IMPLICATIONS OF CONSERVATION AGRICULTURE NARRATIVES ON ENVIRONMENTAL CONSERVATION IN CHIBOMBO, ZAMBIA

By

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A thesis submitted to the University of Zambia in fulfillment of the requirements for the degree of Master of Science in Environmental and Natural Resources Management.

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DECLARATION

I, **Betty Phiri**, do hereby declare that this thesis represents my own work and has not been previously submitted for an award of degree, diploma or any other qualification at this or any other University.

Signature: ..... Date: .....

DEDICATION

This thesis is dedicated to my lovely children Gerald Chabota Mwiilu and Hildah Milimo Mwiilu.

CERTIFICATE OF APPROVAL

This thesis of **Betty Phiri** has been approved as partial fulfillment of the requirements for the award of the Degree of **Master of Science in Environmental and Natural Resources Managemen**t by the University of Zambia.

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ABSTRACT

The focus of agricultural development in Africa and Zambia in particular is on transforming the agricultural system from conventional to conservation agriculture (CA). This study examined the linkages between conservation agriculture narratives and environmental conservation in terms of forest conservation; soil moisture; weeds and agro-biodiversity in Chibombo by using smallholder farmers' experiences. Data was obtained from three focus group discussions with farmers, eight in-depth interviews (five with farmers and three with key informants from the Conservation Farming Unit (CFU) and Forestry department) and direct observations on land use practices. Data was analysed by content and narrative analysis. Results show that CA is donor driven and supported by several actors. Further, the study shows that the overarching CA narrative claims that CA can address both livelihood and environmental needs better than conventional agriculture. The study also shows that CA and forestry conservation are linked by narratives of agro-forestry and sustainable agricultural intensification which focus on use of selected trees for soil fertility and others for food and on minimizing expansion of agricultural land respectively. Soil fertility improvement messages dominated those of forestry conservation in CA promotion. However, results suggest that the contribution of these narratives to environmental sustainability is limited partly because of farmers' negative attitudes towards agro-forestry mainly attributed to land tenure insecurity and length of time required to realise benefits and also because farmers have continued to expand agricultural land. The climate change and adaptation narrative linked CA to environmental conservation through better soil moisture management. While this narrative posits that CA is more resilient to extreme weather conditions than conventional agriculture, farmers only reported this for drought conditions. The CA narrative of labour saving related to weeding was dominant. It claims that herbicide use and crop residues lower weed pressure in CA. Famers supported this narrative but argued that some weeds were becoming resistant to herbicides. Furthermore, farmers reported herbicides as being expensive. Hence, they reverted to conventional weeding methods. The agro-biodiversity narrative of CA claims increased agro-biodiversity through annual crop rotation involving a cereal, cash crop and legume for increased food security, income and soil fertility. Results show that farmers practiced crop rotation though not annually and not on equally proportioned areas because of interruption by negative effects of herbicides and dominance of some crops such as maize and cotton. In conclusion, the link between CA and environmental conservation is mainly through the narratives of agro-forestry, agricultural intensification, climate change and adaptation, labour saving on weeding and agro-biodiversity. However, the variances between CA narratives and farmers' experiences suggest that CA's contribution towards environmental conservation will be limited. Therefore, instead of implementing CA on the basis of narratives, most of which are derived from experiences outside Zambia, there is need to align CA to local contexts rather than apply it universally at all times to all farmers in order to improve its performance.

Keywords: Conservation agriculture, narratives, forest conservation, livelihood.

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ABBREVIATIONS AND ACRONYMS

ACT African Conservation Tillage network

CA Conservation Agriculture

CAP Conservation Agriculture Project

CASPP Conservation Agriculture Scaling Up Productivity and Production

CASU Conservation Agriculture Scaling Up

CFU Conservation Farming Unit

CLUSA Co-operative League of the United State of America.

CLWM Centre for Livelihood and Watershed Management

CSO Central Statistics Office

DAPP Development Aid from People to People

FAO Food and Agricultural Organisation of the United Nations

FGD Focus Group Discussion

FISP Farmer Input Support Programme

FRA Food Reserve Agency

GART Golden Valley Agricultural Research

GRZ Government of the Republic of Zambia

IDS Institute of Development Studies

IFAD International Fund for Agricultural Development

GGIAR Germany Government Investment in Agricultural Research

NGO Non-Governmental Organisation

NWK North West Korea

SCAFE Soil Conservation Agro-forestry Extension

UNZA University of Zambia

ZNFU Zambia National Farmers Union

CHAPTER ONE

INTRODUCTION

This chapter presents the background to the study, problem statement, aim, objectives, research questions and significance of the study.

1.1 Background to the study

Agriculture is one of the world's largest and fundamental industries. It constitutes the backbone of most African economies (World Bank, 2009). In Zambia, agriculture supports the livelihoods of over 70 percent of the population (Sitko *et al.*, 2011). However, government expenditure on the sector is typically small, often less than 10 percent of the total expenditure despite its positive contribution to the Gross Domestic Product (GDP) (Weitz *et al.,* 2015).

Agricultural production systems in Zambia are largely based on smallholder farmers defined as those who cultivate less than 5 hectares, rely primarily on family labour, use low levels of technology, a few purchased inputs and consume most of their produce (Central Statistics Office (CSO), 2000; Jayne *et al.,* 2007). Additionally, smallholder agricultural production systems are mainly rain fed and thus very susceptible to droughts since irrigation is very low (Food and Agricultural Organisation (FAO), 2005). The agricultural systems are also dominated by maize (*Zea mays*), which is grown by about 80 percent of smallholder farming households (CSO 2015; Zambia Development Agency, 2011).

Although Zambia's potential for agricultural production is classified as medium to high given the immense resource endowment in form of land, labour and water, the country has been struggling to utilize its agricultural potential to significantly address food insecurity and poverty (Government of the Republic of Zambia (GRZ), 2009; Sitko *et al.,* 2011). As a result, there are numerous suggested strategies often based on development narratives that seek to address these challenges.

Development narratives are stories that outline a particular course of events and have gained the prominence of conventional wisdom (Sutton, 1999). Examples of one strand of development narratives include those that seek to explain environmental change as a consequence of departure from ecological principles (Institute of Development Studies

(IDS), 2006). In agricultural development, Conservation Agriculture (CA) is an example of narratives rooted in the ecological belief that environmental change is as a result of not adhering to ecological ideals.

The Food and Agricultural Organization (FAO), one of the main proponents of CA considers it as a way of farming that conserves, improves, and ensures efficient use of natural resources through the principles of minimum soil disturbance, surface crop residue retention, and crop rotations and associations (FAO, 2002, FAO, 2014). It represents a fundamental change to agricultural production systems, requiring a holistic awareness of nature or ecosystems and the services they offer so that these are least disturbed when ecosystems are altered for agricultural production (Friedrich *et al.,* 2010).

Similarly, Dumanski *et al.,* (2006) perceive CA as an application of modern agricultural technologies that intend to improve production while simultaneously protecting and enhancing the quality the land resources. In other words, CA system is perceived as one that strives to strike a balance between people's well-being and environmental conservation.

In Zambia, CA is being espoused by donors, development agencies, research institutes and Non-Governmental Organizations (NGOs) as having a huge potential to address the problems of food insecurity, environmental degradation and poverty (International Fund for Agricultural Development (IFAD), 2011). Several terms including minimum tillage, conservation tillage, no-till and conservation farming are often used reversibly with conservation agriculture.

