Name/Theme/ topic of the programme**	**Objective**	**Duration**	**Skill imparted**
1.				
2.				
3.				
4.				
5.				

12. Do you think coping up through adaptations are enough to combat climate change? Yes/No
13. Adaptation strategies observed at the field level

Sl. No.	**Adaptation strategy**		
1	Crop management	1. Change of planting and harvesting date	
		2. Crop rotation	
		3. Crop diversification	
		4. Cultivation of unconventional crops- (Cool seasons vegetables)	
		5. Cultivation of stress tolerant varieties	
		6. Cultivation of Short duration crops	
2	**Soil and fertility management**	1. Minimum tillage	
		2. Increased soil cover	
		3. Use of organic manure	
		4. Use of biofertilizers	
		5. Mulching – (organic)	

		6. Change in time and dose of fertilizer application – Need based application	
3	**Water management**	1. Water conservation – Drip irrigation, Sprinkler	
		2. Supplementary irrigation	
		3. Rainwater harvesting	
		4. Technology advances- Solar water pumps	
		5. Non-water intensive crops	
4	**Pest and disease management & Crop protection**	1. Change in time and dose of plant protection chemicals (Pesticides, herbicides etc)	
		2. Pest and disease tolerant varieties (Development using Grafting)	
		3. Protected cultivation- Greenhouse, polyhouse, rain shelter, net houses	
		4. Pest surveillance- Traps, Lures, Pest scouting	
		5. Use of Biocontrol agents	
5	**Financial management**	1. Income diversification – livestock, poultry, Seed production	
		2. Selling assets	
		3. Formal borrowing	
		4. Use of savings	
		5. Reducing consumption of inputs	
		6. Crop insurances	
		7. Group farming- SHGs, Kudumbashree, FPOs, Cooperatives	
6	**Others**	1. Post- harvest management- Echo shops, Cooperative banks, Export, Cool chamber	
		2. Reduce hired labour- Mechanization	
		3. Getting help from govt& other agencies – Linkage with marketing facilities- VFPCK, Horti Corp, Contract farming	
		4. Avoidance of extreme weather (drought/flood) prone areas	

14. Are there any adaptation strategies that you would recommend?
    1.
    2.
    3.
15. Which are the organizations, you would like to collaborate with, in order to empower farmers in terms of coping climate vagaries? Please specify the type of contact with the following organisations.

Sl. No	**Type of organization**	**Frequency of contact**		
		Regularly	**Occasionally**	**Never**
`1	Kerala Agricultural University			
2	ICAR Research Institutes			
3	College of Climate Change and Environmental Science (CCCES)			
4	Vegetable and Fruit Promotion Council Kerala (VFPCK)			
5	Horti Corp			
6	Self Help Groups			
7	Input Agencies			
8	International Organizations			
9	Credit Institutions			
10	Any other			

16. What are the interventions you would suggest to equip the vegetable farmers?

Sl. No	Interventions	Frequency of intervention		
		Regularly	Occasionally	Never
1.	Training program			
2.	Demonstration			
3.	Field trials			
4.	Field visit			
5.	Group meetings			
6.	Agricultural Exhibitions			

7.	Seminars			
8.	Educational tours			
9.	Various literature			

17. What are the constraints observed in adopting recommended practices?

    1.
    2.
    3.
    4.

18. Details of farmers who observed to obtain profit using climate change adaptation strategies

    1.
    2.
    3.
    4.

