ANALYSIS OF FARMERS’ PERCEPTIONS AND ADAPTATION STRATEGIES TO CLIMATE CHANGE IN YAMÈTHIN TOWNSHIP

POE EI PHYU

NOVEMBER 2017

ANALYSIS OF FARMERS' PERCEPTIONS AND ADAPTATION STRATEGIES TO CLIMATE CHANGE IN YAMÈTHIN TOWNSHIP

POE EI PHYU

A Thesis Submitted to the Post-Graduate Committee of the Yezin Agricultural University as a Partial Fulfillment of the Requirements for the Degree of Master of Agricultural Science (Agricultural Economics)

Department of Agricultural Economics
Yezin Agricultural University

NOVEMBER 2017

The thesis attached here to, entitled **"Analysis of Farmers' Perceptions and Adaptation Strategies to Climate Change in Yamèthin Township"** was prepared under the direction of the chairman of the candidate supervisory committee and has been approved by all members of that committee and board of examiners as a partial fulfillment of requirements for the degree of **Master of Agricultural Science (Agricultural Economics).**

Dr. Nay Myo Aung
Chairman
Supervisory Committee
Head of Department (Administration)
Rector Office
Yezin Agricultural University

Dr. Amy Soe
External Examiner
Assistant Director
ASEAN Division
Department of Planning

Dr. Aye Moe San
Member
Supervisory Committee
Assistant Lecturer
Department of Agricultural Economics
Yezin Agricultural University

Dr. Than Da Min
Member
Supervisory Committee
Professor and Principal
Yezin Agricultural University
Hmawbi Campus

Dr. Cho Cho San
Professor and Head
Department of Agricultural Economics
Yezin Agricultural University

Date ……………………..

This thesis was submitted to the Rector of the Yezin Agricultural University and was accepted as a partial fulfillment of the requirements for the degree of **Master of Agricultural Science (Agricultural Economics).**

Dr. Myo Kywe

Rector

Yezin Agricultural University

Yezin, Nay Pyi Taw

Date ……………………..

DECLARATION OF ORIGINALITY

This thesis represents the original work of the author, except where otherwise stated. It has not been submitted previously for a degree at any other University.

Poe Ei Phyu

Date ……………………..

DEDICATED TO MY BELOVED PARENTS,

U KHIN MAUNG WIN AND DAW KYI KYI AYE

ACKNOWLEDGEMENTS

First and foremost, I sincerely wish to express my heartfelt thanks to Dr. Myo Kywe (Rector), Dr. Soe Soe Thein, Pro-rector (Academic) and Dr. Nang Hseng Hom, Pro-rector (Admin), Yezin Agricultural University for their permission to attend master degree and their review comments, invaluable suggestions and kind administrative support in criticizing the manuscript.

I wish to express my deeply grateful to Dr. Ye Tint Tun, Director General, Department of Agriculture, Nay Pyi Taw for his kind permission for my study leave.

I wish to express my deeply gratitude to Dr. Cho Cho San, Professor and Head, and Dr. Theingi Myint, Professor, Department of Agricultural Economics, Yezin Agricultural University, for their inspiring guidance, motherly concern, critical review and constructive comments to improve this dissertation and throughout my studies.

I would like to express my most sincere thanks to my supervisor and chairman of the supervisory committee, Dr. Nay Myo Aung, Head of Department (Administration), Rector Office, Yezin Agricultural University, for his keen interest, guidance, invaluable advices, generous helps, encouragements, moral support, valuable supervisions and understanding to me throughout my study.

Sincere appreciation and gratitude go the external examiner of the supervisory committee, Dr. Amy Soe, Assistant Director, ASEAN Division, Department of Planning for her professional guidance, expertise, comments and suggestions in the manuscript.

I wish to extend my utmost thanks to supervisor committee members, Dr. Aye Moe San, Assistant Lecturer, Department of Agricultural Economics, YAU and Dr. Than Da Min, Professor and Principal, Yezin Agricultural University (Hmawbi Campus) for their valuable suggestions, careful guidance, encouragement, generous helps and kindness, during the course of my study and for their critical reading and comments on this manuscript.

My great thanks go to Daw Nang Ei Mon The, Lecturer, Department of Agricultural Economics and Daw Ye Mon Aung, Assistant Lecturer, Department of Agricultural Economics for their warmly support during survey trip.

Thanks are also extended to Myanmar Awba Group Co., Ltd for supporting the finance to carry out this research effectively and timely.

My sincere thanks are also due to all of teachers from Department of Agricultural Economics, YAU and all of my colleagues for their helps, kindness, valuable suggestions and assistance throughout my study period.

I am grateful to all of the staff from Department of Agriculture, Yamèthin Township for their help in obtaining the necessary primary and secondary data for this thesis. My special thanks are also extended to the sample farmers in Yamèthin Township for their patient answers.

Last but not least, my deepest and greatest dedication is to my beloved mother Daw Kyi Kyi Aye and my beloved husband, Ko Myo Thaung Oo and my beloved daughter Ma Moe Thoon Kha for their understanding, never-ending love, a lot of help, encouragement and especially generous financial support whenever I need throughout my life.

ABSTRACT

Climate change can affect social and economic development in developing countries. Rural communities in Myanmar are vulnerable to climate change because it is a developing agrarian country. The overall objective of the study was to investigate farmers' perceptions and adaptation strategies to climate change in Yamèthin Township. Totally 130 farmers from Thinpankone, Sekyie and Myinnar villages were chosen by simple random sampling method and individually interviewed with structured questionnaires. The historical climate data for Yamèthin Township were obtained from Department of Meteorology and Hydrology, Yangon. Descriptive analysis, awareness index, and simple regression analysis were done to fulfill the research objectives. The results showed that majority of farmers perceived on climate change and they had high awareness level because they can easily access climate information from many sources. However, the radio and television channels were the common sources among all. Most of farmers' perceptions on climate variables were also consistent with 20 years climate trends. In addition, farmers' climate change awareness level was positively and significantly influenced by farming experience, farm size, perceptions on temperature and climate information access from radio and television channels. Majority of respondents followed more than one adaptation strategies although one-fourth of respondents did not follow any adaptation strategies. Based on findings, climate information from radio and television channels should be disseminated accurately and timely. Climate change education programs should be targeted to small holders and less experience farmers to raise their awareness level. Water management was the most common adaptation strategy and water scarcity was the main barrier in the study area. Therefore, water management practices should be systematically trained to farmers. Moreover, the strategy for providing sufficient irrigated water should be facilitated.

TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS v
ABSTRACT vii
TABLE OF CONTENTS viii
LIST OF TABLES xi
LIST OF FIGURES xii
LIST OF ABBREVIATIONS xiv
CHAPTER I. INTRODUCTION 1
1.1 Overview of the Study 1
1.2 Climate Change and Myanmar 2
1.3 Natural Disasters in Myanmar 8
1.4 Climate Change and Central Dry Zone 12
1.5 Rationale of the Study 12
1.6 Objectives of the Study 13
CHAPTER II. LITERATURE REVIEW 14
2.1 Theoretical Background of Climate Change 14
2.1.1 Weather and climate 14
2.1.2 Climate change and global warming 14
2.1.3 Vulnerability 16
2.1.4 Perceptions on climate change 18
2.1.5 Awareness about climate change 18
2.1.6 Adaptation to climate change 19
2.2 Empirical Evidence 21
2.2.1 Evidence on perception of climate change 21
2.2.2 Review of the studies on awareness about climate change 22
2.2.3 Evidence about relationship between climate variables and time 23
2.2.4 Evidence about factors influencing on awareness index 23
CHAPTER III. RESEARCH METHODOLOGY 24
3.1 Description of the Study Area 24
3.1.1 Study area 24
3.1.2 Climatic statistics 24
3.1.3 Land use pattern 27

3.2 Data Collection and Sampling Procedure 27
3.3 Analytical Methods 30
3.3.1 Descriptive analysis 30
3.3.2 Awareness index 30
3.3.3 Simple regression model 32
3.3.4 Linear regression analysis 32
CHAPTER IV. RESULTS AND DISCUSSION 33
4.1 Demographic Characteristics of Sample Households 33
4.1.1 Land holding size of sample households 35
4.1.2 Household assets of sample households 35
4.1.3 Livestock and farm assets of sample households 35
4.1.4 Livelihood condition and distribution of livelihood status of sample household 37
4.1.5 Income composition of the sample households in the study area 37
4.2 Perceptions on Climate Change 39
4.2.1 Farmers' perceptions on climate change 39
4.2.2 Opinions of respondents on factors of climate change 39
4.2.3 Climatic shocks faced by respondents in the study area 41
4.2.4 Sources of climate change information for respondents 43
4.2.5 Farmers' perceptions on change in temperature from 1997 to 2016 43
4.2.6 Farmers' perceptions on change in amount of rainfall from 1997 to 2016 43
4.2.7 Farmers' perceptions on change in rainy days from 1997 to 2016 43
4.2.8 Opinions of respondents for the most vulnerable livelihood activities in Yamèthin Township 47
4.2.9 Opinions of respondents for the most vulnerable social group in Yamèthin Township 47
4.2.10 Farmers' perceptions on effect of climate change 49
4.3 Awareness about Climate Change by Respondents 51
4.4 Climate Trend of Yamèthin Township 54
4.4.1 Temperature trend of Yamèthin Township 54
4.4.2 Rainfall trend of Yamèthin Township 57
4.4.3 Rainy days trend of Yamèthin Township 57
4.5 Factors Influencing Awareness Index 57

4.5.1 Descriptive statistics of dependent and independent variables..................57
4.5.2 Factors influencing farmers' awareness about climate change..................59
4.6 Adaptation Strategies and Barriers to adapt to Climate Change......................61
4.6.1 Preparation for climate change in agriculture sector 61
4.6.2 Local adaptation strategies to climate change in the study area 63
4.6.3 Barriers to climate change adaptation strategies.......................................65
CHAPTER V. CONCLUSION AND RECOMMENDATION..................................67
5.1 Conclusion 67
5.1.1 Farmers' perceptions of climate change and awareness index 67
5.1.2 Trend of climate variables 67
5.1.3 Analysis of factors influencing awareness index.......................................68
5.1.4 Climate change adaptation strategies and barriers to adaptation strategies 68
5.2 Recommendation 69
REFERENCES 70
APPENDICES 74

LIST OF TABLES

Page

Table 1.1 Global warmest years from 1998 to 2015 5

Table 1.2 The long-term climate risk index (CRI) and most affected ten countries from 1995 to 2014 (annual averages) 7

Table 1.3 Climate change policies and other climate change relevant strategies and plans in Myanmar 9

Table 2.1 Most vulnerable areas in Myanmar 17

Table 3.1 Description of sample villages and sample size in Yamèthin Township 29

Table 3.2 Farmers' awareness of climate change based on their knowledge 31

Table 3.3 Scoring system by the orientation of the statement 31

Table 3.4 Categories of awareness index 31

Table 4.1 Demographic characteristics of the sample farm households 34

Table 4.2 Land holding size of the sample households 34

Table 4.3 Household assets of the sample households 36

Table 4.4 Farm and livestock assets of the sample household 36

Table 4.5 Major shocks faced by respondents during the past 20 Years 42

Table 4.6 Climate change awareness scores by sample respondents in Yamèthin Township 53

Table 4.7 Climate change awareness categorization of respondents in study area 53

Table 4.8 Climate change awareness index of respondents in study area 53

Table 4.9 Descriptive statistics of dependent and independent variables 58

Table 4.10 Factors influencing awareness index about climate change 60

Table 4.11 Preparation for adaptation to climate change (n = 130) 62

Table 4.12 Local adaptation strategies to climate change used by respondents 64

Table 4.13 Barriers to climate change adaptation strategies in the study area 66

LIST OF FIGURES

Page

Figure 1.1 Level of vulnerability to extreme weather event 11

Figure 3.1 Monthly average temperature of Yamèthin Township from 1997 to 2016...25

Figure 3.2 Monthly average rainfall of Yamèthin Township from 1997 to 2016....25

Figure 3.3 Monthly average rainy days of Yamèthin Township from 1997 to 2016...26

Figure 3.4 Land utilization in Yamèthin Township (2016-2017) 28

Figure 3.5 Agricultural land utilization in Yamèthin Township (2016-2017).........28

Figure 4.1 Occupational statuses of the sample households in the study area.........38

Figure 4.2 Income compositions of the sample households....................................38

Figure 4.3 Perceptions on climate change in the study area 40

Figure 4.4 Opinions of respondents on factors of climate change 40

Figure 4.5 Sources of climate change information by sample households 44

Figure 4.6 Opinions of respondents on climate change information 44

Figure 4.7 Perceptions of the respondents on change in temperature from 1997 to 2016 45

Figure 4.8 Perceptions of the respondents on change in amount of R rainfall from 1997 to 2016...45

Figure 4.9 Perceptions of the respondents on change in rainy days from 1997 to 2016 46

Figure 4.10 Opinions of respondents for the most vulnerable livelihood activities in Yamèthin Township 48

Figure 4.11 Opinions of respondents for the most vulnerable social group in Yamèthin Township..48

Figure 4.12 Perceptions of respondents on effect of climate change 50

Figure 4.13 Trend of annual average temperature for Yamèthin Township 55

Figure 4.14 Trend of maximum and minimum temperature for Yamèthin Township...55

Figure 4.15 Trend of average annual rainfall for Yamèthin Township......................56

Figure 4.16 Trend of average annual rainy days for Yamèthin Township.................56

LIST OF APPENDICES

Page

Appendix 1 Monthly mean maximum temperature (°C) for Yamèthin Township 74
Appendix 2 Monthly mean miniimum temperature (°C) for Yamèthin Township 75
Appendix 3 Monthly rainfall (mm) for Yamèthin Township 76
Appendix 4 No of rainy days for Yamèthin Township 77
Appendix 5 Map of Yamèthin township 78

LIST OF ABBREVIATIONS

°C	=	Degree Celsius
CA	=	Conservation Agriculture
CBC	=	Canadian Broadcasting Corporation
CHF	=	Congestive Heart Failure
CO_2	=	Carbon Dioxide
CRI	=	Climate Risk Index
DMH	=	Department of Meteorology and Hydrology
DOA	=	Department of Agriculture
GHG	=	Greenhouse Gas
IFDA	=	International Foodservice Distributors Association
in	=	Inches
INDC	=	Intended Nationally Determined Contribution
IPCC	=	Intergovernmental Pannel on Climate Change
km	=	Kilometer
MAPDRR	=	Myanmar’s Action Plan for Disaster Risk reduction
MCCA	=	Myanmar's Climate Change Alliance
MCCSAP	=	Myanmar Climate Change Strategy and Action Plan
mm	=	Millimeter
MOALI	=	Ministry of Agriculture, Livestock and Irrigation
MOECAF	=	Ministry of Environmental Conservation and Forest
MoF	=	Ministry of Forest
NAPA	=	National Adaptation Programme for Action
NASA	=	National Aeronautics and Space Administration
NCDC		National Climatic Data Center
NEP	=	National Environment Policy
NOAA	=	National Oceanic and Atmospheric Administration
PIOJ	=	Planning Institute of Jamaica
UNCCD	=	United Nations Convention to Combat Desertification
UNDP	=	United Nations Development Programme
UNESCO	=	United Nations Educational, Scientific and Cultural Organization
UNFCCC	=	United Nations Framework Convention on Climate Change

CHAPTER I

INTRODUCTION

1.1 Overview of the Study

Climate change can be defined as a change in the state of the climate that can be identified by changes in the mean or variability of its properties and that persists for extended periods, typically decades or longer. Over the past 150 years, global average surface temperature has increased 0.76°C, according to the Intergovernmental Panel on Climate Change (IPCC 2007). This global warming has caused greater climatic volatility, such as change in precipitation patterns and increases in frequency and intensity of extreme weather events including typhoons, heavy rainfall and flooding, droughts, and also has led to a rise in mean global sea levels. Thus, the world is being faced by the problem of climate change. Changes in climate can affect social and economic development in many countries, especially in developing countries. Negative impacts of climate change on the agriculture sector will be vulnerable since agriculture is climate dependent sector. The extreme temperature of sunlight can reduce agricultural production, especially in tropical region. Drought is one of the most complex natural hazards because its impacts may affect large areas over several years in a row (Apata 2006).

In the past, Green Revolution policy solely focused on increasing production. The Green Revolution emphasis on excessive use of agricultural inputs such as pesticides and fertilizers that has resulted in poor soil quality, reduction of biodiversity, pest resistance, pesticide and fertilizer pollution in the environment (soil and groundwater) and human health risks. Overuse of irrigation water has resulted in salinization and/or a withdrawal of groundwater beyond its replenishment capacity (IFAD 2012). While enhancing crop yields, this approach damaged the environment, caused dramatic loss of biodiversity and associated traditional knowledge, flavored wealthier farmers, and left many poor farmers deeper in debt and led to inefficient productivity.

Nowadays, climate change is gaining significance and international attention, a shift towards a focus on ‘productivity’ is emerging. The most efficient productivity based on approaches which aim to reduce the amount of external inputs and to increase efficiency of natural resources. Thus, climate resilient technologies are vital in agriculture sector.

Tol (1998) expressed that awareness about climate change has great capacity to drive farmers to manage local technologies to aid adaptation. The capacity of farmers to adapt to climate change can be expressively influenced by the level of awareness about climate change in their communities. Moreover, the level of awareness about climate change can be significantly influenced by perceptions of climate change. Thus, level of awareness and perceptions of climate change were important factors in decision making process to adapt to climate change.

Farmers can adapt to climate change by changing their agricultural practices, which may include planting tolerant crop varieties or changing husbandry practices, planting season, cropping pattern and also crop varieties. Adaptation may also involve blending scientific practices with local/traditional knowledge. Adaptation to climate change refers to the adjustments in ecological, social, and economic systems as well as response to climatic conditions and their effects (Tol 1998). Adaptation prevents or moderates damage and happenings beneficial opportunities, by making changes in natural or human systems. Adaptation strategies such as better farm management, use of new cultivars and other new technologies to increase their crop yield as well as to optimize resources for sustainable development are needed to apply. The information about climate is vital for adaptation to climate change.

The global sixteen warmest years from 1998 to 2015 were presented in Table 1.1. According to the data, 2015 is the warmest year during eighteen years. Floods, cyclones, wildfires and heat waves led 2015 a shocking year for a lot of people around the world. During this year, about 200 people in Malawi were dead by widespread flooding. About 2200 people in India and 830 people in Southern Pakistan were dead by heat wave of 47°C and 45°C respectively. Hot weather and very dry conditions caused to hundreds of wildfires in western Canada during the summer of 2015 (CBC 2015). At the end of June 2015, there were heavy floods in many regions of Myanmar (yangonlife.com.mm 2015). Many cultivated crops and areas as well as residents were damaged by flood.

1.2 Climate Change and Myanmar

Myanmar is roughly diamond-shaped with a long southeastern ‘tail’ and extends 925 km (575 miles) from East to West and 2100 km (1300 miles) from North to South. It is bounded by China, Laos and Thailand in the East, by Bangladesh and India in the North and by the Indian Ocean in the West and South.

Myanmar is located in Southeast Asia Region between latitudes 09º 32' North and 28º 31' North and longitudes 92º 10' East and 101º 11' East.

Myanmar's climate can be described as tropical monsoon climate with three main seasons, namely, summer season, rainy season, and the winter season. Summer season is from mid-February to mid-May; the rainy season is from mid-May to the end of mid-October; and the winter season starts in mid-October and ends in mid-February and annual average temperature ranges from 22°C to 27°C year-round. There are three agro-ecological zones, namely, Hilly Zone, Central Dry Zone, and Coastal Zone. Thus, Myanmar's climate conditions differ widely from place to place due to widely differing topographical situations. Mean annual rainfall is lowest in Central Dry Zone (500-1000mm/year) and highest in the Southern and Rakhine Coastal regions (2500-5500mm/year). Mean temperature ranges from 32°C in the coastal and delta areas to 21°C in the Northern lowlands. (http://www.roadto mandalay. com/ business/myanmar_burma.htm.).

Agriculture sector is dominant sector in Myanmar's economy. Temperature variation can affect crop growth rate, pest and disease incidence, water supply in soil and reservoirs. Change in precipitation alter water available to crop and irrigation water supply. Thus, change in climate can affect adversely on agriculture sector. Climate change affects agriculture because they are closely related; the type of agriculture and the output of agriculture are directly dependent on the prevailing climate. Because of the large dependence on climate, the economic performance and livelihoods in rural areas are highly unstable.

In Myanmar, the depletion of forest and trees are threatening on climate change. Deforestation is one of the most important factors that contribute to drought, soil erosion and land slide. Myanmar is exposed to various climate hazards such as cyclone, heavy rain, flood, extreme temperatures, drought and sea level rise. The events may be further complicated by climate change due to global warming.

The observed climate variability and change in Myanmar over the last ~six decades includes the following:

- a general increase in temperatures across the whole country (~0.08°C per decade), most notably in the northern and central regions;
- a general increase in total rainfall over most regions, however, with notable decreases occurring in certain areas (e.g. Bago Region);

- a decrease in the duration of the south-west monsoon season as a result of a late onset and early departure times; and
- an increase in the occurrence and severity of extreme weather events, including; cyclones/strong winds, flood/storm surges, intense rains, extreme high temperatures and drought.