This study endeavoured to examine the narratives associated with conservation agriculture promotion in Zambia in relation to environmental conservation and farmers' experiences. It builds on the work of Mfune (2014) and Whitefield *et al*., (2015) that also looked at CA rhetoric. While Mfune (2014) focused on how rural actors organise their livelihoods and the factors that condition sustainable livelihoods and how that influences the application of CA, Whitefield *et al*. (2015) discussed the potential to open up space within knowledge politics to alternative and counter narratives surrounding up-scaling of CA in Zambia from a political ecology perspective. But this study departs from Whitefield *et al.,* (2015) by getting the voice of smallholder farmers to understand their experiences of CA and environmental conservation rather than only concentrating on the voice of policy makers and CA project representatives. Moreover, this study departs from the two studies in that it analyses the

sustainability of segregated CA practices in relation to forestry conservation, soil moisture conservation, weed pressure and agro-biodiversity. It identifies and evaluates CA narratives against empirical evidence based on farmers' experiences to determine the likelihood of the sustainability of CA practices beyond donor support.

1.2 Statement of the problem

Development programmes are often shaped by how issues are framed and how actors are organized around narratives to ensure that certain activities are promoted. For instance, conservation agriculture promoters assume uniform suitability of its fundamental principles in dealing with environmental and socio-economic problems among smallholder farmers (CFU, 2009). But, the effectiveness of universal application of the prescribed set of solutions embedded in CA is questionable. This is because of the variations in factors such as weather, soil, farmers' interests and livelihoods, wealth, and access to and control over productive assets.

Additionally, the hegemonic narratives tend to be top-down in approach. Thus, not only do they limit farmers' capacity to come up with their own solutions to problems but also often do not explicitly integrate farmers' experiences in finding solutions to the problem. This is because narratives define what constitutes knowledge and its scope, and whose views and interests are deemed legitimate in informing policy and development practice (Hajer, 1995). Therefore, it is possible that farmers' experiences could be at variance with the claims of dominant narratives. Hence, this study examined the narratives associated with conservation agriculture promotion in Zambia and experiences of smallholder farmers in order to assess possible linkages between CA and environmental conservation.

1.3 Aim

The aim of the study was to assess the linkages between conservation agriculture narratives and environmental conservation in Chibombo District.

1.4 Objectives

The objectives of the study were as follows;

1. To identify the dominant narratives linking conservation agriculture and the environment in terms of forest conservation, soil moisture, weeds and agro-biodiversity in Chibombo District.
2. To assess the evidence associated with the linkages between conservation agriculture narratives and the environment in terms of forest conservation, soil moisture, weeds and agro-biodiversity in Chibombo District.
3. To identify implications of the linkages between conservation agriculture and environmental conservation on the livelihoods of small-holder conservation farmers in Chibombo District.

1.5 Research questions

The study was guided by the following research questions;

1. What are the dominant narratives with regards to conservation agriculture and forest conservation, soil moisture, weeds and agro-biodiversity?

2. What evidence is associated with the narratives linking conservation agriculture practices and forest conservation, soil moisture, weeds and agro-biodiversity?

3. What are the implications of the linkages between conservation agriculture narratives and environmental conservation on the livelihoods of small-holder conservation agriculture farmers?

1.6 Significance of the study

Undertaking this study was very important because it has given feedback to CA promoters such as the Conservation Farming Unit, International organizations and donors, NGOs and the Zambian government on the narratives that are consistent with the experiences of farmers in Chibombo District and those that are at variance. Thus, as promoters continue to invest in CA promotion, it is anticipated that the insights will provide a platform to re-examine the narratives that are inconsistent with the experiences of the farmers so that farmers' concerns could be identified and addressed. In this way, trade-offs between the priorities of CA promoters and those of farmers are expected to be minimised. Finally, the study has also contributed to scientific literature concerning conservation agriculture narratives and environmental conservation.

1.7 Organization of the thesis

This thesis has six chapters. Chapter one has presented the background, problem statement, aim, objectives, research questions and significance of the study. It is followed by chapter two which reviews literature on conservation agriculture narratives and environmental conservation. Chapter three presents the description of the study area. Chapter four presents the methodology of the study in which the research design, methods of data collection and analysis are described and justified. Results are presented and discussed in chapter five while chapter six gives the conclusion and recommendations of the study.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter provides information on the literature surveyed which provides the framework for this study. Most of the literature reviewed for this study was drawn from Sub-Saharan Africa including Zambia where attempts to transform agricultural practices from conventional agricultural system to conservation agricultural system are being made.

Literature review has been presented in form of themes in order to provide the context for understanding the topic being investigated. The first theme is about the development of CA. It describes the concepts, variants and principles of CA, the origin, global and local perspectives of CA. The next theme is on environmental narratives in which the meaning of 'environmental narrative' is given; as well as examples. An explanation on why narratives persist is also given. The last theme is on conservation agriculture. It presents existing knowledge on arguments regarding agricultural transformation from conventional agricultural system to conservation agricultural system and identifies some gaps in the knowledge which this study strives to close.

2.2 Development of Conservation Agriculture

The origins and evolution of CA principles and practices are rooted in the farming communities and civil societies of North and South America who, out of necessity, had to counter severe erosion and land degradation problems and productivity losses on their agricultural land which resulted from intensive tillage-based production practices around the 1930s (Warren, 2005; Friedrich *et al*., 2012; Kassam *et al*., 2015).

In the 1990s, CA received more attention from development and research organisations such as FAO, World Bank and GGIAR that helped to raise awareness about CA in other continents through regional workshops, research projects and study tours for farmers and policy makers to Latin America where CA adoption was significant (Kassam *et al*., 2015). As a result, there has been a steady increase of the area globally under CA from about 2.8 million hectares in the 1970s to 6.2 million hectares in the 1980s and from 38 million hectares in the 1990s to 157 million hectares in 2013 as reported in a meta-analysis by (Kassam *et al*., 2015).

In Zambia, the origin of CA is traced from international technological transfer by commercial farmers. Through collaboration with the Zambia National Farmers Union in the 1980s, commercial farmers interacted with other farmers from Latin America, the USA and Australia where CA practices had gained significant ground (Haggblade and Tembo, 2003a). But CA was formally introduced to the smallholder farmers of agro-ecological zones I and II in 1996 by the Conservation Farming Unit (CFU) of the Zambia National Farmers Union after the 1995 drought (IFAD, 2011).

Although estimates are that 270,000 smallholder farmers practiced CA in 2010 (Simasiku *et al.*, 2010) compared to about 70,000-120,000 in the 2002/2003 agricultural season, (Haggblade and Tembo, 2003b), Baudron *et al.*, (2007) note that most of the adopters, have not adopted all the recommended principles. But with conservation agriculture currently being the focus of agricultural development in Zambia, awareness of CA among farmers and possibly adoption is more likely to increase. Additionally, Zambia's affiliation to the African Conservation Tillage Network (ACT) presents opportunities to learn more about CA (Friedrich and Kassam, 2009).

The Zambian version of CA being executed by the Conservation Farming Unit (CFU) involves dry season land preparation either by using animal draught power (ADP) or a tractor to rip or a *chaka* hoe to dig up to 15850 permanent conservation planting basins per hectare (CFU, 2009). A *chaka* hoe was designed by the Conservation Farming Unit in a way that it should make dry season land preparation possible (Baudron *et al.*, 2007). As such, it has a long wooden handle of about one meter long, strong blade of about 20cm X 25cm and relatively heavy (weighs about 4-5Kg) as opposed to an ordinary hoe (Nyanga, 2011).

The recommended dimensions of the basin are 20 cm deep, 30 cm long, and the same width as the blade of the hoe with 70 cm spaces along the row and each row is 90 cm apart. Rip lines are created with the same deep dimensions and row distance as basin (CFU, 2007). Conservation Agriculture principles in Zambia focus on maintaining crop residues, precision of input application, crop rotation involving a cereal, legume and cash crop and planting of winter thorn (*Faideherbia albida*) (CFU; 1996; 2007; 2009).

