



**CONTRIBUTION OF LIVELIHOOD DIVERSIFICATION TO CLIMATE
CHANGE ADAPTATION IN BORICHA WOREDA, SIDAMA ZONE,
SOUTHERN ETHIOPIA**

MSc. THESIS

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**HAWASSA UNIVERSITY
COLLEGE OF AGRICULTURE**

HAWASSA, ETHIOPIA

August 2020

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M.Sc. THESIS

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**A THESIS SUBMITTED TO HAWASSA UNIVERSITY,
PROGRAM OF CLIMATE CHANGE AND SUSTAINABLE
AGRICULTURE, COLLEGE OF AGRICULTURE, SCHOOL OF
GRADUATE STUDIES, HAWASSA UNIVERSITY,
HAWASSA, ETHIOPIA**

**IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE
DEGREE OF MASTER OF SCIENCE IN CLIMATE CHANGE AND
SUSTAINABLE AGRICULTURE**

August 2020

ADVISORS' APPROVAL SHEET

SCHOOL OF GRADUATE STUDIES

HAWASSA UNIVERSITY, COLLEGE OF AGRICULTURE

(Submission Sheet-1)

This is to certify that the thesis entitled **“Contribution of Livelihood Diversification to Climate Change Adaptation: The case of Boricha woreda”** submitted in partial fulfillment of the requirements for the degree of Masters of Science in Climate Change and Sustainable Agriculture, Hawassa College of Agriculture, and is a record of original research carried out by Asrat Adiso under our supervision, and no part of the thesis has been submitted for any other degree or diploma.

Therefore, the assistance and help received during the courses of this investigation have been duly acknowledged. Therefore, we recommend that the student has fulfilled the requirement, and hence hereby can submit the Thesis to the Program.

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ACKNOWLEDGEMENTS

First of all, I would like to express my sincere appreciation and gratitude to my advisors; Endalew Addis (PhD) and Demelash Kefale (PhD) for their guidance, inspiring suggestions and enthusiastic encouragement I received throughout the research work. Without their tremendous support and opportunities, this thesis would not have been possible. I would like to thank the Boricha woreda offices of agricultural and rural development for their logistical support, time and opinions they shared during the field work.

My special note of appreciation also goes to the extension officers, who were facilitating the focus group discussions with farmers. In addition, I thank the Ethiopian National Meteorological Agency database administrator, for allowing me special access to metrological data. I gratefully acknowledge my employer (Aroresa woreda), for providing me financial support throughout my work. I am extremely grateful to my best friends Shemelis Temesgen ,Melese Dike and Tsige Fiseha for their constant support and suggestions throughout my work. Lastly, I would like to thank my family for their entire unconditional love, support and encouragement throughout my career.

STATEMENT OF AUTHOR

I declare and affirm that this thesis is my work and all sources of materials used for this thesis have been fully acknowledged. This thesis has been submitted in partial fulfillment of the requirements for M.Sc. degree at the Hawassa University college of Agriculture and is deposited at the University Library to be made available to borrowers under rules of the library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate.

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DEDICATION

I am entirely indebted to my family, for making me what I am today. They born me, raised me, and supported me, in the hardest of times. To them I dedicate this thesis manuscript!

ABBREVIATIONS

CSA	Central Statistical Agency
CV	Coefficient of Variation
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
FGD	Focused Group Discussion
GDP	Gross Domestic Product
IFAD	International Fund for Agricultural Development
IPCC	Intergovernmental Panel on Climate Change
KII	Key Informant Interview
MoA	Ministry of Agriculture
MNL	Multi Nominal Logit Model
NAPA	National Adaptation Programme of Action
NMSA	National Meteorological Services Agency
NGO	Non-Governmental Organization
SNNPR	Southern Nation Nationalities and Peoples Region
SPI	Standard Precipitation Index
SPSS	Statistical Package for Social Sciences
TLU	Tropical Livestock Unit
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
WMO	World Meteorological Organization

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Contribution of Livelihood Diversification to Climate Change Adaptation in Boricha Woreda, Sidama Zone, Southern Ethiopia

Asrat Adiso (BSc), Endalew Addis (PhD) and Demelash Kefale(PhD)

Abstract

Climate change remains the major threat for livelihood of smallholder farmers in Ethiopia. This study addresses the contribution of livelihood diversification to climate change adaptation in Boricha woreda, Sidama zone, Ethiopia. Multi-stage sampling techniques were used to select 185 households. Primary data were collected using household surveys, key informant interview and focus group discussion. Secondary data were obtained from National Meteorological Agency (climatic data: rainfall and temperature for the period of 1981-2017), published and unpublished sources. Both descriptive statistics and multi-nominal logit model (MNL) were used to analyze the collected data. The results of the study revealed that 96.3% of sample household farmers in Boricha woreda are aware of the occurrence of climate change which manifests itself as changes in temperatures and precipitation patterns. About 89.5% of the farmers indicated temperature was increasing and 88.2% replied that the amount of rainfall was decreasing. Moreover, the finding of the meteorological data reveals that, the average temperature of the woreda shows an annual increment by 0.077°C in the past 36 years. Similarly, there is declining trend of annual rainfall (12.84mm) in the same period with higher inter seasonal variability. The study also revealed that, climate change has affected livelihood components of the community: resulted from low crop productivity (62.2%), crop disease incidence (58.4%), less pasture/grass for livestock (55.1%), loss of income (54.05%), livestock disease incidence (52.2%) and drying river (48.1%) causing increase in rural-urban migration. Consequently, households are forced to diversify their livelihood such as; crop-livestock integration and other best practices (84%), agro forestry practices (55%), non-farm activities (31%), off-farm activities (22%), Change from farming to non-farming (9.7%), and migration (8%), while 6% of them still remain with their business as usual. Regarding the advantages gained from livelihood diversification under climate change; 76.7% of the households claimed that, the diversification has increased their income source, 57.8% ensured food security, 55.6% reduced environmental problem, 53.5% increased household asset and 47.5% reduced risk vulnerability. Results concerning factors affecting livelihood diversification: age, family size, education, farm size, livestock ownership, information about climate change and distance from market were found significantly at ($p < 0.05$) affecting the probability of diversifying livelihood activities. Whereas sex, credit service, extension service and saving of households didn't significantly affected the livelihood diversification in study area. Therefore, development practitioners should pay more attention to those factors which are significantly affecting livelihood diversification before any socioeconomic intervention measures endeavor.

Key words: Climate change, Livelihood diversifications, Multi-nominal Logit Model

CHAPTER ONE

1. INTRODUCTION

1.1. Background of the study

Global climate change alters normal climate variability in various regions, resulting in adverse effects on socio-economic systems throughout the world (Chambwera& Stage, 2010). Similarly; climate change is often recognized as the prime stressor on livelihoods and particularly in the 21st Century and in the developing countries where it can impact on what has been developed for a long time. The impacts of climate change are inevitable across the globe; the weather patterns are shifting, and sea levels are raising leading to increased flash floods and food insecurity (Connolly-Boutin&Smit, 2015).

In developing countries, the impacts of climate change pose major development challenges including retardation and possible reversal of current developmental gains (Chambwera& Stage, 2010). Consequently, many developing countries have experience energy; water and food stress (Intergovernmental Panel on Climate Change, 2007). The impacts may be felt at various economic scales and more so at the micro-economic level, including local communities and poor households (Paavola&Adger, 2006).

Developing countries are the net recipients of climate change impacts, but have limited capacity to adapt (Nianget *al.*, 2007).Additionally, farming as a primary source of income has failed to guarantee sufficient livelihood for most farming households in developing countries and the agricultural development policies have largely produced little improvement, especially in SSA (Babatunde, 2013).This is because the agricultural sector in the SSA is highly characterized by decreasing farm sizes, low levels of output per farm, and a high degree of

subsistence farming and highly variability of climate in the region (Jirstromet *al.*, 2011).In SSA, poverty reduction through increasing agricultural productivity and access to key agricultural resources could not be successful since it excludes non/off-farm livelihood diversification (Emmanuel, 2011).

For these reasons there is a strong consensus that any development intervention to improve the livelihood and food security situation of the rural poor need to take agriculture along with the non/off-farm livelihood diversification, without undue preference being given to farming as the unique solution to rural poverty. Non/off-farm livelihood diversification is a natural starting point for poor rural producers with low levels of capital, who may be able to restructure their production mix more easily than to invest in other non-agricultural areas (Smith *et al.*, 2000).In addition in sub- Saharan Africa, most poor households depend on the natural environment for their livelihood activities (Ellis, 2000a). The extent to which household livelihood activities are diversified determines household ability to adapt to shocks and to accumulate sufficient income to move out of poverty (Ellis & Freeman, 2005).

For rural households in the developing countries of Africa and south-east Asia, livelihood diversification is a strategy for meeting household consumption needs, for generating additional income, and for coping with or adapting to the impacts of environmental and economic shocks (Anderson &Deshingkar, 2005).

Livelihood diversification as a strategy involves the attempt by individuals and households to find new ways to raise income and reduce environmental risk, which differs sharply by the

degree of freedom of choice (to diversify or not), and the reversibility of the outcome (Ellis, 2000).

In Ethiopia, semi-arid rural households are susceptible to the impacts of climate variability including flood and drought-related shocks, such as extreme flooding and river desiccation. Although livelihood studies have been conducted in developing countries, including Ethiopia, there is lack of in-depth knowledge on the extent to which adaptive strategies such as livelihood diversification can buffer households from the impacts of shocks.

The study area (Borichaworeda) is in one of the areas severely affected by drought in the Sidama Zone. Land fragmentation, loss of soil fertility, limited access to safe drinking water, and droughts are the factors that affect agriculture and livelihood in study area. Most parts of the district are predominantly food insecure due to the reliance on irregular rainfall.

The modification of livelihood strategies, agricultural practices and productivity in order to cope with climate change will be imperative in order to meet and continue meet sustainable livelihood. In generally to improve knowledge on household livelihood diversification and its contribution to household adaptation to climate change in the study area, in Boricha woreda, Sidama zone.

1.2. Statement of the problem

The issue of climate change vulnerability and adaptation strategies have drawn a great attention from policy makers and academicians for last decades. In view of that, a number of studies have been done at regional and country levels to estimate economic effects of climate change on livelihood and factors affecting diversification strategies (Deressa *et al.*, 2008).

Current climate change is already imposing a significant challenge to Ethiopia by affecting agriculture, water and range resources, energy supply, poverty reduction and sustainable development efforts, as well as by causing natural resource degradation and natural disasters (EPA, 2011).

The most pronounced problems are recurrent drought, floods, famine and lack of food security. High vulnerability to climatic risks is linked to dependence on climate-sensitive livelihoods, low economic development, low service coverage, underdeveloped water resources, inadequate road infrastructure, low adaptive capacity, and weak institutions. Dependence on undiversified livelihoods based on rain-fed agriculture means that production is sensitive to fluctuations in rainfall (Muluneh *et al.*, 2015).

Within the same framework, SNNPR region have been experiencing climate change. In the last decade, average annual minimum temperature of the SNNPR region had risen by 0.4⁰c (NREPA, 2012) above the national 0.37⁰c (MoWRNMA, 2007). This shows the seriousness of the problem in the region.

Sidama Zone is a typical case in this regard. Sidama's smallholder farmers are heavily vulnerable to shocks, yet their perceptions and vulnerability are largely undocumented and least studied (Seyoum, 2014). The most severely affected areas in the Zone are semi-arid and dry areas, particularly Boricha Woreda.

The study area, Boricha *woreda*, is located in the semi-arid region of Great Rift Valley in Southern Ethiopia and has been experienced drought and excessive flooding for several years (Bewketet *et al.*, 2015). As a result, the area is characterized by seasonal failure of crop yields,

as well as, long term reduction of agricultural productivity, diversified income sources is poor, feed shortage for livestock and shortage of potable water. Furthermore, under extreme climatic conditions many areas of the *Woreda* were abandoned from production and people forced to remain under safety net and food aid programs (BWOANR, 2014).

Few available climate-related studies (Melese , 2018 &Tsegaye, 2014) examined adaptation in other parts of Sidama zone. Only the study of Shemelis (2019) examined climate change adaptation in mixed crop livestock production Boricha woreda, but this study restricted only in some parts of study kebeles and fails to cover the information in relation to climate change and livelihood diversification thoroughly in the Boricha woreda. Thus, none of these studies looked at the contribution of livelihood diversification to climate change adaptation in the Boricha woreda to fill these existing knowledge gaps.

1.3. Objectives of the Study

1.3.1. General objective

General objective of the study is to identify the livelihood diversification practiced by farmers and its contribution to climate change adaptation in Boricha district, Sidama Zone, SNNPRS, Ethiopia.

1.3.2. Specific objectives

- To analyze trends of climate variability in terms of temperature and rainfall in the study area
- To identify different livelihood diversification strategies adopted by farm households in response to climate change in Boricha district

- To explore the role of livelihood diversification by smallholder farmers to climate change adaptation in Boricha district
- To identify factors that affect the adoption of livelihood diversification strategies in the study area

1.4. Research Question

- What are the trends of local climate variability (Temperature and annual rainfall) in the study area?
- What are the livelihood diversification strategies adopted by farm households in response to climate change in Boricha?
- What are the roles of livelihood diversification to climate change adaptation in the study area?
- What are the factors affecting adoption of livelihood diversification strategies in the study area?

1.5. Significance of the Study

The study would try to identify the contribution of livelihood diversification to climate change adaptation strategies to increase the diversification pattern of households. In the developmental endeavors of different regimes in modern Ethiopia, climate change as an issue has attracted the attention of policy makers. It is the key sector in the current government's development strategy because Agricultural Development Led Industrialization (ADLI) is the national economic policy of the country. Thus, the topic of this and its findings have woreda and zonal importance. It is also one of the critical topics in the areas of development studies as a discipline.

Specifically, the importance of this study is to uncover the real challenges for farmers in the areas of agricultural production and related climate change adaptation as well as livelihood diversification, which eventually leads to increase total income of households. Since the study would be contain with both theoretical and conceptual issues, a person who is interested on the area can get both qualitative as well as quantitative information from the document. Furthermore, the study can serve as a basis for further researches on the area.

Farmers have a number of livelihood diversification strategies that they practice for their means of subsistence. In order to improve adaptation potential for climate change of households these include among others: agricultural diversification, participating in different activities outside agriculture and income from remittance transfer etc. Furthermore, understanding values, beliefs and attitudes of these farmers would gave a holistic view for promoting adaptation strategies to climate change in order to ensure resilience within the farming system.

1.6 Scope and Limitations of the Study

The study was delimited to assess the contribution of livelihood diversification to climate change adaptation for smallholder rural farm households in four *Keble* administrations of Boricha *Woreda*. The unit of analysis for this study was the household. However, according to literatures the household is not a homogeneous unit; rather, it has different members who have different roles, responsibilities; and have different opportunities for livelihood diversification.

CHAPTER TWO

2. LITERATURE REVIEW

2.1. Basic concepts

Climate change: - refers to a change in the state of the climate that can be identified (*e.g.* by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcing such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic changes in the composition of the atmosphere or in land use. Human influence on the climate system is clear and recent anthropogenic emissions of greenhouse gases are the highest in history (IPCC, 2014).

Climate variability: -Variations in the mean state and other statistics (such as standard deviations, the occurrence of extremes, etc.) of the climate on all temporal and spatial scales beyond that of individual weather events. The term is often used to denote deviations of climatic statistics over a given period of time (*e.g.* a month, season or year) from the long-term statistics relating to the corresponding calendar period. In this sense, climate variability is measured by those deviations, which are usually termed anomalies. Variability could be due to natural internal processes within the climate system (internal variability), or to variations in natural or anthropogenic external forcing (external variability) (IPCC, 2007b, WMO, 2014).

Climate change adaptation: refers to the process of responding and adjusting to actual or potential impacts of changing climate conditions in ways that moderate harm or take advantage of any positive opportunities from climate change. In other words, adaptation represents a process through which people reduce the adverse effects of climate variability on their health

and wellbeing and take advantage of the opportunities that their climatic environment provides (Burton, 1992 quoted in Smit *et al.*, 2000).

Livelihood: - A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks maintain or enhance its capabilities and assets, while not undermining the natural resource base (Chambers and Conway, 1992).

Livelihood attempts to capture not just what people do in order to making a living, but the resources that provide them with the capability to build a satisfactory living, the risk factors that they must consider in managing their resources, and the institutional and policy context that either helps or hinders them in their pursuit of a viable or improving living (Ellis and Freeman, 2005).

Livelihood diversification: - refers to attempts by individuals and households to find new ways to raise incomes and reduce environmental risk, which differ sharply by the degree of freedom of choice (to diversify or not), and the reversibility of the outcome. Livelihood diversification includes both on- and off-farm activities which are undertaken to generate income additional to that from the main household agricultural activities, via the production of other agricultural and non-agricultural goods and services, the sale of waged labour, or self-employment in small firms, and other strategies undertaken to spread risk; included in this are what has been termed- 'activity or environment diversification' in agriculture (Carter 1997).

2.2. Theoretical framework

The study would be use a livelihood framework theory to conceptualize and understand the livelihood processes in the study area. Livelihood frameworks are often used by researchers to document and analyze the processes by which individuals and households utilize their resources as opportunities to make a living in particular socio-economic and institutional contexts (Scoones 1998; Carney 1998; Ellis 2000; Shanmugaratnam 2008; Hand and Zoomers2005).