Climate change projections for Myanmar predict:

- a general increase in temperature across the whole country, particularly from December – May with the Central and Northern regions experiencing the greatest increases;
- an increase in clear sky days exacerbating drought periods;
- an increase in rainfall variability during the rainy season including an increase across the whole country from March – November (particularly in Northern Myanmar), and decrease between December and February;
- an increase in the risk of flooding resulting from a late onset and early withdrawal of monsoon events;
- an increase in the occurrence and intensity of extreme weather events, including cyclones/strong winds, flood/storm surge, intense rains, extreme high temperatures and drought.

Source: NAPA 2012

Table 1.1 Global warmest years from 1998 to 2015

Year	Anomaly °C	Anomaly °F	Rank 1 = Warmest Period of Record:1998-2015
1998	0.63	1.13	6
1999*	-	-	-
2000*	-	-	-
2001	0.54	0.97	15
2002	0.60	1.08	12
2003	0.61	1.10	9
2004	0.57	1.03	13
2005	0.65	1.17	5
2006	0.61	1.10	9
2007	0.61	1.10	9
2008	0.54	0.97	15
2009	0.63	1.13	6
2010	0.70	1.26	3
2011	0.57	1.03	13
2012	0.62	1.12	8
2013	0.66	1.19	4
2014	0.74	1.33	2
2015	0.90	1.62	1

Source : https://www.ncdc.noaa.gov/sotc/global/201513 2016

Note (* were normal temperature and not counted as warmest year)

According to Kreft et al.(2015), Table 1.2 illustrated top ten climate change affected countries in the world by showing Global Climate Risk Index (CRI) and specific indicators of extreme weather affected events. To obtain climate risk score, social losses (death toll, deaths per 100000 inhabitants) and economic losses (total losses in million US$ PPP, Losses per unit GDP in %) were considered. If CRI score was lower, the country was more vulnerable to climate change. Honduras, Myanmar, and Haiti were the most affected by extreme weather events from 1995 to 2014. Death toll and deaths per 100,000 inhabitants in Myanmar were the highest although number of extreme weather events in Myanmar was relatively less as compared to those in Honduras and Haiti. Based on these two decade data, Myanmar existed as the second worst climate change affected country in the world because Myanmar’s CRI score was 14.17. Therefore, Myanmar needs to immediately undertake climate change adaptation measures for sustainable agricultural development which also addresses the poverty alleviation of poor communities as the majority of national population is engaged in agriculture and livestock rearing.

Table 1.2 The long-term climate risk index (CRI) and most affected ten countries from 1995 to 2014 (annual averages)

CRI 1995-2014 (1996-2013)	Country	CRI score	Death toll	Deaths per 100,000 inhabitants	Total losses in million US$ PPP	Losses per unit GDP in %	Number of Events (total 1995-2014)
1(1)	Honduras	11.33	302.75	4.41	570.35	2.23	73
2(2)	Myanmar	14.17	7137.20	14.75	1140.29	0.74	41
3(3)	Haiti	17.83	252.65	2.76	223.29	1.55	63
4(5)	Philippine	19.00	927.00	1.10	2757.30	0.68	337
4(4)	Nicaragua	19.00	162.30	2.97	227.18	1.23	51
6(6)	Bangladesh	22.67	725.75	0.52	2438.33	0.86	222
7(7)	Vietnam	27.17	361.30	0.44	2205.98	0.70	225
8(10)	Pakistan	31.17	487.40	0.32	3931.40	0.70	143
9(11)	Thailand	32.33	164.20	0.25	7480.76	1.05	217
10(9)	Guatemala	32.50	83.35	0.66	407.76	0.50	88

Source: Kreft et.al. 2015

Climate change policies, strategies, and plans which will fulfill the need for climate-sensitive nation towards transforming Myanmar into a resilient nation were shown in Table 1.3.

1.3 Natural Disasters in Myanmar

Myanmar is a country exposed to a number of natural disasters such as drought, floods, Cyclones, storm, surge, earthquakes, landslides, wildfires, and Tsunamis. Cyclone may occur during the months of April, May, October, November, and December according to historical records. Myanmar coastline (about 2400 km long), borders with the Bay of Bengal and the Andaman Sea, are potentially threatened by the waves, Cyclones and associated weather. Myanmar is affected by flood during mid-May to October. The riverine floods are common in the river delta while the flash floods and landslides are frequent in mountainous areas (Saw Htwe Zaw 2012).

Drought years with moderate intensity were common in the 1980s and the 1990s. Severe droughts have affected from 1990 to 2002. In 2010, severe drought diminished village water sources across the country and destroyed agricultural yields. Over the period 1960-2009, shorter rainfall seasons in combination with erratic and intense rainfall resulted in numerous flooding events. In August 2009, the Bago Division experienced its highest 24-hour rainfall in 45 years, resulting in severe flooding throughout the town. From July to October in 2011, heavy rain and flooding in the Ayeyarwady Region, Bago Region, Mon State and Rakhine State resulted in losses of nearly 1.7 million tons of rice (CSA 2015).

The vulnerable areas in Myanmar due to extreme weather event were shown in Figure 1.1 (NAPA 2012). Rakhine State, Ayeyawady Region and Yangon Region were affected by Cyclone/ strong wind. All lowland, flat, valleys and basins were affected by flood. Intense rain occurred in Tanintharyi Region, Yangon Region, Rakhine State and Mon State. Relatively flat regions, especially Mandalay Region and Magway Region were struck by extreme day temperature. Drought happened in Central Dry Zone. Ayeyawady delta faced sea level rise.

Table 1.3 Climate change policies and other climate change relevant strategies and plans in Myanmar

Initial National Communication (INC) (2012)	It highlights Green House Gas (GHG) abatement potential of Myanmar by taking stock of its GHG inventory. It shows that, although the baseline is from the year 2000, Myanmar is in fact a carbon sink country. The Second National Communication has been undertaken since 2016 and update the inventory.
National Adaptation Programme of Action (NAPA) (2012)	It focuses on climate change adaptation and mainstreaming adaptation and management into policies and plans, increasing climate change research. It was prepared to pinpoint those immediate actions to be taken to kick-start adaptation, with priorities actions in agriculture, early warning systems, forests, health, water, coastal zones, energy and industry and biodiversity.
Intended Nationally Determined Contribution (INDC) (2015)	Builds on the need to balance economic growth with social and environmental sustainability and highlights how Myanmar will contribute to the combat to global warming at local level. The INDC focuses on maintaining the sinking status through maintaining the Forestry land-cover, and to invest in renewable generation of power. Importantly, it underlines that Myanmar must focus on adaptation and that National Climate Change Strategies will be a key tool to this end.
Myanmar Climate-Smart Agriculture Strategy (2016)	Focuses on adapting crop varieties and corresponding farming practices, disaster-risk management, crop and income loss risk management.
Green growth strategy (2016) (in preparation)	The Strategy, currently being developed, focuses on those investments, incentives, insurance mechanisms that can facilitate green and low-carbon economy to emerge in Myanmar. The Strategy is cross-linked to the National Climate Change Strategy and Action Plan and shares its vision.

Table 1.3 Climate change policies and other climate change relevant strategies and plans in Myanmar (Continued)

National and City Waste Management Strategy (in preparation)	The country is developing a national and city waste strategy which makes explicit reference to climate change as a key issue to be addressed, in order to contain potential emissions.
National Environment Policy (revision)	The country has been revising between 2015 and 2016 its National Environment Policy. Among others, the policy makes explicit reference to the need to address climate change, in particular through the implementation of the Strategy.
Myanmar's Action Plan for Disaster Risk Reduction (MAPDRR)	Myanmar's Action Plan for Disaster Risk Reduction (MAPDRR) defines the action of the country to reduce the risks related to the current disasters. It is imperative that the Myanmar Climate Change Strategy and Action Plan (MCCSAP) relates strongly with this document and contribute to its implementation by reinforcing the climate change aspects

Source: MCCSAP 2016

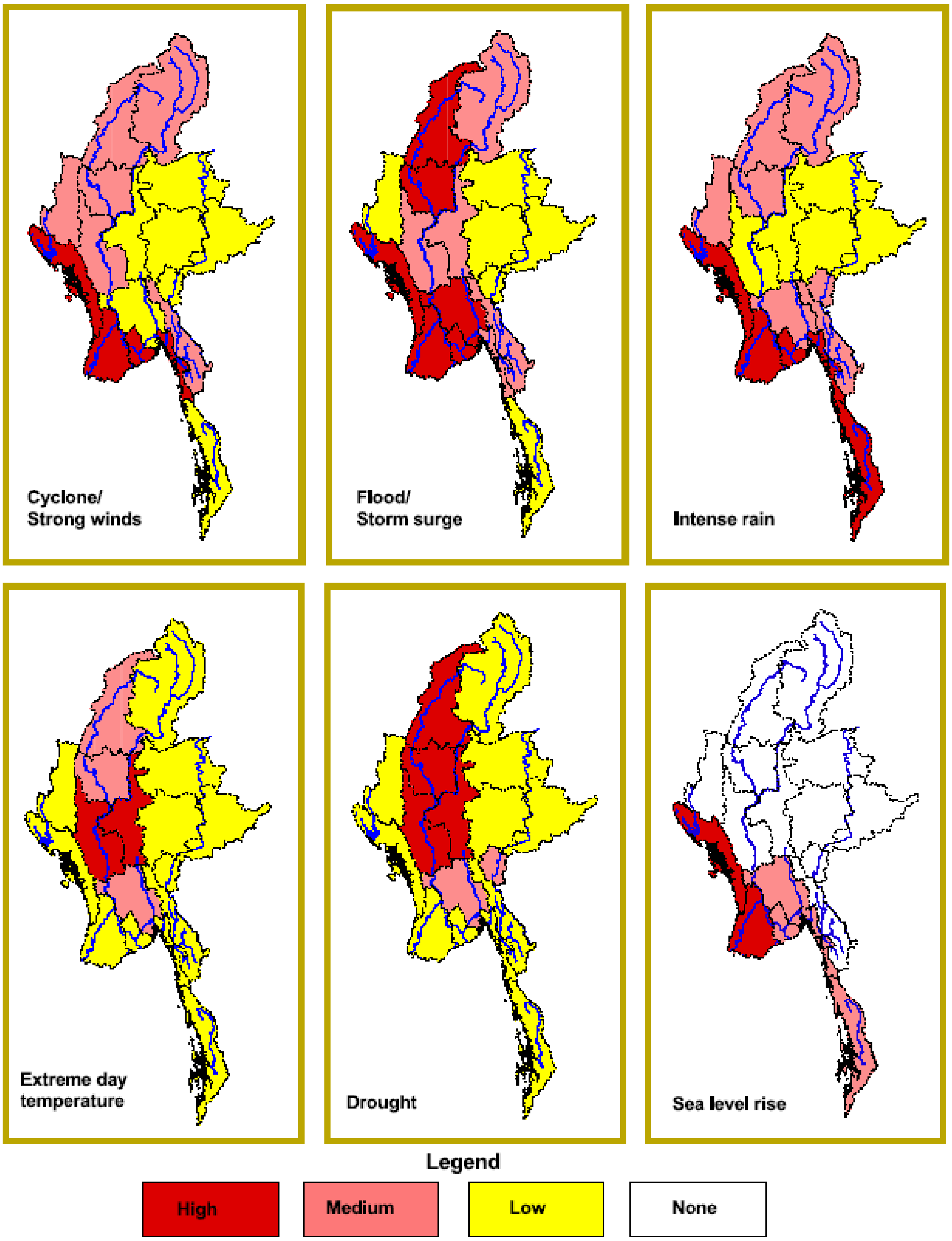

Figure 1.1 Level of vulnerability to extreme weather event

Source: NAPA 2012

1.4 Climate Change and Central Dry Zone

The Dry Zone lies between latitudes 19º 20″and 22º 50″ North and longitudes 93º40″ and 96º 30″ East, stretching across the southern part of Sagaing Region, the western and middle part of Mandalay Region and most parts of Magway Region. It is also located between two elevated regions which are the Shan Plateaus to the East, and the Rakhine Yoma and Chin Hills to the West. Thus, it is lowland, plain area and favors agricultural activity. It is one of the most climate sensitive and natural resource-poor regions.

Drought and water scarcity are the dominant climate-related hazards in Myanmar's Dry Zone. Irregular dry spells and drought have caused in extreme water shortages which in turn establish a constant threat to the livelihoods of the rural poor. Drought can reduce agricultural production and cause food insecurity. Monsoon periods and the duration of rainfall events are decreasing while its intensity in the Dry Zone is increased. These trends of shorter, more intensive cloudbursts increase risks of flooding and farmland erosion.

1.5 Rationale of the Study

Myanmar is one of developing and climate change affected countries. The predominant sector in Myanmar is agriculture. Agriculture is not only the predominant sector but also the most vulnerable livelihood activity and climate dependent sector. Therefore, it is necessary to know climate information for all people.

Central Dry Zone is the area vulnerable to drought as compare to other parts of Myanmar and it is the most food insecure region. In Dry Zone, water is scarce, vegetation cover is thin, and soil is degraded due to severe erosion. The monsoon rain is bimodal with a drought period during July when dry desiccating winds blow from the south. Variation in rainfall has tremendous risks to rain-fed farming communities in the Dry Zone area in Myanmar. Its impacts comprise erratic and unpredictable seasonal rainfall for agriculture leading to low productivity. The undulating land, composed mainly of sandy loam with low fertility is subjected to severe erosion under rain and strong winds (UNDP 2011).

Being part of Central Dry Zone and agriculture-based area, Yamèthn Township is affected by climate change. Moreover, Yamèthin Township is relatively flat region was also struck by extreme day temperature. This area was faced not only drought but also flood. Thus, subsistence farming, the major economic activity of Township is also in danger due to climate change. The rural communities in Yamèthin Township were vulnerable to climate change. Therefore, Yamèthin Township was chosen for the study to investigate farmers' perceptions and adaptation strategies to climate change.

1.6 Objectives of the Study

The overall objective is to investigate the farmers' perceptions and adaptation strategies to climate change in Yamèthin Township. The specific objectives are:

1. To understand the farmers' perceptions towards climate variability and the level of awareness about climate change among respondents during the last 20 years in Yamèthin Township;
2. To verify the farmers' perceptions with last 20 years data of temperature and precipitation;
3. To determine the factors influencing the farmers' awareness level about climate change and
4. To analyze the farmers' adaptation strategies to climate change and the barriers to follow those adaptation strategies.

CHAPTER II

LITERATURE REVIEW

2.1 Theoretical Background of Climate Change

2.1.1 Weather and climate

Weather is the short-term changes in temperature, clouds, precipitation, humidity and wind in a region or a city. Weather can vary greatly from one day to the next, or even within the same day. The climate of a region or city is mean value of the weather condition over many years. The climate can change very slowly. These changes take place on the scale of tens, hundreds and thousands of years (http://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-is-climate-change-58.htmlwww.nasa.gov).

2.1.2 Climate change and global warming

Global warming is a complex issue characterized by substantial uncertainty. Global warming refers to the phenomenon of increasing average surface temperatures of the Earth over the past one to two centuries. The concept is related to the more general phenomenon of climate change, which depends on not only surface temperatures but also precipitation patterns, winds, ocean currents, and other measures of the Earth's climate (Michael 2009).

Emitting gases from several human activities are now proven to create global warming. This includes burning fossil fuels which emit carbon dioxide (CO_2) gas, which traps radiations from the sun in the atmosphere, and progressively warms the Earth surface, the Oceans and the Atmosphere itself. This process leads to global warming. Transportation and heating emit Carbone dioxide. Livestock and agriculture also emit gases such as Methane, or air-conditioning congestive heat failure (CHF) gases etc., which also contribute to the greenhouse effect (MCCA 2015).

Climate change, especially temperature rise can have both negative and positive impacts on crop yield that depend on characteristics of crop and physical growing locations (Pang and Kim 2009). Rise in temperature can increase crop yield in some areas, but it can decrease other areas and may have negligible impacts in other areas (Lobell and Field 2007). Most of developing countries in the tropics and subtropics drop the agricultural production, while most of developed countries in the temperate zones can increase agricultural production due to increase in temperature (Keane et al. 2009).

Climate change will have wide-ranging effects on the environment, socio-economic and related sectors, including water resources, agriculture and food security, human health, terrestrial ecosystems, biodiversity and coastal zones. Changes in rainfall pattern can lead to severe water shortages and/or flooding. Melting of glaciers can cause flooding and soil erosion. Rising temperatures will cause shifts in crop growing seasons which affects food security and changes in the distribution of disease vectors (UNFCCC 2012).

The irregular and scarce rainfall cause extreme water shortage that is a constant threat to the viability of rural livelihoods. As water is a major requirement in the agriculture sector, the lack of enough rainfall challenges the coping strategies of many households and locks them into a cycle of poverty and vulnerability (Myo Win Maung 2014).

"Drought is caused by not only lack of precipitation and high temperatures but by overuse and overpopulation," said David Miskus (2014), a drought expert and meteorologist at the National Oceanic and Atmospheric Administration's Climate Prediction Center.

The four main categories of drought are;

1. **Meteorological drought** is specific to different regions.
2. **Agricultural drought** accounts for the water needs of crops during different growing stages. For instance, not enough moisture at planting may hinder germination, leading to low plant populations and a reduction in yield.
3. **Hydrological drought** refers to persistently low water volumes in streams, rivers and reservoirs. Human activities, such as drawdown of reservoirs, can worsen hydrological droughts. Hydrological drought is often linked with meteorological droughts.
4. **Socioeconomic drought** occurs when the demand for water exceeds the supply. Examples of this kind of drought include too much irrigation or when low river flow forces hydroelectric power plant operators to reduce energy production (http://www.livescience.com/ 21469-drought-definition.html.).

In Myanmar, the first severe drought took place during 1979 and 1980. The second severe drought that hit lower Sagaing and Mandalay was during 1982 and 1983. The third severe drought that hit the whole area of Dry Zone was during 1993 and 1994 (UNCCD 2000).

2.1.3 Vulnerability

Vulnerability is a set of prevailing or consequential conditions, which adversely affect a community's ability to prevent, mitigate, prepare for or respond to climate change. These long-term factors, weaknesses or constraints affect a household's, community's or society's ability (or inability) to absorb losses and to recover from the damage (NAPA 2012). All three agro-ecological zones in Myanmar namely the hilly zone, dry zone, and coastal zone were vulnerable due to climate change and vulnerable areas in Myanmar were described in Table 2.1.

Vulnerability means the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. It comprises a combination of factors that determine the degree to which someone's life, livelihood, property and other assets are put at risk by a discrete and identifiable event in nature and in society (Wisner et al. 2003).

According to the Intergovernmental Panel on Climate Change (IPCC), vulnerability to climate change is a function of:

1. Exposure to climate variability and change, which refers to the degree of climate variability and change that an entity (a country, community, individual or ecosystem) experiences;
2. Sensitivity to climate shocks and stress, which is an assessment of the amount of impact climate factors have on the entity; and,
3. Adaptive capacity, which describes the ability of the entity to manage the negative impacts and take advantage of any opportunities that arise.

Vulnerability is generally defined as a function of risk and exposure. Vulnerability with regard to climate change implies that people are exposed to aspects of climate that are changing in ways that will either generate or increase risk, which generally implies a potential loss of something valued. For food security, the risk is of poorer nutrition or reduced access to food supplies than would be expected under "normal" climate conditions (Glantz 2009).

Table 2.1 Most vulnerable areas in Myanmar

Extreme Weather Event	**Vulnerable Areas**
Drought	Central Dry Zone - Sagaing, Mandalay and Magway Regions particularly agricultural land occurring in these areas.
Cyclone/ strong wind	Coastal regions - Rakhine, Ayeyawady and Yangon Regions/States.
Intense rain	Tanintharyi, Yangon, Rakhine, Ayeyawady and Mon State/Region. These areas have the longest exposure to the south west monsoon flow. Lower Myanmar as well as north-western areas will also be affected.
Flood/ storm surge	All low-land and flat Regions as well as rivers and associated valleys and basins. Areas in close proximity to the Ayeyawady, Chindwin, Sittaung and Thanlwin river systems and coastal areas are particularly at risk to storm surges, hydrological floods, flash floods and river bank overflow associated with snow-melt.
Extreme high temperature	Relatively flat regions in the Central Dry Zone e.g. Mandalay and Magway.
Sea level rise	Coastal zones, especially areas interspersed with tidal waterways e.g. the Ayeyawady Delta. In certain areas, it is thought that low-lying coastal areas may face permanent inundation.

Source: NAPA 2012

2.1.4 Perceptions on climate change

Perception can be defined as the process by which we accept information or stimuli from our environment and convert them into psychological awareness (Ban, V.D. and Hawkins 1996). Thus, perception is a translation of a stimulus. The concept “farmers’ perception” is mostly used to express the ways farmers observe and describe climate change. Farmers’ perception of climate change refers to how farmers feel, observe and describe or interpret climate change.

Farmers’ perception of climate change comprise increased variability of rainfall and temperature, changes in monsoon time, changes in rainfall pattern and amount of rainfall, and increased drought period. Farmers perceive climate change as increased temperature when they faced short cold-period and long hot-period. Sometimes, farmers noticed change in wind flow and wind direction (Tiwari 2014).

