



Climate Change Adaptation Measures in Agriculture: A Case of Conservation Agriculture for Small-Scale Farmers in Kalomo District of Zambia

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Department of Environmental and Geographical Science,

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Somanje Albert Novas (SMNALB001)

Supervisor: Olivier Crespo PhD

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ABSTRACT

In most of the developing countries, small scale farmers (SSFs) are usually the primary agricultural producers of staple crop. Furthermore, they highly depend on rainfall for their rain-fed agricultural production. SSFs have limited capacity to adapt to extreme climate variability, thus rendering them to be among the most vulnerable to climate change. Some recent studies show that agricultural production and productivity is being negatively impacted by climate change and variability in most parts of Southern Africa. This is likely to continue for decades into the future, unless corrective or adaptation measures are implemented to reduce the impact on agriculture.

Conservation Agriculture (CA) is one of the climate change and weather variability adaptation measures being promoted for SSFs in Kalomo District of Zambia. CA is not only being promoted to improve production and productivity for food security for the majority rural population, but also as an adaptation measure for sustainable agricultural production.

The present study analysed the CA practices being promoted in Kalomo district of southern Zambia and the associated challenges in the management and implementation, as well as, how best these challenges can be addressed. Semi structured interviews and literature review were used as methodologies of data collection for the study.

The findings of the study indicate that among the three principles of CA, minimum tillage is mostly practiced compared to crop rotation and retention of crop residue. Within minimum tillage, ripping was found to be practiced on a larger scale compared to making basins. The major challenges include planning and human resource development, financial resource and policy constraints and cultural barriers to adoption of CA.

Key words: Conservation Agriculture (CA), Adaptation, Implementation, Climate Change, Weather Variability, Small-scale Farmers (SSFs) and Food Security.

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ACRONYMS AND ABBREVIATIONS

CA	Conservation Agriculture
CASPP	Conservation Agriculture Scaling up for Increased Production and Productivity
CASU	Conservation Agriculture Scaling Up
CF	Conservation Farming
CFU	Conservation Farming Unit
CSO	Central Statistical Office
CT	Conservation Tillage
DoA	Department of Agriculture
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FISRI	Farmer Input Support Response Initiative
FNDP	Fifth National Development Plan
GDP	Gross Domestic Product
HDI	Human Development Index
MACO	Ministry of Agriculture and Cooperatives
MAL	Ministry of Agriculture and Livestock
MLNREP	Ministry of Lands Natural Resources and Environmental Protection
MT	Minimum Tillage
MTEF	Medium Term Expenditure Framework
MTENR	Ministry of Tourism Environment and Natural Resources
NAP	National Agricultural Policy
NAIP	National Agriculture Investment Plan
NAPA	National Adaptation Plan of Action
NASA	National Aeronautics and Space Administration
NGO's	Non-Governmental Organizations

PEA	Participatory Extension Approach
PRSP	Poverty Reduction Strategy Paper
PMRC	Policy Monitoring Research Centre
QSR	Qualitative Solution Research
R-SNDP	Revised Sixth National Development Plan
ICRAF	International Centre for Research in Agroforestry
IMF	International Monetary Fund
IPCC	Inter-governmental Panel on Climate Change
SSA	Sub-Saharan Africa
SSFs	Small-Scale Farmers
UNFCCC	United Nations Convention on Climate Change
ZVAC	Zambia Vulnerability Assessment Committee

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1. INTRODUCTION

1.1. Background

Climate change is evident, the effects and impacts are already being felt and threatens sustainable human development (Kurji *et al.*, 2011; Howden *et al.*, 2007). The impact of climate change on agriculture has significant potential for negative impact on food production for the ever increasing human population. Adaptation to climate change in agriculture is vital for sustainable food security and economic development. Small Scale Farmers (SSFs) are the major agricultural producers and they are the most vulnerable to climate change and weather variability (Jain, 2007). It is critical to build adaptation capacities among SSFs to minimise the negative impact of climate change.

This study investigates the challenges that agriculture extension officers and farmers face in the management and implementation of climate change adaptation practices in agriculture. In particular, it focuses on the challenges of implementing Conservation Agriculture (CA) as an adaptive measure to climate change. CA has high potential for improving food production and productivity in view of climate change and weather variability (Haggblade and Tembo, 2003). Unlike conventional agricultural practices, CA offers more sustainable and environmentally useful opportunities for farmers.

Conservation Agriculture in Zambia started to gain ground in 1996 when the Conservation Farming Unit (CFU) was established. The establishment of the CFU was facilitated by the Zambia National Farmers Union (ZNFU) which has played the most active role in the promotion of CA (Haggblade and Tembo, 2003). The CFU has been the major promoter of Conservation Farming (CF)/CA in Zambia in collaboration with the Ministry of Agriculture and Livestock. According to the CFU (CFU, 2011), Zambia's small-scale farmers are likely to adopt CF/CA because of its potential to increase yield, its low labour input requirements and substantially reduced production costs. Beside the substantial benefits small scale farmers get from CA, natural resource conservation is also a benefit as a result of the practice.

This study used Kalomo district in the Southern Province of Zambia to study challenges faced in the management and implementation of CA. Kalomo has been implementing CA for more than five years. The district was selected because it is a major producer of the staple crop, maize, and has been exposed to the threats of climate change and weather variability which include prolonged droughts among others.

This dissertation is organized into five (5) chapters as follows; Chapter 1 focuses on the introduction which provides the background to the study. Chapter 2 reviews some literature in relation to other similar studies and policy direction on the subject matter. Chapter 3 looks at the methodology used to capture data for the study. Chapters 4 and 5, reveals the study findings, present discussion and conclusion respectively.

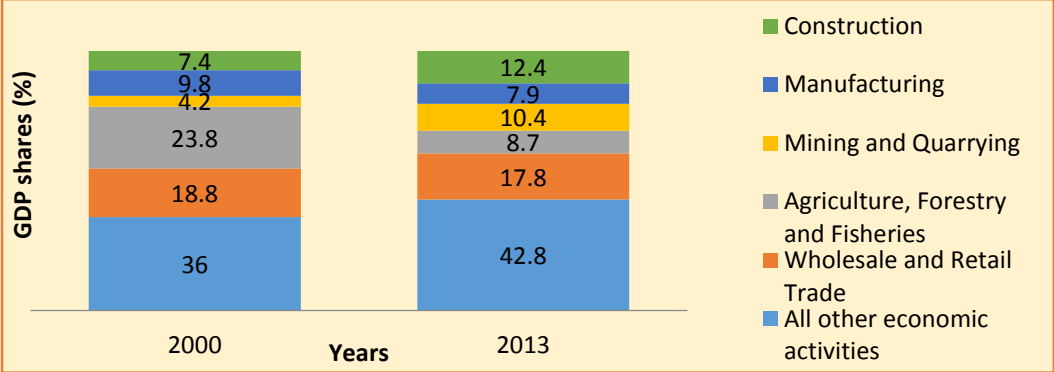
1.1.1. Research Background

Zambia is a landlocked country, surrounded by the Democratic Republic of Congo and Tanzania in the north, Zimbabwe and Botswana in the south, Malawi and Mozambique in the east, Namibia and Angola on the west. It lies between latitude 8° and 18° south and between longitude 21° and 38° east, covering a total surface area of 752,610 km² (water bodies inclusive). According to the 2010 Population Census, Zambia has a population of about 13,092,666 (CSO, 2012). The rural population accounts for about 60.5 % (7,919,216), while urban population is about 39.5% (5,173,450). The gender distribution for the country is about 50.7% for females while that of men is about 49.3%. The average annual population growth rate for the country between 2000 and 2010 was about 2.8%. Within the same period, the growth rate for rural and urban population was about 2.1% and 4.2% respectively. This makes Zambia have one of the fastest growing populations in Sub-Saharan Africa (CSO, 2012). Projections suggest that Zambia's current population is about 14.54 million (World Bank, 2014).

Zambia's annual Gross Domestic Product (GDP) growth rate has been impressive in the last thirteen years, averaging above six percent (6%) over the past decade (Bank of Zambia, 2013). This impressive growth record has placed the country among the ten fastest growing economies in the world and led to its reclassification as a low-middle income country arising from a

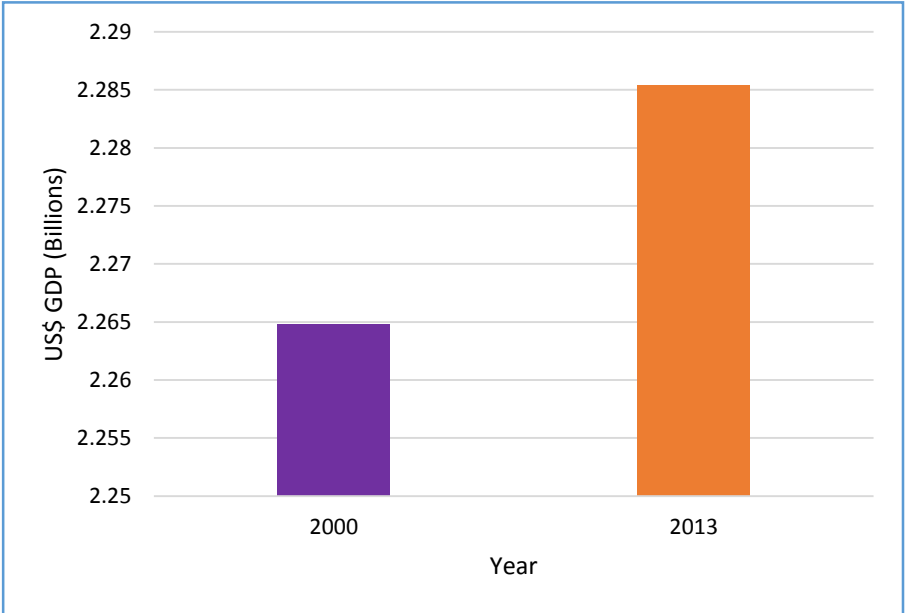
corresponding rise in per capita Gross National Income (GNI) in 2011 by the World Bank. However, agriculture, forestry and fisheries sector contribution to real GDP has declined from 23.8% to 8.7% (Figure 1-1). Fisheries is part of the agricultural sector in Zambia.

Figure 1-1: Real GDP Shares by Economic Sectors (%) (Bank of Zambia, 2013)



Nevertheless, the absolute agriculture contribution to GDP increased by US\$ 0.02 Billion in 2013 compared to the year 2000 (Figure 1-2). The growth rate of agriculture sector compared to other economic sectors has been low resulting in its real GDP contribution to be lower in 2013 (Figure 1-1).

Figure 1-2: Agricultural Contributions to GDP (\$ billions) (Economy watch, 2014; Bank of Zambia, 2013)



Zambia's impressive growth has failed to significantly improve the living standards, reduce poverty and improve key social indicators for the majority of the people. According to the 2014 Human Development Index (HDI) report, Zambia ranks 141 out of 187 countries (HDI, 2014). The gap between Zambia's richest and poorest citizens still remains significant. Zambia's Gini coefficient, which measures the way income is distributed in a country among individuals, shows 0.585 for males and 0.534 for females in 2013. This is still considered to be among the highest in Sub-Saharan Africa (HDI, 2014). Although significant progress has been made towards meeting the Millennium Development Goals (MDGs) targets on child health, education and HIV/AIDS, targets to reduce extreme poverty, hunger and improve maternal health are likely to be missed by the end of the MDGs in 2015. Poverty remains extremely high with the proportion of poor people estimated at 60% (HDI, 2014).

Zambia has a tropical climate (Aregheore, 2009) and is affected by climate change and weather variability despite its emission of 0.2 metric tons of carbon dioxide per capita, lower than the Sub-Saharan Africa average of 0.8 metric tons (World Bank, 2014). Climate change is already felt in the northern part of Zambia with extreme wetness and in the southern part with increased occurrences of drought and dry spells in the rainy season (Kanyanga *et al.*, 2013). Summer precipitation is critical for agricultural production in Zambia, as most of the production is rain-fed. This makes Zambia vulnerable to climate change and weather variability and particularly sensitive to the likelihood of reduced growing season. The reduction in growing season will result in further stress on production and productivity in agriculture (Kanyanga *et al.*, 2013; Kurjia *et al.*, 2011; IPCC, 2007). This threatens rain-fed agriculture production that is already facing the challenge of marginal productivity.

1.1.2. Zambia's Agriculture

Zambia has a total *land area* of about 743,390 km² (without water bodies) and agricultural accounts for about 238,360 km² while about 491,348 km² accounts for forestry area (FAO, 2014b). Zambia's agricultural sector contribution to real GDP in 2013 was low (Figure 1-1). According to the National Agriculture Investment Plan (NAIP, 2013), the agriculture sector is expected to lead the economic growth and job creation prospects by 2017. Therefore, dealing

with challenges in agriculture, implementation of Conservation Agriculture inclusive is critical (NAIP, 2013), if the agriculture sector is to lead the economic growth.

Zambia's climate is characterized by extreme heat in the valley areas in the southern part, also influenced by a cold, dry season from April to August. Zambia has dry and high temperatures in August to November, as well as warm and wet season in November to April. The minimum and maximum temperatures vary from 6 °C to 10 °C and 15 °C to 27 °C respectively, during the cold season. During the hot season temperatures vary from a minimum of 27 °C to a maximum of 35 °C, while the mean annual temperature varies from 18 °C to 20 °C (Aregheore, 2009).

Zambia's rainfall pattern is classified according to three major agro-ecological zones: region I, II and III. The agro-ecological zones are determined by the average amount of rainfall the area receives annually.

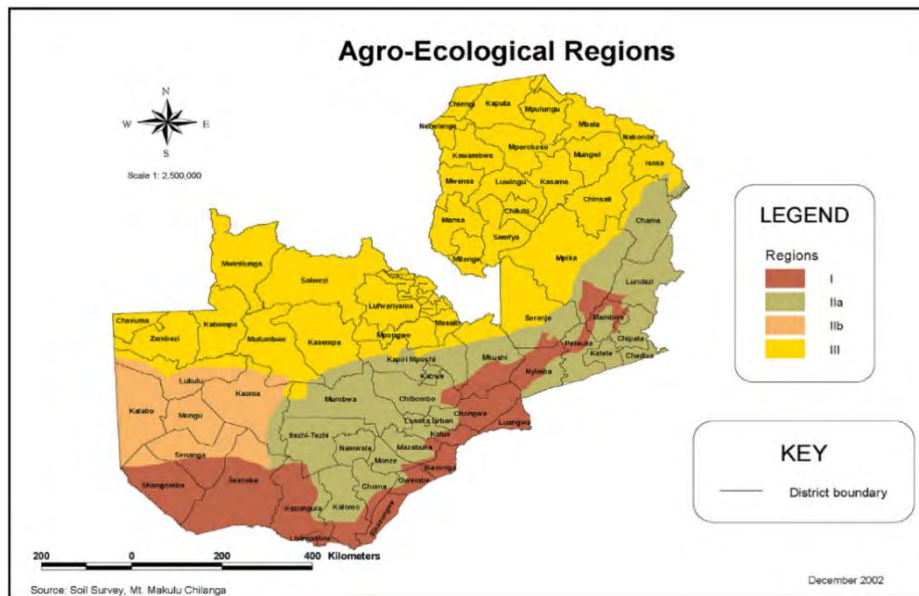
Region I covers the valley part of the southern, eastern and western Zambia (Figure 1-3) and receive less than 800mm of rain annually, its humid and hot because of the low altitude. In this region rainfall varies in time (seasonal), and in space. The region is prone to droughts and is generally dry. This region is suited for early maturing crops (e.g. Sorghum, Millet, and Cotton) because rain days tend to be fewer compared to region II and III (Aregheore, 2009; Mhambi-Musimwa, 2009; NAPA, 2007; MACO, 2004). This region accounts for 12% of land area and it is characterised by loamy shallow soils, it has high potential for winter irrigated maize and cattle production (MACO, 2004).

Region II covers the central part of Zambia (Figure 1-3) stretching from the western (region IIb productive soils) through to the midlands and some parts of Southern and Eastern provinces (region IIa unproductive sandy soil). It extends over 42% of the country's land and has fertile soils suitable for agriculture production (MACO, 2004). The area receives 800-1000mm of annual rainfall that is evenly distributed over the rainy season (November-April) when compared to region I (Aregheore, 2009; Mhambi-Musimwa, 2009; NAPA, 2007; MACO, 2004). Mostly medium to late maturing crops are suitable for this region (e.g. Maize, Sunflower, Cotton, Tobacco,

Wheat, Groundnuts and Soya beans). Dairy and beef production are also appropriate livestock activities in this area (MACO, 2004).

Region III covers areas in North-Western, Copperbelt, Luapula, Muchinga and Northern Provinces of Zambia (Figure 1-3). This region receive more rainfall than any other part of the country ranging between 1000 and 1500mm per annum (Aregheore, 2009; Mhambi-Musimwa, 2009; NAPA, 2007; MACO, 2004). It accounts for 46% of total land area of the country. The area is suitable for late maturing crop (e.g. Rice, Pineapples, Sugarcane, Maize, Coffee and Cassava) that demand higher water uptake and has vast potential for fish farming (MACO, 2004). However, the soils are quite acidic due to high levels of leaching and this limits yields as most farmers do not manage to lime the soils (MACO, 2004).

Figure 1-3: Map of Zambia’s Agro-ecological Regions. Amount of rainfall received per year: less than 800 mm (I); 800–1000 mm (IIa); 800–1000 mm (IIb); 1000–1500 mm (III) (Arslan et al., 2014).



1.1.3. Agricultural Extension System in Zambia

The agricultural extension system in Zambia has gone through transitions over time in line with the advances in agricultural knowledge and skill development. This has influenced the delivery of extension services to the farming community and the manner in which capacity is built among

individual farmers and the community. Agriculture extension officers are currently expected to deliver across four main pillars: education, technology transfer, problem-solving and human development (MAL, 2013a).

Prior to Independence in 1964, the extension services were based on *“Command and Control Approach”*. Farmers were forced to produce crops such as maize to feed miners on the Copperbelt (MAL, 2013a). After independence, the government established *“Farm Institutes and Farmer Training Centres”*. In each province a farm institute catered for in-service training for extension officers and in strategic districts farmer training centres, to train farmers and demonstrate technology use (MAL, 2013a).

Another approach was introduced in the 1990’s called *“Train and Visit”*. The farmers were trained fortnightly and frequent follow-ups were made to check on the farmers practices. This approach was abandoned after the government cut the budgetary allocation during the Structure Adjustment Program as it was felt that the approach was more of a top down approach (MAL, 2013a).

The *“Farming Systems Research (FSR) Approach”* succeeded the Train and Visit in mid-1990’s. This approach was thought to be inclusive in trying to help households improve productivity. The extension officers were expected to understand the farming household decision making process and associated agricultural challenges (MAL, 2013a). In 1998, the government of Zambia with assistance of the World Bank initiated a more holistic *“Participatory Extension Approach (PEA)”* as a mechanism to improve agricultural extension service delivery (MAL, 2013a).

