EFFECTS OF SLM PROJECT ON HOUSEHOLD INCOME AND ITS IMPLICATION TO CLIMATE CHANGE ADAPTATION: THE CASE OF NEDJO DISTRICT, WESTERN ETHIOPIA

MASTER'S THESIS

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EFFECT OF SLM PROJECT ON HOUSEHOLD INCOME AND ITS IMPLICATION TO CLIMATE CHANGE ADAPTATION THE CASE OF NEDJO DISTRICT, WESTERN ETHIOPIA

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APPROVAL SHEET 1

As Thesis Research Advisors, We hereby certify that we have read and evaluated this thesis proposal prepared entitled*: ‘‘*Effect of SLM Project on Household Income and its Implication of Climate Change Adaptation the Case of Nedjo District, Western Ethiopia*’’*. We recommend that it be submitted as fulfilling the requirements for the degree of Master’s with specialization in *Climate Smart Agricultural Landscape Assessment under the department of Agroforestry* by Tamiru Kapitano, ID.NO. CSAL/R021/10.

Therefore, we recommend that the student has fulfilled the requirements and hence hereby can submit thesis to the departments.

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APPROVAL SHEET-II

We, the undersigned, members of the Board of examiners of the final open defence by Tamiru Kapitano Gamada have read and evaluated his thesis entitled "Effect of SLM project on household income and its implication to climate change adaptation the case of Nedjo district, western Ethiopia". This is therefore to certify that the thesis has been accepted in partial fulfilment of the requirements for the Degree of Masters of Science with Specialization in Climate smart agriculture Land Scape Assessment.

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DEDICATION

This work is dedicated to all my beloved families Especially My Mother Kenatu Gelata for her love, care and encouragement. There is their finger print on the very beginning of my today's success! They have inspired me with their hard work and dedication and I will forever remember them.

LIST OF ABBREVIATIONS AND ACRONYMS

(CO_2e) – Carbon dioxide equivalents

AF – Agroforestry

ANSLMP – Before Non-Sustainable Land Management Project

ASLMP – After Sustainable Land Management Project

BNSLMP – After Non-Sustainable Land Management Project

BSLMP – After Sustainable Land Management Project

CA – Conservation agriculture

CSA – Central Statistics Agency

CSA – Climate-Smart Agriculture

FAO – Food and Agricultural Organization

FGD – Focus group discussion

GHG – Green House Gases

HH – Household

IPCC – Intergovernmental Panel on Climate Change

KII – Key Informants Interview

LDCs – Least Developed Countries

M/G – Muchucho Georgis

NMA – National Metrological Agency

NRM – Natural Resource Management

NSLMP – None-Sustainable land management project

PPS – Probability Proportional to Size

S.D – Standard Deviation

SHH – Sampled Household

SLM – Sustainable land management

SLMP – Sustainable land management project

SOC – Soil organic carbon

SOM – Soil organic matter

SSA – Sub Sahara Africa

TFS – Total Family Size

THH – Total Household

UN – United Nation

UNDP – United Nation Development Program

UNFCCC – United Nation Framework Convention on Climate Change

USAID – United States Agency for International Development

USDA – United State Department of Agriculture

W/B – Wagari Buna

Table Contents

Title **Page**

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

LIST OF APPENDICES

Appendix **Page**

EFFECT OF SLM PROJECT ON HOUSEHOLD INCOME AND ITS IMPLICATION TO CLIMATE CHANGE ADAPTATIONTHE THE CASE OF NEDJO DISTRICT, WESTERN ETHIOPIA

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ABSTRACT

Climate change is significantly poses great challenges to all human kind, it is a challenges to the fight against poverty and sustainability of agrarian livelihoods. In study area, it is entailing sudden shocks that disrupt agriculture production, livelihoods of communities, infrastructure, and institutions. This study focused on the impact of climate smart agriculture in sustainable land management project and its implications for farmers' adaptation capacity in case of Nedjo district, Muchucho Georgis and Wagari Buna kebele, since its adaptation capacity and impacts have not been studied. The research had the aim of identifying crop production, livestock, honey production and forest adaptation options and assessing adaptation competence of respondents. Then Crop, livestock, honey and forest production income, adaptation level of respondents five years before and after project and non-SLMP group mean income in ETB was identified. From total population 712 HHs, 128 sample size HHs was identified 92% confidence level and ±8% and stratified by Proportionality allocation of sample size in to SLM project participant (68HHs) and non-SLMP group (60HHs). Data was collected, household survey, key informant and focus group discussions and meteorological data also obtained from NMA. The result indicated that the 30 years trends (1987-2016) of rain-fall a decreasing trend while the temperature was increasing. The five years mean income of households before SLM project was 2597.4 ETB, after project was 11,538.70 ETB as well as the non-SLM (2009-2013) and (2014-2018) income was 5032.80 and 6115.90 ETB respectively. When it compared the average five years income of households in project with pre-project was greater by 8941.30 ETB, and the non-project of the year of (2009-2013) got more than the year of (2014-2018) by 1083.1 ETB. Then the average five year project households' income greater than those of non-project by 7858.20ETB. Adaptation capacity of SLMP participants highly increased and none-SLM project was increased in minimum. Finally SLMP needed for the enhancing adaptation and to diversify source of income. Therefore, promoting SLMP is important since it promotes climate smart agriculture among small holders.

Keywords: ***Adaptation Climate change, Climate-smart agriculture, Sustainable land Management***

1. INTRODUCTION

1.1. Background and Justification

Climate change significantly a great deal of challenges to all humankind, the environment and it poses new challenges to the fight against poverty and sustainability of agrarian livelihoods in sub-Saharan Africa (IPCC, 2007). Climate change acceleration is anticipated to have wide-ranging effects on the future sustainability of the Earth due to adverse ecological, social and economic impacts (Stern, 2006). Climate change and climate variability is often entailing sudden shocks that disrupt agriculture production, livelihoods of communities, infrastructure and institutions (UNDP, 2011). By this climate shocks communities by slow-onset and persistent stress affects agricultural production system and their wellbeing.

The impacts of climate change and climate variability will have major effects on agricultural production, with a decrease of production in certain areas and increased variability of production to the extent that important changes may need to be made in the geographic area where crops are cultivated (IPCC, 2007a). The changing climate is also contributing to resource problems beyond food security, such as water scarcity, pollution and soil degradation (Hanjra *et al*., 2010). Changes in climate have also been found to have adverse effects on the economy and on agriculture production at large (Parry *et al*., 2004).

Although agricultural production systems are expected to produce food for a global population that will amount to 9.1 billion people in 2050 and over 10 billion by end of the century (UNDP, 2011). It is a key sector of both in the global economy and many national economies of developing countries and most Least Developed Countries (LDCs) (FAO, 2009). The problem is most acute in Sub-Saharan Africa (SSA), where population is expected to increase from approximately one billion in 2010 and between 1.9 and 2.4 billion people in 2050

(UNDESA, 2012). Ensuring adequate food supplies in the region will require faster growth in agricultural production output than that observed over the past decade (World Bank, 2013). Consequently, many countries have pledged to increase government support with the ambition of achieving an annual agricultural growth rate of 6 percent, a goal adopted by the Comprehensive most Africa Agriculture Development Programme (Lipper, 2014).

Substantial evidence now exists suggesting that agricultural yields will have to increase significantly in order to meet food needs during the 21st century (Van Oort *et al*. (2015) as cited in Ramirez-Villegas and Heinemann (2015). In Sub-Saharan Africa, climate-smart agricultural practices are increasingly promoted to tackle the challenges of low agricultural productivity and the threats posed by greater weather variability and vulnerability to climate change (James *et al*., 2015). So Climate smart agriculture adoption is as a combined policy, technology and financing approach to achieve sustainable development under climate change. It has developed to represent a set of strategies that can help to meet these challenges by increasing resilience to weather extremes, adapting to climate change and decreasing agriculture's greenhouse gas (GHG) emissions that contribute to global warming (Steenwerth *et al.*, 2014; Nciizah *et al.*, 2015).

Climate-smart agriculture(CSA) can be defined as an approach which seeks to increase productivity in an environmentally and socially sustainable way, strengthen farmers' resilience to climate change, and reduce agriculture's contribution to climate change by reducing GHG emissions and increasing carbon storage on farmland (Behnassi *et al*., 2014). It has the potential to offer 'triple-win' or have three objectives: sustainably increasing agricultural productivity to support increased incomes, food security and development; promoting adaptive capacity at multiple levels; and enabling greenhouse gas (GHG) emission reductions and increasing carbon sinks (FAO, 2013). For smallholder farmers in developing countries including Ethiopia, the opportunities for greater food security and increased income together with greater resilience will be more important to enhance adapting capacity of climate smart agriculture than mitigation opportunities (Neufeldt *et al*., 2011).

Therefore, the present study investigates the perception of local communities towards climate change, and how to prevent them was a necessary condition to conservation technologies in climate-smart agriculture. Agriculture practices such as soil-water conservation that manages land are pertinent in addressing some of the country's challenges and minimizing damages to the resource base. So it must be known about how climate smart agriculture translates into actions and achievement of goals for agricultural development and responses to climate change (Chinsinga *et al.,* 2012). And also the transformation of agriculture from traditional methods to appropriate climate-smart that promote adaptation capacity.

Therefore this study wanted to assess the adaptation implication of climate smart agriculture practices in sustainable land management project (SLMP) of the study area and to identify the major factor that positively or negatively affects agricultural production in Nedjo Woreda, Western Wollegga Zone of Oromia Regional State in view of bridging this gap.

1.2. Statement of the problem

According to the IPCC, "climate change and climate variability is very likely to have an overall negative effect on yields of major cereal crops across Africa, with strong regional variability of yield reduction" (IPCC, 2014). It accelerates farmers' vulnerability level to food insecurity and affects the smallholder farmers' livelihood..

In the study area, as a result of soil erosion, soil fertility decline and reducing crop production is apparent and farmers' livelihood is under problems with low adaptation capacity. To increase farmers' adaptation capacity, the climate smart agriculture has been practiced as the option by sustainable land management project in Nedjo woreda Agar Aleltu watershed from (2014 to 2016) for three years. The project promotes farmers adaptation capacity. To make climate smart agriculture (CSA) work as a source of income for the farmers, assessing and identifying adaptation potential of climate-smart agricultural practices is important (Neufeldt et.al, 2011).

However the role of the SLM project in CSA practiced had not been assessed and also, there is a few research done about the impact of climate smart agriculture practices on the livelihood of smallholder farmers' and on their local adaptation strategies. My study area as the other part of Ethiopia, the issues of climate smart agriculture practices is new and not much studied. Therefore this study was investigating the impact and adaptation implications of climate smart agriculture practices in the SLM project and other practices. In addition, the study explores farmers' perception about the climate variability, since awareness about the Climate variability and the recognition of local adaptation is seen as an entry point to strengthen the adaptation of local people to climate change and variability.

1.3. Objective

1.3.1. General Objective

To assess the effect of climate smart agriculture in Sustainable Land Management Project on household income and its implication to climate change adaptation in the study area.

1.3.2. Specific objective

- To determine adaptation option of climate smart agriculture practices on crop, livestock and forest production in the SLM project

- To determine the effects of climate smart agriculture practices on crop, livestock and forest in the SLM project
- To identify the Perception of farmers on climate change and climate Variability
- To make a comparative analysis between farmers' who applied climate-smart agricultural practices in the SLM project and non- SLM project

1.4. Research questions

- What is the adaptation option of climate smart agriculture practices on crop, livestock and forest production in the SLM project?
- What are effects of climate smart agriculture practices on crop, livestock and forest in the SLM project?
- What are the Farmers' Perception on local climate change and climate Variability?
- What are the farmers' adaptation potential between farmers who are included in the SLM project and non-SLM project?

1.5. Significance of the study

This study will fill the information gaps about the adaptation problems of farmers' in the study area. Specifically, the outcomes of this study will provide an insight towards an understanding of the trends and frequency of food insecurity. And used to forecast their agriculture production, land degradation, soil erosion and also their mechanisms that they are using to enhances adaptation capacity to climate variability.

Hence, the result can be used for governmental and non-governmental offices so as to have appropriate interventions on adaptive the problems and enhance climate smart agriculture practices for sustainable rural livelihood development. It can be also used for rural land management, rehabilitation, development planer, climate variability adaptation and preparedness planner, natural resources managers and policy makers to provide a management and decision process. And it can provide an organized document for the researcher, sustainable land management project (SLM Project) and other concerned body endeavors for climate change adaptation. The main output of this study will benefit the government by filling the information gap of the climate-smart agriculture, the degraded land and at the climate, variability problem exists.

1.6. Scope of the study

The scope of this study was assessing the potential of climate smart agriculture practices of sustainable land management (SLM) in Agar Aleltu Watershed. The study was also identified crop, livestock, honey production and climate-smart NRM. Identifying farmers' perception's on climate change, effect of climate variability on the livelihood of farmers and scanning of the local adaptation capacity and strategies in Nedjo district, Oromia region, Ethiopia. This study was analyzed the determinant factors of the SLM project to their choice of adaptation mechanisms.

1.7. Limitation of the Study

Nevertheless, it is hoped that the results of this study was provided important information on the trends of climate smart agriculture practices to improve farmers' livelihood and risk related. Also, it is fair to say that the study was much better if it is included more kebeles and samples in order to reveal more precise information about the impact of climate variability on the livelihood of farmers and their adaptation strategies against climate variability.

2. LITERATURE REVIEW

2.1. Terminology

The following definitions are used for key terminologies in this study.

Climate Smart Agriculture: CSA can be defined as an approach which seeks to increase productivity in an environmentally and socially sustainable way, strengthen farmers' resilience to climate change, and reduce agriculture's contribution to climate change by reducing GHG emissions and increasing carbon storage on farmland (Behnassi *et al*., 2014). And also it is defined as agriculture that sustainably increases productivity and resilience (adaptation), reduces/removes GHGs (mitigation), and enhances achievements of national food security and development goals. (FAO, 2013; Lipper *et al.*, 2014).

Sustainable land management: Sustainable land management is a knowledge-based procedure that helps integrate land, water, biodiversity, and environmental management (including input and output externalities) to meet rising food and fiber demands while sustaining ecosystem services and livelihoods and the environment (World Bank, 2008).

Adaptation: The adjustment in of a system of natural or human in response to actual or expected climatic variation or their effects, which moderates harm or exploits beneficial opportunities (UNFCCC, 2007). It is defined as activities that aim "to reduce the vulnerability of human or natural systems to the impacts of climate change and climate-related risks, by maintaining or increasing adaptive capacity and systems resilience (OECD 2009).

2.2. Climate Change and Climate Variability in Ethiopia

Climate change is a significant and lasting change in the statistical distribution of weather patterns over periods ranging from decades too long periods (Hansen *et al.*, 2012). Over the last decades in Ethiopia, the temperature increased. The temperature increase in the future and on the other hand, precipitation remained fairly stable over the last 50 years when averaged over the country (McMichael *et al.*, 2006). However, the spatial and temporal variability of precipitation is high, large-scale trends do not necessarily reflect local conditions. Studies with the climate models, however, indicate that the sign of the temperature will very likely continue to increase for the next few decades & the expected precipitation change is uncertain (Solomon *et al.*, 2009).

Ethiopia is one of the poorest countries in a world, its population has low-income opportunities and have low access to education, information, technology, and health services, because of this vulnerable to climate variability and highly sensitive to the weather change (Heltberg *et al.*, 2009). They have low adaptive capacity to deal with the consequences of climate variability and climate change. The average number of Ethiopian people requiring food aid is growing by more than half a million people per year (Sachs, 2008). These chronic and increasing aid requirements may soon extend beyond the capacity of early warning systems (FAO, 2010).