A livelihood is defined as comprising ‘the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household’ (Ellis 2000:10). Put simply, a livelihood is a living gained using endowments (assets), activities and opportunities. Individuals and households, using their endowments, engage in different activities within the bounds of the opportunity structures presented by a particular set of mediating factors (environmental, institutional, infrastructural, technological and socioeconomic) as depicted in for the study area. The mediating factors may facilitate or inhibit the livelihood process thereby influencing the nature of the livelihood outcome (Shanmugaratnam 2008; Haan and Zoomers 2005).

Hence, one’s endowments and the mediating factors determine the kind of livelihood obtained by the individual or the household. It is also important to note that a livelihood outcome impacts directly on endowments. A successful livelihood outcome may help to strengthen endowments, while failure could lead to depletion or loss of endowments. According to Anderson & Deshingkar (2005), the causes of diversification are mainly explained by the asset-based and insurance-based theories. The former state that the diversity of a household livelihood portfolio is determined by the assets which accrue to a household.

The latter explain livelihood diversification as a strategy for ameliorating the adverse effects of income shocks and that its demand is directly related to the extent to which a household is risk averse (Anderson & Deshingkar, 2005).

Using the household model and other analytical frameworks, Ellis (2000b) and Barrett *et al.* (2001) identified six determinants of diversification as, a) seasonality, where households diversify their incomes through labour switching from low to high return activities, b) risk, where households engage in a number of livelihood activities to spread risk and avert failure, c) labour markets, which may push migrants from poorly developed markets to active labour markets in urban areas, d) credit market failures, which compel rural Households to engage in income earning activities to obtain access to finance) asset strategies, which enhance future livelihood strategies and may lead to temporary livelihood diversification, and) coping behavior, which may lead to the creation of new livelihoods or alter future patterns.

In the pursuit of livelihoods, households diversify their income sources, while simultaneously adopting strategies that increase production, avoid or minimize harvest loss, and increase their access to key resources. Farm activities comprise crop and livestock production and the income derived there from. Farmers often diversify on-farm activities (in terms of crop livestock mix and crop diversity) to spread risks (mainly against climate hazards and price changes) and to meet their consumption and marketing needs. Widening income sources by engaging in diverse off farm and non-farm activities is essential as farming alone fails to provide an adequate means of survival (Ellis 2000). Off-farm income includes wages or payment in kind obtained by working on other farms and income from the sale of natural resources, while non-farm income includes income from non-agricultural sources such as petty trade, rural non-farm employment, handicrafts, public support and remittances (Ellis 2000). It is important to note that farm, off-farm and non-farm activities

complement each other. Farm income can provide the capital needed to initiate and expand non-farm activities, while off-farm and non-farm activities can contribute to farm productivity by providing finance for farm input purchases and investment (Reardon, Crawford and Kelly 1994). Similarly, failure in one category of activity will have a negative impact on the other types of activities and the rural economy of developing countries is not based solely on agriculture but rather on a diverse array of activities and enterprises. Hence, the concept of livelihood diversification has been becoming the dominant thinking as a survival strategy of rural households in developing countries (Chapman and Tripp, 2004).

Besides diversification, households also engage in adaptation activities in order to enhance existing security and wealth, or to reduce vulnerability and poverty (Davies and Hossain 1997:5). This involves promoting land and soil quality, adopting drought tolerant and fast maturing varieties, spreading risks by diversifying income sources, increasing access to resources, entering into formal and informal risk sharing arrangements, and building family and kin support bases. Climate variability and uncertainty for years have prompted farming communities to adapt to dynamic environmental and weather conditions. The maintenance of a diversified resource or income base is a prerequisite for adaptation to climate variability as it helps reduce vulnerability by spreading risk (Kelly & Adger, 2000). Diversified livelihood systems also allow farming communities to draw on various sources of food and income and reduce vulnerability to climate change. In this context that already has diversified livelihoods are less vulnerable to climate change or other factors which adversely influence their livelihoods and will have higher chances to successfully cope with future climate change than others (Macchi et al., 2008).

2.3. Trends of climate change and variability

Climate is changing more rapidly than ever before. The evidence comes from direct measurements of rising surface air temperatures, ocean temperatures and from phenomena such as increase in sea levels, retreating glaciers, and changes to physical and biological systems. The existence of greenhouse gases in the atmosphere is vital to life on Earth in their absence; average temperature would be about 30⁰c lower than they are today (IPCC, 2001a).

The report of IPCC (2001a) shows that, human activities are causing atmospheric concentration of greenhouse gases including carbon dioxide, methane, troposphere ozone, and nitrous oxide to rise well above pre industrial level.

According to the IPCC (2001a) report, the atmospheric concentration of CO₂ and ozone has increased by 35% each from the pre-industrial level. The global average temperature has increased by about 0.6⁰C and the concentration of methane has increased by 151%. The atmospheric concentration of carbon dioxide in 2005 exceeds by far the natural range over the last 650 000 years (180 to 300ppm). It is predicted that the global mean annual surface temperature will increase by 1-3.5 0c by 2100 and the global sea level will rise by 15-95 cm, and change in the spatial and temporal patterns of precipitation would occur (IPCC, 1996).

The historical climate record for Africa shows warming temperature of approximately 0.7⁰C over most of the continent during the twentieth century; a decrease in rainfall over large portions of the Sahel (the semi-arid region south of the Sahara); and an increase in rainfall in east and central Africa. Over the twenty first century, this warming trend, and changes in precipitation patterns are expected to continue and be accompanied by a rise in sea level and an increased frequency of droughts and floods (Intergovernmental Panel for Climate Change [IPCC], 2001). The report shows an increase in temperature in all the

regions of sub-Saharan Africa. The same source predicts an increase in precipitation of 2% in West Africa and 7% in East Africa, but a decrease of 4% in southern Africa.

However, other sources have predicted a general decrease in precipitation and water availability. For example, Shiklomanov (1997) shows that between 1970 and 1995, Africa has experienced a 2.8 times decrease in water availability, and that the average discharge of West African rivers has dropped by 40-60% since 1970. Undresses scenarios, Arnell (2004) projects that by the year 2025 about 370 million African people will experience increases in water stress, while about 100 million people are likely to experience a decrease in water stress by the year 2055, as a result of a likely increase in precipitation. In the Nile region, most scenarios of water availability estimate a decrease in river flow up to more than 75% by the year 2100, with implications for agriculture and conflict (Nyong, 2005).

In Ethiopia, Studies indicate that mean temperature and precipitation have changed over time. According to NMSA (2001), the average annual minimum temperature over the country has increased by about 0.25⁰C every 10 years, while the average annual maximum temperature has increased by about 0.1⁰C every decade. The average annual rainfall of the country showed a very high level of variability over the past years, even though the trend remained more or less constant (NMS, 2007). Over the past 60 years, some of the years have been characterized by dry rainfall conditions resulting in droughts and famine whereas the others are characterized by wet conditions. Droughts in Ethiopia can shrink household farm production by up to 90% of a normal year output (World Bank, 2006). Most often, many farmers die of hunger or depend on foreign food aid during extreme drought periods. For instance, during the 1983/84 drought periods, about one million people died due to drought that led to famine. Many households have also been affected during drought periods over different years in the same venin (World Bank, 2006).

2.4. Livelihood Diversification

Livelihood diversification is often defined as the process by which rural households construct a more diverse range of activities to survive and improve their standard of living. It involves the maintenance and continuous shifting of a range of activities and occupations (Meert *et al.*, 2005). Diversification also refers to an increase in the sources of income and the balance between different sources (Ellis, 2000). Accordingly, a household with one source of income would be less diversified than a household with two sources of income, and a household with two income sources, each contributing equal share of the total would be more diversified than a household with one source accounting for 90 percent of its income and the second only for 10 percent (Joshi, 2002 as cited in Minot, 2006:5).

The term income diversification is mostly used in connection with livelihood diversification for ease of analysis and interpretation. However, Ellis (1998) makes a distinction between the two and defines income diversification as the composition of household income at a given point in time while livelihood diversification is considered as an active social process involving engagement in increasingly complex portfolio of activities overtime.

According to (Barrett *et al.*, 2001) diversification is mostly measured by using income earned from different activities/sources. Income allows a clear interpretation of results as it comprises both cash and in-kind contributions to household welfare. Similarly, DFID (2001) define livelihood diversification as an increasing multiplicity of activities, or it can refer to a shift away from traditional agriculture to non-traditional activities. In this context livelihood diversification strategies are conceptualized as getting income from on-farm plus off-farm or on-farm plus non-farm or a combination of three (on-farm, off-farm, and non-farm). In low income countries, rural households pursue diverse livelihood strategies to derive income from a wide range of sources such as farm, off-farm and non-farm activities (Ellis, 2000).

Ellis (1998) distinguishes three different categories of income sources— farm, off-farm and non-farm. Farm income source include income earned from crop and livestock production, including own consumption and sales. Off-farm income mainly refers to wage or exchange of labour in cash or in-kind away from one's own land within agriculture. It also includes some self-employment in natural resource extraction activities. Non-farm income broadly comprises of the following non-agricultural income sources— rural non-farm wage employment, self-employment (own business), property income (from rents) and remittances and transfers.

In above context that already has diversified livelihoods are less vulnerable to climate change or other factors which adversely influence their livelihoods and will have higher chances to successfully cope with future climate change than others (Macchi et al., 2008). Most of the time, subsistence oriented farmers operate in less-favored production environments and often lack most types of productive assets. Even though they are operating outside of the market and are prone to high levels of poverty and food insecurity, they have varied types of livelihood strategies (World Bank, 2006).

Household livelihoods and the strategies they use to obtain their household income are at the center of development. However, the livelihood strategies that they develop to ensure their livelihoods will depend on how they can combine their livelihood assets, taking in to account the vulnerability context in which they live, and the policies, institutions and processes that affect them (Ellis, 2000).

Livelihood strategies are the combination of activities that people choose to undertake in order to achieve their livelihood goals (Haidar, 2009). The same source states that the choices of strategies are a dynamic process in which people combine activities to meet their changing needs. For example, in farming households, activities are not necessarily confined

to agriculture but often include non-farm activities and migrations whether seasonal or permanent in order to diversify income and meet household needs. Livelihood strategies are diverse at every level. Individuals themselves may rely on a range of different income generating activities at the same time, and are likely to be pursuing a variety of goals. Hence, livelihood strategies are the full portfolio of livelihood activities, which involves different combination of income generating activities, uses of assets and choices about investing money in assets.

Rural households earn income from diverse allocations of their natural, physical and human capital assets among various income generating activities. Among these might be diminishing returns on increasing investment in certain activities, missing markets that compel self-provision of goods or services the household desires for own consumption. Similarly, households may wish to diversify as a strategy for coping with an unexpected shock, or to minimize risk by participating in activities that generate imperfectly correlated returns. The presumption is that households choose such patterns of diversification in order to achieve the best possible standard of living (Brown *et al.*, 2006).

Livelihood diversification can be different on the basis of location, assets, income levels, opportunities, institutions and social relations. As a result, diversification is different under different circumstances (Ellis, 2000). However, livelihood diversification determinants can be classified into two broad categories i.e. pull and push factors (Barrett *et al.*, 2001). Push factors such as rural population growth, farm fragmentation and declining agricultural productivity are commonly-cited causes for diversification (Degefa, 2005).

On the other hand, proximity to the market, availability of roads, and the existence of comparative advantages, are pull factors (Barrett *et al.*, 2001). Degefa (2005) also found in Oromiya Zone the main discouraging factors for expanding non-farm income earning

activities which includes notably the lack of waged labour opportunities, lack of initial financial capital, limited knowledge and skills, lack of raw materials, and limited markets.

2.5. Contribution of Livelihood Diversification to Climate Change Adaptation

The participation of rural farm households in different livelihood strategies could improve the total incomes of smallholder farm households. Participation of households into off-farm activities have a potential to improve the living standard of the poor and hence have a greater tendency in reducing income inequality, as it is important source of income for the poor society (Woineshet, 2010).

The importance of income generated from off-farm activities in rural Ethiopia is increasing through time. Furthermore, in confirming the importance of livelihood diversification in addition to agriculture, growth of non-farm rural income generating activities offers important opportunities to reduce rural poverty (Minot *et al.*, 2006).

Moreover, diversification of income sources has positive effect on the livelihood of rural households and reduces their poverty situation. Income diversification is the key for risk management and it could help vulnerable households to meet and smoothing their consumption needs, social and labour needs and improve households' income (Adugna, 2012).

World Bank, (2009) stated that in addition to agriculture, growth of non-farm rural income generating activities offers important opportunities to reduce rural poverty. Several studies made on rural livelihood diversification in Ethiopia also reflect some of the differing impacts of diversification. For instance, Demissie and Workneh (2004) in their study of household choice of diversification in southern Ethiopia found out that while diversification has a positive outcome for maintaining household consumption, it largely fails to improve

household economic conditions due to the diversion of income earned from off-farm and non-farm activities to consumption rather than investment in critical assets or cash crop production. In terms of the contribution of types of diversification strategies, non-farm activities can have more positive implications for livelihoods than activities that are tied to farming (Sabates-Wheeler *et al.*, 2008).

For example, certain non-farm activities those have different risk profiles than farming such as trade or migration can be important sources of cash for the purchase of necessary food and non-food items from the market and enhance the food security of households in lean seasons (Yared, 1999). The positive role of non-farm activities and income is also evidenced by a study made on the determinants of adaptation to climate change in Ethiopia and South Africa by (Bryan *et al.* 2009). Next to basic household and demographic characteristics, mainly education and age, non-farm income is identified as having the most positive effect in encouraging adaptation options in agricultural livelihoods.

2.6. Determinants of livelihood diversification strategies

This section examines factors which constrain livelihood diversification among rural Households. These include: age, gender, education, credit access, saving, extension service and livestock holding and etc.

Reardon (1999) addressed the importance of education and skills as determinants of business start-ups and wages earned off-farm in Africa. Better-educated members of rural populations have better access to any non-farm employment, and are also more likely to establish their own non-farm businesses. Better educated individuals are more likely to migrate to take up employment opportunities in other areas, as they have greater chances of success than their less-educated or uneducated counterparts. Human capital such as age, skills, education broadens the set of employment and entrepreneurial options for individuals. Household age

composition (usually assessed in the form of dependency ratios) and education levels are an often-cited measure of human capital used empirically to explaining the degree of participation across a wide range of income groups in the rural non-farm economy (Gordon, 1999). Gordon (1999) cited literatures that indicated the inverse relation of age with participation in non-farm work.

The other factor that determines rural households and individuals wishing to start a business, whether in the farm or non-farm sector, is access to capital or credit. Without start-up funds, or with only little cash available for investment, households are limited to a small number of activities which yield poor returns, partly because of the proliferation of similar low entry barrier enterprise.

Gender is a significant factor determining access to RNF opportunities. As Griffith with his colleagues informs the majorities of the poor in sub-Saharan Africa are women and have greater need for the income that can be secured through involvement in the non-farm sector. But as he noted women have long been constrained in the activities in which they are permitted or able to participate, by tradition, religion, or other social norms (Griffith *et al*, 1999 cited in Gordon and Craig, 2001). The result of Hag blade and his research accompany as cited in Gordon and Craig (2001) indicated that women are identified as a specific group for which access to education is more limited. The effect of this, in combination with childcare responsibilities and other social expectations, means that there is greater involvement of women in the informal than the formal employment sector. Thus rural men have better opportunities to diversify their livelihood than women.

Gordon and Craig mentioned a higher level of education is positively correlated with a higher probability of participation for both husbands and wives in the RNFE, and is higher for wives than husbands (Gordon and Craig, 2001). However, a higher level of educational

attainment for a wife lessens the probability of the husband participating in the RNFE. Women's participation in non-farm work was more sensitive to a lack of household cash than their husbands' participation.

Natural capital is considered vital condition for sustainable livelihoods (Gordon, 1999). Gordon and Craig (2001) described the natural resources such as water, land and common property resources provide a foundation for farming and also for much of the RNF economy. Davis and Bezemer strongly argue that asset endowments (such as land, livestock, and real estate) and savings, i.e. wealth, as well as income levels increase the opportunity to invest in education, contacts or in productive assets that generate income either through entrepreneurship or wage labour, in particularly where there are no or poor credit markets (Davis and Bezemer, 2003). Gordon and Craig also emphasize the influence of natural capital on non-farm activities to be multiple and crucial (Gordon and Craig, 2001).

Coleman argues that personal networks help people identify and access alternative income sources by providing information, and facilitating access to natural and financial capital (Coleman, 1994 cited in Gordon, 1999). Individuals and households with better social networks have greater opportunities in the non-farm sector. Once again, this discriminates against the poorest, who suffer a lack of social networks and are, therefore, unable to capitalize on informal opportunities and remain excluded from formal support systems.

Ellis (1998) reviewed in his literature relating to diversification that in Africa, poverty can be largely explained in terms of location, and lack of access to facilities. Reardon *et al* (1998) find that the availability of low entry barrier, labour intensive jobs tends to be associated with good infrastructure, high population and market densities (which lower the per capita costs of providing infrastructure), dynamic agriculture, unequal landholdings and the development of rural towns outside metropolitan areas. Markets may be generally absent or

malfunctioning in a region (i.e. land markets, credit markets), or they may be inaccessible for people (typically the rural poor) with low social, financial or human capital. Market access is also determined by factors such as distance to markets, access to transport infrastructure and telecommunications, access to market information, the quality of goods and services produced, volumes produced, etc. Areas with better market proximity and better infrastructure can help farmers to generate farm and non-farm income from a wide range of sources (Reardon, 1999).

