**Investigations on climate smart agriculture practices use among smallholder farmers to cope with climate change and variability in Mozambique**

**Vânia Faustino Amimo**

**(R1712057)**

**University of Zimbabwe**

**Faculty of Agriculture**

**Department of Crop Science**

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## Abstract

The effects of climate change and variability on agriculture are severe, and constitute one of the most significant emerging challenges to household livelihoods in Africa. As such, it is imperative that efforts to address agriculture in the context of food security and rural development take climate change into consideration. Climate-Smart Agriculture (CSA) is defined as agricultural practices that sustainably increase productivity and system resilience, while reducing greenhouse gas (GHG) emissions. The study was focused on socio-economic characteristics factors; and the objectives of this were two fold: 1) To identify CSA practices used by smallholder farmers to address climate threats to agricultural production and livelihoods and; 2) To identify the factors that constrain and/or facilitate the adoption of CSA practices to cope with climate change and variability. A survey was held in two districts of Zambezia province (Nicoadala and Namacurra) using a survey. Most of the questions looked into climate change and variability. Information was collected from 100 respondents for data collection and semi-structured questionnaires were used using interview method with both opened and closed questions. For data analysis descriptive statistic and the binary logistic regression model were used with the purpose of describing the socio-economic characteristics and the technologies used by farmers showing its percentages and frequencies and also to identify the factors that had significant influence on adoption of CSA practices. The results showed that farmers in both districts current use agroforestry, improved/ drought tolerant crop variety, minimum tillage, crop diversification, earlier sowing date, irrigation. The factors that had significant influence in the adoption of CSA practices were gender education level, size of the household and source of information. The study, therefore conclude that to increase land productivity in the study sites, there is a need to consider farmers` heterogeneity in terms of household gender, age, education, extension services. The study suggests that the government can put in place structures to educate the people to be able to access education and can promote training the extension service officers that they can teach people in the simplest term with the goal to enhance the adoption of agricultural technologies.


**Key words:** CSA, technologies, smallholder farmers, climate change, variability, adoption

## Declaration

I, Vânia Faustino Amimo, do hereby declare that this thesis is a result of my original work undertaken by myself except where clearly and specifically acknowledged. It is being submitted in partial fulfillment of the requirements for the Master of Science Degree in Agronomy (Crop Science). It has not been submitted and published before for any degree or examination in any other University.

Approved by

**Supervisor: Professor R. Chikowo………………………………….Date ………………**

**Department Chairperson: Dr E. Gasura……………………………Date…………….**

## Dedication

I dedicate this thesis to all the smallholder farmers of the districts of Namacurra and Nicoadala for their commitment and dedication in their agricultural activities to guarantee the sustenance of their families and for their willingness to be part of this research, I would not have completed the research if were it not for them.

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**List of Abbreviation**

CA- Conservation Agriculture

CAP- Agricultural Census

CGAP- Consultancy Group to Assist the Poor group

CSA-Climate Smart Agriculture

FAO- Food and Agriculture Organization

GDP- Gross Domestic Product

GFDRR- Global Facility for Disaster Reduction and Recovery

GHG-Greenhouse gas

IFAD- International Fund for Agricultural Development

INGC- National Institute of Management and Calamities

IPM- Integrated Pest Management

MAE- Ministério de Administração Estatal

MICOA- Ministry of Co-ordination of Environmental issues

MINAG- Agriculture Ministry

NGO-Non Governmental Organization

SSA-Sub-Saharan Africa

SHFs-Smallholder farmers

TIA- Integrated Agricultural Inquiry

UND- University of Notre Dame

WGCCD-Working Group on Climate Change and Development

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# CHAPTER 1

## 1.0. Introduction

The effects of climate change and variability on agriculture are severe, and constitute to be one of the most significant emerging challenges to household livelihoods in Africa. As such, it is imperative that efforts to address agriculture in the context of food security and rural development take climate change into consideration. Climate-Smart Agriculture (CSA) is defined as agricultural practices that sustainably increase productivity and system resilience, while reducing greenhouse gas (GHG) emissions. It is not a single specific agricultural technology or practice that can be universally applied; it is a combination of policy, technology, and finance options that involves the direct incorporation of climate change adaptation and mitigation into agricultural development planning and implementation (FAO, 2010).

In rural Sub-Saharan Africa (SSA) rural farmers earn their livelihood mostly from climate-sensitive rain-fed agriculture. Their production is typically limited to a 3-6 month rainy season and crops grown are mainly staple cereal crops meant to sustain their livelihood (Burney and Naylor, 2012). However, the yields from these crops are subject to weather-driven fluctuations and are generally low. Dependence of smallholder farmers in SSA on such climate sensitive, seasonal staple production systems often leads them into multiple-scale poverty traps (Barrett and Swallow, 2006). Additionally, this often makes economies in the region (SSA) vulnerable to climate variability and change (Barnichon and Peiris, 2008; and Davies et al., 2009).

Agriculture is one of the vulnerable sector to the risk and impacts of global climate change and climate variability directly affects agricultural production because agriculture is inherently sensitive to climate conditions. Also climate change will affect food security by reducing livelihood productivity and opportunities. The impacts will be mostly negative in Mozambique (Ehrhart and Twena, 2006).

Climate change will increase average temperatures but also shift distributions of daily temperature and humidity highs. Such changes will require adaptation by outdoor farm workers to new working cycles, and is likely to have impacts on daily time-use and seasonal labor productivity.

Even in the face of climate change challenges, it is expected that smallholder farmers will continue to play a significant role in agriculture, particularly in developing countries (Wiggins and Keats, 2015). Yet, not all smallholders will remain in agriculture, particularly when faced with adverse climate change impacts. (Dorward, 2009) describes three main options for smallholders: "hanging in," "stepping up," or "stepping out" of agriculture. "Stepping out" of agriculture into the non-farm economy may be a realistic option for smallholders in areas where climate change is expected to adversely affect agricultural production. Rural youth who do not view farming as a source of sustainable livelihoods are also stepping out of agriculture and rural areas in large numbers (White, 2012). While climate change and climate variability are expected to have an impact on rural-to-urban mobility patterns due to displacement, voluntary migration and/or planned relocation, it should be noted that climate and weather effects are one amongst the many drivers of rural-to-urban migration (Brown, 2008).

**CSA and Mozambique agriculture context**

In Mozambique agriculture is the backbone of the economy contributing a quarter of Domestic Gross Product and providing livelihoods to more than 80% of the population (IFAD, 2010).

According to the Ministry of Agriculture and Food Security, Mozambique has 36 million hectares of agricultural land and more than 3 million can be irrigated but only 3% is currently under irrigation. Furthermore, agriculture in Mozambique is predominantly subsistence and is characterized by low use of new agricultural technologies and hence low productivity.

The most marginalized smallholders are described as "hanging in," currently barely subsisting from agriculture (Dorward, 2009). Many smallholder households using handheld agricultural tools with limited farm energy and labor constraints fall in this category. Climate change will likely aggravate the risk of food insecurity for such groups. "Stepping up" in agriculture, is where smallholder farmers have better opportunities for agricultural intensification, and to become more engaged in markets. For many smallholders, the lack of options to step up (or step out) of agriculture means that the agriculture sector will remain important for improving food security and rural livelihoods (Diao, Hazell, and Thurlow, 2010; Lipton, 2012; Wiggins and Keats, 2015). In general, CSA practices are being promoted to assist those men and women farmers whose aim is to stay in agriculture.

## 1.1. Objectives

## 1.2. Aim:

To analyze the factors influencing the adoption of CSA practices among smallholder farmers to cope with climate change.

Questions to be addressed are:

- What practices are currently being utilized in the area of interest?
- What are the factors influencing adoption of CSA practices?

## 1.3. Specifics objectives:

- To identify CSA practices used by smallholder farmers to address climate threats to agricultural production and livelihoods using a survey;
- To identify the socio-economic factors that influences the adoption of CSA practices to cope climate change and variability.

## 1.4. Hypothesis:

Farmers who are more aware of CSA will be able to adopt CSA practices and make more efficient use of their resources and thus cope with any adversities.

## 1.5. Research problem

Agriculture in Mozambique is mainly rain-fed and small-scale, with average farm size estimated at 1.2 hectares (CGAP, 2016). Roughly 72% of the farmers in the country work on farms that do not exceed 2 ha, using limited amounts of purchased inputs and practicing slash-and-burn extensively. Small-scale farms are concentrated in the province of Zambezia in the central region, which also has the largest land area under agriculture (approximately 1 million ha) (Ekman and Carmen, 2014). Furthermore, research shows that most smallholder farmers own land that is less than 2 hectares and produce mainly for the purpose of consumption.

Mozambique is one of the most vulnerable countries to climate change, because this country is strongly dependent on rain-fed agriculture and natural resources. And also many families rely on agriculture for alleviate poverty. However, many farmers in Mozambique are hittered by the consequences of climate change that is visible in form of drought, floods, cyclone, upsurge of pests and diseases, change in season and also accelerate land degradation that results in poor crops, poor income and less food. To lead with these problems, farming communities need to build resilience to the impact of climate change and adapt in changing climate.

It is argued that one of the contentious issues around the world is how to mitigate the impact of climate change. However, the question is how developing countries can practice agriculture in order to increase productivity especially in the era where the world is affected by global warming due to change in weather patterns (Branca et al., 2014). Even though there are many agricultural practices that teach on how to practice smart agriculture (Lipper et al., 2014) but uptake of these practices and technologies by small-scale farmers in Mozambique is significantly hampered by low access to knowledge and technology, high investment costs, and limited access to credit (Mucavele, 2014). Therefore, the purpose of this study is to analyze the factors that influence the adoption of CSA practices by smallholder farmers to cope with climate change in order to improve their crop production.

## 1.6. Research Justification

Mozambique's agriculture is characterized by small scale rain-fed farming and pastoralist systems that are particularly vulnerable to climate change and food insecurity. As poverty and environmental degradation exacerbate food insecurity for many farmers, poverty reduction is the core issue in mitigating climate related risks on agricultural production in Mozambique (Midgley et al., 2012).

The main food crops grown include tuber crops such as cassava and sweet potatoes; cereal crops such as maize, rice, sorghum and pearl millet; and root and grain legume crop such as beans.

Smallholder farmers dominate the agriculture sector and utilize 99% of family labor. Most of these farmers cultivate small plots of land between 0.5 to 1.5 hectares in size (USAID, 2017).

The vulnerability of African countries, including Mozambique, to climate change is compounded by strong dependent on rain-fed agriculture and natural resources; high levels of preparedness for climate events; and poor infrastructure in rural areas. Temperatures in Sub-Saharan Africa are already close to or beyond thresholds at which further warming reduce (already low) yields (Cline, 2008). In this context, CSA is critical for food security and development. It is an approach that can help reduce the negative impacts of climate change and can increase the adaptive capacity of farming communities to long term climate trends (FAO, 2010). Therefore, there is a need to identify CSA practices to cope with climate change and variability in order to increase productivity and income of smallholder farmers.

# CHAPTER 2

## 2.0. Literature review

### 2.1. Climate Smart Agriculture in the context of Africa

Climate-smart agriculture includes proven practical techniques, such as mulching, intercropping, conservation agriculture, crop rotation, integrated crop-livestock management, agro-forestry, improved grazing and improved water management and innovative practices, for instance better weather forecasting, more resilient food crops and risk insurance (Boto et al., 2012).

CSA shares many of the practices of conservation agriculture (CA). (Milder et al., 2011) define CA as a farming approach that fosters natural ecological processes to increase agricultural yields and sustainability by minimizing soil disturbance, maintaining permanent soil cover and diversifying crop rotations.