2.3. Climate smart agriculture in Ethiopia

Climate smart agriculture has designed in Ethiopia for improving the integration of agriculture development and climate responsiveness. It aims to achieve food security and broader development goals under a changing climate and increasing food demand. CSA initiatives sustainably increase productivity, enhance resilience, and reduce/remove greenhouse gases (GHGs), and require planning to address trade-offs and synergies between these three pillars: productivity, adaptation, and mitigation (FAO, 2010).

Agricultural systems are almost exclusively rain-fed. Of an irrigation potential of approximately 2.7 million hectares of land, only 2–3% of the cropland is currently irrigated (Yirgu *et al.*, 2013). In 2015/16, roughly 1.4 million farmers (180,000 ha of cultivated land) used irrigation for crop cultivation, mainly from rivers and natural ponds, and, to a lesser extent, through installed water harvesting systems. Most of this irrigated area was used for maize, sorghum and coffee production, while sugarcane, potato, and vegetables, such as onions and tomatoes, are also among the commonly irrigated crops. However, the country is endowed with huge water resources (springs and rivers), and its irrigation potential is highly underused.

CSA practices present opportunities for addressing climate change challenges, while simultaneously supporting the economic growth and development of the agriculture sector. For this profile, practices are considered climate-smart if they maintain or achieve increases in productivity as well as at least address one of the other objectives of climate smart agriculture (adaptation and mitigation). Hundreds of technologies and practices around the world fall under the heading of CSA (FAO, 2010).

Ethiopia have been found to improve soils and natural vegetation, regulate floods, improve soil fertility, provide alternate income in the form of beekeeping and provide a source of fodder (cut-and-carry system) for livestock. These benefits are in addition to the carbon sequestration benefits that accrue as the landfills with vegetation (Joosten *et al.*, 2017). Many of the crop- and livestock based CSA practices also help build a system's resistance to pests and diseases, such as in the case of drought-tolerant crop varieties and livestock breeds, and the use of rotations in crop production (Georgis, 2010).

In the broader Ethiopian context, climate-smart practices and technologies are being implemented within the framework of integrated watershed management, which incorporate a broad range of practices in crop and livestock production including agroforestry, crop rotation and intercropping (FAO, 2016) as well as broader soil and water conservation measures such as soil/stone bunds, terracing, infiltration ditches, and tie-ridges among others. It is important to note that although soil conservation practices, such as reduced tillage and crop rotations, have long been practiced by farmers in Ethiopia, the promotion of conservation agriculture as a package with associated benefits has experienced various challenges related to knowledge, and technology awareness that still needs to be addressed (FAO, 2016).

2.3.1. Adaptation option of climate smart agriculture practices on crop production

Crop production for food, fiber and animal feed is practiced within a very diverse range of farming systems and each which is subject to widely differing socio-economic, climatic and soil conditions (Rhodes *et al.,* 2015). There are three main means of increasing agricultural production to meet projected increases in a food demand: bringing new land into agricultural production; increasing the cropping intensity on existing agricultural lands, and increasing yields on existing agricultural lands. Adoption of any one of these strategies will depend upon local availability of land and water resources, agro-ecological conditions and technologies used for crop production (FAO, 2009).

The continued land degradation and water scarcity even in the absence of climate change could also have major impacts on the future agricultural supply response. The salinization of soils, nutrient depletion, and soil erosion all reduce the productivity of lands for agricultural production (FAO, 2009). Overall, UNEP (2009) estimates a loss of 0.2 percent in cropland productivity per year globally due to unsustainable agricultural practices. Climatic variability affects crop development and yield response to weather variables and exceeding of well-defined crop thresholds, particularly, temperature (Porter and Smenenov, 2005).

Crop productivity can be increased through the breeding of higher-yielding crop varieties, though crop and crop nutrient management, improved agronomic practices and through the choice of crop species that have higher yield potentials under given environmental conditions (Rhodes *et al.,* 2015; Nhamo *et al.,* 2016).

Farmers who currently grow drought-tolerant maize may have to switch to these alternative cereals in the future (Cooper *et al.*, 2008). Various coping and adaptation strategies were employed by farmers as responses to the declining rainfall and crop productivity (Kessler, 2016). The vulnerability of a system depends on its exposure and sensitivity to changes, and on its ability to manage these changes (IPCC, 2007a; WB, 2010a). Both household vulnerability and vulnerability of agricultural systems could be reduced by altering exposure, reducing sensitivity, and improving the adaptive capacity of the system (Adger *et al.*, 2004; OECD, 2009).

The three conservation agriculture principles are aims to improve the productivity and profitability of smallholder farms while also enhancing their resilience to climate change (Nyasimi et al., 2014; Richards *et al.,* 2014). First maintaining good soil cover means keeping plant residues and weed biomass on the ground surface without burning. Many definitions of CA use 30% permanent organic soil cover as the minimum, but the ideal level of soil cover is site-specific (Richards *et al.,* 2014). The second principle is: minimum soil disturbance is a non-negotiable basic and may involve controlled tillage in which no more than 20 to 25% of the soil surface is disturbed. And also the third is crop rotations, intercropping and relay cropping can incorporate legumes into the system improves soil health and reduces pests and diseases (Antle *et al.,* 2008; Nyasimi *et al.,* 2014; Richards *et al.,* 2014). From the second cropping season onwards, maize yields, for example, are 11–70% higher with conservation agriculture, especially in years of low rainfall and CA reduces water needs of crops by 30%, lowers energy needs by 70% and sequesters significant amounts of carbon (Hailu and Campbell, 2011).

2.3.2. Adaptation option of climate smart agriculture practices on Livestock Production

Climate change is likely to have considerable impacts on livestock production and these will include a substantial reduction in the quantity and quality of forage available in where higher temperatures and lower rainfall are expected to reduce rangeland yields and increase degradation (FAO, 2009). Restoring degraded grazing lands and improving forage species is important to sequestering SOC and more serious impacts are anticipated in grazing systems, as a result of their close links to climate and the natural resource base that is being damaged by climate change (Lal, 2004; Baudeon et al., 2007; Opio *et al.,* 2013). Given the current and future resource scarcity and in the face of projected demand for livestock products, there is considerable agreement that more efficiency gains in resource use are a key component to improving the sector's environmental sustainability and make a large contribution to climate-smart food supply systems (Pierre, 2006).

Interventions that target improved forage, animal feed resources, and quality feed directly increase productivity. Similarly, interventions aimed at improving animal health, such as appropriate vaccination programs and the use of more disease-resistant animals, will also improve animal productivity (FAO, 2009). Other key measures for livestock productivity include management of herd size and age structure, and appropriate manure management can also lead to increased productivity of both food and fodder crops (Hailu and Campbell, 2011; USDA, 2013). Livestock's role in adaptation practices relates to organic matter and nutrient management (soil restoration) and income diversification (Lal, 2004; Pierre, 2006).

2.3.3. Adaptation option of climate smart agriculture practices on Forestry and AF

Agroforestry activities are widely perceived as a longer-term sustainable land use practice that can help achieve a range of rural development objectives related to improved land use, farmer livelihoods and tackle climate change (Persha, 2014). Farmers may use trees to complement rather than replace their crop-planted acreage, for example, through nitrogen-fixing legumes that provide additional nutrients to the soil and combat widespread soil fertility declining food production (Hailu and Campbell, 2011). In more recent years, a heightened awareness of the projected negative effects of climate change across the region has promoted interest and effort in expanding agroforestry efforts in sub-Saharan Africa to improve yields (Persha, 2014). Agroforestry practices increase the absorptive capacity of the soil and reduce evapotranspiration. And also canopy cover from trees can also have direct benefits: reducing soil temperature for crops planted underneath and reducing runoff velocity and soil erosion caused by heavy rainfall (Rhodes *et al.*, 2015). Agroforestry in the rural landscape contributes to environmental sustainability and benefits climate change adaptation by storing carbon, halting land degradation, and fixing nitrogen (Zoysa and Inoue, 2014).

2.3.4. Overview of adaptive capacity

Communities have a long record of adapting to the impacts of weather and climate through a range of practices that include climate smart agriculture practices (crop and livestock production related to climate-smart agriculture) such as; crop diversification, irrigation, water management, disaster risk management, and insurance. Adaptation measures that also consider climate change and climate variability are undertaken by a range of public and private actors through policies, investments in infrastructure and technologies, and behavioral change (IPCC, 2007).

3. MATERIALS AND METHODS

3.1. Description of the study area

3.1.1. Geographic Location

The study was conducted at Nedjo Woreda, Oromia Region, and West Wollegga Zone; Ethiopia. Nedjo district is located geographically between $9^0$15'00"_$9^0$45'00" N latitude to $35^0$15'00"_$35^0$45'00" E longitudes in Western Oromia regional state of Ethiopia.

It is situated about 497km west of Addis Ababa. It borders/surrounded by three woreda's and one regional state that named as Boji Chokorsa district on the East, Jarso District to the south, Lata Sibu district, & Benishangul Regional State in the North to South East of the study area.

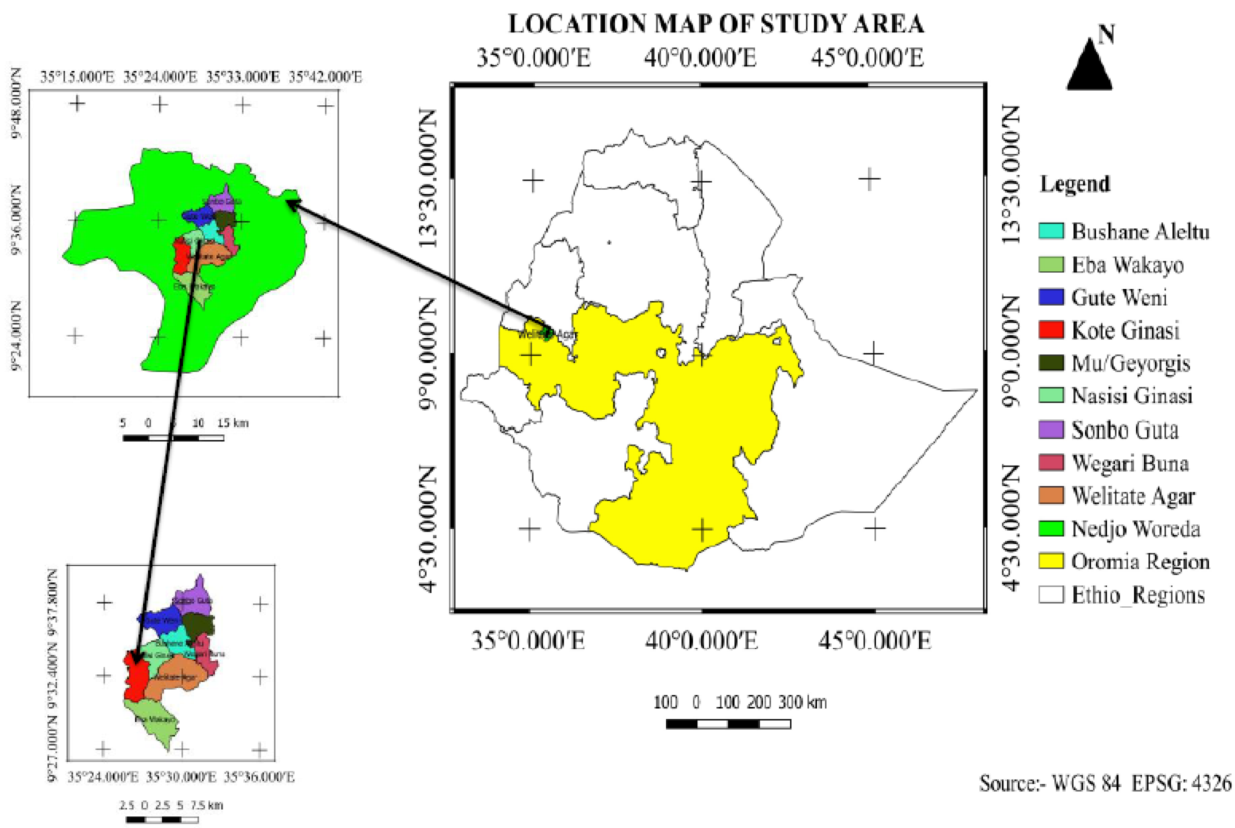


Figure 1: Map of Study Area

Source: Developed from Ethio-GIS, (2019)

3.1.2. Climate and Agro-ecology

The study area has two agroecology zones dega /high land 95% and weyina dega /midland 5% and the altitude ranges from 1600-1900m.a.s.l. The average annual temperature varies from 18^0 to 28^0 while annual rainfall varies between 1200mm to 1600mm. The main rains season of the woreda lasts from May through September (NMA, 2019).

3.1.3. Topography

The topography of the Woreda is generally rugged and broken, with many hills and ridges, making the most area unsuitable for agriculture, even though cultivated. According to the Nedjo Woreda Office of Agriculture and Natural Resources, 2019 the land form of the Woreda is classified as 61.5% undulating, 29.5% mountainous, and 9% valley.

3.1.4. Vegetation Types

According to the potential natural vegetation of eastern Africa (Breugel et.al. 2015), the vegetation type of the study area is mainly composed of vegetation type is Afromontane densely large parts of the Ethiopian highlands. The predominant vegetation type of the study area is Afromontane densely undifferentiated forest. However, there are also substantial areas with semi-evergreen bushland and thicket at lower margins. Broad leafed deciduous tree species such as *Cordia africana, europaea, eucalyptus camaldulensis Albizia gummifera, Grevillea robusta, Sesbania sesban, Leucaena leucocephala, Cupressus lusitanica, and fruits like Carica papaya, Mangifera indica,* etc are vegetation type of the study area.

3.1.5. Soil Types

The soils of the study area differ in color and type depending on the topography and types of the parent materials. The commonly observed soils in the areas vary in color from black to red. Regarding the types, the oxisols which are acidic is the dominant of the study areas (FAO, 2014).

3.1.6. Population

The district is classified in to 35 rural and 2 urban peasant associations/kebeles. Based on the population projection estimates on the 2007 census, Nedjo Woreda has a total population 174,888 of which 86,084 are males and 88,804 are females. From this 23% of them reside in town and 77% of them are in rural. The total households of the District are 23,352, from which males comprise 21, 885 and females are 1,467.

3.1.7. Land use, Cropping system, and Economic Activities

Nedjo woreda has different land use patterns, which is supporting the livelihood of the inhabitants in different ways. The land use pattern of the Woreda has a total of 72601.777ha. Of this cultivated land 20223 ha, grazing land 671.1 ha, forest and bushland 11839.35 ha and, gulley land 1623 and other land 30178.887ha, building and settlement constitute 8066.44 ha,

Nedjo Woreda is endowed with diverse agro-ecology and natural resources, with the capacity to grow diverse annual and perennial crops. According to the data from Nedjo Woreda Office of Agriculture and Natural Resources, 2019 the cultivable size of land suitable for crop production in the woreda is 27,454ha. The dominant crops grown in the Woreda are teff, sorghum, maize, wheat, barley, vegetables, mung bean, haricot bean and, chickpea during the Meher/wet and Belg seasons. Coffee and chat are the dominant cash crops grown in the district. The average landholding size per household (HH) is 0.894 ha while the average cropland size per household (HH) is 0.866 ha according to source from the office of Nedjo woreda Agricultural and Natural Resource, 2019. According to the same source, crop production share from the annual crop production in the district season are spring/Belg, Autumn/Mehir and summer.