The rationale for promoting CA was to mitigate the negative environmental and social impacts of conventional tillage practices (International Resources Group, 2011). Conventional tillage is characterised by soil inversion, ridging, extensive tillage and overall

digging with a hoe after the onset of the rains, monoculture, shifting cultivation, burning of crop residue, ploughing and reliance on highly subsidised fertilizer (CFU, 2007).

CA is more often than not perceived as a flexible system that can be practiced by all farming communities, in all size of farms and ecologies (Kassam *et al.*, 2015). However, this assumption is often based on data gathered through field experiments on which generalizations are made without a detailed evaluation of intangible factors such as culture, values and farmers' experiences. Thus, this study looked at CA narratives in line with the experiences of the smallholder farmers as people intended to execute the ideals promoted in CA.

2.3 Environmental Narratives

Environmental narratives are succinct summaries of the causes, effects and presumed measures and interventions for environmental problems (Roe, 1991). In other words, they describe what is wrong and how it must be corrected. Interventions are often framed in particular ways by a group of individuals and institutes (actors) who share similar belief systems, codes of conduct and established patterns of behaviour (Sutton, 1999). Narratives emerge from a desire to simplify complex and uncertain sequences of cause and effect into convenient summaries (IDS, 2006).

Narratives are quite firm because actor networks link up parts of the administration surrounding the problem with government, the private sector, donors and actors in civil society such as journalists, scientific researchers and non-governmental organisations (NGOs) to exchange ideas and strategies (Sutton, 1999). For instance, IDS (2006) points out that through chains of persuasion and influence such as journals, conferences, mass-media, education or informal introductions, norms of good practices are reinforced, research agendas are set and conventional wisdoms are reiterated while unconventional views are suppressed. In addition, narratives tend to be self-replicating once established because political actors often repeat them in order to gain visibility and alliances in environmental debates (Sutton, 1999). Furthermore, it is claimed that the storylines and metaphors of narratives are so taken for granted that they limit thinking of different views to solve problems such that they become the way things are thought about over time (IDS, 2006).

Roe (1995) argues that environmental narratives are frequently associated with notions of crisis as a justification for development assistance or land management and further points

out that the framing reveals what is thought to be significant to people, what stands to reason, and cannot be negotiated. That is, narratives provide a code of conduct or guidelines on how to act concerning a particular subject. The 'tragedy of the commons', 'desertification', 'soil erosion', and 'biodiversity loss' are all examples of environmental narratives which often posit the destructive nature of the local people and claim that professionally trained resource managers are the ones who are capable of saving resources from destruction (Carr, 2010, Roe 1995). This is the line of thought that provided the justification for an array of colonial and post-colonial state policies that 'protected' environments from people and in the process dispossessed communities of their resources by evicting them from protected areas (IDS, 2006). Conservation Agriculture (CA) also fits into this realm of crisis environmental narratives as it claims that environmental degradation results from unsustainable conventional tillage practices which, if not reversed through CA package, could worsen food insecurity and poverty among smallholder farmers.

Forsyth (2003) further argues that narratives of environmental crisis often impose singular solutions which in turn obscure more accurate understanding of the biophysical processes of environmental change and the anthropogenic drivers of change. Ultimately, alternative voices on how to address environmental change are marginalized. In this regard, environmental accounts can be seen as narratives of control and exclusion. In addition, Bixler (2013) explains that any intervention that is inattentive to historical and geographical specifications, local conditions and local knowledge is likely to fail and stresses the need to engage local people and their knowledge in resource governance. Therefore, understanding local narratives based on experiences of the people is critical for conditioning local responses and mitigation plans for environmental change. In this way, the individuality of each community, its specific complex of unequal relations and institutional arrangements, and specific ecological system would be appreciated.

2.4. Conservation Agriculture

This theme is about the debate by various scholars regarding agricultural transformation from conventional agriculture system to conservation agriculture system.

2.4.1 Sustainability aspects of conservation agriculture system

Proponents of the conservation agriculture system often regard CA as being economically, environmentally and socially sustainable (FAO, 2014, CFU, 2009). Kassam *et al.,* (2009) for example, argue that conservation agriculture achieves high productivity by using a more ecologically friendly way through low input practices such as precise input application, use of legumes in crop rotations to reinstate soil nutrients, improve soil carbon and reduce reliance on fertilizer use.

In Lesotho, farmers practicing conservation agriculture who were reported to employ inorganic fertilizer used on average only 87 kg per hectare compared to 105 kg per hectare of inorganic fertilizer among conventional farmers (Silici, 2010). Furthermore, a multi-perspective analysis of smallholder conservation agriculture in Southern, Central and Eastern Zambia by Umar (2012) also found that households applied slightly lower levels of fertilizer on their CA plots (30kg/ha) than on conventional plots (34.2kg/ha).

In South Asia, diesel consumption is said to have reduced by 50-60 litres per hectare and savings on herbicides ranged between $33 and $50 per hectare because of conservation agriculture (Malik *et al.,* 2005, Sharma *et al.,* 2005). A study in Laikipia District in Kenya also established that the majority of conservation agriculture adopters were large-scale farmers who had the goal of reducing production costs to remain in business in a liberalised market economy (Kaumbutho and Kienzle, 2007). In Ghana and Kenya, farmers reported 40 percent saving in labour associated with maize production in CA systems (FAO, 2009).

Similarly, interest in conservation agriculture among commercial farmers in Zambia developed because low-till cultivation enabled them to reduce fuel consumption from 120 to 30 litres per hectare (Haggblade and Tembo, 2003a). Furthermore, Duminski *et al.,* (2006) posit that conservation agriculture makes farming communities to be providers of more healthy living environments for the wider community through reduced use of fossil fuels, pesticides, and other pollutants, and through conservation of environmental integrity and services.

However, Kaumbutho and Kienzle (2007) point out that farmers who reconsider their agricultural practices and follow the path to more sustainable agriculture usually embark on a journey that takes them several years as they have to adjust to different types of implements, increasingly incorporate specific practices and mastery of the three principles. Although the literature above suggests that CA is a sustainable system, it does not show the extent to which smallholder farmers in Zambia and particularly in Chibombo District can fully exploit CA.

2.4.2. Conservation agriculture and soil moisture conservation.

Climate change is presented as a major threat to agricultural productivity in Southern Africa which in turn poses serious challenges to food security and poverty reduction (Umar, 2012). Thus, it is envisioned that if agriculture becomes more sustainable, increases its productivity and becomes more resilient against the impact of climate change, hunger and poverty levels would reduce tremendously (FAO, 2009). To this effect, transformation of agriculture from conventional system to CA system is being espoused as a pathway that can lead to increased resilience of crops to dry spells. This is attributed to CA practices of mulch cover and minimum tillage through ripping and planting basins. The claim is that mulch cover and high organic matter content enhance the water holding capacity of soils by reducing soil temperature, runoff and evaporation in fields with planting basins and those with ripped lines (Marongwe *et al.;*2012).

For example, Devita *et al.,* (2007) found that water saving in CA was 20 percent to 30 percent greater than in conventional tillage across growing seasons in the Ganges plains of South Asia. Additionally, in the Karatu district of Tanzania where rains are erratic, water efficiency is noted as one of the main reasons that encouraged many farmers to take up CA systems (Shetto and Owenya, 2007). Umar (2012) also found that yield variations in extreme years whether wet or dry were less pronounced under conservation agriculture than conventional agriculture in her multi-analysis study involving Central, Eastern, and Southern Provinces of Zambia.