CSA offers the promise of a locally-adapted, low-external-input agricultural strategy that can be adopted by the poorest and most vulnerable farming communities, as well as by those that can afford varying levels of mechanization and external inputs. Despite its promise, however, CSA adoption in Africa is low (Milder et al., 2011).

### 2.2. The Mozambican context

Mozambique is among the most vulnerable and least prepared countries with regard to natural disasters, ranking 153 out of 178 nations on the Global Adaptation Index (ND-GAIN), with a score of 38.6 (UND, 2015). The country's vulnerability is driven by an array of biophysical, climatic, and socio-economic factors.

Over the period 1996-2015, climatic hazards such as droughts, floods, and cyclones generated economic losses of approximately US$ 790 million. Mozambique's coastline, which extends over 2,700 km and where half of the country's population lives, is affected by tropical cyclones which occur at varying intensity at least once a year. In 2000, Cyclone Eline brought about record levels of precipitation, resulting in floods which cost the economy an estimated 20% of the GDP) (GFDRR, 2012). In March 2019 an even more devastating cyclone IDAI destroyed much of Sofala, Zambezia and Manica provinces, killing an estimated 602 people and destroyed at least 65% of cropped lands. And on 25 April the cyclone Kenneth affected north of Mozambique killed an estimated 50 people and 28189 hectares of crop land are totally destroyed. A 2009 estimate of drought and flood costs indicated average annual losses of maize and sorghum of 9% and 7% respectively (GFDRR, 2012)

Changes in weather and climate are also visible in the form of sea level rise (inundation), increased incidence of wildfires, increases in mean annual temperature, increase in number of hot days, upsurge of crop and livestock pests and diseases, decreases in rainfall amounts, and shifts in seasons.

Climate projections for the country indicate an expected change in mean annual temperature by up to +1.4°C by 2030 and by +2.2°C by 2070, with the Northeast experiencing the highest increase. The greatest increases in temperatures are expected to occur between December and May. Total precipitation is not likely to decrease significantly, ranging from a 4% reduction in the north-eastern parts of the country to just 1% in the southern parts. However, negative impacts of climate change on agriculture will primarily be caused by the increased likelihood of extreme events such as cyclones and flooding (Choudhary and Suit, 2015).

**2.3. Regional projections**

Climate change will affect people in Africa more than anywhere else in the world due to the nature of changes they are facing, deteriorating terms of trade, inappropriate policies, high rates of population growth, the inequitable distribution of land, over-dependence on natural resource based livelihoods and over-reliance on rain-fed agriculture (IPCC, 2001).

Africa's climate is already changing. In general, the continent is becoming warmer and drier. Rainfall is becoming unpredictable. Meanwhile, storms, droughts and floods are becoming more common and intense.

Africa's average temperature rose at a rate of 0.05ºC per decade from 1900 to 2000 for a total increase of 0.7ºC (IPCC, 2001). Temperature is due to rise by a further 0.2 to 0.5ºC per decade, with the greatest warming occurring "over the interior of semi-arid margins of the Sahara and central southern Africa"

### 2.4. Climate change in Mozambique

Mozambique's weak socio-economic infrastructure and geographic location make it particularly vulnerable to the impacts of climate change (MICOA, 2003). Research by the government of Mozambique suggests that mean air temperatures will raise by at least 1.8 to 3.2ºC nationwide by 2015 (MICOA, 2003). Precipitation is predicted to fall 2 to 9%, which will take greatest effect between November and May (during which period the IPPC forecasts there will be a 5 to 15 % drop in regional rainfall). As this coincides with the growing season, it will have an especially pronounced impact on crop yields. Other expected changes are a 2 to 3% increase in solar radiation, and a 9 to 13% rise in evapotranspiration.

Extreme events are likely to pose the greatest climate change threat to Africa (WGCCD, 2005). In Mozambique, they will take the form of drought, flooding and tropical cyclones that are expected to become more frequent, intense and unpredictable (IPCC, 2003). The recurrence of slow-onset, extreme weather condition, such as droughts and floods, and sudden events, such as tropical cyclones, highlight the country's vulnerability to current climatic hazards. Droughts are most common in the south, and tend to manifest themselves slowly over time, lasting for periods of up to three to four years. Floods have a shorter time perspective, but can prevail for several months, occurring most frequently in central and southern regions, along river basins, in low-lying regions, and in areas with poor drainage systems, (MICOA, 2003).

#### 2.4.1. Socio-economic implications of climate change and variability

Poor people are particularly to climate change because:

- Is often linked to a higher reliance on natural resources. This makes poor people more sensitive to changes affecting the environment and can lead to degradation of natural resources-thus creating a vicious circle of increasing vulnerability to climate change (Tschakert, 2006).

- Constrains people's adaptive options/capacity. Climate change is an 'underlying cause of poverty in that it triggers or worsens a wide range of immediate and intermediate causes of poverty. Slowly changing climatic conditions and more frequent extreme events are likely to pose a threat to food and livelihood security, water supply, and human health. Because different social groups will feel the impacts of climate change disproportionately, there may also be consequences for social cohesion and gender equality. In areas where marginal groups struggle to gain access to increasingly degraded and scarce natural resources, climate change can lead to displacement and violent conflict (Tschakert, 2006).

### 2.4.2. Food security and livelihood productivity

Climate has important impacts on the agricultural sector, since the single most important source of risk for crop failure nation-wide is drought. According to a study done for maize, rice, sorghum and groundnut, drought constitutes between 48-73% of the risk of crop failure in Mozambique (Walker, 2006).

The country has three easily recognizable geographical zones in terms of agricultural potential. The north (Niassa, Cabo Delgado, and Nampula) is largely a sub-humid zone (1,000-1,200 mm rainfall annually). The centre (Zambezia, Tete, Manica and Sofala) is a mixture of sub-humid zones (1,000-1,200 mm annual rainfall) and humid highlands; and the south (Inhambane, Gaza, Maputo) with arid zones in some parts (400- 1,000 mm annual rainfall) (World Bank, 2006).

The effects of climate change represent a threat to agriculture by deepening poverty in communities that they make little or no contributions to climate change through greenhouse gas emissions. The country is also prone to droughts of varying severity, approximately every three to four years, and to floods caused by tropical cyclones. Survival and everyday life in the drought-affected areas depend to a large extent on rain-fed farming, exploration of local resources and fishing. The weakness of the road network, subject to severe disruption by heavy rain and flooding also imposes challenges for livelihoods.

Recurring droughts and floods are forcing farmers to adapt their farming systems to the differing conditions, often on a year-to-year basis. The effects of climate change undoubtedly have a greater impact on societies or individuals with scarce resources, where technologies are lacking, and where infrastructure and institutions are least able to adapt. These are the communities that have the least resources to adapt and cope with its effects (Parkinson, 2011).

Erratic weather will undermine rain-fed agricultural systems; heat stress on crops will reduce yields; increases in carbon dioxide concentrations will decrease protein content of vegetation (with implications for both human and livestock health and productivity); rising rate of evapotranspiration will increase pressure on water supplies (especially in areas where river runoff is reduced and shallow wells become unreliable); rate of disease will rise for humans, plants and livestock; salt water incursions will contaminate water supplies and damage ecosystems; sea level rise will claim land in low-lying, populated coastal areas; environmental services will decline (e.g. water and biodiversity); and higher ocean temperatures, salinity and acidity will devastate marine organisms and fisheries.

Given the importance of agriculture for the vast majority of the population, impacts specific to the sector are outlined in more detail in Box 1.

**Box 1**

**Impacts of climate change on agriculture**

**Agriculture**

- Unpredictable rainfall will lead to uncertainty in cropping patterns
- Areas with less rainfall will lose water through evapo-transpiration and require irrigation
- Flooding will cause nutrient leaching, soil erosion and water logging
- Changing pest and disease patterns
- Prolonged dry spells may extend beyond normal patterns
- Predicted fall in the nutritional content of biomass and grains, including maize
- Increase in quantity of foliage in rangelands, but fall in quality (nutritional content)
- Shift in agro-ecological zones
- Increased weed competition with crops for moisture, nutrients and light

**Livestock**

- Favorable condition for ticks, snails, blood-sucking insects and pests outbreaks
- Eruption of new pests and diseases
- Reduce productivity (draught power, milk and meat) as increased carbon dioxide reduces protein available from vegetation
- Livestock deaths due to heat waves.

Sources: IPCC, 2001 and MICOA, 2003

## 2.5. Smallholder farming system in Mozambique

Agriculture in Mozambique is mostly practiced by smallholder farmers, who account for 99 per cent of the total number of farming units and farm 96 per cent of the 5.6 million ha of cultivated land (CAP, 2011). The majority of these farmers practice rain-fed subsistence production on small areas (cultivated land measures on average 1.35 ha) (TIA, 2012), with limited integration into markets and with low use of external inputs, animal traction and mechanical implements.

Many studies suggest that low-external input; sustainable agriculture can contribute to food security by increasing productivity while at the same time being more climates resilient and environmentally sustainable than high-external input agriculture, especially in marginal environments (Pretty et al., 2011). This view is reflected in many reports by influential international organizations that have recently praised the benefits of agro-ecology and other sustainable practices under multi-functional agriculture and sustainable food systems. It is also the gist of the concept of ‘Climate Smart Agriculture’ (CSA), defined as an approach that “integrates the three dimensions of sustainable development (economic, social and environmental) by jointly addressing food security and climate challenges” (FAO, 2013).
In Mozambique, food crops account for 57 per cent of the total cultivated land (CAP, 2011) and for 90 per cent of the volume of total crop production (MINAG, 2014); they include cereal crops such as maize, rice, sorghum and pearl millet, root and tuber crops (mainly cassava and sweet

potato), and grain legume crops. Horticulture takes up 6.9 per cent of the total cultivated land. Cash crops include cotton, cashew, tobacco, sugar cane, coconut, sesame, soybean and fruit. The main livestock produced are cattle, goats and poultry (CAP, 2011), although different livestock dominate in different regions. The most consumed staple foods in Mozambique are maize followed by cassava and rice (Walker et al., 2006; and TIA, 2012).

**2.6. Effects of climate changes on maize production**

The crop growth, development and yield are limited by the two of the most important environmental factors (water shortages and heat stress) (Prasad and Staggenborg, 2008).

Ambient temperature affects the phenology (whole plant development rate) and physiology (functioning of internal process) of many major crops. Changing in phenology and physiology, warming is likely to change the optimal times and locations for cropping. Food insecurity can arise when these agri-climatic shifts cross national bounds or if the communities lack means of adaptation to altered growing conditions (White and Reynolds, 2003).

Yield can be reduced directly by warmer growing season temperatures in two important ways. The first is that, the higher temperatures accelerate crop growth for crops that the phenology is predominantly regulated by temperature, such as maize. This results in reduction of the time for plant and grain development, limiting the attainment of yield potential. Second, if extreme heat occurs during flowering (maize “silk-tasseling” phase), pollination may be inhibited and entirely the development of grain may be prevented. Additionally, increasing in temperature could accelerate plant development enough that the reproductive period, the stage requiring the most water, would shift away from the typical wettest time of the cropping season (a problem for rain-fed maize production system) (White and Reynolds, 2003).

Reduced yields at warmer temperature are explained by the effect of temperature in reducing the length of growth cycle, especially the grain filling phase (White and Reynolds, 2003).

Hot and dry weather hasten pollen shed and delays silk emergence, narrowing the duration of co-occurrence. Additionally, temperatures above 32 $^{o}$C greatly reduce the ability of pollen to germinate on silks (Basra, 2000).

## 2.7. Effects of climate change on rice production

Drastic climate change and increase water scarcity challenge global food security which is further exacerbated due to the need to feed a growing global population (Lesk, Rowhani, and Ramankutty, 2016).

Crop yield is affected by agronomic factors and various environmental variables such as water availability and temperature (Awika, 2011; Hatfield, and Prueger, 2015).