2.1.5 Awareness about climate change

Education level tends to be the single strongest predictor of public awareness of climate change. In the United States, the key predictors of awareness are civic engagement, communication access, and education. Meanwhile in China, climate change awareness is most closely associated with education, proximity to urban areas, and household income (Leiserowitz and Howe 2015).

Watson and Corbett (2012) indicated that awareness and theoretical knowledge may be seen as very important for changing one’s personal mind-set, worldview and also long-term personal intellectual development.

Education and awareness-raising about climate change support knowledgeable decision-making,and also play an essential role in increasing adaptation and mitigation capacities of communities. Moreover, awareness about climate change permits women and men to adopt sustainable lifestyles (UNESCO 2014).

Myo Win Maung (2014) stated that awareness about climate change is paramount for farmers in the Dry Zone area to accept to climate variability. Age, education, number of family members who completed schooling, farmer training experience, cultivated area and crop yield performance, and family annual income were found to be not major influencing factors because the courses concerned with environment or climate change were not being accessible in school in Myanmar. Even Ministry of Environmental Conservation and Forestry (MOECAF) was established in 2011 after renaming the Ministry of Forestry (MoF) so as to undertake environmental conservation more effectively and to improve the awareness of climate change. In demographic characteristics, only gender variable was major influencing factor on climate change awareness. Male farmer would tend to have more knowledge on climate change awareness.

2.1.6 Adaptation to climate change

Adaptation to climate change can be defined as the process through which people reduce the adverse effects of climate on their health and well-being, take advantage of the opportunities that their climatic environment provides (Burton 1992). On the other hand, adapting to climate change entails taking the right measures to reduce the negative effects of climate change (or exploit the positive ones) by making the appropriate adjustments and changes (UNFCCC 2012). Adaptation involves adjustment to enhance the viability of social and economic activities and to reduce their vulnerability to climate, including its current variability and extreme events as well as longer-term climate change (Smit 1993).

Adaptation is adjustment in ecological, social, or economic systems in response to actual or expected climatic stimuli and their effects or impacts. This term refers to changes in processes, practices, or structures to moderate or offset potential damages or to take advantage of opportunities associated with changes in climate (Smith et al. 1996).

Adaptation, mitigation and coping strategies are responses to climate change. The central difference between adaptation and mitigation is the scale at which they might take place (Fussel and Klein 2006). Mitigation can take place at the global scale and adaptation is an activity that must take place at a number of scales, from local to global. The major difference between adaptation and coping is the time frame. Coping strategies refer to strategies in response to short-term and adaptations strategies refer to strategies refer to long-term.

Aggarwal et al. (2010) stated that some climate change strategies in the agriculture sector that were crop variety improvement, change in the variety and improve crop management, adjustment in sowing time, efficient utilization of irrigation and fertilizers, increased seed replacement, improved crop management, watershed management, conservation agriculture, development of location-specific fertilizer practices, improved fertilizer supply and distribution systems, improved risk management through early warning system, improved information technology, early warning system for pest and diease incidence, recycling of waste water and solid waste in agriculture, post-harvest management for minimizing losses, establishment of community-based post-harvest structure, research and development of climate change impacts and appropiate adaptations in agriculture.

Conservation Agriculture (CA) is required to be widely practiced as a coping strategy for conservation and adaptation of drought. An understanding of rainfall variability and trends in that variability is needed to help vulnerable dry land agriculturalists and policymakers address current climate variation and future climate change (Batisani and Brent 2010).

Adaptation measures are designed based on the following concepts.

1. Risk avoidance: Preventive measures against the occurrence of estimated impacts. (e.g., disaster prevention facilities and regulation of development in vulnerable areas)
2. Reduction of negative impacts: Measures to reduce the damage caused by impacts that occur. In the area of disaster prevention, examples include measures to reduce the damage from disasters, recovery assistance, etc.
3. Risk sharing: Measures to suppress the concentration of impacts by spreading their burden across a wider population and over time.
4. Risk acceptance: Accepting the potential for adverse impacts that have a low likelihood of occurrence, by not taking any specific measures today, or by delaying the implementation of measures while monitoring the situation.
5. Exploitation of opportunities: Among the impacts of climate change, new business and other opportunities may appear from positive impacts, depending on the sector and region. The key here is to proactively utilize those opportunities (Mimura, Ando and Seita et al. 2010).

Most farmers in the dry zone change their practices based on commodity prices, farm input costs and agricultural support and they did not consider climate conditions, because lack of knowledge about climate change (Myo Win Maung 2014).

Adaptation may not be satisfactory or successful, often for one or more of the following reasons:

1. Understanding of climate change effects may be limited or even erroneous;
2. Understanding of the possible adaptation options may be limited or defective;
3. Adaptation responses undertaken by one group may impact adversely on another group;

4. The needs of future generations may not be taken into account;
5. There may be cultural constraints to certain adaptation responses;
6. Individuals or communities (or other groups or institutions) may not have adequate resources to implement the most desirable adaptation measures; and
7. It may be more cost effective, and in other ways more efficient and effective, to implement certain adaptation responses on a more collective basis, rather than at the level of the individual or community (Hay 2002).

Six reasons to adapt to climate change were;

1. Climate change cannot be totally avoided.
2. Anticipatory and precautionary adaptation is more effective and less costly than forced, last-minute, emergency adaptation or retrofitting.
3. Climate change may be more rapid and more pronounced than current estimates suggest. Unexpected events are possible.
4. Immediate benefits can be gained from better adaptation to climate variability and extreme atmospheric events.
5. Immediate benefits also can be gained by removing maladaptive policies and practices.
6. Climate change brings opportunities as well as threats. Future benefits can result from climate change (Burton 1996).

2.2 Empirical Evidence

2.2.1 Evidence on perception of climate change

Ndamani and Watanabe (2015) analyzed to investigate perception about causes and effects of climate change in Lawra district of Ghana. This study indicated that the majority of farmers (82%) perceived an increase in temperature over the past 10 years, about 9% of respondents perceived no change, 6% perceived a decrease in temperature, and 3% did not know if there was a long-term change in temperature. A total of 87% of respondents perceived a decrease in rainfall amount over the past 10 years, 6% perceived no change in precipitation, and 7% did not know.

Nang Ei Mon The (2012) conducted a survey of 112 respondents in the villages of Pakokku Township, Myanmar to examine the local peoples' perceptions on climate change. It was resulted that 67% of the respondents recognized and the rest 33% of the respondents unrecognized about climate change.

2.2.2 Review of the studies on awareness about climate change

In Jamaica, the respondents with secondary education level had a fairly high level of knowledge about climate change. About 82.6% of respondents with secondary education level indicated that they knew the term of “climate change”. A cross-tabulation which explored the relationship between education levels of household respondents and their hearing the term “climate change” indicated that there was a significant difference among respondents’ education levels in relation to whether or not they heard the term “climate change”. Persons who completed tertiary level education were heard the term “climate change”. This recommends that education levels should be considered a key segmentation variable when planning any communication-based intervention (PIOJ 2012).

Idrisa et al. (2012) studied to analyze the awareness and adaptation to climate change among small-scale farmers in the Sahel Savannah agro-ecological zone of Borno State, Nigeria. It was observed that the majority (82.22%) of respondents were aware of the changing climate and 39.11% got their information about climate change from extension agents, 26.67% from friends and neighbors, and 11.11% through media (mainly radio), while only 5.33% got the information from Non-Governmental Organizations (NGOs).

Buloshi and Ramadan (2015) conducted a survey of 350 respondents in six divisions (Wiliyat) of Muscat governorate in Oman. In this study, 96% of the sample respondents have some knowledge about the climate change while the remaining parts 4% showed that they have no idea. Most of them 86.7% of the sample supposed that change in climatic condition as temperature increase, while only 4.7% assumed that climate change as a drop in temperature degrees. The remaining percentage of 8.7% explained that they cannot identify any feature of climate change, but they feel that there is some change.

Myo Win Maung (2014) conducted a survey of 150 farmers in the villages of Monywa Township to know the level of awareness about climate change in terms of three items, namely, drought incidence, flooding incidence, and winter temperature variation. It was resulted that71% believed it has become drier, 45% perceived less flooding, and 83% of the respondents said that it has become warmer. All of the farmer-respondents regardless of farming practice were aware of climate change, that there was a negative effect (79%), there was shorter growing season (66%), and there was increase in the erratic weather patterns (96%).

2.2.3 Evidence about relationship between climate variables and time

Yegbemey (2014) analyzed the relationship between climate variables and time in Benin by using simple regression analysis. The climate trends were analyzed from 1950 to 2009. As the result of the study, the average annual rainfall was decreased and the annual temperature was increased over time.

Nang Ei Mon The (2012) also analyzed the relationship between climate variables and time by using simple regression analysis in Myanmar. The climate data were available for 16 years (from 1996 to 2011).The results indicated that the average maximum annual temperature was increased by 0.012°C per year and the average minimum annual temperature was also increased by 0.184°C per year. The average annual rainfall was increased by 1.303 mm per year.

Theint Theint Soe Mon (2016) conducted a survey of 150 farmers to assess the farmers' awareness and behavior to climate change in rice-rice growing area of Maubin Township, Ayeyawaddy Division, Myanmar. . The climate trends were analyzed from 12007 to 2015. It was resulted that annual rainfall was decreased. Among these years, the highest total precipitation was 3137.92 mm in 2007 and the lowest total precipitation was 2460.50 mm in 2015. The average temperature was increased.

2.2.4 Evidence about factors influencing on awareness index

PIOJ (2012) conducted a survey on climate change knowledge, attitude and behavioral practice in Jamaica. It indicated that various communication channels were important factor to raise awareness about climate change.

Myo Win Maung (2014) studied that the relationship between demographic characteristics of respondents and awareness of climate change in Monywa Township, Myanmar. The results indicated that age and sex were positively correlated to awareness and education status was negatively related to awareness.

According to Theint Theint Soe Mon (2016), age and schooling year were positively related to awareness index while farming experience was negatively related to awareness index.

CHAPTER III
RESEARCH METHODOLOGY

3.1 Description of the Study Area

3.1.1 Study area

Yamèthin Township of Mandalay Region was selected as study area which is one of the Dry Zone areas. Mandalay Region is composed of the districts of Mandalay, Pyin Oo Lwin, Kyaukse, Myingyan, Nyaung U, Meiktila and Yamèthin, comprising 28 townships. Yamèthin Township is located in Yamèthin district that is situated between from 20˚10'N to 20˚35'N latitude and from 95˚45'E to 96˚32'E longitude. It is bordered by Pinlaung Township on the East, Natmauk Township on the West, Takkone Township on the South, Pyawbwe Township on the North and Thazi Township on the Northeast. Sample villages were selected by using simple random sampling method.

3.1.2 Climatic statistics

In Yamèthin Township, there are three seasons: the rainy season (mid-May to mid-October), the winter season (mid- October to mid-February) and the summer season (mid- February to mid-May).

Figure 3.1 was drawn by the data of Department of Meteorology and Hydrology, Yangon for Yamèthin Township. The monthly average maximum temperature was 33.4°C and the monthly average minimum temperature was 20.5°C. The hottest month was April and the coldest month was January.

According to rainfall data recorded for Yamèthin Township from DMH, the monthly average rainfall from 1997 to 2016 was 908 mm per year. The highest total precipitation was 1716 mm in 2016 and the lowest total precipitation was 522 mm in 2009. The lowest precipitation was found in January, February, and March and the highest precipitation was found in the months from May to October (Figure 3.2). September and August months had the highest monthly rainy days and January and February occupied the lowest monthly rainy days (Figure 3.3).

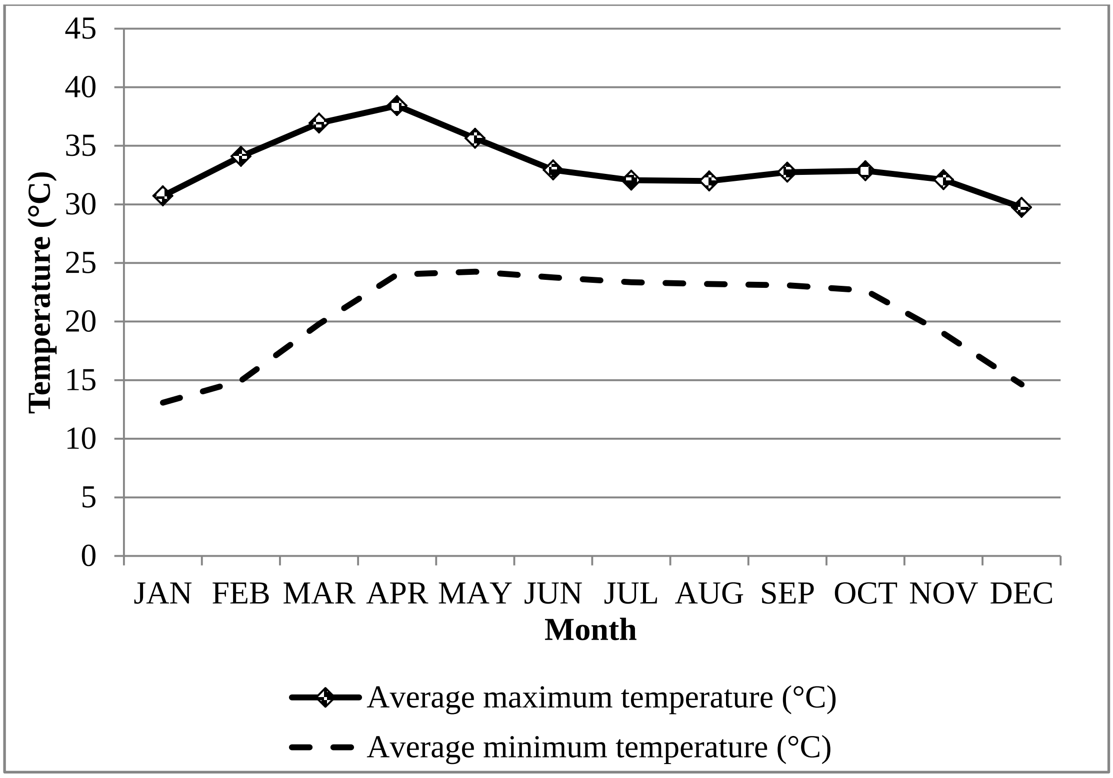

Figure 3.1 Monthly average temperature of Yamèthin Township from 1997 to 2016

Source: DMH 2017

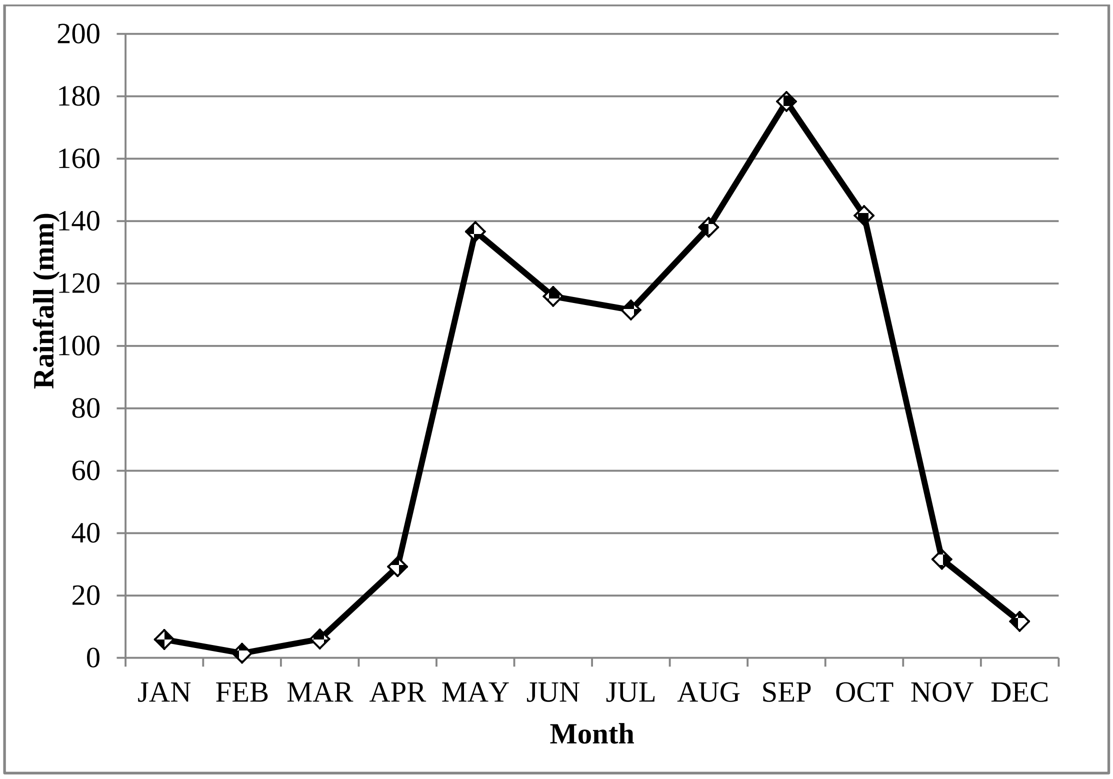

Figure 3.2 Monthly average rainfall of Yamèthin Township from 1997 to 2016

Source: DMH 2017

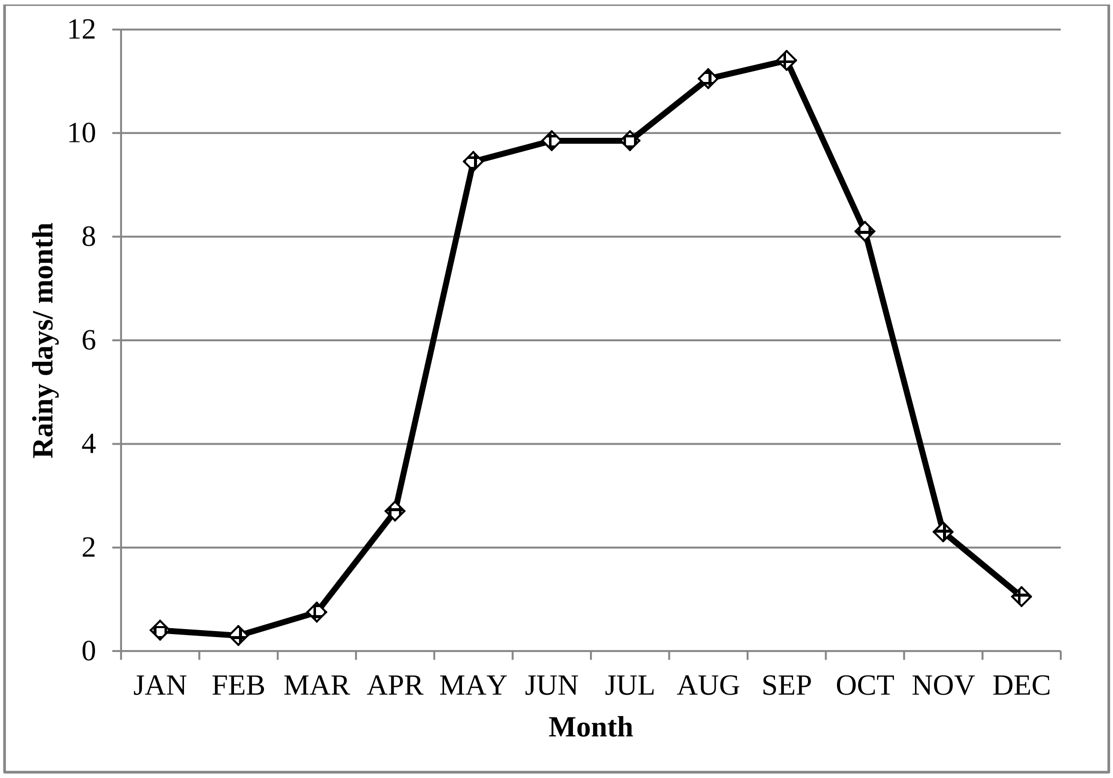

Figure 3.3 Monthly average rainy days of Yamèthin Township from 1997 to 2016

Source: DMH 2017

3.1.3 Land use pattern

The total area of Yamèthin Township is 216765 hectares and cultivated land 76392 hectares occupies the largest share as 35% of the total area. About 18% (38765 hectares), 13% (29221 hectares) and 2% (3769 hectares) of total land use are classified and used as other forest land, forest land and wild land respectively. The remaining 32% (68618 hectares) of total land use is other land (Figure 3.4).

In agricultural land, upland (Yar) is about 55 % (42117 hectares) while lowland (Le) occupies about 44% (33736 hectares) of the net sown area. Only 1% (539 hectares) is Orchard and Kaing/ Kyune (Figure 3.5). Therefore, in the study area, upland cultivation is the major cropping system because of characteristics of dry zone which has highly variable rainfall that has led to drought along with increased risks of rain fed farming (DOA 2016).

3.2 Data Collection and Sampling Procedure

Both primary and secondary data were used in this study. For primary data, the field survey was conducted in July 2016 in Yamèthin Township. One farm household was considered as one sampling unit and there were total 130 sample rural households in this study (Table 3.1). Comparing 22 sample farm households from Thinpankone village, 47 sample farm households from Sekyie village and 61 sample farm households from Myinnar village, sample households were individually interviewed with structured questionnaire to get demographic characteristics, perceptions on climate change, perceptions on temperature, perceptions on amount of rainfall, perceptions on rainy days, awareness level, vulnerable livelihood activities, vulnerable social group and experienced climate shock as well as their climate change adaptation strategies and barriers to follow these adaptation strategies.