In general, better-off households have better opportunities to diversify their livelihoods. Swift and Hamilton (2001) noted that the poorest have fewest livelihood options and these are least likely to provide sustainable or secure outcomes. This is due to inadequate endowments of all forms of capital, including the forms of human capital which would enable them to take up opportunities, or the social networks which create opportunities. The poor often face greater institutional restrictions, through the lack of self-organization or institutionalized constraints to access livelihood resources. Increased assets can empower people to influence the policies, institutions and processes that affect their livelihoods. The wealthy households usually tend to diversify in the form of trade, shop keeping, and transport (non-farm business activities) while the poor tend to diversify in the form of daily wage laborer.

In Ethiopia diversification decision is driven by various factors and variables and its effects also vary. According to Adugna (2006), the performance of the agricultural sector in Ethiopia is weak and that preventive policies, drought, population pressure and environmental degradation are among the major bottlenecks in the development of agriculture. A study conducted by (Freduet *al.* 2006); on income diversification of rural households in Northern Ethiopia, found out that diversification strengthens income

inequality. Arise in income from non-farm income and livestock, according to their study increases income inequality. They also originate that social capital is a significant factor determining non-farm income but not so for crop income.

On the other hand, a study conducted out in three sites in southern Ethiopia, Carswell (2002) generalizes that lack of credit and lack of labour are the two key obstacles to entry for diversification activities. The key policy task identified in the study is how to find effective ways of articulating formal credit delivery and informal systems. Other key institutions identified include institutions markets around labour and natural resource tenures. The institution of caste, the traditional authority which it implies, kinship and social network are also deemed to have a serious role in living strategies of people in the study area.

Tegegne (2000) carried out a study in KachaBira and Damot Gale *Woredas* southern Ethiopia, in an attempt to examine the effect of non-farm activity on the production decision of farmers, and to classify the factors influencing non-farm activity. The study found that in the study sites the farm sector is described by shortage of land, low yield of crops shortage of draught animals and lack of grazing land. The implication made is that the farm sector is not enough to support the high density of population in the study sites. Farmers in the study sites, therefore, have exposed higher involvement in non-farm activities and income from non-farm bases play a major role in their livelihood. Those contributing in non-farm activities are found to be relatively younger and more educated. Family size was not found to be an important variable, while villages near urban centers tend to have more number of households making non-farm income and engaging in trade activities.

According to Beyene (2008), most of the sample farmers 79 % are participating in off-farm activities mainly to supplement their agricultural income, since production and productivity of agricultural sector is low, farm household's income is not sufficient even to feed their

families. Excess labour in the family and the seasonality of agriculture are factors responsible for farmers to participate in off-farm activities. Large family size results in declining farm size which in turn result in low level of per capita production and hence less income. The seasonality of agriculture causes a farm family to have excess labour during the slack season, which induces them to take on in other non-farm activities.

2.7. Conceptual framework

Rural livelihood diversification referred to the phenomenon where rural households engage in multiple activities (either on-farm or non-farm,) in order to survive and to improve their standard of living (Shahrekie and Sharifzadeh, 2015). On-farm diversification includes the introduction of new crops into farming systems or farmers investing in livestock. This is distinguished from „off-farm“ activities which generally refer to activities undertaken away from the household’s own farm such as wage employment on other farms. As indicated earlier, the „non-farm“ sector refers to those economic activities that are not primary agriculture even though they are usually related to farm activities. Regarding adaptation, a common argument is that diversifying into non-farm activities is preferable to activities tied to farming (Sabates-Wheeler *et al.*, 2008).

For example, most non-farm activities have different risk profiles from farming (such as trade, or remittances from migration) and can improve food security as they provide income during the lean seasons caused by weather variability (World Bank, 2009). For instance, the positive role of non-farm activities and income is also suggested by (Bryan *et al.*, 2009) study on the determinants of adaptation to climate change in Ethiopia and South Africa. Therefore, the literature review presented in this conceptual framework tries to link livelihood diversification practiced by farmers and its contribution to adapt climate change and variability.

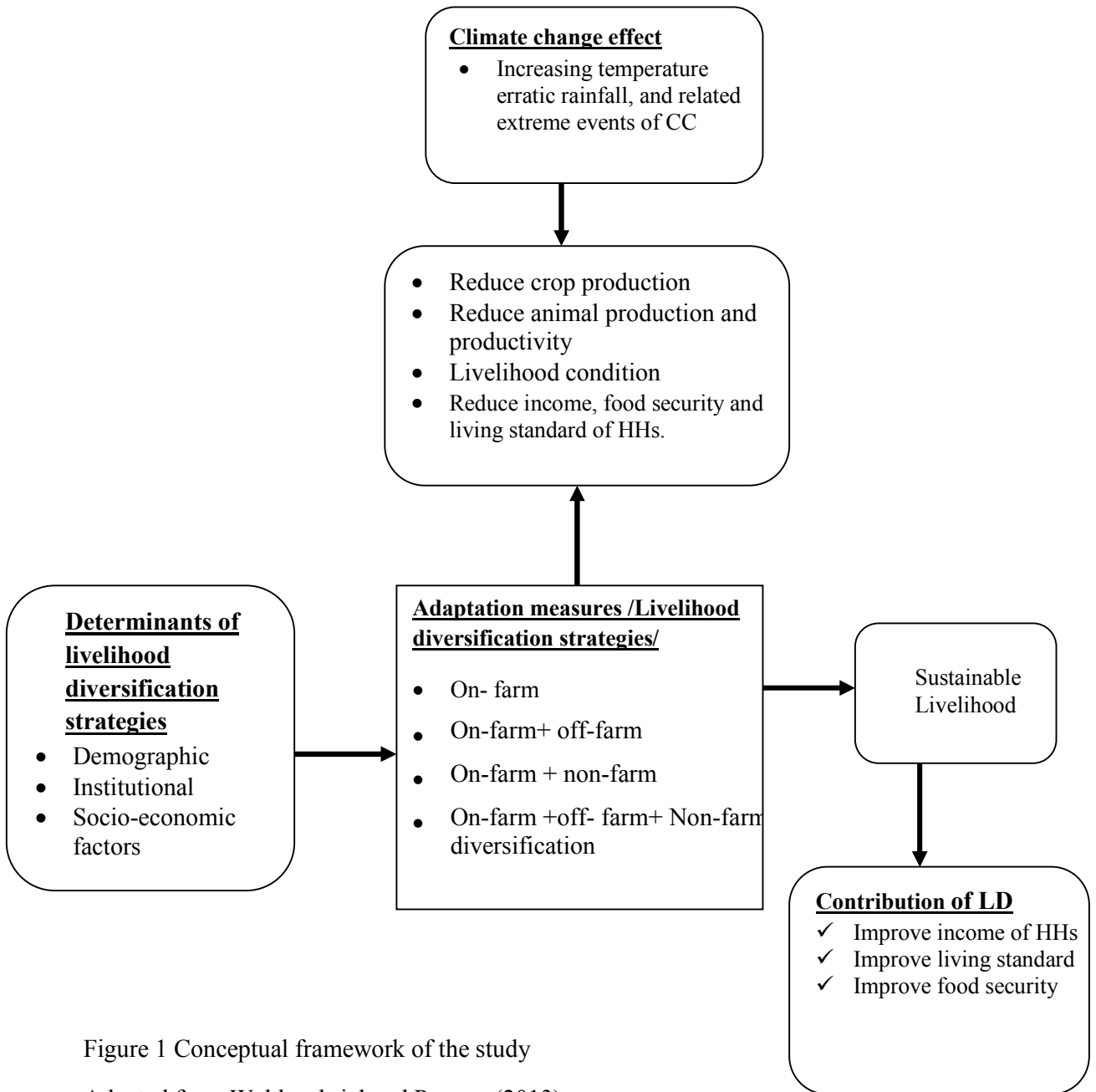


Figure 1 Conceptual framework of the study

Adapted from Weldegebriel and Prowse (2013).

CHAPTER THREE

3. MATERIALS AND METHODS

3.1. Description of the Study Area

Boricha district is found in Southern Nations Nationalities and Peoples' Regional State of Sidama Zone. It is located at 305 and 31 km South of Addis Ababa and Hawassa respectively. It is bordered by Hawassa Zuria district and Oromiya Region in the Northeast, Loka Abaya and Dale district in the Southeast, Shebe dino district in the East and Woita Zone in the West (BWOANR, 2014). Its geographical location extends from 6⁰46'N and 38⁰04'E to 7⁰01'N and 38⁰24'E. It has an estimated area of 588.05sq km that comprises of 42 Keble's of which 3 are urban and the remaining rural. The altitude varies between 1700 and 2000m above sea level and the area is characterized by low land agro-ecological zones. Annual mean of temperature varies from 28-33c⁰, while the rainfall ranges between 500-1,242 mm (Bechaye, 2011). Boricha district has a total population of 250,260, of whom 125,524 are men and 124,736 women. Only 4.16% of its population is urban dwellers (CSA, 2007).

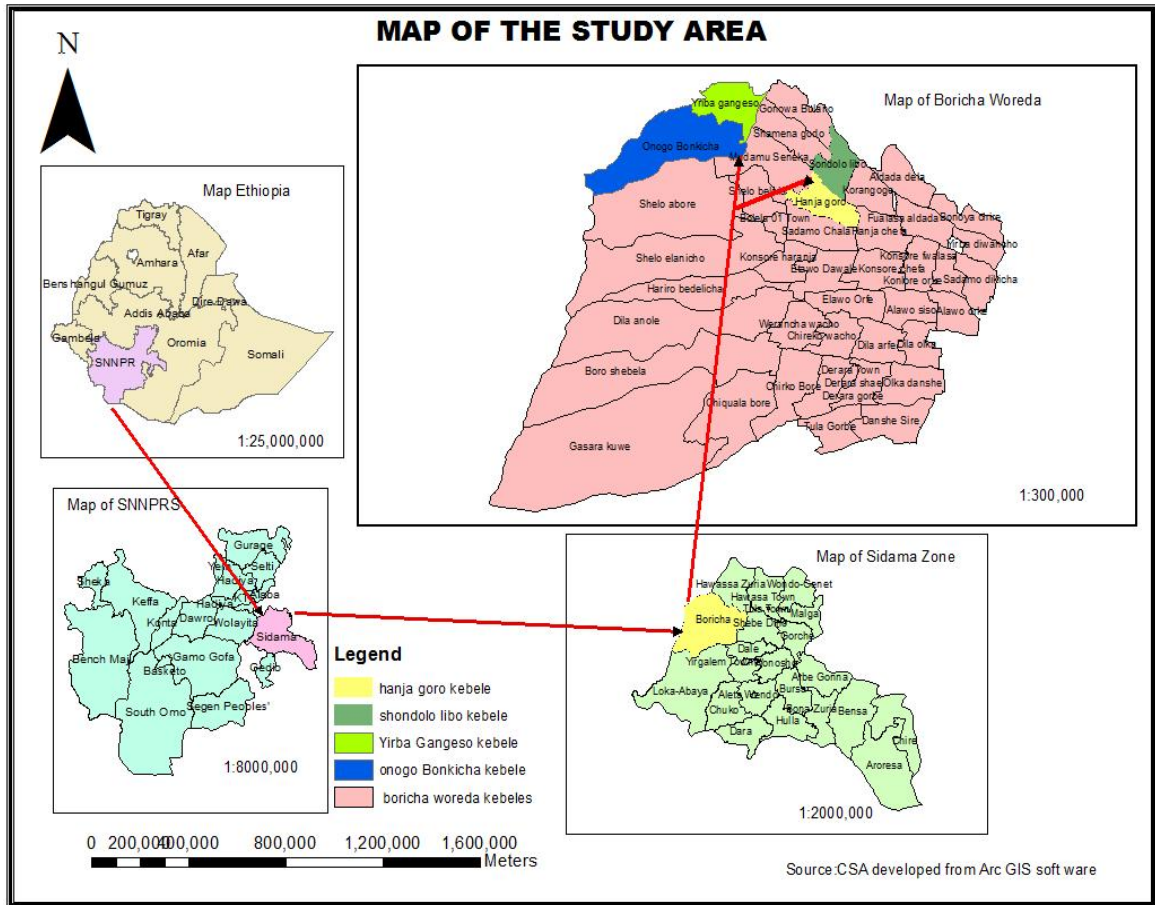


Figure 2 Map of the study area.

There are two cropping seasons in the study area, i.e., Belg (short rainy season) which is from March to May and Meher (main rainy season) which occurs in the months from June to September. Belg rains are mainly used for land preparation and planting long cycle crops such as maize. The Meher rains are used for planting potato, green paper, haricot bean, sweet potato and to some extent Tef (Bechaye, 2011).

Farming system of the study area generally depends on rain fed agriculture and mixed farming system. Both crop production and animal husbandry are commonly practiced. The main crops grown during the two cropping seasons are maize, haricot bean, potato, green pepper, sweet potato, and in some parts sugar cane and enset. The main livestock species are cattle, goats, sheep and poultry. Major cash crops are maize, haricot bean, potato, green paper (Nandeeswara and Bealu, 2015). Most of people earn their living from agriculture and livestock and the remaining earn their living from trade and other livelihood activities. Land ownership of the district population in % which; under 0.1ha 15%, 0.1- 0.5ha 50%, 0.51-1ha 20%, 1.01-2ha 20%, and more than 2.01ha was owned by 5% of household heads (BWOANR, 2014).

3.2. Research approach and Design

Research design is the master plan for the collection, measurement and analysis of data. It is the blueprint for fulfilling research objectives and answering research questions (John *et al.*, 2007). It ensures that the study would be relevant to the problem and that it uses economical procedures. In this research both quantitative and qualitative research approach was applied. According to Markand Adrian (2009) mixing qualitative and quantitative approaches gives the potential to cover each method's weaknesses with strengths from the other method. The types of research employed under this study are explanatory research. The purpose of explanatory research is to identify significance of relationship between explanatory and responsive variables.

The overall framework of the study allows the researcher guide to meaningful findings. Cross-sectional survey design was used to assess the overall activities at one shot and the data were collected using household questionnaires, key informant interviews and focus group discussions to capture quantitative and qualitative data at a single point in time.

3.3. Data type and Source

Both qualitative and quantitative data was used for this study. A quantitative data type was obtained from sample household interviews that can be measured and quantified. Qualitative data focused on the expressions and feelings of smallholder farmers, key informants, and focus group discussion participants.

Both primary and secondary data sources were used. The primary data was generated from sample household, focus group discussions members and from key informants. Whereas, secondary data was obtained from agricultural office, internet sources, archives, document files, research journals and articles, different report and metrological data (Rainfall and Temperature data of past 36 years) was gathered from Ethiopian metrological agency.

3.4. Methods of Data Collection

The method of data collection included Focus Group Discussions (FGDs), Key Informant Interview (KII) and Household Surveys. Checklists for FGDs and KII were developed; likewise, semi-structured questionnaires were prepared and pre-tested.

3.4.1. Key informant interviews (KII)

A total of thirteen key informant's interviews was conducted which have included DAs, *kebeles* administer, elder informants and *woreda* expert was carried out to generate information about livelihood diversification and climate change and variability. Accordingly,

4 development agents, 4 *kebeles* administer 4 elders' informants and 1 *woreda* Agriculture and Natural Resource Office experts were involved during the interview process.

3.4.2. Focus group discussions (FGDs)

Farmers representing different age groups, with different education level both male and female farmers and a different wealth group was selected from each *kebele* and total of four FGDs was conducted. At each *kebele* one focus group discussions was held, each group included eight individuals which is elders of the community, youth and women association, rural *kebele* administration leaders, religious leader, model farmer, was included in the discussion in each *kebele*. The discussion was aimed to constraints of livelihood diversification strategies, temperature and rainfall patterns, climate change effects, and contribution of livelihood diversification and its role of climate change adaptation for local farmers. This would help to crosscheck the data obtained through household survey.

3.4.3. Household survey

Interviews was employed to generate household level data on household assets (like age, sex, land size, extension contact, education level of household heads, households use of diversified income source, households use of credit, saving habitat.) households' livelihood activities, strategies, trends of climate change for the past 36 years and contribution of livelihood diversification strategies to climate change adaptation. The interview schedule was pre-tested among 10 randomly selected farmers from non-sampled *kebeles* having similar/identical characteristics to the sampled household.

3.4.3.1 Sampling Procedure and Sample Size Determination

The study followed a multi-stage sampling procedure where a combination of purposive and random sampling (non-probability and probability method) was employed. Boricha *woreda* is frequently susceptible to climate related problems. The *woreda* has food shortage and

under the support food aid and productive safety net (PSNP). Its rainfall variability is high. Boricha woreda is subdivided into kola and woynadega agro-ecological zones, which is attractive for such study.

There are 39 rural *kebeles* in Boricha out of those *kebeles* four drought prone *kebeles* would be selected due to agro-ecological variation (micro climate variations) and proximity. Accordingly, the selected *kebeles* would be HonogoBonkicha and YirbaGangesso from kola area and Hanja Goro and ShondoloLiwo from woynadega area. All *kebeles* are accessed by transportation network and are under food aid that is due to climate change (BWOANR, 2014).

Then, 185 sample households were selected using systematic random sampling technique with probability proportional to size. This study used a simplified formula provided by Cochran (1963).