Although an increase in temperature is beneficial for crop productivity in some cooler regions of the world, drought still significantly reduces national cereals production by 9-10% on global scale (Lesk, Rowhani, and Ramankutty, 2016) via negative effects on plant growth, physiology and grain development (Farooq, Hussain, and Siddique, 2014; Matiu, Ankerst, and Menzel, 2017; Fahad et al., 2017).

Caused by reduced precipitation and increased in temperature (Parry et al., 2007) drought has been the most important factor for crop productivity and ultimately, for food security worldwide (Daryanto, Wang, and Jacinthe, 2017).

The challenge of drought is even greater for crops such as rice when compared with other crops such as maize and wheat, as it has relatively higher water needs (Todaka et al., 2015). Rice is sensitive to deficit in soil water content because rice cultivars have been historically grown under flood irrigation conditions where the soil matric potential is zero (Bouman et al., 2002). Moreover, as compared to several other field crops, rice has relatively weak resistance to drought and its production systems are more vulnerable to drought than other cropping systems (O’Toole, 2004).

Drought has had significant negative effect on the livelihood of rain-fed lowland rice farmers. The severe and the duration of drought stress determine the extent of the yield loss by shortening the life and the duration of grain filling (Farooq, Hussain, and Siddique, 2014).

A change in any agronomic traits under drought conditions alters the final crop yield including the growth parameters (e.g. plant height and biomass at the harvest) and components of harvestable yield such as Panicle number per unit area (PNPU), the grain number per panicle (GNPP), 1000-grain weight (GW), the panicle land (PL), and filled grain percentage/seed setting rate (FP) (Boonjung, and Fukai, 1996).

The increased occurrence of prolonged droughts in SSA is a worrying trend as the region is highly dependent on rain-fed agriculture. In order to enhance sustainable crop production in the face of drought and the constantly changing climatic conditions around the world, there is need for constant efforts to adapt our crops and production systems to the existing and emerging environmental challenges.

### 2.8. Sub-Saharan Africa vulnerability to climate change impacts

The vulnerability of African countries to climate change is compounded by strong dependence on rain-fed agriculture and natural resources, high levels of poverty, low levels of human capital, low levels of preparedness to climate change effects and poor infrastructure in rural areas. Other key challenges include poor soil fertility, reduced soil organic matter and increased occurrence of acidified soils, due in part to limited fallow periods and to poor cultivation and water management practices. The limitations of Africa's agriculture are further exacerbated by limited functioning of markets and prohibitive trade policies, constraining access to inputs (IFAD, 2011). As a result, the average yields of grain crops in sub-Saharan Africa have stayed below 1 tons per hectare since the 1960s, compared with average cereal yields of 2.5 tons/ha in South Asia and 4.5 tons/ha in East Asia (Gilbert, 2012).

Smallholder farmers, with limited capacity to invest or manage risk due to poorly functioning credit and insurance markets, are constrained in their ability to increase yields and incomes, and thus are particularly vulnerable to impacts of climate change and current climate variability. Women farmers may suffer the most, as they are estimated to receive less than 5% of extension, and less than 1% of all available agricultural credit (IFAD, 2007).

### 2.9. Adoption of Climate change adaptation strategies by smallholder farmers

Technology adoption occurs when the user becoming aware of the technology and has decided to make full use of the new technology as a best course of action for addressing a need (Rogers, 2003).

Technology adoption is influenced by several factors including socio-economic, environmental and mental process that are governed by a set of intervening variables such as individual needs, knowledge about the technology and perceptions about used to achieve those needs (Thangata and Alavalapati, 2003). This study was focused on socio-economic characteristics factors.

Smallholder farmers are one of the most vulnerable groups to climate change and variability as it adds pressure to their already stressed ecosystems (Grainger-Jones, 2011)

To respond to the effects of climate change and variability requires continuous development of new techniques and improvement of the existing ones and, more importantly, their widespread adoption by farmers (Campbell et al., 2011)

Smallholder farmers need training on how and why to use technologies and appropriate incentives to adopt them, so as to allow them to maximize the use of water supplies and optimize their production (Leal, 2012).

To address the negative effects of climate changes, farmers have adapted irrigation, drought resistant seed varieties, shifting to other crops, conservation agriculture preserving both soil and water, dry and early planting, varying planting dates and others do nothing to cope with the effects of climate change (Boko et al., 2007).

To adopt CSA requires substantial change both in practices and in the mindset (Derpsch, 2008).

Many farmers are used to think that plough or the hoe is an essential part of agriculture and may find it difficult to overcome the idea that ploughing is not required for successful planting. It can be particularly difficult to convince farmers to adopt CSA if they do not experience strong environmental or economic pressures to change. Conventional agricultural practices may also be tightly woven into local culture and ritual, making such practices even more entrenched (Milder, et al., 2011).

While farmers who practice CSA tend to have a positive view of it (Friedrich and Kassam, 2009), lack of experience and evidence-based knowledge hinders adoption. As with agriculture in general, CSA is a knowledge-intensive process that requires substantial planning, intuition and a willingness to experiment and learn (Milder et al., 2011). When reliable information on CSA is not available from formal support systems (extension agents, NGOs, private sector), neighbors or prior experience, farmers may not be able or willing to adopt CSA fully or optimally from the start, which can lead to disappointing results and subsequent non adoption.

Climate change has disproportionate effects on women and girls in Mozambique, since they are more dependent on natural resources for household and agricultural tasks. Women are normally responsible for crop production (men are in charge of livestock) and availability of food and water for the household. Women's rights and control over natural resources is less than men's, and they are often underrepresented in decision-making bodies. Women's burdens are aggravated if they are left alone by men who migrate to larger cities or even abroad (which is according to some an increasingly common coping strategy to climate-related hazards, while other studies report reduced male migration in recent years) (Arnall, 2006). As a result, in many areas over 50% of households is female-headed, and women and girls need to cope with the burdens of reduced water availability and food security (Midgley, Dejene, and Mattick, 2012; Mucavele, 2010).

# CHAPTER 3

## 3.0. Research Methodology

### 3.1. Description of the study area

The present study was undertaken in the Zambezia province. The province was selected due to its vulnerability to climate related disasters like drought.

Another reason is that Zambezia is the one of the largest and most populous of the Mozambique and has the largest area under agriculture (1 million) where the majority of the population depends on agriculture for their livelihood and they live in the rural area.

The province lies between Latitude: -17° 00' 0.00" S and Longitude: 37° 00' 0.00" E (https://latitude.to › Articles by country › Mozambique).

Agricultural products include rice, maize, cassava, cashews, sugarcane, soybeans, coconuts, citrus, cotton and tea (Di Matteo, Otsuki and Schoneveld, 2016).

The climate of this province is characterized by being humid tropical and has green vegetation from the coast to the interior (Fauna e Flora. majaliwa.tripod.com/zambezia.htm).

#### 3.1.2. District selection

Zambezia province consists of 16 districts. Out of these districts Nicoadala and Namacurra were selected because they were easily accessible, they were one of the districts that were affected by drought than others adversities and the populations stayed far from water source. The researcher needed to find strategies that can make household in the districts more resilient to climate related chocks.

***Namacurra district***

The district of Namacurra is located in the South of Zambezia province, with limits to the north of Mocuba, to the west of Nicoadala, south of Indian Ocean, and the east with Maganja da Costa district (MAE, 2015).

The geographical coordinates of the district are 17° 29' 31" South, 37° 1' 44" East. According census 2017 Namacurra district has total an area of 2,021 $km^2$, its population is estimated in 242,126 inhabitants and population density of 119 inhabitants/$km^2$.

Namacurra has tropical climate with two seasons, rainy season and dry season with medium average temperatures of 25.5ºC. The mean annual precipitation of the district is 1.194 mm with an average annual evapotranspiration of 1.533mm. The high rainfall occurs between November to April in the following year. This varies in quantity and distribution from year to year.
November is the hottest month of the year with an average temperature of 28.0ºC. The lowest average temperature of the year is 21.7ºC and it occurs in July.

***Nicoadala district***

The Nicoadala district is located in the central part of Zambezia province, confining the districts of Mocuba and Namacurra to the North; Morrumbala and Mopeia to the West; Inhassunge to the South and the Indian Ocean (MAE, 2015).

The geographical coordinates of the district are 17° 39' 31" South, 36° 49' 11" East. According census 2017 Nicoadala district has total area of 3,381 $km^2$, its population is estimated in 180,686 inhabitants and population density of 53.44 inhabitants/$km^2$.

Nicoadala has tropical rainy climate with two distinct seasons, rainy season and dry season with medium average temperatures of 25.7ºC. The mean annual precipitation of the district is about 1.206 mm with evapotranspiration of 1.533. The high rainfall occurs between November to April in the following year. The hottest month of the year is November with an average temperature of 28.3ºC. July has an average temperature of 22.4ºC, which is the lowest temperature of the year.
In general, subsistence agriculture consists mainly intercropping and forms basis in manual tools and they cultivate local varieties (MAE, 2015).

In both districts the agricultural production is predominantly under rain-fed conditions, not always successful, since the risk of crop loss is high, given the low soil moisture storage capacity during the growing season.

Some families use traditional methods of soil fertilization, such as fallow land, incorporation into the soil of plant, manure or ash stubble. In addition to climatic issues, the main constraints to production are insect pests, drought, lack or insufficiency of seeds and pesticides (MAE, 2015).

The Figure 1 below illustrates sites in central Mozambique

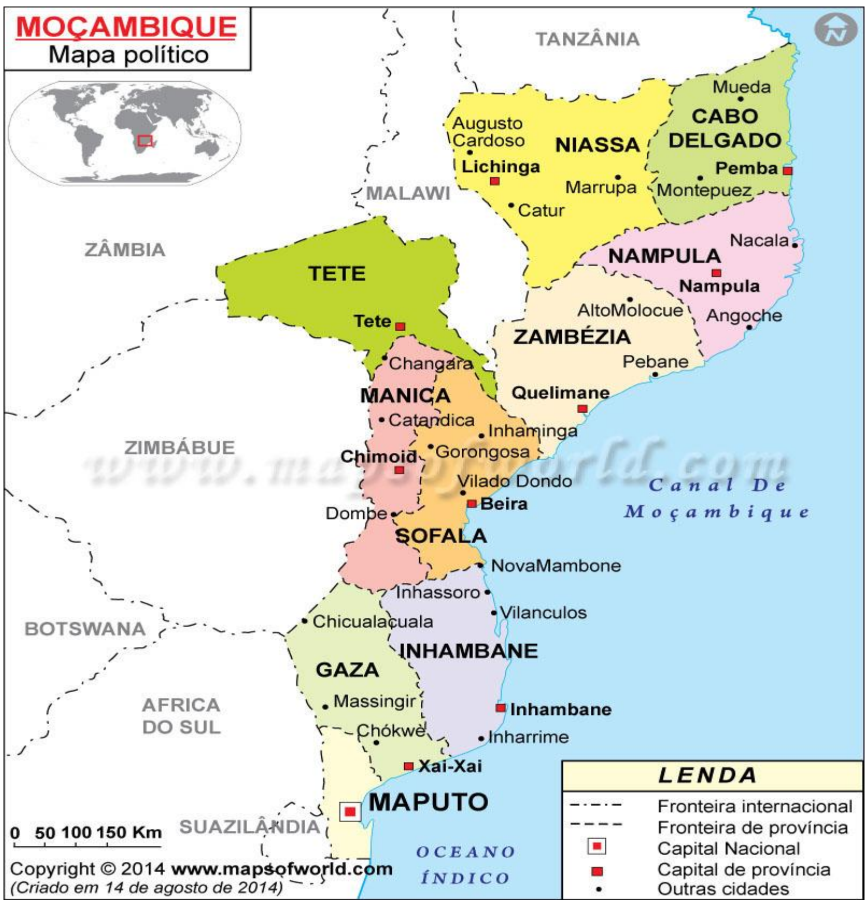


Figure 1: Map of Mozambique that showing the Zambezia province

The Figure 2 illustrates the two districts involved in the research


Figure 1: Map of Zambezia province showing the districts sites of the research

### 3.2. Research methods, sampling size and data analysis

The research was conducted in two districts of Zambezia province, Nicoadala and Namacurra.