Main features of Participatory Extension Approach (PEA) are;

- The community takes part in identifying their challenges and rank them.
- They set their own agenda and support their own decision making process.
- Since the community is involved from the beginning, planning is more systematic.
- Furthermore, community planning is complete compared to other methods where it is done on behalf of the community.

- The most pressing issues are addressed by a broad-based community action plan for development or implementation.
- Community structures are formed to take charge of the community development program implementation.
- PEA empowers the members of the community to request for better, specific and on time services.
- The community is in control of the implementation process, evaluation of results and impact (MAL, 2013a).

PEA is complemented by the Lead Farmer (LF) approach in the provision of extension services under Conservation Agriculture (CA) promotion. This involves a LF who is a member of the community that is identified as a change agent. The LFs are trained as master trainers by the agricultural extension officers implying that they are expected to train a number of their fellow farmers hence the integration of Participating Farmers (PF). Most LFs benefit from CA program incentives while PFs do not (FAO, 2011). This helps LF approach to deliver extension services to a larger segment of farmers. However the effectiveness of this extension methodology may have its own limitations in delivery of quality extension services.

1.2. Rationale

Agriculture, in Zambia, is the main economic activity on which rural population depend on for livelihood, both directly and indirectly employing more than 50% of the population (R-SNDP, 2014). Agriculture is also a priority on the economic development agenda for Zambia (MFNP, 2014; MTEF, 2014; R-SNDP, 2014).

The Ministry of Agriculture and Livestock is the primary implementer of adaptation measures in the agricultural sector. The agricultural extension system plays a pivotal role in information dissemination and in achieving climate change adaptation for SSFs.

The present research focuses on investigating challenges and provides some ways of improving management and implementation of Conservation Agriculture as an adaptive measure to climate change and weather variability.

Kanyanga *et al.*, (2013) has projected that cereal yields will reduce by about 25% in 2050 due to climate change and weather variability and this will have a substantial impact on the agricultural sector. The potential consequent economic losses call for serious and sustainable intervention. However, only a limited number of studies have investigated the challenges facing CA promotion at field extension service level. It is against this background that improvement in the current management and implementation of CA as an adaptive measure to promote sustainable agricultural production should be enhanced.

1.3. Problem Statement

The agricultural sector is one particular area that has been affected by climate change. Indicators of climate change and weather variability are certain and real and their effects already visible (Kurji *et al.*, 2011). The growth rate of population around the world has surpassed the rate of agricultural food production. It is projected that about 70% more food must be produced to feed the world's population estimated to exceed 9 billion by 2050 (Mba *et al.*, 2012). On one hand, the chances of meeting world food security needs through increased food production and productivity will require 37% historic increase, while on the other hand, this historic increase is likely to be challenged by the negative effects of climate change and weather variability (Mba *et al.*, 2012).

Africa has low capacity to adapt to climate change because of many challenges it faces which includes poverty, slow economic development and HIV/AIDS. Studies show that there are adaptation practices that are being implemented. However, they are inadequate and improvement is required given the future changes in climate, (IPCC, 2007:13). Zambia's agricultural sector plays a significant role in economic development as it is certainly one of the primary contributors to the country's Gross Domestic Product (GDP). Despite the agriculture, fisheries and forestry being one of the major contributors to GDP, the real GDP has declined from about 23.8% to 8.7%, from 2000 to 2013 respectively (Bank of Zambia, 2013).

Zambia is vulnerable to the impact of climate change and weather variability. It is estimated that 70% of the country's agricultural production comes from SSFs who rely on rain-fed agriculture

(Jain, 2007). Economic growth is also dependent on the agricultural sector as it is the major employer (R-SNDP, 2014). Any variation in climate and weather pattern affects the income levels of farmers, reduces employee output ratio among rural population that is mostly dependent on agriculture. Urban population food security is also impacted as most cities supplies are produced by SSFs in rural areas.

Kalomo district, the study location found in the Southern province of Zambia had a 21% drop in maize production in 2011/2012, due to the late onset rains and its erratic distribution. In addition, the province had lower nutrition levels in the pasture. This resulted in increased occurrence of livestock diseases due to overcrowding in pockets where pasture was available. Such challenges affect both crop and livestock production, as agriculture in the Southern province of Zambia relies on crop-livestock integration (ZVAC, 2013).

Long-term climate change studies suggest that Southern Zambia's cereal production and yield levels will reduce by up to 25% in 2050 (Kanyanga *et al.*, 2013). Natural water fish stocks will decline due to drought (NAPA, 2007). Different climate models all suggest that future mean annual rainfall in Zambia, from 2000 to 2050, will decrease, and average temperature will increase by about 2 °C in the southern parts of the country (Kanyanga *et al.*, 2013).

Success of Conservation Agriculture (CA) as an adaptation measure for crop production is affected by the low number of farmers consistently practicing CA (adoption) and high number of farmers who stop practicing CA (dis-adoption). These setbacks in CA promotion among small-scale farmers have been identified as challenges that agricultural extension services need to address (Arslan *et al.*, 2014; R-SNDP, 2014; Baudron *et al.*, 2007; Haggblade and Tembo, 2003), in view of climatic projections that suggest further crop yield reduction (Kanyanga *et al.*, 2013).

1.4. Research Objectives

1.4.1. Aim

The overall goal of this study is to investigate the challenges and ways to improve management and implementation of Conservation Agriculture as a climate change adaptation practice by the agricultural extension service in Kalomo district of Zambia. In order to respond to the overall goal, the study was designed to tackle the following specific objectives:

1.4.2. Specific Objectives

1. To analyse the current status of the agricultural adaptation practices that are being implemented under Conservation Agriculture;
2. To identify gaps and challenges associated with management and implementation of Conservation Agriculture by agricultural extension officers;
3. Recommendations for improvement.

1.4.3. Research Impact

1. This research highlights challenges and suggests options of improving the adaptation capacities in the context of Kalomo district in Zambia. It is evidence-based research that will lead to better planning for CA management and implementation. The research is useful in engaging the provincial and national office when addressing priority challenges in management of CA in Kalomo district.
2. The research contributes to the wider literature on adaptation to climate change in agriculture providing CA practices that are specific to Kalomo district. The research is useful to CA practitioners, implementers, policy makers and researchers.

2. LITERATURE REVIEW

2.1. Introduction

This chapter provides the operational definitions of some key words used in this study. In addition, the chapter reviews studies that provide international and local evidence on this topic. The policies at the national level that directly and indirectly play a role in the area of the study in Zambia are also reviewed to understand the institutional structure linked to the topic. Policies provide an in-depth understanding of the direction for the country and how they contribute to climate change adaptation in the agricultural sector.

2.2. Definitions

2.2.1. Climate Change

According to Intergovernmental Panel on Climate Change (IPCC), climate change is defined as the “state of the climate that can be identified using statistical test, by changes in the mean and/or the variability of its properties, and that persist for an extended period, for decades or longer. Changes in climate may be because of natural internal processes or external forcing such as modulations of the solar cycle, volcanic eruption, and persistent anthropogenic changes in the composition of the atmosphere or land use”, (IPCC, 2014:4).

The United Nations Framework Convention on Climate Change (UNFCCC), article 1, defines climate change as “a change in climate attributed to direct or indirect human activity that changes the makeup of the global atmosphere in addition, to natural climate variability observed over comparable periods” (UNFCCC, 1992:3).

For this study both definitions will be considered, as both definitions are widely used in climate change literature and they are ideal for this study.

2.2.2. Weather Variability

For this study weather variability is defined as, the variation in average weather patterns over a short period, minute to months (NASA, 2005). The definition is ideal for the study as it specifies the time period which clearly distinguishes it from climate change.

2.2.3. Adaptation

Adaptation is defined “as an adjustment in ecological, social or economic systems in response to observed or expected changes in climatic stimuli and their effects in order to alleviate adverse impacts of change or take advantage of new opportunities,” (IPCC, 2014:5; Neil *et al.*, 2005:78). This definition will be used for this study as it is used by IPCC and widely used in adaptation literature.

2.2.4. Food Security

Food security is defined as “ a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life” (FAO, 2013:16). This definition is widely used and accepted and it is adequate for this study.

2.2.5. Conservation Agriculture

Conservation Agriculture (CA) is defined as a method of land preparation with the aim of minimizing the loss of moisture and soil, with the combination of 30% crop cover as mulch or the previous crop residue covering the soil surface (Powlson *et al.*, 2014; CFU, 2011). (Hobbs, 2007), defines CA as minimal disturbance of the soil and permanent mulch together with crop rotation. He describes CA as being a more sustainable way of farming as compared to conventional agriculture mostly practiced.

According to CFU (CFU, 2011), other terms that are included in CA include;

1. Minimum Tillage (MT): reducing the overall tillage to a minimum or zero till
2. Conservation Tillage (CT): this includes reducing the overall tillage to a minimum or zero till combined with retention of crop residues

3. Conservation Farming (CF): this is where CT is done incorporating legumes. It can be in the form of intercropping, crop rotation on fallow.

The CFU (CFU, 2011) observed that farmers will move between these practices due to a number of factors that may include: shifts in prices; availability of inputs; subsidies; and incentives. The CFU argues that MT alone can provide above all, significant agricultural benefits to SSFs.

For the purpose of this study, (Hobbs, 2007) definition of CA will be considered. It covers the major principles of CA, these are; minimum tillage, retention of crop residue (permanent mulch) and crop rotation. All CA principles are also CA practices, however not all CA practices are considered CA principles.

Some terms used in CA can describe one or a combination of CA principles ie MT, CT and CF. Principles are technologies that must be practiced in combination to achieve maximum results under CA. Other practices other than CA principles just enhance CA and they include; application of lime to the soil (reduces soil acidity levels), use of animal manure (improving soil structure and fertility), use of herbicides in controlling weeds (CFU, 2011), and integrating of soil fertility tree, such as *Faidherbia albida* (Shitumbanuma, 2012; CFU, 2011).

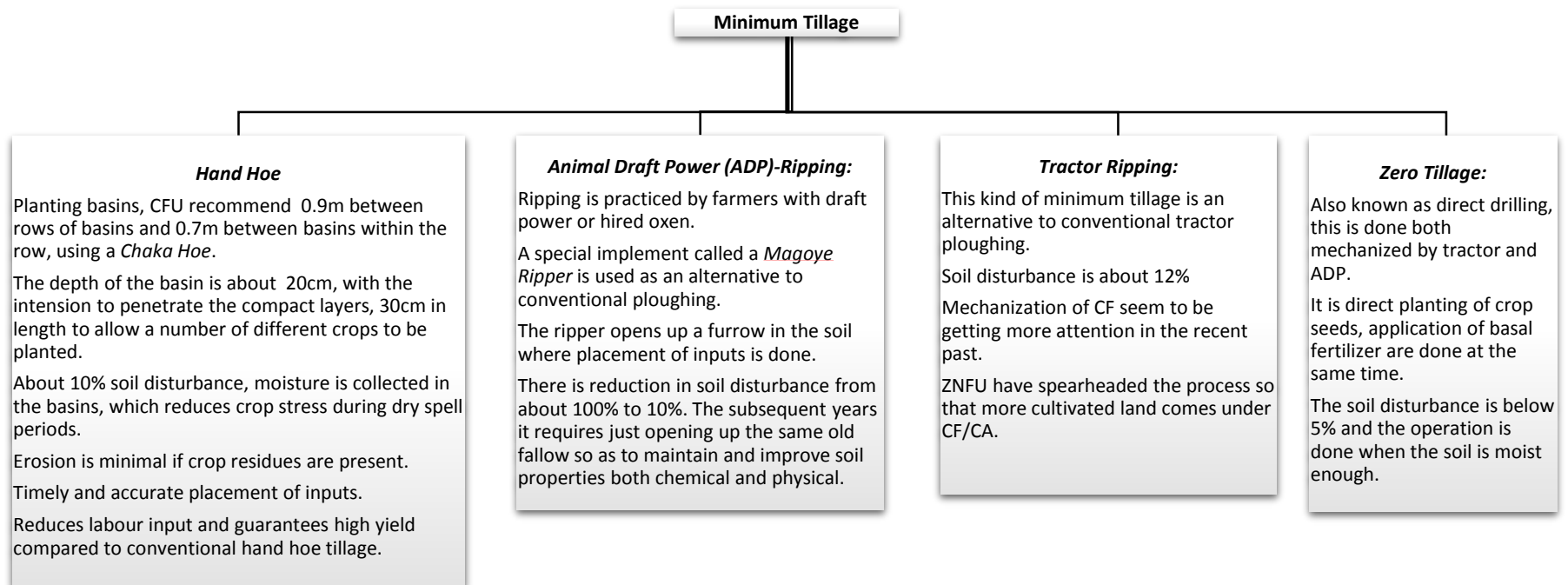
2.2.6. Conservation Agricultural Principles

I. Minimum Tillage

Minimum tillage has different technologies associated with it. It includes the use of a hand hoe, animal draft power (ADP) ripper and tractor ripper. Zero till by animal draft power and tractor is part of Minimum Tillage, Figure 2-1 below. Minimum tillage has more potential for adaptation than mitigation to climate change (Powlson *et al.*, 2014).

This thesis will focus on basins and ripping (all type of ripping and zero tillage inclusive).

Figure 2-1: Minimum Tillage Technology Diagram (Powlson *et al.*, 2014; CFU, 2013; CFU, 2013a; CFU, 2011, FAO, 2011, Haggblade, S. & Tembo, G. 2003)



Use of herbicides for weed control is not a principle of CA, but it significantly supports minimum tillage. Minimum tillage practices are linked to fast weed germination before and after planting in areas where the soil has not been disturbed in the field. Smallholder farmers are encouraged to use herbicides before or after planting. Prior to crop germination, a non-selective herbicide is often recommended to encourage minimum tillage. Further, selective herbicide application has the advantage of minimizing soil disturbance as well, while drying weeds in the field protect the soil from erosion, act as mulch and help water to infiltrate into the soil. It is estimated that the use of herbicides cuts down labour cost for weeding ranging from about 60% to 80% to those SSFs who normally weed using hand hoes (CFU, 2011).

Prudent weed control using herbicides requires considerable practical training, without which, the effectiveness to maximize its use is eroded. Lack of practical knowledge by farmers may lead to poor practices, thereby leading to poor results and wastage of money. Good knowledge on the use of the correct sprayers with perfect sprayer nozzle, correct herbicides with recommended dilution and timing of application, are vital in herbicide use. In the case of Zambia, the widely grown maize (mono-cropping) presents good opportunities for smallholder farmers to learn how to transition from ADP or hand weeding to herbicides use, because of the availability of selective herbicides for maize (CFU, 2011).

II. Retention of Crop Residue

Retention of crop residue is defined as maintaining the crop residue in the field. According to CFU (2011), cotton and maize crop residues are enough, if field yields exceed 1.5tons/ha and 3.5 tons/ha respectively assuming appropriate improved seed varieties were used. The common challenges for this method relate to uncontrolled bush fires and animal grazing, especially in areas where communal grazing is common. The benefits include improved infiltration of water, reduce soil erosion and moisture loss (through evaporation) and increases soil organic matter (soil carbon), which guarantees nutrient availability after decomposition (CFU, 2011).

III. Crop Rotation

This method involves the sequential planting of different crops on the same piece of land. In Zambia, it is common for most smallholder farmers to plant a small portion of legumes (both

edible and non-edible crops) that usually covers not more than 15% of the total cultivated area (CFU, 2011). Promotion of crop rotation is encouraged because it improves soil fertility when compared to mono-cropping. Nitrogen fixing crops are recommended for rotation with non-nitrogen fixing crops. Some of the challenges faced by SSFs practicing crop rotation include high prices of seed, access to seed and market availability for produce. Mono-cropping is not an option for CA farmers. Incorporation of trees with well-known nitrogen fixing properties to the soil such as *Faidherbia albida* is promoted in Zambia (Shitumbanuma, 2012; CFU, 2011). Fallow crops are also encouraged on land that has been abandoned because of exhausted soils.

2.3. Conservation Agriculture Practices

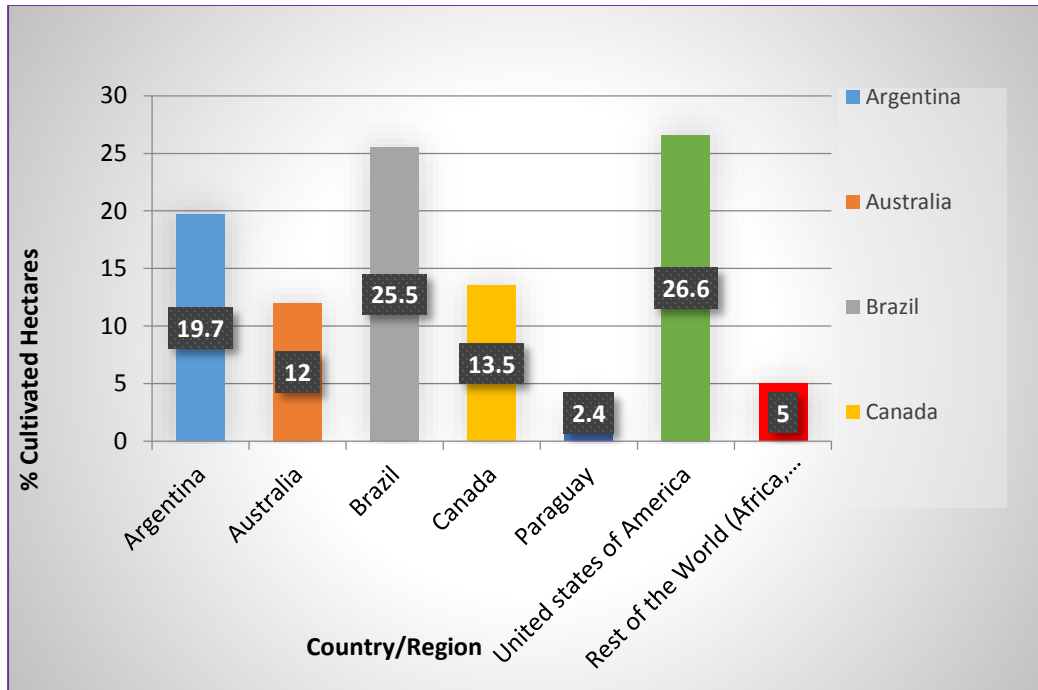
2.3.1. International Evidence

Conservation agriculture (CA) has been practiced across the world at different scales and with diverse equipment suited for various environments. The three (3) main principles of CA, that is crop rotation, minimum soil disturbance and soil cover, are constant globally (FAO, 2014; Kassam *et al.*, 2009; Hobbs, 2007). The use of crop varieties that do well, depending on the climatic stress being experienced supplements the CA principles. The early maturing and drought tolerant varieties are suited for drought prone areas, while late maturing varieties are best suited for prolonged rainfall areas and seasons (Mendelsohn and Dinar, 1999).