APPENDIX- III

Climatic data of Palakkad from 2012-2021

Monthly T max average of Palakkad district

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
2012	32.9	35.4	35.6	35.3	33.5	30.6	29.9	29.3	30.6	32.4	32	33.2	390.7	32.5
2013	34.3	35.1	36	35.7	34.9	28.9	28.7	29.8	30.3	31	32.4	32	389.1	32.4
2014	33.3	35	37.2	36.1	34.1	31.5	30	30	31.4	32.1	32.3	32.6	395.6	33
2015	33.2	34.7	35.8	32.2	32.9	31.2	30.5	31	32	32.5	32	32.6	390.6	32.5
2016	33.2	35	37	37	34.2	30.1	30	30.5	30.3	31.5	33	33	394.8	33
2017	34.1	36	36	35.7	34.4	29.6	28.2	29.7	30.9	31.2	32.1	31.8	389.7	32.4
2018	32.8	34.5	35.6	34.3	32.3	29.7	29.2	28.6	32.2	32.3	32.5	32.7	386.7	32.2
2019	32.4	35.3	36.4	35.9	34.9	31.6	29.7	28.9	30.6	31.6	32.3	29.9	389.5	32.4
2020	33	35.2	36.9	32.8	32.4	30.4	29.6	29.9	29.5	30.9	32.8	32.2	385.6	32.1
2021	32.2	33	36.1	34.4	32	31	36.3	29.8	28	28.9	29	29.8	380.4	31.7

Monthly T min average of Palakkad district

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
2012	20	21.1	23.9	25	25.5	24.1	23.9	23.8	23.7	23.7	22.3	21.7	278.7	23.2
2013	20.7	22.7	24.1	25.5	25.9	23.5	23.2	23.7	23.7	23.4	23.4	20.9	280.7	23.4
2014	21.3	21.2	23	25.3	25	24.3	23.3	23.3	23.2	23.5	22.5	21.8	277.7	23.1
2015	20.2	21	23.5	23.8	24	21	23.5	23.7	23.7	24	23.3	22.5	274.2	22.9
2016	21.4	22.3	24.9	26.5	25.2	24	23.8	23.9	24	23.1	23	21.4	283.5	24
2017	21	22	24	25.4	24.3	23.6	23	23.7	23.5	23.4	22.6	20.9	277.4	23.1
2018	13.6	-	22.4	23.3	22.2	22.5	22.1	21.2	22.8	22	21.8	20.8	236.2	19.6
2019	17.4	21	22.2	23.2	23.4	22.3	21.4	21.3	-	21	-	27.2	283.5	23.6
2020	19.7	19.4	22.1	20.1	22.7	20.6	21.5	22	22	21.9	20.9	22.4	255.3	21.2
2021	22.5	25.2	23.9	24.8	24.3	22.7	20.4	23	21.1	22.5	21.5	21.8	273.5	22.7

Monthly rainfall of Palakkad district

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
2012	0	0	0.3	104.4	42.5	459.7	297.8	489.3	220.2	234.9	74.6	6.2	1929.9	160.8
2013	0	79.5	55.2	0	19.8	934.3	895.9	262.3	242.6	155.2	104.6	0.2	2749.6	229.1
2014	0	4.2	0	23.8	167.4	398.9	608.3	661.1	217.5	360.7	78.3	6.3	2526.5	210.5
2015	0	0	59.2	139.4	207.1	419.4	428	172.3	229.4	317.8	194.2	101.5	2268.3	189
2016	0	0	0	0.3	191.7	480.6	344.6	120.2	90.1	59.6	4.1	34.3	1325.5	110.4
2017	0	0	42.3	13.5	190.6	550.5	354.4	412.9	291.2	64.2	101.7	35.4	2056.7	171.3
2018	0	46.3	68.4	48.8	407.1	788.2	713.2	673.5	38.3	227.3	10.6	1.4	3023.1	251.9
2019	0	0	0	68	82.5	351.1	561.9	1090.3	378.5	455.3	49.2	0	3036.8	253
2020	0	0	37	37.9	77.8	349.1	325.6	407	581.3	183.6	14.9	8.7	2022.9	168.5
2021	19.9	6.4	40.8	54.8	455.7	261.8	535.9	429.3	354.9	766.2	271.3	12.5	3208.7	267.3

Monthly rainy days of Palakkad district

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
2012	0	0	0	3	3	23	18	20	15	8	4	1	95	7.9
2013	0	2	2	0	2	27	30	15	14	13	8	0	113	9.4
2014	0	1	0	3	5	18	25	19	14	16	5	1	107	8.9
2015	0	0	2	9	9	22	19	11	15	12	11	4	114	9.5
2016	0	0	0	0	10	24	19	16	9	4	1	4	87	7.2
2017	0	0	3	1	7	21	20	13	18	11	4	2	104	8.6
2018	0	1	3	5	16	25	22	24	3	12	1	0	107	8.9
2019	0	0	0	3	4	16	23	17	16	20	4	0	110	9.1
2020	0	0	1	3	5	19	21	22	20	9	4	1	100	8.3
2021	2	1	2	4	15	14	24	14	17	18	16	2	137	11.4