3.2. Research Methods

3.2.1. Sources of data

The primary data sources include household interviews, focus group discussion (FGD), key informants, and interview and field observation. Secondary data such as time series rainfall and temperature data from the National Meteorological Agency (NMA, 2019) branch office and relevant published and unpublished documents/reports was collected from libraries and government offices.

3.2.2. Sampling Techniques and Sample size

Sampling Techniques: In the study district, there are 37 kebeles and almost all the kebeles (65%) are in the high land (Dega) while the remaining parts (35%) shared by midland (Woina Dega) agro-ecology zone. The multi-stage sampling procedure was employed to select sample households. Out of 37 kebeles found in Nedjo district, nine kebele found in Agar Alaltu watershed, on which SLM project has been adopted. From the above nine kebeles, two kebeles (Wagari Buna and Muchucho Georgis) were selected purposively. That means in both kebeles there are households those participated in the SLM project and there are those not included in the project and almost their livelihood similar with the 7 kebeles of Agar Aleltu watershed. The farmers are categorized in the development group/cluster. There are 26 developments group/cluster which 14 of them are included in the SLM project and 12 are excluded from both two kebeles. One group included in between 20 to 30 households.

Sample size: In this regard, the number of sample households of the target population at 92% confidence level and 0.08 (8%) level of precision was determined by using a simplified formula provided by Yamane (1967).

$n = \frac{N}{1+N(e)^2}$ -- (Yamane, 1967)

Where *n* is the sample size, *N* is the population size, and *e* is the level of precision at 92% confidence level.

SLMP adopted households =**378 (from W/B=106HH & from M/G=272HH)** and

Non-SLMP adopted households =**334 (from W/B=214HH & from M/G=120HH)**

Total Household of the two kebele: - Wagari Buna and Muchucho Georgis **712HH**

Total sampled households of the two kebele:- $\boldsymbol{n = \frac{N}{1+N(e^2)}} \quad = \frac{\mathbf{712}}{\mathbf{1+712(0.0064)}} = \mathbf{128}$

Probability Proportional to Size (PPS) sampling technique would be used to determine the number of sample households selected from each *kebeles*. Finally, simple random sampling technique (Lottery method) would be used to select sample households from the two *kebeles.*

nh =Nh x $\mathbf{N^{-1}}$:- nh = probability proportional size

N=Total population

Nh = Total population with in strata

n = total sample

Probability proportional size (nh) of each kebele:-

nh of SLMP included = Nh x n x N^{-1}=378THH x 128 / 712 =48384/712= **68 SHH**

nh of SLMP excluded =Nh x n x N^{-1} =334THH x128 / 712 =42752/712=**60 SHH**

Then the number of the two Population sample size is 68 SHH+60 SHH**= 128 SHH**

The study area both included SLM and Non- SLM project adopted on the clusters of the two kebeles of the district. The respondent were 59 male & 9 female from SLMP and 53 male & 7 female from non- SLM project , in general 128 HHs (68 of SLM and 60 HHs of Non-SLM project) were selected (Figure 2).

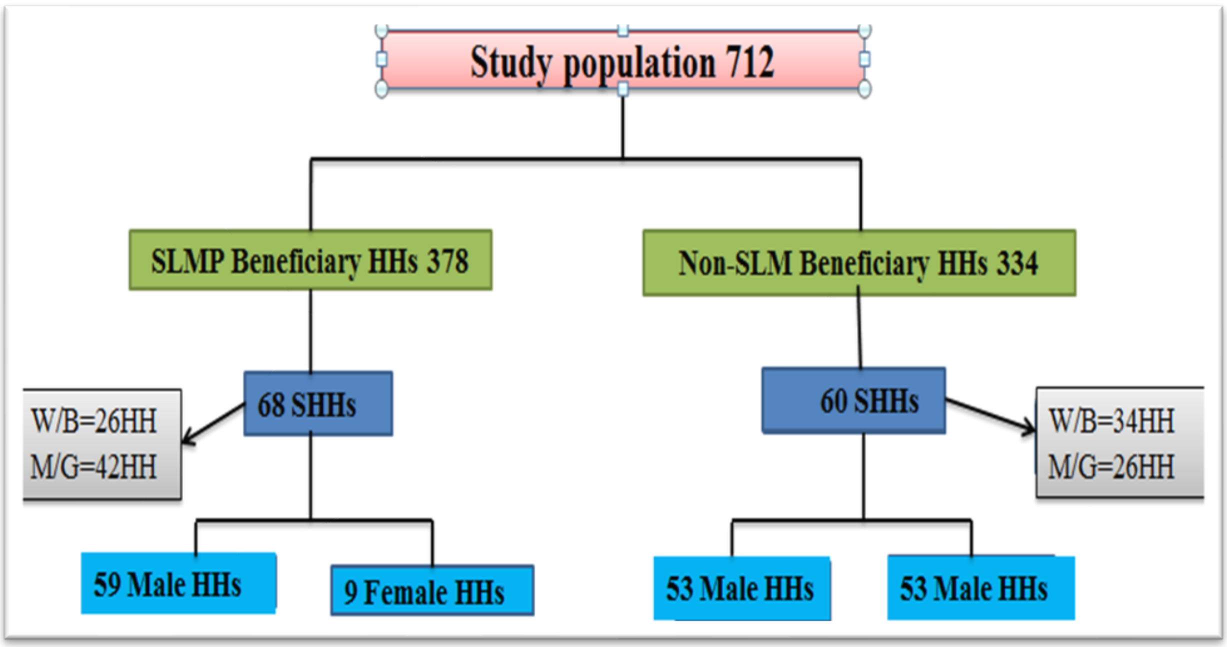


Figure 2: Sample size determination of stratified groups (in SLMP and NSLMP)

Data Source: Field Survey data, (2019)

3.2.3. Data Collection Methods

Both qualitative and quantitative approaches were used to address the objectives of the study. In this study, the perception of selected households on the effect of climate variability was assessed. Different methods such as semi-structured household survey, key informants interview and focus group discussion and field observations were used to collect both qualitative and quantitative data.

- **Household Survey**

One method of gathering primary data is the household survey method. By this particular method, 128 households (18% of the total households of the two kebeles) were considered. The household survey questionnaire has both open and closed-ended questions. The main contents of the questionnaire would include personal information of the respondent, household demographic information and mobility history, farmers' household hold in watershed, crop, livestock and forest production information before the project and after the SLM project, and availability of social services, Applied perception on climate change and variability and farmers' adaptation capacity. The questionnaire was prepared in English language and translated to the local language. Pretesting of the questionnaire was conducted to see about inclusiveness, its validity, relevance, and comprehensiveness. Based on the pre-testing feedback, final questionnaire would be prepared and administered accordingly.

- **Focus group discussion (FGD)**

Focused group discussion helps to generate data at the households level and involves a small group of respondents to discuss on issues forwarded by the facilitator who is a skilled moderator focusing on key issues of the research topic (Mwanje, 2001). The focus group discussion was conducted to get general information about the impacts of climate smart agriculture on farmers' livelihood and the community adaptation capacity. According to Gill and Chadwick (2008), a focus group discussion composed of between six and fourteen members is adequate in a group. Then in this particular research, three group discussions were conducted with 8 members of each group and in general 3groups and 8members per each purposively selected knowledgeable community members consisted of elders, youth and women. The main purpose of the focus group discussions is to get insights on and understand the impact and adaptive implications of climate smart agriculture practices, and their responses to the climate variability induced risks.

- **Key Informants Interview (KII)**

The interview was adopted as a method for data collection partly due to its cost-effectiveness and its strength of capturing empirical data in both informal and formal settings (Kothari, 1990). KII would be employed in order to support the data, which were collected from the household survey. Key informants are knowledgeable people who know about the study area and impacts of CSA practices on farmers' livelihoods between before, after and none- adopted of the SLMP project and its adaptive implications. Accordingly, 10 key informants were interviewed for this particular research from knowledgeable local elders, group leaders and clan leaders 5 people and government offices 3 people and from 2 kebeles leader who knows about the study area, agricultural practices, climatic situations and local adaptation strategies that have been practiced by the local community. The checklist of key informant's interview has three major parts namely perception of sustainable land management project (SLMP) impacts on climate variability and on the smallholder farmers livelihoods, effects of climate smart agriculture practices (climate-smart crop, climate-smart livestock and climate-smart forest production in SLM project and the adaptation strategies of the practices.

- **Field observations**

Field observation was used during the whole period of fieldwork activities by informally discussing with people; observed different climate smart agriculture activities (climate-smart crop, climate-smart livestock, climate-smart NRM and others activities) carried out by sustainable land management project (SLMP) to adapt the impacts of climate variability and attended different community meetings.

3.2.4. Data Analysis

- **Methods of Data Analysis**

The data was collected from household survey (128), key informants' (10) interview and focus group discussion (FGD) (24) entered into a computer for analysis mainly using micro soft Excel and Minitab version 17.1 (Minitab V17.1). Before running the analysis, some internal consistency checks were made to assess the quality of data. The relationship between different parameters was tested by using Descriptive Statistical method such as means, frequency, Minimum, Maximum, Variances, and Standard Deviation. In addition graphs, charts, diagrams, tables, ratios, percentages, and histograms were used to summarize and present the result. After selecting the important variables data interpretation and analysis were employed to fit the data with the best explaining variables. Whereas data collected through open-ended questionnaire, KII, FGDs, and documents were narrated following the quantitative data results.

4. RESULTS AND DISCUSION

4.1. Demographic Socio economic Characteristics of the Sample Households

A total of 128 HHs, were interviewed for this study of which 112 were males and 16 of them were females. Out of the 112 males households (53.57%) was from Muchucho Giorgis, and (46.43%) were from Wagri Buna. Among the 16 female households, 68.75% of them were from W/Buna 31.25% were from Muchucho Georgis. The surveyed househlds had a total of 712 persons in their households. The survey revealed that the average family size were 4.34 persons per household. This implies that households with large family size put more pressure on cultivable land if the population growth is intensified in the future; given the present trend, there would be low employment opportunity in off-farm activities in the area (Table 1).

Table 1: Number of Respondents and Total Populations of Study Kebeles

Study Kebeles	**SHHs of Respondents**			Total Family Size			**Total Population**	
	Male HHs	Female HHs	THHs	Male	Female	Sum	THHs	TFS
M/Georgis	60	11	71	143	197	340	370	1635
W/Buna	52	5	57	110	106	216	292	1259
Total	112	16	128	253	303	556	662	2894

Data Source: Field Survey data, (2019)

The largest number of respondents (87.5%) was male-headed farming households. Female-headed farming households constituted only 12.5% of the respondents. This indicates that a majority of the farm operations in the study area were managed by men more likely to perform the various agricultural tasks than women.

Majority of smallholder farmers own small pieces of land where they cannot grow sufficient crops to support their livelihood. Many children in a homestead need large pieces of land for smallholder farmers to support their livelihood including healthcare, education, feeding and clothes. Many children per household are a result of high fertility rate and early marriages among women in the region. A household with many children may fails to meet all the basic needs for children upbringing hence undermining their welfare. The undermines both food and income security for the households in the region. The findings this study contradicts previous studies which show that family planning supports the country sustainable development goals and ensures that a few children help parents provide the required basic needs to the their children.

4.1.1. Family Size

Family size influences various activities in term of family labour availability, annual income of family etc. With regard to the family size of the surveyed households, 57.83% (25.8% & 32.03%) replied that they have greater than 6 families, 21.87% have 3up to 5 families, while 20.30% less than 3 families (Figure 4).

Details of the results are presented According to the research conducted by Nkonya et al., (2008) in Uganda; a household with a large family size is more likely to adopt labor-intensive technologies. Therefore, in this research, households with more family sizes had advantages of implementing agricultural practices than those holds with less family size.

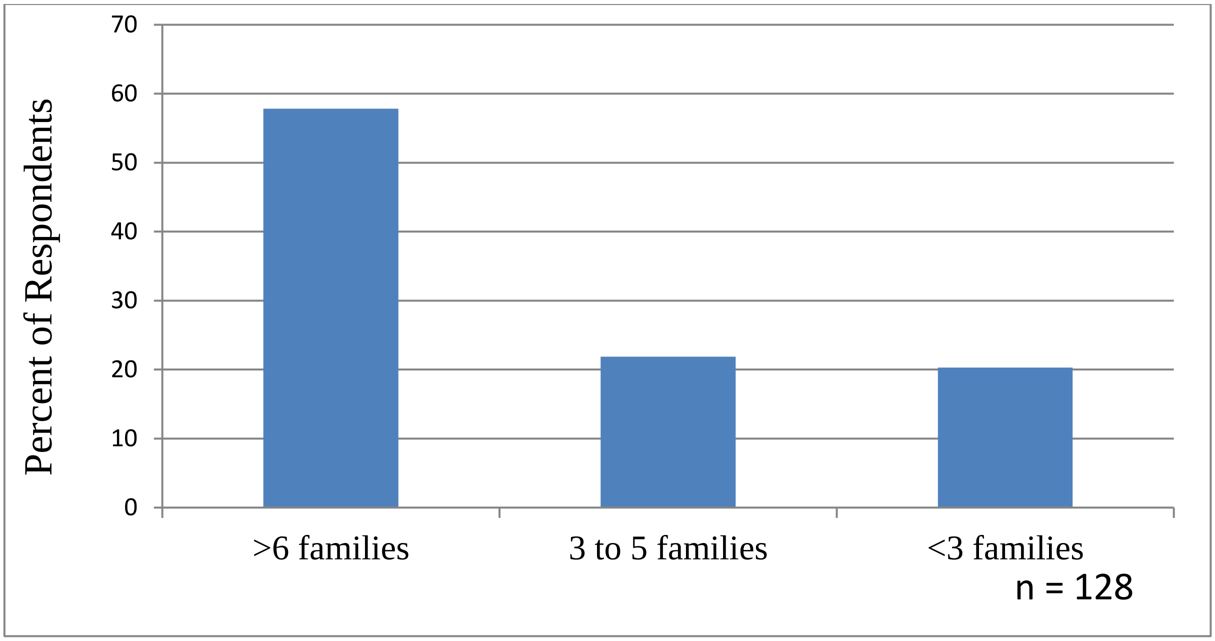


Figure 3: Family size of respondents

Data Source: Field Survey data, (2019)

Households that have a large family size with working class greater than 14years aged have a good contribution to agricultural farming. In this regard, Silvestri et al., (2012) argued that having a large family enables one to have higher labor that is needed to carry out different farm activities. Among the 128 respondents, most of the households (56.25%) between 21 and 41 years aged. This indicates that the majority of respondents' participated in the agriculture system.

4.1.2. Marital Status of Respondents

When considering the marital status, out of 128 respondents, 112 (87.5%) interviewees reported that they were married, 4HHs (3%) were unmarried, while 12(9.5%) were widowed (Figure 3).