CA is practiced in almost all the continents, North America (United States of America and Canada), South America (Argentina, Brazil, Cuba, Colombia, Chile and Paraguay), Australia, and Europe (Ukraine, Kazakhstan, Switzerland, Finland) and Africa (Kenya, Tanzania, South Africa, Nigeria, Zambia and Zimbabwe), Asia (China and North Korea), (Derpsch and Friedric, 2009; Kassam *et al.*, 2009; Mhambi-Musimwa, 2009; Knowler and Bradshaw, 2007; Dumanski *et al.*, 2006).

South America has the highest cultivated area under CA and Brazil leads. Africa, Asia and Europe have the least cultivated area under CA (Figure 2-12). According to Giller *et al.*, (2009), Africa's contribution is small due to its lagging social-economic situation that plays a significant role in adoption of CA for SSFs, whom are the majority producers in Africa.

Figure 2-2: World Overview of CA/No Till Adoption, (Derpsch and Friedric 2009).



Africa’s contribution to global CA practices is small (Figure 2-2) because it lags behind in the social-economic sector, which plays a significant role in adopting CA by SSFs who are the major agricultural producers in Africa. Hence there is need for more research to improve the adoption rates for any meaningful increase in cultivated land under CA in Africa.

2.3.2. Regional Evidence

In Southern Africa, Conservation Agriculture (CA) is actively promoted by different organisations ranging from faith based and non-governmental organizations (NGO’s) to governments, with Minimum Tillage as the main focus (FAO, 2010).

Giller *et al.* (2009) states that it is difficult for Sub Saharan African (SSA) countries to fully adopt CA because of the social-economic nature of SSFs. He points to a few countries like South Africa, Ghana and Zambia where a few small-scale farmers have adopted CA. The argument he makes, is that there is overwhelming evidence that among SSFs the uptake of CA is not there in SSA. Instead of reducing labour requirement it has increased due to lack of herbicides, competing use of crop residue (animal feed), which is needed for soil cover under CA. However, conservation farming studies done in Zimbabwe on SSFs who use CA technologies consistently for

four years reveal improved cereal yields by 50 to above 100% in many farm households (Twomlow *et al.*, 2008).

According to Food and Agriculture Organization of the United Nations (FAO), Sub-Saharan Africa is practicing CA on a very small arable land despite the well-established benefits. FAO attributes it to limited support that CA receives within the region and divergent agricultural policies among governments in the region (FAO, 2010).

Nonetheless, South Africa has the largest land under CA (Table 2-1) (FAO, 2010; Derpsch and Friedric 2009; Kassam *et al.*, 2009), mainly due to its largely mechanized commercial farming (FAO, 2010a). CA is expected to provide smallholder farmers better yields given the vast opportunities for its adoption in the region. For example, improved CA adoption is likely to reduce the adverse impact drought and climatic variation is causing on widespread conventional agriculture production (FAO, 2010a). In Zimbabwe, evidence suggests that CA is helping the recovery of the economy as 70% of the population is dependent on agriculture for livelihood (FAO, 2014a). This was achieved through the support FAO provided to farmers such as labour saving mechanical implements that has created incentives and generated good spill-overs for rapid adoption of CA in Zimbabwe.

Table 2-1: Cropland under CA in Percentage of Total Land in Thousand Hectares for Some of the Countries in Sub Saharan Africa (FAO, 2010; Derpsch and Friedric, 2009; Kassam *et al.*, 2009)

Country	Year	
	2003-2007 (%)	2008-2009 (%)
Kenya	4.54	2.82
Lesotho	0.04	0.03
Morocco	-	0.86
Mozambique	2.73	1.93
South Africa	90.87	79.10
Sudan	-	2.15
Tunisia	1.82	1.29
Zambia	-	8.60
Zimbabwe	-	3.22
Total	100	100

2.3.3. Conservation Agriculture in Zambia

A number of Conservation Agriculture studies have been done in Zambia. Studies have been done on a number of technologies that are part of CA principles (Arslan *et al.*, 2014; Nolin and von Essen, 2005; Haggblabe and Tembo 2003), their adoption (Arslan *et al.*, 2014; Baudron *et al.*, 2007; Haggblabe and Tembo 2003) and effectiveness in different weather conditions (Arslan *et al.*, 2014; Nyanga, 2012; Umar and Nyanga, 2011; Mhambi-Musimwa, 2009).

A major study by Haggblabe and Tembo (2003), the study was conducted to consider impacts and adoption rates of Conservation Farming (CF) and conventional farming across farming households and agro-ecological regions. Yields were found to be higher under CF compared to conventional farming and under CF, basins performed better than ripping. Basins were higher by 60% than conventional plough. The findings also showed that the use of a ripper had a 7% increase in the probability of a group member adopting basins as a minimum tillage method. Access to assets, especially cattle or labour, also played a role in the adoption of CF. Individual farmer character was found to be an attribute in adoption of CF.

The landscape of Conservation Agriculture/CF in Zambia is changing, a decade has passed since the study was conducted and social-economic factors and policies have changed. Hence there is need for further research to understand the current status.

Nolin and von Essen (2005) undertook a minor field study on CA in Zambia, with an aim of comparing soil fertility under CA and conventional agriculture in Southern province of Zambia.

The result showed no significant difference in organic matter and soil pH, but significant high mean on nitrogen was found outside the basins. No significant difference for phosphorus (Olsen-P) between treatments, however, phosphorus was higher in ripped lines than outside the basins. Phosphorus was suggested to be high because the samples were taken near termite hills in the field. Also the number of years under CA on sampled farms was too few to notice major changes in the soils properties.

The farms sampled in the study had different soil types and CA was not fully practiced as prescribed (Nolin and von Essen 2005). The sample size was small and that may not significantly be used to generalise the situation for the entire province and Kalomo district in particular.

A study by Mhambi-Musimwa (2009) for a Dissertation Masters on “the Social Economic Effects of Conservation Farming in Drought Mitigation on Mpima Women in Kabwe, Zambia”, showed that Conservation Farming increased income and food security for some women. The findings were attributed to the differences in the rate of up-take of the CF principles and individual women ability to work in the field (Mhambi-Musimwa, 2009).

The research gap in the above study is that, it was not clear on the details of how the data was analysed as part of the methodology. The research focused only on women and cannot be replicated on men (gender biased). Seven (7) of the respondents were new both to the group and CF practices and may not have fully realised the benefits of CF, thereby affecting the results. The community was under a project implemented by Africare, Zambia. Therefore an NGO’s challenges in extension service provision may differ from that of MAL and private sector.

Another study was done by Umar and Nyanga (2011), on CA and rainfall variability in Zambia. The study covered parts of the three agro-ecological zones of Zambia, Eastern province, Southern province and Central province. Six hundred and forty (640) questionnaires were administered in 2007 and the respondents were interviewed again in 2008 and 2009 with the reduction in sample size to 535 and 486 in 2008 and 2009 respectively. Key informants in the study included agricultural extension officers. Furthermore, two group discussions were conducted on the experiences of CA under flooding and drought conditions (Umar and Nyanga, 2011). The results from the study suggested that there is higher production and productivity potential for CA than conventional agriculture in time of floods or drought among SSFs in Zambia (Umar and Nyanga, 2011).

The question that still needs more answers is why the potential is not being achieved despite CA promotion being done for over a decade? Many studies have been done on-farms, however, the need for more studies on implementing institutions and methodologies by which the extension support is being delivered still remains critical.

Recently, a study by Arslan *et al* (2014), investigated the factors that influence farmers to start practicing CF (crop rotation and minimum tillage). The study covered all the provinces of Zambia and across all the agro-ecological zones. The study used panel data for two surveys carried out in 2004 and 2008 with additional national survey for post-harvest of 1999/2000. A total of 8000 households were sampled and interviewed across all the nine provinces of Zambia (Arslan *et al.*, 2014).

The results indicated that no social-economic variables significantly influenced the adoption of minimum tillage except for oxen availability in Eastern province. The higher the number of oxen per household significantly lowered the chances of adoption of CA by farmers. For crop rotation, a man with more than one wife and better levels of education increased the chances of adoption in the whole sample. The most significant rate of adoption for crop rotation in the whole sample was households with wealth, either oxen or agricultural wealth (agricultural assets). Dis-adoption levels were found to be about 95% country wide. One of the consistent variable in explaining better adoption levels and pattern in Eastern province was found to be provision of extension services (Arslan *et al.*, 2014). Suggesting that in other provinces this variable was not consistent.

The study suggests further understanding of extension service provision is effective in the promotion of CF (Arslan *et al.*, 2014). This study is going to contribute to this area, to further understand if there are challenges that affect extension service provision on CA specifically in Kalomo district of Zambia.

2.3.4. Research and Promotion of Conservation Agriculture in Zambia

The leading CA/CF research hubs in Zambia are Golden Valley research station, CFU and Ministry of Agriculture (Haggblade and Tembo, 2003). They aim to develop CA practices that are conducive and suited for Zambian conditions and farmers. CFU had conducted 1,000 demonstration trials across the country by 2001 (Haggblade and Tembo, 2003). In the Eastern province of Zambia, the International Centre for Research in Agroforestry (ICRAF) now World Agroforestry Centre had conducted substantive research in the use of nitrogen fixing plants to be used for improving land under the fallow method. This was aimed at improving soil fertility naturally. The CFU has worked

with many partners in the promotion of CA/CF, which include private, faith based and non-governmental organisations (Haggblade and Tembo, 2003). Due to a number of promoters of CA in extension service provision, there is limited coordination to ensure uniformity in the extension messages and services (Haggblade and Tembo, 2003).

2.3.5. Adoption Rates of Conservation Agriculture in Zambia

In Zambia, and the sub-Saharan region in general, CA has been found to possess high potential to reduce the impact of weather variability as well as to improve the food security. It has potential to improve the food security situation for small-scale farmers (Nyanga, 2012; Mba *et al.*, 2012; Umar and Nyanga, 2011; Thierfelder, 2010 Twomlow *et al.*, 2008; Haggblade and Tembo, 2003). It is practised as a major climate adaptation measure in areas that are humid and experience lower amounts of annual rainfall in Zambia.

Although Conservation Agriculture has been promoted for a number of years, the adoption rate by small-scale farmers is low, and the area under Conservation Agriculture has not increased (Arslan *et al.*, 2014; Baudron *et al.*, 2007; Haggblade and Tembo, 2003).

Low adoption and withdrawal by some farmers has also affected the uptake of CA. Between 2004 and 2008 minimum tillage dropped from 13% to 5% (Arslan *et al.*, 2014). The substantial withdrawal from CA is attributed largely to the abolition of subsidies on inputs once promotional programmes aimed to demonstrate CA are phased out. Thereafter, a significant number of farmers were unable to procure inputs at non-subsidized prices (Arslan *et al.*, 2014; Haggblade and Tembo, 2003). NGOs that promoted Conservation Agriculture failed to sustain the operations and the absence of proper exit strategies, caused huge uncertainty among farmers and adverse expectations about CA hence some withdrawals. In some cases, NGOs lacked adequate technical personnel to facilitate monitoring and aid significant capacity building among farmers (Haggblade and Tembo, 2003). Ideally, these identified loopholes should have been filled by the government agricultural extension service as the Ministry of Agriculture and Livestock oversees all agricultural activities in Zambia.

Haggblade and Tembo (2003), indicate that between 20, 000 and 60, 000 farmers practiced CA under planting basins (using hand hoe) in 2001/2002 season and 4, 000 had used rippers. CA doubled in 2002/2003 season following increased donor support (Haggblade and Tembo 2003).

The Ministry of Agriculture and Livestock (MAL, 2013b), scaled up CA for smallholder farmers from 12 to 31 districts across all the 10 provinces. The Department of Agriculture (DoA) claims that 127, 232 small-scale farmers practiced CF country wide. SSFs practicing minimum tillage alone increased from 20,000 to 259, 000 farmers between 2009 and 2013. Furthermore, the DoA estimated that CF had increased maize yields from the initial 1.3 tons to 3.6 tons per hectare (MAL, 2013). As part of promotion of crop rotation under CA, the Ministry of Agriculture and Livestock pledged to continue promoting cultivation of other crops besides maize, through both production and marketing of other crops. Some of the prioritized crops include soya beans, cotton, rice, sorghum and groundnuts (MAL, 2013).

Extension support to farmers plays an important role in the adoption of CA (Arslan *et al.*, 2014; Haggblade and Tembo, 2003). However MAL recognized some of the challenges faced by farmers and the role the Ministry has to play in order to overcome them. “Although there is a significant increase in the area planted to crops other than maize, productivity amongst SSFs for all crops is still low. This is mostly due to low adoption rates for appropriate agricultural technologies and poor farming practices among SSFs. The Ministry will put more effort in increasing productivity through good farming practices such as Conservation Farming, promoting the use of certified seed and advancing the adoption rate of appropriate agricultural technologies” (MAL, 2013:7)

According to FAO, (2014), the European Union (EU), FAO and the Zambian government through the Ministry of Agriculture and Livestock launched a €11 million facility for CA promotion to 315,000 small-scale farmers in nine of the ten provinces in an effort to increase production and productivity. The four year programme, Conservation Agriculture Scaling-Up (CASU) was launched in Lusaka, Zambia on June 18, 2013 and expected to be implemented up to the year 2017. The project builds on the past achievements made by EU-sponsored FAO Conservation Agriculture activities in Zambia. For the previous project, Farmer Input Support Response

Initiative (FISRI) between 2009 and 2012, EU contributed funds to a tune of €16 million (FAO, 2014).

As can be seen from adoption rates and literature, adoption is dynamic, depending on different factors such as time and methodologies applied in different studies as well as insufficient and updated information. With changing social economic situation, updated information is required.

2.4. Enablers and Barriers to Adaptation

Government local institutions, the private sector, business organizations and non-governmental organizations (NGOs) play a pivotal role both directly and indirectly in influencing SSFs in communities to adapt to climate change. The same is true in the delivery of agricultural extension services to SSFs for adaptation. Meanwhile, most of the institutions and organizations at local level are highly influenced by interaction by their ministries, national or international partner organizations, actors on the market and social transformation (Christoplos *et al.*, 2009; Haug, 1999).

The local culture and traditions, specifically those that are closely related to management of local natural resources, affect communities' responses to climate change and are responsible for the actions of other institutions. At local levels the understanding of cultural norms and traditions normally define the interaction between the local communities, public and private institutions. But the beginning point for processes of these institutions is embedded in formal structures and policies that are made at global and national levels (Christoplos *et al.*, 2009). Community organizations work within local cultural, traditional rules and norms to deliver and facilitate processes of adaptation. However, their management of resources depicts the ongoing motivation for listening to the needs of the community and or just reacting to the political, commercial and donor vested interest beyond local scale (Christoplos *et al.*, 2009; Haug, 1999).

According to the IPCC (2014), the need to improve adaptation capacity for SSFs in rural areas is vital. Emphasizing that adaptation is location and situational specific, without one particular approach across all scales (IPCC, 2014; Giller *et al.*, 2009). Information on where and when adaptation measures work best, for whom, and how adaptation measures should be configured

in different settings is urgently needed (Giller *et al.*, 2009). The Importance of local knowledge in climate change adaptation is sometimes not well utilized by international and national policy makers in an effort to manage climate change adaptation (IPCC, 2014; Christoplos *et al.*, 2009).

Christoplos *et al.*, (2009), further states that a lot is expected from local government, shift of responsibilities to local authorities is vital for adaptation to take place. He notes that the decentralization process should not only be in the form of structure but also enough resources should be allocated to the local authorities. Plans must be in place to build capacities in local institutions (Christoplos *et al.*, 2009).

A number of reasons have been suggested for poor results in agricultural extension service. Some of the reasons are inefficiencies service delivery and extension staff not being accountable to farmers for their agriculture service (Belay & Abebaw, 2004; Haug, 1999; Purcell & Anderson 1997). In most SSA countries, agricultural extension services lack objectivity and normally lose focus as the extension agents are made to execute all the agricultural policies at farmer level (Belay & Abebaw, 2004; Haug, 1999).

There is no single extension approach that is good enough to warranty uniform use on all SSFs situation. However a number of principles define the effectiveness of extension approaches. One of them is the relevance to the situation of the SSFs, which requires understanding the local community's farming system (Fowler & Rockstrom, 2001; Purcell & Anderson 1997). Fowler & Rockstrom, (2001), argue that some extension methodologies being implemented in SSA also challenge traditional approaches since they are based on one direction, extension officers to farmers. Haug (1999) proposes a public private partnership, which will foster open access to extension services from governments and the private sector. Private sector alone tends to commercialise extension services to a point where SSFs cannot afford the service (Haug, 1999).

2.5. National Agriculture Policy (NAP)

The Zambian National Agriculture Policy (2004-2015), recognised the agricultural potential the country has, and the reasons why the potential has not been exploited to its fullest. Some of the highlighted reasons in the Agriculture Policy for not attaining full potential in the agricultural sector are; adverse weather conditions, macroeconomic dynamics and poor policy management (R-SNDP, 2014; MACO, 2004). Economic growth and food security for the country can be achieved, if the high potential in the agriculture sector is fully exploited.

MAL developed NAP to increase production and productivity, private sector participation, private and public partnership and effective agricultural service delivery. NAP (2004-2015) was aimed at guaranteeing sustainable agriculture production and growth as the government had recognised that most SSFs are resource poor, have low productivity and food insecure (MACO, 2004). NAP also acknowledged the importance of conserving the agricultural resource base while increasing production and productivity. Environmental challenges associated with agricultural production were to be given special attention. To guarantee sustainable agricultural industry in the country, promotion of sustainable farming practices including conservation agriculture (CA) were set to be a priority (R-SNDP, 2014; MFNP, 2014; MACO, 2004).

Boughton *et al.*, (2003) studied the cotton sector policies performance in Zambia and Mozambique. It was noted that Zambia was doing better than Mozambique in terms of agricultural service delivery under the liberalized policies (Boughton *et al.*, 2003).

The International Monetary Fund (IMF, 2007), noted that there is a weak link between economic growth and poverty reduction. The focus of Poverty Reduction Strategy Paper (PRSP) is on sectors that are pro-poor such as agriculture, but growth is more in capital-intensive sectors such as mining. In addition, the allocation and use of resources in the agricultural sector is a challenge. The concerns were that not enough funds are allocated to programs known for increasing agricultural production and productivity, such as diversification of crop production for food security, irrigation development and research. A significant amount of the budget is used for subsidizing fertilizer input support program for SSFs but it is poorly targeted and reaches only

less than 10% of the intended beneficiaries, resulting in crowding out more productive and sustainable programs (IMF, 2007; Jain, 2007). This is also reflected in the 2015 national budget presented to Zambian parliament, October 10, 2014 (MFNP, 2014).