Monthly windspeed of Palakkad district

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	MEAN
2012	4.4	4.4	3.5	3.4	3.4	1.9	2.8	2.1	1.7	2	2	4.6	36.2	3
2013	4.2	4.8	3.6	3.4	3.9	2.7	2.5	3.8	2.7	2.2	2.8	4.1	40.7	3.4
2014	6.1	4.8	4.4	3.1	3	2.9	2.7	2.3	2.7	1.9	2.5	3.9	40.3	3.3
2015	4.1	4.8	4	2.6	2	2.3	2.6	2.7	2.1	1.7	3	5	37	3.1
2016	6	3.8	3.3	2	3	2.1	2.6	3.2	3.2	1.9	2.3	3.6	37	3.1
2017	5.5	6	3.4	3.3	2.1	1.9	3.5	4.2	2.8	1.7	0.2	4.6	39.2	3.2
2018	4.6	4.8	1.2	4.03	3.1	3.9	3.9	4.4	3.4	2.5	3.6	2	41.7	3.4
2019	2.5	1.8	0.8	1.3	1.1	0.3	5.9	5.7	0	0	0	0	16.9	1.4
2020	0	1.3	1.9	5.7	6.9	1.8	1.5	2.4	1.8	1.8	3	4.9	33.3	2.7
2021	10.3	4.4	3.5	2.8	1.8	1.9	5.6	1.9	1.4	1.4	1.6	3.5	45.3	3.7

APPENDIX- IV

Farmers perception on effect of climate change

Sl.No	Effects	Indicators/ way as experienced	Frequency of farmers (N=160)			
			Nil	Mild	Moderate	Severe
1	Water related	Water shortage	17.5 (28)	46.25 (74)	23.75 (38)	12.5 (20)
		Quality issues (salinity, heavy metal)	71.25 (114)	23.125 (37)	5.625 (9)	-
2	Crop related	Increase in growing period	30 (48)	43.125 (69)	20 (32)	6.875
		Reduction in crop yield	1.25 (2)	18.75 (30)	43.125 (69)	36.875 (59)
		Quality deterioration	6.25 (10)	27.5 (44)	39.375 (63)	26.875 (43)
		Decreased shelf life	6.25 (10)	35 (56)	48.125 (77)	10.625 (17)
		Pest and disease outbreak	-	3.75 (6)	25 (40)	71.25 (114)
		Emergence of new weeds	19.375 (31)	21.875 (35)	55.625 (89)	3.125 (5)
		Increased crop weed competition	40.625 (65)	36.25 (58)	22.5 (36)	0.625 (1)
		Increased water stress	11.875 (19)	56.875 (91)	30 (48)	1.25 (2)
		Decrease in fertilizer use efficiency	4.375 (7)	57.5 (92)	38.125 (61)	-
3	Calamity related	Heavy rain	1.25 (2)	38.125 (61)	35.625 (57)	25 (40)

		Drought	3.125 (5)	43.75 (70)	38.75 (62)	14.375 (23)
		Hailstorm	100 (160)	-	-	-
		Flood	19.375 (31)	39.375 (63)	31.25 (50)	10 (16)
		Landslide	88.125 (141)	6.25 (10)	3.125 (5)	2.5 (4)
4	Soil related	Reduced soil fertility	12.5 (20)	26.875 (43)	49.375 (79)	11.25 (18)
		Depletion of ground water	13.125 (21)	54.375 (87)	26.875 (43)	5.625 (9)
		Disturbed soil structure	20.625 (33)	58.75 (94)	14.375 (23)	6.25 (10)
		Increased soil erosion	48.75 (78)	34.375 (55)	11.25 (18)	5.625 (9)
		Reduced water holding capacity	52.5 (84)	32.5 (52)	9.375 (15)	5.625 (9)
5	Animal husbandry related	Low productivity of livestock	7.5 (12)	23.125 (37)	52.5 (84)	16.875 (27)
		Emergence and transmission of pest and diseases	7.5 (12)	21.25 (34)	56.25 (90)	15 (24)
		Increased mortality	17.5 (28)	48.125 (77)	30 (48)	4.375 (7)
6	Others	Presence of new animal or bird species (Eg: Peacock), wild	0.625 (1)	6.25 (10)	68.75 (110)	24.375 (39)