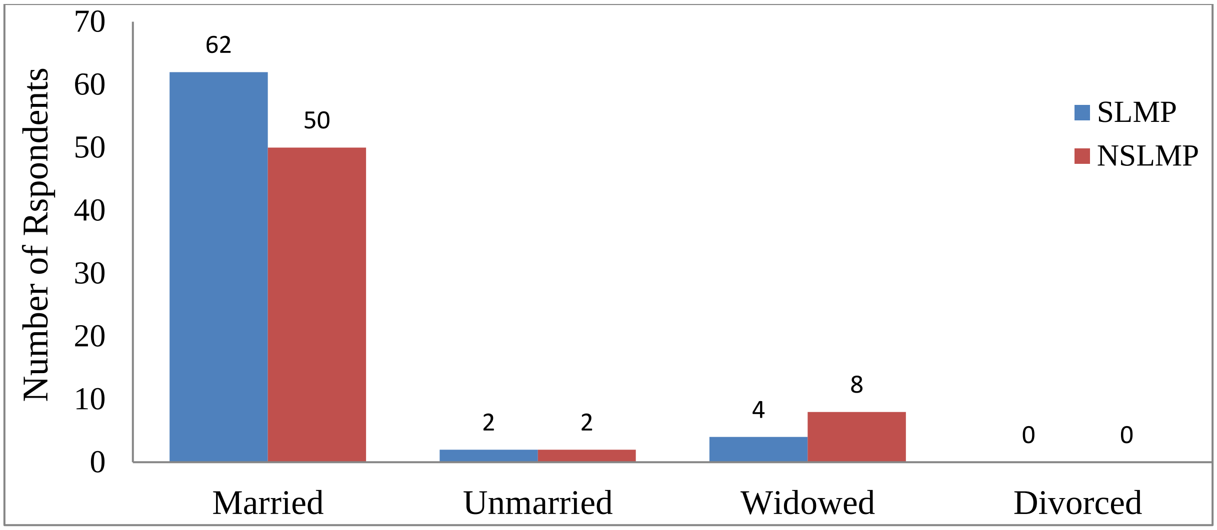


Figure 4: **Distribution of respondents according to Marital Status**

Data Source: Field Survey data, (2019)

4.1.3. Education Level of Households

In terms of educational achievement, out of 128 household heads, (33.6%) were illiterates, (20.31%) can read and write, 26.56% had attended from grades 1to 4, 15.62%) had covered grades 5 to 8, 2.34 % attended from grade 9 to 12 and only 1.56% those were grade 12 (Fig 5).

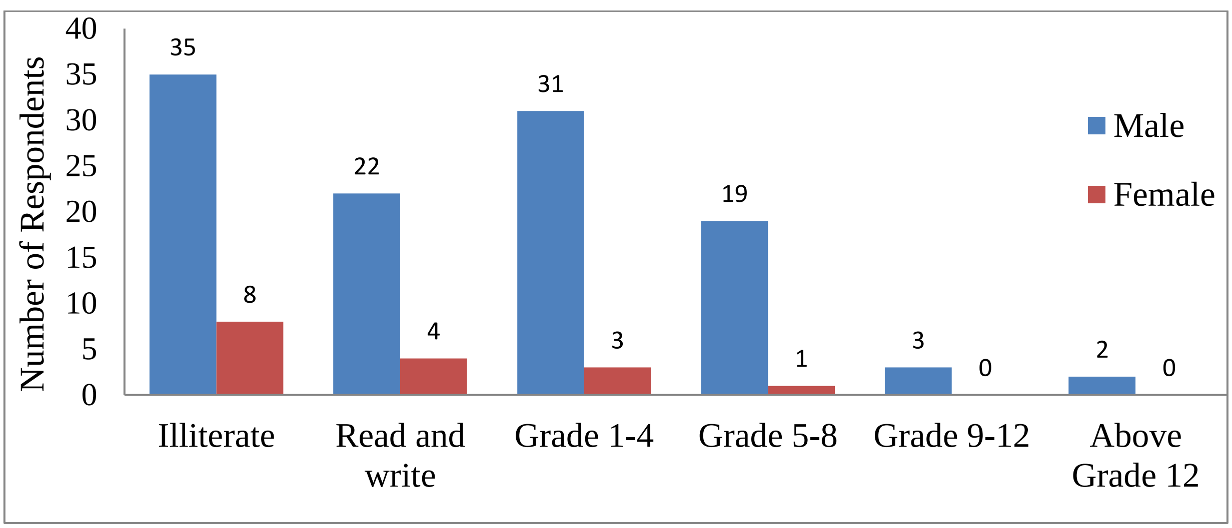


Figure 5: Educational Level of Respondents by Sex

Data Source: Field Survey data, (2019) The study area survey revealed that 43 of households were founded illiterate. Illiterate smallholder farmers and those with a low level of education will have difficulty understanding climate change, adaptation messages and take to adopting technologies. Here the respondents those educated and not educated in the SLM project are different in accepting and adopting technologies as well as an understanding of climate change and adaption message. For example; according to Deressa et al, (2007) education increases the probability of adapting to climate change. Hence, improving the education level would be very significant to adapt and use of improved technologies, irrigation and tree planting as adaptation strategies to climate change.

According to Dunne, *et.al.,* 2005 study, states that there is positive associations between education and technology adoption and using because educate persons understand and accept technology more than others. Concepts of education and farm efficiency through worker effect, allocative effect, and choice of production technique are well-defined in Schultz (1975). Another concept of productivity, Education enhances a farmer's ability to know his alternatives, to know when and where to buy and sell. A better-educated farmer is more likely to know what prices are likely to prevail in equilibrium, and can, therefore, become a better bargainer. They may also have finer discrimination of differences in quality and may be able to judge quality more accurately. Many existing studies find positive effects of education on the adoption of agricultural innovations by farmers.

4.1.4. Farmers Landholding

The size of the landholding of surveyed farmers was very small in the study area. According to Nedjo woreda Land Administration and Environment Protection office 2019, the two kebeles of SLM and non-SLM project villages, 36% of farmers Owen between 0.5 and 1 hectare of land, 12.6 % had between 1-2ha, 11.9% of them were 2-3 ha, while those cultivate less than 0.5 ha was 39.5 % (Figure 6).

The minimum and maximum size of landholding was 0.125 and 3 ha, the average being 0.894 ha. The majority of interviewed households indicated that the land they cultivate is insufficient to support their household. During the FGD at kebele level, more than 95% of respondents suggested that the individuals' landholding size had shown a declining trend. According to the above report, per household landholding of the woreda is expected to decline from average of 0.894 ha in 2019 to 0.82 ha and 0.66 ha in years 2020 and 2022 respectively. It argued that fragmentation has a negative impact on the intensity of management of the land which in turn has an influence on the productivity and degradation status of land (Gebremedhin, 2003).

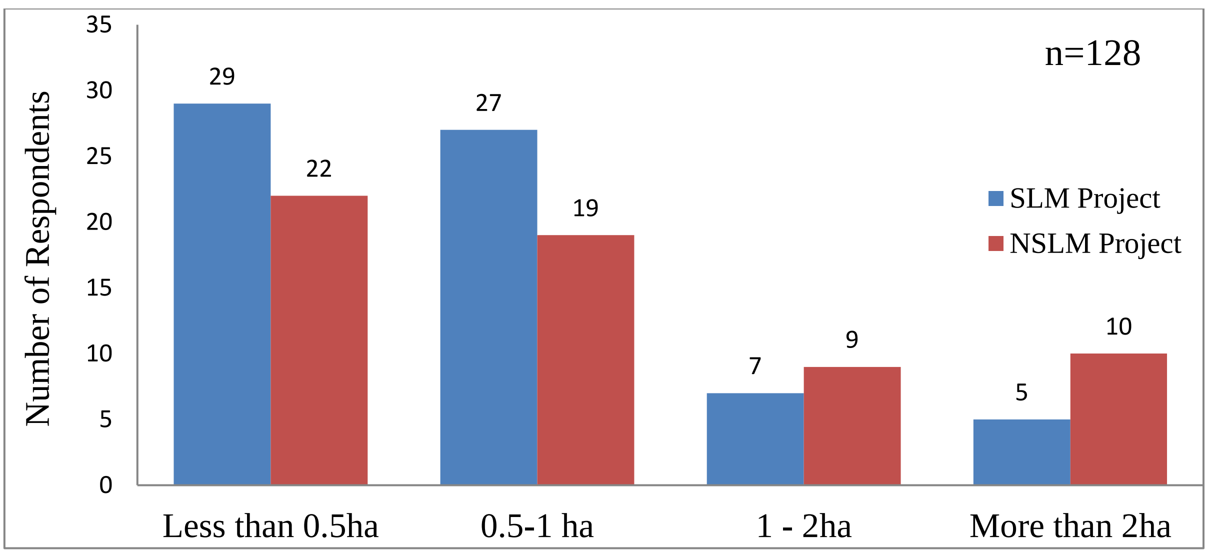


Figure 6: Landholding

Data Source: Nedjo Land Administration & Environment Protection Office, (2019)

The SLM project included respondents' even if their average land holding less than that of the non-SLM project but they cultivate almost a great percent than others. This is because they were supported by the project. They provide training on different agricultural technology to practiced row planting, using compost, on soil and water conservation, on contracting irrigation, and etc. For example, the finding points out that small land holdings that may require the application of intensive and sustainable practices by the project in order to support the increasing needs of farming households with a rising population (Bewket and Stroosnijder, 2004). This helped them to bring uncultivated land to productive while the non-SLM project households simply cultivated a minimum percentage of their land holding (Figure 7).

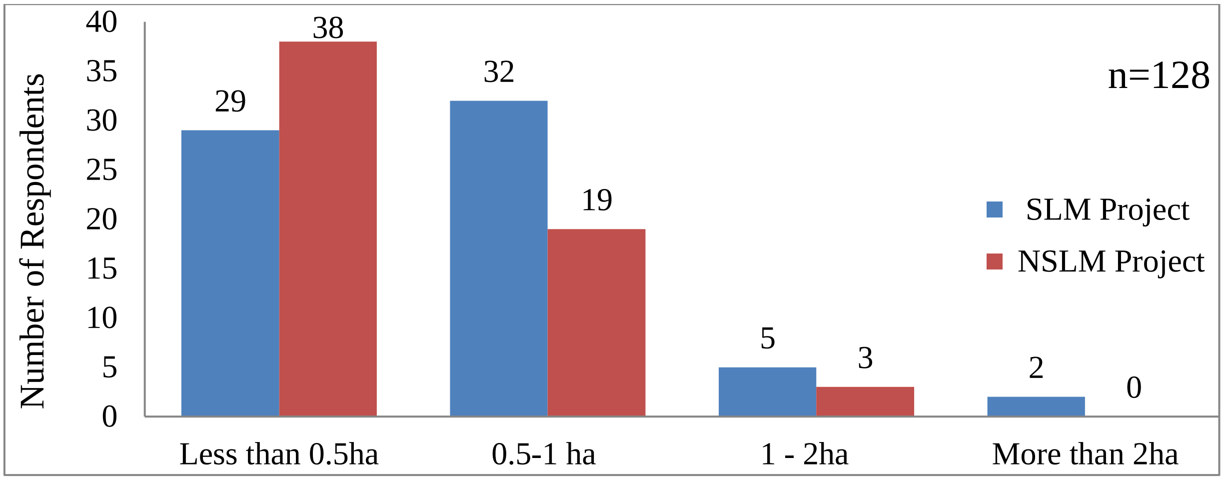


Figure 7: Level of Cultivation Land by Respondent

Data Source: Field Survey data, (2019)

4.1.5. Farmers livelihood

The land in the midlands of Nedjo district is subjected to the variability of rainfall in areas where the topography and there are steep slopes. As the KI of Agricultural Extension staff revealed, the agricultural land is also in constant competition with grazing land as there is no balanced management through land use planning. Often it is argued that fragmentation has a negative impact on the intensity of management of the land which in turn has influence in the productivity and degradation status of land while in case of SLM project included respondent's crops and livestock production had increased.

The project included respondents who have been using improved crop seed variety and livestock variety, such as conservations agriculture, practiced soil and water conservation intervention (trenches, terracing, organic manure, intercropping, crop rotation) etc. Crop productivity can be increased through the adoption of higher-yielding crop varieties, though crop and crop nutrient management, improved agronomic practices and through the choice of crop species that have higher yield potentials under given environmental conditions (Rhodes et al., 2015; Nhamo et al., 2016).

4.1.6. Farmers' Perception on local climate change and Variability

Accordingly, 128 of the households perceived that there is a change in the climate, where the level of precipitation was sometimes lower and sometimes higher in the study kebeles of districts. For the question asked about the long-term changes in temperature over the last 30 years, 122 of households replied "Yes", while only 6 replied as "No". With regard to the long term changes in the amount and distribution of rainfall, 118 of households responded: "Yes", that there is a long term change, only 10 of households said, "No" (Figure 8).

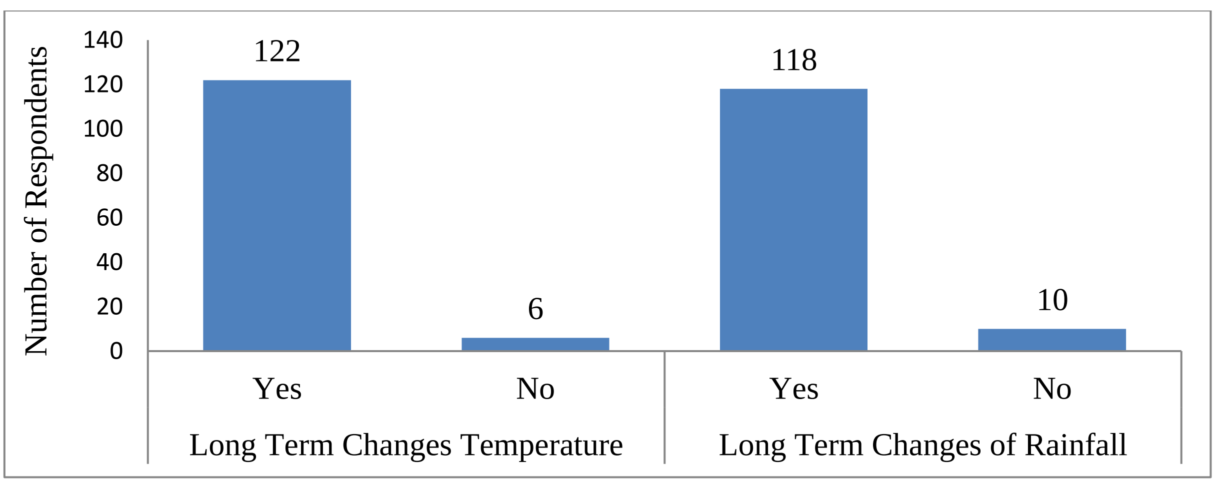


Figure 8: Perception of climate changes in the study area

Data Source: Field Survey data, (2019) Respondent’s level of awareness and perception to the local climate change was assessed in the study sites. The households were asked whether they perceived long-term climate changes in temperature and rainfall.

During the field survey both temperature and rainfall were easily perceived by farmers. Follow up questions were raised in order to assess farmers level of understanding and knowledge of climate change. The result had indicated that surveyed farmers had basic knowledge of climate change as the 95% of farmers access climate change information from different sources (including the media) and 5% of them have very little understanding.

Information technologies serve as decision support instruments for farmers to make sound decisions (Sassenrath et al., 2008). Accordingly, when asked about how they know regarding climate change, 35.2 % of them have been informed about climate change from Extension Workers (Table 2).

Table 2: Respondents’ Source of Information on Climate

Name of Kebeles	No of Respondents and Sources of Information				
	from Extension Workers	Training/ workshops	From media (radio, etc)	From kebele leaders	Total
M/Gorgis	20(15.625%)	11(8.6)	15(11.7%)	22(17.19%)	68(53.125%)
W/Buna	25(19.53%)	16(12.5)	9(7.03%)	10(7.8%)	60(46.875%)
Total	**45(35.2 %)**	**27(21.1%)**	**24(18.7%)**	**32(25 %))**	**128(100%)**

Data Source: Field Survey data, (2019)

During the FGD, participants were asked to explain whether there was an event of climate change in the districts or kebele. Almost all had replied that there was a change in the climate, soil erosion, soil fertility reduction and etc. As climate change exhibits in different ways, in different parts of the districts, the FGD revealed that the most common feature of climate change evidence is either late or early on-set of rainfall in a prolonged way. This resulted in the reduction of crop yield. Because of the loss of production quality, the market price of these crops decline.