NAP also recognizes the unfinished implementation of the policies in the agricultural sector that have resulted in challenges, that include limited agricultural services for SSFs, poor infrastructure (resulting in constraints in marketing of agricultural produce) and lack of agricultural credit and finance institution. Poor enforcement and weak laws and land administration in Zambia still pose a challenge (MACO, 2004).

2.6. Climate Change Adaptation Policies

Rural areas are expected to be impacted more by climate change in SSA, which may result in decreased availability of food, water, agricultural production and change of production areas for certain crops (IPCC, 2014). Impacts will mostly affect the wellbeing of the less privileged in the rural areas, especially households headed by females who may have less accessibility to land and improved inputs (IPCC, 2014).

In response to UNFCCC recommendation, which Zambia is a signatory; Zambia developed the National Adaptation Plan of Action (NAPA), by assessing the impacts of climate change on the most important sectors of the economy. The agricultural sector was highly ranked for urgent adaptation intervention together with natural resources and wildlife, energy, water and human health. NAPA serves as a communication document to the local and international community on critical areas and activities that require immediate attention for adaptation to climate change and weather variability (NAPA, 2007). NAPA also plays a major role in terms of contributing to the National Climate Change Policy direction.

Zambia has realised that climate change has become a significant challenge in delivering sustainable development. The country places more emphasis on climate change adaptation in order to achieve the Millennium Development Goals (MDGs) that have been affected by climate change and weather variability. The National Climate Change Response Strategy (NCCRS) is a

framework through which support and coordination to climate change matters are addressed (MTENR, 2010).

Agriculture is given priority as it is seen to be one of the main drivers of economic growth. The sector has potential and opportunities that are high for uplifting the livelihood of 60% of the country's population. With more than 70% of the poor living in rural areas and depending on agriculture for livelihood, land use and water resource management have been identified as key under agriculture. Sustainable water and land use system will increase agriculture productivity and production that will guarantee food security in the face of climate change and weather variability (MTENR, 2010).

According to the University of Gothenburg (2010), in its policy brief that was issued on Zambia's environment and climate change, the university reported that the Sixth National Development Plan (SNDP) poorly integrated climate change. Only the environmental sector has been mentioned as a cross cutting issue, with targets to be measured not clearly spelt out. The policy brief points out that, it becomes difficult to manage climate change and the environment at national level, if vital issues such as climate change are not clearly spelt out in national documents (University of Gothenburg, 2010). IPCC, (2014), notes that in some countries adaptation policies are available, but the implementation process is a challenge. Success in implementation and mainstreaming of adaptation policies in development plans improves the adaptive capacity to climate change (IPCC, 2014).

2.7. Harmonisation of Agriculture and Adaptation Policies

Zambia is in the process of coming up with National Climate Change Adaptation Policy to incorporate climate change in all the development sectors and programs of the country. The MAL is also revising its NAP of 2004-2015 to facilitate the changes in the political, social-economic and environment with a focus on climate change impacts on agriculture.

The MAL and MLNREP had to dialogue for the valuable contribution of agricultural and climate change polices, for the country to achieve sustainable food security, lower poverty and increase economic growth. This was meant to harmonise the differences in the two policies that existed.

The harmonization process feeds in the broader climate change policy development with key result areas of;

1. Agriculture policy objective explicitly considers effects of climate change
2. Agriculture policy objectives clearly considered in the climate change policy
3. Agriculture policy aligned and consistent in objectives at sector and national level
4. Reduced policy conflict on climate adaptation and mitigation measures and agricultural growth
5. Cost saving on resources as joint planning and implementation of programs, thereby reducing duplication (MAL and MLNREP, 2013).

2.8. Climate Change Adaptation in Agriculture and Policy Improvement

Improving climate change adaptation at regional and national levels in the agricultural sector is essential, and a number of recommendations have been made that are policy related. These include; building capacity in the lead institutions, investment in research, engagement with stakeholders, improvement in agriculture technologies, increasing the use of climate information in policy and planning (IPCC, 2014; Zinyengere *et al.*, 2013; Ziervogel *et al.*, 2008; Mendelsohn and Dinar, 1999).

Adaptation is considered to be driven by management planning both at local and international level (Howden *et al.*, 2007). Mainstreaming adaptation into policy planning should be in line with the aspirations and the requirements of agricultural decision makers (Howden *et al.*, 2007). Christoplos *et al.*, (2009), points out that, shifting of responsibilities to local authorities is vital for climate change adaptation to take place.

It is evident from the reviewed literature that the topic under investigation has had considerable research and has been considered in a number of policies. There is overwhelming evidence that CA if well practiced as prescribed has beneficial impacts both economically and environmentally to the SSFs.

It is not a new topic for Zambia, but evidence suggests that more needs to be done to improve adoption rate to increase resilience and adaptive capacity for SSFs.

Limited studies have gone a step further in focusing on the challenges in agricultural extension services of CA promotion. It is in this vain that this study had to be undertaken to understand the Challenges in CA extension provision which has continued to result in poor adoption rates.

3. METHODOLOGY

3.1. Introduction

This chapter describes the methodology used to capture the data for this research work. Study area description has also been highlighted.

The study adopted a cross section qualitative approach based on Semi-structured interviews. This approach is used in social and natural sciences in cases where full-fledged survey data is not available or cannot be easily collected due to financial and other logistical constraints (Longhurst, 2003; Sofaer, 2002). The interviews were supplemented with literature reviews of reports related to the subject from the Ministry of Agriculture and Livestock, Kalomo District.

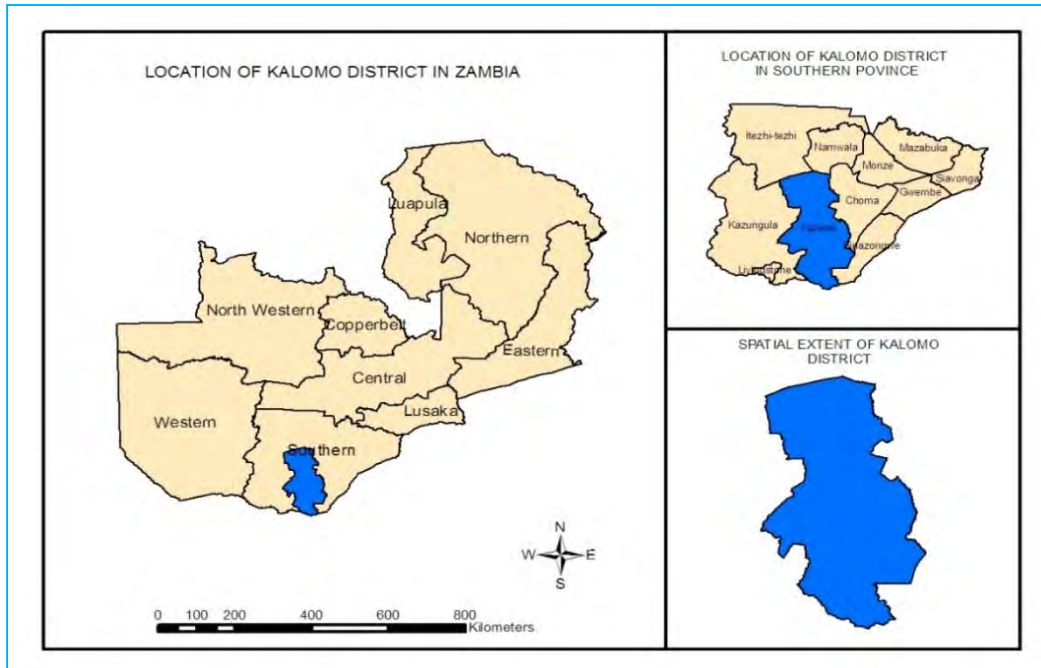
The location of study was selected firstly, because it has two agro-ecological regions, secondly there has been a considerable number of CA practices implemented for more than five years and thirdly because it has most productive SSFs in the province and the country (CSO, 2011; CSO, 2006).

The interviews were done in Kalomo district that is located in the Southern province of Zambia (Figure 3-1). Kalomo District has a total surface area of about 15,000km² with a population of about 258,570 people. The district has a population growth rate of about 4.4% and has the largest share of population in the province of about 16.3% (CSO, 2012). The District has about 42,325 registered Small-Scale farming households (MACO, 2011). Maize cultivation and cattle rearing are the major agricultural and economic activities in the district with most of the production concentrated among small-scale farms. The district is partly located in the drier part of the country situated in agro-ecological regions I and II. This implies that it partly receives the least amount of rainfall annually (region I less than 800mm).

The district has been implementing CA in 24 out of the 35 agricultural camps. An agricultural camp is the smallest geographical area manned by one agricultural extension officer. Agricultural camps are within farming communities which makes it easier for farmers to learn new farming methods, access agricultural extension services and adapt to climate change at local level. Some extension officers are based at district office. Twelve (12) out of 24 camps implementing CA have

56 Lead Farmers (LF) and the other 12 camps have 28 LF. Each LF is expected to train 15 Participating Farmers (PF) in CA technologies according to the LF extension approach (MAL, 2012). In total about 15,120 SSFs should be actively participating in CA out of about 42, 325 in Kalomo district.

Figure 3-1: Map of Zambia (left), the Southern province (top right) and the Kalomo district (bottom right) (CARE, 2012).



3.2. Ethical Consideration

There were ethical issues relating to this method of collecting data that were considered. The respondents were adequately informed about the study and permission was sought prior to the interview. The informant’s details were protected to minimize any risk of exploitation and unanticipated harm and in line with University policy. Only the names of organisations are highlighted in the final thesis.

3.3. Data collection

Interviews were conducted in a conversation manner with Ministry of Agriculture and Livestock extension officers, as they play a vital role in the promotion of Conservation Agriculture. It is one of the ways in which information could be gathered. The semi structured interviews were

important in gathering information from individual extension officers through probing. A list of questions was prepared in advance and predetermined. The list of guiding questions was pretested before the interviews were conducted (Appendix 10).

The questionnaire had three parts; the first part had questions probing the CA practices being promoted and the CA principles that were being easily adopted. The second part of the questionnaire was designed to establish the challenges being faced in the promotion of CA. The last part was aimed at tapping into the local understanding on what could be the options to improving the management and implementation of CA for the purpose of generating recommendations.

The conversations were directed by the respondent but guided by semi-structured questions. The order of the questions was predetermined but offered flexibility. For example, when the respondent started answering part of a question that was yet to be asked, they were not disturbed. Only notes were taken by the researcher and made sure the respondent finished answering all the questions, without sticking to the order. The interviews were being done in a conversational manner by asking follow-up open-ended questions such as; *“Why are some of the CA principles not fully practiced?”*, *“How do the challenges mentioned affect CA implementation?”* so that the respondents gives more details in the conversation (Guion *et al.*, 2011; Mack *et al.*, 2005; 29). The interviews gave time to the respondents to look at other detailed issues within the topic that the respondent may have considered to be of importance to the conversation (Guion *et al.*, 2011; DiCicco-Bloom, 2006; Opdenakker, 2006; Cohen and Crabtree, 2006; Longhurst, 2003; Sofaer, 2002). For example, issues such as deplorable state of accommodation for extension staffs and how it affects agriculture extension service delivery. It was not just about asking questions but also being attentive, open-minded about the issues that surfaced during the interview, which improved the aspects of being non-judgmental. An atmosphere that made the respondents more comfortable to express themselves was created through meeting them at their preferred venues (Cohen and Crabtree, 2006; Mack *et al.*, 2005; Longhurst, 2003; Sofaer, 2002). Some respondents preferred being interviewed at an agricultural show, others at the district office. For each interview, notes were being taken in writing for further review and analysis.

3.4. Data Sources

3.4.1. Ministry of Agriculture and Livestock District Extension Officers

The primary data was collected from key respondents from the Ministry of Agriculture and Livestock. Key respondents were vital because of time limitation. The Ministry of Agriculture and Livestock is the overall coordinator of agricultural activities in this sector. The Ministry of Agriculture and Livestock supported the study in organising meetings with the selected respondents who have been implementing CA practices. The respondents operate from different geographical areas within the district.

3.4.2. Stakeholders

Part of the primary data collected was gathered from stakeholders that work with the Ministry of Agriculture and Livestock in the implementation of Conservation Agricultural practices in Kalomo district. They include World Vision, Care International, Seed Companies (Pannar, Monsanto and Zamseed), Conservation Farming Unit (CFU), and Zambia National Farmers Union (ZNFU).

The stakeholders proved to be a vital source of information as they actively provide CA extension services within the district and they are in contact with farmers. Seed companies support CA through the supply of appropriate seed varieties, herbicide and other inputs. Seed companies together with CFU and ZNFU support CA demonstration and work closely with the Ministry of Agriculture and Livestock extension officers in delivering CA extension services. ZNFU also provide agricultural credit facilities that support CA and marketing platform for agricultural produce. The NGOs also work closely with the District Disaster Management Committee in providing adaptation and mitigation measures in time of drought/floods to SSFs. In addition they build resilience within the small scale farming communities in the rural areas.

3.4.3. Secondary Data Source

The secondary data was collected from the Special Conservation Agricultural project reports, quarterly and annual Kalomo district reports generated by the Ministry of Agriculture and Livestock (Appendix 11).

3.4.4. Sampling

The participants that were selected for interviews were carefully sampled based on experience in the implementation of Conservation Agriculture within Kalomo district as guided by Longhurst (Longhurst, 2003). The focus of having, extension officers as part of the key respondents was motivated by the focus of the study, which is improving management and implementation process of Conservation Agriculture. The farmers were not a focus because the research was not focusing on adoption rates or evaluating the Conservation Agriculture.

Table 3-1: Sample Size of Data Sources

Interviews/ Literature	Primary Data Sources			Secondary Data Sources		
	Agricultural Extension Officers	Stakeholders	Total No of Interviews	MAL Reports	MAL CA Project Reports	Total NO of Reports Reviewed
Planned	20	5	25	5	-	5
Achieved	20	7	27	7	7	14

Table 3-1 above, shows the sample size of the interviews that were conducted and sources of secondary data. The planned target for interviews was 20 agricultural extension officers and 5 relevant stakeholders, considering the time frame, distances and resources. However, the total number of interviews that were conducted for relevant stakeholders were 7 with the target for extension officers was exactly met. The availability and the willingness to share information by the two extra stakeholders proved to be extremely beneficial to the research. The sample size for extension staff and stakeholders was determined by experience in implementation of CA practices and the limitation on time for data collection. Less than 30 out of 41 agricultural extension officers have had experience in the implementation of CA practices at the time of the research in Kalomo District.

Conservation Agricultural project reports and MAL District reports between 2009 and 2013 formed part of the data sources. Only reports for the period 2009 to 2013 had well documented Conservation Agriculture activities for the district and were readily available. In total, data collection took about four weeks, after ethical clearance by the University of Cape Town Institutional Review of the Faculty of Science.

3.5. Data Analysis

The data was analysed using Nvivo 10, qualitative research software (QSR, 2014). The software Nvivo 10 used for analysis of the data is able to combine both the primary data from the interviews and secondary data from the literature. The interview notes and reports were imported into the software. The software allows the user to import any soft copies of data (documents, PDF, data set, video, audio and pictures) from multiple sources to be analysed within the software. All interview notes were reviewed for emerging themes (QSR, 2014) within Nvivo 10. A range of themes were identified and uniquely coded (Appendix 1). Themes are phrases with similar meaning and are inter-related, that constantly appeared in the interview notes and literature used for the study.

For this study the analysis of interview notes and literature was combined. The literature for the district from 2009-2013 and had broader scope to supplement notes from the interviews. The five (5) years period of the reports was readily available and significant enough for analysis of CA status. The details of the different data sources contribution to the results are attached in appendix 6-9.

3.5.1. Data Coding

A code is a representation of a theme and in Nvivo 10 a code is also referred to as a node. Coding was done in Nvivo 10 (QSR, 2014) by dragging an identified phrases from the interview notes or MAL reports to a code. A code was created within the software by the user, each code represented a particular theme identified after reviewing the interview notes and MAL reports. Some sub-codes were created also for detailed analysis of the main codes. The user of the software had control over codes and how themes are assigned to codes during data review. Four major codes were created. The first code was for the CA principles and CA practices being promoted and implemented; the second code was for CA principles and CA practices that are practiced by farmers (being adopted). The third code was for challenges in the implementation of CA. The fourth code was for options for improvement in CA promotion. All identified themes in the text that related to the major themes were coded in them with different sub-code associated to the theme. Relationships between code, matrix and graphs was created within the

software. The software is also capable of filtering data in datasets. The coded themes were analysed to meet the set specific and overall objective of the research. All the codes were in line with the study objectives, focusing on current status of CA, challenges in management and implementation of CA and options for improvement of CA.

The software was used to search the data based on text or word queries that helped to identify the major words associated to themes or mostly used words in the different data sources (Appendix 2-5).

3.6. Advantages and Limitation of the Methodology

3.6.1. Advantages

The methodology employed in this study to be proved beneficial due to the following reasons:

- I. Pretesting of the interview guide helped to adequately familiarise with questions ahead of field interviews, fixed the flaws and ensured improvement in the data collected.
- II. The qualitative analysis software (NVIVO 10) was helpful in analysis of the texts both from the interview notes and reports, by using text or word query, word frequency and Coding.
- III. The liberty given to the respondent to express themselves and their views on their own terms, helped gather vital information.

3.6.2. Limitations

This kind of study requires sufficient monetary resources and time. However, time and money were limited in this particular study, therefore, the data collected was not as what might be required to draw strong conclusion.

4. RESULTS AND DISCUSSION

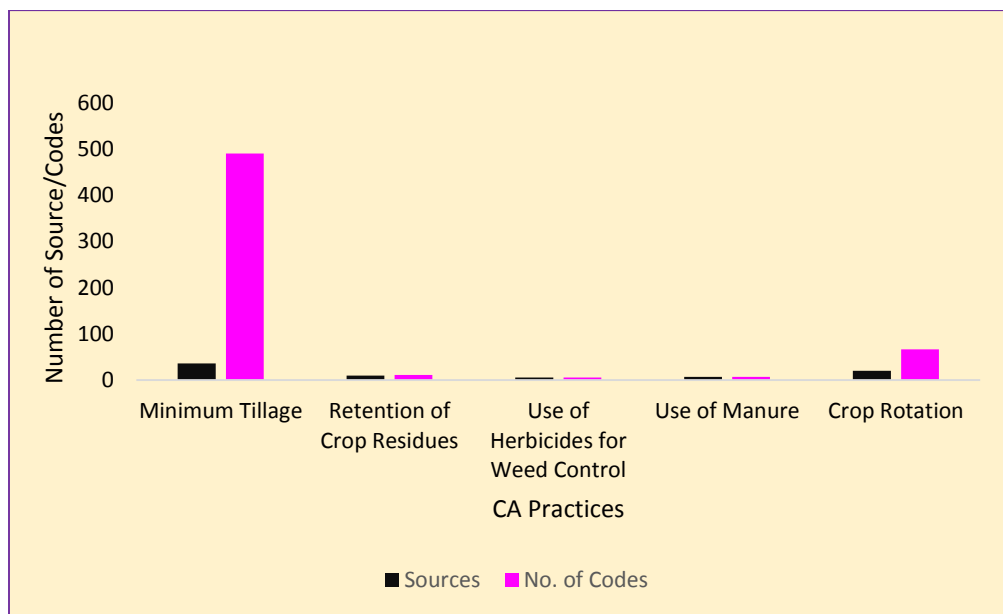
4.1. Introduction

This chapter presents the findings from the analysed data gathered from both primary and secondary sources. The codes in Nvivo 10 were created in accordance with the themes that emerged from the interview notes and literature review. In addition, CA practices being implemented and the challenges associated with management and implementation of CA, as well as improvement option are presented.