The determination of sample size is resolved by Cochran (1963:75) formula for calculating a sample for proportions

$$n_0 = \frac{Z^2pq}{e^2} \dots\dots\dots (1)$$

$$n_0 = \frac{1.96^2(.5)(.5)}{0.07^2} = 196$$

Where n_0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails ($1 - \alpha$ equals the desired confidence level, e.g., 95%) which is 1.96, e is the desired level of precision which is 7%, p is the estimated proportion of an attribute that is present in the population which is 0.5(maximum variability) and q is $1-p$ which is 0.5.

Using finite population correction for proportions the sample size (n_0) can be adjusted as follows

$$n = \frac{n_0}{1 + \frac{(n_0-1)}{N}} \dots\dots\dots (2)$$

$$n = \frac{196}{1 + \frac{(196-1)}{3242}} \approx 185$$

Where n is the sample size and
 N is the population size.

Table 1 Households sampling technique

<u>N₀</u>	Name of sample kebeles	Total households	Sample size
1	Hanja Goro	984	56
2	ShondoloLiwo	809	46
3	HonogoBonkicha	567	33
4	YirbaGangesso	882	50
	Total	3242	185

3.5. Method of Data Analysis

In this study, descriptive statistics and inferential statistics such as multinomial logit model was used. For descriptive part of the research, tables, percentages, frequency, pie charts, histogram, bar graphs and mean value were used (object 2 and 3). To analyze the factors affecting the livelihood diversification multinomial logit model was used (Objective 4). Trends of rainfall and temperature data of the past 36 years (1981-2017) was analyzed by undertaking linear trend analysis, Coefficient of variation and percent of deviation was used to determine rainfall variability (objective 1). SPSS (Statistical Package for Social Science) version 20 and STATA version 14.2 were used to analyze both descriptive and MNL model results.

3.5.1. Econometric Model Specification

In this study four mutually exclusive livelihood diversification strategies were identified. These include on-farm only, on-farm plus non-farm, on-farm plus off-farm, and on-farm plus off-farm plus non-farm. According to many literatures multinomial logit regression model is a widely used technique in applications that analyze polychromous response categories in different areas of economic and social studies.

Multinomial logit regression model is an important model to examine the determinants of household livelihood strategy choices among the alternative livelihood strategies. Thus, to identify the determinants of smallholder farming rural households' decision to choose which livelihood diversification strategy should follow multinomial logit regression model was used. The assumption is that in a given period at the disposal of its asset endowment, a rational household head chooses among the four mutually exclusive livelihood strategies that could offer the maximum utility (Greene, 2003).

Suppose for the i^{th} respondent faced with j choices, the utility choice j can be specified as:

$$U_{ij} = Z_{ij} + \epsilon_i \text{-----} (1)$$

If the respondent makes choice j in particular, then U_{ij} is the maximum among the j utilities.

So the statistical model is derived by the probability that choice j is made, which is:

$$\text{prob}(U_{ij} > U_{ik}) \text{ For all others } k \neq j \text{-----} (2)$$

Where; U_{ij} is the utility to the i^{th} respondent from livelihood strategy j ; and U_{ik} is the utility to the i^{th} respondent from livelihood strategy k . Thus, the i^{th} household's decision can be modeled maximizing the expected utility by choosing the j^{th} livelihood strategy among J discrete livelihood strategies, i.e.:

$$M_{axj} = E(U_{ij}) = f_j(x_i) + \beta_{ij}, j=0, \dots, J \text{-----} (3)$$

In general, for an outcome variable with J categories, let the j^{th} livelihood strategy that the i^{th} household chooses to maximize its utility could take the value 1 if the i^{th} household choose j^{th} livelihood strategy and 0 otherwise. The probability that a household with characteristics x chooses livelihood strategy j , P_{ij} is m

$$p_{ij} = \frac{\exp(x'\beta_j)}{\sum_{j=0}^J \exp(x'\beta_j)}; j=0 \text{-----} (4)$$

With the requirement that $\sum_{f=0}^J p_{if} = 1$ for any i

Where; P_{ij} = probability representing the i^{th} respondents chance of falling into category j ;

X_i = Predictors of response probabilities; and β_j = Covariate effects specific to j^{th} response category with the first category as the reference. A convenient normalization that removes indeterminacy in the model is to assume that $\beta_1 = 0$ (Greene, 2003). So that $\exp(X_i\beta_j) = 1$, implying that the generalized equation (4) above is equivalent to:

$$\Pr(y_i = \frac{j}{x_i}) = p_{ij} \frac{\exp(x_i\beta_j)}{\sum_{j=1}^J \exp(x_i\beta_j)} \text{for } j=0, 1 \dots j \text{ and}$$

$$\Pr(y_i = \frac{j}{x_i}) = p_{ij} = \frac{1}{\sum_{j=1}^J \exp(x_i\beta_j)} \text{-----} 5$$

$$\ln \frac{p_{ij}}{p_{iJ}} = x'(\beta_j - \beta_J) = x'\beta_j; \text{if } j = 0 \text{-----} 6$$

3.6. Model Variables

This study was focused on the rural households in the study area. Thus, variables employed here was the characteristics of household heads. The independent variables that expected to affect diversification of livelihood strategies of rural households in the study area are provided in table 2.

Table 2 Description of explanatory variables and their hypothesized signs

Variable	Meaning	Type	Measurement	Expected sign
AGE	Age of the household head	Continuous	Years	+/-
ED	Education of the household head	Continuous	Years of formal Education	+
SEX	Sex of the household head	Dummy	1=Male 0=Female	
EXT	Access to extension service	Dummy	1 if yes and 0, otherwise	+
CTSA	Access to credit service	Dummy	1 if yes and 0 otherwise	+
CIA	Access to climate information	Dummy	1 if yes and 0 otherwise	+
DFMA	Distance from market	Continuous	Km	+/-
SVG	Savings (formal and informal) of the household	Dummy	1 if the household has savings; and 0 otherwise	+
FRMSZ	Farm size of the household head	Continuous	Ha	+
TLU	Livestock holding in TLU	Continuous	Number	+

Livelihood diversification is a polychromous dependent variable which takes the value 1 if the household livelihood strategy is on farm only; 2 if the households' livelihood strategy is on-farm plus non-farm; and 3 if the households' livelihood strategy is on-farm plus off-farm and 4 if the households' livelihood strategy is non-farm plus non-farm plus off-farm activities.

On farm (on-farm): on farm income is an income return to the household from farming activities. This is a dummy variable and expected a positive sign for the farmers“ who are used adaptation to climate change.

Off farm (off-farm): this is an income of household obtains from outside of farming activities. For example, trade, remittance and governmental employer are among others. Such income is makes the farmers not to follow up or motives properly to agriculture. Therefore, the expected sign of this variable is positive for the farmers“ who are used adaptation method to climate change and it is a continuous variable. This variable also measures in Ethiopian Birr.

Non-farm (non-farm) defined as all those activities associated with waged work or self-employment in income-generating activities (including in-kind income) that are not agricultural but located in rural areas. This is a dummy variable and expected a positive sign for the farmers who are used adaptation to climate change.

CHAPTER FOUR

4. RESULTS AND DISCUSSION

4.1. Background of the Respondents

Demographic and Socio-Economic Characteristics of Studied Households

The results of the demographic and socioeconomic characteristics of the rural households of Boricha district are discussed as follows:

Age of respondents

Age of household is important factor which utilize and adopt different livelihood diversification. Majority of the respondent household heads constituting 33.5% were in the age category of 41-50years, while 32.4% of the respondents were above 51 years (Table3).

Table 3 Age categories of sample respondents

Age	Frequency	Percentage
18-30	18	9.7
31-40	45	24.3
41-50	62	33.5
51 and above	60	32.4

Sex of household heads

Out of the total sampled households in the study area 92.4% was male-headed and the remaining are female headed households (Table 4). There was common thinking that sex of the household was also taken as a proxy variable for his/her livelihood diversification activities since most of them are practiced by men due to labor requirements in Boricha district, Sidama zone like other parts of Ethiopia, male headed household is dominant.

Table 4 Sex of sample households

Sex	Frequency	Percentage
Male	171	92.4
Female	14	7.6

Educational status

Regarding educational status, from the total number of respondent household heads (61.1%) were unable to read and write, while 11.9%, 17.3%, 7%, and 2.7% of the respondent household heads were categorized under the grade level of 1-8, 9-10 and 11-12, respectively (Table 5). It can be concluded that there is high literacy rate among respondent household in the study area. It is believed that, higher education level encourages the households to be engaged in diversified livelihood strategies. According to Daniel, (2009) education of household head is the source of key decision making in the family, the better he or she learns the better he or she will be likely to be aware of information and technology adoption. This finding is also supported by Shibru, (2009) that education level of farmers has positive relationship with livelihood diversification.

Table 5 Education level of sample households

Education level	Frequency	Percentage
Cannot read and write	113	61.1
Can read and write	22	11.9
Primary school (1-8)	32	17.3
Secondary school (9-10)	13	7
Preparatory (11-12)	5	2.7

Field survey, 2019

Household family Size

According to field survey this study shows the distribution of the household by family members (Table 6). The households with less than 4 members make up 20%, with 4-6 members 56.7%; with 7-9,18.3% and with 10 and above constitute 4.8%. The sample survey of 185 households of Boricha district shows that,87% of the rural households had an average of 6.2 family members. Household size is the source of labor division and plays an important role in on-farm and off-farm activities.

Table 6 Family size of the sample households

Household family size	Frequency	Percentage
1-3	37	20
4-6	105	56.7
7-9	34	18.3
10 and above	9	4.8

Field survey, 2019

Farm Size

Farm size is a foremost component of agricultural livelihood diversification. The farm size is an indicator of land source availability. It affects the efficiency of livelihood diversification, resource allocation and productivity. The land holding of farmers in the study area varied from less than 0.25 hectare to more than 1.0 hectare with an average holding of 0.83 hectare per households (Table7).

Table 7 Farm size of studied household

Farm size	Frequency	Percentage
<0.25	18	9.7
0.26-0.5	20	10.8
0.51-1.0	93	50.2
1.0<	54	29.1

Field survey, 2019

Livestock Ownership

In the study area, cattle are kept for many purposes. Cattle are considered as a multiple function animal. The livestock holding of farmers in the study area varied from less than 2.5 to more than 10TLU with an average number of 8.4 TLU per households (Table 8).

Table 8 Livestock number in Tropical Livestock Unit (TLU)

Livestock ownership in Tropical Livestock Unit(TLU)	Frequency	Percentage
<2.5	49	26.4
2.6-5	102	55.1
5.1-10	20	10.8
10<	14	7.5

Source: Field survey (2019)

4.2 Trends of climate change and variability

4.2.1. Farmer Perceptions of Climate Change and Climate Change Impacts

Farmers Perception on Climate Change

About 96.3 percent of the farmers surveyed reported that, they have perceived changes in local climate over the last decades (Table 9). The most commonly reported change by 96.1% of the respondent farmers was overall temperature rise. Among farmers perceiving changes in overall rainfall as the most common change especially declining of annual rainfall was perceived by 88.2%, of the respondents, while an increase of uncertainty in onset of rainfall

was mentioned by 11.8%. Many farmers also reported changes in the seasonality of the rainy season. Farmer perceptions of how rainfall patterns had changed differed across landscapes.

Maddison (2006), describe importance of understanding local people's perception to climate change and variability to designing appropriate adaptation and coping strategies for many poor countries that are highly vulnerable to the impact of climate change and variability. In order to dig out locally available adaptation measure to climate change and variability it is important to have an insight of local people's view on key elements of local climate trends of change. According the information obtained from households about the change/variability of climate at household level not on farm level, all of the respondents perceived change in local climate, mainly in terms of increased temperature and decreased rainfalls. Respondent's perceived/experienced increase in number of hot days and decrease in number of cold days, increased dry spells, intense sun heat, unusual drought, floods respectively. According to FGDs conducted in study Kebeles, farmers were reported observing a shortening of the rainy seasons; rains start later than they used to do in the past. In addition, they said that rainfall amount, frequency and distributions have changed. The problems have become more severe since the last five years. This can lead to scares or no pasture growth, increased water scarcity and depletion of resources. And they had noticed that, belg rains declined more and has become variable than rains of kiremt. In this regard, analyses of meteorological data agree with perception of farmers on climate change and variability. These indicate that there was lack of enough moisture for plant growth, forage for livestock and it affects crop production. As, the farmer start sowing with the coming of belg rain, moisture stress and high temperature can affect the germination capacity as well as growing performance of crops.

Table 9 Respondents' perceptions on local climate change in Boricha Woreda

Perception of local climate in study area	Farmers response (N=185)
	Percentage
Perceive climate has been changed	96.3
Rainfall	
Rain fall amount has decreased	88.2
Early onset of rain fall	37.6
Rainy season begins later than usual	63.4
Early cessation of rain fall	68.7
Unpredictable/erratic rainfall	70.3
Perceived changes in Temperature	
Intense sun's heat	67.5
The temperature has increased	89.5
Increased dry spells	67.21
Unusual drought	75.4
Frequent flood	51.3

Source: Assessed from survey (2019)

In line with this finding shows that farmers are well aware of climate change and its effects such as change in rainfall patterns, frequent drought and floods, increase in temperature, and stronger winds; the results corroborate as reported by Kapoury *et al.* (2016). They studied farmer's perception of climate change in southern Mali and reported increases in the frequency of strong wind, dust, drought, high temperatures, and number of hot days as the main climate change-related indicators, and an early cessation of the rainy season, frequent drought, and wind the factors impeding a better delivery of the ecosystem services from the parklands. Similar findings were reported by Ayanwuyi *et al.* (2010), Mertz *et al.* (2009), Odewumi *et al.* (2013), Sofoluwe *et al.* (2011), and Mengistu (2011).

4.2.2. Long Term Climate Trends

Trend analysis was conducted using long term (1981-2017) climate especially rainfall and temperature data of the district obtained from National Meteorology Agency (NMA) as presented below.

4.2.2.1. Rainfall Trends

Annual Rainfall

The 36 years' meteorology data for the period 1981 to 2017 indicated variation of rainfall in Boricha district. The variation of the annual rainfall of the study area ranged between 406.3mm and 1664.1mm (Figure 3), showing the extent of inter-annual variability of annual rainfall over the last 36 years. The rainfall of the study area showed a declining trend with an annual average rate of 12.8 mm over the years considered (Figure 3). The regression analysis also indicated the contribution of time series as a factor in the change of annual rain was 32.9% as expressed by the value of coefficient of determination.

According to UNEP, (2006).the Sahel region will be drier in the 21st century than it has been earlier. Furthermore, there is a trend of increased precipitation in already wet regions and a trend of reduced precipitation in already dry regions (Delespau*et al.*, 2008).Different climate models in Ethiopia present that mean annual rainfall shows large spatial and temporal variation. Same authors also indicated that, rainfall variability is increasing (and predictability is decreasing) in Oromia and Tigray, while total average rainfall is declining in these regions (Aragie, 2009).

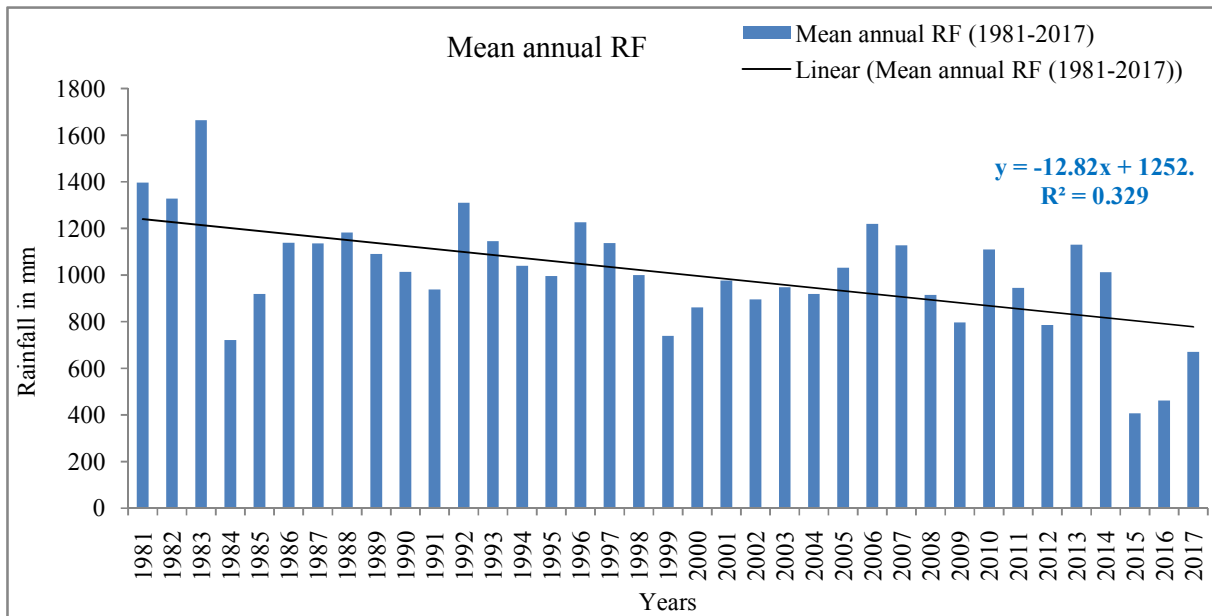


Figure 3, Annual rainfall trends at Borichaworeda (1981-2017)

Source: NMA (2019)

Seasonal Rainfall Trends

There was high inter-seasonal variability in the amount of belg (small) and kiremt (main) rainfalls (Figure 4). Rainfall of belg season has shown decline trend within the period of 1981-2017 by 5.94 mm per year. Similarly, the kiremt rainfall amount has decreased, by 5.28 mm per year in the period noted above.