Field trials in Zambia and Zimbabwe by Thierfelder and Wall (2010a and 2010b) also showed that the water infiltration rates and soil moisture content were higher where CA was maintained than on the ploughed treatment. But this did not necessarily result in higher maize productivity under CA because water logging in the wetter years prevented better crop performance. Higher maize grain yields were achieved only in seasons when there was

marked moisture stress. On the other hand, a global meta-analysis by Pittelkow *et al.,* (2015) showed yield variations in CA across temperate, sub-tropical and tropical latitudes and contexts where yields in no-till increased relatively to those in conventional tillage. Additionally, yields in cereals declined in all latitudes with tropical areas being the most affected especially when maize was grown, followed by sub-tropical and then temperate latitudes. While these studies have shown consensus as regards to CA being more resilient to droughts than conventional farming, yields in CA varied across latitudes indicating that the ultimate benefits are locally specific. Additionally, the susceptibility of CA system to flooding and its effects across CA forms of tillage is hardly investigated. Furthermore, the literature does not compare the empirical evidence against the narratives thus methodologically different from this study. Thus, this study uses evidence from farmers to compare with the narratives of CA.

2.4.3 Conservation agriculture and weed pressure

In CA, retention of crop residues and herbicide use are considered fundamental in weed control because residues suppress weed growth by blocking light which is necessary for photosynthesis and herbicides kill the metabolic processes of weeds (Baudron *et al.,* 2007). It is asserted that in the long term, crop residues and herbicides reduce weed intensity and save the energy, time and labour that would have been needed for weeding (Kassam *et al.,* 2009). Furthermore, Kassam *et al.,* (2009) argue that the tillage based systems can quickly become unsustainable especially among farmers who rely fully on family labour should labour supply be reduced through sickness or migration. Additionally, they claim that why farmers in Latin America adopted conservation agriculture was among other reasons the positive impact of conservation agriculture on the distribution of labour during the production phase and more essentially, the reduction in labour requirement. On the other hand, Sims and Kienzle (2015) have not only attributed the success of CA system in Latin America to the use of herbicides for weed control but also to a long history of mechanisation which make field operations efficient and quick.

The Zimbabwean task force on conservation agriculture also found that precision conservation agriculture (PCA) spreads labour for land preparation over the dry seasons and encourages timely planting, resulting in reduction of peak labour loads at planting and weeding; and higher productivity and incomes (Twomlow *et al.,* 2008).

CFU (1996) also asserts that depending on herbicides reduces labour inputs by about 60 percent to 80 percent especially among women and children who do a substantial proportion of weeding. CFU (1996) further posits that the likelihood of burning crop residues because they inhibit hoe weeding is reduced since herbicide use is encouraged. Similarly, CFU (2009) points out that at GART research station, labour requirement for weeding reduced by 50 percent over a four year period from 1997-2001.

On the other hand, Silici (2010) found that labour was considerably higher in CA fields than in conventional fields in Lesotho when hand hoe weeding was used especially the first three years of shifting to CA. Moreover, although Shetto and Owenya (2007) illustrate that in conventional agriculture, hand-hoe planting takes 3 people a day on average to plant 1 acre while one person using a hand jab planter in CA takes 3 to 4 hours to plant the same area, they also found that manual weed control among smallholder farmers in Tanzania was a challenge. Since 70 percent of the power source for smallholder farms in sub-Saharan Africa (SSA) is supplied by manual labour Sims and Kienzle (2015), the extent to which smallholder farmers can fully exploit CA is questionable.

Nicholas *et al.,* (2015) have also shown contradicting outcomes from empirical studies in their review on weed dynamics and conservation agriculture principles. They cited some studies (e.g. Anderson *et al.,* 1998) that posit persistent weed problems in CA compared to conventional tillage even after several years. Other studies showed that tillage had no effect on weed pressure (Barberi *et al.,* 2001) while some claimed that tillage increased weed seed bank (sosnoskie *et al.,* 2006). Similar disagreements concerning the effects of crop rotation and residues on weeds are also found. For example, Anderson (2005) claims that weed pressure is less in no-till with rotation than in tillage systems and no-till monoculture systems.

Conversely, weed biomass was found to be similar in conventional tillage and no-till with residues while in no-till without residues, weed biomass had nearly doubled in Zimbabwe (Ngwira *et al.,* 2014). These studies show that weed pressure is dynamic even within CA fields depending on how CA principles have been incorporated. The studies also suggest that results are context specific in which it is not a guarantee that weed pressure in CA shall be less than in conventional agriculture. Most of the literature above lacks clarity on how sustainable CA weed management methods are especially among smallholder farmers. But

through this study, experiences of the farmers on CA weed management methods bring clarity about their sustainability in relation to environmental conservation.

2.4.4 Conservation agriculture and agro-biodiversity

Agro-biodiversity refers to the diversity of plants, animals and soil micro-organisms that underpin agricultural systems (Biodiversity Community Network, 2009). CA proponents encourage diversified annual crop rotations to increase agro-biodiversity above and in the soil (Thierfelder and Wall, 2010b). Crop rotation is the practice of growing a series of different types of crops in the same field in sequential seasons (IFAD, 2011). This system is opposed to the mono-cropping system in which one crop species is grown season after season. The Conservation Farming Unit recommends that 30 percent of the cultivated land be planted with a nitrogen-fixing crop to be rotated with maize and cotton (Baudron *et al.*, 2007).

It is argued that mono-cropping is unsustainable because it leads to an increase in plant-specific pests and diseases in many cases while diversified crop rotations interrupt the chain of infection between subsequent crops and in turn reduce the risk of crop failure (Thierfelder and Wall, 2010b). It is also claimed that diversified crop rotations provide an optimum environment for the root-zone to maximum possible depth so that crops can function effectively and without restrictions to capture plant nutrients and water as well as interact with a range of soil micro-organisms beneficial for crop performance (Kassam *et al.*, 2010).

Diversity in crops is also considered essential for intensifying production from the collective output of different types of crops grown which in turn provide essential dietary components and source of income. For instance, Shetto and Owenya (2007) claim that the diet diversified in Arumeru District of Tanzania through intercropping of edible crops such as lablab, pigeon pea, soybean, beans and pumpkin with maize in CA systems. Similarly, in a study on women smallholder farmers and sustainable agricultural intensification in Central, Eastern and Southern provinces of Zambia, Umar and Nyanga (2014) reported an increase in crop productivity and crop diversity from conservation agriculture, as well as improvements in household food security. A study in Malawi by Ngwira *et al.*, (2014) also found that food preferences influenced the extent of crop rotation.

On the other hand, diversified crop rotations with some legumes provide additional ecosystem services such as efficient nutrient cycling (Kassam *et al.*, 2008). Thierfelder and

Wall (2010b) found that conservation agriculture plots in general possessed higher population of earth worms, higher total carbon; more water stable aggregates and had higher yields than in conventional treatment at Monze Farmer Training Centre in Southern Province of Zambia. While most of the literature above does not consider the sustainability aspect of agro-biodiversity through diversified crop rotations in CA among smallholder farmers, this study does and focuses on farmers' experiences.

2.4.5 Conservation agriculture and forest conservation

In Zambia, the rate of deforestation is significantly high, with approximately 300,000 hectares of forest cover lost per year (Day *et al.,* 2014). The consequences of deforestation are devastating, including among others a reduction in the provision of overall ecosystem services, and also contribute to global warming (Vinya *et al.*, 2011). Agricultural expansion for smallholder farming systems often based on inappropriate practices is alleged to be the main cause of deforestation (Campbell *et al.*, 2011). Accordingly, the government's support for conservation agriculture was aimed at, among other reasons, enabling sedentary farming in perpetuity and reversing deforestation in the long run (IFAD, 2011). It is asserted that sustainable agricultural intensification in CA increases crop production and in turn discourages smallholder farming families from migrating in order to search for more fertile land and supplementary but unsustainable income sources such as charcoal production (Campbell *et al.,* 2011). Sustainable agricultural intensification entails producing more output per unit of land, nutrient, and water, (input) while reducing environmental impacts and increasing natural capital and environmental services (Pretty *et al*., 2011).