4.2. Conservation Agriculture Practices in Kalomo District

A number of practices are being promoted under CA in Kalomo. In addressing one of the questions that were asked on CA practices (What CA practices are promoted in Kalomo district?) to determine other practices beyond CA principles. Minimum tillage is the most promoted, followed by crop rotation, while retention of crop residues and crop rotation are less promoted. The use of herbicides for weed control and use of cattle manure are some of the measures being promoted to enhance CA principles (Figure 4-1).

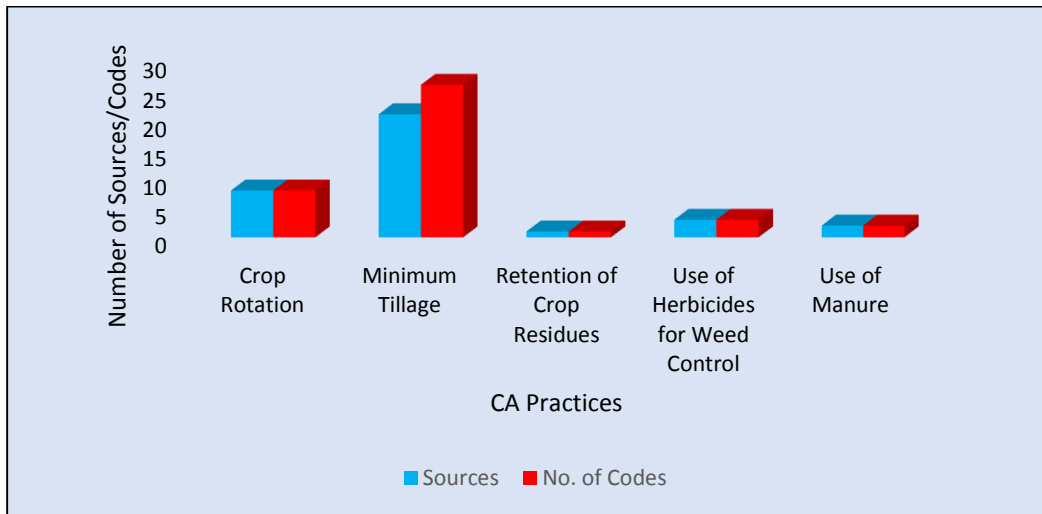
Figure 4-1: Types of Conservation Agriculture Practices Being Promoted In Kalomo



4.2.1. Practiced Conservation Agriculture Principles

The findings show that among the major three principles of CA, minimum tillage is more practiced among small-scale farmers than crop rotation and retention of crop residue (Figure 4-2). Other measures that are practiced include the use of herbicide for weed control to avoid soil disturbances and the use of manure for soil improvement for both physical and chemical properties. Although the use of herbicides and manure are not the main principles of CA, they are significant in reducing soil disturbance and improvement respectively. Not all the CA principles are practiced at the same level (other principles are practiced more than others) (Figure 4-2). Retention of crop residue as soil cover and mulch are the least practiced CA principles. Use of lime and fertility trees seem not to be promoted or practiced in Kalomo district.

Figure 4-2: Break-down of Most Practiced Conservation Agriculture Principles

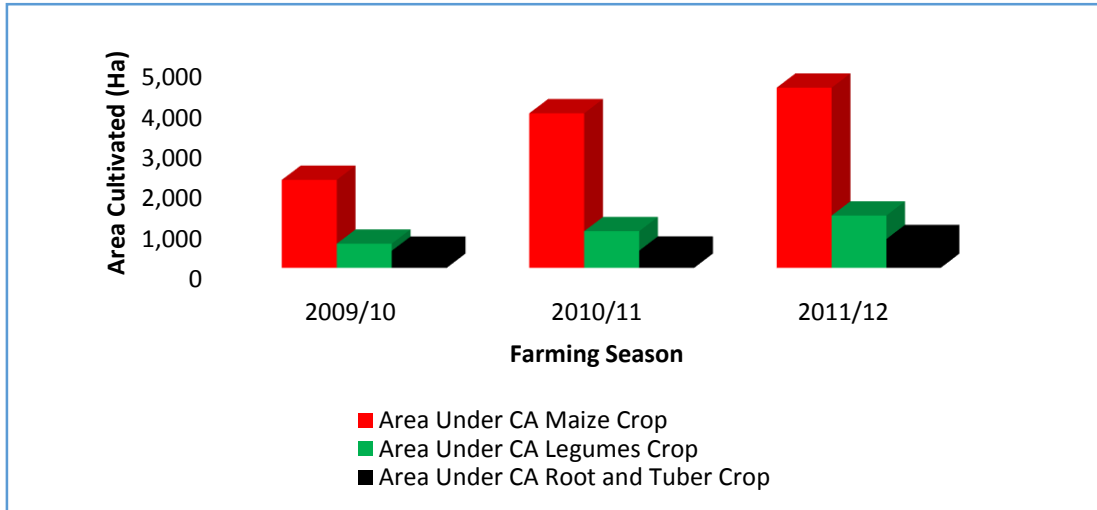


4.2.2. Cultivated Area and Crops under CA

There is an increase in the area under minimum tillage, legumes and tuber crops, from 2009/2010 to 2011/2012 farming season. The total area under minimum tillage has increased from 3,185 hectares in 2009/2010 to 6,438 hectares, in 2011/2012 agricultural seasons, representing a 50.5% increase. Maize is the major crop cultivated by most SSFs and the area under other crops is less than the area cropped only with maize. Crop rotation has recorded some improvement in implementation as one of the principles of CA. There has been an increase in the area planted

under maize, legumes and root tubers by 51.2%, 53.8% and 40.6% respectively (MAL 2012), see Figure 4-3 below.

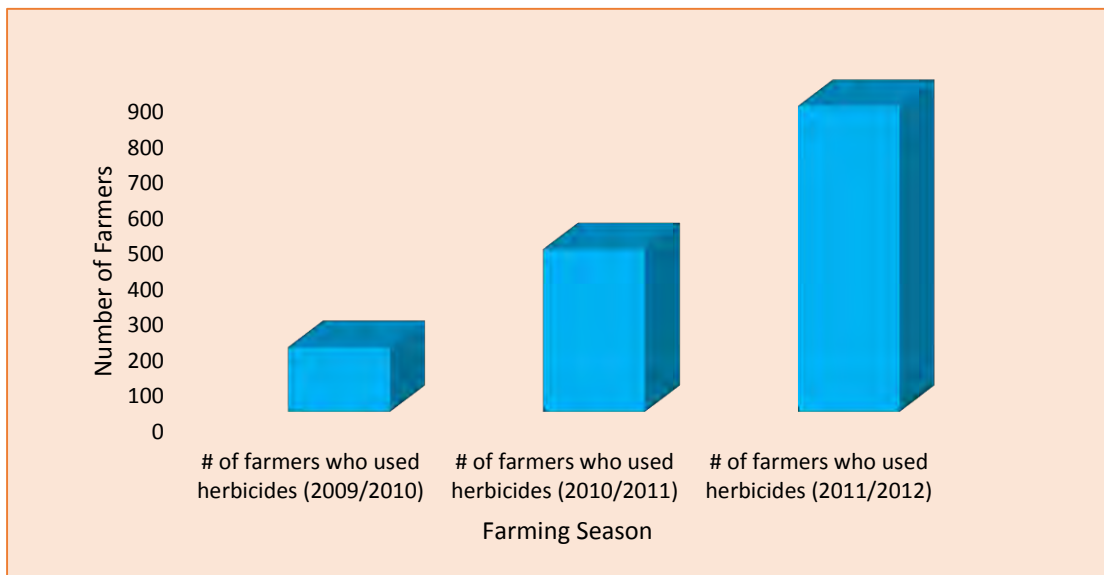
Figure 4-3: Evolution of Area under CA (both Ripping and Basins), Contributing to Crop Rotation - Years 2009-2012 (MAL, 2012).



4.2.3. Herbicides Use and Minimum Tillage

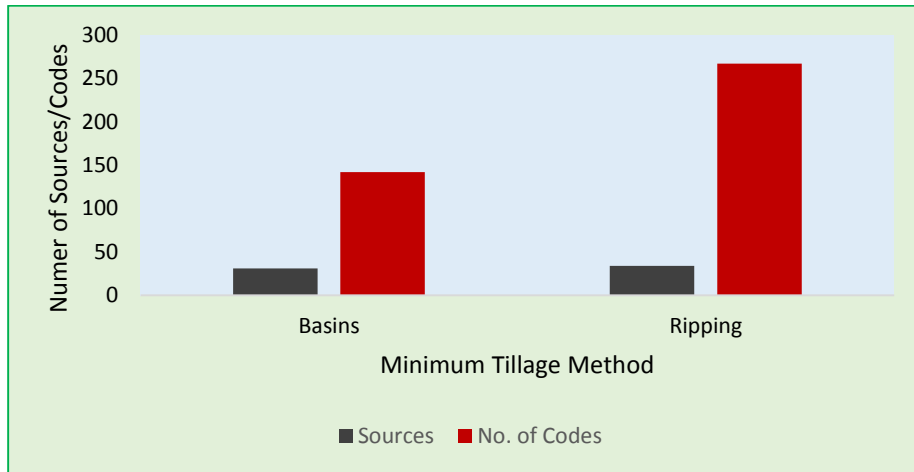
The number of farmers that have been using herbicide has increased by 78.9% from 2009 to 2012 (Figure 4-4). The increase is just 11.36% of the total SSFs that are actively practicing CA, both LFs and PFs. Herbicide use is vital for weeding, as it complements minimum tillage.

Figure 4-4: Time Evolution of the Number of Farmers who Use Herbicides under CA-Years 2009-2012 (MAL, 2012).



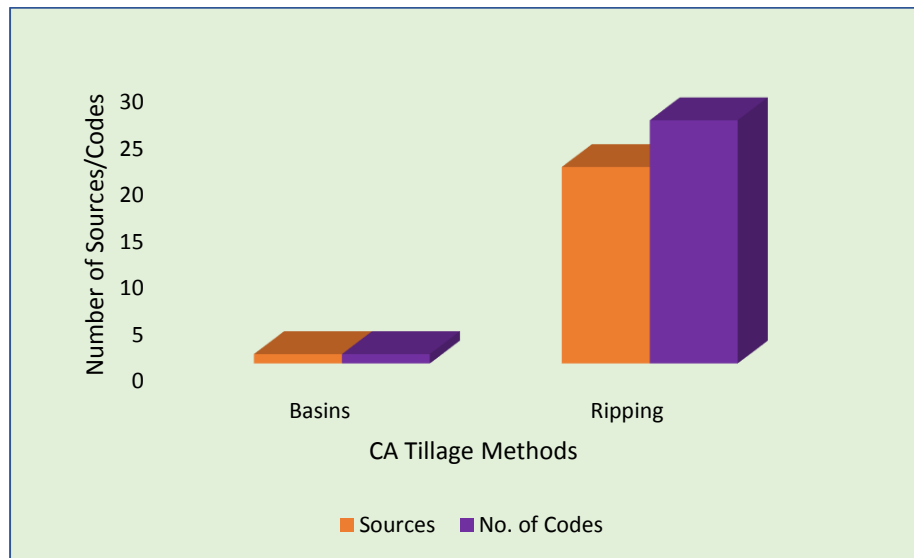
Further analysis of the sub-codes of minimum tillage for measures being promoted, show that ripping is higher compared to basins (Figure 4-5). Minimum tillage is the most practiced principle and makes it stand out for further analysis. The results suggest that ripping is promoted more than basins. Ripping includes both animal draft power and tractor tillage technologies.

Figure 4-5: Break-Down of Minimum Tillage According to Technologies Being Promoted



Similar to technologies promoted above, decomposition of minimum tillage being practiced, ripping is high compared to Basins (Figure 4-6). This suggests that most farmers practicing CA are using ripping technologies for minimum tillage.

Figure 4-6: Break-down of the Most Practiced Minimum Tillage Methods

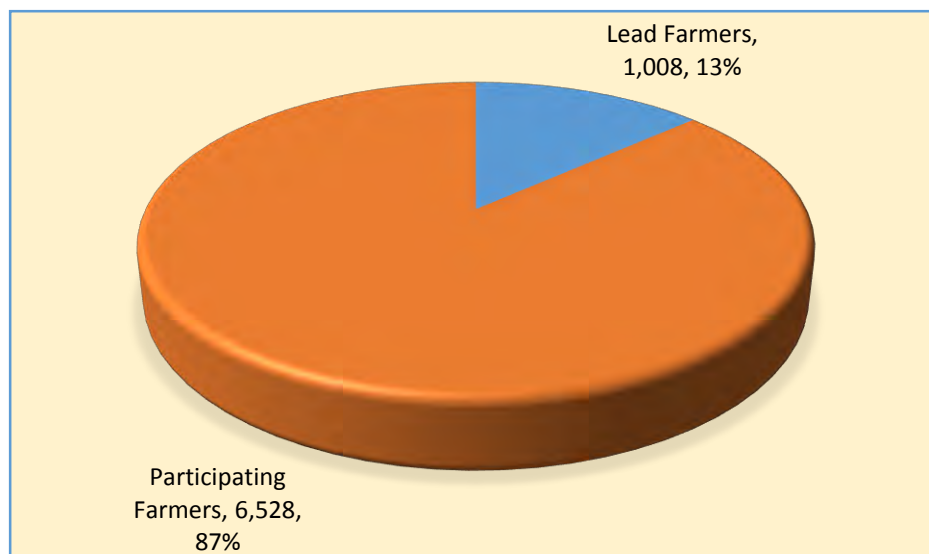


4.2.4. Farmers Practicing Conservation Agriculture

Kalomo District has 1,008 Lead Farmers (LF) at present compared to 672 in 2009, with 30% female representation currently and in 2009 respectively (MAL, 2012). LF leads more than 13,411 registered PFs. Only 6,528 PFs are practicing CA (Figure 4-7), representing less than 50% of the total PFs. The PFs have a 42% female representation (MAL, 2012). The ratio of LF to *PFs practicing CA* is 1:6.5 compared to 1:15 as per guiding principle for LF extension approach being implemented in the district.

Between 2009/2010 and 2010/2011 agricultural seasons the number of LFs who practiced CA using basins reduced from 316 to 232 representing a decrease of 26.6%. While that of PFs reduced by 38%, from 1,495 to 921, between 2010/2011 and 2011/2012 farming seasons respectively. For ripping, the numbers of LFs had increased by 44.3%, from 511 in 2009/2010 to 917 in 2011/2012 farming seasons (MAL, 2012). The total number of farmers practicing ripping is high compared to basins, confirming the findings from interviews that shows ripping to be more practiced among farmers than basins (Figure 4-6). Maize yields has increased for both LFs and PFs from 2.5 tons/ha under conventional farming to an average of 3.1 and 3.6 tons/ha under ripping and basin respectively (MAL, 2012).

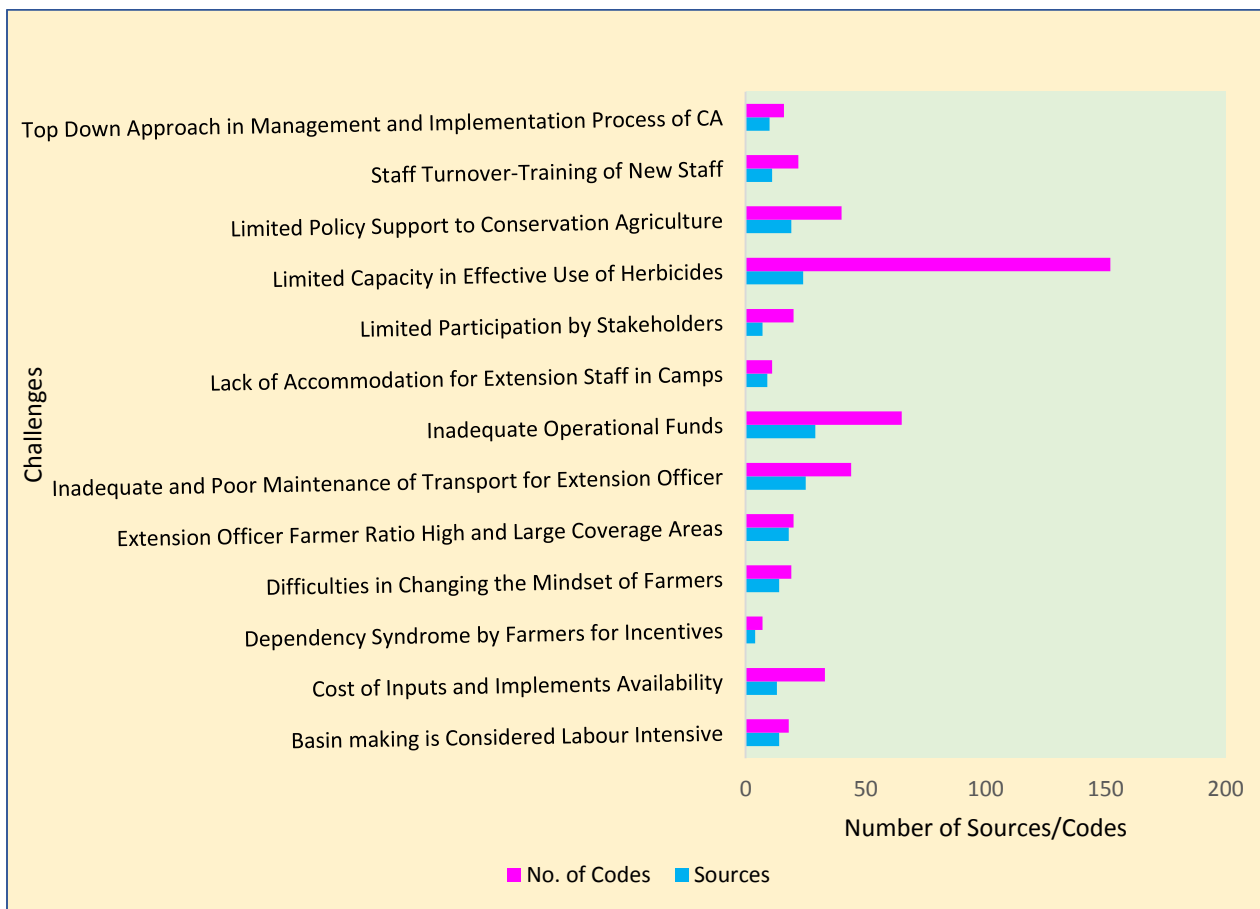
Figure 4-7: Pie Chart of % of Farmers Actively Practicing Conservation Agriculture (MAL, 2012).