Relevant secondary data was taken from various published and unpublished documents. The informative data were obtained from Ministry of Agriculture, Livestock and Irrigation (MOALI), Department of Agriculture (DOA), Department of Meteorology and Hydrology (DMH) and other related documents.

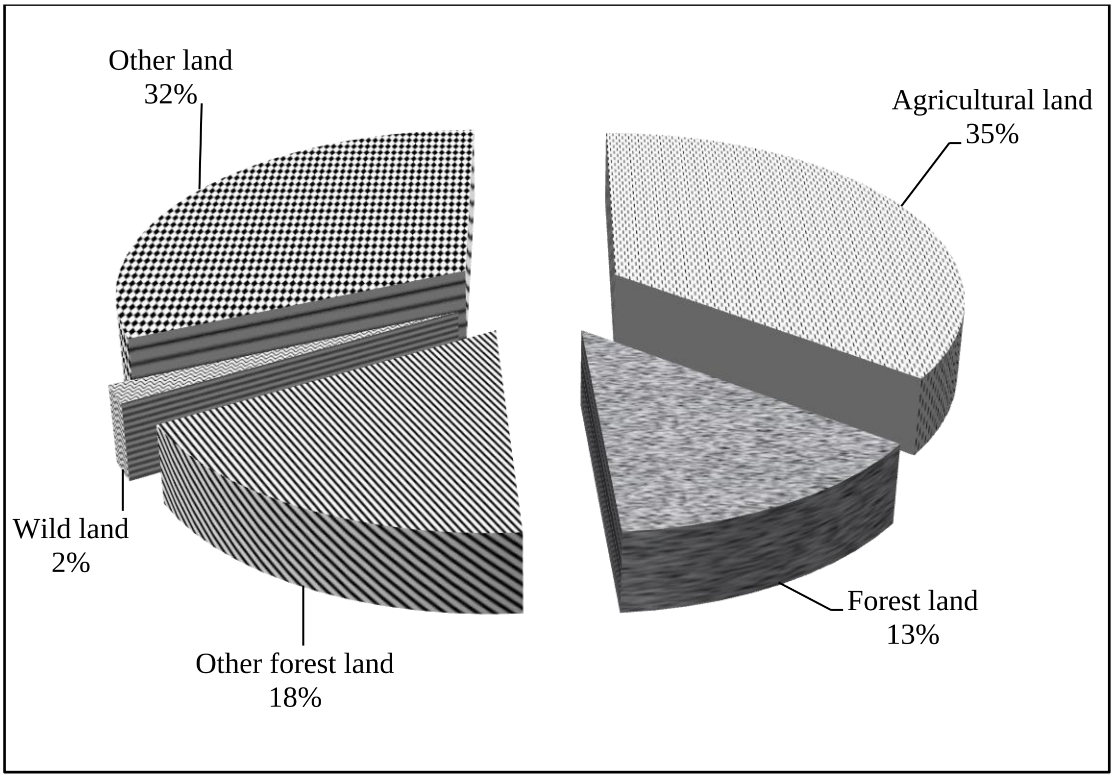

Figure 3.4 Land utilization in Yamèthin Township (2016-2017)

Source: DOA 2016

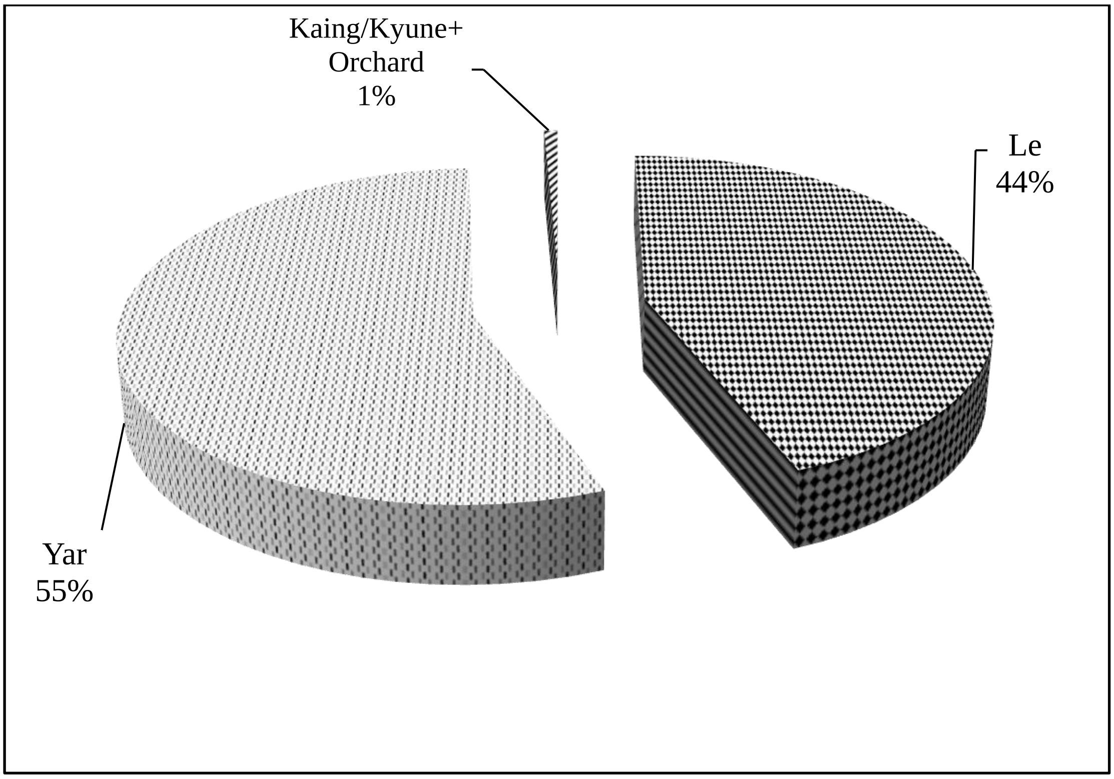

Figure 3.5 Agricultural land utilization in Yamèthin Township (2016-2017)

Source: DOA 2016

Table 3.1 Description of sample villages and sample size in Yamèthin Township

Village Tracts	Villages	Households (No)	Population (No)	Sample Size (No)
Kantharaye	Myinnar	125	765	61
Sekyie	Sekyie	170	1190	47
Thinpannkone	Thinpannkone	220	1065	22

Source: DOA 2016

3.3 Analytical Methods

Both qualitative and quantitative data were firstly entered into the Microsoft Excel program. These data was analyzed by Statistical Packages for Social Science (SPSS) version 16.0 software. The analytical techniques used in this study were the descriptive analysis, awareness index, simple regression and linear regression analysis.

3.3.1 Descriptive analysis

Descriptive analysis was applied to understand demographic characteristics of rural households. Descriptive statistics of demographic characteristics (age, education level), household assets and farm assets were analyzed and described by Tables and Figures. Descriptive statistics was also used to present the perceptions of climate change, perceptions of temperature, perceptions of rainfall, access to climate change information, preparation for climate change in agriculture sector, local adaptation strategies to climate change and barriers to climate change adaptation strategies were also presented in Tables and Figures.

3.3.2 Awareness index

Awareness about climate change was calculated as index score by using a set of questionnaire based on their knowledge on climate change along with 11 statements. These statements were mentioned in Table 3.2.

The level of awareness on each given statement was scored accordingly to the orientation of the questions. For instance the options were shown, “Strongly agree” was scored as “5 point”, “4 point” for “Agree”, “3 point” for “Neutral”, “2 point” for “Disagree”, and “1 point” for “Strongly disagree”, in Table 3.3. Thus, minimum possible score was 11 if the respondents would strongly disagree to the mentioned eleven statements while the maximum possible score could be 55 if the respondents would strongly agree all eleven statements.

Then the respondents’ actual scores were summed and the awareness index was calculated by using the following formula (Hubert and Schultz 1976).

$$\text{Awareness Index} = \frac{\text{Sum of Scores - minimum possible score}}{\text{Difference between maximum and minimum possible score}}$$

Three different ranges of awareness indices were separated with frequency distribution as high awareness (0.70 to 1.00), medium awareness (0.35 to 0.69) and limited awareness (0.00 to 0.34). The higher the awareness index, the more knowledge on climate change by sample farmers (Table 3.4).

Table 3.2 Farmers' awareness of climate change based on their knowledge

No	Statements
1	The climate today is different from what it used to be in the past 20 years
2	Monsoon period is changing
3	The amount of rainfall is changing
4	The rainy days are changing
5	The temperature is increasing
6	There is change in soil moisture and intensity due to climate variability
7	The climate variability can affect crop growing time
8	The climate variability can affect growing crop types
9	Unusual high temperature leads to drying of seedlings after germination
10	Unusual irregularity in temperature leads to crop failure on the farm
11	Irregular seasonal rainfall leads to poor harvest

Table 3.3 Scoring system by the orientation of the statement

Level of agreement	Scores for positive statement
Strongly agree	5
Agree	4
Neutral	3
Disagree	2
Strongly disagree	1

Table 3.4 Categories of awareness index

Categories	Value of index
High awareness	0.70 - 1.00
Medium awareness	0.69 - 0.35
Limited awareness	0.00 – 0.34

Source: Hubert and Schultz 1976

3.3.3 Simple regression model

The simple regression model was used by Yegbemey (2014) was employed to analyze the trend of average annual temperature, average maximum temperature, average minimum temperature, average rainfall, and average rainy day in Yamèthin Township from 1997 to 2016. The linear trend between the time series data (y) and time (t) was specified as follow,

$$Y = a + bt$$

Where;

Y = temperature or rainfall

t = time (year)

a = constant

b = coefficient of time

3.3.4 Linear regression analysis

The following model was used to examine the factors influencing the level of awareness about climate change. Dependent variable was awareness index and independent variables were farming experience, level of education, farm size, perceptions on temperature, perceptions on rainfall and climate information access from radio and television channels was used as dummy variable.

$$Y = \beta_0+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+ b_1D_1+ \mu$$

Where;

Y = awareness index

X_1 = farming experience (years)

X_2 = level of education

X_3 = farm size (hectare)

X_4 = perception on temperature

X_5 = perception on rainfall

D_1= climate information access from radio and television channels (if yes = 1, no = 0)

β_0 = constant

μ = error term

CHAPTER IV

RESULTS AND DISCUSSION

This chapter is divided into five portions. These are the detail demographic characteristics of sample households, farmers' perceptions and awareness level of climate change, climate trends during two decades, the factors influencing awareness index, adaptation strategies to climate change and barriers to follow those adaptation strategies in the study area.

4.1 Demographic Characteristics of Sample Households

The demographic characteristics of respondents were presented in Table 4.1. Among the sample households, 79 households were male-headed and 51 households were female-headed. The respondents' age ranged from 20 to 85 years and average age was 48.29 years. Farming experience play important role in agricultural activities. The average farming experience of the total respondents were 26.72 years with maximum 60 years and minimum 1 year.

The level of education of the farmers was important for decision making of climate change adaptation strategies. In this study, education level of the sample farmers was categorized into six groups: (0) "Illiterate" referred to those who could not read and write; (1) "Monastery education" referred to informal schooling although they could read and write; (2) "Primary level" referred to formal schooling up to 5 years; (3) "Secondary level" intended formal schooling up to 9 years; (4) "High school level" referred to the formal schooling up to 11 years; and (5) "Graduate" referred to achievement of bachelor degree from university or diploma certificate from collages. Most of the sample household's head (48.46%) had primary education level. About 22.31% of respondents had middle school level, 14.82% of respondents had monastery, and 7.69% of respondents had high school level. Only 4.62% of respondents were graduate, and only 2.31% of respondents were illiterate.

Table 4.1 Demographic characteristics of the sample farm households

Item	Unit	Value
Average age of respondents	Year	48.29
Average farming experience of respondents	Year	26.72
Male	Percent	60.77
Female	Percent	39.23
Education level of respondents		
Illiterate	Percent	2.31
Monastery	Percent	14.62
Primary	Percent	48.46
Secondary	Percent	22.31
High	Percent	7.69
Graduate	Percent	4.62

Table 4.2 Land holding size of the sample households

Items	Unit	Mean	Range	Standard deviation
Lowland (Le)	Hectares	2.37	0.40 -10.12	1.54
Upland (Yar)	Hectares	0.57	0.40 - 8.09	1.09
Kaing/Kyune	Hectares	0.03	0.20 - 1.21	0.14
Total	Hectare	3.98	0.40-11.74	2.11

4.1.1 Land holding size of sample households

Land holding status of sample households could be categorized into three groups namely Lowland (Le), Upland (Yar) and Kaing/Kyun. Sample households had Lowland (Le), average 2.37 hectares ranging from 0.40 to 10.12 hectares while Upland (Yar) was 0.57 hectares ranging from 0.40 to 8.09 hectares, and Kaing/Kyun was 0.03 hectares ranging from 0.20 to 1.21 hectares (Table 4.2). The total land holding size of the sample households was 3.98 hectares in average ranging from the smallest 0.40 hectare to the largest 11.74 hectares. According to the data, sample households occupied lowland area as majority in the study villages although Yamèthin Township was mainly covered by the upland area.

4.1.2 Household assets of sample households

The possession of the household assets such as mobile phone, radio, motorcycle, television, EVD, well, bicycle, tricycle, refrigerator and car were shown in Table 4.3. The majority (80.60%, 78.46%, 70.90%, 66.42%, and 64.93%) of households possessed mobile phone, radio, motorcycle, television and EVD respectively and about 38.06% of sample households had own well for household water supply. Less than 5 % each of sample households occupied bicycle, tricycle, and refrigerator respectively. Only 1.49% of sample household possessed a car for transportation and other households did not possess a car. Majority of sample households can easily access weather information because they had phone and radio.

4.1.3 Livestock and farm assets of sample households

The sample households in the ownership of the livestock and farm assets such as tractor, plough, harrow, water pump, sprayer, cattle, pig, chicken, buffalo, cart, and thresher were presented in Table 4.4. About 66.15%, 14.62%, 9.23%, and 1.54% of sample households owned cattle, pig, chicken, and buffalo respectively. About 10.77% of respondents possessed tractor while 77.69% of respondents had plough and 76.15% of respondents had harrow for land preparation. According to these results, most of the farmers were still using their traditional practices instead of farm mechanization in the study area. Around 83.08% of sample households had manual sprayer and they were used in chemical application to control pest and diseases. Less than 1% of sample households had thresher. Almost 17% of sample respondents occupied cart not only for family use but also for bringing farm materials.

Table 4.3 Household assets of the sample households

Assets	Frequency	Percentage
Mobile Phone	108	80.60
Radio	102	78.46
Motorcycle	95	70.90
Television	89	66.42
EVD	87	64.93
Well	51	38.06
Bicycle	6	4.48
Tricycle	4	2.99
Refrigerator	4	2.99
Car	2	1.49

Table 4.4 Farm and livestock assets of the sample household

Assets	Frequency	Percentage
Sprayer	108	83.08
Plough	101	77.69
Harrow	99	76.15
Cattle	86	66.15
Water pump	28	21.54
Cart	22	16.92
Pig	19	14.62
Tractor	14	10.77
Chicken	12	9.23
Buffalo	2	1.54
Thresher	1	0.77

4.1.4 Livelihood condition and distribution of livelihood status of sample household

The types of occupation of the sample household were very diverse such as farmer, farm labor, wage labor, government staff, carry, livestock rearing, handicraft, trader, and own business. According to the data, about 54.62% of sample household had only one occupation, 41.54% of sample household had two occupations, and only 3.85% had three or more occupations (Figure 4.1). Thus, the sample households in the study area had low livelihood diversification. In primary occupation, all the respondents were farmers. The secondary occupation were livestock rearing, own business, casual labor, Government staff, handicraft, trader, farm labor, farmers and cycle carry.

4.1.5 Income composition of the sample households in the study area

The household income of the sample households was composed by income from different income generating activities as shown in Figure 4.2. About 80.98% of the sample household income came from crop farming and it was the main source of income. About 14.00% of the household income was generated from non-farm activities which was the second major income source for the sample households. Share of livestock income in total household income was about 2.95% for the sample households and only small portion of annual household income was contributed by remittance (1.20%). Less than 1% of household income was from off-farm employment activities. Therefore, the highest portion of annual household income was farm income in this study since the majority of households in study area relied on agriculture.

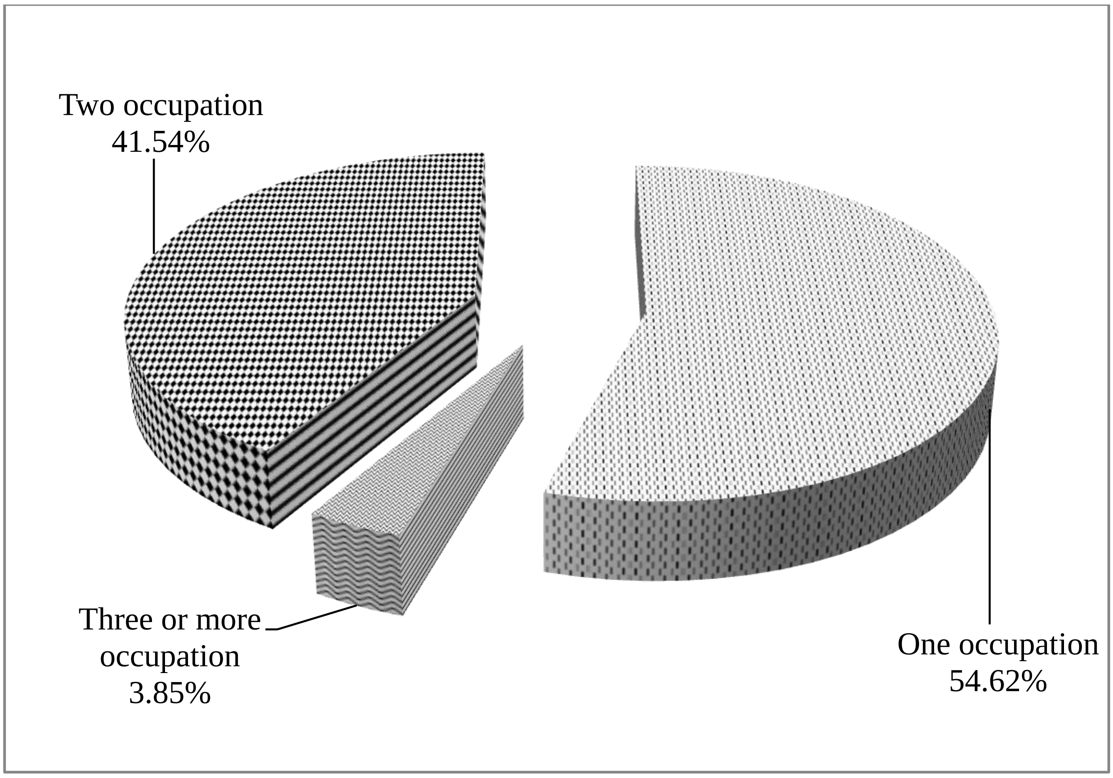

Figure 4.1 Occupational statuses of the sample households in the study area

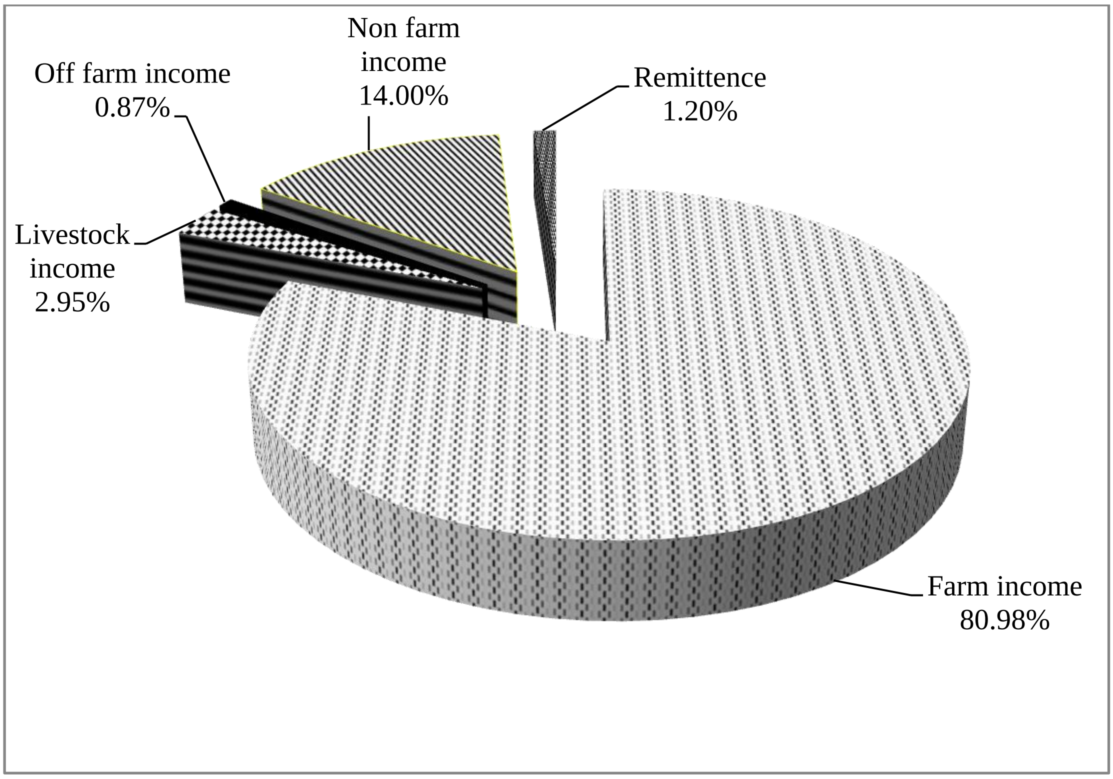

Figure 4.2 Income compositions of the sample households

4.2 Perceptions on Climate Change

4.2.1 Farmers' perceptions on climate change

Local peoples' perceptions on climate change were shown in Figure 4.3. Majority of respondents (about 94.38%) recognized that there was change in climate condition while only 4.62% of respondents unrecognized about climate change. Thus, majority of respondents had knowledge about climate change.