		animals straying into villages.				
		Increase in cost of cultivation	-	3.125 (5)	63.75 (102)	33.125 (53)
		Increase in adoption of non-farming activities for livelihood	7.5 (12)	26.25 (42)	58.75 (94)	7.5 (12)
		Increase in urban migration of framers/ rural youth from rural areas	13.75 (22)	29.375 (47)	53.125 (85)	3.75 (6)

APPENDIX- V

Adaptation strategies adopted by vegetable farmers

Adoption of the adaptation strategies followed by vegetable farmers under crop management (n=160)

Sl. No	Adaptation strategies	Followed				Not followed	
		Continued		Discontinued			
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Change of planting and harvesting date	134	83.75	23	14.375	3	1.875
2	Crop rotation	147	91.875	7	4.375	6	3.75
3	Crop diversification	120	75	25	15.625	15	9.375
4	Cultivation of stress tolerant varieties	21	13.125	81	50.625	58	36.25
5	Cultivation of Short duration crops	13	8.125	35	21.875	112	70

Adoption of the adaptation strategies followed by vegetable farmers under soil and fertility management (n=160)

Sl. No	Adaptation strategies	Followed				Not followed	
		Continued		Discontinued			
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Minimum tillage	9	5.625	8	5	143	89.375
2	Use of organic manure	159	99.375	1	0.625	-	-

3	Use of biofertilizers	30	18.75	40	25	90	56.25
4	Mulching – (organic)	33	20.625	17	10.625	110	68.75
5	Change in time and dose of fertilizer application – Need based application	99	61.875	38	23.75	23	14.375

Adoption of the adaptation strategies followed by vegetable farmers under water management (n=160)

Sl. No	Adaptation strategies	Followed				Not followed	
		Continued		Discontinued			
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Water conservation – Drip irrigation, Sprinkler	81	50.625	22	13.75	57	35.625
2	Supplementary irrigation	122	76.25	8	5	30	18.75
3	Rainwater harvesting	2	1.25	5	3.125	153	95.625
4	Technology advances- Solar water pumps	2	1.25	-	-	158	98.75
5	Non-water intensive crops	62	38.75	11	6.875	87	54.375

Adoption of the adaptation strategies followed by vegetable farmers pest and disease management (n=160)

Sl.No	Adaptation strategies	Followed				Not followed	
		Continued		Discontinued			
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Change in time and dose of plant protection chemicals	99	61.875	28	17.5	33	20.625
2	Pest and disease tolerant varieties	56	35	51	31.875	52	32.5
3	Protected cultivation	6	3.75	2	1.25	152	95
4	Pest surveillance	105	65.625	37	23.125	18	11.25
5	Use of Biocontrol agents	4	2.5	7	4.375	149	93.125

Adoption of the adaptation strategies followed by vegetable farmers under financial management (n=160)

Sl. No	Adaptation strategies	Followed				Not followed	
		Continued		Discontinued			
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Income diversification	116	72.5	25	15.625	19	11.875
2	Selling assets	-	-	9	5.625	151	94.375
3	Crop insurances	62	38.75	36	22.5	62	38.75

4	Group farming- SHGs, Kudumbashree, FPOs, Cooperatives	30	18.75	32	20	98	61.25
5	Use of Credit	39	24.375	17	10.625	76	47.5