4.3. Challenges in Management and Implementation of CA Practices

The major challenges that affect the management and implementation of CA within the district are; (1) limited capacity among extension officers and farmers in the effective use of herbicides, (2) inadequate operational funds for CA implementation, (3) limited policy support to CA and (4) inadequate and poor maintenance of transport for extension staff (Figure 4-8).

Figure 4-8: Challenges in Management and Implementation of CA Practices



The categories presented in Figure 4-8 can be summarized in some broad categories that are connected and interrelated. The major broad themes to summarise these challenges are; (1) *planning and human resource development constraints*, (2) *financial resource constraints*, (3) *policy constraints* and (4) *cultural barriers to adoption* (Table 4-1 and Figure 4-9 below). This also give a model picture to how these challenges have an impact on adaptation capacity of SSFS (Figure 4-10)

Table 4-1: Broad Summary of Challenges

Planning and Human Resource Development	Financial Resource Constraints	Policy Constraints	Cultural Barriers
Limited Capacity in Effective Use of Herbicides	Inadequate Operational Funds	Limited Policy Support to Conservation Agriculture	Difficulties in Changing the Mind-set of Farmers
Staff Turnover-Training of New Staff	Inadequate and Poor Maintenance of Transport for Extension Officer	Top Down Approach in Management and Implementation Process of CA	Basin making is Considered Labour Intensive
Extension Officer farmer Ratio High and large Coverage Areas	Lack of Accommodation for Extension Staff in agricultural Camps	Cost of Inputs and Implements Availability	Dependency Syndrome by Farmers for Incentives (Subsidised Inputs)
		Limited participation by Stakeholders	

Planning and human resource development constraints have more themes in the documents compared to rest of the broad themes presented in Figure 4-9 below. Cultural barriers are the least identified themes in the analysed interview note, MAL reports and MAL CA reports.

Figure 4-9: Summary of Challenges with Broad Themes

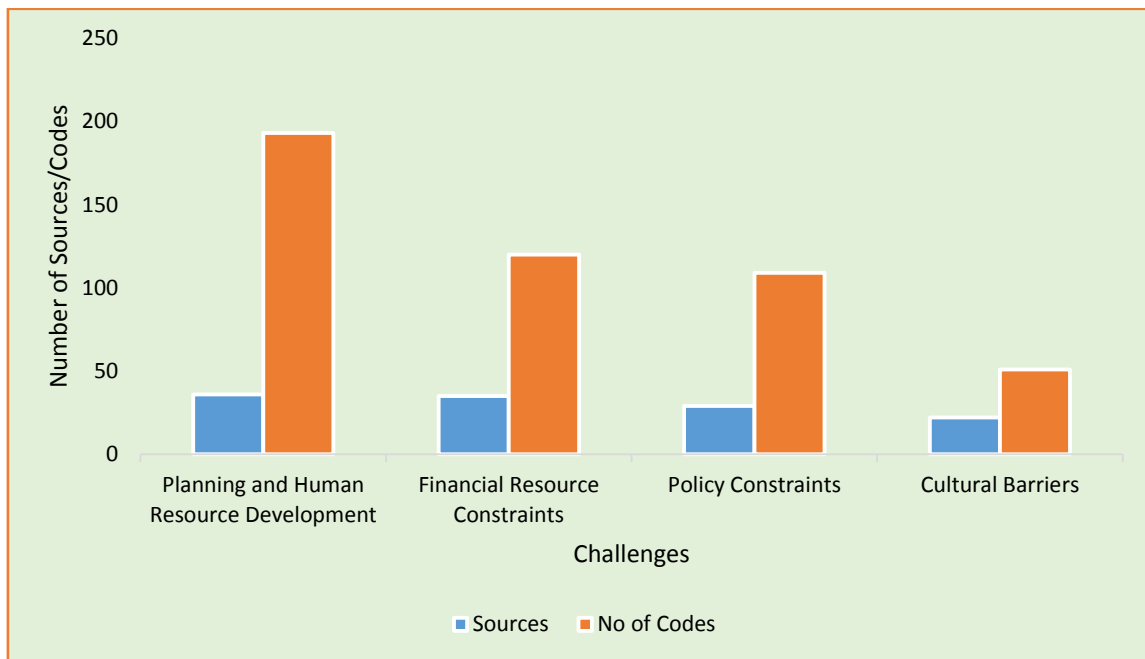
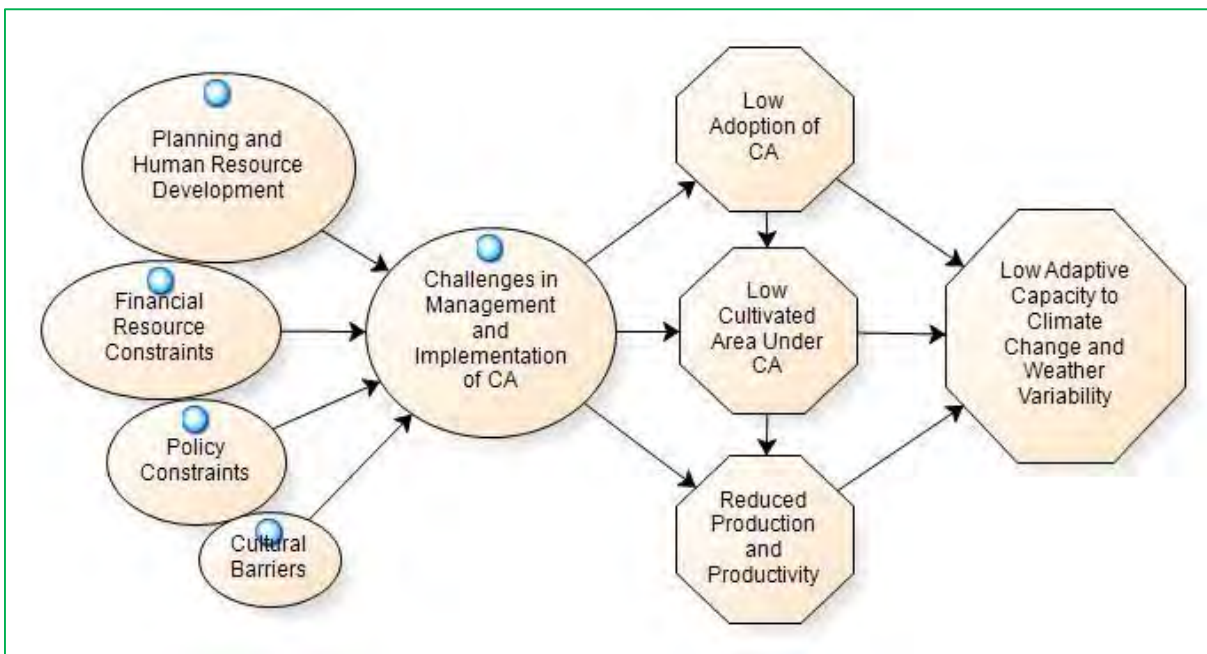


Figure 4-10: Model of Impact of Challenges on CA Management and Implementation on Adaptive Capacity to Climate Change and Weather Variability by Small-Scale Farmers.



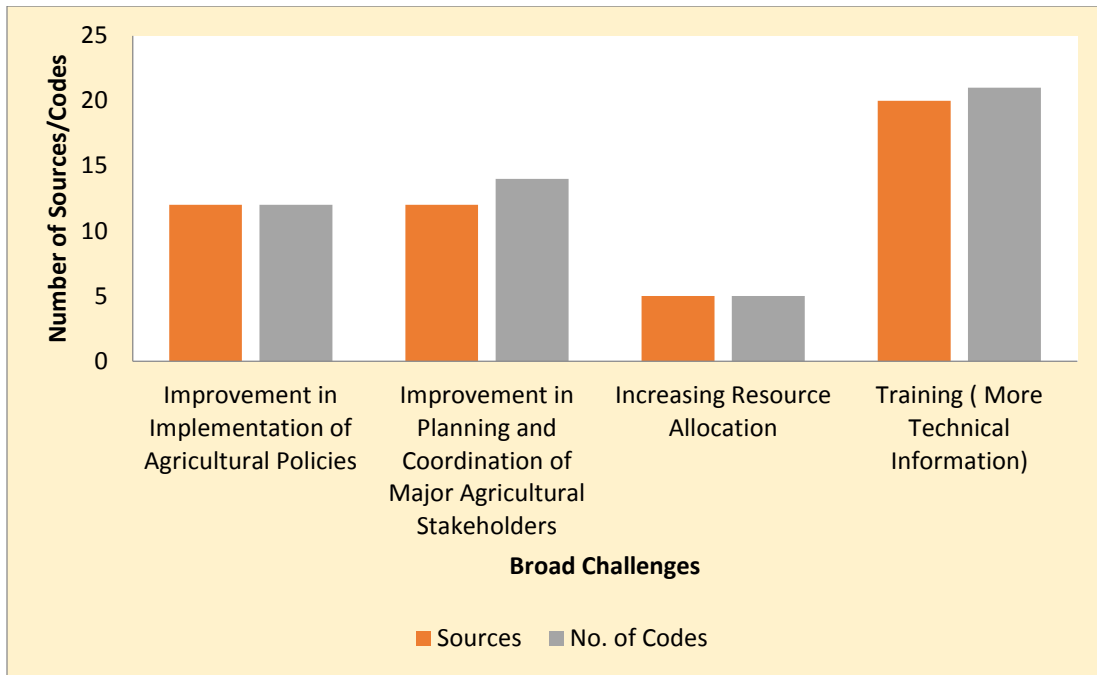
4.3.1. Remedial Action to the Challenges

When the respondents were asked what they thought are the options to solving the challenges being faced in CA promotion (Figure 4-8), four major themes were dominant. These are;

- I. *Training and technical capacity building.* Capacity building through recruitment and training of both extension officers and farmers
- II. *Improvement in management planning and coordination of major agricultural stakeholders.* Re-organising objectives and activities to achieve agricultural sector goals
- III. *Improvement in implementation of agricultural policies that support CA.* Full implementation as opposed to partial or non-implementation of policies that would enhance CA.
- IV. *Increasing financial resource allocation.* Especially budgetary allocation for agricultural extension provision, combined with effective and efficient use of these resources.

Training is considered to be the priority and scored high on both the number of sources of information and coded themes. The least in both document sources and themes is the increase in the allocation of resources (Figure 4-11).

Figure 4-11: Remedial Actions to the Challenges that are faced in the Implementation of Conservation Agriculture



4.4. Discussion

4.4.1. Conservation agricultural Practices

The results suggest that minimum tillage is more practiced compared to other CA principles (Figure 4-2), and it is considerably promoted (Figure 4-1). Promotion and practices of minimum tillage seem to be the focus because of the immediate benefits of moisture conservation during droughts.

Crop rotation is being practiced, but maize still has the largest area under cultivation (Figure 4-3). This may be attributed to the availability of agro-dealers and subsidized maize seeds and fertilizer. The available market for maize is the Food Reserve Agency (FRA), under the Ministry of Agriculture and Livestock, is an additional incentive. Concurrently, the market for legume crops is limited to the private sector and availability of seed is low. These limitations tend to limit cultivated area under legumes and other crops, hence affecting promotion of crop rotation.

Retention of crop residue is the least practiced principle. Most respondents attributed this to the fact that SSFs use the crop residue as feed for their livestock and in particular cattle. During the dry season communal livestock grazing is common. Even famers without cattle retain crop residue, but it is difficult to control cattle because of communal free range grazing practices. This situation seems to be common in a number of areas that practice crop-livestock integration within the district. This is also consistent with the literature on low levels of retention of crop residue by SSFs practicing CA in SSA (Giller *et al.* 2009; Twomlow *et al.*, 2008).

In between the two minimum tillage methods, ripping is more practiced than basins. In Kalomo district, farmers culturally use their cattle as a source of draft power to cultivate. Even families that don't own cattle hire or borrow after the owners have finished cultivating. Hence ripping using animal-drawn implements might be preferred to basins. In addition, the Ministry of Agriculture and Livestock has contributed to ripping preference, through distribution of subsidized implements under certain projects such as CASSP and FISRI for LFs. It is expected that this will continue under CASU project funded by the EU through FAO (FAO, 2014). Under FISRI, one tractor with full CA equipment and 26 ox-drawn zero till planters with sprayer for herbicide application were loaned out to farmers to provide services to participating farmers (MAL, 2011). Hiring of these CA services seems to have led to an increase in land under CA.

Because of easy access to Animal Draft Power (ADP) for cultivation, very few farmers practice CA using basins. Despite a lower number of farmers practicing CA in basins, yields performance is higher, consistent with some studies conducted in Zambia (Kaczan *et al.*, 2013; Umar and Nyanga, 2011; Haggblade and Tembo, 2003). High yields in basins are attributed to precise placement of inputs and high moisture retention compared to ripping. However, some farmers may disregard the increase in yield under basins as it is considered labour intensive. Apart from yields, CA has other advantages such as lower costs, or rebuilding of soils (Haggblade and Tembo, 2003).

Subsidised tractor herbicide sprayer and Knapsack sprayers that have been distributed to some Lead Farmers to provide weed control services (MAL, 2011), may have enhanced farmers access and use of used herbicides (Figure 4-4). The increase in the use of herbicides is 5% of the total number of farmers practicing CA, suggesting that most famers still have challenges in controlling

weeds. Weed pressure makes farmers go back to conventional weeding using a plough, and increase soil disturbance. This confirms literature finding by Arslan *et al.*, (2014), that the country has high levels of farmers who stopped practicing CA.

4.4.2. Challenges in Management and Implementation of CA Practices

1. *Planning and Human Resources Development Constraints*

The results suggest that there is a major negative impact on the implementation and management of CA because of poor planning and human resource development.

Lack of full technical capacity among extension officers and farmers on CA such as effective use of herbicides (Figure 4-8), affects the knowledge transfer to farmers on the ground. The MAL has no official CA training manuals for extension officers and farmers. CA training manuals are vital to support proper delivery of CA strategies from extension services to farmers. Reference guides are necessary for both new and old staff on the ground, for efficient promotion of CA.

Issues such as retirement; transfers, recruitment and proper orientation of recruited officers seem to have a great impact on the delivery of extension services. Maintenance of the human resource with similar CA capacities, despite changes, is lacking. For example, the information gathered during interviews indicates that a number of extension staff retired between 2012 and 2014. These were well trained in CA, but young officers who were recruited later, have limited CA capacity and awareness, and limited opportunity to build this capacity without interaction with their retired colleagues.

Agricultural extension officer to farmer ratio is higher, 1:1000-4000 than 1:500 the recommended for all extension services, and officers are further required to cover vast areas. This reduces the effectiveness and quality of agriculture service delivery to farmers, CA inclusive. Under CA, the LF approach is being implemented and does not comply with the recommended LF to PF ratio. In addition to the fact that LFs are not fully qualified as agricultural extension staff, even further exacerbate challenges of CA delivery to farmers.

2. Financial Resource Constraints

The Ministry of Agriculture and Livestock driven CA activity plans are facing financial challenges in their application at local levels.

Delivery of CA extension services requires financial resources because of the nature of field work involved; trainings, monitoring, and supervision. Inadequate financial resources are a challenge and results in inconsistent provision of extension service. Limited resources for transport, accommodation and other work related expenses negatively impact the condition of service. The timing of financial release is critical as well, as most respondents from the Ministry of Agriculture and Livestock stated recurrent disaccord with the farming calendar. Most SSFs depend on rain-fed agriculture, which affects training calendar, which flexibility cannot be accommodated by financial current challenges.

Most operational funds that are used in the promotion of CA are received from donor projects through the Ministry of Agriculture and Livestock. However, when a project ends, it is difficult to maintain the momentum of CA activities without the MAL taking up the responsibility to financially support the activities. Only selected areas of the district are covered by current and previous projects on CA due to limited financial resources. One of the respondent stressed the point that, *“Ministry of Agriculture and Livestock is not owning the whole CA as its own baby, but taking CA as projects...what I mean is we have seen a lot of projects on CA, donor supported but once funding or projects ends the Ministry of Agriculture and Livestock should fund the activities for continuity at the same purse to keep the momentum and the promotion process going. That’s what is lacking”* (Anonymous, 2014). Kuteya, (2012), provides further evidence that agricultural developmental programmes are less funded, much of the budget (50%) is allocated to Fertilizer Input Support Programme (FISP) and maize marketing through Food Reserve Agency (FRA). These are two heavily subsidized programmes that affect and distort the government budget for the agricultural sector (Kuteya, 2012).

3. Policy Constraints

A number of policy papers in place consider CA as a sustainable way for increased production and productivity. However, the implementation of these policies has not yet been effective to the point where CA promotion is taken as a priority. Zambia political environment shifted 4 times in the past decade, which has affected policy direction and lead to inconsistencies in policy implementation. As an illustration, this research emphasised that the government through FISP has been promoting mono-cropping through the perpetual subsidies on maize crop to SSFs, while crop rotation is one of the fundamental principles of CA, and stated as such in the national policies supporting crop diversification. As another example, since white maize is the only produce bought by the government through FRA in the district, it is difficult for CA adopters to practice crop rotation. FISP and FRA are additional challenges to extension services program and their role in promoting CA.

Stakeholders from the private sector are the major suppliers of agriculture inputs and implements. However there is limited policy support for these agro-dealers to stock more of inputs and implements tailored for CA. There are more conventional agriculture implements on the market compared to CA. This affects the prices of CA implements and inputs as well as their availability to SSF.

The Ministry of Agriculture and Livestock lacks holistic approach in implementation of policy strategies that would improve links among different departments in line with climate change adaptation. The coordination between research and extension is weak as well as agriculture production and agribusiness departments are not strong.

Despite Zambia decentralisation policy, decision making is limited at local level. Management and implementation of CA activities has been more of directives from national level than engagement of extension officers and farmers on the ground. This was also noted in a FAO evaluation report that there is disjointed monitoring, supervision and evaluation among stakeholder in the management and implementation of CA activities on the ground (FAO, 2012).