4.2.2 Opinions of respondents on factors of climate change

Although 94.38% of respondents perceived on climate change, some of respondents did not have any idea on climate change (11.54%). About 20.00% and 17.69% of the respondents assumed that climate change was because of variations in temperature and heavy rainfall respectively while 9.23%, 5.38%, 4.62%, 3.08%, 0.77%, 0.77% of total respondents revealed the climate change occurred due to deforestation, scanty of rainfall, irregular rainfall, erratic weather condition, strong wind, and El Niño respectively. However, about 27.00% of the respondents thought climate change is caused by more than one factor (Figure 4.4).

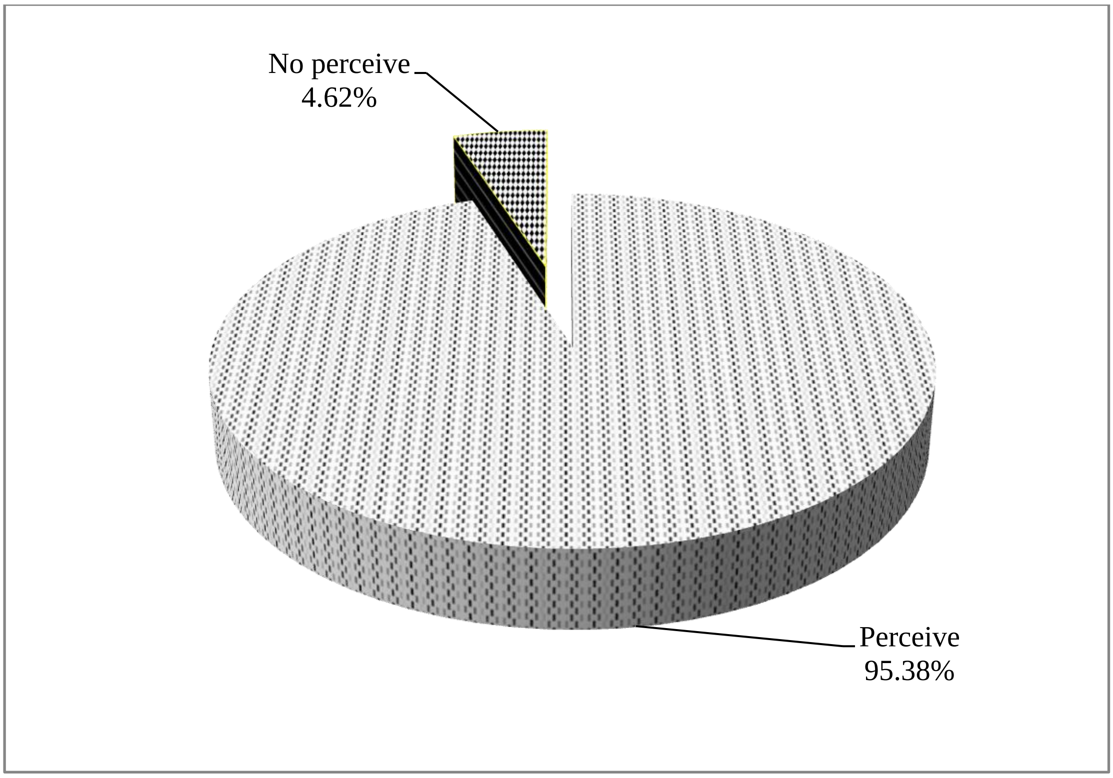

Figure 4.3 Perceptions on climate change in the study area

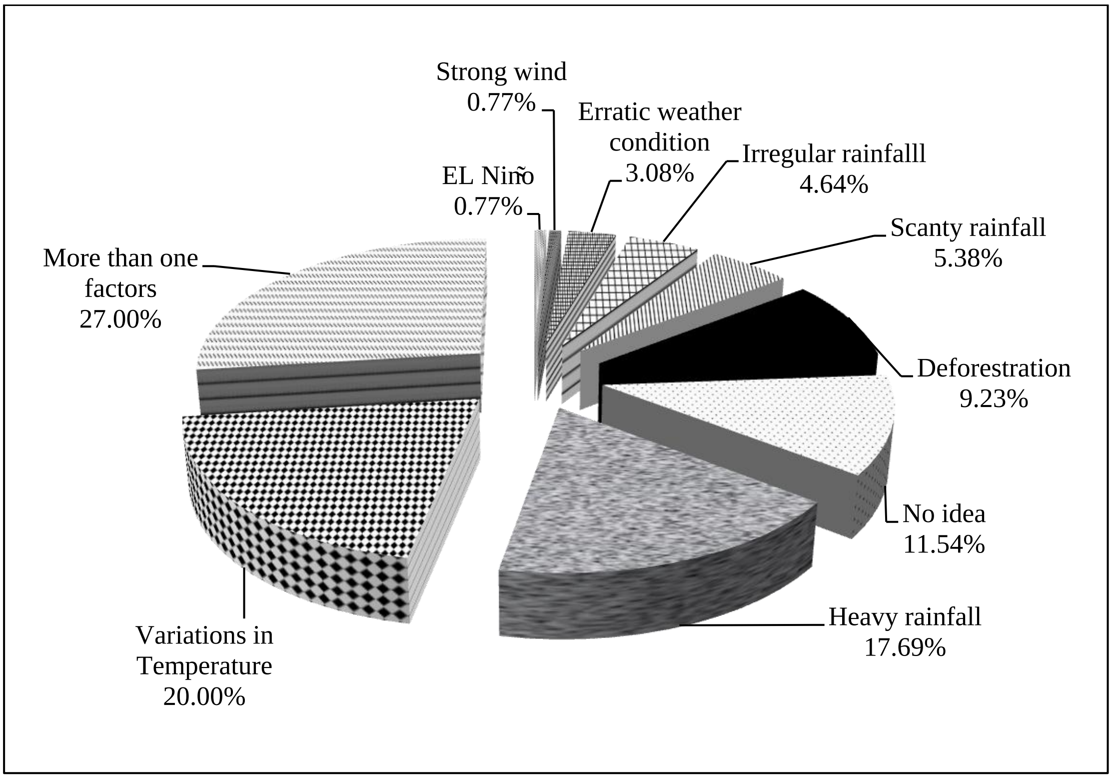

Figure 4.4 Opinions of respondents on factors of climate change

4.2.3 Climatic shocks faced by respondents in the study area

The respondents countered to have various climatic shocks and their experienced climatic shocks over the past twenty years were mentioned in Table 4.5. In this study, 29.23% of sample respondents faced scanty rainfall as major shock, 27.69% of respondents noticed strong wind were the most serious shock. While 8.46% of the respondents said that flood was the most significant climatic shock and the other 8.46% of the respondents did not aware any climate shocks. About 7.69% of the respondent thought that extreme temperature were grave concern. About 6.92%, 4.62%, 2.31%, and 1.54% of respondents faced scanty rainfall and strong wind, scanty rainfall and flood, flood and strong wind, and scanty rainfall, flood and strong wind, respectively. Only 0.77% each of respondents thought that scanty rainfall and extreme temperature; scanty rainfall, flood and extreme temperature; strong wind and extreme temperature; and flood, storms and extreme temperature were their faced climatic shocks respectively.

Table 4.5 Major shocks faced by respondents during the past 20 Years

Types of Shock	Frequency	Percentage
Scanty rainfall	38	29.23
Strong wind	36	27.69
Flood	11	8.46
No awareness	11	8.46
Extreme temperature	10	7.69
Scanty rainfall + Strong wind	9	6.92
Scanty rainfall + Flood	6	4.62
Flood + Strong wind	3	2.31
Scanty rainfall + Flood + Strong wind	2	1.54
Scanty rainfall + Extreme temperature	1	0.77
Storms + Extreme temperature	1	0.77
Scanty rainfall + Strong wind + Extreme temperature	1	0.77
Flood + Strong wind + Extreme temperature	1	0.77
Total	**130**	**100.00**

4.2.4 Sources of climate change information for respondents

Sample respondents received climate information from different sources as shown in Figure 4.5. About 36.47 % and 26.67% of respondents received climate information from radio and various television channels respectively, while 19.22%, 6.27%, 5.88 %, 3.92%, less than 2% each were received climate information from neighboring farmers, mobile applications, newspapers, other sources such as Facebook pages, journals and magazines respectively.

As shown in Figure 4.6, 94.03% of total respondents believed the climate change information while 5.97% of total respondents did not believe the climate change information. Thus, majority of respondents believed on climate change information.

4.2.5 Farmers' perceptions on change in temperature from 1997 to 2016

Majority of respondents (about 91.54%) perceived that the temperature was increasing while about 6.15% of respondents presented that the temperature was stay the same and the rest exposed that the temperature was decreasing over the past twenty years (Figure 4.7).

4.2.6 Farmers' perceptions on change in amount of rainfall from 1997 to 2016

Regarding perceptions on amount of rainfall over the past 20 years as revealed in Figure 4.8, about 57.69% of the total respondents perceived that amount of rainfall was increasing, however, about 37.69% of respondents supposed that amount of rainfall was decreasing while only 4.62% of respondents noticed that the amount of rainfall was stay the same.

4.2.7 Farmers' perceptions on change in rainy days from 1997 to 2016

Farmers' perceptions on change in rainy days from 1997 to 2016 were shown in Figure 4.9. Most of the respondents which were about 66.15% exposed that the rainy days were increasing, on the other hand, about 30.00% of respondents indicated that the rainy days were decreasing and the remaining respondents perceived that the rainy days were neither increasing nor decreasing over the past twenty years.

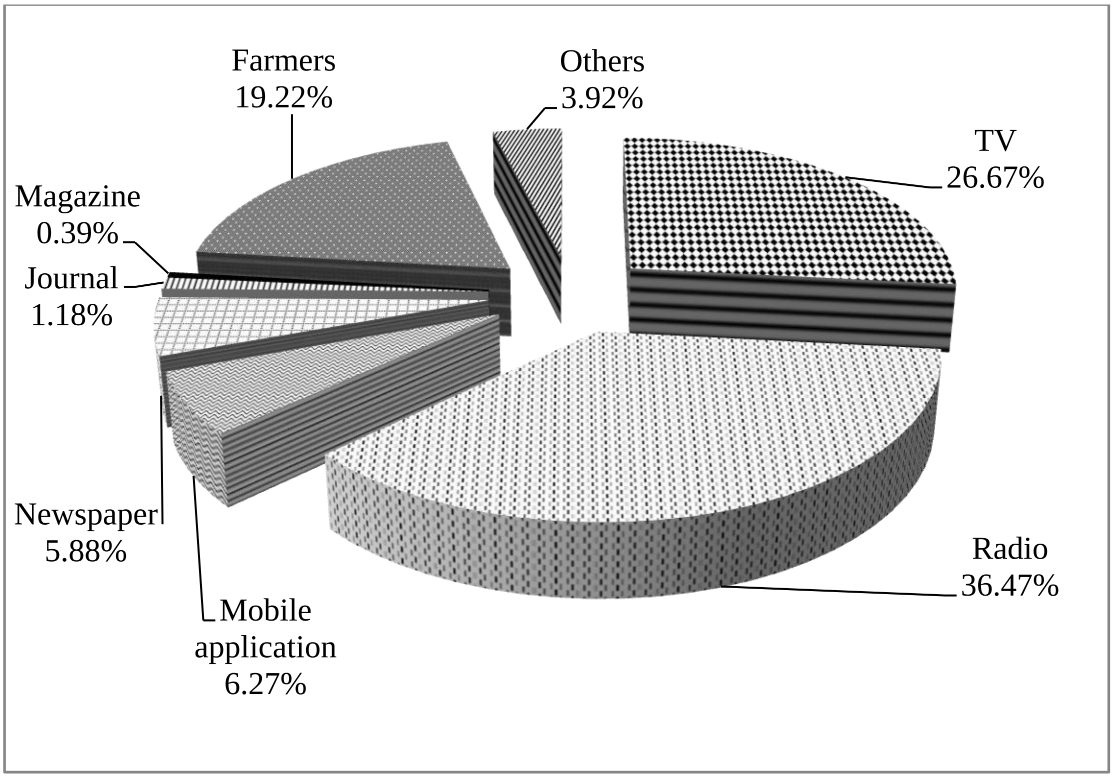

Figure 4.5 Sources of climate change information by sample households

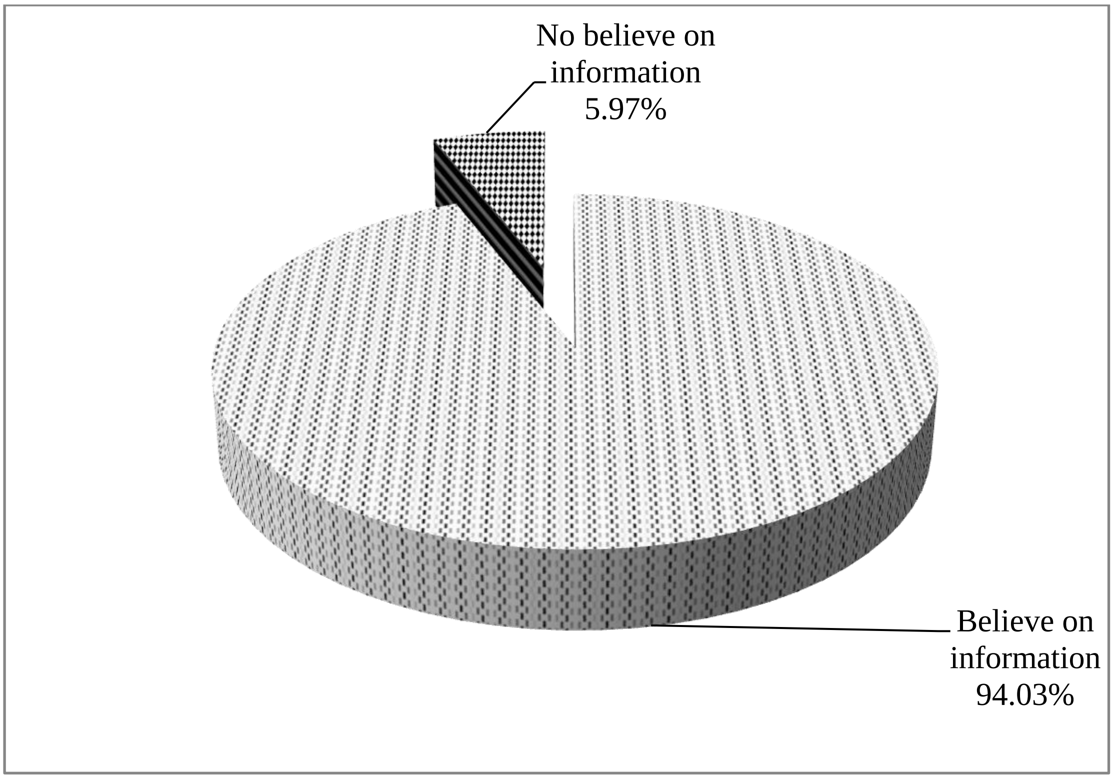

Figure 4.6 Opinions of respondents on climate change information

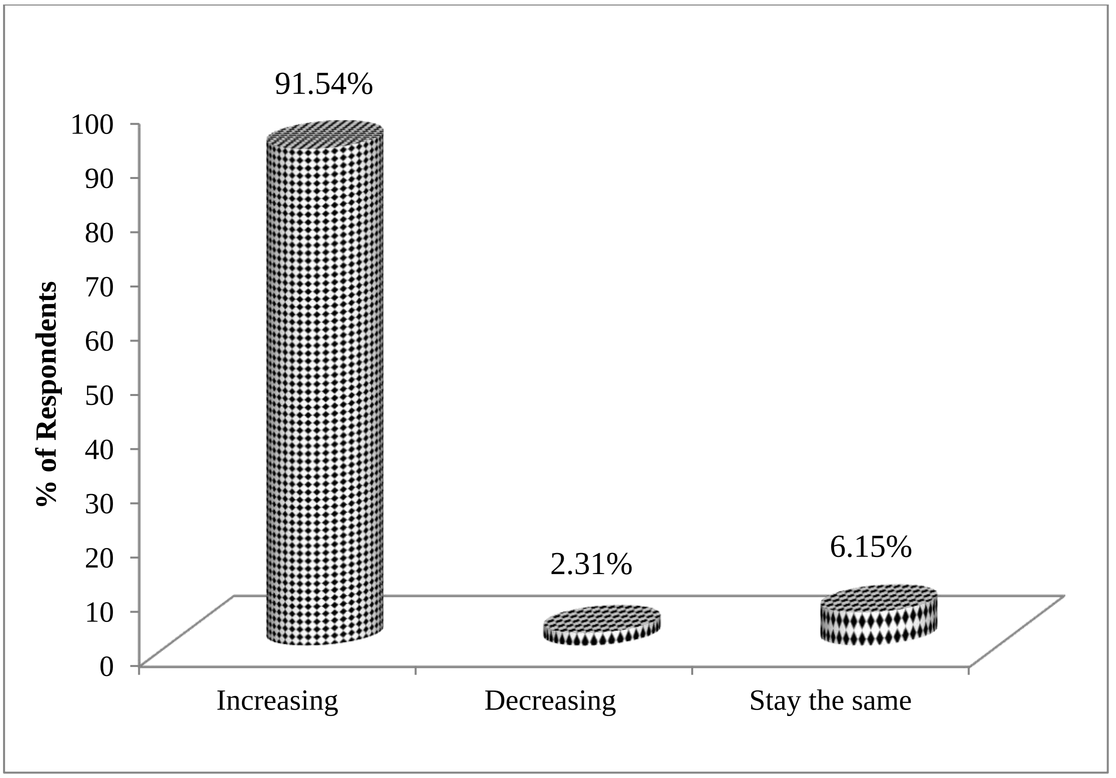

Figure 4.7 Perceptions of the respondents on change in temperature from 1997 to 2016

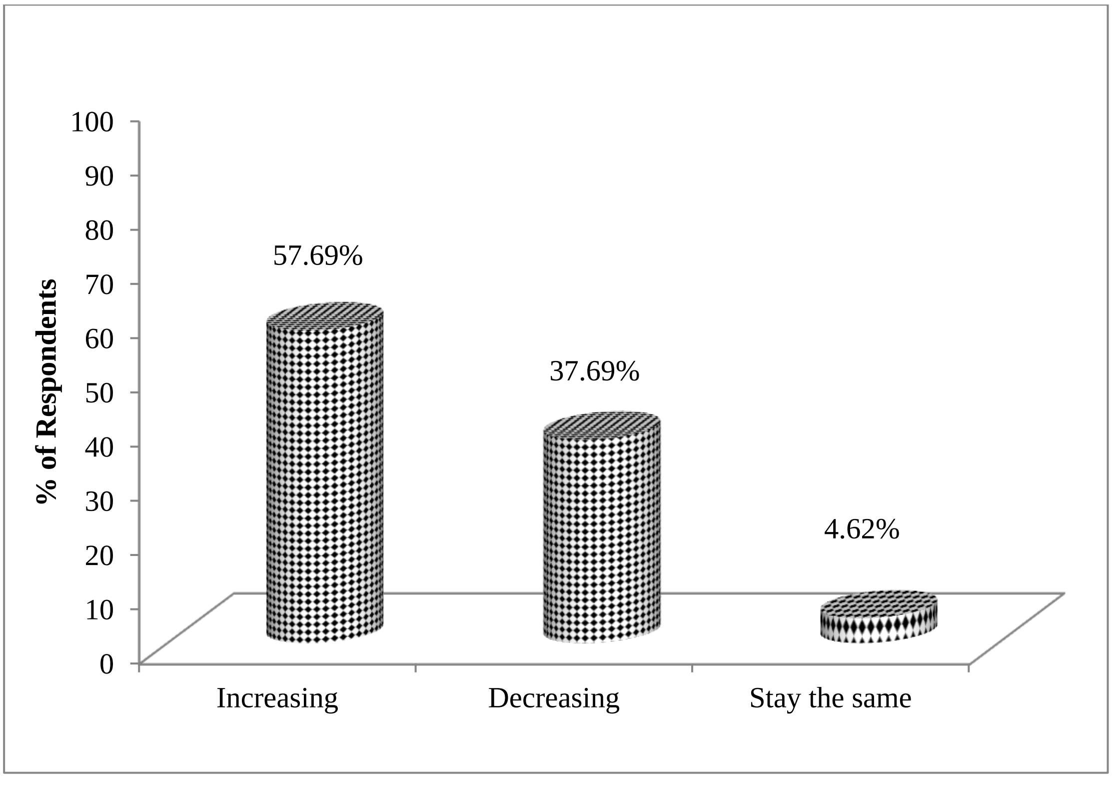

Figure 4.8 Perceptions of the respondents on change in amount of R rainfall from 1997 to 2016