For example in Nedjo District in the year from 2013 to 2014, the late on-set of rainfall than usual occurred and affected both crops and livestock production. The average productivity of the major crops in the area was recorded very low and for some farmers, it was almost none.

During the KI interview, participants were asked to explain whether they have experienced any climate changes in their lifetime and the type of climate shock they encountered. They pointed out that there was an early or late onset of rainfall and early or late cessation of rainfall with a low or high level of intensity. However, they had faced a severe shortage of rainfall during the “Belg” season in 1991, which subjected them to loss of planted major crops (maize crops, teff, wheat, millet, sorghum, pulse crop etc).

One of the Key Informants, from Mchucho Georgis kebele, informed that she has experienced the variability of the rainfall and remembered that she lost all her cultivated food and pasture crops due to waterlogging as a result of heavy rainfall, and due to shortage of rainfall in May to July of the year 2014 forced her to sell her livestock to sustain the family. There were some observations and expressions of study participants on the manifestation of rainfall change.

4.2. Analysis of meteorological information on rainfall and temperature

4.2.1. Rainfall data analysis over Nedjo study areas

One of the meteorological information stations is located at Nedjo district, which most likely represents the Muchucho Georgis and Wagari Buna, which have no meteorology station. The main rainy season for Nedjo is from May to September and the second short rainy season, depending on the altitude is between January and March which contribute significantly for its annual rainfall.

In the Nedjo district, the rainfall pattern has changed either decreases or increases in amount and frequencies. While there were years of short but heavy rainfall seasons and there occurs also dry seasons. According to the climatic data collected from NMA, the 30 years' (1987 – 2016) average annual rainfall was 1448.7mm for Nedjo. As analysis made from NMA monthly climatic data, within the same period, the average rainfall for the peak 3 months of June to August was 263.0 mm per month, while for the short rainy months of February, March, and November, the average monthly rainfall was 13.4 mm per month. The surveyed households felt that the trends of rainfall were decreasing while the temperature was increasing for the past 30 years or three decades.

As the climate data obtained from National Meteorology Service Agency had revealed there was an uneven distribution of rainfall throughout the years between 1987 and 2016. The amount of rainfall had increased in 1989, in 1993, 1995, 1997 to 1999, 203 to 2004, 2008 and 2010. The highest amount of rainfall was recorded in the years 2008 (1825.4mm) and the lowest in the year of 1991 (1001.5mm). On the other hand, the trend of the rainfall amount was decreasing in the years 1991-1992, 1994, 2001,2005,2012, 2013 and 2006 (NMA, 2019). This it indicates that there was rainfall erratic from 1987 to 2016.

The rainfall data analysis was made on an annual basis but farmers' perception is basically related to rainfall (cropping) seasons as their main concern is whether it is sufficient for crops to grow. The study has also witnessed that the total amount of annual rainfall was in a decreasing trend, rainfall seasons un normal distribution, cause extreme events such as flood hazard and rainfall seasons were getting shorter (late start and early cessation) but sometimes with heavy torrential and erratic rainfall. The majority of farmers' have perceived that rainfall was decreasing at the study sites and the analysis on the amount of annual rainfall data over 30 years has shown a decreasing trend with visible variability(Figure 9 and 10).

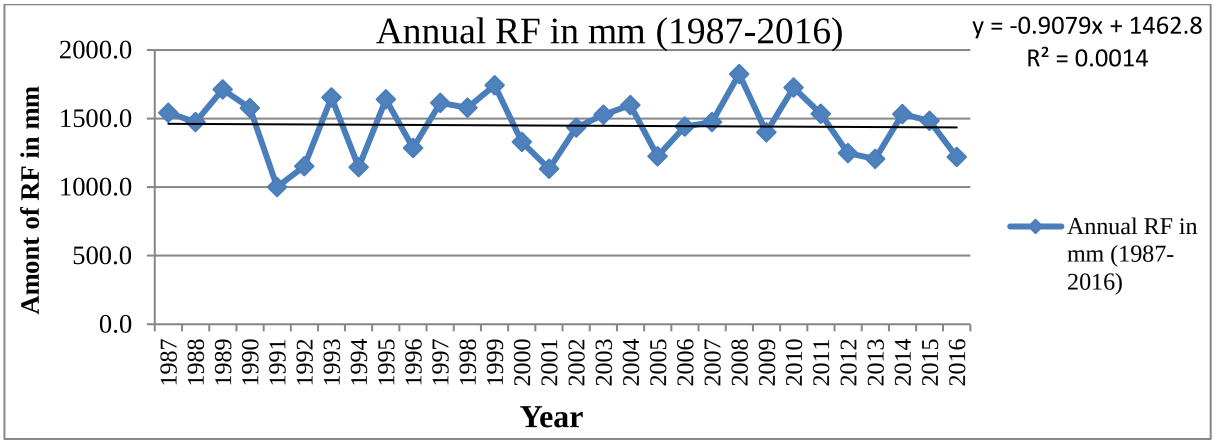


Figure 9: Annual Rainfall of Nedjo District

Source: NMA, (2019)

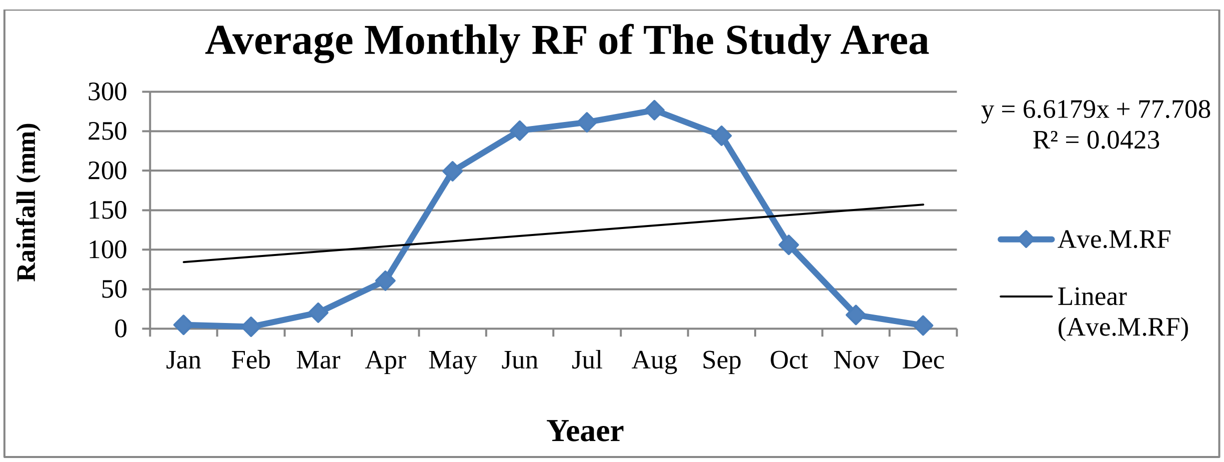


Figure 10: Thirty Years (1987-2016) Average monthly Rainfall of the Nedjo District

Source: NMA, (2019)

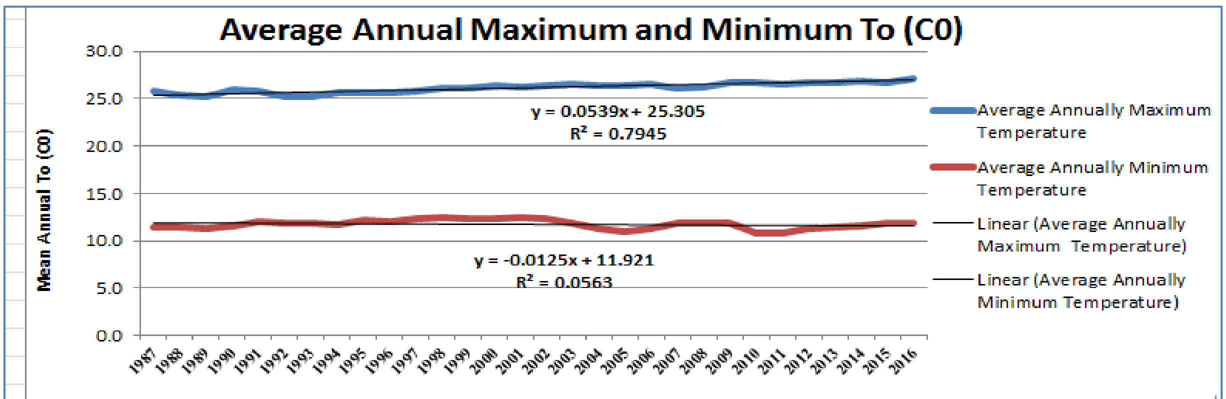
According to the information obtained from different FGDs, the timing, as well as the type of climate change that took place in the two surveyed kebeles of Nedjo districts, was similar even though the impacts, as well as the responses, depended on the prevailing situations at each kebele. FGD participants in that particular kebele, however, claim that climate change had taken place for a continued period up to this date. The climate change was reflected in terms of the length of the rainy and dry seasons, as well as in the intensity and the amount of rainfall received.

The KI from Muchucho Georgis and Wagari Buna kebeles in Nedjo District stated that climate change has been well experienced for the past thirty years. In the previous periods, the normal "Belg" rainfall season used to occur from February to mid-April, during which the land is plowed and remained in the sun during the month of May, which was normally dry and sunny. The "Meher" season starts in April and ends in September, with few showers in October. In the year 2014, the rainfall during the "Meher" season was unfamiliar or unusual with too much rainfall.

4.2.2. Temperature data analysis over Nedjo District

The average of maximum and minimum annual temperature of the district is 313.7C^0 and 11.7 C^0 respectively. The monthly maximum temperature of Nedjo District for the period 1987 to 2016 had shown an increasing trend. Notably, the increase of maximum temperature pattern is consistent with the trends and scenarios for climate change in Ethiopia with the common worldwide climate changes which are consistently increasing over the years (NMA, 2019). Besides, as the data for the last 30 years shows, there was a trend of increasing the maximum temperature for Nedjo, which was also in agreement with the surveyed households' perception in the area. However, the temperature has also decreased sometimes which for a moment had brought about frost and have an effect on crop production as some surveyed households and FGD participants had witnessed. Hence, analysis of the trend of maximum temperature and the perception of the majority of farmers' on long term temperature is in line with the analysis of meteorological data on temperature (NMA, 2019).

The monthly minimum temperature of Nedjo district is also presented for the period 1987 to 2016. As indicated below, the average minimum temperature had shown an even distribution trend. In contrary with this, a decreasing trend of monthly mean minimum temperature was observed which was not in line with the trend in the maximum temperature as well as with the overall pre diction of temperature trends in the country (Figure 11).



Mean Max To	25.8 25.4 25.2 25.9 25.8 25.2 25.2 25.6 25.6 25.6 25.7 26.1 26.1 26.4 26.2 26.5 26.5 26.4 26.4 26.5 26.1 26.3 26.72 67 26.5 26.6 26.7 26.8 26.8 27.2
Mean Min To	11.4 11.4 11.3 11.6 12.0 11.81 1.8 11.8 12.1 12.0 12.3 12.4 12.3 12.3 12.5 12.3 11.9 11.2 11.0 11.3 11.9 11.9 11.8 10.8 10.8 11.3 11.4 11.6 11.8 11.8
CV	19.6 19.8 19.0 17.3 16.5 19.1 18.2 17.7 16.1 16.6 14.9 17.3 15.0 16.1 16.8 15.6 18.0 19.1 23.1 15.5 17.5 14.3 17.1 13.9 27.2 20.1 18.5 21.7 18.9 20.8

Figure 11: Mean Annual Maximum and Minimum Temperature Trend at Nedjo District

Source: NMA, (2019)

In Wagari Buna kebele of Nedjo, one of the KI indicated that the past ten years have observed an increase in temperature and rainfall becoming erratic in the area. There were incidences of low and high temperature with frost dry that damaging crops early in the mornings. The trends of climate data of the meteorology agency agree with the surveyed households' perception in the study of the area.

4.3. Climate Smart Agricultural Practices Option that increased crop production

According to the field survey, from the two kebeles SLM project participants have indicated the various options for increasing their crop production and different factors that also necessitate for adaptation to climate variabilities. When asked about other methods they could consider increasing their crop production from SLM project 68 respondents, stated 61 of them have used organic fertilizer and practiced conservation agriculture; such as cover crop, inter cropping, crop rotation, green manure, mulching, apply lime gypsum, compost, row planting, good quality seeds, and etc. This is the indication of enhancement climate smart agriculture technology and farmers adaptive capacity of the study area. The adaptive capacity of a community is its ability to adjust to climate change, to restrain or cope with the effects, and take advantage of the opportunities. Adaptive capacity determined by a range of factors, processes, and structures such as income, literacy, technology, and services, (IPCC 2007). Many definitions of CA use 30% of soil organic cover but the ideal level identify the site soil cover (Richards *et al*., 2014). And also the crop rotations, intercropping and relay cropping can incorporate legumes into the system improves soil health and reduces pests and diseases (Nyasimi *et al*., 2014; Richards *et al*., 2014).

The SLM project respondents employed various agricultural technologies to increase the production or adaptation capacity in changing climate. 90% of the respondents practiced conservation agriculture, agronomic practices and conserving soil/water conservation intervention and improved varieties. Yet, the finding of a study conducted in Oromia region showed many advantages of compost over chemical fertilizers (Figure 12). Breeding of higher yielding crop varieties, through improved agronomic practices, crop and crop nutrient management, improved agronomic practices and the choice of crop species that have higher yield potentials under conditions environment (Rhodes *et al*., 2015; Nhamo *et al*., 2016). On the other hand, majority of the households of non- beneficiaries of the project did not employ these technologies. Figure 12 shows the adaptation options for the group (68) respondents.