The study was aimed at investigating the socio-economic factors that influence the adoption of Climate Smart Agriculture practices to cope with climate change and variability. Then farmer strategies were selected randomly. For present study, information was collected from 100 respondents for the data collection and semi-structured questionnaires were used using interview method.

The sample size was involved 40 respondents in Nicoadala district and 60 respondents in Namacurra district. The sample was different because these districts present different number of household. According census (2017) Nicoadala has about 44.252 household and Namacurra with

62.018 household. The pilot study was done using 20 respondents. These respondents were not included in the final survey. The purpose of pilot study was to see if the data was analyzable and to check the questionnaire, if the questions were understandable.

For data collection, a semi-structured interview was used. The researcher relied on extension agent that was familiarized with the area, issues of climate change and the importance of research on climate change adaptation the research.

The questionnaire was distributed in all the two study sites. Data were collected by the researcher herself. The task was accomplished through a door to door visit to the selected respondents and it was collected in the year of 2018-19.

Data was analyzed using descriptive statistics for determining the frequency and percentage of farmers that used CSA practices and also to describe its socio-economic characteristics; the Binary Logistic Regression Model was used for determining the factors influencing the adoption of CSA practices. Initially the questionnaire was edited and coded before the analysis. Analysis was done using SPSS version 20.

In the descriptive statistics was applied for socio-economic characteristics information such as:

a) Gender of the household head

The gender was the sex of the household head; it had value 1 for men and 2 for women.

b) Marital status

In this variable was intended to know the marital status of the household head.

c) Household size

This variable measures the size of household, i.e. the number of people who live in the same house and share the meals and resources.

d) Age of household

This variables measures the age of the household head. Mugwe et al., (2012) reported that the age is regarded as a primary dormant attribute in technology adoption decisions.

e) Education level

The education variable measures the education level achieved by the head. Education is another factor that affecting the adoption of technology.

f) Land size ownership

The land size ownership variable measures the size of land of the smallholder farmers.

g) Decision making about the land

Decision making variable measures the decision made about what crops to grow in the land if it was done by man or woman.

h) Main crops

This variables measures the main crop that the farmers grew to their subsistence and source of income.

i) Source of information

Source of information variable measures the source of information about the agricultural practices or innovation. The information and knowledge are the one of the factors that affect the adoption of the technologies and the farmer depends on the different sources of information.

**Methodological limitation**

- Unavailability of respondents;

Unavailability of the respondents was a limitation because in their absence the researcher had to immediately look for another respondent that was not included in the selection. It was difficult to find the farmers at home because it was time of growing season and most of them were on the farm and when it was the farm, sometimes they were not available to respond by claiming that they were being hampered by their activities. So the researcher felt obliged to wait until they finished their activities or even spend the night in a nearby place to ensure that the follow day would be at their door before leaving for the farm.

# CHAPTER 4

## 4.0. Results

### 4.1. Introduction

This chapter presents the results and the analysis of the data collected at two sites (Nicoadala and Namacurra) in the province of Zambezia, Mozambique. The data were obtained by applying a survey to a group of representative individuals in the two mentioned areas. The analysis of the data was made taking into account the objectives drawn for this work, and therefore, aligned with them, the analysis consisted of:

(1) Description of the data:
Descriptive statistic was used to describe socio-economic characteristics of the respondents given frequencies and percentages and also identify key practices used by farmers to deal with climatic hazards.

(2) Logistic regression models:
The regression model seeks to measure the significant impact of one or several factors on a variable (response variable). In this case, to identify the different factors that had significant influence on the different technologies used by farmers, it was considered the binary logistic regression model. The fact that the response variables are dichotomous (with only two possible answers: yes or no), the adjusted regression model for such variables is binary logistic.
In all cases, the different variables of the study were analyzed considering the farmer's zone (Nicoadala and Namacurra) as a block factor, that is, all analyzes were made in a comparative way of the farmers of these two zones.

### 4.2. Descriptive analysis of data

#### 4.2.1. Independent variables (Socio economic characteristics of the respondents)

As a part of the research it was important for the researcher to identify the key characteristics that may influence on the adoption of technologies with the goal to help the researcher to know which influence those characteristics have on the smallholder farmers. The characteristics will find in the Table 4.1 and the numbers in bold are with the highest percentages.

Table 4.1: Socio-economic characteristics of the respondents in Nicoadala and Namacurra obtained through household survey

| Variables | Nicoadala | | Namacurra | |
|---|---|---|---|---|
| Gender of the household head | Frequency | Percentage% | Frequency | Percentage % |
| Male | 19 | 47.5 | 22 | 33.7 |
| Female | 21 | **52.5** | 38 | **66.3** |
| Marital status | | | | |
| Monogamy | 18 | **45** | 40 | **65** |
| Polygamy | 5 | 12.5 | 5 | 8.3 |
| Divorced | 2 | 5 | 3 | 5.0 |
| Single | 9 | 22.5 | 11 | 18.3 |
| Wife/husband away from 3 months | 4 | 10 | 2 | 3.3 |
| Others | 2 | 5 | | |
| Size of household | | | | |
| 0-5 | 19 | 47.5 | 24 | 40 |

| | | | | |
|---|---|---|---|---|
| 6-10 | 20 | **50** | 30 | **50** |
| 11-15 | 1 | 2.5 | 6 | 10 |
| Age of household head | | | | |
| 15-45 | 37 | **92.5** | 58 | **96.3** |
| 45-75 | 3 | 7.5 | 2 | 3.7 |
| Level of education | | | | |
| No formal education | 8 | 20 | 17 | 28.3 |
| Primary | 27 | **70** | 23 | **38.3** |
| Secondary | 5 | 10 | 20 | 33.3 |
| Land ownership | | | | |
| Owned 1/4-2ha | 38 | **95** | 53 | **86.9** |
| Owned 2.5-3.5ha | 1 | 2.5 | | |
| Rented 1ha | 1 | 2.5 | 4 | 6.6 |
| Borrowed 1ha | | | 2 | 3.7 |
| Sharecropped 1 ha | | | 1 | 1.6 |
| Decision Making about the land | | | | |
| Only man/husband | 5 | 12.5 | 20 | 33.3 |
| Only woman/wife | 23 | **57.5** | 22 | **36.7** |
| Male and woman responsible | 12 | 30 | 18 | 30 |
| Main crops | | | | |
| Cotton | | | 2 | 3.7 |
| Maize | 12 | 30 | 17 | 28.3 |

| | | | | |
|---|---|---|---|---|
| Rice | 23 | **57.5** | 35 | **59.3** |
| Cassava | 5 | 12.5 | 5 | 8.5 |
| Source of information | | | | |
| Government extension | 8 | 20 | 16 | 26.7 |
| NGOs | 3 | 7.5 | 1 | 1.7 |
| Community meetings | 3 | 7.5 | 3 | 5 |
| Family members | 17 | **42.5** | 28 | **46.7** |
| TV | 1 | 2.5 | | |
| Radio | 2 | 5 | | - |
| Neighbors | 2 | 5 | 5 | 8.3 |
| School | - | - | 1 | 1.7 |
| Own experience | 4 | 10 | 6 | 10.0 |
| Total | 40 | 100 | 60 | 100 |

Data from the Table 4.1 indicates socio-economic characteristics of the respondents in two districts. This is because the decision at to adopt technologies at individual farmer level is always determined by several factors (Mwangi et al., 2015; Kebede et al., 1990).

**Gender of the household head**

Gender was the sex of the household head.

The results show that the majority of the household in the two districts were headed by female with 52.5% in Nicoadala and 66.3 % in Namacurra districts. It is hypothesize that household headed by women will be more likely in adopt new technology that household headed by men.

**Marital status**

In both sites the household head were married with single husband at 45% in Nicoadala and 65% in Namacurra, followed by single in both sites with 22.5% in Nicoadala and 18.3% in Namacurra respectively.

According CGAP (2016), in Mozambique, 67% of smallholder farmers household headed by female were divorced, separated or widowed.

**Household size**

The result shows that the household in both districts were between 6 to 10 people with about 50% respectively.

**Age of the household head**

The result shows that both sites the household were age between 15 to 45 with 92.5% in Nicoadala and 96.3% in Namacurra respectively, these households head were considered as young farmers.

**Education level of the head**

Regarding education level, the results revealed that in both districts the majority of farmers had primary school with 70% in Nicoadala and 38.3% in Namacurra; followed by mo formal education in both sites with 20% in Nicoadala and 28.3% in Namacurra respectively. The researcher expects that farmers who had low education level will be less likely in adopt some technologies.

CGAP (2017) reported that in Mozambique 30% of household headed by female have no formal education and 67% did not continue their education past primary school. Only 12% have advanced through secondary school.

### Land size ownership

About 95% of the respondents from Nicoadala district were owner of their land with size between of 1/4 to 2 ha and 86.9% respondents from Namacurra were also owner of their land with size between of 1/4 to 2 ha. The average of these lands was less than 1 ha per household, so, they had small piece of land.

### Decision making about the land

Regarding decision making about the land, the results revealed that the majority of decision making about land were done by only woman in both sites with 57.5% in Nicoadala and 36.7% in Namacurra. Followed by both responsible in Nicoadala with 30% and made by only man in Namacurra at 33.3% respectively.

### Main crops

The results show that the main growing crops in both districts were Rice at 57.5% in Nicoadala and 59.3% in Namacurra; followed by maize at 30% in Nicoadala and 28.3% in Namacurra. The farmers assumed that those crops were only for subsistence. Only 3.4% of farmers from Namacurra grew cash crops (e.g. Cotton).

### Source of information

Source of information variable measures the main source of information about the agricultural practices or innovation. The information and knowledge are one of the factors that affect the adoption of the technologies and the farmers depends on the different sources of information

The main source of information that influenced adoption was family members with 42.5% in Nicoadala and 46.7% in Namacurra; followed by government extension. It means there are weak extension services in these villages, so the smallholder farmers are less likely to adopt the technologies and they had the same sources of information. CGAP (2016), reported that farm turn to their family and friend most often and frequently for information on agricultural activities, followed by messages coming across radio waves. And the results found in its survey was about 73% of farmers never had information from government extension workers.

### 4.2.2. Dependent variables

#### 4.2.2.1. Perception of climate change impacts

The researcher intended to know which impact climate change brought to the farmers in those districts in order to evaluate its perception among smallholder farmers.

Table 4.2 shows the results of the perception of farmers about the impacts of climate change in last 10 years. The majority of the respondents in Nicoadala and Namacurra districts perceived that climate change had negative impact on the crops have reduced its yield with 90% and 95%; followed by increased period of drought and increasing in temperature in both sites.

These results confirm that the existence of global warming has brought an increase in temperature causing long periods of drought with negative impacts on crop productivity. And also these findings indicated that the farmers in the research areas perceived the negative impacts of climate change on their crop activities and therefore, the need of use CSA technologies is a key to solve these problems.