Similar with this finding for some southern, south-western and south-eastern regions of Ethiopia, Belg and Kiremt rainfall have decreased by 15-20% between 1975 and 2010 (Eshetu *et al.*, 2014). This result is in agreement with the report on rainfall trend (NMA, 2009), that indicated rains have decreased during the *belg* rainy season in the east and southeast with the largest percent reductions. Moreover, rainfall decrease during the short rainy season has been typical for some parts of Ethiopia during the last decade (Nater, 2010).

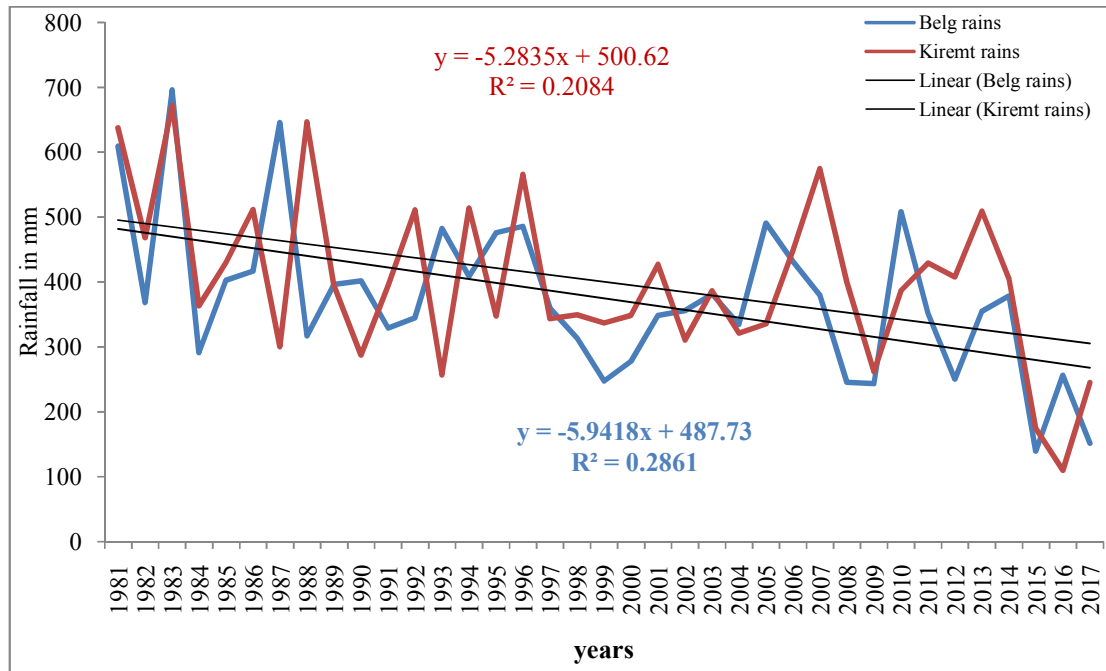


Figure 4, Belg and Kiremt seasonal rainfall trends at Boricha woreda (1981-2017)

Source: NMA, 2019

The result of this study also revealed that the coefficient of variation 32.0 and 31.3% for belg and kiremt seasons respectively indicate that, the rainfall during both seasons is not only declining but it is also highly variable which would reduce its reliability for agriculture and force the farmers to look for potential livelihood diversification (Table 10).

Annual rainfall is less variable as compare to *kiremt* and *belg* rainfalls. NMSA confirmed that the seasonal rainfall during short rainy season is erratic and its pattern is highly variably in amount. In particular, rains have decreased during the *Belg* season in the East and Southeast with the largest percent reductions (NMA, 2009).

Table 10 Annual and Seasonal Variability of rainfall at Boricha woreda (1981-2017)

Rainfall	Mean	CV	SD
Annual RF	1008.88mm	24%	242mm
Belg RF	374.83mm	32.08%	120.25mm
Kiremt	400.23mm	31.3%	125.28mm

Source: Computed from NMA data (2019)

4.2.2.2 Temperature Trends in Boricha woreda

In order to detect the trends of both maximum and minimum temperature data of Boricha woreda simple linear trend equation was used. The results showed that annual temperature is with an increasing trend by for the last three decades (Figure 5). The estimated values for the maximum and minimum temperatures showed an increasing trend by 0.07 and 0.08⁰C per year respectively for the last 36 years.

The analysis of households' observations of their surrounding environment shows that farmers' perceptions appear to be in accordance with the statistical record in the woreda. About 89.5% of the surveyed households observed increasing temperature trend over the past 36 years. Only 10.9% of the households noticed the contrary have not noticed any temperature change. The direction of the temperature trend in the study woreda was consistent with several other studies (Amsalu *et al.*, 2014; Degefu and Bewket, 2014; Gedefawet *et al.*, 2018; Weldegerimaet *et al.*, 2018) at various spatial and temporal scales have recognized warming trends in minimum and maximum temperature.

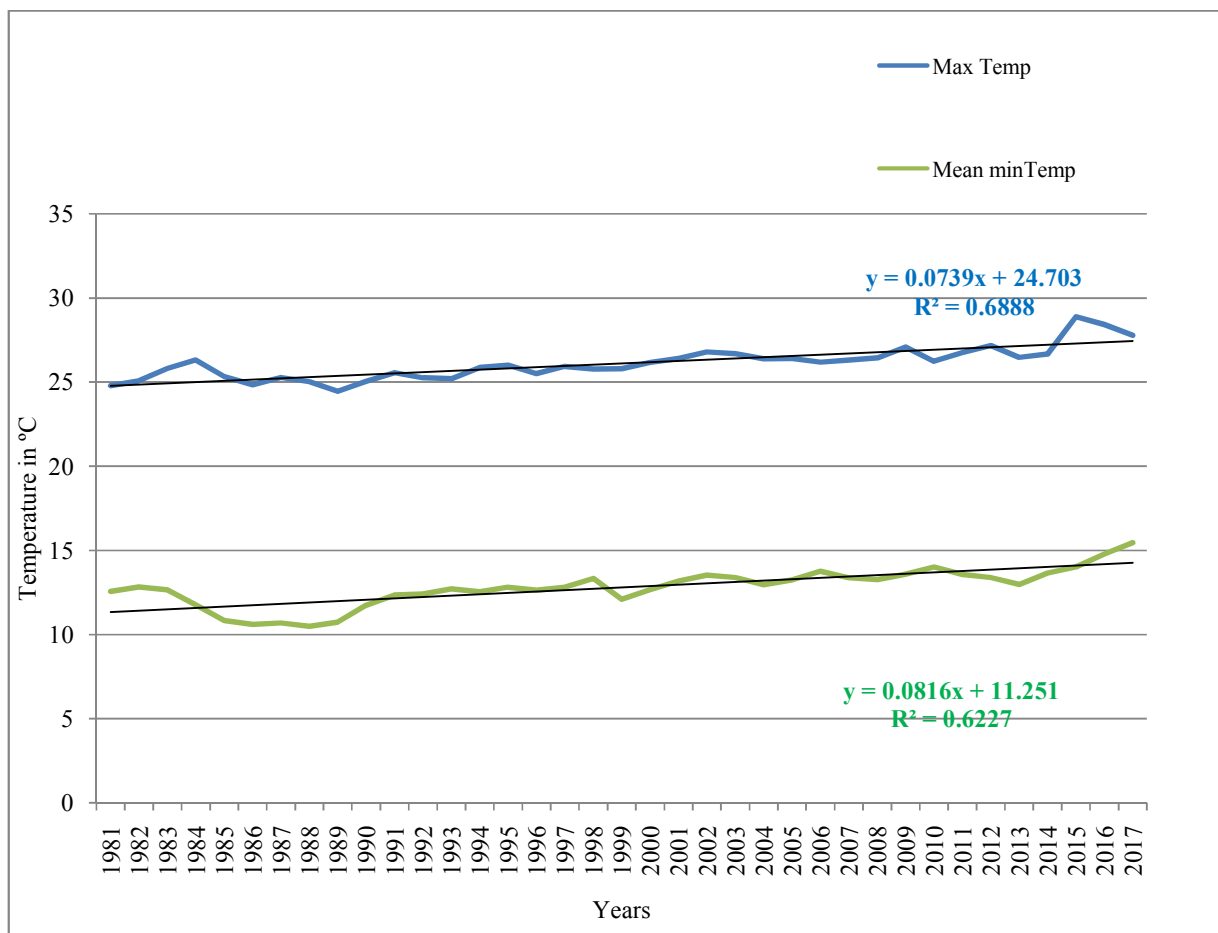


Figure 5. Mean annual, maximum and minimum temperature (1981-2017)

Source:NMA (2019)

4.2.3 Climate Change Impact on Livelihood Components

According to the respondent farmers of Boricha woreda have expressed that incidences of climate change related frequent droughts, increased temperatures, and erratic and unpredictable rainfalls resulted in considerable negative impacts on livelihood components (Table11). Majority of farmers indicated that climate change has resulted in low crop productivity (62.2%), crop disease incidence (58.4%), less pasture/grass for livestock (55.1%), loss of income (54.05%), livestock disease incidence (52.2%) and drying river (48.1%) followed by crop failure, increase rural-urban migration and reduced cultivated land. In line with this (IPCC, (2014),Megersa.*et al.*,(2014),Ogalleh.*et al.*,(2012);UNFPA *et*

al., (2011) and WFP, (2012) indicated that climate change impact on production affects intra and inter-household social networks and arrangements, which are vital forms of food security practices (Article 4). These includes high temperatures are often associated with drought while increase in temperature is expected to reduce crop yields and increase levels of food insecurity. Similarly, the traditional animal sharing is affected due to a climate change impact on livestock production. Moreover, the farmer's participation in social activities is affected because of climate change impacts on production and incomes. The study shows that climate change affects health, food security, employment, incomes and livelihoods, gender equality, education, housing, poverty and mobility—either directly or indirectly.

Table 11 Farmers' response of climate change impact on livelihood in the study area

Climate change impacts	Respondent HHs(N=185)	
	Frequency	Percentage
Crop failure	88	47.56
Low crop productivity	115	62.2
less pasture/grass for livestock	102	55.1
Increased heat stress	97	52.43
Drying rivers	89	48.1
Crop disease incidence	108	58.4
Livestock disease incidence	104	52.2
Reduced cultivated land	73	39.45
Loss of income	100	54.05
Increase rural-urban migration	82	44.32

*Note * 100 percent was not put underneath since all respondents perceived the impacts of CC in different extents.*

Source: Assessed from field survey (2019)

4.3 Livelihood Diversification Strategies Used by Households

Households reported that they have used more than one type of livelihood diversification strategies in response to climate change. This implies that a single strategy is not adequate in adapting to the impact of climate change as combination of several strategies is likely to be more effective than a single strategy. Table 12 reveals the analysis of livelihood diversification strategies made by respondents in Boricha district. Majority of household reported that they diversified their livelihood from crop-livestock diversification and other good practices (84%), agro forestry practices (55%), non-farm activities (31%), off-farm activities (22%), Change from farming to non-farming (9.7%), migration (8%) and Not diversifying any activity (6%).

Table 12 Share of livelihood diversification in changing climate (NHH=185)

Diversification strategies	Frequency	Percentage
Crop–livestock diversification and other good practices (mixed cropping, crop rotation, mulching, organic fertilizer)	155	84
Agro forestry practices	101	55
Off-farm jobs	41	22
Change from farming to non-farming	18	9.7
Non-farm activities	57	31
Migration	15	8
Not diversifying any activity	11	6

Source: Assessed from survey (2019)

The livelihood strategies are presented in Table 12 in terms of their dominance in respect to the number of households that identified the given strategy as their dominant livelihood strategy:

Crop–livestock diversification and other good practices (mixed cropping, crop rotation, mulching, and organic fertilizer): Majority of farmers used it as dominant diversification strategies. The farmers stated that the integration between cropping and livestock husbandry offer various opportunities for raising productivity and increasing efficiency of resource use, thereby increasing their incomes and securing availability and access to food.

The households in their discussions had also indicated that crop-livestock diversification and using other good practices in changing climatic condition is crucial to buffer against weather fluctuations, control erosion by planting forages, diversified income sources and more regular income streams, provides security and a means of saving. Similarly, KIIs explained that crop-livestock diversification as a livelihood activity in our woreda remains insurance; when crop farming fails it will be replaced by livestock under extreme climatic condition, improved nutrient cycling because of direct soil–crop–manure relations, reduce soil erosion, helps to cover draught power and provides farmers the opportunity of micro-investment at farm level.

In line with this study (Babatunde and Qaim, 2010; Challinor *et al.*, 2015; Lemaire *et al.*, 2014; and Porter *et al.*, 2014) indicated that the interactions between crops and livestock identified the main livelihood activities among rural households as farming (cropping and/or livestock), can be managed to contribute to environmentally sustainable intensification, diversification and risk management.

Agro forestry practices: -About 55% (Table 12) of studied farmers used agro forestry practices as diversification strategy in response to climate change in the study area. Agro forestry practices by farmers include planting trees as woodlots along internal and external hedges as well as scattered in croplands. FGDs in their discussion realized that the integration of agro forestry practices remains an inherent part of crop and animal production in these systems. KIIs also suggested that in Boricha woreda agro forests play a significant role in *alleviating* poverty and advancing sustainable development through the diversification of products and services. Most effects of agro forestry are expected to be indirect in the sense that agro forestry increases farmers' food security, livelihoods, and income, and thereby reduces climate vulnerability and raises adaptive capacities. In line with this study it was clearly showed that how agro forestry systems contribute to managing climate risk. Trees on farms may mitigate direct climate impacts, e.g., providing erosion control (Ma *et al.*, 2009; Mutegi.*et al.*, 2008) or reducing the loss of grain production in drought years (Sileshi.*et al.*, 2011).

But most of the effects are indirect in the sense that agroforestry tends to improve livelihoods and wellbeing and thereby reduces vulnerability to climate impacts as much as development related factors (Garrity.*et al.*, 2010).

Non-farm activities: -Small-scale non-farm activities are a key income source for the poor farmers in Boricha woreda. An example is petty trade which includes purchase and sale of goods, retail of Luuollo (wet coffee) and of enset products as well as of maize flour. Although the income from these sources is small, it contributes to access food. Sale of avocado and banana is another seasonal income source in the coffee growing area. Some people buy avocado directly from the farmers and sell to traders who further retail it in urban areas. These people buy the avocado on the tree before it reaches maturity.

In my informal discussions, some of them told me that obtain a better price were their challenge. An informant said: a bag contains up to 70-80 kilograms. ... The quality of the today's avocado is good. My plan is to sell each of the bags up to 350 - 460 Birr. In line with this several studies (Cinner *et al.*, 2010; Lohmann & Liefner, 2009; Martin & Lorenzen, 2016; Rigg, 2006; Simtowe *et al.*, 2016) realized that non-farm income generating activities provide an important source of primary employment in the rural areas of most developing countries', and it is assumed that as farm size due to population pressure becomes smaller, the percentage of non-farm income becomes larger (Hilson, 2016). Non-farm activities have the potential to play a crucial role in reducing vulnerability to poverty by providing households with a form of insurance against the risks of farming and reducing reliance on natural resources.

Off-farm activity: -Is also essential source of livelihood for the poor farmers in study area. For instance, hoe-based agricultural production requires more labor than plow-oxen agriculture; participating in the coffee picking job, the farmers in focus group discussions was also mentioned that today members including children from the food secure households earn an income from the coffee harvest. In with this several authors indicated that the off-farm activities are the other facet of diversification is to cope with ex post shocks to income at the time of crop failure and loss of livestock.

In this case, off-farm income may reduce the fluctuation of farmers' total income and enhance their ability to resist and properly handle the challenges of farm income risks (Jette-Nantel *et al.*, 2011, p. 330). Studies equating off-farm labour supply as an ex post reaction to low farm income lead to the hypothesis that agricultural income and off-farm labour participation are negatively correlated (Bhaumik *et al.*, 2011, p. 379).

Change from farming to non-farming: -According to 9.7 % (Table12) of studied households diversified their livelihood by changing farming activity to non-farming. Farmers indicated that if we manage to successfully diversify into the non-farm sector and decrease their dependence on the land, they will be less vulnerable to land degradation and they may use the earned cash to finance soil conservation investments and the use of fertilizers, so as to stabilize their livelihood. KIIs interviews in their discussions indicated that livelihood diversification to non-agricultural practices may cause beneficial environmental impacts.

This study corroborated with the study of (Sabates-Wheeler *et al.*,2008) regarding adaptation, a common argument is that diversifying into non-farm activities is preferable to activities tied to farming. For example, most non-farm activities have different risk profiles than farming (such as trade, or remittances) and can improve food security as they provide income during lean seasons caused by weather variability (World Bank, 2009). A more extreme version of this argument is that “diversification within natural-resource use may be regarded as reinforcing vulnerability to climate change” (Thomas and Twyman, 2005: 118).

Migration: - Migration to an urban area (for instance as reported by households’ migration to Hawassa, Addis Ababa and other cities in Ethiopia is also an important livelihood diversification strategy in response to climate change in low income gainer members of household in study area.