4. Cultural Barriers

Resistance to change is one of the challenges, one that has a lot to do with cultural behaviour, norms or values, in that context, change of mind-set of some farmers in their agricultural practices is a challenge that can contribute to low adoption levels of CA by SSFs. Sometimes even extension agents are not sure and not fully convinced of the suitability of CA compared to Conventional Farming. *“Among ourselves extension staff, some are not serious so to speak, they require change of mindset as well, not farmers alone. They need to be convinced that CA works first before they convince the farmers. Some extension officers have farms and fields but they are not practicing CA...how do they convince a farmer?”* (Anonymous, 2014).

The Participatory Extension Approach being used by the MAL, demands that it is up to the farmer to take up the technology or not. Farmers are encouraged to request for agriculture extension services, but if they are not willing to do so, it becomes difficult for extension service providers to do their work effectively. The willingness of the farmers to learn and change is vital, as agricultural extension services can't be forced on them. However, the promotion of CA is done with willing farmers through field days demonstrations. Changing mind-set requires more time, understanding local conditions and continuous promotion of CA. A good example is the low adoption of basins as opposed to ripping. Basin tillage is regarded by most farmers as being labour intensive. The elderly and ill ones would prefer hiring or borrowing oxen and practice conventional farming to CA, especially at the time of weeding. Feeding of cattle with crop residue is a culture that cannot be easily changed, but rather can be promoted through crop livestock integrated farming.

Incentives prove to be another barrier to early adopters of CA. A number of CA projects and programmes had a component of incentivising, LFs inclusive, through subsidised inputs and implements. Some farmers tend to implement CA principles only when inputs are given to them and producing a “dependency Syndrome”. Later, without the subsidies, they practice conventional agriculture, this practice tend to distort the adoption rates and cultivated areas under CA. Incentives as a support for adoption has value, yet selection of LFs or beneficiaries should be done with caution. Also, it tends to affect the sustainability of CA promotion as during

implementation adoption rate increases and when projects ends dis-adoption becomes the norm. The findings about public agricultural extension service systems concur with very poor results and challenges observed in SSA (Belay & Abebaw, 2004; Haug, 1999).

5. Remedial Actions to the Challenges

Remedial measures provided by the respondents (Figure 4-11), capacity building for both extension officers and farmers is given the priority, if CA promotion is to be improved (Figure 4-1).

Besides inadequacy of resources being a second ranked issue among the challenges (Figure 4-9), it is the least in terms of recommendations for improvement (Figure 4-11). This suggests that resource availability is also highly dependent on improving management capacity to efficiently and effectively utilise the available resources. Policy Monitoring Research Centre provides further evidence to this, an analysis of Auditor General Report indicate that the MAL had 20.6% of the total abused funds across all ministries in 2012. The percentage of funds that were not properly utilised by the MAL increased from 3.7% in 2010 to 58% in 2012. The report further indicates that, this trend has been increasing since 2010 (PMRC, 2014). Such inefficiencies in planning and resource management might significantly contribute to lack of resources within the MAL to properly manage programmes such as CA.

4.5. Conclusion

Among the three principles of Conservation Agriculture, minimum tillage is best-practiced compared to crop rotation and retention of crop residue in Kalomo district. Ripping is practiced more compared to basins among minimum tillage methods.

Lack of CA capacity from both extension services and farmers, especially in the practical use of herbicides for weed control, is the top challenge.

The current status of CA in Kalomo and identified challenges answers some of the gaps and questions raised in the literature, such as low cultivated area under CA, low adoption rates of CA and low adaptation capacity among SSF to climate change.

5. CONCLUSION AND RECOMMENDATION

5.1. Introduction

Chapter five (5) covers the conclusion from the research findings, with a reflection on the objectives of the study. Furthermore, it highlights the issues that may require further research, as they were not part of this particular study. In addition to the improvement options for the challenges for management and implementation of CA that were identified in the results of this study, further options are recommended.

5.2. Conclusion

This research has shown that there are some CA measures being implemented as adaptive measures to climate change and weather variability within Kalomo district of Zambia. Not all measures and principles of CA are being implemented fully. However, adaptation is a process, and is location specific. It is suffice to note that progress is being made to ensure promotion of sustainable agricultural production and food security in the face of climate change and weather variability. Minimum tillage is the most practiced CA principle, while retention of crop residue is least practiced within Kalomo district. The district has more than 50% of participating farmers who have stopped practicing CA from 2009-2012. Progress has been made so far, but not at the desired rate, as less than 50% of participating farmers are practicing CA.

From the findings, it can be documented here that there are a number of challenges in management and implementation of Conservation Agriculture in Kalomo District as a measure to adaptation to climate change. *Constraints in planning and human resource development are the most pressing challenges. Although, collectively the impact of these challenges (planning and human resource development constraints, financial resource constraints, policy constraints and cultural barriers to adoption) significantly affect the promotion of CA (Figure 4-10).* Furthermore, these challenges identified can reduce the adaptation capacity of SSFs to climate change and weather variability. Food security for SSFs might be further impacted, as production and productivity are negatively affected.

Addressing these challenges is critical to improving the management and implementation of CA and adaptive capacity of SSFs to climate change. However, not all the challenges can be addressed at once, but prioritising is critical as most of the challenges border on full implementation of agricultural policies, effectiveness in planning, management and availability of financial resources. The most critical being *planning and human resource development constraints* and the least significant are *cultural barriers to adoption*.

5.2.1. Further Research

There is need for further research to understand the difficulties being faced in the use of herbicides. Lack of capacity may just be one of the many factors. Do SSFs have access to enough clean water which is critical for herbicides use? Is this clean water available to all the SSFs that CA is being promoted to? Availability means also the proximity of water sources to their fields, given the different sizes of the fields.

Is the current extension methodology effective for CA promotion? Evaluation of the effectiveness of extension methodology for CA is required. These are some of questions that this study was not able to answer in this research due to limited time and financial resources.

5.3. Recommendations

Based on the findings in this study, the following recommendations are made;

5.3.1. District

- The district should focus on building technical and practical capacity in weed control using herbicides. Capacity building for both extension staff and farmers to improve Conservation Agricultural practices.
- Conservation Farming Unit CA training materials should be effectively utilized, for updated information on CA in the absence of official CA training manual from the Ministry of Agriculture and Livestock.
- There is need to select farmers that are willing to adopt CA and not rely on CA programmes for inputs and implements to reduce the levels of dis-adoption and improve sustainability of CA promotion.

- Involving the private sector, especially in agricultural inputs/implement and service delivery that promote CA in a well-coordinated manner at district level should be encouraged. This will improve availability and affordable access to CA inputs and implements.
- Engaging the department of Marketing and Agribusiness in the promotion of CA should be enhanced as this will help to facilitate any business components involved. Involving relevant departments within the Ministry of Agriculture and Livestock is cardinal in order to reduce departments working in isolation and further maximize the use of available meagre resources.
- Extension staff and farmers need to utilize e-extension service, provided by the Zambia National Farmer Union, for accessing marketing information and agronomic services.
- There is need to Focus on promoting cattle manure use where retention of crop residue is hardly practiced as this could be a better integrated approach and more beneficial where cattle manure is very much available.
- Culturally most farmers use animal draft power for cultivation, hence promotion of ripping for minimum tillage should be encouraged. It is more promising as an adaptive measure than basin making. However, where necessary basin making may continue to be promoted, for those ready to practice the technology.

5.3.2. National

- There is need to integrate Conservation Agriculture within the University and College curriculum. Proper training in CA should be done at college level, to reduce cost of retraining officers once they are employed, as is the case currently.
- Developing a comprehensive and updated CA training manual for extension officer and improving the interaction of the extension department and the research department. To improve CA knowledge transfer.
- Engaging and harmonising the different departmental programmes when dealing with climate change adaptation within the Ministry of Agriculture and Livestock to reduce duplication of work and enhance efficient use of resources.

- Strengthening policy support especially inputs and crop marketing, to improve CA principle of crop rotation and stimulate crop diversification.
- Strengthening core-decision making with lower and local structures to ensure smooth delivery of CA services.
- Improving agricultural activity planning and resource management (financial and human). Furthermore, providing of adequate budgetary allocation to agriculture extension services, with timely release of resources for effective service provision.
- Engaging and incentivising the private sector to provide implements/inputs to SSFs at affordable prices, as availability and affordability is vital for CA promotion.

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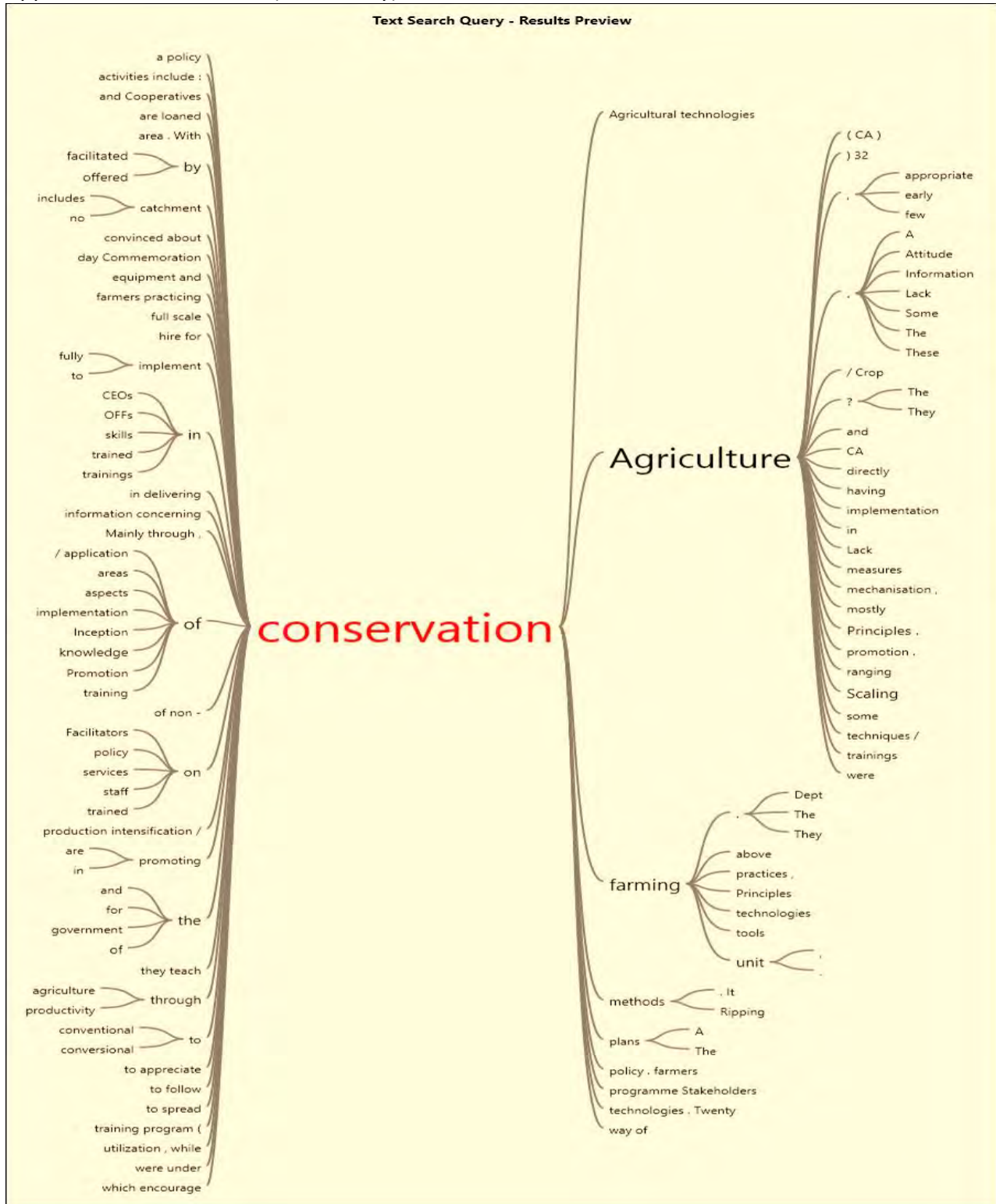
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APPENDICES

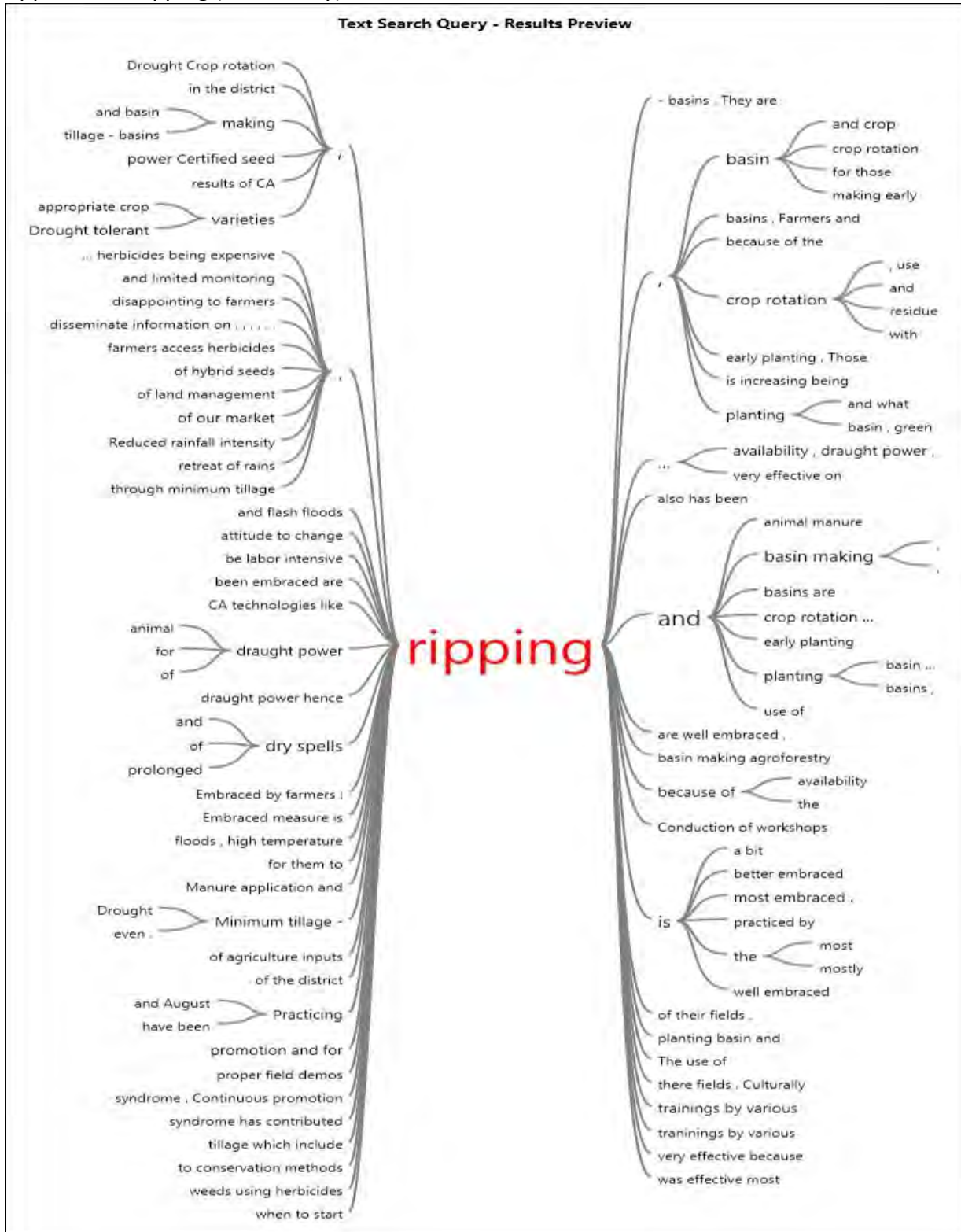
Appendix 1: Coded Themes in Nvivo 10

	Sources	No. of Codes
Challenges in Implementation of Conservation Agriculture (Parent Code)		
Cultural Barriers		
Basin making is Considered Labour Intensive	14	18
Dependency Syndrome by Farmers	4	7
Difficulties in Changing the Mind-set of Farmers	14	19
Crop Residues Used as Animal Feed	6	7
Financial Resource Constraints		
Inadequate and Poor Maintenance of Transport for Extension Officer	25	44
Inadequate Operational Funds	29	65
Lack of Accommodation for Extension Staff in Camps	9	11
Planning and Human Resource Development		
Limited Capacity in Effective Use of Herbicides	24	152
Staff Turnover-Training of New Staff	11	22
Extension Officer Farmer Ratio High and Large Coverage Areas	18	20
Limited Participation by Stakeholders	7	20
Policy Constraints		
Poor Policy Support to Conservation Agriculture	19	40
Top Down Approach in Management and Implementation Process of CA	10	16
Cost of Inputs and Implements Availability	13	33
Conservation Agriculture Practices Being Promoted (Parent Code)		
Minimum Tillage	35	409
Basin Making	31	142
Ripping	34	267
Retention of Crop Residues	10	11
Use of Herbicides for Weed Control	6	6
Use of Manure	7	7
Crop Rotation	20	67
Well Embraced CA Measure by Farmers (Parent Code)		
Crop Rotation	8	8
Minimum Tillage	21	26
Basin Making	1	1
Ripping	21	26
Retention of Crop Residues	1	1
Use of Herbicides for Weed Control	3	3
Use of Manure	2	2
Recommendations (Parent Code)		
Improvement in Implementation of Agricultural Policies	12	12
Improvement in Planning and Coordination of Major Agricultural Stakeholders	12	14
Increasing Resource Allocation	5	5
Training (More Technical Information)	20	21