Table 4.2: Perception of Climate Change impacts in Nicoadala and Namacurra districts obtained through household survey

| Impacts of Climate change | Nicoadala | | Namacurra | |
|---|---|---|---|---|
| | Frequency | Percentage % | Frequency | Percentages% |
| Increasing in temperature | 35 | **87.5** | 52 | **86.7** |
| Change in rainfall pattern | 29 | 72.5 | 42 | 70 |
| Increase period of droughts | 34 | 85 | 52 | 86.7 |
| Reduce crop yield | 36 | **90** | 57 | **95** |

**4.2.2.2. Awareness of CSA practices**

Regarding awareness of CSA practices the researcher wanted to know in which technology the farmers are more or less aware and relate with its adoption, this information will be find in the table 4.3 below.

Table 4.3: Awareness of CSA practices in the Nicoadala and Namacurra districts obtained through household survey

| Practices | Nicoadala | | | | Namacurra | | | |
|---|---|---|---|---|---|---|---|---|
| | Frequency | | Percentage % | | Frequency | | Percentage % | |
| | No | Yes | No | Yes | No | Yes | No | Yes |
| Agroforestry | 1 | 39 | 2.5 | **97.5** | 4 | 56 | 6.7 | **93.3** |
| Crop rotations | 4 | 36 | 10 | **90** | 8 | 52 | 13.3 | **86.7** |
| Improved or stress tolerant crop variety | 19 | 21 | 47.5 | **52.5** | 28 | 32 | 46.7 | **53.3** |
| Improve irrigation | 3 | 37 | 7.5 | **92.5** | 16 | 44 | 26.7 | **73.3** |
| Minimum tillage | 19 | 21 | 47.5 | **52.5** | 17 | 43 | 28.3 | **71.7** |
| Earlier planting date | 4 | 36 | 10 | **90** | 7 | 53 | 11.7 | **88.3** |
| Crop diversification | 1 | 39 | 2.5 | **97.5** | 4 | 56 | 6.7 | **93.3** |
| Intercropping | 24 | 16 | 60 | 40 | 21 | 39 | 35 | **65** |
| Use fertilizers/pesticides | 2 | 38 | 5 | **95** | 10 | 49 | 16.7 | **81.7** |
| Mulching | 14 | 26 | 35 | **65** | 21 | 39 | 35 | **65** |

Table 4.3 above showed the percentage of awareness of the ten practices used in the study sites.

In general, in both districts the farmers were aware of all CSA practices, but they were more of agroforestry and crop diversification with 97.5% in Namacurra; followed by use of fertilizers/pesticides at 95%. While about 93.3% of respondents in Namacurra district were more aware of crop diversification; followed by agroforestry at 90% respectively. There is one practice that the awareness was low particularly in Nicoadala where 60% of sample size was not aware of intercropping.

#### 4.2.2.3. Use of CSA practices

To answer the objectives of the study was used this variable.

Regarding it was intended to know which practices were currently used by SHFs and in the follow sub-chapter find the factors that significant influence the adoption of the CSA practices in order to answer the second objective of the research. The results are in table 4.4 below.

Table 4.4: Current practices used in both study sites obtained through household survey

| | Nicoadala | | | | Namacurra | | | |
|---|---|---|---|---|---|---|---|---|
| Practices | Frequency | | Percentage % | | Frequency | | Percentage % | |
| | No | Yes | No | Yes | No | Yes | No | Yes |
| Agroforestry | 14 | 26 | 35 | **65** | 21 | 39 | 35 | **65** |
| Crop rotations | 28 | 12 | 70 | 30 | 36 | 24 | 60 | 40 |
| Improved or stress tolerant crop variety | 20 | 20 | 50 | **50** | 42 | 18 | **70** | 30 |
| Improve irrigation | 24 | 16 | 60 | 40 | 29 | 31 | 48.3 | **51.7** |
| Minimum tillage | 19 | 21 | 47.5 | **52.5** | 45 | 15 | **75** | 25 |
| Earlier planting date | 22 | 18 | 55 | 45 | 20 | 40 | 33.3 | **66.7** |
| Crop diversification | 18 | 22 | 45 | **55** | 30 | 30 | 50 | **50** |
| Intercropping | 21 | 19 | 52.5 | 47.5 | 39 | 21 | 65 | 35 |
| Use fertilizers/pesticides | 24 | 16 | 60 | 40 | 42 | 18 | 69.5 | 30.5 |
| Mulching | 23 | 17 | 57.5 | 42.5 | 48 | 12 | **81.4** | 18.6 |

The table 4.4 above showed the current practices used among smallholder farmers in two sites.

The result showed that generally the smallholder farmers used all of the practices, but some of them the uptake was low. The percentages in bold highlight indicate the practices over 50% that they most current used.

The majority farmers in Nicoadala used agroforestry with 65%; followed by crop diversification, minimum tillage and improved or stress tolerant crop variety; while in Namacurra district the most current used practice by farmers was change in sowing date with 67.7%; followed by agroforestry, improved irrigation and crop diversification. But there is a lot of practices that was very low uptake, the worst been mulching particularly in Namacurra district where 81.4% of sample size do not even practice mulching, 75% do not practice minimum tillage and 70% do not practice improved/ drought tolerant variety.

The farmers used those practices due to several advantages that brought to their cropping activities. The advantages are illustrated in the Table 4.5 below. Improved productivity, improved soil fertility, insurance in case of crop failure, improved water retention, improved household income, reduced household labor requirement and reduced household labor requirement are the advantages that facilitate the use of CSA practices. Despite these advantages, they aware that the major cause of climate change is deforestation, so they practice agroforestry not only to increase productivity and income, but also to remove large amount of GHG emissions from the atmosphere.

Table 4.5: Advantages of use CSA practices among smallholder farmers in Nicoadala and Namacurra districts

| Advantages | Nicoadala | | Namacurra | |
|---|---|---|---|---|
| | Frequency | Percentage % | Frequency | Percentage % |
| Improved productivity | 38 | **95** | 57 | **95** |
| Improved soil fertility | 34 | **85** | 51 | 85 |
| Insurance in case of crop loss | 31 | 77.5 | 52 | **86.7** |
| Reduced risk of drought | 31 | 77.5 | 38 | 63.3 |
| Improved water retention | 29 | 72.5 | 45 | 75 |
| Improved HH income | 26 | 65 | 37 | 61.7 |
| Reduced HH labor requirement | 31 | 77.5 | 52 | 86.7 |

The results from the table 4.5 above showed that the majority of respondents cited improved crop productivity as the main advantage in use of CSA practices with 95% in both districts; followed by improved soil fertility in Nicoadala with 85% and insurance in case of crop failure at 86.7% respectively.

Apart of insurance in case of crop failure, they used crop diversification because decreased proliferation of pests and diseases and also help to control weed problems reducing the demand of input (herbicides and/or pesticides). And they also said that irrigation is a major adaptation measure in response to climate change because reduce the potential risks associated with insufficient and unreliable rainfall.

Despite the advantages the respondents argued that they had disadvantages in use some technologies. The disadvantages are illustrated in the table 4.6.

Increased water supply and input requirements (fertilizers, herbicides and pesticides), increase labor requirements, high start-up cost, lack of financial resources, lack of knowledge, skills and information, limited access of land and hard to find/obtain materials, these are several challenges that constrained the use of some practices.

Table 4.6: Disadvantages of adoption CSA practices among smallholder farmers in two study sites

| | Nicoadala | | Namacurra | |
|---|---|---|---|---|
| Disadvantages | Frequency | Percentage% | Frequency | Percentage% |
| Increased labor requirement | 28 | 70 | 49 | 81.7 |
| Lack of knowledge/information | 20 | 50 | 39 | 65 |
| Limited access of land | 23 | 57.5 | 22 | 36.7 |
| Increase water supply and input requirement | 34 | **85** | 50 | **83.3** |
| High start-up cost | 24 | 60 | 47 | 78.3 |
| Lack of financial resources | 36 | **90** | 50 | **83.3** |
| Hard to find/obtain material | 31 | 77.5 | 38 | 63.3 |

The results from the table 4.6 showed that the majority of respondents in both districts stated lack of financial resources as the major disadvantage in use some CSA practices with 90% in Nicoadala and 83.3% in Namacurra, followed by increased water supply and/or input requirements in both sites. These were claimed about the lack of collateral to access credit in the bank and also they have weak visits of extension services.

### 4.3. Analysis of factors influencing the adoption of CSA technologies in the both study sites.

This section presents the analysis of the main factors that contribute in a significant way in the decision of the use or not of a certain technology of production. To this end, we consider the 10 practices as response variables, where a logistic regression model was fitted with each one, considering several factors as explanatory variables.

The idea of applying this statistical method (regression) is justified by the need to identify the factors that significantly influence the different technologies presented, as expressed in the second specific objective of this study. The adjusted models are logistic because all the response variables are categorical and because they have only two possibilities of answers: yes or no, they follow a binomial distribution, hence the models are: binomial logistic regression models.

The analytical expression of this model can be represented by:

$$\frac{p}{1-p} = e^{\beta_0+\beta_1 x_1+\cdots+\beta_k x_k}$$

Where p is the probability that favors the occurrence of the phenomenon under study (success) and 1-p and the probability of non-occurrence (failure)

$\beta j$, with $j = 0, ..., k$, are the coefficients of the model and, for $j \neq 0$, $\beta i$ measures the impact of each variable xj on the probability of the response.

Consider the response variable represented by Y, and as was said earlier, in both cases this takes two values, which can be represented by Y = 1 in cases where it takes a category of Y, and Y = 0 in cases where it takes another category.

The objective of the models is to identify the factors that influence the adoption of the technologies described, in this case, P (yi = 1) = p corresponds to the probability that the individual use a given technology and P (yi = 0) = 1-p does not use.

Thus, the quotient p / (1-p) corresponds to the ratio of these two probabilities (odds), which is equal to zero, indicates that p = 1-p, that is, the probability of occurrence of yi = 1 and yi = 0 is the same. If not, then these probabilities are different and it is important to know which factors contribute to the increase / decrease of probability of occurrence of a category.

Of all adjusted models, six were significant at 5% level: what takes the variable earlier sowing date, crop diversification, improved or drought tolerant crop varieties, minimum tillage, use of fertilizers and crop rotation.

**Model 1: Analysis of factors influencing adoption of earlier sowing date**

The table 4.7 below shows a set of explanatory variables, the variables that significantly influenced this practice are highlighted in red in table, these were: size of household and level of education. It was found a positive and significant influence on earlier sowing practice. Both variables had positive coefficient (B=8.916) and (B=4.527) indicate that the household with large family and with primary school are more likely to adopt earlier sowing date than counterparts.