4.3.1 Relationship of Livelihood Diversification with Climate Change

Results in Table13 indicated the associations of climate change and livelihood diversification in Boricha woreda. Livelihood diversification under changing climate in study area is grouped into five categories due to none of the study farmers diversify single activities. The categories are: diversifying on-farm activities, off- farm activities, non-farm jobs, and on-farm + off- farm activities+ non-farm activities and not diversifying any

activity. Majority of households replied that diversifying to on-farm activities are highly related with rain fall and temperature (89% and 74.5% respectively). Similarly, farmers replied that off-farm activities are mainly and highly related with rainfall, but some linkage with temperature (72% and 31.5% respectively), whereas non-farm activities have some linkages with both rainfall and temperature (52% and 44% respectively). Farmers who were diversifying many more activities (on-farm + off-farm activities+ non-farm activities) indicated that it has some linkages with rainfall, but highly related with temperature (30% and 70% respectively). Amazingly farmers who have not been diversifying any livelihood activities has no that much linkages with climate change (mainly with rainfall and temperature) this was due to lack of assets (farm land and livestock), merely engaging in direct support productive safety net program (PSNP) and due to lack of appropriate access to technology, and institutional support to diversify their livelihood in response to climate change.

Concerning result (Table13), farmers in FGDs emphasized how on-farm activities, rainfall and temperature are highly interrelated to manage farming activity. They explained what they did while diversifying on-farm activities (agricultural operation): diversify crop types and varieties, including crop substitution, to address the environmental variations and economic risks associated with departure of rainfall and temperature for over long period of time. Moreover, diversify livestock types and varieties to address the environmental variations and economic risks associated with climate change.

KIIs suggested that there were high relations between on-farm activities, rainfall and temperature so farmers developed farm-level resource management innovations to address the risk associated with changing temperature, moisture and other relevant climatic conditions. Also they explained Climate change adaptation for on-farm activities requires a

higher resilience against both excess of water, due to high intensity rainfall, and lack of water, due to extended drought periods”.

Contrary to on-farm activities farmers in FGDs indicated that they diversify non-farm source of livelihood activities in order to address the risk of climate-related income loss during higher temperature and drought in the study area. Again KIIs explained that in fragile rural areas the poor diversify incomes and assets especially into the non-agricultural sector. This reduces their vulnerability to agricultural shocks and alleviates their poverty. The labor-intensive non-agricultural activities are most easily available to the poor, such as small commerce, portage, farm labour, and unskilled construction labour and migration periods.

However, there is an inverse relationship between the fragility of the resource base and the availability of off-farm activities. There tend to be best work opportunities in areas where agriculture is most dynamic or there is active urban-rural exchange and least less work opportunities in fragile and less dynamic areas where their need would be most pressing and their benefits perhaps most visible. There is, in addition, considerable heterogeneity among households in the faced constraints and incentives. For instance, the sunk costs that exist to enter higher-return activities such as store keeping and transport are a reason why non-farm income commonly exacerbates income inequality.

The poor are often impeded from access to more remunerative activities due to insufficient endowments of productive assets, poor access to information, markets, financing or social groupings that condition entry into markets. In line with this study, several studies (Deressa.*et al.*, 2009; CEEPA, 2006; Nater2010, Weldegebriel and Prowse, 2013; Wondimagegnhua.*et al.*, 2016; Yishak.*et al.*, 2014; Yizengaw.*et al.*, 2015) clearly indicating the link between climatic variables and livelihood diversification.

Table 13 Associations between climate changes and adaptation strategies in Boricha district

Livelihood diversification as an adaptation to climate change	Relationship between CC & LDs(n=185)	
	Relations with rainfall and percentage of HH	Relations with Temperature and percentage of HH
On-farm activities	▲ (89)	▲ (74.5)
Off- farm activities	▲ (72)	▼ (31.8)
Non-farm jobs	▼ (52)	▼ (44)
On-farm + off- farm activities+ non-farm activities	▼ (30)	▲ (70)
Not diversifying any activity	▼ (2)	▼ (4)

NB: ▲ means that the elements of climate change and livelihood diversification as the adaptation strategy is highly related and means that the element of climate changes and livelihood diversification as the adaptation strategy has some linkages

4.4. Contribution of Livelihood Diversification to Climate Change Adaptation

Livelihood diversification has its contribution to climate change adaptation (Table14). Out of studied households 76.7, 57.8, 55.6, 53.5 and 47.5% of households found advantage from livelihood diversification under climate change: diversify & increase income sources, ensure food security, reduce environmental problem, increase household asset and reduce vulnerability to risk.

Farmers at FGDs were agreed in their discussion that diversification of livelihood have role to diversify source of households' income, contributes to give the opportunity to cope up climate change by reducing environmental problem, sustain our environment, and improving food security. KIIs also asserted that livelihood diversification activities are central to the building of sustainable livelihoods and food security, and their importance will long last to

future. Livelihood diversification is importance in addition to agriculture, growth of non-farm rural income generating activities offers important opportunities to reduce rural poverty.

In line with this study, among several studies (Addisu, 2017; Bealu, 2018; Mentamo and Geda, 2016) indicated that livelihood diversification shares biggest contribution in climate change adaptation.

Table 14 Contributions of livelihood diversification to farm households under changing climatic condition

Contributions of livelihood diversification	Frequency	Percentage
Increase household assets	99	53.5
Reduce environmental problem	103	55.6
Reduce vulnerability to risk	88	47.5
Diversify & increase income sources	142	76.7
Ensure food security	107	57.8

Source: Assessed from field survey (2019)

4.5 Factors Determining Livelihood Diversification

To examine the factors affecting rural households to choose/diversify certain livelihood strategies MNL model was used .It indicates the direction of explanatory variables on dependent variables.

Table 15 Parameter estimates of the multi nominal logit adaptation model

Explanatory Variables	On-farm-diversification	On-farm + Off-farm	On-farm+Non-farm	On-farm, Off-farm& non-farm
	Coef Marginal p-value	Coef Marginal p-value	Coef Marginal p- value	Coef Marginal p-value
Sex	-0.36 (0.88)	2.63 (0.312)	0.79 (0.691)	0.24 (0.907)
Age	.86 (0.31)	2.05 (0.042)**	-.23 (0.72)	.208 (0.768)
Family size	-.43 (0.53)	-.777 (0.295)	.21 (0.691)	-.17 (0.752)
Education	.63 (0.37)	3.33 (0.000)***	1.30 (0.021)	1.26 (0.030)**
Ext-service	.616 (0.98)	1-.91 (0.180)	-1.25 (0.22)	-1.44 (0.174)
Acc-to Credit	-.090 (0.46)	-.29 (0.831)	-.77 (0.430)	-.74 (0.462)
Saving	-1.78 (0.24)	12.70 (0.990)	-1.71 (0.198)	-1.60 (0.238)
Farm size	9.04 (0.043)**	1.34 (0.754)	.81 (0.829)	-3.95 (0.348)
Livestock	.057 (0.12)	-.129 (0.742)	.14 (0.610)	0.072 (0.799)
Climate-info	0.30 (0.025)**	1.91 (0.217)	3.45 (0.004)***	4.60 (0.000)
Market	.80 (0.004)***	-.180 (0.170)	0.44 (0.068)*	.57 (0.022)**

The marginal effects that explain the effect of a unit change in explanatory (independent) variables on the dependent variable are shown in Table 16.

Table 16 Marginal effects of explanatory variables from multinomial logit model

Explanatory Variables	On-farm-diversification	On-farm+Off-farm	On-farm+Non-farm	On-farm, Off-farm&Non_farm	Diversifying nothing
	Coef Marginal p-value	Coef Marginal p-value	Coef Marginal p-value	Coef Marginal p- value	Coef Marginal p- Value
Sex	-0.40 (0.542)	0.62 (0.267)	0.67 (0.652)	-0.67 (0.631)	-0.21 (0.701)
Age	.028 (0.178)	.56 (0.002)***	-.099 (0.004)***	.023 (0.492)	-.007 (0.683)
Family size	-.016 (0.416)	-.021 (0.168)	.067 (0.043)**	-.031 (0.29)	.002 (0.886)
Education	-.026 (0.108)	.063 (0.006)***	.010 (0.706)	.005 (0.836)	-.042 (0.003)***
Ext-service	.68 (0.985)	-.076 (0.979)	-.34 (0.985)	-.23 (0.982)	-.023 (0.994)
Acc-to Credit	-.009 (0.772)	.011 (0.711)	-.018 (0.758)	-.004 (0.944)	.021 (0.446)
Saving	-.054 (0.986)	.039 (0.989)	-.022 (0.986)	-.119 (0.989)	0.0008 (1.000)
Farm size	.036 (0.008)***	.033 (0.662)	.032 (0.174)	-.70 (0.005)***	-.021 (0.834)
Livestock	.018 (0.056)*	-.007 (0.333)	.003 (0.793)	-.010 (0.441)	-.004 (0.593)
Climate- info	-.005 (0.861)	-.040 (0.165)	-.038 (0.625)	.188 (0.016)	-.103 (0.001)***
Market	.015 (0.007)***	-.018 (0.109)	-.005 (0.682)	.020 (0.064)*	-.013 (0.052)*

NB: *, ** and *** stands for significant at 10, 5 and 1 sig level.

Among different factors age, family size, education, farm size, livestock ownership, information about climate change and distance from market was found positively and negatively affected the probability of diversifying different livelihood activities significantly at ($p < 0.05$) significance level. Whereas sex, credit service, extension service and saving of households were not significantly affected the livelihood diversification in study area

The discussions of significant variables were elaborated as follows: -

Age: - As expected age (Age) was found significant at 1% sig. level, affected small holder farmers' livelihood diversifications into on-farm+ off-farm and on-farm + non-farm activities positively and negatively respectively. Holding other factors constant, the unit increases in age of farmers, and the probability of farmers to diversify these activities (On-farm + Off-farm and On-farm + Non-farm) would be increased and decreased by 56 and 9.9% respectively (Table16)

Family size:-It also affected the livelihood diversification strategies positively and significantly at 5 % of significant level. If the number of family size increased, the likelihood of diversifying the On-farm + Non-farm activities increased by 6.7 % at 5% significance level. The more family size is act as a source of labor force to diversify livelihood. According to (Asfir and Tamerat, 2016) family size positively affects livelihood diversification. This is due to presence of large families to practice multiple activities as household laborer to diversify livelihood strategies.

Education: -As it was also hypothesized positively and negatively affected the probability of diversifying on-farm + off-farm activities at 1% significance level. This implies that the unit increases in schooling years of household, the probability of diversifying on-farm + off-farm activities and not diversifying any activity increased and decreased respectively. This is due to probability of educated person ability to gain better skill, experience, knowledge and

capability to find a job. In lined with these, educated person had better ability to diversify livelihood strategies since they may have better skill, experience and knowledge (Debele and Desta, 2016).

Farm size: -Land/farm size also affected the household's probability of livelihood diversification positively and negatively. This means that the household with more farm size promotes on-farm activities by 3.6 % at 1% significance level. Similarly, the farmer with more farm size discourages probability of diversifying all strategies (on-farm, off-farm& non-farm) by 70 % at 1% significance level. Hence, the probability of engaging in various livelihood strategies decreases when land holding size of household increases because farmers with larger farm land size were encouraged to involve more on farming activities (Tamerat, 2016; Gecho, 2017; Aababbo and Sawore, 2016).

Livestock: -The number of livestock measured in Tropical Livestock Unit (TLU) owned was positively influenced the probability of diversifying livelihood. Farmers with more animal numbers increase probability of diversifying on-farm activities by 1.8 % at 10% significant level. The possible reason could be livestock plays a very important role by providing traction (especially oxen) for crop production and manure required for soil fertility maintenance. This is also explained by the fact that the many more herd size is a proxy for wealth status of farmers. Those farmers with large herd size have better chance to earn more money to invest on tools required for on-farm activities. This result agreed with the works of Prowse (2015 and Mentamo, (2016). On the other hand, farmers having more number of oxen are less likely to diversify livelihood than less number of oxen, this is due to diversifying different livelihood activities owning large number of animals is difficult rather than investing only on on-farm activities ,this idea is also corroborated with the works of (Ofolsha and Mansingh, 2015; Gecho, 2017).

Information about climate change: -Access to information on climate change (temperature and rainfall) has a significant and negative impact on farmers' not diversifying any livelihood activities. Getting information about seasonal forecasts and climate change, decreases the probability of farmers not diversifying any livelihood activities by 10.3% at 1% of significance level as compared to farmers' not getting climatic information, keeping other variables constant, in line with this result Pettengell(2010) reported access to climate information is the important for farmers to be able to plan what to do on their farm in face of increasing temperature and disruptive rainfall.

Distance to market: -Distance from town is institutional factor determine livelihood diversification. The study revealed (Table16) that the household those who were near to market have more probability to diversify on-farm activities and all activities (on-farm, off-farm& non-farm) by 1.5 and 2% at 1 and 10% significance level. In other ways the farmers those who were near to market decreases the probability of not diversifying any livelihood activities by 1.3% at 10% significance level. Based on previous study of (Prowse ,2015) rural populations that are closer to a town are able to source markets for their produce and also have a chance to access facilities and infrastructure such as markets, banks, credit facilities and health facilities that can further develop their livelihood. According to Belayneh(2013) study shows that market distance positively influenced livelihood diversification in Ethiopia. Contrary to this result, Yenesew.*et al.* (2015) and Adugn (2012) found negative correlation between market distance and livelihood diversification.

CHAPTER FIVE

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

Climate change is affecting their livelihood activities of Boricha woreda households. The finding of the study revealed that, the rainfall of the study area showed a declining trend with an annual average rate of 12.8 mm over the last 36 years. The coefficient of variation 32.0 and 31.3% for belg and kremt seasons respectively, indicate that, the rainfall during both seasons was highly variable. The maximum was increasing by the rate of 0.7⁰C per decade likewise minimum temperatures also showed increasing trend by 0.8⁰C per decade.

The most commonly reported changes among the farmers were: decreased amount of rainfall, late onset of rainfall, rainy season begins later than usual, early cessation of rainfall unpredictable/erratic rainfall, temperature, increase, increased dry spells, frequent drought. The study revealed that climate change affected livelihood components: resulting in low crop productivity, crop disease incidence, less pasture/grass for livestock, loss of income, livestock disease incidence and drying river, crop failure, and increase rural-urban migration.

The findings of study revealed that most households diversified their livelihood practicing off-farm activities and change from farming to non-farming. Diversifying livelihood activity could contribute to climate change adaptation through: increasing income sources, ensure food security, reduce environmental problem, increase household asset and reduce vulnerability to risk.

The results also identified the factors affecting livelihood diversification including: age, family size, education, farm size, livestock ownership, information about climate change and distance from market were positively and negatively affecting the probability of diversifying

livelihood activities significantly ($p < 0.05$). Whereas impacts of sex, credit service, extension service and saving of households were not significant on the livelihood diversification in the study area.

5.2 Recommendations

On the basis of these findings, policies and interventions should target at removing the bottlenecks down at household level.

- Effective and reliable meteorological data should be provided for Boricha woreda farm households to ensure that farmers receive up-to date information about rainfall and temperature patterns.
- Agricultural research and development support systems need to focus on different livelihood diversification activities focused on Onfarm, off-farm and, non-farm diversification.
- Providing education to household members may provide an opportunity to diversify their livelihood activities which could contribute to climate change adaptation.
- Livelihood diversification should be widely encouraged due to its contribution for the effect of climate change in Boricha district
- Capacitating rural households through agricultural training so that they can diversify their income. These agricultural training services may allow for increased agricultural land use and the production of high-value agricultural commodities in changing climate.
- Provision of adequate infrastructure to the rural communities to enable income diversification among rural households.