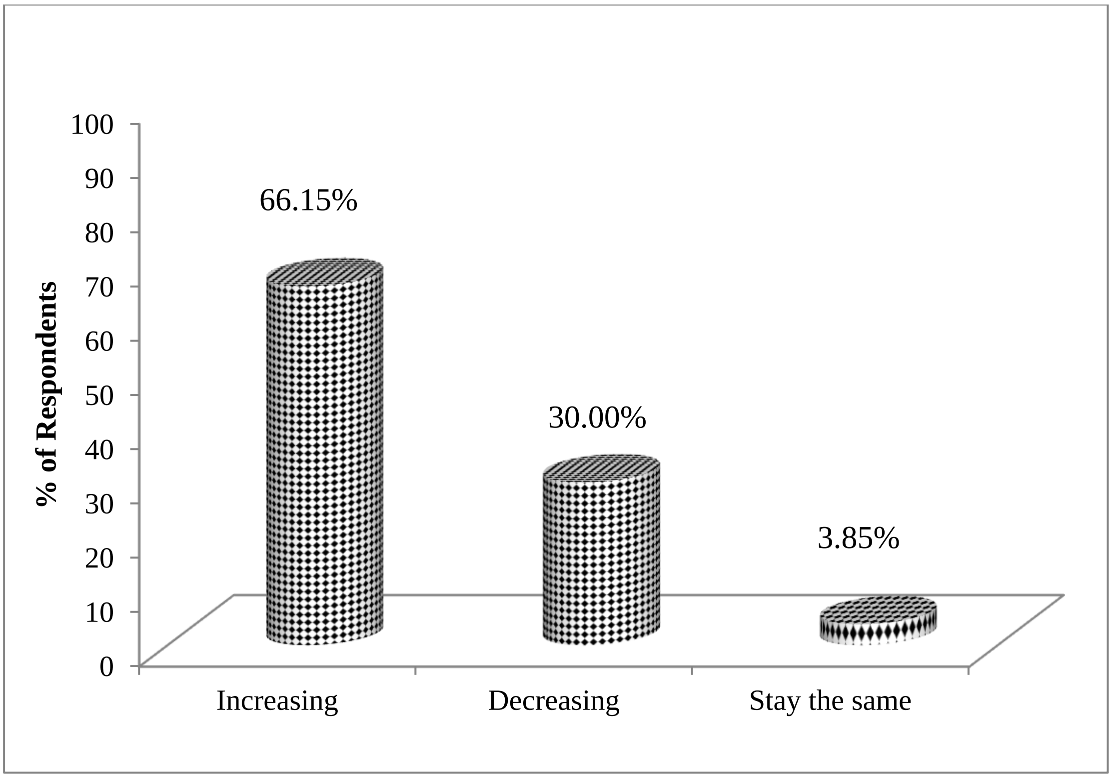

Figure 4.9 Perceptions of the respondents on change in rainy days from 1997 to 2016

4.2.8 Opinions of respondents for the most vulnerable livelihood activities in Yamèthin Township

All sample respondents were farmers. Thus, majority of respondents (80.77%) thought that agriculture (i.e. crop production) was the most vulnerable livelihood activity while about 10.00%, 1.54% and 0.77% of respondents thought the most vulnerable livelihood activities were livestock rearing, worked as casual labor and merchants along with crop production, respectively. Other 5.38% of respondents assumed that only livestock rearing was the most vulnerable activity for them whereas the remaining 1.54% of respondents thought that climate change could not affect their livelihood activities (Figure 4.10).

4.2.9 Opinions of respondents for the most vulnerable social group in Yamèthin Township

The opinions of sample respondents for the most vulnerable social group in the study area were shown in Figure 4.11. According to the data, about 45.45% of total respondents thought that the most vulnerable social group was aged person. About 44.89% of total respondents assumed that the children who were affected by climate change. About 5.68% of total respondents suggested female were affected by climate change. While 3.98% of total respondents stated that male were vulnerable due to climate change.

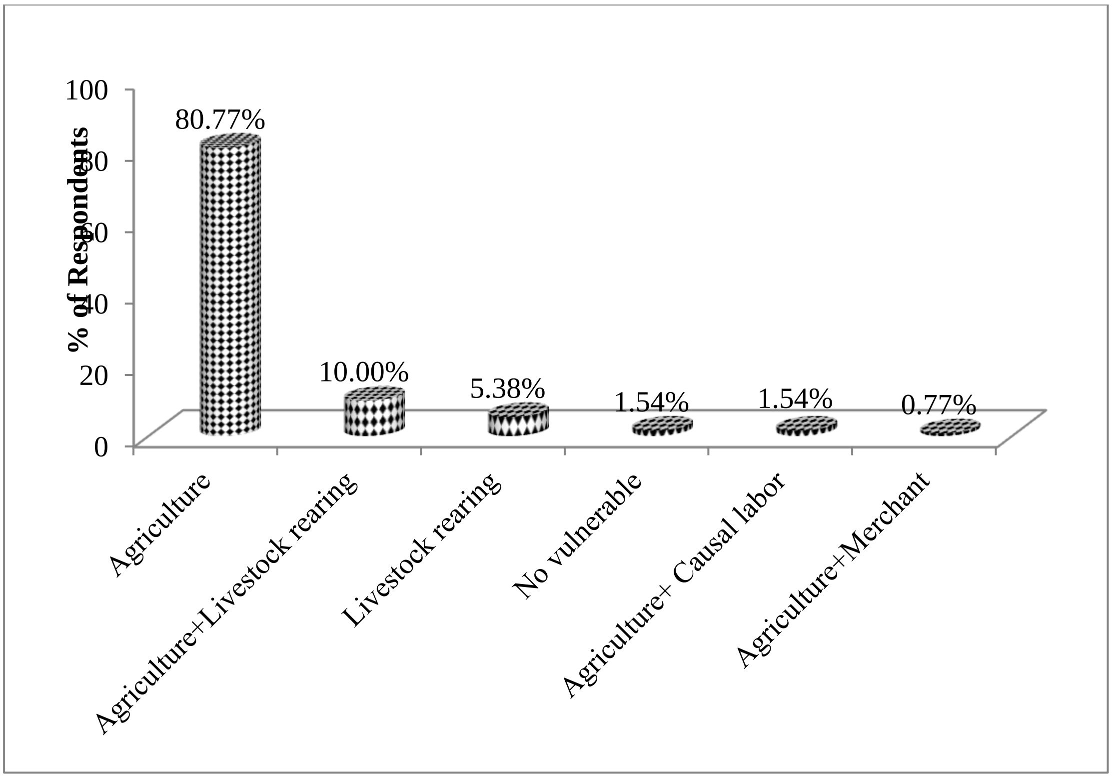

Figure 4.10 Opinions of respondents for the most vulnerable livelihood activities in Yamèthin Township

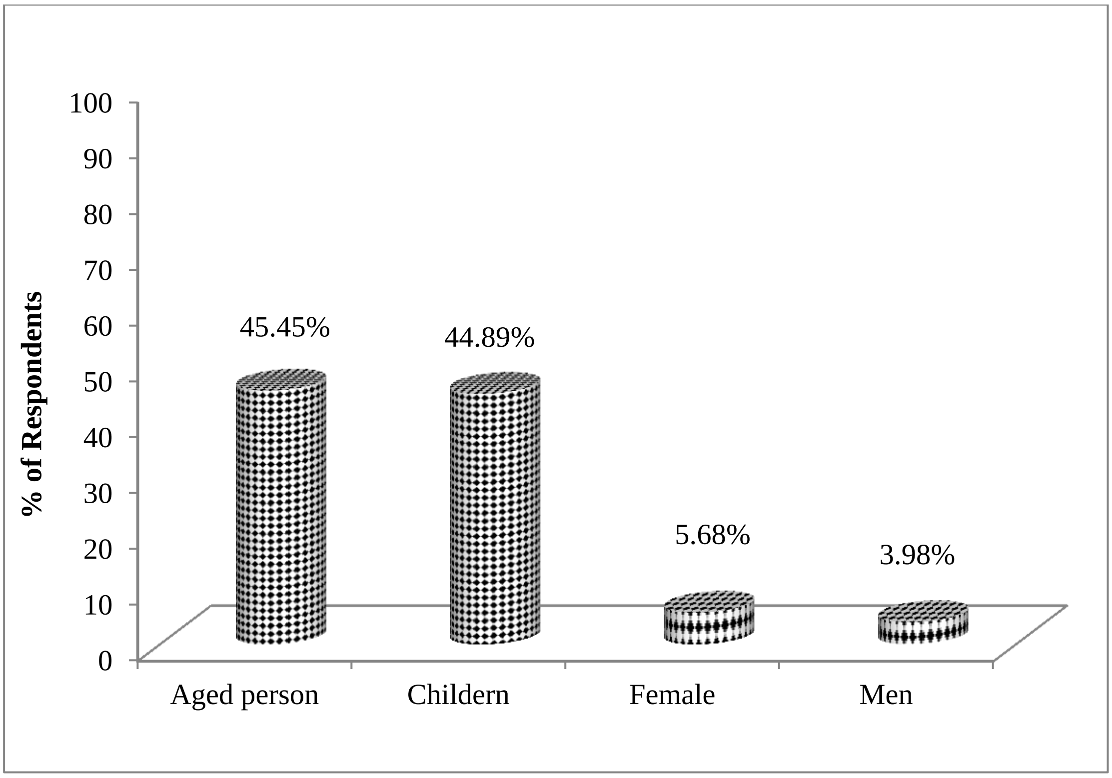

Figure 4.11 Opinions of respondents for the most vulnerable social group in Yamèthin Township

4.2.10 Farmers' perceptions on effect of climate change

The perceptions of respondents on the effect of climate change on livestock rearing, crop production and crop production practices were illustrated in Figure 4.12. About 72.31% of respondents perceived that climate change can affect livestock rearing while 27.69% of respondents perceived that climate change cannot affect livestock rearing. The results of the study revealed that 90.77% of total respondents thought that there were effects of climate change on crop production. Whereas 9.23% assumed that there were no effects of climate change on crop production. About 64.62% of total respondents perceived that there were effects of climate change on the crop production practices while only 35.38% thought that there were no effects of climate change on the crop production practices. Thus, in the study area, majority of respondents perceived that there were effects of climate change on livestock rearing, crop production and crop production practices.

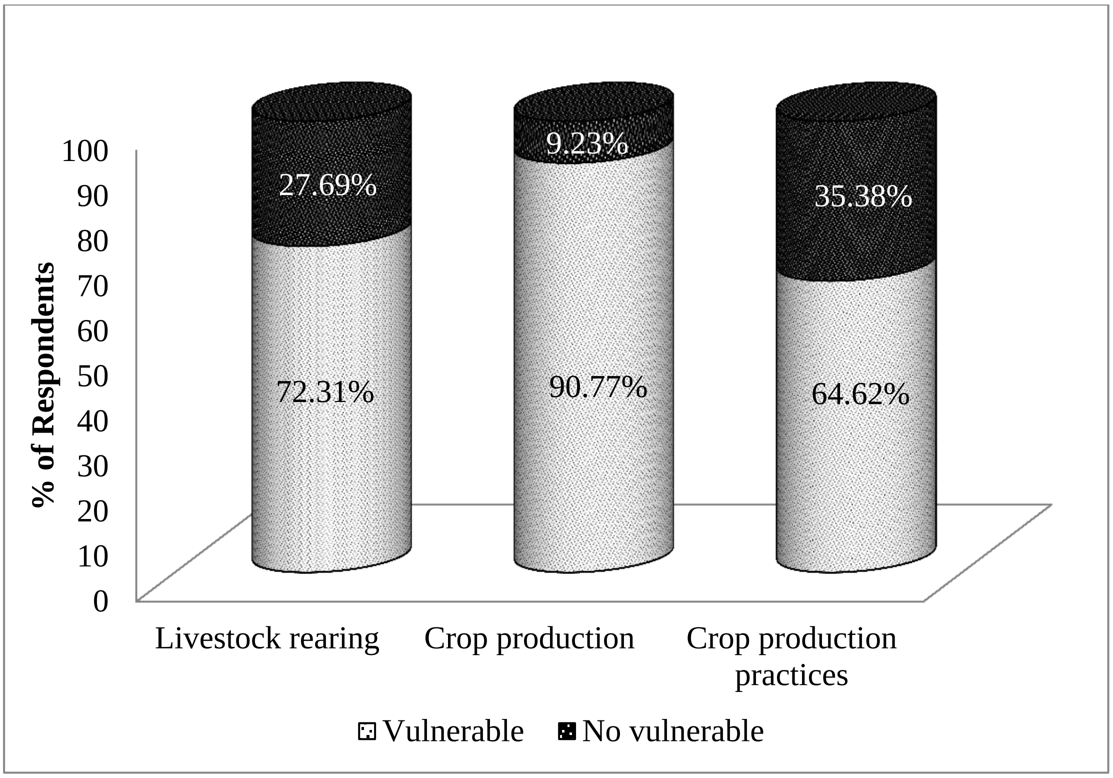

Figure 4.12 Perceptions of respondents on effect of climate change

4.3 Awareness about Climate Change by Respondents

Mean scores of sample farmers' awareness on climate change in Yamèthin Township were indicated in Table 4.6. The average awareness score of sample farmers for statement number 1 was 4.44, thus, it explained that sample farmers had a good knowledge on climate change as the statement was about the difference between current and the past 20 years' climate condition.

The mean score relating to the changing of monsoon time statement number (2) was 4.35. It mentioned that the knowledge upon the changing of monsoon time was good. The mean score for statement number (3) that is decreases in amount of rainfall was 4.31. Farmers had knowledge about rainfall amount that is important factor for agriculture especially for Central Dry Zone because of scarcity of water.

The sample farmers had a good knowledge on the rainy days because the mean score for the statement number (4) was 4.42. The crop production cycle can be adjusted by the rainfall pattern when the full demand for agricultural water cannot be meet. For statement number (5) concerned with increase in temperature, the mean score was 4.49. Increase in temperature can affect pollination and rate of plant development.

The mean score was 4.22 for statement number (6) that indicates there is change in soil moisture and intensity due to climate variability. It explained that the farmers had good knowledge about moisture content. The statement number (7) shows the climate variability can affect crop growing time. In this statement, the mean score was 4.21 that caused the farmers who had a good knowledge about the relationship between climate variability and crop growing time.

The mean score for statement number (8) that is the climate variability can affect growing crop types was 4.05. It indicated that the respondents realized to choose crop type depend on climate condition.

The mean score for statement number (9) was 4.16. It indicates the respondents understand that unusual high temperature led to drying of seedlings after germination. In the statement number (10) concerning with the unusual irregularity in temperature led to crop failure on the farm, the mean score was 4.22. The mean awareness score of sample farmers for the statement number (11) was 4.48. Thus, the respondents understand that irregular seasonal rainfall led to poor harvest.

Awareness index of sample farmers into different categories were presented in Table 4.7. Higher awareness index means more knowledge on climate change by sample farmers. Three different ranges of awareness index were separated with frequency distribution. The sample respondents (91.54%) fell within the range of 0.70 to 1.00, which indicated that the majority of respondents had high awareness index. Whereas 8.46% of the respondent had medium awareness index (0.35 - 0.69), and there were no respondents having limited awareness index. Therefore, most of respondents recognized the impacts of climate change although they themselves thought they have no awareness about climate change. According to the survey data, the mean awareness index was 0.83 ranging from the highest awareness index, 1.00 and the lowest awareness index, 0.57 (Table 4.8).

Table 4.6 Climate change awareness scores by sample respondents in Yamèthin Township

No	Statements	SD (%)	D (%)	N (%)	A (%)	SA (%)	Mean
1	The climate today is different from what it used to be in the past 20 years	0.00	0.77	1.54	50.77	46.92	4.44
2	Monsoon period is changing	0.00	1.54	2.31	60.00	37.69	4.35
3	The amount of rainfall is decreasing	0.00	1.54	3.08	58.46	36.92	4.31
4	The rainy days are changing	0.00	1.54	3.08	47.69	47.69	4.42
5	The temperature is increasing	0.00	2.31	1.54	40.77	55.38	4.49
6	There is change in soil moisture and intensity due to climate variability	0.77	2.31	9.23	49.23	38.46	4.22
7	The climate variability can affect crop growing time	0.00	3.85	3.08	61.54	31.54	4.21
8	The climate variability can affect growing crop types	3.08	3.08	6.92	60.00	26.92	4.05
9	Unusual high temperature leads to drying of seedlings after germination	0.77	10.00	3.85	44.62	40.77	4.16
10	Unusual irregularity in temperature leads to crop failure on the farm	0.77	6.15	2.31	51.54	39.23	4.22
11	Irregular seasonal rainfall leads to poor harvest	0.77	2.31	1.54	39.23	56.15	4.48

Note: SA =Strongly agree = 5, A = Agree = 4, N = Neutral =3, D = Disagree =2 and SD = Strongly disagree =1

Table 4.7 Climate change awareness categorization of respondents in study area

Range of Awareness Index	Definition	Percent of Respondent
0.00-0.34	Limited Awareness	0.00
0.35-0.69	Medium Awareness	8.46
0.70-1.00	High Awareness	91.54
Total		**100.00**

Table 4.8 Climate change awareness index of respondents in study area

Items	Mean	Maximum	Minimum
Awareness index	0.83	1.00	0.57

4.4 Climate Trend of Yamèthin Township

To verify farmers' perceptions on climate change, trend of climate variables for Yamèthin Township were analyzed by simple regression model. In this analysis, historical climate data for Yamèthin Township were obtained from department of Meteorology and Hydrology, Yangon.

4.4.1 Temperature trend of Yamèthin Township

As shown in Figure 4.13, the trend of average temperature from 1997 to 2016 revealed that the average temperature rose about 0.022°C across 20 years although there were no significant changes (P = 0.227) among the average annual temperature from year to year. According to field survey data, most of respondents perceived that temperature was increasing during the last 20 years. Thus, the perceptions of farmers were consistent with 20 years temperature trend.

The trend of average maximum temperature and average minimum temperature for Yamèthin Township from 1997 to 2016 was presented in Figure 4.14. According to trend analysis, the annual average maximum temperature was increased by 0.057°C per year. But the annual average minimum temperature was decreased by 0.014°C per year. The p-value for annual average minimum temperature 0.505 was insignificant with time variables whereas the p-value for annual average maximum temperature was 0.019 showing 5% level of significance. The hottest year was 2010 with maximum temperature 34.7°C and the coldest year was 2006 with minimum temperature 18.9°C.