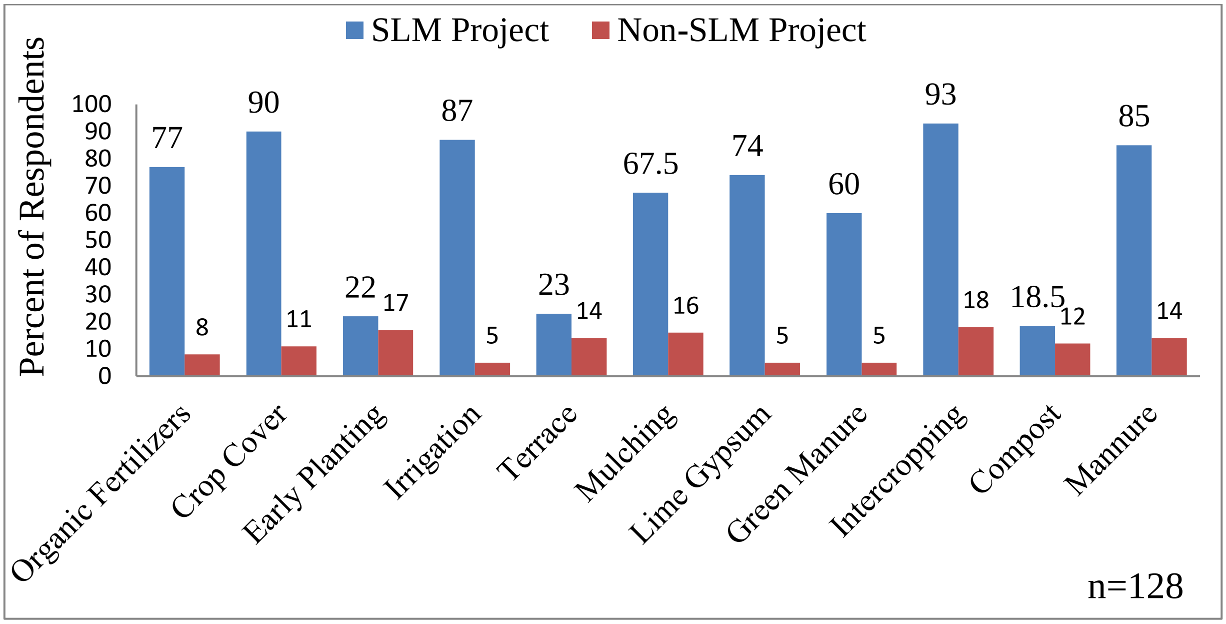


Figure 12: Adaptation option from CSA

Data Source: Field Survey Result, (2019)

The increases crop productivity by using maximum organic fertilizers with inorganic fertilizers applications. The use of organic fertilizers was improves soil quality by minimizes negative environmental impacts and is improved by increased levels of organic matter more diverse microbial populations, and improved nutrient and after retention enhance cycling, which may increase crop productivity and the ability to cope with drought and harsh condition (Liu *et al.*, 2006). Low inorganic fertilizer use has been that farmers cannot afford. The productivity increase from before SLMP to Non- SLMP which is 3466kg to 4920kg. It increased by 1452kg. While in case of non-SLMP group from (2019-2013) to (2014-2018) it decreased by 1124kg.

4.4. Analysis of Climate Smart Agriculture Practices & its Income in SLM Project

4.4.1. Climate Smart Crop Production and Its Income in SLM Project

As a result, the households who are included in SLM project produced more annual crop than those out of the project. Below Figure 13 shows crop production of before project, and after for SLMP project participants & none-project respondents'.

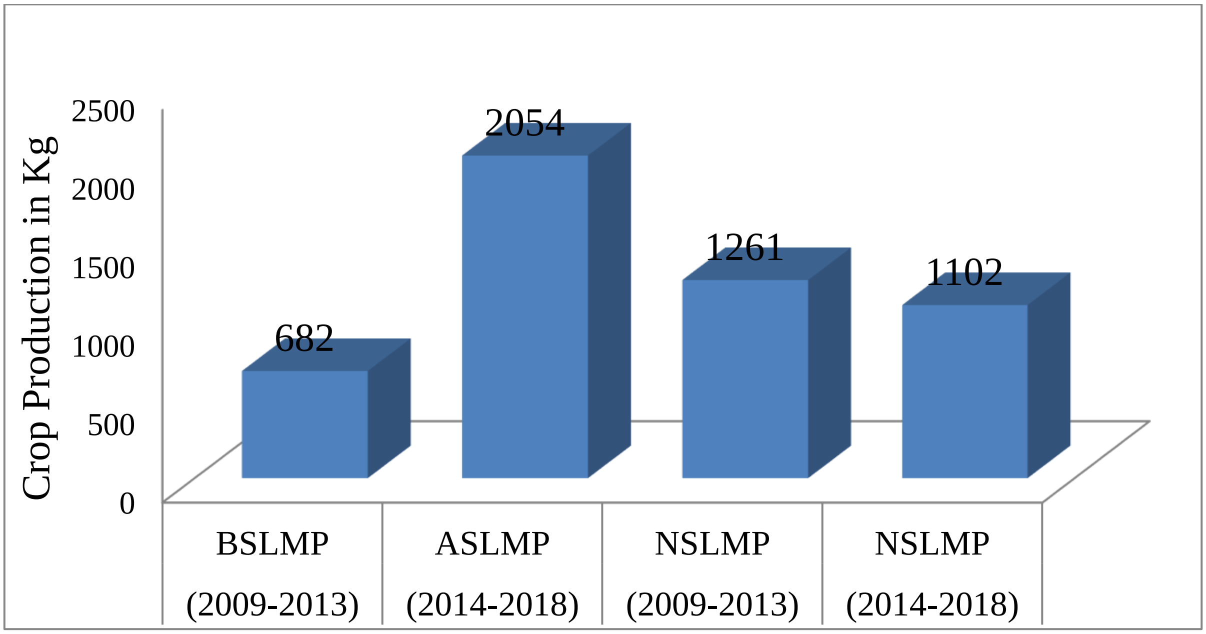


Figure 13: Average households Crop Production (kg)

Source: Survey Data Result, (2019)

The gathered crop data from the field analysis indicate a significant difference between SLM, pre-SLM project non-SLMP. Those respondents supported by SLM project produced mean annual crop than the pre-project with the difference of 1372 kg, and comparing with non-project respondents of 2009-2013 and 2014-2018 they produced more by 793 & 952 kg respectively.

Regarding the annual income earnings of surveyed respondents from crop production, the two kebeles SLM project respondents have indicated various options for increasing their crop production that necessitate for adaptation to climate variabilities.

According to Deressa, Hassan, and Ringler (2011) one reason for farmers' lack of openness to new technologies and adaptation strategies is that they are only applied, when the farmers see that the profit from using the new technology is significantly higher than of the old method. In the study area, the average year crop production income of the SLM project respondents was high from 2014 to 2018 where as the pre project and non-SLM project were low.

Below figure 14 shows average income from crop data analysis. The income from crop was defined by cash income rather than subsistence. Then the production goatherd from surveyed household's income estimated by doing the pre- harvesting of woreda crop production and by market performance from Market trade & production office. The average income in SLMP included respondents was birr 6678 and this was higher than those non-included in SLM and pre-SLM project.

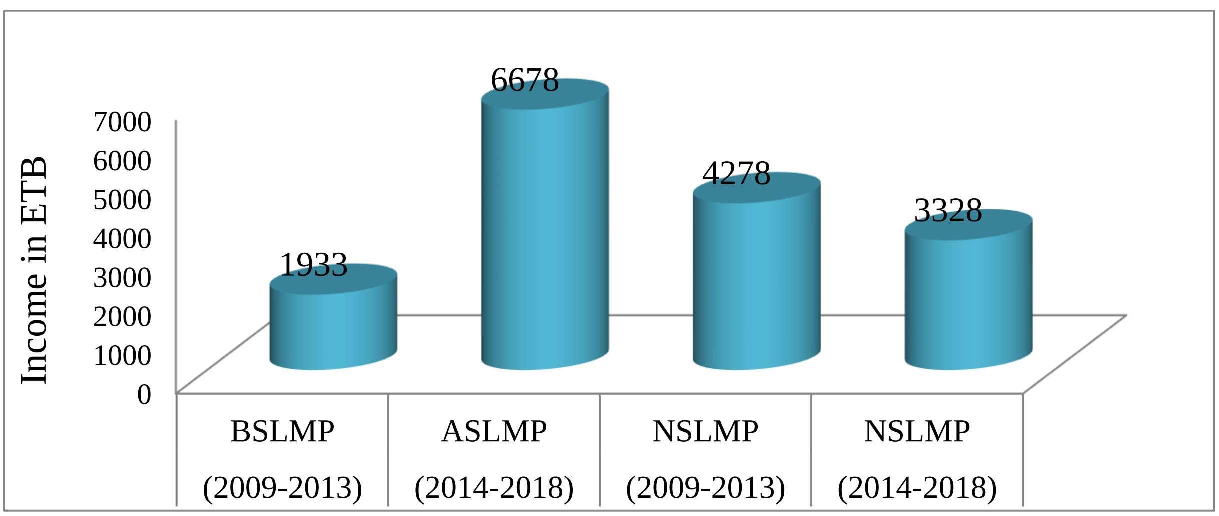


Figure 14: Average households Crop Production Income (ETB)

Source: Survey Data Result, (2019)

The field surveyed data analysis indicate that there was significantly difference between income SLMP and non- SLMP. This indicates the improvement of the buffer capacity or resilience of SLMP respondent. The respondents included in the project earned more mean years income than others from crop production. Income was calculated by subtracting from Gross output, the total production cost. For example had got average income more than those before the project of average years by 4745ETB, but then those of none- project of after-five years to before-five years was decreased by 950 ETB. This it indicates that the farmers included in project capacity built, trained varies technology and they were use fertilizers efficiently; bring unproductive land to productive by different management mechanism and they were constructed irrigation, etc.

4.4.2. Climate Smart Livestock production income in SLM

The two kebeles SLM project respondents indicated that the various options for increasing their livestock production and other factors that enhance their adaptation to climate variabilities. The farmers' included in SLM project 68 respondents stated that their livestock production has increased. For example, using improved forage production, improved livestock breed, improved milk production, fattening, animal health and etc. Majority of them decreased the number of local livestock varieties shift to the improved variety with better management.

Regarding the annual income earnings from livestock production, the average income of the SLM project included respondents was higher than that of the pre-project and non-project respondents (Figure 15)

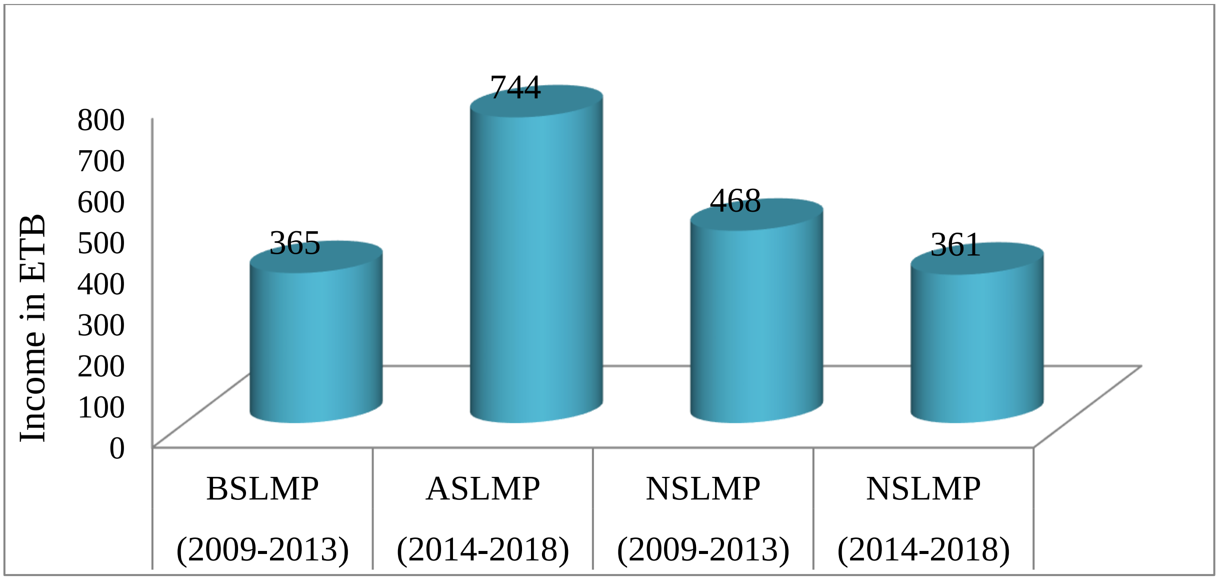


Figure 15: Average households' livestock production income (ETB)

Source: Survey Result, (2019)

The gathered livestock incomes data from the field analysis indicate the SLMP respondents got more than that of non-SLMP respondents. The Respondents those supported by the SLM project earned more mean income from livestock production than the pre-project by of 379 ETB while in case of non-project 2009-2013 and 2014-2018, the decreases by 107 ETB.

Regarding the annual income earnings of surveyed respondents from livestock production, the two kebeles SLM projected population were the various options for increasing their livestock production income and there are different factors that also necessitate for adaptation to climate variabilities.

4.4.3. Climate Smart Honey production, in SLMP

The respondent those included in project were practiced the various options for increasing their honey production. It is also used to necessitate for adaptation to climate variabilities. When asked about other methods they could consider increasing their honey production, 32.3% SLM project respondents stated that they have three types of hives (modern, transition and traditional hive). According to farmers report there were so many factors which increased honey production. These are favorable site for the production, have been constructed house, strengthen its management, they were planting flowering tree and etc around their honey bee production.

Accordingly, the project included respondents who have produced more honey, and as the reported by the survey, they were got more income than that of out of the project (Figure 16).

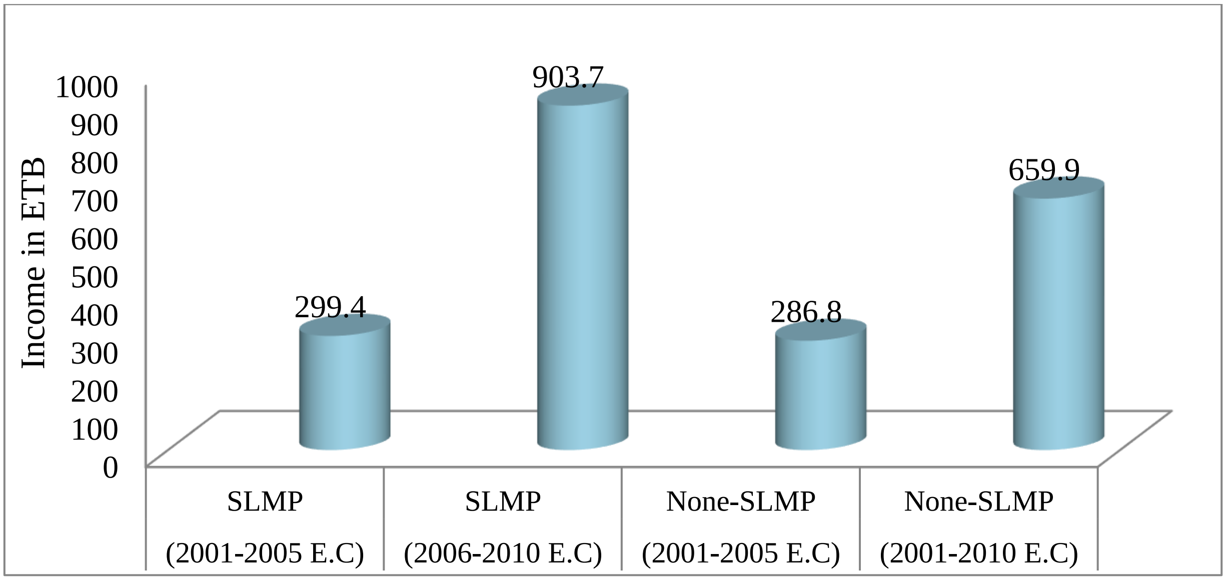


Figure 16: Five years Average households Honey Production Income (ETB)

Source: Survey Result, (2019)

The surveyed honey production income data analysis indicates that to have a difference between SLMP and non- SLMP. The mean five years income from honey production project included respondents than five years before-project was greater by 604.4 ETB, while the non-project 2014-2018 than the years of 2009-2013 by 373.10 ETB

4.4.4. Climate Smart Forest Production, in SLMP

According to the field survey, the farmers those work and earned income from forest product were minimum. The farmers from the two kebeles SLM projected population indicated had the various options for increasing their forest production and there are different factors that also necessitate for adaptation to climate variabilities. In two kebele Muchucho Georgis and Wagari Buna; 20.6% of growing forest seedling on nursery site and 7% of them work on area closure. They earn cash income by selling seedling and forage grass. In the case of non-SLM project households even if produce seedling and work on area closure they were not earning income by selling forest seedling and animal forage or grass (Figure 17).