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Appendices

Appendix A Minimum Temperature; 1981-2017

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AVMin
1981	11.8	12.1	13.8	13.7	13.3	12.7	12.8	12.6	12.5	13.3	11.8	11.5	12.7
1982	12.3	13.5	13.0	13.5	13.4	12.6	12.6	13.0	13.0	12.4	12.9	11.9	12.8
1983	11.6	12.8	14.1	13.3	13.7	13.2	12.8	13.8	13.0	12.4	11.1	10.2	12.7
1984	9.9	9.3	12.2	12.9	13.4	12.6	12.5	12.7	11.9	10.9	11.8	11.2	11.8
1985	10.2	9.8	10.8	11.7	10.8	10.9	12.8	11.0	11.3	10.5	10.3	9.9	10.8
1986	9.2	10.2	10.4	11.9	11.2	11.7	11.3	10.8	11.1	9.8	9.6	10.1	10.6
1987	9.6	9.7	12.2	11.0	12.0	11.4	10.8	11.2	10.7	11.2	9.1	9.5	10.7
1988	10.1	11.1	11.0	12.0	11.3	10.7	10.6	11.2	11.0	10.8	7.9	8.3	10.5
1989	9.1	9.3	11.0	11.1	10.5	10.8	11.5	11.2	11.4	10.7	10.5	12.0	10.8
1990	9.8	13.0	12.4	13.4	12.7	11.7	11.7	12.2	11.6	10.9	11.4	10.1	11.7
1991	12.1	12.3	12.9	12.1	13.0	12.7	12.5	12.5	12.4	11.9	12.3	11.5	12.4
1992	12.2	12.9	13.0	12.8	12.3	12.4	11.8	12.2	12.3	12.5	11.9	12.6	12.4
1993	12.8	12.6	12.9	14.5	13.6	12.9	12.6	12.3	12.0	12.7	12.2	11.5	12.7
1994	10.9	12.3	13.7	13.6	13.7	13.2	12.9	13.0	13.1	11.7	11.9	10.7	12.6
1995	11.1	13.0	13.4	14.2	13.3	13.0	13.3	13.2	12.8	13.1	11.3	12.1	12.8
1996	12.8	12.6	13.2	13.8	13.5	13.6	13.0	12.9	13.3	12.0	10.5	10.5	12.6
1997	12.5	11.4	13.0	12.8	12.7	12.6	13.0	12.9	13.4	13.5	14.0	12.0	12.8
1998	13.1	13.8	14.3	14.9	15.2	13.1	13.6	13.8	13.4	13.9	10.9	10.1	13.3
1999	11.6	11.5	13.6	13.0	13.1	12.8	12.6	12.2	12.0	12.5	10.3	10.1	12.1
2000	10.8	11.2	12.7	13.5	13.3	12.7	13.4	13.4	13.1	13.7	12.6	11.7	12.7
2001	12.1	12.3	13.7	14.1	14.0	13.6	13.2	13.7	13.3	13.8	12.0	12.3	13.2
2002	13.3	12.9	14.3	13.9	14.1	13.4	13.8	13.7	13.3	13.3	12.6	13.8	13.5
2003	12.5	13.2	14.2	14.7	14.4	13.5	13.4	13.4	13.3	13.2	13.0	12.0	13.4
2004	12.9	12.6	12.6	13.2	13.3	12.8	13.0	13.5	13.3	12.8	13.0	12.6	13.0
2005	12.2	13.2	14.7	14.8	14.1	13.9	13.4	13.6	13.6	13.5	11.7	10.2	13.2
2006	12.8	13.5	14.4	14.2	14.1	13.8	14.0	13.9	14.1	14.2	13.0	13.3	13.8
2007	12.9	13.8	13.5	14.3	14.5	13.9	13.7	13.6	14.2	12.4	12.6	11.0	13.4
2008	11.9	12.6	13.0	14.1	14.2	13.9	13.9	13.7	14.0	13.6	12.6	11.7	13.3
2009	12.2	13.3	13.9	14.5	13.9	13.4	13.4	13.8	14.2	14.0	12.6	13.9	13.6
2010	13.2	15.2	14.6	15.2	15.5	13.9	13.9	13.8	14.0	14.0	12.7	12.2	14.0
2011	12.8	12.4	14.4	14.6	14.8	14.2	13.6	13.6	14.2	13.4	13.7	11.2	13.6
2012	11.8	11.6	14.5	13.5	14.6	14.5	13.9	13.7	14.0	13.5	13.1	12.0	13.4
2013	12.1	13.0	14.1	13.4	12.9	13.7	13.5	13.3	13.3	13.5	11.4	11.5	13.0
2014	12.5	13.6	13.7	13.8	13.7	13.4	14.9	14.3	14.2	14.5	13.4	11.9	13.7
2015	12.6	11.7	14.4	14.2	14.7	14.2	14.0	14.1	14.3	14.3	15.0	14.6	14.0
2016	15.0	15.1	15.8	15.9	15.3	14.8	14.7	14.9	15.1	15.4	13.3	12.0	14.8
2017	15.6	15.8	15.2	14.9	15.4	15.8	14.3	15.0	14.8	15.9	14.8	13.9	15.1

Appendix B Maximum Temperature; 1981-2017

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	AvTmax
1981	28.0	28.2	25.7	23.6	24.2	23.6	21.4	21.9	22.8	24.7	26.1	27.2	24.8
1982	27.0	26.9	28.4	25.3	24.4	23.9	22.1	22.7	24.3	24.4	25.3	26.1	25.1
1983	28.1	28.2	29.6	26.4	25.0	24.7	23.1	23.0	24.2	24.7	25.8	26.8	25.8
1984	27.9	29.0	30.2	29.3	25.1	23.2	23.0	23.8	24.2	26.7	26.7	26.7	26.3
1985	27.0	27.7	28.1	24.2	23.7	22.8	22.4	22.8	24.6	25.8	27.1	27.7	25.3
1986	27.2	27.2	27.0	24.6	23.9	22.1	21.8	22.9	23.7	24.9	26.1	26.7	24.8
1987	27.0	27.6	26.2	25.3	24.2	23.1	23.4	23.7	24.9	24.7	26.1	27.0	25.3
1988	27.4	28.3	28.7	26.3	24.7	23.2	21.0	22.1	23.2	23.8	25.4	26.1	25.0
1989	26.4	26.5	27.0	24.2	24.7	22.5	21.1	23.0	23.5	24.4	25.4	24.7	24.5
1990	26.1	26.4	26.2	25.9	25.4	24.1	22.4	22.7	24.5	24.6	26.0	26.2	25.0
1991	27.9	27.7	27.0	26.6	25.5	24.2	21.4	23.2	24.7	25.6	26.4	26.5	25.6
1992	27.3	27.1	28.7	26.8	24.9	24.0	22.8	22.5	24.2	23.8	25.3	25.7	25.3
1993	25.8	25.9	28.4	25.9	24.4	22.9	22.3	23.0	24.0	25.1	26.9	27.9	25.2
1994	28.9	29.5	28.6	26.2	24.3	23.2	22.0	23.0	25.0	26.0	26.2	27.4	25.9
1995	28.7	28.9	27.0	25.4	25.7	25.1	23.2	23.3	24.8	25.5	26.9	27.6	26.0
1996	27.4	29.3	27.9	25.9	25.3	22.4	22.1	23.1	24.1	25.2	26.3	27.0	25.5
1997	27.8	29.2	29.3	25.4	25.5	24.2	22.8	24.3	27.0	24.9	25.3	25.5	25.9
1998	26.2	27.5	28.8	28.7	26.4	24.5	23.0	22.9	24.6	23.9	25.7	27.0	25.8
1999	27.9	29.9	27.2	26.6	25.6	25.0	22.3	23.9	24.7	24.0	25.7	26.7	25.8
2000	28.7	29.8	30.4	27.3	23.6	23.5	23.6	23.8	25.0	24.6	26.1	27.5	26.2
2001	28.2	29.5	28.0	26.8	25.7	23.9	23.8	24.2	25.5	25.8	27.2	28.2	26.4
2002	28.1	30.1	28.0	27.8	26.3	24.9	25.3	24.4	25.6	26.1	27.9	27.1	26.8
2003	27.4	30.0	29.8	27.3	26.6	24.8	22.9	24.0	25.9	27.1	27.7	26.7	26.7
2004	27.9	28.2	29.3	26.2	26.2	24.8	24.0	24.5	25.3	26.0	26.7	27.5	26.4
2005	28.3	30.6	28.8	28.0	24.6	24.1	23.2	24.5	25.0	25.7	26.4	27.6	26.4
2006	29.3	29.6	28.1	25.9	26.1	24.9	23.3	23.8	25.1	25.6	26.1	26.3	26.2
2007	27.7	29.2	29.8	27.0	26.0	23.6	23.5	23.4	24.6	26.0	27.0	27.8	26.3
2008	28.9	29.3	30.4	27.8	25.3	24.8	23.2	23.5	24.9	25.8	25.8	27.5	26.4
2009	28.1	29.4	30.3	27.2	26.8	26.0	24.7	25.3	26.3	26.0	27.9	26.9	27.1
2010	28.4	28.1	27.5	26.5	25.3	24.5	23.0	23.7	25.0	26.9	28.0	28.0	26.2
2011	29.1	30.0	29.8	29.5	25.9	24.5	24.2	23.8	24.8	26.6	26.2	26.7	26.8
2012	29.4	30.4	31.4	27.2	27.0	25.3	23.6	24.3	25.0	26.8	27.2	28.3	27.2
2013	29.2	31.1	29.8	26.6	25.2	24.1	23.0	23.7	25.5	25.7	26.1	27.7	26.5
2014	29.4	28.8	28.9	27.4	26.1	25.6	24.3	24.7	25.0	25.5	26.7	27.5	26.7
2015	29.8	31.1	31.2	29.9	28.1	26.8	26.9	27.6	28.3	28.7	29.3	28.7	28.9
2016	29.9	31.0	30.9	28.9	27.6	27.0	26.6	26.8	27.6	27.7	27.9	29.1	28.4
2017	29.9	31.4	30.1	30.3	29.9	29.2	29.2	28.3	28.2	28.7	28.3	29.3	29.4

Appendix C Yearly Rainfall; 1981-2017.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TRF
1981	0.5	39.1	266	207.5	135.8	83.8	218.7	161.1	173.9	74.6	31.4	3.6	1396
1982	40	57.8	71	127.8	169.7	120.5	128.8	104.7	113.8	112.1	206	75.1	1327.3
1983	2.2	60.9	127.5	294.8	273.7	136	195.2	177.6	163	138.5	91.6	3.1	1664.1
1984	0	0	32.7	47.6	210.7	40	71	102.6	149.8	35.4	20.4	10.8	721
1985	7.8	2.2	63.7	180.3	158.5	95.6	115.7	96.2	122.3	47.3	25.3	3.8	918.7
1986	0	80.1	109.9	161.3	145.2	140.2	113.4	109.6	148.5	85.8	10.8	33.2	1138
1987	1.3	43.5	203.8	151	290.8	65.6	47	78	109.6	135.2	5.6	3.5	1134.9
1988	18.6	48.2	62	189.6	65.1	147.5	219.5	135.5	144.2	143.4	0	8.5	1182.1
1989	30.1	36.2	99.3	207.9	88.8	95.4	72	62.3	164.2	105.1	41.2	87.3	1089.8
1990	30.4	199.5	160.7	130.8	110.1	51.9	75.5	84.9	74.8	61	24.7	9.9	1014.2
1991	30.7	68.6	116.1	93.3	119.6	105.2	82.9	109.1	97.3	75	0.7	39.2	937.7
1992	36.5	81.9	102	121.2	121.4	95.1	101	131.2	183.8	217.4	83.1	35	1309.6
1993	103.1	96.4	39.5	190.6	252.2	83.3	35.2	54.1	84.3	182.6	24.5	0.6	1146.4
1994	0	5.4	64.4	197.8	146.6	119.7	193.3	100.6	100.2	55.5	46.2	10.6	1040.3
1995	0	33	103.3	261.7	110.9	63.9	73.5	61.9	148.3	71.6	13.8	53.8	995.7
1996	57.4	25.1	158.2	173.7	153.6	195.5	116.2	97.4	156.7	68.9	22.9	0	1225.6
1997	21.6	0	57	196.1	106.5	70.3	102.4	87.6	83.2	216.7	172.3	23.5	1137.2
1998	73.2	63.9	73	121.7	119.1	76.6	97.4	90.2	85.2	181.9	17.2	0	999.4
1999	12.1	0.1	100.4	64.9	82.1	75.9	90.9	82.1	87.7	127.7	9.8	5.7	739.4
2000	0	0	14.7	121	141.8	57.8	102.4	91.3	96.8	140.2	66.9	27.2	860.1
2001	15.8	16.7	105.4	95.9	147.1	116.1	87.2	100.8	123	146.8	8	13.9	976.7
2002	44.1	19	145	109.5	101.2	67.5	53.7	95.5	93.5	65.3	0	101.1	895.4
2003	34.7	5.8	102.1	217.9	61.4	82.1	83.3	111	110.1	61.2	42.5	36.6	948.7
2004	75.5	54.2	39.5	184.8	110.2	50.1	65.2	82.7	123.3	78.8	41.2	13.8	919.3
2005	30.7	10.7	91.9	174.3	224.7	59	103.4	53	120	104	59	0	1030.7
2006	2.7	48.1	129.1	175.3	127	101.4	117.5	134.8	94.6	175.9	43.7	69	1219.1
2007	34.5	46.7	86.3	144.6	148.8	156.9	104.5	142.3	170.6	79.5	13.4	0	1128.1
2008	12	4.6	11.3	119.3	114.9	65.1	107.2	91.9	135.1	168.9	84.8	0	915.1
2009	42.9	13.3	61.5	91.7	89.8	71.6	48.8	54.1	87.2	151.3	22.3	62.6	797.1
2010	34.5	84.7	131.7	200.5	175.9	97.5	73.5	99.6	116.4	39.1	39.7	16.6	1109.7
2011	0.5	16.1	31.8	99	220.8	69.2	112.1	161.6	86.3	62.8	83.9	0	944.1
2012	0	0	30.3	125.4	94.6	67.2	142.8	74.2	123.6	76.3	44.1	6.7	785.2
2013	27.6	2.2	93.3	182.9	78.8	100.8	141.9	126.8	139.8	173.9	62.4	0	1130.4
2014	1.6	37	122.5	111	144.9	62.6	98.1	127.9	116.3	144.8	42.9	3.1	1012.7
2015	0	0	14.7	47.8	76.9	80	39	26	29.3	32.3	46.8	13.5	406.3
2016	1.1	7.4	21.1	172.2	62.7	43.5	34.3	16.4	15.6	36.6	49.5	1.7	462.1
2017	28.4	28.3	42.07	78.1	31.3	51	43.06	64	86.9	97	73.5	47	670.63

Source: NMA (2019).

Appendix D Result of multi-nominal logit model

```
. mlogit strategies sex age education familysize extension credit saving farmsize livestock info  
market, baseoutcome(0).
```

Iteration 0: log likelihood = -273.50766

Iteration 1: log likelihood = -151.85415

Iteration 2: log likelihood = -126.66443

Iteration 3: log likelihood = -119.36874

Iteration 4: log likelihood = -117.86745

Iteration 5: log likelihood = -117.72878

Iteration 6: log likelihood = -117.70324

Iteration 7: log likelihood = -117.69685

Iteration 8: log likelihood = -117.69562

Iteration 9: log likelihood = -117.69542

Iteration 10: log likelihood = -117.69538

Iteration 11: log likelihood = -117.69537

Multinomial logistic regression Number of obs = 185

 LR chi2(44) = 311.62

Prob> chi2 = 0.0000

Log likelihood = -117.69537 Pseudo R2 = 0.5697

Strategies	Coef. Std. Err.	z	P>z	[95% Conf. Interval]
Nothing	(base outcome)			
On_farm_iversification				
Sex	-.36329 2.467038	-0.15	0.883	-5.198595 4.472015
Age	.8614283 .8610952	1.00	0.317	-.8262873 2.549144
Education	.6362625 .7162608	0.89	0.374	-.7675829 2.040108
Familysize	-.4324826 .6988656	-0.62	0.536	-1.802234 .9372688
Extension	16.68931 925.8818	0.02	0.986	-1798.006 1831.384
Credit	-.9066075 1.238634	-0.73	0.464	-3.334285 1.52107
Saving	-1.781016 1.534866	-1.16	0.246	-4.789297 1.227266
Farmsize	9.041949 4.471165	2.02	0.043	.2786265 17.80527
Livestock	.5764486 .3750057	1.54	0.124	-.1585491 1.311446
Info	3.207605 1.429446	2.24	0.025	.4059413 6.009268
Markek	.8040451 .2802612	2.87	0.004	.2547433 1.353347
_cons	-28.77184 925.9057	-0.03	0.975	-1843.514 1785.97
On_farm__Off_farm				
Sex	2.631787 2.601998	1.01	0.312	-2.468035 7.731609
Age	2.059291 1.01081	2.04	0.042	.0781404 4.040441
Education	3.337193 .8279014	4.03	0.000	1.714536 4.95985
Familysize	-.7775519 .7430282	-1.05	0.295	-2.23386 .6787567
Extension	-1.916641 1.430902	-1.34	0.180	-4.721157 .887875
Credit	-.2930654 1.371695	-0.21	0.831	-2.981537 2.395406
Saving	12.70007 1004.303	0.01	0.990	-1955.697 1981.097
Farmsize	1.344661 4.296801	0.31	0.754	-7.076913 9.766236
Livestock	-.1296691 .3942803	-0.33	0.742	-.9024443 .6431061
Info	1.913377 1.550442	1.23	0.217	-1.125434 4.952187
Markek	-.1803188 .4850402	-0.37	0.710	-1.13098 .7703426
_cons	-28.6321 1004.324	-0.03	0.977	-1997.072 1939.807
On_farm__Non_farm				
Sex	.7965688 2.006091	0.40	0.691	-3.135298 4.728436
Age	-.2333437 .6830547	-0.34	0.733	-1.572106 1.105419
Education	1.303533 .5660885	2.30	0.021	.1940197 2.413046
Familysize	.210978 .5316249	0.40	0.691	-.8309876 1.252944
Extension	-1.250879 1.02736	-1.22	0.223	-3.264467 .76271

Credit	-.7775933	.9850627	-0.79	0.430	-2.708281	1.153094
Saving	-1.713434	1.331322	-1.29	0.198	-4.322777	.8959088
Farmsize	.8198116	3.799006	0.22	0.829	-6.626103	8.265726
Livestock	.1405286	.2757613	0.51	0.610	-.3999535	.6810108
Info	3.451226	1.202882	2.87	0.004	1.09362	5.808832
Markek	.4429086	.2428916	1.82	0.068	-.0331501	.9189674
_cons	-7.650808	5.338814	-1.43	0.152	-18.11469	2.813074
On_farm__Off_farm__Non_farm						
Sex	.2406646	2.062935	0.12	0.907	-3.802614	4.283943
Age	.2085224	.7057406	0.30	0.768	-1.174704	1.591749
Education	1.263224	.5836973	2.16	0.030	.1191984	2.40725
Familysize	-.1721131	.5448828	-0.32	0.752	-1.240064	.8958376
Extension	-1.446501	1.064728	-1.36	0.174	-3.53333	.6403275
Credit	-.745906	1.014887	-0.73	0.462	-2.735047	1.243235
Saving	-1.607563	1.363591	-1.18	0.238	-4.280153	1.065027
Farmsize	-3.954522	4.215616	-0.94	0.348	-12.21698	4.307932
Livestock	.0725023	.284074	0.26	0.799	-.4842726	.6292771
Info	4.602936	1.30448	3.53	0.000	2.046202	7.15967
Markek	.5718954	.249557	2.29	0.022	.0827727	1.061018
_cons	-7.240883	5.524933	-1.31	0.190	-18.06955	3.587786