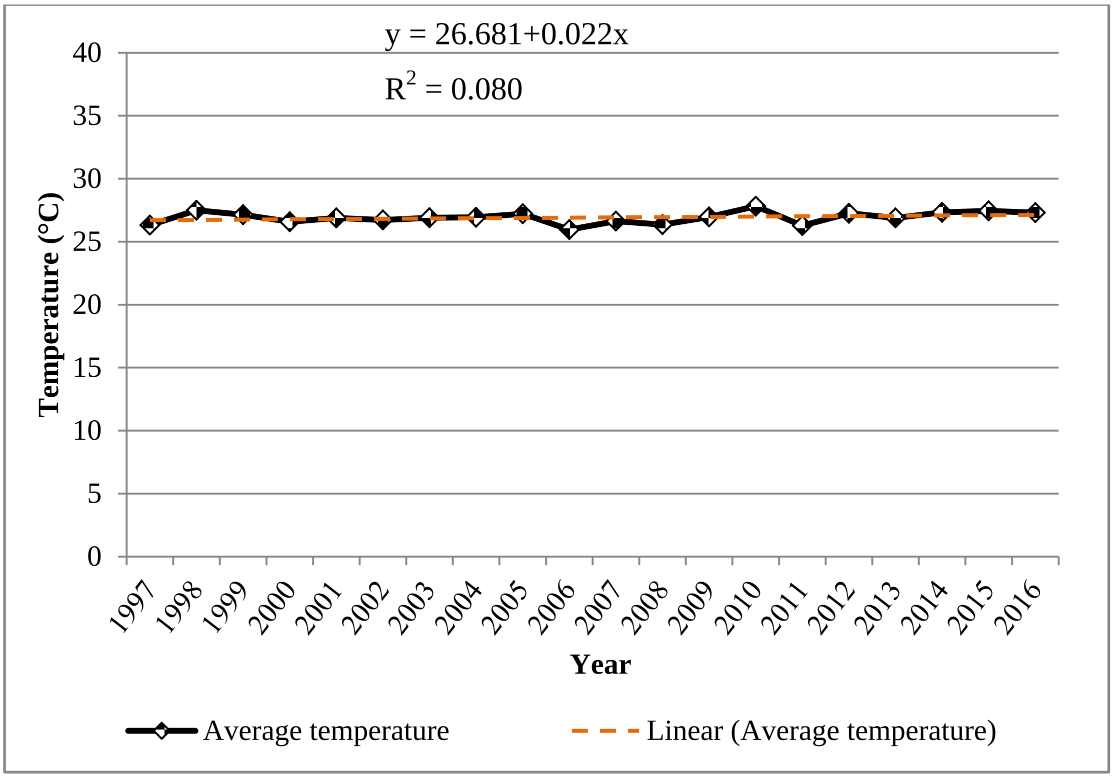

Figure 4.13 Trend of annual average temperature for Yamèthin Township

Source: DMH (2017)

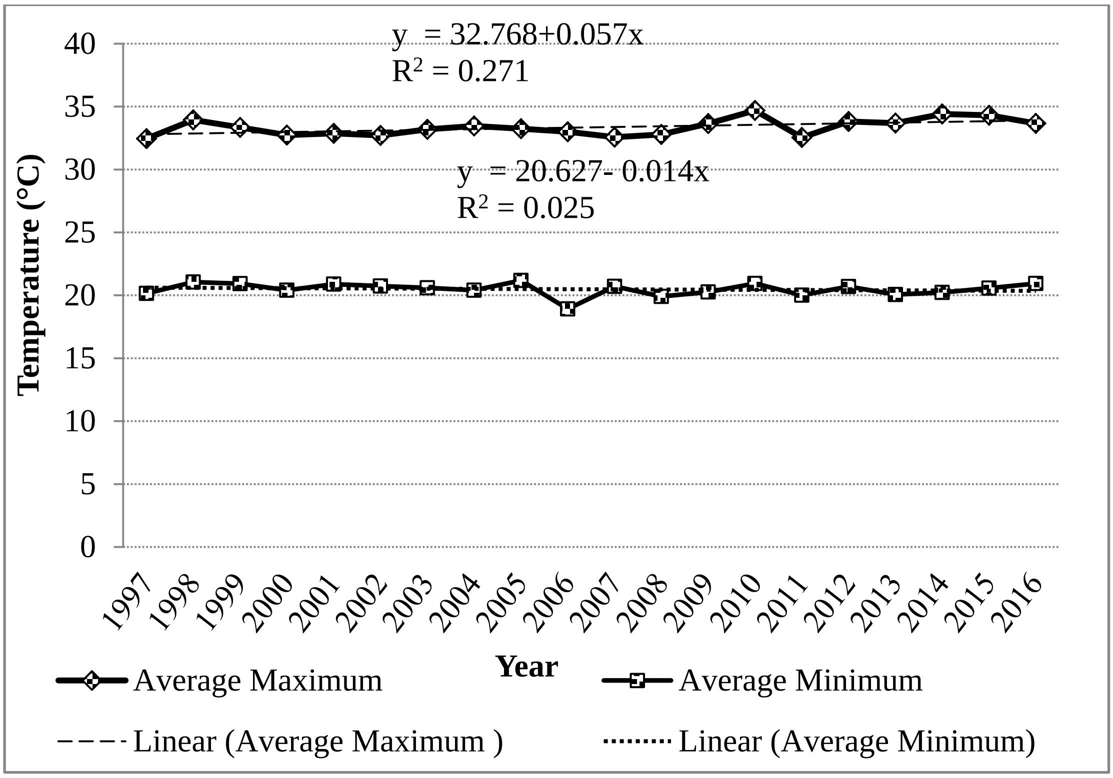

Figure 4.14 Trend of maximum and minimum temperature for Yamèthin Township

Source: DMH (2017)

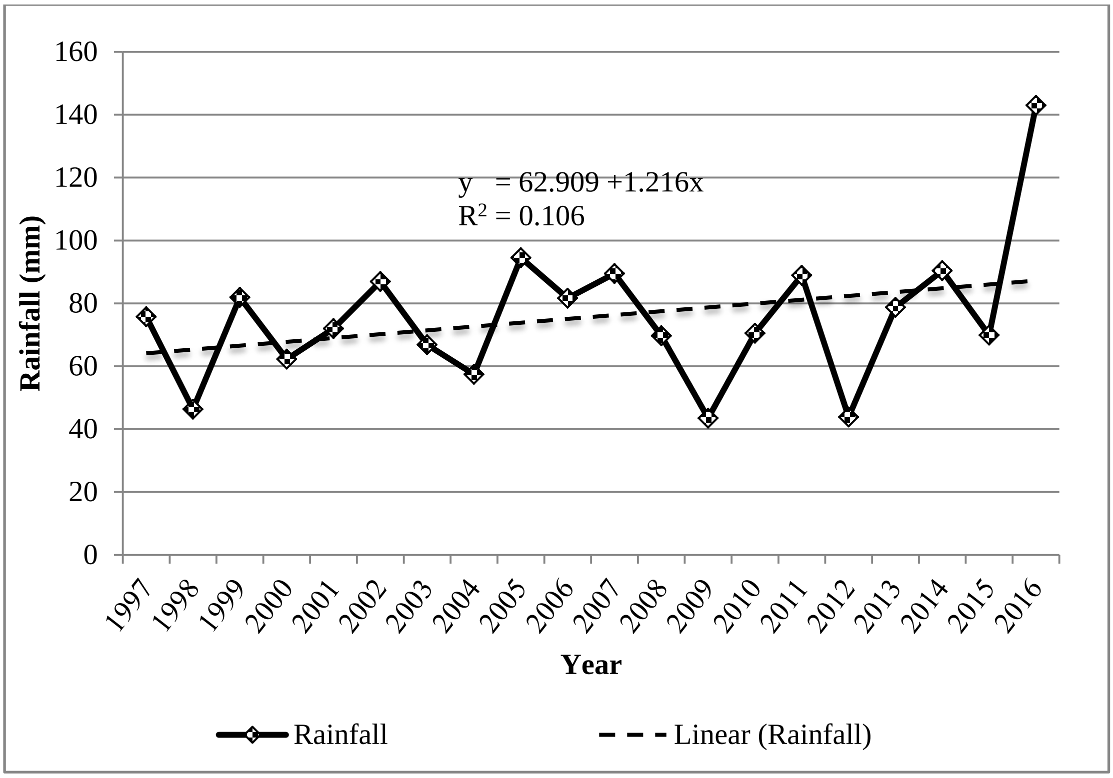

Figure 4.15 Trend of average annual rainfall for Yamèthin Township

Source: DMH (2017)

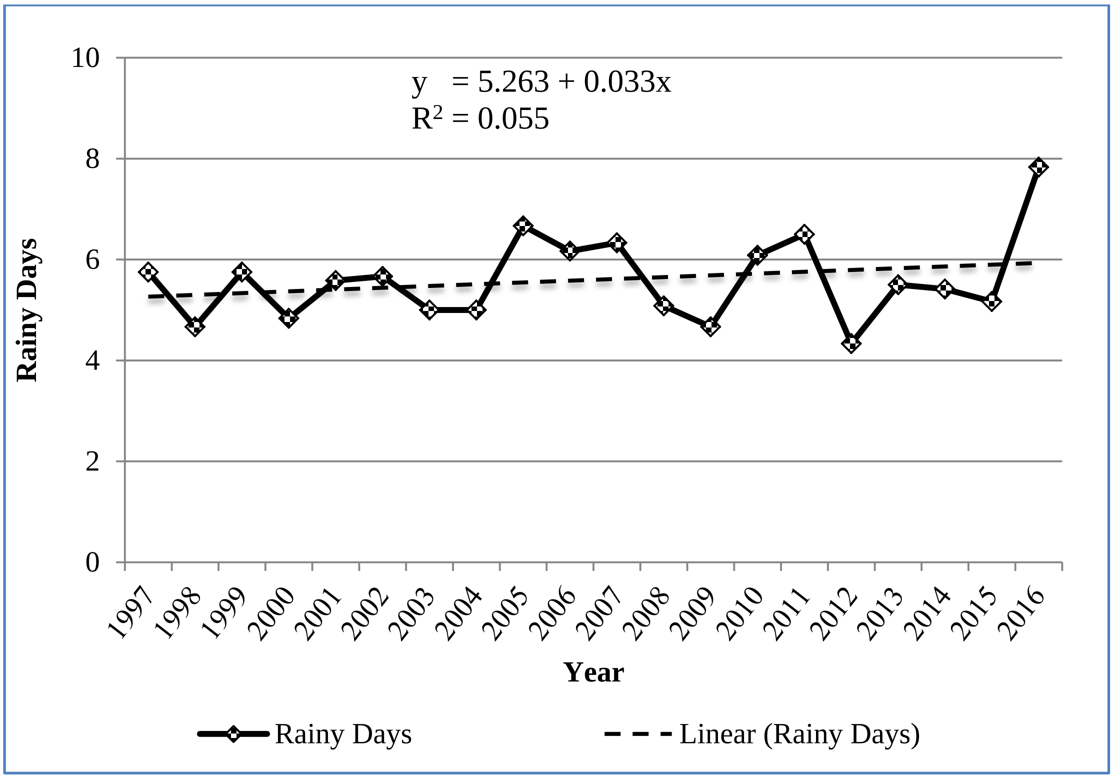

Figure 4.16 Trend of average annual rainy days for Yamèthin Township

Source: DMH (2017)

4.4.2 Rainfall trend of Yamèthin Township

During 1997 to 2016, 2009 was observed as the driest year with 43.50 mm of average rainfall per month and 2016 was the wettest year with 143.00 mm of average rainfall per month in study area.The average annual rainfall was increased by 1.216 mm through 20 years but there were no significant changes (P = 0.162) among the amount of annual rainfall (Figure 4.15). Therefore, respondents' perceptions were consistent with 20 years records of rainfall by Department of Meteorology and Hydrology as more than half of respondents perceived that amount of rainfall was increasing.

4.4.3 Rainy days trend of Yamèthin Township

The rainy days were increased by 0.033 day from 1997 to 2016 though annual rainy days were not significantly different from year to year with P value of 0.312 (Figure 4.16). Nearly two-third of respondents had accurate perceptions on change in rainy days because their perceptions were consistent with time series rainy day records.

4.5 Factors Influencing Awareness Index

To determine the factors influencing awareness index, linear regression function was employed. The explanatory variables included farming experience, farm size, level of education, perception on temperature, perception on rainfall.

4.5.1 Descriptive statistics of dependent and independent variables

The awareness index was used as dependent variable and it was about 0.83 in average. The descriptive statistics of independent variables were also shown in Table 4.9. The average farming experience was 26.72 years and average farm size was 2.99 hectare. As level of education, only 2.31% of respondents were illiterate, 14.62%, 48.46%, 22.31%, 7.69% and 4.62% of respondents were primary, secondary, high school and graduate, respectively. About 91.54% of respondents perceived that temperature was increasing while 2.31% of the respondents exposed that temperature was decreasing and 6.15% of the respondents thought that temperature was stay the same. For perception on rainfall, 57.69% of respondents perceived that amount of rainfall was increasing, 37.69% of the respondents thought that amount of rainfall was decreasing and 4.62% of the respondents assumed that amount of rainfall was stay the same.

Table 4.9 Descriptive statistics of dependent and independent variables

Description of variables	Unit	Mean	%
Awareness index	-	0.83	-
Farming experience (year)	Year	27.00	-
Farm size (ha)	Hectare	2.99	-
Level of education		-	-
0 = Illiterate	Percent	-	2.31
1 = Monastery	Percent	-	14.62
2 = Primary	Percent	-	48.46
3 = Secondary	Percent	-	22.31
4 = High school	Percent	-	7.69
5 = Graduate	Percent	-	4.62
Perception on temperature		-	
1 = Increasing	Percent	-	91.54
2 = Decreasing	Percent	-	2.31
3 = Stay the same	Percent	-	6.15
Perception on rainfall		-	
1 = Increasing	Percent	-	57.69
2 = Decreasing	Percent	-	37.69
3 = Stay the same	Percent	-	4.62
Climate information access from radio and television (Dummy)			
1 = access	Percent	-	54.62
0 = no access	Percent	-	45.38

4.5.2 Factors influencing farmers' awareness about climate change

According to the results described in Table 4.10, all explanatory variables were positively related to awareness index. The farming experience of respondents was positively and significantly correlated with awareness level of farmers about climate change at 1% level. Farmers' awareness index on climate change will be increased by 0.002 if farmers had an additional year in farming experience. Thus, the more experience in farming the higher the awareness index about climate change. The climate information access from radio and television channels was the positively and significantly related with farmers' awareness index at 5% level. Concern with dummy variable, climate information access from radio and television channels (access = 1, no access = 0) specified that the awareness index of the farmers who had radio and television was 0.032 more than that of farmers who did not have radio and television. It indicated that the farmers who had radio and television were more aware about climate change as compared to the farmers who did not possess radio and television. Among these variables, farm size and perceptions on temperature were also positively and significantly related with awareness level of farmers about climate change at 10% level. These result indicated that one unit increases in farm size and perceptions on temperature expressing the awareness index was expected to be increased by 0.009 and 0.039 respectively. It means that the farmers who owned larger farm size and had high perception on temperature can have higher awareness index. Education level and perception on rainfall were positively related to awareness index but not significant. The F value showed that the selected model was significant at 1% level. The R^2value 0.380 indicated that the selected independent variables could explain about 38% in determining the influencing factors for farmers' awareness level about climate change.

Table 4.10 Factors influencing awareness index about climate change

Independent Variables	Unstandardized coefficient (B)	Standardized coefficient (β)	t - value	sig
Constant	0.659***		28.742	0.000
Farming experience	0.002***	0.240	2.790	0.006
Farm size	0.009*	0.147	1.675	0.096
Respondents' education level	0.012^{ns}	0.122	1.262	0.209
Perception on temperature	0.039*	0.194	1.839	0.068
Perception on rainfall	0.003^{ns}	0.017	0.190	0.850
Climate information access from radio and television channels	0.032**	0.153	2.036	0.044

Dependent variable = Awareness index
R^2 = 0.380
Adjusted R^2 = 0.349
F = 12.339***

Note: ** and *** are significant at 5% and 1% level respectively and ^{ns} = not significant

4.6 Adaptation Strategies and Barriers to adapt to Climate Change

Preparation for climate change in agriculture sector, adaptation strategies used by respondents and barriers to adapt to climate change were presented.

4.6.1 Preparation for climate change in agriculture sector

Before the farmers used adaptation strategies, they prepared for their farming. Although majority of farmers faced water scarcity, they could not prepare for water management according to several reasons in financial difficulty, lack of awareness in water harvesting technology, not assurance to get water even investment is made in digging well because of the depth of the water level in the area is so high, and etc. Nearly one-third of respondents did not prepare for many reasons.

Preparation for climate change in agriculture sector was presented in Table 4.11. According to the study, about 12.31% of respondent prepared seedbed early and early land preparation was applied by 10.77% of farmers. About 10.00% of respondent selected seed early and about 9.23% changed sowing time and about 5.38% of respondents used storage system. Use of chemical was applied by 3.85% of the respondents, and about 2.31% of respondent harvested early. The combination of early seed bed preparation and early seed selection were used by 2.31% of respondent. The combination of early seed bed preparation and use of chemical, the combination of early seed bed preparation and change sowing time and the combination of early seed selection and use of chemical were applied by 1.54% each of respondents respectively. The combination of early seed bed preparation and early land preparation, the combination of early seed selection and early land preparation and combination of early seed selection and change sowing time, the combination of change sowing time and early harvest and the combination of early harvest and storage were used by 0.77% each of respondents respectively. Moreover, three combinations of preparation were used by 5.39% of respondents. However, about 30.00% of respondents did not follow any preparation in agricultural activities for climate change.

Table 4.11 Preparation for adaptation to climate change (n = 130)

Preparation Activities	Frequency	Percentage
Early seed bed preparation	16	12.31
Early land preparation	14	10.77
Early seed selection	13	10.00
Change sowing time	12	9.23
Storage	7	5.38
Use of chemical	5	3.85
Early harvest	3	2.31
Early seed bed preparation + Early seed selection	3	2.31
Early seed bed preparation + Use of chemical	2	1.54
Early seed bed preparation + Change sowing time	2	1.54
Early seed selection + Use of chemical	2	1.54
Early seed bed preparation + Early land preparation	1	0.77
Early seed selection + Early land preparation	1	0.77
Early seed selection + Change sowing time	1	0.77
Change sowing time + Early harvest	1	0.77
Early harvest + Storage	1	0.77
Early seed bed preparation + Early seed selection + Change sowing time	1	0.77
Early seed bed preparation + Use of chemical + Early land preparation	1	0.77
Early seed bed preparation + Change sowing time + Early harvest	1	0.77
Early bed preparation + Early harvest + Storage	1	0.77
Early seed selection + Use of chemical + Change sowing time	1	0.77
Early seed selection + Early land preparation + Change sowing time	1	0.77
Early seed selection + Change sowing time + Early harvest	1	0.77
Nothing	39	30.00
Total	**130**	**100.00**

4.6.2 Local adaptation strategies to climate change in the study area

Local adaptation strategies in Yamèthin Township were water management, change in variety, change in sowing time, use of pesticide and herbicide, change in cultural practices and change in cropping pattern. The most common adaptation strategy was water management by irrigating and draining. Some of respondents used more than one adaptation strategies and more than one-fourth of respondents did not follow any adaptation strategies.

As shown in Table 4.12, some of respondents did not use any adaptation strategies. However, users of adaptation strategies, water management is mostly used (16.15%) followed by change in variety (8.46%). About 7.69% each of respondents changed sowing time; and used pesticide and herbicide respectively. About 5.38% of respondents changed cultural practices as adaptation strategy. The combination of change in cultural practices, change in variety and change sowing time was used by 3.85% of respondents and about 3.08% of respondents changed cropping pattern. About 2.31% each of respondents used the combination of change in variety and change sowing time; the combination of change sowing time and water management; and the combination of use of pesticide and herbicide and irrigation and water management. About 1.54% each of respondents used the combination of change in cropping pattern and use of pesticide and herbicide; the combination of change in cropping pattern and water management; the combination of change in variety and water management; and the combination of change in cultural practices and use of pesticide and herbicide, respectively. The 0.77% each of respondents used fertilizer; the combination of change in cropping pattern and change sowing time; the combination of change in cultural practices and change in variety; the combination of change in cultural practices and change sowing time; the combination of change in variety and use of pesticide and herbicide; the combination of use of fertilizer and water management; the combination of change in cultural practices, change in variety, and water management; and the combination of change in variety, change sowing time, and water management, respectively. Another 1.54 % of the respondents used the combination of four kinds of adaptation strategies. About 26.92% of respondents explained that they did not follow any adaptation strategy.

Table 4.12 Local adaptation strategies to climate change used by respondents

Adaptation Strategies	Frequency	Percentage
Water management	21	16.15
Change in variety	11	8.46
Change sowing time	10	7.69
Use of pesticide and herbicide	10	7.69
Change in cultural practices	7	5.38
Change in cultural practices + Change in variety + Change sowing time	5	3.85
Change in cropping pattern	4	3.08
Change in variety + Change sowing time	3	2.31
Change sowing time + Water management	3	2.31
Use of pesticide and herbicide + Water management	3	2.31
Change in cropping pattern + Use of pesticide and herbicide	2	1.54
Change in cropping pattern + Water management	2	1.54
Change in cultural practices + Use of pesticide and herbicide	2	1.54
Change in variety + Water management	2	1.54
Use of fertilizer	1	0.77
Change in cropping pattern + Change sowing time	1	0.77
Change in cultural practices + Change in variety	1	0.77
Change in cultural practices + Change sowing time	1	0.77
Change in variety + Use of pesticide and herbicide	1	0.77
Use of fertilizer + Water management	1	0.77
Change in cultural practices + Change in variety + Water management	1	0.77
Change in variety + Change sowing time+ Water management	1	0.77
Change in cropping pattern+ Change in cultural practices + Change in variety + Use of pesticide and herbicide	1	0.77
Change in cultural practices + Change in variety + Change sowing time+ Use of pesticide and herbicide	1	0.77
Nothing	35	26.92
Total	**130**	**100.00**

4.6.3 Barriers to climate change adaptation strategies

The farmers faced many barriers to adapt to climate change such as water scarcity, lack of seed, labor scarcity, high cost, insufficient capital and poor access to the technologies. Water scarcity was the most common barrier. It may be high temperature.

As shown in Table 4.13, some of the respondents did not have any barriers to climate change adaptation strategies in the study area. However, water scarcity was the most common barrier in the study area because about 22.31% of respondents faced water scarcity. Whereas about 12.31% of respondents indicated that lack of seed was barrier for them. About 4.62% each of respondents faced labor scarcity; high cost; and insufficient capital were barriers to climate change adaptation strategies, respectively. About 3.85% of respondents stated that poor access to the technology was barrier to adapt to climate change. The combination of lack of seed and labor scarcity; the combination of lack of seed and water scarcity; the combination of insufficient capital and water scarcity, respectively were barriers to adapt to climate change for about 3.08% each of respondents . About 1.54% each of the respondents indicated that the combination of lack of seed and lack of credit; the combination of lack of seed and high cost; the combination of labor scarcity and high cost; the combination of labor scarcity and water scarcity; and the combination of lack of seed, labor scarcity, and water scarcity, respectively were the barriers in their climate change adaptation strategies. In addition, about 0.77% each of respondent indicated that the combination of lack of seed and insufficient capital; the combination of high cost and water scarcity; the combination of lack of seed, insufficient capital, and water scarcity; the combination of labor scarcity, high cost, and water scarcity; and the combination of high cost, insufficient capital, and lack of credit, respectively were the barriers to climate change adaptation strategies. However, about 26.87% of respondents indicated that there was no barrier to adapt to climate change.