It is also claimed that promotion of agro-forestry;-a system of agriculture involving the growing of useful trees and shrubs in association with crops or livestock CSO (2006) would help to conserve forests by limiting exploitation of forest resources to the agricultural landscape. Furthermore, agro-forestry would promote soil carbon sequestration and control erosion because some trees are used as living contour hedges (CFU, 2007).

Angelson and Kaimowitz (2001), however, maintain that the extent to which agriculture intensification can help to alleviate tropical forest decline remain blurred. They argue that new technologies that increase agricultural productivity and tend to be labour intensive can reduce the need for subsistence driven land clearing, but raising incomes and the returns to agricultural activities can also provide incentives to convert forests to farmland or other uses. This is also the thinking that underlies the "*Jevons paradox*" which suggests that the

economical use of fuel results not in diminished consumption but in an over-all increase (Blake, 2008).

Furthermore, in an analysis of one hundred and fifty-two studies of tropical deforestation, Geist and Lambin (2002) found that economic factors *inter alia*, changes in national and international prices for agricultural products, national prices for land or labour, as well as the domestic or international demand for wood products are, in general, the most important indirect drivers. In South America for instance, when currencies devaluated in the 1970s and exports were promoted to restore trade balances, the result was great increase in large scale mechanized crop production and meat production which eventually resulted to a consistent decline of native vegetation across all Brazilian biomes (Metz, 2010, Ferreira *et al.,* 2012). Similarly, in his macro study on agricultural intensification in Zambia, Saasa (2003) found that a number of economic and political variables do ultimately matter in a farmer's decision whether to intensify or not. There is a dearth of knowledge in this literature regarding CA as a forestry conservation strategy. This study focuses on farmer's experiences of CA in order to clearly understand the extent to which CA can be a sustainable forestry conservation strategy in Zambia and particularly in Chibombo District.

2.4.6 Conservation agriculture and soil fertility

It is argued that promotion of permanent soil cover, diversified crop rotations and minimal soil disturbance in CA systems enhance soil fertility when residues decompose and by minimizing disturbance of soil organisms that enrich the soil and through fixation of nitrogen by crops in rotations (FAO, 2008). In Zambia, the growing of winter thorn (*Faidherbia albida),* a leguminous tree for soil fertility is the focus of CA systems. The Conservation Farming Unit (CFU) has been encouraging farmers to plant 100 winter thorn trees per hectare as a long term means of boosting soil fertility (Umar, *et al.,* 2013). Winter thorn is a deep rooting tree that has the unique property of shedding leaves during the rains. CFU (2009 P: 47) reports that "through leaf fall and pod fall, nitrogen fixation and association with soil micro-organism, fertility accumulation under the canopy is 75kg N, 27kg P_2 O_5, 183kg CaO, 39kg MgO, 19kg K_2O and 20kg S." It is argued that in the long run, winter thorn lowers production costs because it reduces the need for fertilizer application which in turn makes soils acidic and unproductive (CFU, 2009). On the contrary, Pedzisa *et al.,* (2014) found that yields in CA reduced by 12 percent without fertilizer in Zimbabwe and concluded that CA could be effective with fertilizer. In their global meta-analysis, Pittelkow *et al.,* (2015) had similar findings in which yields in no-till

without N fertilizer reduced by 12 percent and by 4 percent where N inorganic fertilizer was applied.

But a study by Akinnifesi *et al.,* (2010) found that fertilizer trees add more than 60 kg N ha^{-1} per year through biological nitrogen fixation, substantially increase crop yield and that nutrient contributions from fertilizer tree biomass can reduce the requirement for mineral N fertiliser by 75 percent, translating to huge savings on mineral fertilizers for the majority of the vulnerable smallholder farmers. Similarly, in their study on effects of *Faidherbia albida* on the fertility of soil in smallholder conservation agriculture systems in Eastern and Southern Zambia, Umar *et al.,* (2013) found that *Faidherbia albida* improved soil fertility in farmers' fields. The nutrient levels were 42, 25 and 31 percent higher under the tree canopies than away for total nitrogen, potassium, and organic carbon respectively. Conversely, Dodo (2009) in Tanzania found that cultural traits influenced people's decisions on farm management in which males had control over what types of crops and or trees should be grown.

2.4.7 Conclusion

The literature reviewed show that CA promoters see it as a way to develop sustainable farming systems that should substitute conventional farming practices blamed for environmental degradation, poverty and food insecurity. Literature indicates that even if farming communities are heterogeneous in many respects, farmers are urged to apply all the principles of CA by its promoters. Literature also shows that although there are cases where claims of CA benefits for the farmer and the environment are supported, there are equally scientific reports that contradict these claims. Thus, this study argues that universal application of CA principles may not be the best solution to environmental and socio-economic problems especially among smallholder farmers. It considers the fact that conventional farming practices have been evolved, adapted, and adjusted over decades and cannot be replaced by a package of CA practices imported from elsewhere without first adjusting and adapting the new practices to local situations.

CHAPTER THREE

DESCRIPTION OF THE STUDY AREA

3.1 Introduction

This chapter presents the description of the study area. It provides the location of the study area, physical characteristics of the study area and socio-economic activities.

3.2. Location of the study area

The research was conducted in Chibombo District of the Central Province of Zambia (figure 1). The study sites were Chitumbo, Jelemiya and Mpikwa villages in Chief Liteta's chiefdom.