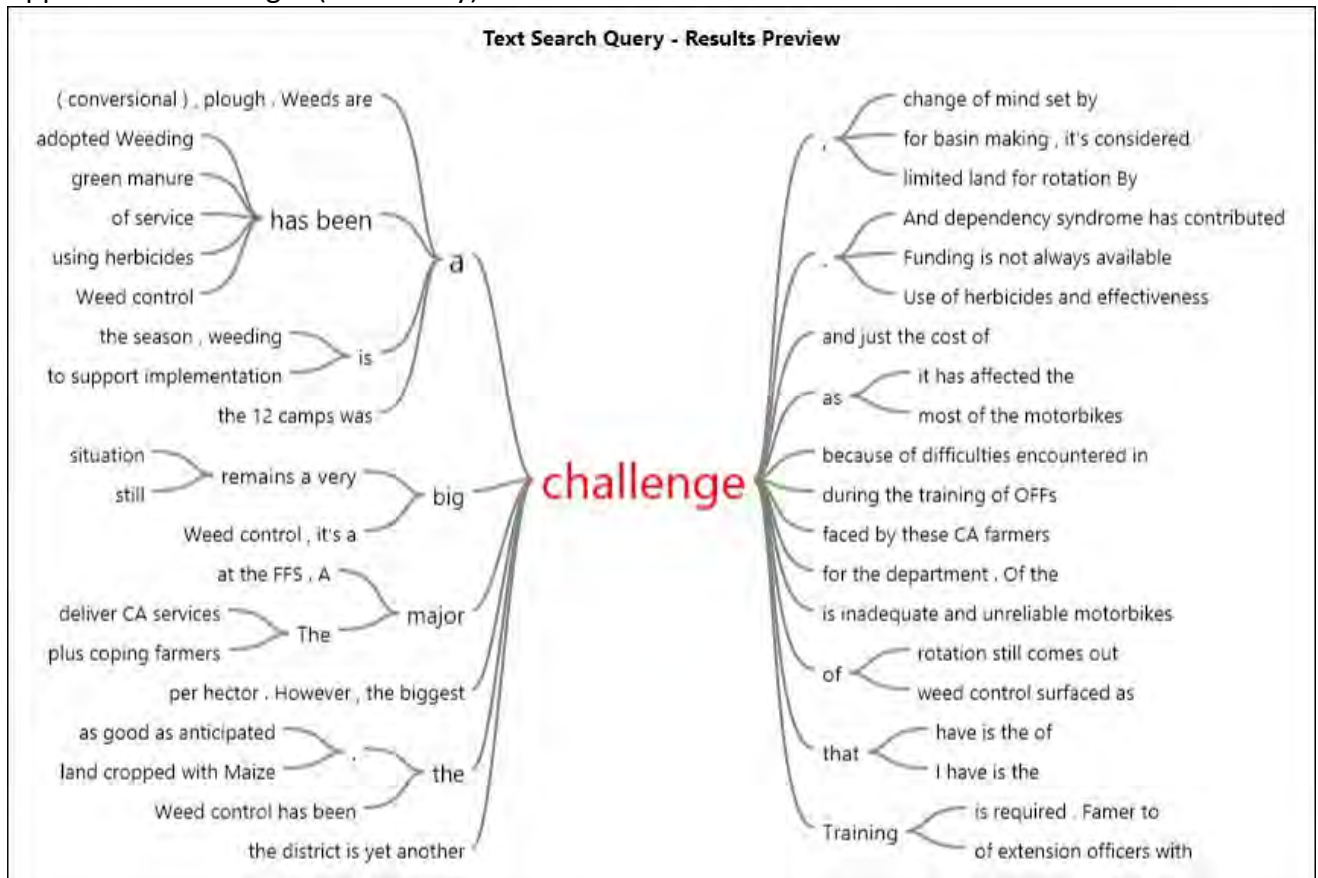
Appendix 2: Conservation (Text Query)



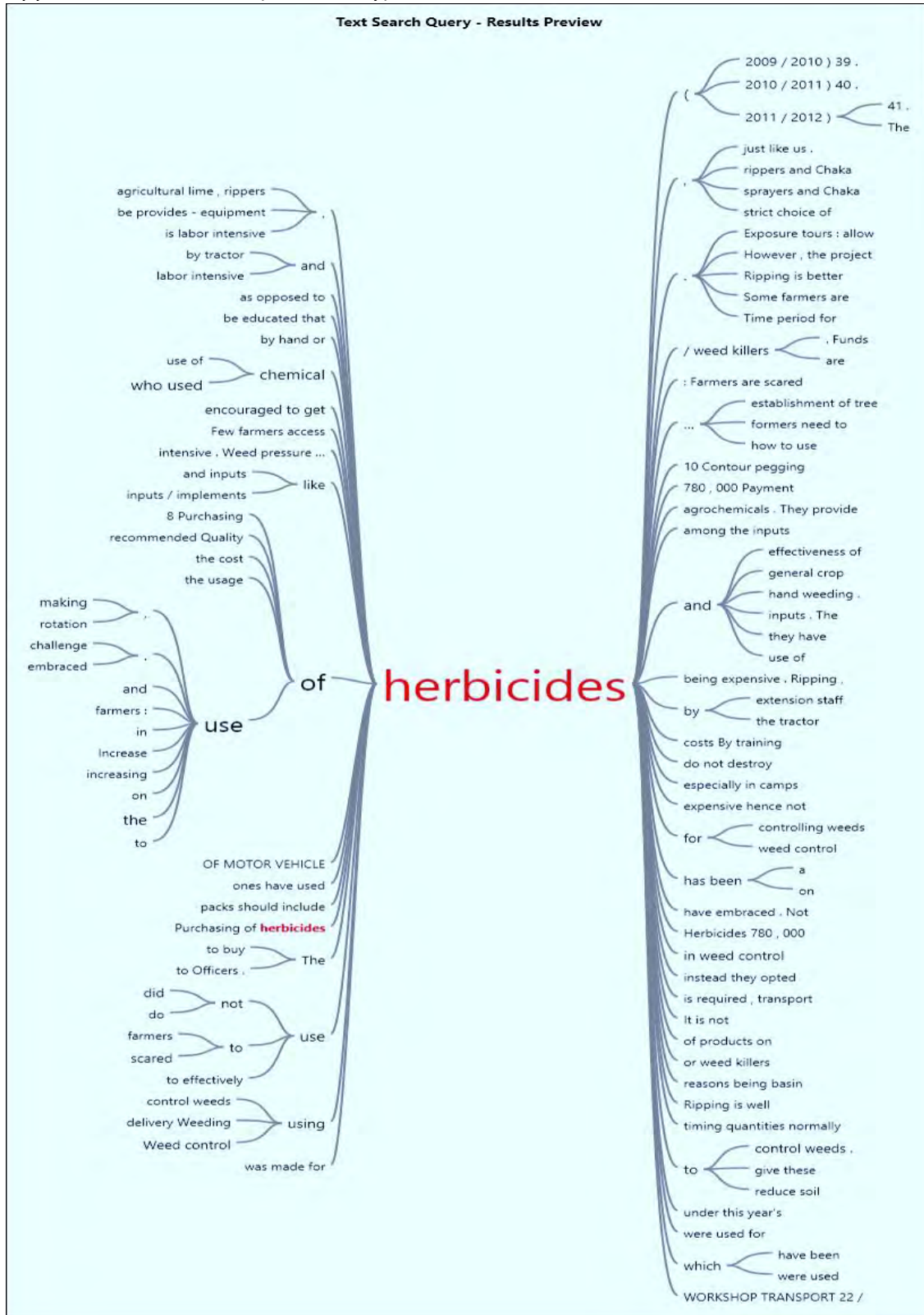
Appendix 3: Ripping (Text Query)



Appendix 4: Challenges (Text Query)



Appendix 5: Herbicides (Text Query)



Appendix 6: CA Measures Promoted

CA Measures Promoted	Codes	Coverage of Source Notes
01-07-2014 Agricultural Extension Officer 1	20	3.04%
01-07-2014 Agricultural Extension Officer 2	12	0.92%
01-08-2014 Agricultural Extension Officer 18	21	1.93%
02-07-2014 Agricultural Extension Officer 3	26	2.99%
02-07-2014 Agriculture Extension Officer 4	10	6.61%
10-07-2014 Agricultural Extension Officer 5	11	2.27%
10-07-2014 Agricultural Extension Officer 6	20	8.54%
14-08-2014 Agriculture Extension Officer 19	18	5.12%
16-07-2014 Agricultural Extension Officer 7	15	4.88%
17-07-2014 Agricultural Extension Officer 8	16	3.98%
19-07-2014 Agricultural Extension Officer 9	28	13.51%
19-07-2014 Stakeholder Respondent 1	17	6.52%
19-07-2014 Stakeholder Respondent 2	6	2.62%
19-07-2014 Stakeholder Respondent 3	28	4.85%
19-07-2014 Stakeholder Respondent 4	13	1.27%
19-07-2014 Stakeholder Respondent 5	24	3.04%
20-07-2014 Agricultural Extension Officer 10	15	4.60%
20-07-2014 Agricultural Extension Officer 11	10	4.72%
2011 Annual Report, Department of Agriculture Kalomo District	2	0.53%
2011 First Quarter Report, Department of Agriculture Kalomo District	2	1.26%
2012 Department of Agriculture Annual Report Kalomo District	17	0.21%
2013 Fourth Quarter Report (Dept. of Agric. Kalomo)	11	0.35%
23-07-2014 Agricultural Extension Officer 12	7	1.50%
23-07-2014 Agricultural Extension Officer 13	11	8.39%
25-07-2014 Agricultural Extension Officer 15	12	7.01%
26-07-2014 Agricultural Extension Officer 16	13	2.15%
28-07-2014 Stakeholder Respondent 6	15	2.48%
29-07-2014 Agricultural Extension Officer 17	10	0.79%
30-06-2014 Agricultural Extension Officer 20	13	2.03%
31-07-2014 Stakeholder Respondent 7	11	2.58%
CASPP Annual Report 2009, Kalomo District	16	1.25%
FISRI First Report 2010, Kalomo District	4	0.19%
FISRI Progress Report January 2012 Kalomo District	23	1.82%
FISRI Second Progress Report 2011, Kalomo District	6	0.85%
Kalomo District FISRI Annual Report 2009, Kalomo District	15	0.62%
Kalomo District FISRI Progress Report May-July 2012, Kalomo District	16	2.03%

Appendix 7: Most Practiced CA Principles

Sources	Codes	Coverage of Source Notes
01-07-2014 Agricultural Extension Officer 1	4	4.28%
01-07-2014 Agricultural Extension Officer 2	1	2.71%
01-08-2014 Agricultural Extension Officer 18	2	1.73%
02-07-2014 Agriculture Extension Officer 4	1	9.57%
10-07-2014 Agricultural Extension Officer 5	2	4.35%
14-08-2014 Agriculture Extension Officer 19	1	1.77%
16-07-2014 Agricultural Extension Officer 7	2	1.48%
19-07-2014 Agricultural Extension Officer 9	1	3.17%
19-07-2014 Stakeholder Respondent 1	1	1.78%
19-07-2014 Stakeholder Respondent 2	1	3.98%
19-07-2014 Stakeholder Respondent 3	1	1.45%
19-07-2014 Stakeholder Respondent 4	2	4.61%
19-07-2014 Stakeholder Respondent 5	2	4.68%
20-07-2014 Agricultural Extension Officer 10	2	4.95%
20-07-2014 Agricultural Extension Officer 11	2	5.79%
23-07-2014 Agricultural Extension Officer 13	3	6.60%
25-07-2014 Agricultural Extension Officer 14	3	7.00%
25-07-2014 Agricultural Extension Officer 15	2	3.85%
26-07-2014 Agricultural Extension Officer 16	1	1.70%
28-07-2014 Stakeholder Respondent 6	1	0.48%
29-07-2014 Agricultural Extension Officer 17	1	4.36%
30-06-2014 Agricultural Extension Officer 20	2	0.94%
31-07-2014 Stakeholder Respondent 7	1	3.12%

Appendix 8: Challenges in Management and Implementation of CA

Sources	Codes	Coverage of Source Notes
01-07-2014 Agricultural Extension Officer 1	18	29.58%
01-07-2014 Agricultural Extension Officer 2	18	40.89%
01-08-2014 Agricultural Extension Officer 18	18	27.88%
02-07-2014 Agricultural Extension Officer 3	8	10.94%
02-07-2014 Agriculture Extension Officer 4	21	25.62%
10-07-2014 Agricultural Extension Officer 5	14	22.19%
10-07-2014 Agricultural Extension Officer 6	26	33.11%
14-08-2014 Agriculture Extension Officer 19	17	26.21%
16-07-2014 Agricultural Extension Officer 7	20	43.88%
17-07-2014 Agricultural Extension Officer 8	18	38.24%
19-07-2014 Agricultural Extension Officer 9	17	34.50%
19-07-2014 Stakeholder Respondent 1	24	32.49%
19-07-2014 Stakeholder Respondent 2	23	39.05%
19-07-2014 Stakeholder Respondent 3	5	12.94%
19-07-2014 Stakeholder Respondent 4	9	21.49%
19-07-2014 Stakeholder Respondent 5	8	24.42%
20-07-2014 Agricultural Extension Officer 10	16	32.58%
20-07-2014 Agricultural Extension Officer 11	23	31.63%
2011 Annual Report, Department of Agriculture Kalomo District	1	0.16%
2011 First Quarter Report, Department of Agriculture Kalomo District	3	1.33%
2012 Department of Agriculture Annual Report Kalomo District	4	1.34%
2012 Third Quarter Report, Department of Agriculture	2	0.60%
2013 Fourth Quarter Report (Dept. of Agric. Kalomo)	6	2.98%
2013 Third Quarter Report, Department of Agriculture Kalomo District	2	3.37%
23-07-2014 Agricultural Extension Officer 12	16	43.19%
23-07-2014 Agricultural Extension Officer 13	13	36.28%
25-07-2014 Agricultural Extension Officer 14	21	45.50%
25-07-2014 Agricultural Extension Officer 15	17	39.59%
26-07-2014 Agricultural Extension Officer 16	14	36.03%
28-07-2014 Stakeholder Respondent 6	7	19.23%
29-07-2014 Agricultural Extension Officer 17	17	35.46%
30-06-2014 Agricultural Extension Officer 0	10	34.49%
31-07-2014 Stakeholder Respondent 7	13	27.35%
CASPP Annual Report 2009, Kalomo District	6	3.70%
First FISRI Progress Report March-April 2012, Kalomo District	3	1.55%
FISRI First Report 2010, Kalomo District	3	3.66%
FISRI Progress Report January 2012 Kalomo District	1	0.92%
FISRI Second Progress Report 2011, Kalomo District	1	0.83%
Kalomo District Annual Report 2013, Kalomo District	1	0.11%
Kalomo District FISRI Annual Report 2009, Kalomo District	8	3.08%
Kalomo District FISRI Progress Report May-July 2012, Kalomo District	1	0.31%

Appendix 9: Recommendations

Sources	Codes	Coverage of Source Notes
01-07-2014 Agricultural Extension Officer 1	4	17.98%
01-07-2014 Agricultural Extension Officer 2	1	7.32%
01-08-2014 Agricultural Extension Officer 18	2	5.43%
02-07-2014 Agricultural Extension Officer 3	1	2.99%
02-07-2014 Agriculture Extension Officer 4	1	5.37%
10-07-2014 Agricultural Extension Officer 5	2	10.86%
10-07-2014 Agricultural Extension Officer 6	3	9.34%
14-08-2014 Agriculture Extension Officer 19	1	2.04%
16-07-2014 Agricultural Extension Officer 7	1	4.07%
17-07-2014 Agricultural Extension Officer 8	1	5.45%
19-07-2014 Agricultural Extension Officer 9	2	13.76%
19-07-2014 Stakeholder Respondent 1	2	17.22%
19-07-2014 Stakeholder Respondent 2	2	15.54%
19-07-2014 Stakeholder Respondent 3	2	6.02%
19-07-2014 Stakeholder Respondent 4	2	6.07%
19-07-2014 Stakeholder Respondent 5	2	5.13%
20-07-2014 Agricultural Extension Officer 10	4	11.07%
20-07-2014 Agricultural Extension Officer 11	2	4.24%
23-07-2014 Agricultural Extension Officer 12	2	2.63%
23-07-2014 Agricultural Extension Officer 13	2	13.08%
25-07-2014 Agricultural Extension Officer 14	1	3.31%
25-07-2014 Agricultural Extension Officer 15	2	3.26%
26-07-2014 Agricultural Extension Officer 16	2	10.37%
28-07-2014 Stakeholder Respondent 6	2	8.40%
29-07-2014 Agricultural Extension Officer 17	2	2.21%
30-06-2014 Agricultural Extension Officer 0	2	16.90%
31-07-2014 Stakeholder Respondent 7	2	5.82%

Appendix 10: Interview Guide

Climate Change Adaptation Measures in Agriculture: A Case of Small-Scale Farmers in Kalomo District-Zambia

STUDY INTRODUCTION AND INFORMED CONSENT

Hello. My name is Albert Novas Somanje. I am a post graduate student at the University of Cape Town. I am conducting a research on Climate Change Adaptation Measures in Agriculture (conservation agriculture), specifically for Small-Scale Farmers in this District. You have been kindly purposively selected to be one of the respondents. Your contribution to this research is highly appreciated. I would like to now ask you vital questions on Conservation Agriculture as an adaption measure of climate change and weather variability. Please be assured that all the information that you'll share will be used for academic purposes and it is confidential. Are you volunteering to be interviewed now?

Informed consent granted: Yes = 1 No = 2

What is your job title?.....

Date.....

Interview Guide Questions for Interviews

1. Please state the major climatic and weather variability factors that currently affect agricultural production in Kalomo District? E.g droughts, floods, precipitation?
2. What conservation agriculture adaptation measures/principles are being promoted in the District and how effective are they?
3. How is weather information integrated in service delivery of conservation agriculture?
4. For how long has these measured under conservation agriculture been implemented?
5. How has been the uptake by Small-Scale Farmers of these measures?
6. What factors do you think are responsible for the current level of uptake in CA?
7. Which CA measures/principles are well practiced by farmers and which ones are not and why?
8. How are conservation agriculture extension services being sustained in the district?
9. How is management and implementation process of conservation agriculture like (MAL)?
10. How well is the district covered in agriculture extension services on conservation agriculture?
11. What are the major challenges for you as an extension officer in implementation of conservation farming measures effectively?
12. Are they being addressed?
13. If not, why do you think they have not been addressed?
14. How effective are the roles that other departments/stakeholders play in the implementation of conservation agriculture?
15. How is the coordination between the district, province and national offices in the implementation of conservation agriculture (MAL)?
16. Has the district got capacity to fully implement conservation agriculture measures in the district?
17. Which areas of conservation agriculture implementation process do you think requires improvement for effective implementation and adoption by Small-Scale Farmers?
18. Is there anything else that you think is of importance to improve adaptation of SSFs in Kalomo through CA, that you feel has not been covered in our discussion?

Appendix 11: Data Sources

Interviews

Officers, Ministry of Agriculture and Livestock, Kalomo District

Officer, Care International, Kalomo, District Office

Officer, World Vision Zambia Kalomo, District office

Officers, Zambia National Farmers Union (ZNFU) and Conservation Farming Unit (CFU), Kalomo Office

Officers, Seed Companies (Pannar, Pioneer, Zamseed and Monsato)

Secondary Data

Ministry of Agriculture and Livestock (MAL), Kalomo District

- 2013, District Annual Report
- 2013, Fourth Quarter Report, Department of Agriculture
- 2013, Third Quarter Report, Department of Agriculture
- 2012, Annual Report, Department of Agriculture
- 2012, Third Quarter Report, Department of Agriculture
- 2011, Annual Report, Department of Agriculture
- 2011, First Quarter Report, Department of Agriculture
- 2012, FISRI Progress Report March - April (CA Project)
- 2012, FISRI Progress Report May-July (CA Project)
- 2012, FISRI Progress Report January (CA Project)
- 2011, FISRI Second Progress Report (CA Project)
- 2010, FISRI First Progress Report (CA Project)
- 2009, FISRI Annual Report (CA Project)
- 2009, CASPP Annual Report (CA Project)