Table 4.13 Barriers to climate change adaptation strategies in the study area

Barriers	**Frequency**	**Percentage**
Water scarcity	29	22.31
Lack of seed	16	12.31
Labor scarcity	6	4.62
High cost	6	4.62
Insufficient capital	6	4.62
Poor access to the technologies	5	3.85
Lack of seed + Labor scarcity	4	3.08
Lack of seed + Water scarcity	4	3.08
Insufficient capital + Water scarcity	4	3.08
Lack of seed + High cost	2	1.54
Lack of seed + Lack of credit	2	1.54
Labor scarcity + High cost	2	1.54
Labor scarcity + Water scarcity	2	1.54
Lack of seed + Labor scarcity+ Water scarcity	2	1.54
Lack of seed + Insufficient capital	1	0.77
High cost + Water scarcity	1	0.77
Lack of seed + Insufficient capital+ Water scarcity	1	0.77
Labor scarcity+ High cost+ Water scarcity	1	0.77
High cost+ Insufficient capital + Lack of credit	1	0.77
Nothing	35	26.92
Total	**130**	**100.00**

CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This study attempted to observe farmers' perceptions of climate change, climate change awareness index, adaptation strategies to climate change and barriers to climate change adaptation strategies. In July 2016, totally 130 farmers were interviewed in three sample villages by using simple random sampling method. In this study, historical climate data for Yamèthin Township were obtained from Department of Meteorology and Hydrology, Yangon.

5.1.1 Farmers' perceptions of climate change and awareness index

In the study area, majority of respondents perceived that there was climate change during the past two decades. All respondents had knowledge about climate change because they can easily get about weather news from different sources such as radio, television channels, neighboring farmers, mobile applications, newspapers, social media, journals and magazines. Majority of respondents believed on climate information received from above mentioned sources. Radio and Television channels were the most common information sources for respondents.

Scanty rainfall was major climatic shock faced by farmers because average rainfall of Yamèthin Township was lowest in 2009 and 2012. In the case of vulnerable livelihood activities, agriculture was seen as the most vulnerable livelihood activity affected by climate change because it was climate dependent activity (rain-fed farming) in study area. According to opinions of respondents, old person and children were the most vulnerable social groups in the study area. They cannot resist to extreme weather events and climatic shocks.

Majority of respondents had high awareness index because they had some knowledge about climate change.

5.1.2 Trend of climate variables

Simple regression model was used to analyze the trend of climate variables. The analysis showed that the average temperature and maximum temperature of Yamèthin Township were increasing although minimum temperature was decreasing. Thus, temperature difference between maximum and minimum temperature was increasing. According to temperature trend, the year in 2006 was the coldest year with the average minimum temperature of 18.93°C and the year in 2010 was the hottest year with the average maximum temperature of 34.69°C.

Rainfall trend analysis showed that amount of rainfall and rainy days were increasing. Majority of farmers faced scanty rainfall as major climatic shock because 2009 and 2012 were driest years with 43.5 mm and 43.8 mm of average annual rainfall. Farmers faced flash flood in 2016 which was the wettest year with 143 mm of average annual rainfall.

5.1.3 Analysis of factors influencing awareness index

According to regression analysis, the significant factors influencing on awareness index were farming experience, climate information access from radio and television channels, perceptions on temperature and farm size. It was obvious that the farmers with more experience had more knowledge about climate change. Climate information access was very important factor to have climate change awareness. The farmers with large farm size had high awareness about climate change because they were rich farmers and they possessed information sources such as television and radio.

5.1.4 Climate change adaptation strategies and barriers to adaptation strategies

Farmers prepared their agricultural practices before they used adaptation strategies. The preparation activities used by majority of farmers in the study area were early seed bed preparation and early land preparation. In accordance with these results, farmers had some knowledge to prepare. However, few farmers had no plan to prepare with many reasons such as water scarcity, labor scarcity and insufficient capital. Farmers have been following climate change adaptation strategies such as change in cropping pattern, cultural practices, crop variety, sowing time, use of pesticide and herbicide and water management. The results showed that about one-fourth of farmers did not follow adaptation strategies because they had many barriers such as water scarcity lack of seeds, labor scarcity and insufficient capital. However, most of respondents followed more than one adaptation strategies because they had abilities to adapt to climate change. Although majority of respondents had many kinds of barriers to follow climate adaptation strategies, only 26.92% of farmers had no barrier.

5.2 Recommendation

Based on the finding of study, radio and television programs about climate information should be disseminated accurately and timely because these were the most common sources of weather information in the study area. Furthermore, climate information should be disseminated from mobile application because majority of respondents had mobile phone. As agriculture was the most vulnerable livelihood activity, local adaptive capacity by providing public goods and services, such as better climate information, research and development on climate-resistant crop variety and other techniques, early warning systems, and efficient irrigation systems should be enhanced. Moreover, crop insurance or weather index insurance should be initiated for farmers and risk management system should be motivated.

Climate change education programs and trainings should be targeted to small holders and less experience farmers to raise their awareness level.

Water management practices should be systematically trained to farmers. The strategy for providing sufficient irrigated water should be facilitated. Moreover, water saving technologies should be transferred to the farmers.

Urgent action to combat climate change and its impacts should be taken. However, the suitable policies and mechanisms for the effective implementation of adaptation strategies to overcome hunger in the face of climate change have to balance among economic, society and environment aspects. This study was conducted in only three villages in a Township. Therefore, the further studies should be conducted in other areas of Myanmar in order to know the situation of climate change especially on agricultural communities as farmers’ perception, awareness and adaptation strategies about climate change can be different from place to place.

REFERENCES

Aggarwal, P., S. Kumar and Pathak. 2010. Impacts of Climate Change on growth and Yield of Rice and Wheat in the Upper Ganga Basin. WWF-India and Indian Agricultural Research Institute (IARI).

Apata, T. 2006. Effect of Global Climate Change on Nigerian Agriculture. CBN Journal of Applied Statistics, 31-50.

Batisani, N. and Y. Brent. 2010. Rainfall variability and trends in semi-arid Botswana: Implications for climate change adaptation policy. Applied Geography.

Buloshi, A. S. and E. Ramadan. 2015. Climate Change Awareness and Perception amongst the Inhabitants of Muscat Governorate, Oman. American Journal of Climate Change, 330-336.

Burton, I. 1996. The growth of adaptation capacity: practice and policy. In J. Smith, N. Bhatti, R. Benioff, G. Menzhulin,, M. Budyko, M. Campos. Adapting to Climate Change: An International Perspective (pp. 55-67). New York.

CBC (Canadian Broadcasting Corporation). 2015. www.cbc.ca. Retrieved July 26, 2017, from http://www.cbc.ca/news/world/year-end-2015-natural-disasters-1.3346639.

Codjoe, F., C.Ocansey, D. Boateng, and J.Ofori. 2013. Climate Change Awareness and Coping Strategies of Cocoa. Journal of Biology, Agriculture and Healthcare, Vol 3, No 11.

CSA. 2015. Myanmar Climate-Smart AgricultureStrategy.

DMH (Department of Meteorology and Hydrology). 2017. Monthly Climatic Data for Yamèthin Township (1997-2016).Department of Meteorology and Hydrology, Myanmar.

DOA (Department of Agriculture). 2016. Agriculture Land Utilization in Yamèthin Township, Department of Agriculture, Yamèthin Township, Myanmar.

Fussel, H.M. and R. Klein. 2006. Climate Change Vulnerability Assessment. In Climate Change (pp. 301-329).

Glantz, M. 2009. Coping with a Changing Climate:Considerations for Adaptation and Mitigation in Agriculture. Rome: FAO.

Hay, J. E. 2002. Integrating Disaster Risk Management and Adaptation to Climate Variability and Change: Needs, Benefits and Approaches, from a South Pacific Perspective. In U. (. Programme, A Climate Risk Management Approach to Disaster Reduction and Adaptation to Climate Change (pp. 87-117). Havana.

Hubert, L. and J.Schultz. 1976. Quadratic Assignment as a General Data Analysis Strategy. British Journal of Mathematical and Statistical Psychology.

Idrisa, Y., B. Ogunbameru, A. Ibrahim and D. Bawa. 2012. Analysis of Awareness and Adaptation to Climate Change among Farmers in the Sahe, lNigeria. British Journal of Environment & Climate Change, 220.

IFDA (International Foodservice Distributors Association). 2012. Climate-smart smallholder agriculture.

IPCC (Intergovernmental Pannel on Climate Change). 2007. Climate change 2007: Impacts, Adaptation and Vulnerability. Cambridge University Press.

Keane, J., S. Page, A. Kergna and J. Kenan. 2009. Climate Change and Developing Countries Agriculture : An Overview of Expected Impacts, Adaptation and Mitigation Challenges, and Funding Requirements, International Centre for Trade and Sustainable Development (ICTSD). Geneva, Switzerland, and International Food& Agricultural Trade Policy Council (IPC), Washinton,DC, USA.

Kreft, S., D.Eckstein, L. Dorsch and L.Fischer. 2015. Global Climate Risk Index 2016. Germanwatch E.V.

Leiserowitz, A. and P. Howe. 2015. Climate Change Awareness and Concern in 119 Countries.

Lobell, D. and C. Field. 2007. Global Scale Climate-Crop Relationships and the Impacts of Recent Warming. Environmental Research Letters, 1-7.

Myo Win Maung. 2014. Climate Change Awareness and Farm Level Adaptation of Rainfed Farmers (Central Dry Zone) in Monywa Township, Sagaing Region, Myanmar. Master of Science Thesis, University of the Philippiles Los Baños, Philippine.

MCCA (Myanmar's Climate Change Alliance). 2015. http://myanmarccalliance.org/ en/ climate- change-basics/ what-is-climate-change/. Retrieved 3 7, 2017

MCCSAP (Myanmar Climate Change Strategy and Action Plan). 2016. Myanmar's Action Plan for Disaster Risk reduction (MAPDRR). Nay Pyi Taw: Myanmar's Action Plan for Disaster Risk reduction (MAPDRR).

Michael, E. 2009. Do Global Warming and Climate Change Represent a Serious Threat to Our Welfare and Environment? Social Philosophy and Policy Foundation. Meteorology and Geosciences, Pennsylvania State, University, USA.

Mimura, N., H. Ando and Seita. 2010. Approaches to Climate ChangeAdaptation. Japan.

Nang Ei Mon The. 2012. Impact of Climate Change on Rural Livelihoods in Pakokku Township, Magway Region, Myanmar. Master of Science Thesis, Department of Agricultural Economics, Yezin Agricultural University, Nay Pyi Taw, Myanmar.

NAPA (National Adaptation Programme for Action). 2012. Myanmar's National Adaptation Programme of Action (NAPA) to Climate Change.

Ndamani, F. and T. Watanabe. 2015. Farmers' Perceptions about Adaptation Practices to Climate Change and Barriers to Adaptation: A Micro-Level Study in Ghana. Water 2015, 7, 4593-4604; doi:10.3390/w7094593, 4593-4604.

Ngaira, J. 2007. Impact of Climate Change on Agriculture in Africa by 2030.

Pang, A. and M. Kim. 2009. Climate Change Impact on Rice Yield and Production Risk. Rural Development ; 32(2), 17-29.

PIOJ (Planning Institute of Jamaica). 2012. Climate Change Knowledge, Attitude and Behavioural Practice Survey. Jamaica.

Saw Htwe Zaw. 2012. Regional Characteristics and Disasters in Myanmar.

Smit, B. 1993. Adaptation to climatic variability and change. Canada.

Smith, B, Mcnabb and D, Smithers, 1996. Agricultural Adaptation to Climate Change; Climate Change. doi:10.1007/BF00140511, 7-29.

Theint Theint Soe Mon. 2016. Farmers' Awareness and Behavior to Climate Change in Rice-Rice Growing Area of Maubin Township, Master of Science Thesis, Department of Agronomy, Yezin Agricultural University, Nay Pyi Taw, Mandalay.

Tiwari, U. 2014. Socio-Economic Analysis of the Impact of Climate Change on Nepalese Agriculture. Margraf Publishers.

Tol, R. 1998. Adaptation to Climate Change in the Context of Sustainable Development and Equity. Global Environmentalchange, 109-123.

UNCCD (United Nations Convention to Combat Desertification). 2000. United Nations Convention to Combat Desertification.2000. National Report on theUNCCD implimentation, Union of Myanmar.

UNDP (United Nations Development Programme). 2011. Report of Addressing Climate Change Risks on Water Resources and Food Security in Dry Zone of Myanmar. United Nations Development Programme.

UNESCO (United Nations Educational, Scientific and Cultural Organization). 2014. Education for Sustainable Development (ESD) Programme.

UNFCCC(United Nations Framework Convention on Climate Change). 2012. Climate Change: Impacts.

Van, D. B. A. and H. Hawkins. 1996. Agricultural Extension.

Watson, R. and J. Corbett. 2012. An information strategy for environmental sustainability.

Wisner, B., P. Blaikie, T. Cannon and L.Davis. 2003. At Risk: natural hazards, people's vulnerability and disasters Second edition.

Yegbemey, R. N. 2014. Adaptation to climate change and sustainable agriculture in West Africa, A case study of maize farming in Benin. Margraf.

APPENDICES

Appendix 1 Monthly mean maximum temperature (°C) for Yamèthin Township

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1997	29.7	32.0	35.7	35.3	36.7	31.8	30.7	31.1	32.9	33.4	30.7	29.5
1998	31.0	33.1	36.4	38.3	36.6	34.8	31.5	32.9	33.0	34.3	33.6	31.8
1999	31.9	36.2	38.0	38.8	33.9	32.1	33.5	31.0	33.2	32.6	30.5	28.5
2000	31.1	33.0	35.4	38.6	33.1	32.5	32.6	33.1	31.9	31.6	30.5	29.5
2001	31.0	34.0	36.2	39.6	33.8	31.2	31.0	31.9	33.1	32.2	30.7	29.8
2002	30.5	34.4	36.6	38.6	34.6	32.6	31.4	31.5	31.8	33.1	29.3	28.1
2003	29.0	32.6	36.0	38.3	34.7	31.0	34.1	32.8	33.2	33.0	32.6	31.0
2004	31.4	33.5	37.1	37.5	35.0	32.4	31.9	32.2	32.2	33.9	33.6	30.8
2005	31.5	35.6	36.8	38.3	37.1	32.5	32.4	30.8	31.6	33.9	31.1	27.4
2006	30.3	34.6	37.3	36.4	34.5	33.0	31.1	31.9	32.7	32.6	32.0	29.6
2007	30.8	32.1	36.9	38.9	33.5	33.4	31.4	31.7	32.3	32.2	28.6	29.0
2008	30.6	33.0	36.9	38.7	34.0	32.5	30.8	32.4	32.1	32.6	30.5	29.3
2009	30.8	35.3	36.2	37.7	36.5	32.8	32.3	32.3	32.9	33.8	33.4	29.8
2010	31.4	34.3	36.9	40.6	38.2	33.9	33.3	32.7	32.9	31.8	42.1	28.2
2011	28.7	33.2	35.5	36.2	34.0	32.7	32.3	31.3	32.4	32.2	32.6	29.5
2012	30.5	34.8	37.0	38.0	37.7	32.7	32.0	32.0	33.3	34.1	32.6	31.1
2013	31.7	36.3	38.5	40.1	35.6	34.0	33.0	31.4	32.2	31.4	31.3	28.8
2014	31.3	34.1	38.1	38.0	37.3	35.2	33.4	32.5	34.1	33.9	33.5	31.6
2015	30.5	34.5	38.7	38.8	38.6	35.1	31.8	33.2	34.4	32.4	32.5	31.2
2016	30.9	35.2	38.4	41.7	37.4	32.6	30.7	31.1	32.8	32.4	30.4	30.4

Appendix 2 Monthly mean miniimum temperature (°C) for Yamèthin Township

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1997	11.2	12.8	19.8	21.9	24.7	23.0	23.4	23.7	23.3	22.5	20.0	15.6
1998	13.2	14.6	18.3	23.3	25.9	25.1	24.0	23.8	24.0	23.7	20.7	16.1
1999	13.6	17.5	21.1	25.2	23.8	23.6	23.9	23.2	23.3	23.1	19.1	13.8
2000	13.2	15.7	18.3	24.8	23.6	23.7	23.6	23.6	23.2	23.3	18.1	13.8
2001	12.1	16.3	21.7	25.7	24.0	23.2	23.3	23.7	23.5	23.3	18.8	15.1
2002	13.4	14.8	20.1	23.5	23.9	23.8	23.4	23.5	23.5	22.8	20.6	15.6
2003	14.3	15.1	18.5	24.0	23.6	23.4	24.1	23.5	23.8	23.6	17.3	15.9
2004	13.0	14.5	19.3	23.5	24.1	24.3	23.3	23.8	23.5	22.2	19.2	14.2
2005	13.2	15.5	21.9	24.2	24.6	24.2	24.0	23.6	23.5	23.6	19.4	16.5
2006	13.5	14.4	19.2	22.1	23.1	23.3	21.4	19.2	19.5	19.5	17.9	14.0
2007	12.9	14.9	18.4	24.4	23.8	24.2	23.8	24.0	24.2	23.3	20.4	14.2
2008	13.3	13.8	19.2	24.6	24.2	24.1	23.0	23.2	22.7	22.2	16.4	12.2
2009	13.6	13.9	18.3	23.2	24.5	23.3	23.7	23.3	23.2	23.3	19.5	13.4
2010	13.7	15.4	21.8	24.8	25.9	24.3	23.3	23.5	23.1	22.5	18.4	14.6
2011	14.0	13.8	19.9	22.9	22.5	23.3	22.9	22.8	22.6	22.8	17.6	15.0
2012	12.9	15.1	19.9	24.1	25.1	23.5	23.6	23.3	23.5	22.3	20.9	14.2
2013	13.4	17.3	21.4	25.2	23.1	22.2	21.6	21.4	20.8	21.1	19.3	14.0
2014	12.1	15.4	18.5	23.9	24.2	24.6	23.9	23.4	23.1	21.6	18.1	14.0
2015	14.0	13.0	19.6	23.3	25.7	24.1	22.9	23.7	24.0	23.1	19.3	14.2
2016	10.9	15.4	20.8	25.6	24.8	24.1	24.0	23.8	23.5	23.4	18.7	16.3

Appendix 3 Monthly rainfall (mm) for Yamèthin Township

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1997	0	0	21	28	108	207	232	160	93	17	37	6
1998	0	0	18	17	65	30	74	85	224	16	27	0
1999	0	4	2	36	104	133	50	164	233	211	46	0
2000	0	0	15	1	172	54	49	73	224	159	0	0
2001	0	0	9	0	253	85	82	167	117	145	4	2
2002	3	0	0	22	194	141	56	95	217	95	219	1
2003	7	13	0	16	130	168	22	88	123	235	0	0
2004	0	0	0	3	215	54	89	90	130	101	7	0
2005	0	0	16	49	100	189	61	209	295	82	38	95
2006	0	0	23	48	161	68	167	89	316	97	11	0
2007	0	10	0	6	227	70	126	210	81	257	87	0
2008	8	0	3	49	125	150	101	27	126	246	0	1
2009	0	0	7	4	125	52	42	99	88	105	0	0
2010	0	0	0	10	75	58	105	91	189	236	4	78
2011	48	1	5	94	64	155	69	238	106	247	5	35
2012	3	0	0	49	19	71	52	96	150	44	29	13
2013	1	0	0	0	151	165	51	184	220	151	21	1
2014	0	2	0	104	146	192	119	282	159	60	21	0
2015	45	0	2	47	75	76	174	84	204	129	1	2
2016	3	0	0	2	224	199	509	230	272	202	75	0

Appendix 4 No of rainy days for Yamèthin Township

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JULY	AUG	SEP	OCT	NOV	DEC
1997	0	0	2	3	5	14	15	12	9	5	3	1
1998	0	0	2	3	9	4	10	8	15	4	1	0
1999	0	1	1	4	12	7	6	16	10	9	3	0
2000	0	0	2	0	15	9	7	4	12	9	0	0
2001	0	0	1	0	13	14	11	10	9	8	0	1
2002	1	0	0	2	11	9	7	10	13	5	10	0
2003	1	2	0	2	11	13	5	6	11	9	0	0
2004	0	0	0	1	10	11	13	10	10	4	1	0
2005	0	0	1	4	4	12	7	15	18	7	4	8
2006	0	0	1	7	8	9	15	13	13	6	2	0
2007	0	2	0	1	15	6	13	11	11	13	4	0
2008	1	0	1	2	11	8	10	3	13	12	0	0
2009	0	0	1	1	10	6	7	12	11	8	0	0
2010	0	0	0	1	7	10	12	10	14	15	1	3
2011	2	0	2	7	10	11	9	14	8	9	1	5
2012	0	0	0	6	4	8	9	6	7	4	6	2
2013	0	0	0	0	13	13	5	12	13	8	2	0
2014	0	1	0	7	9	11	6	18	7	4	2	0
2015	3	0	1	3	3	9	13	12	9	8	0	1
2016	0	0	0	0	9	13	17	19	15	15	6	0

Appendix 5 Map of Yamèthin township