3	.0562348	.0183077	3.07	0.002	.0203524	.0921171
4	-.0998093	.0349983	-2.85	0.004	-.1684047	-.0312138
5	.0230033	.0335049	0.69	0.492	-.0426652	.0886718

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Education |

_predict |

1	-.042597	.0144738	-2.94	0.003	-.0709651	-.0142289
2	-.0265613	.0165207	-1.61	0.108	-.0589413	.0058188
3	.0637564	.0123725	5.15	0.006	.0395067	.0880061
4	.0107531	.0284924	0.38	0.706	-.0450911	.0665972
5	-.0053512	.025846	-0.21	0.836	-.0560084	.045306

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Family size |

_predict |

1	.0021679	.015082	0.14	0.886	-.0273924	.0317281
2	-.0161951	.0199201	-0.81	0.416	-.0552376	.0228475
3	-.0217156	.0157638	-1.38	0.168	-.0526121	.009181
4	.0676101	.0333933	2.02	0.043	.0021604	.1330597
5	-.0318673	.0301252	-1.06	0.290	-.0909116	.0271769

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Extension |

_predict |

1	-.023835	3.317719	-0.01	0.994	-6.526444	6.478774
2	.6824498	35.22793	0.02	0.985	-68.36303	69.72793
3	-.0769324	2.874515	-0.03	0.979	-5.710877	5.557013
4	-.3443711	18.25076	-0.02	0.985	-36.1152	35.42646
5	-.2373113	10.78558	-0.02	0.982	-21.37666	20.90204

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Credit |

```

_predict |
  1 | .0214644 .0281819  0.76  0.446  -.033771  .0766999
  2 | -.0095682 .0329807 -0.29  0.772  -.0742092  .0550728
  3 | .0110439 .0297986  0.37  0.711  -.0473602  .0694481
  4 | -.0189397 .0614594 -0.31  0.758  -.139398  .1015186
  5 | -.0040006 .0566462 -0.07  0.944  -.115025  .1070239

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```

Saving   |
_predict |
  1 | .0008246  3.419832  0.00  1.000  -6.701924  6.703573
  2 | -.0546888  3.11795  -0.02  0.986  -6.165759  6.056381
  3 | .3968071  28.10291  0.01  0.989  -54.68388  55.47749
  4 | -.223709  13.09811  -0.02  0.986  -25.89553  25.44812
  5 | -.1192339  8.467814  -0.01  0.989  -16.71584  16.47738

```

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```

Farm size |
_predict |
  1 | -.0216778 .1035178 -0.21  0.834  -.2245689  .1812134
  2 | .3697584 .0902377  4.10  0.008  .1928957  .5466212
  3 | .0322071 .0737174  0.44  0.662  -.1122764  .1766907
  4 | .3271208 .2406441  1.36  0.174  -.1445329  .7987745
  5 | -.7074087 .2540391  -2.78  0.005  -1.205316  -.2095012

```

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```

Livestock |
_predict |
  1 | -.0042961 .0080327 -0.53  0.593  -.0200398  .0114477
  2 | .0187206 .0097818  1.91  0.056  -.0004515  .0378926
  3 | -.007862 .0081252 -0.97  0.333  -.0237871  .0080631
  4 | .0039798 .0152499  0.26  0.794  -.0259094  .0338691

```

```

5 | -.0105424 .0136743 -0.77 0.441 -.0373435 .0162588
-----+-----
Info      |
   _predict |
1 | -.1035467 .0308163 -3.36 0.001 -.1639456 -.0431479
   2 | -.0055453 .0317405 -0.17 0.861 -.0677554 .0566649
   3 | -.0402356 .0290064 -1.39 0.165 -.097087 .0166158
   4 | -.0386992 .0791222 -0.49 0.625 -.1937759 .1163775
   5 | .1880268 .0780856 2.41 0.016 .0349818 .3410718

```

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-----+-----
Market    |
   _predict |
1 | -.0131117 .006762 -1.94 0.052 -.026365 .0001416
2 | .0157596 .0058043 2.72 0.007 .0043835 .0271358
3 | -.0181399 .0113323 -1.60 0.109 -.0403508 .0040709
4 | -.0052419 .0128111 -0.41 0.682 -.0303513 .0198675
5 | .0207339 .011177 1.86 0.064 -.0011726 .0426404

```

Source: Own computation by STATA version 14.2 based on survey (2019)

Appendix E. Result of Multi co linearity

Explanatory variable	Co- linearity Statistics	
	VIF	1/VIF
Sex	1.40	0.71218
Age	1.54	0.64935
Education	1.46	0.68493
Familysize	1.63	0.61349
Extension	1.35	0.74074
Credit	1.21	0.82644
Saving	1.24	0.80645
Farmsize	1.15	0.86956
Livestock	1.37	0.72992
Info	1.18	0.84745
Markek	1.39	0.71942

Source: Own Result (2019)

Appendix F Livestock Category & Tropical Livestock unit

Livestock category	TLU-equivalent
Calf	0.25
Weaned calf	0.34
Heifer or Bull	0.75
Cows or Oxen	1.00
Donkey (young)	0.35
Donkey (adult)	0.70
Sheep or Goat (adult)	0.13
Sheep or Goat (young)	0.06
Horse or Mule	1.10
Chicken	0.013

Source: Storck *et al.* (1991).

Questionnaire for the survey on the Contribution of Livelihood Diversification to Climate Change Adaptation in Boricha Woreda, South Ethiopia

Questionnaire ID _____

Keble: - _____

Name of interviewer: - _____ Signature _____

Date of Interview: _____

Dear Respondent

The purpose of this questionnaire is to gather information which is used for study on the Contribution of Livelihood Diversification to Climate Change Adaptation in Boricha Woreda. This study is going to be conducted for the partial fulfillment of MSc degree in Climate Change and Sustainable Agriculture at Hawassa University. Your full support and willingness to respond to the question is very essential for the success of the study. Therefore, you are kindly required to answer all questions and give clear, appropriate and reliable information on the issues. Be sure that the information you provide is only for the purpose of this study.

Thank you.

Part I: Demographic and Socio-economic Characteristics of households

1. Sex of the respondent. 1. Male 2. Female
2. Age of the respondent_____
3. Educational level_____
 1. Cannot read and write 2. Can read and write
 3. Primary School (grade 1-8) 4. Secondary School (grade 9-10)
 5. Preparatory (11-12) 6. Diploma or above
4. How many family members do you have?_____
5. For how long have you been living in this area? _____ (yrs.)
6. How much is your land size currently(hectare) _____?
7. Do you have livestock? A) Yes B)No
8. If your answer for Q7 is “yes” please tell us in detail about livestock types

Livestock types	Total number of livestock owned	Total sales in birr
Sheep		
Goats		
Bull		
Cow		
Calf		
Donkey		
Horse		
Poultry		

9. What is the main occupation of the household head?
 1. Fulltime farmer 2. Regular salaried job 3. Seasonal/temporary job 4. Unemployed
 5. Self-employed 6. Student 7. Other (specify)

Part II: Climate Change and variability

10. Have you heard of the word “climate change” before? 1. Yes 2. No
11. Have you experienced any changes in your local climate in the last 30 years? 1. Yes 2. No

- 12.** What has been the trend of rainfall for the past 30 years to date according to your Perception? 1. Increasing 2. Decreasing 3. Fluctuating
- 13.** Do you feel that the timing of rainfall is a problem?
1. Yes, it onsets late and ends up late 2. Yes, it onsets early and ends up early
3. No, there is no problem on timing of rainfall but on its amount
4. Yes, it onsets on time but ends up early 5. Yes, it onsets late and ends up early
- 14.** What has been the trend of temperature for the past 30 years to date according to your perception? (Please tick the appropriate answer)
1. Increasing 2. Decreasing 3. Fluctuating 4. Constant 5. Don't know
- 15.** Do you face the problems of household income reduction due to changing of rainfall pattern? 1. Yes 2. No
- 16.** Your experiences and over all indicators about climate change

No	Have you experienced with the following types of climate change and variability indicators	Response		How often?(in past decade)
		Yes	No	
1	Drought			
2	Floods			
3	Off-seasonal rainfall			
4	Too much rain			
5	Too little rainfall			
6	Higher temperature			
7	Frost (coolness)			
8	High winds			
9	Others			

17. What do you say about climate change effects on livelihood?

Climate change effects	Respondents who experienced the impacts of CC(NHH=185)	
	Mark "X" Under the response	
	Yes	No
Crop failure		
Low crop productivity		
less pasture/grass for livestock		
Increased heat stress		
Drying rivers		
Crop disease incidence		
Livestock disease incidence		
Reduced cultivated land		
Loss of income		
Increase rural-urban migration		

18. Which local indicator do you use to evaluate these days?

- | | |
|--|----------------------------------|
| 1. Loss of some plant and animal species
productivity/fertility | 5. Decline of soil |
| 2. Increased drought and flood frequency | 6. Decline of agriculture yields |
| 3. Growing period shortened | 7. Decreased available water |
| 4. Rainfall comes early or lately | 8. Other (specify)_____ |

19. Do you think that production per unit area has been declining since the last 30 years?

1. Yes 2. No

20. What do you think the major factors affecting crop production in this area?

- | | | |
|----------------------------|---------------------------------|--|
| 1. Unpredictable rain fall | 2. Increased temperature | 3. Inadequate farm land |
| 4. Low soil fertility | 5. High price of farm implement | |
| 6. Shortage of labour | 7. Increased pest and disease | 8. Lack of farm implements
(fertilizer, improver seeds, pesticides etc) |

21. Did you face mortality of livestock? 1. Yes 2. No
22. If the answer for Q21 is “yes” what is/are major problems? 1. Lack of veterinary service
2. Drought 3. Shortage of forage 4. Shortage of water 5. Increase of diseases out break

PART III: livelihood diversification strategies

23. What are the livelihood activities for your families?
1. Rearing of livestock 2. Crop production
3. Employment in daily labor activities 4. Charcoal making
5. Small business/ petty trading 6. Remittance 7. Other, specify

24. Do you diversify your livelihood activities? 1. Yes 2. No
25. If yes for “Q24” can you tell livelihood diversification strategies in changing climate

Diversification strategies	Yes	No
Crop–livestock diversification and other good practices (mixed cropping, crop rotation, mulching, organic fertilizer)		
Agroforestry practices		
Find off-farm jobs		
Change from farming to non-farming		
Non-farm activities		
Migration		
Others specify		

26. If you were engaged in any of off/non-farm activities why you were engaged in such type of activities?
1. for survival strategy with changing condition of climate
2. Risk minimization from climate variability and change
3. For income improvement 4. Other

PART IV: Contribution of livelihood diversification to climate change adaptation in smallholder farmers

27. What are contributions of on-farm and non/off-farm activities to farm households?
1. Increase annual household income 2. Reduction of environmental risk

2. Give information about rainfall distribution in order to give early warning
3. About climate change impact and how it can be cope up
4. Give awareness about diversified livelihood
5. Others (specify)_____
40. Do you have access to any formal credits when you faced shortage of money to undertake your usual On-farm and Off-farm /Non-farm activities 1. Yes 2.No
41. Do you have access to any informal credits (from neighbours, friends, relatives etc)?
1. Yes 2. No
42. If yes to '40&/or41' where you look for credit to fill your financial constraints?
1. Relatives and Friends 2. Non-formal money lenders
3. Microfinance Institutes 4. Others (specify)_____
43. If you were not employed in any of non-farm/off-farm activities what are the constraints that you faced
1. Lack of credit 2. Lack of labour 3. Lack of working capital
4. Lack of support from GOs and NGOs 5. Availability of different agricultural and non-agricultural risks 6. Lack of different opportunities like poor infrastructure
7. Lack of information about the usage non/off-farm activities 8. Others (specify)
44. Do you have saving habit? 1. Yes 2. No
45. If answer for Q44 is "yes;" how much is the current amount of saving_____ birr or in kind_____ Qt. which is extra of consumption.
46. Do you have access to climate information? 1. Yes 2. No
47. If your answer is yes, from which medium do you possess?
1. TV 2. Radio 3. DAs 4. Newspaper 5. Other (specify)
48. What type of climate information do you get about?
1. Adaptation 2. Cause and impact of climate change 3. Temperature and rainfall
4. Other (specify)
49. Distance to selling market? (Walking distance in hr/km on average)_____
50. Distance to purchasing market? (Walking distance in hr/km on average)_____

Interview guide for Focus Group Discussion (FGDs)

A. Back Ground Information of Focus Group Discussion Participants

1. Sex _____ 2. Age _____
3. Educational level _____ 4. Family size _____

B. Assessment of farmer's perception on climate change and variability

- Do you know the meaning of climate variability?
- Is the pattern of weather is changing?
- How do you explain the change?
- What would be the cause?
- In the past 30 years how would you describe the rainfall pattern in terms of: -
 - a. Rainfall on-set and Cessation
 - b. Rainfall amount
 - c. Rainfall seasonal distribution.
 - d. Temperature
- Do you have any event that you remember causing life and property damage?
- What are the manifestation of climate change and variability? Are flood, drought, high temperature, too little rainfall, and frost frequently occurring?
- Has it impact on agricultural practice? Could you tell us the major impacts that you perceived?
- Have you faced food insecurity? How you explain it in relation with climate change?
- What are the local coping mechanisms used to reduce the impacts of climate change and food insecurity? Please list community based, governmental and/or NGOs assistance?
- Which crop and livestock types is more resistance to climate variability?

C. Livelihood Diversification strategies

- What are the major livelihood activities in your village?
- Do you diversify your income sources? Does this include on-farm, off-farm and non-agricultural income generating activities?
- In your opinion, are there enough on-farm, off-farm and non-farm income generating activities in your village?

- What are the common on-farm, off-farm and non-farm activities that people in your village engage in?
- Do you think these types of activities help you to withstand the effects of climate-change related shocks?

D. Contribution of livelihood diversification to climate change adaptation

- Do you think that on-farm, off-farm and non-farm diversification helps you to adapt to climate variability and change?
- Do you have any programs or projects that deal with increasing the capacity of households to better withstand the effects?
- Do you think contribution of livelihood diversification systems to climate change adaptation in the study area?
- What kind of support do you think is necessary for the farmers when they decide to diversify their livelihood systems?
- How do you assess the contribution of the income in terms of promoting the resilience of rural households towards climate-related disasters in the study area?

E. Determinants of livelihood diversification strategies

- What do you think are the major barriers/ constraints to engage in (on-farm, off-farm and non-farm) activities in your village?
- Do you have access to credit, saving, food aid, extension, agricultural inputs and technologies?
- Do you receive early warning information on short term variations and/or long term climate change from any sources? From which?
- Where do people sell their diversified products (on-farm, off-farm and non-farm)? And how far is it from your village?
- Finally, what should be done in order to minimize the impact and increase the adaptive capacity of the community?

Interview guide for Key Informant Interview/KII

a. Back Ground Information of key informant interview/KII Participants

1. Sex _____ 2. Age _____
3. Educational level _____ 4. Family size _____

b. assessment of farmer's perception on climate change and variability

- Have you heard of a word “climate variability and change”? If yes, from which sources have you heard?
- What does climate variability and climate change mean to you?
- How do you characterize the weather of your area in terms of its temperature and precipitation? Is there any change?
- Have you experienced any effects of climate variability and change on livelihood in your locality? If yes, describes the affects you have observed:
- What action you have took to address the challenges?

c. Livelihood Diversification strategies

- What are the livelihood activities in your locality?
- Do you think diverse activities (on-farm, off-farm and non-farm) helps to increase income of the smallholder farmers? If yes, how?
- Have you received technical support/or experience from any government body regarding to diversify livelihood systems in your Keble?
- Does your local peoples diverse livelihood activities as coping mechanisms?

d. Contribution of livelihood diversification to climate change adaptation

- Do you think that diversified of livelihood helps to climate change adaptation?
- Do you think diversification of income source activities are possible to adapt to the effect of climate change?
- How do you assess the contribution of the district government in terms of promoting the resilience of rural households towards climate-related disasters in your district?
- Is there any program or projects that deal with increasing the adaptive capacity of households to better withstand the effects?
- What should be done by farmers, developmental agents, administrators, financial institutions and others to enhance livelihood diversification?

e. Determinants of livelihood diversification strategies

- What are the constraining factors for household's livelihood diversification strategies? (e.g. For, On-farm, Off-farm and Non-farm) activities
- What are the credits and saving institutions related problems in your locality? What do you think the possible solution?
- What factors may have strengthened or weakened the contribution of livelihood diversification strategies?
- Do you receive early warning information on short term variations and/or long term climate change?

Biographical Sketch

The author was born on 29th march, 1987 G.C in Iltama *kebele*, Aroressa district, Sidama Zone; SNNPR to his Father Adiso Limasa and Mother Yure Yute He attended his primary, secondary

and preparatory school at Aroressa, Kebena Gaxa and Aleta Wondo woreda in the same Zone. He joined the Hawassa University in 2010 academic year and graduated with B.Sc. degree in Natural Resource Management in June, 2012. Soon after his graduation, he was employed by Government Organization, as the early warning and disaster prevention management at Agriculture and Rural development office in the Aroressa woreda, Sidama Zone until August 2016, and then he joined the School of Graduate Studies at Hawassa University in 2016/17 academic year to pursue his MSc program in Climate change and sustainable agriculture development.