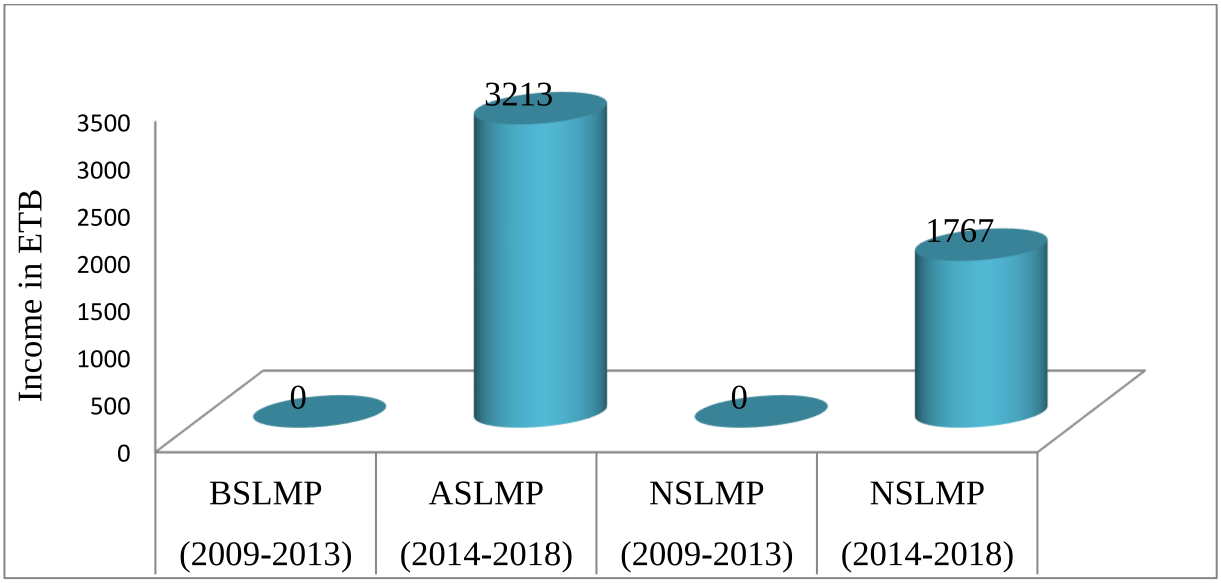


Figure 17: Five years Average households Forest Production Income (ETB)

Source: survey result, (2019)

The analyzed survey data shows that there were non–SLM project respondents produce seedling and earn a minimum annual income which is 1767ETB. While in the case of the project, the respondents were earn 3213ETB per average of five years. When it compared with the non-project it increased by 1446ETB.

4.4.5. Climate Smart Agriculture Practices Income in SLM Project

Accordingly the survey, the project increased the household's agricultural production income (*from crop production, from livestock, from Honey Production, from forest products and etc*). The production goatherd from surveyed household income estimated by doing the pre-harvesting of woreda crop production and by market performance from Market trade & production office. The following table 3 shows the SLM and non-SLMP respondents' income.

Table 3: Difference Five years Average households Agricultural production Income (ETB)

Source of income	BSLMP(2009-2013)	ASLMP (2014-2018)	BNSLMP (2009-2013)	ANSLMP(2014-2018)	(ASLMP-BSLMP)	(ASLMP-BNSLMP)	(ASLMP-ANSLMP)	(ANSLMP-BNSLP)
Crop income	1933	6678	4278	3328	4745	2400	3350	-950
Livestock income	365	744	468	361	379	276	383	-107
Honey income	299.4	903.7	286.8	659.9	604	616.9	243.8	373.1
Forest income	0.000	3213	0.000	1767	3213	3213	1446	1767
Total	**2597.4**	**11,538.7**	**5032.8**	**6115.9**	**8941.3**	**6505.9**	**5422.8**	**1083.1**

Source: survey data Result, (2019)

- *BSLMP=Before SLM project, ASLMP= After SLM project,*

-*BNSLM=Before SLM project, ANSLP=after non- SLM project.*

- D/ce B/n ASLMP&BSLMP =**8941.30 ETB** and D/ce B/n ANSLMP &BNSLP = **1083.10ETB**

The households agricultural production (crop, livestock, Honey and forest production) data from the field analysis indicate have a difference between SLM project, before SLM project and non-SLMP (Table 3). The Respondents those supported by the SLM project earned more mean five years income than the pre-project by 8941.30 ETB, while in case of non-project 2009-2013 and 2014-2018 increasing only by 1083.1 ETB. From this there is a significance difference between the two SLM project and none- project income (8941.30 ETB - 1083.1 ETB) which is 7858.20 ETB.

Regarding the annual income earnings of surveyed respondents from agricultural production, the two kebeles SLM projected had various options. It indicated that the farmers those included in the project got more income from the product.

4.5. Diversifying income sources of project beneficiary Respondents

Sources of income of the respondents were analyzed based on classifying the period of income of the four groups (before SLM project group 2009-2013, SLM beneficiary group 2014-2018 non- SLM group 2009-2013 and non- SLM group 2014-2018). Accordingly (76.5%) of respondents were still depend on agriculture as primary source of income, (17.6%) shift their primary sources of income from agriculture to small trade due to SLM project while (5.9%) built houses in town and rent it to diversify their livelihood. Diversifying income sources enabled project beneficiaries to be resilient /adapt to changing climate. On the other hand, non-SLMP group remained with their agricultural practices as their only means of income.

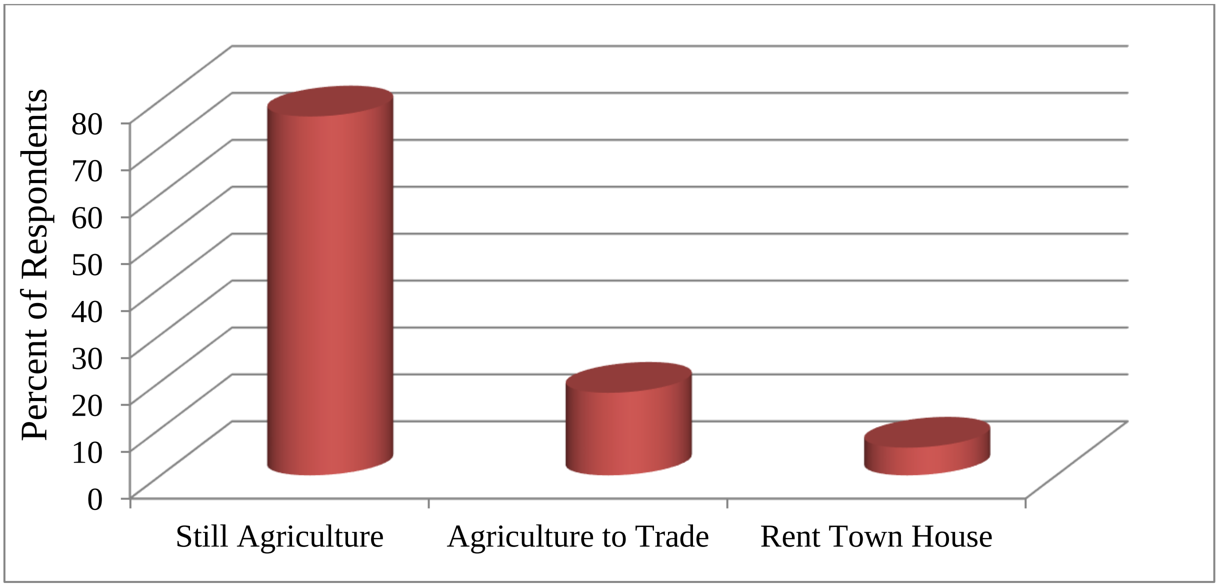


Figure 18: Diversifying income sources of project beneficiary Respondents

Source: Surveyed Data Result, (2019)

5. CONCLUSIONS AND RECOMONDATION

5.1. Conclusion

In the study sites of Nedjo Districts Agar Aleltu Watershed, it was learned that the community suffered from changes and variability of climate from time to time. Especially, since the last ten years it has become a challenge for agricultural practices and related means of livelihoods. Agricultural productions that dominate the livelihoods of the population in the study area have become more sensitive and adversely affected by climate change and variability. The study has also witnessed that there has been both an increase in crop, livestock production and forest of SLM project beneficiaries than non-beneficiaries of the study districts.

Respondents also pointed out a long term change in temperature and rainfall. These have been reflected in terms of increasing duration of dry seasons/dry spell, hot days, and irregularity in amount and distribution of rainfall. Late on-set and early cessation of rainy season has also been observed. The surveyed households revealed that particularly the periods between (1987-2016) rainfall was unpredictable, erratic with uneven distribution pattern, and prolonged dry seasons result in reduction of crop yield. In response to the changing climate, farmers have been adjusting their adaptation mechanisms through CSA of different farming practices. SLMP increases production of crop, livestock, honey, forest production etc. The study findings indicated the adoption of CSA practices like Climate Smart Crop Production, Climate Smart Livestock Practices, Climate Smart Forest practices and etc. Therefore identified CSA Practices options were increased smallholder farmers adaptation potential and enhanced livelihood income.

5.2. Recommendations

- It required that introduce and promote intensive farming practices coupled with appropriate, adaptable and affordable technologies for the farmers' such as, early maturing varieties of crops, drought resistant varieties, vegetables, etc.
- There is a direct need to initiate and strengthen other system such as climate smart agriculture practices, off-farm activities and related income generating activities, productive self-employment options to diversify the source and means of livelihoods.
- Sustainable land management project should be expanding through the country to build-up the adaptation potential and to capacitate of the participant in the study area.
- To achieve immediate response over climate change; financial support, strengthening farmers on their farm, training and experience sharing and on creation of demonstration site is important.
- Introduce and establish weather station and community level early warning system along with preparedness strategy to give out regular weather information, to make conscious, and strengthen the small holders' responsiveness to climate change risk reductions.

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APPENDICES

APPENDIX 1: Survey Questionnaire for Rural Households

Location

1. Name of Kebele ____

2. Name of Sub Kebele/Dev.t Group/interviewee _________________________

3. District___________________ Zone _____________ Region ____________

4. Agro-ecology: a) Upper Highland (from 1600-1900 meters above sea level (Dega)

b) Mid Highland (from 1600-1900 meters above sea level (Woina Dega)

5. Household Name. ____

6. Wealth Status: 1) Poor 2) medium 3) better-off/Rich

Part I:

1. Demographic and socio-economic characteristics of the respondent household

1. The household head

a, Male adult headed ______ b, Female adult headed _____c, Male Child headed____

d, Female child headed____,e, Elderly male headed____,f, Elderly female headed___

1. Age of household head: __________

2. Sex of households head: 1. Male 2. Female

3. Total family size? Female____________ Male ___________ Total___________

2. Household literacy assessment; Please exclude the respondent. Fill the following table

Literacy level	Number of family members	Remark
Non-literate		
Read and write		
Primary-level education (grade1-8)		
High school education (grade 9-12)		
Above High School		

5. Household sources of livelihoods and climate change impact

6. Family sources of livelihoods? **(Tick √)** List them in order of importance starting as 1, 2...

A. Animal husbandry__C. Trade (Livestock …)__ B. Crop cultivation _ D. Food for work __

7. What are the major challenges/problems that you face in your crop production? Please indicate them in order of importance.

Challenge	Rank				
	1st	2nd	3rd	4th	5th
Erratic Rainfall					
Erosion problem					
Lack of oxen					
Land Shortage					
Lack of improved variety					
Soil fertility,					

APPENDIX 2: Survey of Climate smart agriculture practices

Part I: **Land holding and Crop Production**

1. What is the size of your land holding? ________________ ha

2. Do you cultivate your entire land holding? Yes_________ 2. No_____________

3. Do you feel that your land holding is adequate to produce enough for your subsistence?

1. Yes _________ 2. No_________

4. How is the topography of your farm land? 1. Plain 2. Medium 3. Very steep slope?

5. Have you constructed SWC structure on your land holdings? 1. Yes 2. No

6. Are you use green manure on your crop production? On what type crop land?

A. Agronomic practices (Adaptation option)

Type	Yes/Not	Type	Yes/Not
Crop cover		Applying lime gypsum	
Early planting		Green manure crop land	
Use of Micro irrigation		Legume intercropping	
Terraces, contour farming		Applying compost	
Mulching		Use Manure	

7. Do you use fertilizer for your farm land? 1. Yes 2. No

8. If your answer for Q11 is yes what type of fertilizer do you use for crop production

1. In organic fertilizer 2. Organic fertilizer 3. Mixing both in organic and organic

9. In which category do you classify your soil on basis of its fertility?

1. Low fertility 2. Medium fertile 3. Highly fertile

10. How many kilogram do you produce by major crop type per year on average?

12. How many income (in birr) do you get in from crop production per year?

1. Before the project___________ 2. After the project? ____________

13. How do you perceive your crop production? 1. Increasing, 2. decreasing, 3. No change

PART II: Livestock Husbandry

1. Livestock Production

1. How many heads of the following livestock do you have before and after project?

a. Increasing ____ b. Decreasing____ c. No change

2. How is your income from animal production after the project?

a. Increasing ____ b. Decreasing____ c. No change

3. How many cash income you gain from livestock production, poultry and honey production?

2. Honey Production

1. How many hives of the following do you have before and after project?

A. Traditional back yard hives B, Transitional hive & C. Improved (Modern) hive

2. How many kilogram honey and beewax you sell per production cycle?

a. before the project b. after the project, 3, Non-SLMP

3. How many total income birr you get every year from honey & beewax sell annually?

a. before the project b. after the project 3, Non-SLMP

PART III. NRM (SWC, Forest production Income)

1. Growing seedling on Nursery

1. Do you produce forest seedling?__________

2. Do you selling forest seedling production? 1. Yes 2. No

3. How many annual income you gain from selling forest seedling per year?____

2. Soil and Water conservation

1. Adoption trend soil nutrient and water conservation technologies

2. Have you adopted any soil and water conservation? 1. Yes ______ 2.No______

3. Benefits of soil and Water conservation?

Climatic variable	**Yes**	**No**		**Yes**	**No**
Rainfall amount has increased			Poor distribution of rainfall		
Rainfall amount has decreased			Late onset of rainfall		
Early onset of rainfall			High temperature		

APPENDIX 3: Assessment of Adaptation option to climate change and barriers faced

1. What adjustments by SLMP in your farming have you made to the long-term shifts in the rainfall?

a. Enhance traditional irrigation schemes:

b. used improved crop varieties

c. shifting from crop producing to planting vegetation

d. adopts crop rotation and mixed cropping

e. enhancing animal rearing practice

f. If there are others list them:

APPENDIX 4: Guiding questions for Focus Group Discussion (FGD)

Address (location) of the village: _____________Focus group size: ____________________

Focus group composition: *Male headed households/Women headed households/Youth Group, Kebele Leaders*

<u>Checklist of questions</u>

1. What visible changes have you observed as related to rain fall, temperature, soil fertility, forest vegetation, wildlife, crop productivity, livestock productivity, flow of streams, occurrence of big floods, incidence of drought, forest vegetation cover, river/stream flow etc during your life time in the village?

2. Have you heard of "climate change", "climate variability"? If yes, from which sources?

3. Do you have any adaptation mechanism cope up the impacts of climate change /variability on your livelihood?

4. How does climate variability and change expressed in your kebele?

5. Do you think climate change or variability affect your way of life. If Yes, Please explain it

6. What are your traditional or local indicators to realize that there is climate change?

7. Do farmers have sufficient knowledge about Adaptation options to climate change?

8. Are the crops you cultivate now the same as the crops before the project was growing? If no, reasons for changing the crops?