Adoption of the adaptation strategies under other practices

Sl. No	Adaptation strategies	Followed				Not followed	
		Continued		Discontinued			
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
1	Post-harvest management-	42	26.25	36	22.5	82	51.25
2	Reduce hired labour - Mechanization	77	48.125	32	20	51	31.875
3	Getting help from govt& other agencies	66	41.25	48	30	46	28.75
4	Avoidance of extreme climate areas	20	12.5	17	10.625	123	76.875

GENDER DISAGGREGATED ANALYSIS OF CLIMATE-CHANGE ADAPTATIONS AMONG VEGETABLE FARMERS

By

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ABSTRACT OF THE THESIS

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ABSTRACT

The threats posed by climate change are no longer a far-off phenomenon and has become more widespread in many countries of the semi- arid tropics including India. Among agrarian populations, these impacts are particularly pronounced, as they contend with ever-more uncertain conditions to raise food and earn a living. Climate change found to have different impacts on women's and men's natural, physical, social and financial capital. Therefore, a gender sensitive perspective is essential while responding to the environmental and humanitarian crises caused by climate change. With this backdrop, the present study was conducted to know gendered difference in climate change adaptations among vegetable farmers.

The respondents were selected from four randomly selected blocks of Palakkad district. Data collection was carried out among 80 male farmers, 80 female farmers with minimum ten years' experience in vegetable cultivation and 20 extension personnel from the selected area. An interview schedule was developed and standardized to collect data from the respondents.

The results revealed that among the 160 vegetable farmers, more than 90 per cent farmers were found to be aware of climate change indicators except increase in number of rainy days. The gender disaggregated analysis of perception on the effect climate change shows that a greater number of male vegetable farmers have perceived severe effects of climate change on water, soil, animal husbandry and other effects including increase in cost of cultivation. While, greater number of female farmers experienced crop related effects and calamities at severe levels.

Using the Analytical Hierarchy Process (AHP), adaption strategies were examined among male and female key farmers and found that the most substantial strategy among male farmers was use of organic manure (global priority-0.13) and that of female farmers was crop rotation (global priority- 0.12). Analysis of farmers levels of adoption for each adaptation strategy within each component shows that crop rotation (92%), use of organic manure (99.38%), supplementary irrigation (76.25%), pest surveillance (65.62%), income diversification (72.50%) and getting help from government and other agencies (71.25%) are the most adopted practices. With regard to the mean climate change adaptation index, two sample t-test was employed and results indicated a significant difference in the adoption of financial management and

other strategies by male and female farmers (p values 0.5 and 0.42). Results of binary logistic regression of climate change adaptation with socioeconomic variables taken as independent variables revealed that gender and change in level of extension contact or risk bearability could bring a corresponding chance of 21, 14 and 87 per cent respectively for a farmer to adopt a climate change adaptation strategy. The major constraints faced by vegetable farmers, associated with the climate change adaptation were lack of government support, high cost of the agricultural inputs needed for adaptation strategies and inadequate credit facilities and lack of agricultural subsidies.

Other salient findings from the study shows that, majority of the farmers (58.75% male and 63.75% female farmers) belonged to middle age groups. Slightly above half (51.25%) male farmers and 37.5 per cent female farmers had secondary level of education. Majority of the male farmers (70%) and female farmers (62.5%) had medium range of farming experience (12-26 years). Majority of farmers belonged to marginal farmers (65% male and 78.75% female). More than half of the respondent male farmers (60%) and female farmers (51.25%) had medium range of annual income (1.30- 3.74 lakhs). Majority (61.25% of males and 65% of females) of the respondents have not integrated any of the components. Vast majority of the respondents (93.75% male and 91.25% female farmers) acquired climatic information through fellow farmers regularly. A large number of farmers (57.5% male and 46.25% female) have been attending training programmes regularly. VFPCK officials followed by Agricultural Officers were the most preferred extension officials. All the male vegetable farmers and majority of the female vegetable farmers had social participation with 13.75 per cent males and 8.75 per cent females held official position in the organizations. Majority of the farmers were found to be availed credit (70% male and 75% female) and insurance (63.75% males and 60% females). A greater number of the respondents have medium risk bearability (67.5% male and 87.5% female), market orientation (72.5% male and female) and scientific orientation (68.75% male and 67.5% female).