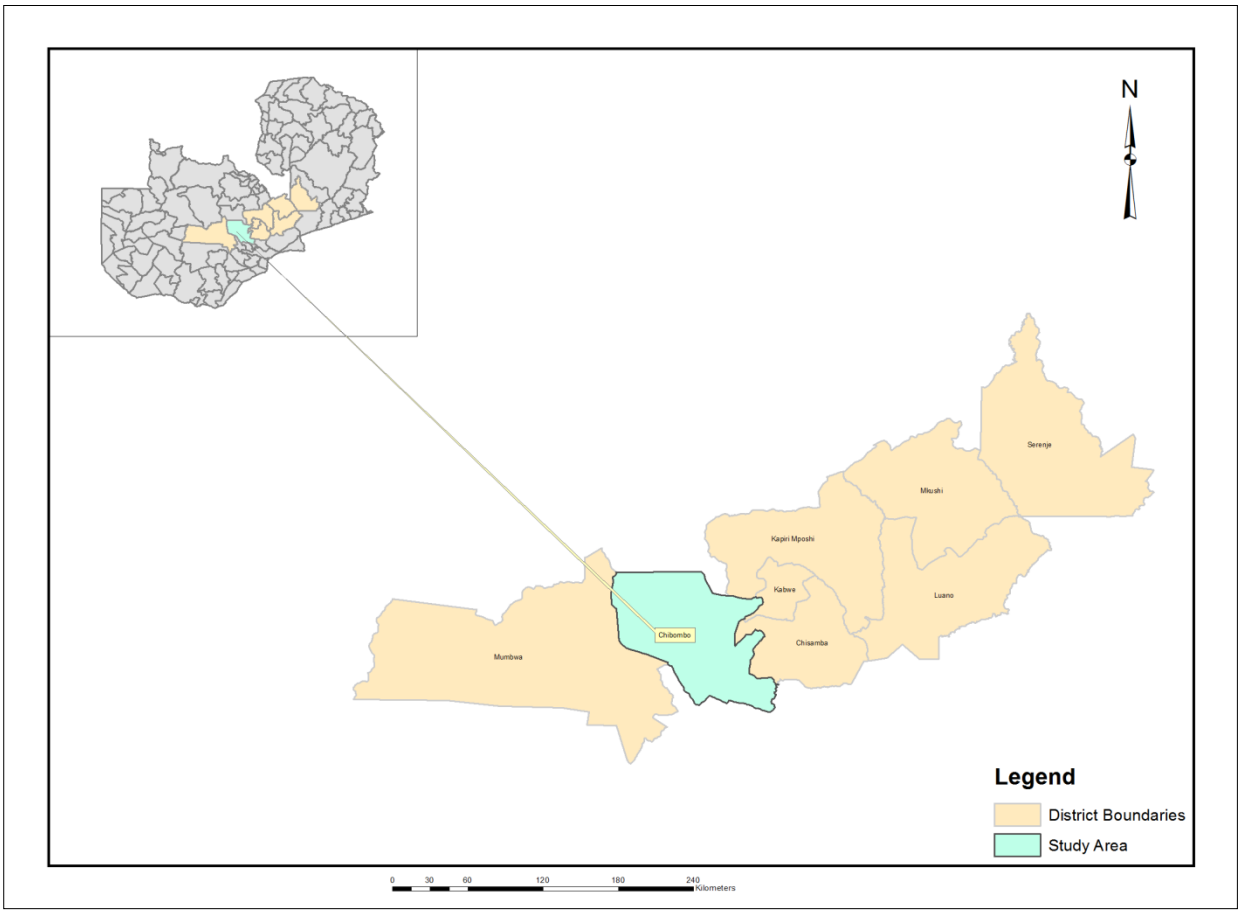

Figure 1: Location of the study area

Chibombo is about 95 Km from Lusaka on the Great North Road. It occupies 13, 423 $Km^2$of the 94,394 Km^2covered by the entire Central Province (CSO, 2014 a). The main reason for selecting Chibombo as the study area was because of its long exposure to promotion of conservation agriculture which formally started in 2007 under the Conservation Agriculture Project (CAP) (Nyanga, 2011). Additionally, Chibombo has the largest proportion of agricultural households compared to other districts in central province (CSO, 2014 b). On the other hand, the three villages were purposively chosen as study sites not only because of long exposure to conservation agriculture promotion but also due to their accessibility.

3.1 Physical characteristics of the study area

This section presents the climate, soil and natural vegetation of the study area.

3.2 Climate

Chibombo District is characterised by three distinct seasons namely; cool and dry season, hot and dry season and the hot and wet season (CSO, 2014 b). It experiences seasonal rainfall ranging between 800mm and 1000mm on average and mean temperatures ranging from 18^{oc} to 24^{oc} in a year. The crop growing period lasts between 120 days and 150 days (GRZ, 2002).

3.3 Soils

Chibombo lies in a plateau area at an average altitude of between 900m and 1200m above sea level. It has moderately leached clay to loamy slightly acidic soils which are considered to be the best for crop production (GRZ, 2002).

3.4 Natural vegetation

Zambia is dominated by *Miombo* ecosystem accounting for about 61 percent of the woodland biome (GRZ, 2009). In Central province where Chibombo is found, the main tree species are *Acacia, Brachystegia*, *Julbernadia* and *Isoberlinia.* These tree species are important for timber production and fuel wood.

3.5 Socio-cultural and economic characteristics

The 2006 and 2010 Living Conditions Monitoring Survey Report shows that Chibombo District is predominantly rural with agriculture being the main economic activity (CSO, 2012). The types of farmers include; smallholder farmers, emergent farmers and commercial farmers. The main crops grown are maize, *Zea mays*, cassava (*Manihot esculenta),* tobacco (*Nicotiana tabacum),* sunflower (*Helianthus annuus*), groundnuts, (*Arachis hypogaea*), cotton (*Gossypium hirsutum*), beans (*phaseolus vulgaris),* vegetables and citrus fruits. Additionally, there is livestock production involving the rearing of cattle, goats, pigs, donkeys, sheep and poultry. However, households involved in crop production are more than those who raise livestock (CSO, 2014b). Fishing from the *Lukanga* swamp and surrounding rivers such as *Mwembeshi* is also an important source of livelihood.

The analytical report on Central province of the 2010 Census of Population and Housing shows that Chibombo District's population at 309,519 was the highest in the province and was dominated by females (CSO, 2014a). The report further shows that the population density was at 22.6 persons per km ^{2}. The main ethnic groups of Chibombo are the *Lenje*, *Tonga* and *Bemba.* But the main language spoken is *Lenje* because the *Lenje* people are the original inhabitants. The land tenure type is principally customary under Liteta chieftaincy.

CHAPTER FOUR

RESEARCH METHODOLOGY

This chapter describes the process used to gather and analyse data needed to answer the research questions for the study. This is described in terms of research design, selection of respondents, data collection and analysis. Associated reasons for methodological choices are also given.

4.1 Research design

This study was purely qualitative because there was need for an in-depth understanding of people's opinions, values and experiences of CA and environmental conservation. Triangulation of different qualitative techniques was also done in order to have multiple ways of examining the problem so as to enhance the credibility of results as recommended by Bryman (2008).

4.2 Selection of respondents.

Purposive sampling was the means by which all participants in this study were selected. This is a non-probability sampling technique in which the researcher relies on personal judgment when choosing participants (Etikan et al., 2016). The criterion for selection of participants was to have those with experience and or with knowledge on CA as farmers or promoters. Thus, only those whose background expertise was related to the objectives of the study were considered. This is because the interest was to have only those who could provide useful data on the subject being investigated in a way that was less costly and less time consuming. All participants were consenting adults and included thirty-five smallholder farmers who had practiced conservation agriculture for at least three years, three key informants; two of whom were extension officers from the Conservation Farming Unit (CFU) and one forestry official from the Forestry Department.

The study area was visited prior to the commencement of data collection so that the researcher could get familiar with the area and with the farmers involved in CA. With the help of research assistants who knew the area and the farmers, arrangements were made to talk to famers about their participation in the research as respondents. The names of those who were willing to take part in the research were written down together with their

respective villages. Thereafter, dates were fixed for focus group discussions for each of the three villages.

4.3 Primary data collection methods

Primary data was collected through focus group discussions (FGDs), in-depth interviews and direct observations on land use practices. Field work was conducted in September 2015.

4. 3.1 Focus group discussions

Three focus group discussions were conducted with smallholder farmers in *Lenje*-the local language so that farmers could express themselves easily. This was achieved with the help of two research assistants who were very conversant with the local language. Each focus group discussion lasted approximately two hours, and was conducted each day for three days. The first focus group discussion was conducted in Mpikwa village on 3rd September 2015. It was a mixed group of six men and six women who willingly registered their names during the visit prior to data collection. The second focus group discussion was conducted on 4th September, 2015 with eleven women of Jelemiya village. The third focus group discussion was with twelve men of Chitumbo village on 5th September, 2015.

The recommendation by Baumgartner, Strong, and Hensley, (2002); Krueger, (2000) of 6-12 participants per focus group influenced the researcher's decision of the size of focus groups. Additionally, the reason for the range of focus group size was based on the goal that focus groups should include enough participants to yield diversity in information provided, yet they should not include too many participants because large groups can create an environment where participants do not feel comfortable sharing their thoughts, opinions, beliefs, and experiences (Bryman, 2008). Thus, the categories of participants were chosen in order to triangulate experiences, knowledge, values, opinions and issues of concern held within and between the two genders on CA narratives and environmental conservation.