9. Are the animals you are raring no and income from is the same as the animals before the project used to rare? If no, reasons for changing the animals?

APPENDIX 5: **Guiding question for Key Informants in the Study Kebeles**

Address (location) of the village: ____

Key Informants may: - *knowledgeable people of local leaders, Group leaders, Clan leaders, Government offices and from kebeles leaders who know about the study area.*

<u>Checklist of questions</u>

1. How often is the occurrence of drought in the locality? And what are the probable causes?/How is the trend of the rainfall during the past 30 years? Is it increasing, decreasing, coming on time and stopping at the right time?

2. What coping and adaptation strategies have community members crafted to alleviate problems arising as a result of climatic variability/drisk?

3. What effect has climate change inflicted on the livelihood of the local people?

4. How do you evaluate the CSA practices role in motivating and mobilizing the community to strengthen their adaptive strategies to climatic changes?

5. What is the sustainable land management project agents' role to strengthen the effectiveness of climate smart agriculture?

6. What are the successes stories you observed in relation to coping and adaptation strategies adopted by SLMP to withstand climatic shocks?

APPENDIX 6: **Guiding questions for institution staff**

Guiding questions for government institution staff (*Agricultural Development Offices, Land Administration Offices, Meteorological Agency, Disaster Prevention and Preparedness Agency, Agricultural Research Institute***)**

1. What do you understand by the term climate change and climate variability?

2. What are the indictors of the occurrence of climate change?

3. How do you evaluate the climate situation in the district over the years?

4. What are the damages inflicted by climate change to the society?

5. How does agricultural research in the region attempt to address the need for crop varieties tolerant to moisture stress and other supporting technologies to tackle climate change?

6. What are the successes stories you observed in relation to coping and adaptation strategies adopted by farmers to withstand climatic shocks?

APPENDIX 7: Meteorological Data

I. Rainfall Data in mm (2087-2016) of Nedjo District

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Sum	Mean
1987	0.0	0.0	33.6	11.5	323.5	280.4	286.0	225.8	217.0	128.6	35.6	0.0	1542.0	128.5
1988	3.1	0.0	45.9	0.0	184.1	256,6	459.7	285.7	347.1	140.6	6.9	0.3	1473.4	122.8
1989	0.0	0.0	56.2	50.9	191.5	312.9	379.4	332.4	220.6	130.6	24.1	14.3	1712.9	142.7
1990	2.6	0.0	26.5	7.0	130.7	264.5	380.8	370.0	308.6	84.5	1.8	0.2	1577.2	131.4
1991	0.0	0.0	12.5	40.2	120.0	49.0	4.5	386.7	269.9	118.2	0.5	0.0	1001.5	83.5
1992	0.0	0.0	20.8	79.2	122.0	281.5	229.6	22.5	272.5	111.5	13.5	0.0	1153.1	96.1
1993	3.8	6.2	28.1	81.2	123.0	390.0	322.8	346.8	223.0	106.8	23.2	0.0	1654.9	137.9
1994	2.0	0.0	5.5	101.6	254.2	203.8	12.5	222.1	189.0	79.7	74.2	1.3	1145.9	95.5
1995	0.0	0.0	69.5	122.6	148.6	336.2	199.2	331.6	325.0	99.0	1.6	6.7	1640.0	136.7
1996	1.9	0.0	60.8	39.1	239.6	198.4	306.2	169.0	191.9	49.9	27.9	0.0	1284.7	107.1
1997	0.0	0.0	15.7	53.6	236.8	223.9	285.5	242.7	218.1	285.4	22.6	30.5	1614.8	134.6
1998	0.5	0.0	0.2	56.6	216.6	311.6	187.3	287.9	356.9	148.3	12.7	0.0	1578.6	131.6
1999	41.1	0.0	0.0	41.8	319.8	280.6	253.4	306.6	240.8	245.4	13.0	0.0	1742.5	145.2
2000	0.0	0.0	0.2	102.3	189.2	282.3	241.3	178.5	183.8	131.6	19.3	0.0	1328.5	110.7
2001	0.0	0.0	9.4	35.4	150.7	200.7	238.7	203.5	178.1	83.0	0.0	35.0	1134.5	94.5
2002	1.7	0.0	13.7	24.5	77.4	311.9	367.1	282.7	264.1	82.2	3.6	4.8	1433.7	119.5
2003	0.0	18.4	7.2	11.4	85.1	325.3	299.7	298.7	396.5	48.2	37.1	0.0	1527.6	127.3
2004	28.6	5.4	13.0	30.9	197.0	258.0	365.6	346.9	236.2	82.5	33.3	1.5	1598.9	133.2
2005	0.0	4.5	11.0	22.0	167.0	233.0	211.3	232.0	221.2	67.3	55.2	0.0	1224.5	102.0
2006	7.0	2.3	0.6	1.7	278.0	232.8	279.0	277.4	212.8	144.5	0.2	6.4	1442.7	120.2
2007	0.0	3.1	47.1	132.8	254.7	312.5	301.5	123.2	205.9	35.3	53.6	5.6	1475.3	122.9
2008	5.7	0.0	0.3	215.0	318.2	306.7	340.4	291.1	242.5	61.5	44.0	0.0	1825.4	152.1
2009	3.6	1.3	2.0	77.8	78.0	348.4	218.2	437.9	121.5	97.3	0.3	14.2	1400.5	116.7
2010	22.7	3.9	0.0	79.3	261.1	316.3	290.7	459.2	219.0	67.6	4.0	3.5	1727.3	143.9
2011	0.0	1.5	41.3	85.1	125.1	333.9	255.4	364.0	276.3	51.2	1.0	0.0	1534.8	127.9
2012	8.8	13	31.1	67.4	211.2	211.1	122.7	222.2	312	45.3	1.1	1	1246.9	103.9
2013	9.6	15	29.2	45.7	223	45.6	213.2	333	255.5	33.3	1	1	1205.1	100.4
2014	0.0	0.0	0.0	77.0	268.0	187.1	309.8	319.6	201.2	158.1	10.7	0.0	1531.5	127.6
2015	0.0	0.0	15.0	66.0	272.9	250.1	289.0	201.0	221.0	165.0	2.5	0.0	1482.5	123.5
2016	0	0	12	59	211	240	189	199.3	199	108.9	1.5	0	1219.7	101.6
Sum	142.7	74.6	608.4	1818.6	5978.0	7528.5	7839.5	8300.0	7327.0	3191.3	526.0	126.3		
mean	4.8	2.5	20.3	60.6	199.3	251.0	261.3	276.7	244.2	106.4	17.5	4.2	___	_____ _

II. Maximum Temperature in ^{0}C (2087-2016) of Nedjo District

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1987	27.9	28.8	28.5	28.8	25.2	23.2	23.1	22.8	24.7	24.1	24.9	27.1	**25.8**
1988	28.2	28.4	29.7	30.1	25.5	23.2	20.7	21.1	22.6	23.8	25.1	26.5	**25.4**
1989	27.4	28.1	28.1	27.9	25.0	23.3	22.7	22.2	23.4	23.8	25.1	25.8	**25.2**
1990	27.3	29.0	29.4	29.7	27.4	23.6	22.2	22.5	22.8	24.3	25.7	27.3	**25.9**
1991	28.1	29.6	29.5	29.8	26.6	23.0	21.6	22.0	23.7	24.0	25.3	26.4	**25.8**
1992	28.0	28.2	29.9	28.0	25.8	22.9	21.8	21.1	22.8	23.0	24.2	26.2	**25.2**
1993	26.9	27.4	28.9	26.5	25.6	23.2	22.3	22.4	22.0	24.4	24.9	26.8	**25.2**
1994	27.9	29.3	30.1	29.5	25.3	23.0	21.8	21.6	23.3	24.2	24.6	26.3	**25.6**
1995	27.9	28.6	29.2	28.0	25.6	24.3	21.6	22.3	23.5	24.3	25.8	26.4	**25.6**
1996	27.7	29.8	28.9	28.6	24.7	22.4	22.1	22.4	24.0	24.6	25.5	26.4	**25.6**
1997	28.1	29.3	29.7	27.4	25.1	23.8	22.3	22.7	24.7	24.1	24.8	26.8	**25.7**
1998	28.0	29.8	30.6	31.3	26.0	23.9	21.7	22.1	24.4	24.2	24.5	26.7	**26.1**
1999	27.8	29.6	30.5	31.4	26.3	24.0	21.9	22.2	24.6	24.1	24.5	26.5	**26.1**
1999	28.1	29.9	30.7	31.6	26.2	24.1	21.8	22.2	26.7	24.2	24.3	26.6	**26.4**
2001	28.2	29.6	30.9	31.2	26.1	24.1	22.3	22.4	23.9	24.0	25.1	26.6	**26.2**
2002	27.3	29.4	29.4	30.0	28.8	24.4	23.6	22.8	24.1	24.4	25.9	27.3	**26.5**
2003	28.8	29.9	30.0	29.9	29.6	23.4	22.1	22.8	23.9	25.1	25.8	27.2	**26.5**
2004	28.1	29.1	30.4	28.8	27.8	23.6	23.3	23.5	24.3	25.0	25.7	27.0	**26.4**
2005	28.1	31.0	29.7	29.8	27.2	23.7	22.5	23.2	24.1	24.3	25.7	27.2	**26.4**
2006	28.9	30.1	30.4	30.4	26.6	24.2	23.1	22.7	23.8	25.0	25.8	26.9	**26.5**
2007	27.2	29.5	30.7	29.1	25.7	23.8	23.0	22.7	23.4	25.4	26.0	27.2	**26.1**
2008	27.9	29.4	30.5	27.1	25.6	23.8	23.9	23.0	24.7	25.3	26.6	27.5	**26.3**
2009	28.6	29.3	30.7	29.3	27.8	23.9	23.8	22.9	24.6	25.3	26.5	27.3	**26.7**
2010	29.0	30.2	31.5	32.1	26.6	23.9	22.1	22.9	24.1	25.1	26.1	26.6	**26.7**
2011	27.6	30.2	29.5	30.0	26.4	24.0	23.7	23.1	23.9	25.5	26.4	27.4	**26.5**
2012	27.5	30.3	29.5	30.8	26.2	24.4	23.8	23.8	24.0	25.6	26.5	27.0	**26.6**
2013	27.7	30.3	29.6	30.9	26.8	24.4	22.9	23.9	24.2	25.6	26.6	27.1	**26.7**
2014	33	30.4	29.6	31	25.3	24.3	22.9	22.7	24.3	24.4	26.3	27.2	**26.8**
2015	28.6	30.6	30.4	30.8	26.5	24.4	22.8	23.1	24.5	24.8	27	27.6	**26.8**
2016	29.9	30.8	30.5	32.1	26.8	24.4	22.9	23.2	24.5	25.7	27.2	27.8	**27.2**
Mean	**28.2**	**29.5**	**29.9**	**29.73**	**26.34**	**23.75**	**22.54**	**22.61**	**23.98**	**24.59**	**25.61**	**26.89**	**26.1**

III. Minimum Temperature in ^{0}C (2087-2016) of Nedjo District

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1987	6.7	9.1	11.2	11.0	13.0	13.9	13.2	13.7	13.0	12.4	10.4	9.1	**11.4**
1988	7.4	10.9	10.2	11.8	13.4	13.4	13.6	13.2	13.5	12.3	9.7	7.6	**11.4**
1989	6.7	9.0	11.7	11.6	13.4	13.2	13.3	12.9	13.0	11.1	9.8	9.3	**11.3**
1990	9.0	9.5	10.7	12.3	13.8	13.9	13.5	13.6	13.2	11.5	9.9	8.6	**11.6**
1991	9.1	10.1	12.8	12.8	13.6	13.8	13.8	13.4	13.6	12.7	10.2	8.4	**12**
1992	8.8	8.7	12.7	13.9	13.8	13.7	13.3	13.7	13.0	12.3	10.0	8.1	**11.8**
1993	8.0	9.5	12.2	14.0	13.8	14.1	13.3	13.1	12.6	12.2	10.4	8.6	**11.8**
1994	8.6	10.5	10.5	14.4	13.7	13.9	13.4	13.3	12.7	11.1	11.2	8.2	**11.8**
1995	8.9	10.2	11.0	13.3	14.6	14.3	13.5	13.8	13.2	12.1	10.1	10.1	**12.1**
1996	8.4	10.6	12.5	13.2	14.0	14.1	13.6	13.5	13.5	11.9	9.9	9.3	**12**
1997	8.9	9.8	12.9	13.5	14.1	13.8	13.5	13.4	13.3	13.0	11.5	9.7	**12.3**
1998	8.9	9.0	13.0	13.9	15.1	14.1	14.1	13.6	13.2	13.2	11.1	9.8	**12.4**
1999	9.0	9.8	12.4	12.8	14.4	14.0	14.0	13.4	13.2	13.0	11.0	10.0	**12.3**
2000	9.1	10.2	11.8	13.2	15.1	14.1	14.0	13.5	12.4	13.2	11.2	9.2	**12.3**
2001	9.1	10.6	12.8	13.9	15.8	14.2	13.4	14.1	13.6	12.8	9.6	10.4	**12.5**
2002	9.8	11.4	12.4	13.7	13.8	14.3	14.2	13.8	13.4	11.8	10.7	8.4	**12.3**
2003	8.6	11.0	13.7	12.9	13.7	13.8	13.4	13.5	13.4	10.9	9.8	8.0	**11.9**
2004	8.1	9.3	11.7	13.0	13.3	13.1	13.8	12.7	12.4	10.1	9.1	8.1	**11.2**
2005	8.9	10.0	11.9	13.1	13.7	12.4	13.8	12.4	12.3	10.6	7.6	5.7	**11**
2006	8.9	9.1	9.7	11.6	12.6	12.0	12.4	13.4	13.5	12.9	10.3	9.2	**11.3**
2007	8.3	10.2	11.9	11.1	14.7	14.5	13.7	13.4	13.6	11.6	10.5	9.4	**11.9**
2008	9.9	11.2	11.5	13.9	13.5	13.2	13.1	13.1	13.0	11.6	9.0	9.4	**11.9**
2009	9.6	11.7	10.4	13.8	13.6	13.8	13.5	13.1	13.2	12.0	8.8	8.4	**11.8**
2010	7.2	10.4	11.2	11.6	12.6	12.3	11.6	11.3	11.1	11.0	10.2	8.8	**10.8**
2011	6.3	5.6	8.8	10.4	11.5	14.1	13.9	13.4	13.9	12.5	10.0	9.2	**10.8**
2012	7.2	8.9	11.2	10.0	12.0	14.2	13.8	13.6	13.0	12.4	9.8	9.0	**11.3**
2013	7.4	9.8	8.9	10.6	12.4	14.2	14.0	12.8	13.0	12.7	11.0	10.1	**11.4**
2014	7.9	7.8	10.8	10.9	14.3	14.2	14.2	12.9	13.8	12.8	10.7	8.4	**11.6**
2015	7.8	9.5	12.0	12.8	14.2	14.1	14.1	11.3	13.8	12.6	10.8	8.6	**11.8**
2016	7.8	9.8	12.5	12.5	14.3	14.2	14.2	13.7	13.6	12.3	9	8.2	**11.8**
Mean	**8.34**	**9.77**	**11.6**	**12.58**	**13.73**	**13.76**	**13.57**	**13.22**	**13.13**	**12.09**	**10.11**	**8.843**	**11.7**

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