Table 4.7: Factors influencing adoption of earlier sowing date

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | Gender (1) | -3.755 | 1.948 | 3.716 | 1 | .054 | .023 |
| | Marital status | | | 3.000 | 4 | .558 | |
| | Marital status (1) | -17.065 | 23385.216 | .000 | 1 | .999 | .000 |
| | Marital status (2) | 1.534 | 26942.151 | .000 | 1 | 1.000 | 4.636 |
| | Marital status (3) | -22.684 | 23385.217 | .000 | 1 | .999 | .000 |
| | Marital status (4) | -20.207 | 23385.217 | .000 | 1 | .999 | .000 |
| | Size of HH | | | 6.270 | 2 | .043 | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Size of HH (1) | 3.499 | 2.257 | 2.403 | 1 | .121 | 33.096 |
| Size of HH (2) | 8.916 | 3.705 | 5.790 | 1 | **.016** | 7447.003 |
| Level of education | | | 7.026 | 2 | .030 | |
| Level of education (1) | 6.752 | 2.685 | 6.324 | 1 | .012 | 855.621 |
| Level of education (2) | 4.527 | 2.035 | 4.947 | 1 | **.026** | 92.479 |
| Land ownership | | | 1.191 | 3 | .755 | |
| Land ownership (1) | 13.786 | 40193.002 | .000 | 1 | 1.000 | 970504.727 |
| Land ownership (2) | 10.424 | 40193.002 | .000 | 1 | 1.000 | 33644.377 |
| Land ownership (3) | 13.790 | 40193.002 | .000 | 1 | 1.000 | 975260.937 |
| Decision Making | | | .901 | 2 | .637 | |
| Decision Making (1) | -2.003 | 2.259 | .786 | 1 | .375 | .135 |
| Decision Making (2) | -2.024 | 2.312 | .766 | 1 | .381 | .132 |
| Source of information | | | 2.260 | 6 | .894 | |
| Source of information (1) | 3.840 | 3.669 | 1.095 | 1 | .295 | 46.536 |
| Source of information (2) | -20.789 | 40192.970 | .000 | 1 | 1.000 | .000 |
| Source of information (3) | 14.287 | 15433.731 | .000 | 1 | .999 | 1602441.576 |
| Source of information (4) | 1.152 | 2.789 | .171 | 1 | .680 | 3.165 |
| Source of information (5) | -.360 | 3.349 | .012 | 1 | .914 | .698 |
| Source of information (6) | 38.364 | 56841.458 | .000 | 1 | .999 | 45822070085 800712.000 |
| Constant | -23.569 | 61464.018 | .000 | 1 | 1.000 | .000 |

**Model 2: Analysis of factors influencing adoption of crop diversification**

The results from the table 4.8 indicates that there was one factor that influenced significantly the crop diversification

The variable that significantly influenced this practice are highlighted in red in table, this was the size of the household. The positive coefficient of this variable (4.046) indicates that there was positive relationship between size of household and crop diversification practice. Therefore, these farmers are more likely to diversify crops.

Table 4.8: Factors influencing adoption of crop diversification

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | Age of HH (1) | -19.841 | 40192.961 | .000 | 1 | 1.000 | .000 |
| | Gender (1) | .103 | .906 | .013 | 1 | .910 | 1.108 |
| | Marital status | | | 1.987 | 4 | .738 | |
| | Marital status (1) | 1.676 | 2.163 | .601 | 1 | .438 | 5.346 |
| | Marital status (2) | .084 | 2.468 | .001 | 1 | .973 | 1.088 |
| | Marital status (3) | 1.046 | 3.153 | .110 | 1 | .740 | 2.846 |
| | Marital status (4) | .246 | 2.460 | .010 | 1 | .920 | 1.279 |
| | Size of HH | | | 4.892 | 2 | .087 | |
| | Size of HH (1) | 4.046 | 1.921 | 4.435 | 1 | **.035** | 57.173 |
| | Size of HH (2) | 2.969 | 1.899 | 2.445 | 1 | .118 | 19.471 |
| | Level of education | | | 2.780 | 2 | .249 | |
| | Level of education (1) | 1.606 | 1.126 | 2.035 | 1 | .154 | 4.984 |
| | Level of education (2) | 1.856 | 1.161 | 2.554 | 1 | .110 | 6.396 |
| | Land ownership | | | .044 | 3 | .998 | |
| | Land ownership (1) | 19.526 | 40192.944 | .000 | 1 | 1.000 | 302087610.042 |
| | Land ownership (2) | -2.546 | 44036.090 | .000 | 1 | 1.000 | .078 |
| | Land ownership (3) | 19.054 | 40192.944 | .000 | 1 | 1.000 | 188434899.243 |
| | Decision Making | | | 1.524 | 2 | .467 | |
| | Decision Making (1) | 1.299 | 1.092 | 1.416 | 1 | .234 | 3.666 |
| | Decision Making (2) | 1.086 | 1.188 | .836 | 1 | .361 | 2.962 |
| | Source of information | | | 6.500 | 6 | .370 | |
| | Source of information (1) | 3.251 | 1.985 | 2.681 | 1 | .102 | 25.815 |
| | Source of information (2) | 22.225 | 40192.970 | .000 | 1 | 1.000 | 4487682939.625 |
| | Source of information (3) | 4.492 | 2.518 | 3.183 | 1 | .074 | 89.275 |
| | Source of information (4) | .637 | 1.554 | .168 | 1 | .682 | 1.891 |
| | Source of information (5) | 3.882 | 2.375 | 2.671 | 1 | .102 | 48.498 |
| | Source of information (6) | 2.764 | 56841.437 | .000 | 1 | 1.000 | 15.866 |
| | Constant | -7.691 | 56841.416 | .000 | 1 | 1.000 | .000 |

**Model 3: Analysis of factors influencing the adoption of improved and/or drought tolerant crop variety**

The analysis from the table 4.9 shows that there was one factor that influences adoption of crop varieties. This factor is level of education with coefficient (B=-8.314) and p-value 0.27. The negative sign indicate a negative and significant influence on adoption of improve or drought tolerant crop varieties, therefore the farmers with no formal education are less likely to adopt improved and/or drought tolerant crop variety than those who had primary school.

Table 4.9**:** Factors influencing the adoption of improved and/or drought tolerant crop variety

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | Age of HH (1) | 12.495 | 40192.963 | .000 | 1 | 1.000 | 267035.669 |
| | Gender (1) | -1.408 | 2.093 | .453 | 1 | .501 | .245 |
| | Marital status | | | 4.084 | 4 | .395 | |
| | Marital status (1) | -.140 | 2.528 | .003 | 1 | .956 | .870 |
| | Marital status (2) | -5.687 | 4.252 | 1.789 | 1 | .181 | .003 |
| | Marital status (3) | 36.586 | 26229.435 | .000 | 1 | .999 | 7744616630523905.000 |
| | Marital status (4) | 4.140 | 3.712 | 1.244 | 1 | .265 | 62.802 |
| | Size of HH | | | 3.396 | 2 | .183 | |
| | Size of HH (1) | -5.787 | 3.151 | 3.373 | 1 | .066 | .003 |
| | Size of HH (2) | -1.883 | 2.055 | .840 | 1 | .359 | .152 |
| | Level of education | | | 7.040 | 2 | .030 | |
| | Level of education (1) | -8.314 | 3.766 | 4.874 | 1 | **.027** | .000 |
| | Land size ownership | | | .000 | 3 | 1.000 | |
| | Land size ownership (1) | -12.397 | 40192.960 | .000 | 1 | 1.000 | .000 |
| | Land size ownership (2) | -34.002 | 43483.024 | .000 | 1 | .999 | .000 |
| | Land size ownership (3) | -33.729 | 48505.326 | .000 | 1 | .999 | .000 |
| | Decision Making | | | 2.651 | 2 | .266 | |
| | Decision Making (1) | 3.521 | 3.479 | 1.024 | 1 | .311 | 33.831 |
| | Decision Making (2) | -.092 | 2.967 | .001 | 1 | .975 | .913 |
| | Source of information | | | 3.864 | 6 | .695 | |
| | Source of information (1) | 5.809 | 3.749 | 2.401 | 1 | .121 | 333.181 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Source of information (2) | -12.174 | 40192.970 | .000 | 1 | 1.000 | .000 |
| Source of information (3) | 6.525 | 4.344 | 2.256 | 1 | .133 | 682.028 |
| Source of information (4) | 2.396 | 3.442 | .485 | 1 | .486 | 10.984 |
| Source of information (5) | 1.624 | 2.646 | .377 | 1 | .539 | 5.073 |
| Source of information (6) | -.679 | 56841.439 | .000 | 1 | 1.000 | .507 |
| Constant | .926 | 56841.412 | .000 | 1 | 1.000 | 2.524 |

**Model 4: Analysis of factors influencing the adoption of minimum tillage**

Table 4.10 below shows that there was any relationship between minimum tillage practices and the explanatory variables. In order to identify the variable (s) that influences the variable response, can see table 4.10 below which shows the set of explanatory variables, their estimated coefficients, their odds ratios and their respective p-value. In the table, it can be observed that gender and level of education are the explanatory variables that significantly influence minimum tillage (Sig <0.05) and the factors that were statistically significant are highlighting in the table. The positive coefficient associated with this variable (B= 4.018) and p-value (0.028) is less than 0.05, indicate that gender was found to have a positive relationship with minimum tillage, that is, the household headed by women are more likely to adopt this technology than men.

The level of education of the household head was found to be statically significant in explaining the adoption of minimum tillage as the p-value (0.044) is less than 0.05. From table 4.10 below, the coefficient for education of household is (B=6.995) the positive sign indicates an increase in the probability of adoption of minimum tillage. However the household with primary school are more likely to adopt minimum tillage than those had no formal education.

Table 4.10: Factors influencing the adoption of minimum tillage

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | Gender (1) | 4.018 | 1.832 | 4.812 | 1 | **.028** | 55.600 |
| | Marital status | | | 2.252 | 5 | .813 | |
| | Marital status (1) | -.355 | 2.753 | .017 | 1 | .897 | .701 |
| | Marital status (2) | 1.081 | 3.192 | .115 | 1 | .735 | 2.947 |
| | Marital status (3) | 38.033 | 56841.406 | .000 | 1 | .999 | 3291067630854364 8.000 |
| | Marital status (4) | 2.630 | 2.940 | .800 | 1 | .371 | 13.868 |
| | Marital status (5) | 1.958 | 3.019 | .421 | 1 | .517 | 7.087 |
| | Size of HH | 1.037 | 1.397 | .551 | 1 | .458 | 2.821 |
| | Age of HH head | -22.687 | 25167.184 | .000 | 1 | .999 | .000 |
| | Level of education | | | 4.044 | 2 | .132 | |
| | Level of education (1) | 3.148 | 3.326 | .896 | 1 | .344 | 23.293 |
| | Level of education (2) | 6.995 | 3.479 | 4.042 | 1 | **.044** | 1091.074 |
| | Land size ownership | | | .000 | 2 | 1.000 | |
| | Land size ownership (1) | 65.905 | 69616.212 | .000 | 1 | .999 | 4188541396451151 0000000000000.000 |
| | Land size ownership (2) | 86.374 | 80385.893 | .000 | 1 | .999 | 3.250E+037 |
| | Source of information | | | 4.469 | 7 | .724 | |
| | Source of information (1) | 3.387 | 2.998 | 1.277 | 1 | .258 | 29.589 |
| | Source of information (2) | 5.179 | 3.022 | 2.937 | 1 | .087 | 177.538 |
| | Source of information (3) | 4.373 | 3.043 | 2.065 | 1 | .151 | 79.273 |
| | Source of information (4) | .303 | 1.621 | .035 | 1 | .851 | 1.355 |
| | Source of information (5) | -18.656 | 40192.949 | .000 | 1 | 1.000 | .000 |
| | Source of information (6) | 1.363 | 2.588 | .277 | 1 | .598 | 3.907 |
| | Source of information (7) | 44.068 | 47422.168 | .000 | 1 | .999 | 1375762540888767 3000.000 |
| | Decision making | | | 3.488 | 2 | .175 | |
| | Decision making (1) | 7.226 | 3.935 | 3.372 | 1 | .066 | 1375.189 |
| | Decision making (2) | 1.650 | 1.643 | 1.009 | 1 | .315 | 5.207 |
| | Constant | -56.129 | 74025.647 | .000 | 1 | .999 | .000 |

**Model 5: Analysis of factors affecting use of fertilizers and/or pesticides**

Analysis from the table 4.11 below shows that there was any relationship between use of fertilizer practice and the explanatory variables. In the table, it can be observed that gender and level of education are the explanatory variables that significantly influence use of fertilizers and /or pesticides (Sig <0.05) and the factors that were statistically significant are highlighting in the table. The negative coefficient associated with this variable (B= -2.499) and p-value (0.037) is less than 0.05, indicate that household with no formal education was found to have a negative relationship with use of fertilizers, that is, the household with no schooling are less likely to adopt the use of fertilizers than advanced level.