Focus group discussions were centred on selected topics in line with the objectives. For example, discussants were asked what they were taught regarding CA, how they were taught and by which organizations. This was meant to identify the dominant CA narratives. Discussions also focused on farmers' experiences and associated reasons. This was in order to identify evidence linking CA narratives and environmental conservation. Discussants were also asked how they had benefitted from CA so as to identify the implications of CA on farmers' livelihoods.

Focus group discussions were followed by in-depth interviews with some participants from each focus group and key informants. With permission from the participants, focus group discussions and in-depth interviews were recorded in order to retain the exact words. Notes were also taken.

4.3.2 In-Depth Interviews

A total of eight in-depth interviews taking about one and a half hours each were conducted. Five of them were with farmers who participated in focus group discussions and could communicate experiences and opinions on the subject in an articulate, expressive, and reflective manner. These included a man and woman from the first group, a woman from the second group and two men from the third group. Initially, two women were selected for individual interviews in the second group but on the material day, one had a bereavement and finding a replacement was impossible. On the other hand, three of the in-depth interviews were with key informants from the CFU and the Forestry Department.

Farmers were followed at their homes the day after their FGDs. Extension officers from CFU were interviewed on 18th September, 2015 and 25th September, 2015 respectively. The interview on the 18th of September was conducted from El-Phaso lodge near Chibombo turn off. This was the only convenient place at the time that could easily be accessed. On the other hand, the interview on the 25th of September was conducted from the CFU Regional Office in Kabwe where the officer had just been transferred from Chibombo. The Forestry official was interviewed on 23rd September, 2015 in his office.

While participants from CFU were chosen because CFU is the main proponent of CA in Zambia, the official from the Forestry Department was in the right position to address forestry conservation issues. Thus, in-depth interviews with key informants were conducted to gather expert knowledge and insights on CA narratives and its linkages to environmental conservation. Interviews with extension officers from CFU were centred on what they taught farmers regarding CA and associated reasons and how they taught farmers. On the other hand, the key informant from the Forestry Department was interviewed on the drivers of deforestation, the attitude of the local people towards forest conservation and on how the department was collaborating with CFU in environmental conservation particularly forest conservation.

An interview guide was the basis for the interviews because of its flexibility in that the researcher was not restricted to follow the order of the questions. Probing was also possible in the course of the interviews.

4.3.3 Direct observation

Bryman (2008) encourages use of senses such as sight in data collection. To this effect, data on observable activities such as land use practices of the farmers and off farm activities was also collected. Field notes were taken.

4.4. Secondary data collection

To collect secondary data, desk analysis was conducted. Materials reviewed included academic journal articles, reports and training manuals by CA promoters and policy documents on agricultural practices and conditions in Zambia. Secondary data was useful in identifying the narratives of CA from the global and local perspective. Thus, secondary data provided the framework by which this study examined the CA narratives that were prevailing in the study area.

4.5 Data analysis

Data analysis involved a systematic process of examining the collected data in order to provide meaning and understanding of the phenomenon researched. The data in this research was analysed using content and narrative analysis as explained below.

4.5.1 Content analysis

Hsieh and Shannon (2005) described content analysis as a research technique that interprets text data from a naturalistic paradigm. The technique makes inferences from texts about the communicator's experiences, opinions and feelings, the message, the situation surrounding its creation including the socio-cultural background of the communication and or the effect of the message on behaviour (White and Marsh, 2006). Content analysis was suitable because it made possible the identification of some biased terms used by CA promoters that influence the opinions or behaviour of people as regards to agricultural practices.

In this study, content analysis involved transcribing of audio data and examining the occurrence and relevance of particular words and phrases in the original text data for the purpose of classifying the data into efficient categories that represented similar meanings.

Thus, categories of similar ideas regarding dominant CA narratives and farmer's experiences were developed into the following major themes;

I. The origin of conservation agriculture
II. Environmental narratives
III. Conservation agriculture narratives

4.5.2 Narrative analysis

Narrative analysis is an approach through which narrations provide the context by which the participants' experiences of the world are interpreted and made meaningful (Bell, 2003, Creswell, 2007 Sandelowski, 1990). Similarly, Bryman (2008) points out that narrative analysis covers a broad range of approaches that are concerned with the search for and analysis of the stories that people employ to understand their lives and the world around them. Thus, narrative analysis connects events in people's lives and explains change over time by focusing on what was done, when or where it was done, who did it, how it was done and why it was done. In this way, individual and cultural dimensions of experience over time are captured.

In this study, narrative analysis involved the interrogation of research participants on their experiences of CA in relation to forest conservation, soil moisture, weed pressure, and agro-biodiversity in order to assess evidence and understand the arguments and claims regarding the linkages of CA and environmental conservation. The focus was on how research participants made sense of CA and actions in their lives through a thorough examination of their accounts. Research participants' accounts were transcribed and scrutinised for similarities and differences in order to confirm their interpretation. Thereafter, data were integrated and summarised into similar themes. Narrative analysis was considered ideal for this study because narratives show how change can translate into specific and sometimes unprecedented actions and results as well as provide alternative pathways to the improvement of the local people's well-being (Bixler 2013).

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Introduction

This chapter presents and discusses the results of the research. It describes the dominant narratives of conservation agriculture and its linkages to the environment in terms of forest conservation, soil moisture, weeds and agro-biodiversity. This is done alongside farmers' experiences in order to assess the evidence linking conservation agriculture narratives and environmental conservation. Further, the implications of the linkages of conservation agriculture narratives and environmental conservation on the livelihoods of smallholder conservation agricultural households are explained.

5.2 Dominant narratives linking CA to environmental conservation

Using the experiences of smallholder conservation farmers and expert knowledge from key informants, the narratives discussed in this section emerged dominant.

5.2.1 Conservation agriculture is a sustainable agricultural system

In this study, key informants from CFU described CA as a sustainable agricultural system. They claimed that CA is environmentally, economically and socially sustainable. This is the overarching narrative in which the key informants asserted that CA can address environmental degradation through its principles; that it is lucrative since it emphasizes on precision of input application and removes heavy dependence on external inputs in the long run and that it is suitable for all farmers. One key informant from CFU narrated that:

> Conventional tillage caused farmers to produce less than 1.2 tonnes of maize per hectare before promotion of CA began in 2006 in Chibombo. But with CA, farmers can produce 6-12 tonnes per hectare.…

He further explained that low productivity contributed to the problem of food insecurity and poverty and that it was the main reason why CFU's messages to farmers discourage conventional tillage practices. CFU is of the view that if farmers adhere to CA principles, the three pillars of sustainability mentioned earlier would be realized. When asked on what they were being taught by CA promoters, farmers' reports from FGDs and accounts from in-depth interviews revealed that the messages were centred on agricultural transformation

from conventional agricultural system to conservation agricultural system. For instance, one male participant from the focus group comprising men and women reported that:

> We are not allowed to plough and to burn fields because these activities kill soil organisms that help to make the soil fertile…we are urged to rip with a tractor or animal ripping or dig planting basins with a *chaka* hoe in the dry season.

Furthermore, it was pointed out by other participants in all the FGDs that in CA, crop rotation and mixed cropping were emphasized because the risk of crop failure and food insecurity reduces. For instance, one female participant from the FGD comprising both men and women reported that:

> Crops such as cow peas, okra, pumpkins and groundnuts mature early and cushion us from hunger…..