Table 4.11: Factors affecting use of fertilizers and/or pesticides

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | Age of HH (1) | 17.986 | 40192.965 | .000 | 1 | 1.000 | 64751144.504 |
| | Gender (1) | -.211 | 1.061 | .040 | 1 | .842 | .809 |
| | Marital status | | | 2.587 | 4 | .629 | |
| | Marital status (1) | -38.073 | 30617.947 | .000 | 1 | .999 | .000 |
| | Marital status (2) | -39.011 | 30617.947 | .000 | 1 | .999 | .000 |
| | Marital status (3) | -40.727 | 30617.947 | .000 | 1 | .999 | .000 |
| | Marital status (4) | -39.086 | 30617.947 | .000 | 1 | .999 | .000 |
| | Size of HH | | | 3.936 | 2 | .140 | |
| | Size of HH (1) | .093 | 1.709 | .003 | 1 | .956 | 1.098 |
| | Size of HH (2) | 2.386 | 1.788 | 1.781 | 1 | .182 | 10.867 |
| | Level of education | | | 5.048 | 2 | .080 | |
| | Level of education (1) | -2.499 | 1.199 | 4.346 | 1 | **.037** | .082 |
| | Level of education (2) | -2.213 | 1.200 | 3.399 | 1 | .065 | .109 |
| | Land size ownership | | | .733 | 3 | .865 | |
| | Land size ownership (1) | 22.409 | 40192.997 | .000 | 1 | 1.000 | 5396558778.815 |
| | Land size ownership (2) | 21.003 | 40192.997 | .000 | 1 | 1.000 | 1322858262.938 |
| | Land size ownership (3) | 22.276 | 40192.998 | .000 | 1 | 1.000 | 4725926141.681 |
| | Decision Making | | | .225 | 2 | .893 | |
| | Decision Making (1) | .369 | 1.144 | .104 | 1 | .747 | 1.447 |
| | Decision Making (2) | .573 | 1.226 | .218 | 1 | .640 | 1.773 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Source of information | | | 3.554 | 6 | .737 | |
| | Source of information (1) | 1.375 | 1.926 | .510 | 1 | .475 | 3.957 |
| | Source of information (2) | -18.030 | 40192.970 | .000 | 1 | 1.000 | .000 |
| | Source of information (3) | -21.112 | 21644.805 | .000 | 1 | .999 | .000 |
| | Source of information (4) | -.642 | 1.583 | .165 | 1 | .685 | .526 |
| | Source of information (5) | -19.834 | 16859.356 | .000 | 1 | .999 | .000 |
| | Source of information (6) | -2.851 | 56841.440 | .000 | 1 | 1.000 | .058 |
| | Constant | -2.649 | 64563.222 | .000 | 1 | 1.000 | .071 |

**Model 6: Analysis of factors influencing adoption of crop rotation**

The analysis from the table 4.12 below shows that there was a relationship between explanatory variables and crop rotation. The factor that is associated with this practice was source of information that had positive and influence on adoption of crop rotation. Therefore the farmers who were informed of agricultural practices from the family members and extension officers are more likely to adopt crop rotation that those who received from community meetings.

Table 4.12: Factors influencing adoption of crop rotation

| | | B | S.E. | Wald | df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|---|
| Step 1[a] | Age of HH (1) | 21.895 | 40192.917 | .000 | 1 | 1.000 | 3227608390.639 |
| | Gender (1) | -.656 | .925 | .504 | 1 | .478 | .519 |
| | Marital status | | | 4.015 | 4 | .404 | |
| | Marital status (1) | -1.036 | 1.907 | .295 | 1 | .587 | .355 |
| | Marital status (2) | .602 | 2.304 | .068 | 1 | .794 | 1.826 |
| | Marital status (3) | -.499 | 2.226 | .050 | 1 | .823 | .607 |
| | Marital status (4) | 1.643 | 2.260 | .529 | 1 | .467 | 5.172 |
| | Size of HH | | | 2.350 | 2 | .309 | |
| | Size of HH (1) | 2.388 | 1.574 | 2.303 | 1 | .129 | 10.895 |
| | Size of HH (2) | 2.195 | 1.565 | 1.967 | 1 | .161 | 8.983 |
| | Level of education | | | 4.781 | 2 | .092 | |
| | Level of education (1) | 1.899 | 1.070 | 3.151 | 1 | .076 | 6.679 |
| | Level of education (2) | .089 | 1.036 | .007 | 1 | .932 | 1.093 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Land size ownership | | | .055 | 3 | .997 | |
| Land size ownership (1) | 17.854 | 40192.940 | .000 | 1 | 1.000 | 56736428.586 |
| Land size ownership (2) | 18.226 | 40192.940 | .000 | 1 | 1.000 | 82291507.258 |
| Land size ownership (3) | -4.469 | 48621.722 | .000 | 1 | 1.000 | .011 |
| Decision Making | | | .600 | 2 | .741 | |
| Decision Making (1) | .439 | .875 | .252 | 1 | .616 | 1.551 |
| Decision Making (2) | .787 | 1.027 | .588 | 1 | .443 | 2.198 |
| Source of information | | | 4.392 | 6 | .624 | |
| Source of information (1) | 4.021 | 2.051 | 3.845 | 1 | **.050** | 55.749 |
| Source of information (2) | 20.601 | 40192.970 | .000 | 1 | 1.000 | 884894870.643 |
| Source of information (3) | -20.176 | 19339.132 | .000 | 1 | .999 | .000 |
| Source of information (4) | 3.775 | 1.840 | 4.210 | 1 | **.040** | 43.586 |
| Source of information (5) | 2.944 | 2.022 | 2.121 | 1 | .145 | 18.996 |
| Source of information (6) | 48.623 | 56841.406 | .000 | 1 | .999 | 13078899419205 48000000.000 |
| Constant | -45.865 | 56841.371 | .000 | 1 | .999 | .000 |

# CHAPTER 5

## 5.0. Discussion

### Introduction

This study investigated the use of CSA practices in central of Mozambique. It involved 100 farmers from two districts (Nicoadala and Namacurra) that were interviewed using the semi-structured questionnaire.

The results from Omnibus test estimation were used to explain the model. The P-values revealed that four of the explanatory variables were statistically significant and affected adoption of six practices (earlier sowing date, crop diversification, use of fertilizers/ pesticides, minimum tillage, crop rotation and improved and/or drought tolerant crop varieties), these were gender, level of education, household size and source of information. These four variables had positive and significant influence in adoption of CSA practices and also one of the four variables had negative and significant influence on adoption. The factor that had both positive and negative influence on adoption of one of the CSA practices was level of education.

### Does gender have an effect on CSA implementation?

Both males and females are likely to play different roles in the technology adoption, depending on the nature of technology (He et al., 2007).

The results showed that the majority of the household were headed by women. This is contrary with CGAP (2016) that reported that in Mozambique 77% of household were headed by male. While households are male dominated, women do play an important, if not critical, decision-making role when it comes to the agricultural activities of the household. The results found in the study area were probably due to migration of the men from rural to urban looking for better opportunities. However, as expected, the gender variable had a positive and significant influence on adoption of minimum tillage practice. This indicates that a household headed by woman are more likely to adopt minimum tillage than in a household headed by man. This probably could be the fact that in most societies, the land preparation is done by women and it is normally occur during the dry season. In this period, men would be busy with other jobs which would hinder them for participating in dry land preparation hence reduced probability of adoption. This is in line with Chibbamulilo and Phiri (2000) who reported that women are more likely to adopt minimum tillage than men. And also Nhemachena and Hassan (2007) found that female-headed households are more likely to take-up adaptation measures than male-headed households. The authors explain that females are engaged in more farm activities than males and have better farm experience and information.

According Giller et al., (2009) some agricultural practices, such as conservation agriculture and no-till or minimum tillage, can increase the amount of manual weeding needed an activity often performed by women in Africa south of Sahara.

Arnd et al., (2011) report that the amount of the time that women and men allocated to agricultural production is comparable, but that women usually spend relatively more time taking care of food crop production, whereas men tend to control cash crops production.

**Does size of household have any influence in adoption of CSA practices?**

Household size can influence adoption of the technologies negatively or positively because HH size is associated with availability of labor supply (Kai, 2011).

As expected, HH size had a positive and significant influence on adoption of crop diversification practices and earlier sowing date. This indicates that large families are more likely to sowing earlier than small family. Therefore family size had a significance association with earlier sowing date due to high availability of labor that allow farmers to sow early and finish their activity much quickly as possible and then generate other source of income in off-farm activities. This is in line with Kai (2011) reported that household size can influence adoption of the technologies negatively or positively because household size is associated with availability of labor supply. And also the household size had positive relationship with crop diversification. The results showed that small families are more likely in diversify their crops. Therefore, family size was significantly associated with crop diversification practices. This is in contrary with Kassie et al., (2012), Piya and Lall (2013) and Babulo et al., (2014) who found that families with high labor availability are more likely to diversify into several agricultural enterprises. The results of this research was different probably due to awareness that farmers had about the advantages of crop diversification offers to reduce the negative impacts of climate change, that made the families with small families diversify their crops.

**Does age have an effect on CSA implementation by households?**

The results showed that there was no relationship between age and adoption of CSA practices. It hypothesized that the young farmers are more likely to adopt agricultural technology because their ability of learn about innovations and are able to face risks than older farmers.

It was found that households head had age between of 15 to 45 belong young farmers. So, these farmers are more likely to adopt CSA practices than older ones. According to Mugue et al., (2012), age is regarded as a primary dormant attribute in technology decision. The results found in this study are in line with Adesina, et al., (2000) and Comer et al., (1999) that documented that young heads of households have a greater chance of being updated on innovations in terms of agricultural methods; thus, new technologies are more likely to be adopted by young farmers than older ones, who have tendency to stick to traditional methods. Tizale (2007) observed that older farmers have shorter planning horizons and hence are more reluctant to invest in modern agriculture technologies which take a long time before farmers realize the benefits.
Acoording Adesina and Baidu-Forson (1995), that there is no consensus on how age affects adoption decision.

**Education level as important factor on CSA adoption by household**

The results revealed that the majority of farmers were primary school; therefore, as expected, the level of education influenced positively the adoption of minimum tillage and earlier sowing date. The farmers with primary level are more likely to adopt the practices than those with no formal education. This indicates that CSA practices that may be knowledge intensive for these people may be easier. This is in line with Kassam et al., (2009) who reported that conservation agriculture has been described as a knowledge intensive technology and as such training and experience of the household is important for its ability to make use of technology. Regarding earlier sowing date, if the farmers are educated, they will be able to access information about the weather forecast make them sowing early in anticipation of shocks and reducing the negative impacts of climate change.

And also was found a negative relationship between level of education and use of improve or drought tolerant varieties. The farmers with no formal education had negative influence on adoption of use of improved or drought tolerant varieties, these farmers are less likely to adopt this practice than other advanced level. This indicates that decrease level of education also decrease the rate of technology adoption. This is agreement with Amaza et al., (2017) who reported relationship between improved maize variety adoption and education status. However, Gichangi et al., (2012) confirm that the ability of farmers to obtained process and use information relevant to production is increased by education. And also Indimuli (2003) who documented that lack of education hinders the ability of farmers to perceive, interpret and make use of modern technology.

Adesina and Baidu-Forson (1995) and Maddison (2007) reported that the more a farmer is educated, the more likely he/she is to access information, perceive and adapt to climate change.

According Amaza and Tashikalma (2003), the rate of education farmers is important as it determine the rate for adoption for increase productivity. The level of education of farmers will directly affect their ability to change and accept new ideas.

In the same way, it was found a negative relationship between farmers with no formal education level and use of fertilizers and/or herbicides. The explanatory variable had a negative and significant influence on adoption of use of fertilizers at 5% significance level. This indicate CSA that may be knowledge intensive for literacy people may be difficult therefore, farmers are able to interact more with simple technology involved some traditional methods. And use of fertilizers involves knowledge in use on correct and balanced way to avoid emission of GHG. Therefore these farmers are less likely in use of fertilizers than advanced level. This finding is in consonance with Michael et al., (2007) who reported that there are many types of fertilizers application of the appropriate types for specific crops, soil types and their specific requirements, application regimes rates and timing increases with exposure through education. So, with no education it becomes difficult to achieve these requirements. According Omamo et al., (2002) and Omamo et al., (2001) the education level of the household head may be taken as a proxy for being exposed to (or able to access) technical information on fertilizer use, and thus may be positively associate with fertilizer use.

CGAP (2017) reported that in Mozambique 30% of household headed by female have no formal education and 67% did not continue their education past primary school. Only 12% have advanced through secondary school.

According to Murgor et al., (2013), education can change the behavior of smallholder farmers regarding their attitude and awareness toward new technology. It is expected that educated farmers have good information and knowledge, so, they adopt technologies faster than those who never went to school.

**Land ownership as a key variable in CSA adoption**

The omnibus test shows that there was no relationship between land size ownership with CSA practice. The majority of the farmers in the study were owner of their farms with size between of 1/4 to 2 ha. It means for those farmers are less likely to adopt some CSA that require large piece of land. The maximum size in the study was 3.5 ha. However, for those farmers is suitable to use intercropping practice.

According Murgor et al., (2013), farm size can have different effects on the probability of adoption, depending on the characteristics of the technology. Abara and Singh (1993) acknowledge the existence of differences in technology adoption between large and small farms.

Baumuller (2012) reported that a central factor affecting investment, production and conservation decisions is the smallholder farmer`s level of control over his land. In addition, SHF with secure tenure is much more likely to think of long term production and conservation activities than sharecroppers.

Regarding decision making about the land, the results showed that there was no any relationship between this variable and CSA practices. The majority of decision was made by only woman/wife, this is line with de Braw (2015) that reported that female-controlled plots, women make only 70% of the decision making regards what to plant; de Braw finds that this number is ever lower in male-head household, where women make only 60% of cropping decisions for the land they control in the other hand, in female-headed women make all of the cropping decisions.

According Smith (2003); Kes et al., (2011) and Jacobs et al., 2011), women tend to have more decision-making authority over issues concerning household food consumption and nutrition and less authority over decisions relating to household land

.

The results revealed that the main crops produced in the study area were rice followed by maize. This is in line with Silici et al., (2015), that documented that the main food crops grown in Mozambique include cereal crops such as maize, rice, sorghum and pearl millet, root and tuber crops such as cassava and sweet potato, and grain legume crops such as beans. According Walker et al., (2006) and TIA (2012), the most staple foods in Mozambique are maize followed by cassava and rice.

According CGAP (2016), households in Mozambique use their crops in multiple ways and consumption is a prime use for household. 96% of maize and 92% of rice are for their consumption. An estimate nine out of 10 smallholder farmers consume at least a portion of their crops.

**Source of information as a main factor influence CSA adoption by household**

Farmers depend on different sources of information regarding farming information.

The results revealed that source of information had a positive and significant influence on adoption of crop rotation practices. The main source of information that influenced the adoption was family members and government extension services. Farmers that received farming information from the family members and extension are more likely to adopt crop rotations than who get their farming information from other sources. This is because there was network or social interaction between farmers and with their ancestors; and also with extension agents. This is in line with Toborn and Harvestin, (2011) who reported that personal contacts, i.e. through extension, are more effective in forming an opinion about a new idea. Therefore crop rotation requires knowledge and information regarding the type of crops include in rotation. This result is in consonance with Mango et al., (2015) who documented that access to extension advice is important in aiding smallholder farmers' production decisions since it can be a reliable source of technologies advice on current knowledge.

According Sasa (2009), report that extension programs aimed at increase adoption of technology. And Ackello-Ogutu (2011), documented that increased frequency of extension visits to impart information could result in increased productivity and income generation.

The results showed that the majority of the respondents stated that the reason why they do not adopt some CSA practices were due to lack of financial resources and increase water supply/input requirement. According Mucavele (2014) reported that the results from 2014 survey showed that 52% of the respondents (small-scale farmers) were not adopting CSA practices due to lack of knowledge and lack of financial capacity to invest in on-field interventions. And according of World Bank (2011) reported that limited land access is a major restraint for people's options to cope with climate change. Land access restrictions often make it impossible for farmers to move to different areas, and restrict their coping options to changes in planting/harvesting patterns and finding alternative livelihood activities.

The hypotheses of this study was to understand if the farmers who were more aware of CSA practices would be able to adapt these practices and make use efficient of their resources than those were not aware. The results showed that the farmers were more aware of CSA practices but were not highest adopters to those practices. So, it means that high rate of awareness does not mean high rate of adoption. This is in line Maddison (2007); Mahajan et al., (2011) and Bryan et al., (2009) reported that perception is not, however, an adequate condition for adaptation measures.

According Giller at al., (2009), documented that sometimes, farmers do not adopt because the technology does not fit with existing practices. Farmers` involvement in new technologies requires tradeoffs with other activities from which they currently generate their livelihood and if the new technology does not fit with them, they will hesitate to take it up.

# CHAPTER 6:

## 6.0. Conclusion

The purpose of this study was to identify the extent CSA practices used by smallholder farmers and to identify the factors that influence the adoption of CSA practices among smallholder farmers in Zambezia province. To achieve these objectives it was necessary to pass through some of the answers. Therefore, the researcher is convinced that the results and the corresponding analysis made in accordance with the objectives of the study, answer the research questions. So, the study concludes that:

- The practices that the farmers used in the two districts were agroforestry, earlier in sowing date, irrigation, improved and/or drought tolerant crop variety, minimum tillage and crop diversification;
- The adoption of the technologies was very low than the awareness in both sites due to lack of knowledge, financial resources, increase input requirement and also limited access to credit;
- Between 8 factors analyzed in the study, the gender, level of education, size of household and source of information had significant influence on adoption of earlier sowing date, crop diversification, use of fertilizers and/or pesticides, minimum tillage, crop rotation, adoption of improved or drought tolerant crop varieties practices.
- There was weak visit of extension service officers that difficult to farmers to get some reliable information regarding agricultural practices.
- There was low level of education among smallholder farmers in two districts and also they did not have access of the communication lines regarding weather forecast.

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# CHAPTER 7

## 7.0. Recommendations

The study suggests that:

- The government reduce drought vulnerability in farming by guarantee water supply and training farmers in issues about climate like grow drought tolerant crop (example: cassava, sweet potatoes, pearl millet).
- Government can promote training the extension service officers, so that they can quickly teach people in the simplest term with the goal to enhance the adoption of agricultural technologies;
- Should put in place financial resources and provide agricultural inputs to farmers;
- Can put in place structures to educate the people to be able to access basic education.
- Should improve communication line to make weather forecast and climate information available to communication;
- Finally, the study also recommends that farmers have to continue to embracing the use of agroforestry since it helps to reduce the GHG emissions from the atmosphere caused by deforestation

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# APPENDICES

**Appendix 1: Work Plan**

| Months | Activities |
|---|---|
| September | Developmental and submission of the proposal |
| October | Resource procurement |
| November | Resource procurement |
| December | Going to field and Data collection |
| January | Data collection and Processing |
| February | Thesis writing and submission the first thesis draft to supervisor |
| March | Correction of first thesis draft |
| April | Submission the final thesis draft to the supervisor |
| May | Submission to the department |

**Appendix 2: Budget**

| | Costs | |
|---|---|---|
| Item | MZN | USD |
| 1. Fuel for local transport (motorbike) | 17250 | 283 |
| 1.1. Travel | 15000 | 246 |
| 1.2. Allowance (Research assistant) | 25000 | 410 |
| 1.3. Allowance researcher | 37500 | 615 |
| Subtotal | 94750 | 1554 |
| 2. Consumable | | |
| 2.1. Paper | 1000 | 16 |
| 2.2. questionnaire Photocopy | 3000 | 49 |
| 2.3. Toner for printing | 5000 | 82 |
| 2.4. Pens | 600 | 10 |
| 2.5. Pencils, sharpener and rubber | 60 | 1 |
| 2.6.Notebook | 600 | 10 |
| 2.7. File folders | 1500 | 25 |
| 2.8. Puncher | 500 | 8 |
| 2.9. Stapler | 700 | 11 |
| 2.10. Staples | 200 | 3 |
| 2.11. Communication (recharge) | 4500 | 74 |
| 2.12. Internet | 4000 | 66 |
| 2.13. Binding | 3100 | 51 |
| 2.14. Rain boots | 1700 | 28 |
| 2.15. Rain coat | 2000 | 33 |
| 2.16. Antivirus | 3000 | 49 |
| 2.17. Posters (images) | 12500 | 205 |
| 2.18. Calculator | 1500 | 25 |
| Subtotal | 45460 | 746 |

| | | |
|---|---|---|
| Total | 140210 | 2300 |
| Unpreditable costs 10% of total cost | 14021 | 230 |
| Grand  total | 154231 | 2530 |

**Appendix 3: Questionnaire**

Use of Climate Smart Agriculture practices

Date (___/___/______)                Time:

**Section 1: Household data**

1.1.Respondent ID                                        [ ____ ]

1.2.Gender of the household head

( 1=Male, 2=Female)        [____]

1.3.Marital status of the head

1=Monogamy

2=Polygamy

3=Widowed

4=Single

5= Husband/wife away for more than 3 months

6=Other (Specify) ________________

1.4.Household size [____]

1.5. Household age

1= 15 to 45

2= 45 to 75

3= More than 75

1.6. What is the highest level of education of the Head? [____]

1=No formal education

2=Primary

3=Secondary

4=Under graduate

1.7. Land ownership and size

1. Owned 1/4 to 2
2. Owned $2^{1/2}$ to 3
3. Rented
4. Sharecropped
5. Borrowed

1.8.Who is responsible for making decisions about the land? [____]

1=Only man/husband

2=Only woman/wife

3=Man responsible for some parts and woman responsible for others

4=Man and woman jointly responsible

5=Other

1.9.What are your main crops? [____] [____] [____]

| | | | | |
|---|---|---|---|---|
| 1=Cotton | 3=Maize | 5=Rice | 7=Millet | 9=Soybean |
| 2=Cowpea | 4=Sorghum | 6=Bean | 8=groundnuts | 10=cassava |

**Section 2: Cimate Smart Practices**

2.1. How do you perceive the impacts of Climate change?

**Fill the entire columns**

| **2.2** | **2.3** | **2.3a** |
|---|---|---|
| **Practice** | Are you aware of (practice)? | Are you using the practice currently on your farm? |
| | ***1=Yes*** ***0=No*** | ***1=Yes*** ***0=No*** |
| Agroforestry or tree planting | | |
| Crop rotation | | |
| Improved or stress tolerant crop varieties | | |
| Improve Irrigation | | |
| Zero tillage | | |
| Change sowing date | | |
| Crop diversification | | |
| Intercropping | | |
| Inputs (fertilizers, pesticides) | | |
| Mulching | | |

2.4. What are the benefits of the practices marked YES in 2.3a?

2.5.What are the reasons of not using the practices said NO 2.3a?

2.6. What is the main source of information about the practices?

1 - Government extension workers
2 - NGOs
3 - Community meetings
4 - Farmer organizations
5 - Research stations/Researchers
6 - Religious groups
7 - Agri-service providers, seed companies
8 - Family members
9 - Neighbors
10- Radio
11- TV
12- Newspaper
13- School/teachers
14- Internetr
15- Traditional knowledge
16- Agricultural shows
17-Farmer Field Days
18-Own experience