Additionally, key informants who were CA promoters from CFU reported that the cost of hiring a tractor and hiring oxen to rip one hectare was the same and ranged between ZMW 300-ZMW 350 (US$ 30-US$ 35) while ploughing one hectare in conventional tillage system cost between ZMW 550-ZMW 700 (US$ 55-US$ 70). This lower tillage cost for CA was not only an opportunity for CA promoters to make tractor ripping popular among smallholder farmers but also to enable the switch to CA relatively easy as tractor ripping is faster than ADP ripping. But up until then, tractor ripping was not a top priority among farmers because they lacked finances for hiring. Additionally, although CA promoters put emphasis on dry season land preparation, it is unpopular since using oxen in the dry season is not culturally acceptable. It is perceived as being harsh because this is the time of the year when the soil is hard, pasture is inadequate and oxen are susceptible to diseases. For example, a male participant in in-depth interviews narrated that:

> I feel for my oxen this time (September) when the ground is very hard, so I have done shallow ripping and I will rip again after the first rains.....

Thus, the emphasis on dry season land preparation with either ADP or tractor by CA promoters is likely to be unsustainable in this local context in that dry season land preparation was culturally not acceptable with ADP and that farmers could not afford to hire a tractor.

The study also shows that farmers resorted to cheaper tillage methods such as digging planting basins with a *chaka* hoe which was reported as being labour intensive especially by women in FGDs. This lack of mechanisation and labour burden associated with the *chaka* hoe implies that the application of CA and its contribution to food security and environmental conservation will be restricted. This situation in the study area is contrary to the success story of CA system in Latin America with a long history of mechanised farming which make field operations efficient and quick (Sims and Kienzle, 2015). Therefore, even though some authors such as (CFU, 2009; FAO, 2014) argue that CA is socially, economically and ecologically sustainable; this study found that some components are not as shown in Table 1.

Table 1: Sustainability of CA practices beyond donor support

Practices promoted by CA narratives	**Likelihood of Sustainability**
Permanent fields	Less likely
Efficient input use	More likely
Agro-forestry	Less likely
Minimum tillage	More likely
Plant residue cover	Less likely
Herbicide use	Least likely
Diversified cropping rotation	Most likely

Source: Field Data (September, 2015).

Conversely, it was found that the transformation of agriculture from conventional system to conservation agricultural system has support from a diverse profile of actors. For instance, key informants from CFU reported that since promotion of CA began in Chibombo, its projects and programmes were being funded by donors especially the Royal Norwegian government. Some of the projects include Soil Conservation Agro-Forestry Extension (SCAFE), Conservation Agriculture Scaling Up for increased Productivity and Production (CASPP); and Conservation Agriculture Scaling Up (CASU). The Conservation Farming Unit (CFU) was found to be the main actor but it collaborated with the government through the Ministry of Agriculture Livestock and cooperatives, the Golden Valley Agriculture Research Trust (GART), International organisations such as World Vision and Environmental Africa Trust; and local non-Governmental Organisations (NGOs) such as Centre for Livelihoods and Watershed Management (CLWM), and Plan Zambia.

Civil society groups such as Cooperative League of the USA (CLUSA), Development Aid from People to People (DAPP), Agro-services, and private cotton companies such as North West Korea (NWK) formerly Dunavant, and the Cotton Association of Zambia were also cited as CA supporters in Chibombo District. It was also found that seed companies were involved in CA promotion. Among the actors involved in CA promotion, CFU had a leading role in training extension workers.

The study also shows that various methods were being used to disseminate CA messages to farmers. One of the methods was training farmers how to execute CA principles. Key informants from CFU for instance pointed out that since the commencement of the Conservation Agriculture Project in Chibombo during the 2006/2007 agricultural season to the 2014/2015 agricultural season, an average of 4 trainings were being conducted by CFU each season in each of the following catchment areas of the district; *Chibombo* central, *Chiyuni*, *Muchenje* and *Mwachisompola*. Each catchment area was under 30 farmer coordinators and each one of them was supposed to conduct 4 trainings. This implies that 120 farmer coordinators drawn from all the catchment areas conducted 960 trainings per season and a total of 3840 trainings during the period from 2006/2007 agricultural season to 2014/2015 agricultural season in the whole district. The structure of communication started with field officers who trained farmer coordinators to train farmers. Key informants from CFU reported that farmer coordinators received incentives in the form of agricultural input vouchers worth ZMW 1600 (US$ 160) as motivation from seed companies and agro-dealers which collaborated with CFU. Each farmer coordinator was also given a bicycle to ease their mobility.

Despite trainings being crucial; given the fact that farmers had to master new farm management practices, inadequate donor funding resulted to number of trainings being reduced to 3 in each catchment area. This scenario demands that development programmes should be designed in such a way that they should be able to function fully with or without external resources.

On the other hand, reports and accounts from FGDs and in-depth individual interviews showed that conservation agriculture practices were also being promoted through field days conducted between March and April every year. These were days when farmers would be invited by farmer coordinators to explore best performing CA fields in their catchment areas in order learn the success stories. Additionally, farmers' reports revealed that demonstration

plots of 50m x 50m in size were also set aside for showcasing CA practices and that farmers who managed these plots received free agricultural inputs.

The media also plays an important role in reinforcing CA messages on agriculture and development programmes but above all, CFU posters such as the one below advertise CA immeasurably in Zambia. The poster bears a positive statement which entails that CA is the way to go for the farmers because it works. Such posters are often strategically located to be seen by many people. The use of posters to advertise CA in Zambia departs from the common approaches of farmer field schools, field days and demonstration plots identified in studies by Kaumbutho and Kienzle (2007) in Laikipia District of Kenya; Shetto and Owenya (2007) in Arumeru District of Tanzania and Twomlow *et al*., (2008) in Masvingo District of Zimbabwe.

Figure 2: CFU Poster -Marketing Conservation Farming

(Source: Field data).

Worth noting also is that despite huge investment in CA promotion, the effectiveness of CA messages still remains questionable because socio-economic problems experienced by smallholder farmers force them to select some of the practices and leave out others. Meanwhile, because many actors are involved in CA promotion in Zambia and several avenues of promotion are used; smallholder farmers have continued to be exposed to the same CA practices even though some of them are incompatible with their socio-economic status. This seems to suggest that CA is intended to address only the needs identified by those promoting it and not the concerns identified by the farmers. This is in line with IDS (2006) and Sutton (1991) that illustrate how actors manage to reinforce and reiterate norms of conventional wisdom and suppress unconventional views through among other means; conferences, mass-media, and informal introductions. As a result, the application of CA and its intended benefits is likely to be restricted since farmers have limited resources to push their agendas in agricultural development.

5.2.2 Narratives linking CA and forest conservation

The results of this study show that the narratives that link CA and forestry conservation are sustainable agricultural intensification and agro-forestry narratives. The narrative of sustainable agricultural intensification linked CA to forest conservation through minimized expansion of agricultural land by using minimum tillage, diversified crop rotations and retention of crop residues to enhance nutrient cycling and for maximizing crop yields. According to this narrative, CA promoters perceived a reduction on farmer migration in search of fertile land and maintaining of relatively small agricultural land.

However, results from FGDs revealed that maintaining of permanent fields is less likely because land is not limiting in most parts of rural Zambia. Moreover, it was found that famers who had production assets such as rippers and oxen were motivated to expand agricultural land from less than a hectare to 1-2 hectares because the use of rippers was considered less labour intensive. Additionally, one farmer from the male only FGD pointed out that:

> I have expanded my field from 1 hectare to about 2 hectares because in meetings, farmer coordinators explained to us about the benefits we can get from CA even on a small plot but I am interested in getting more benefits….

Discussions with farmers revealed that the source of land for agricultural expansion was woodlands and reclamation from those who migrated to other places. On the other hand, the discussions with farmers also revealed that forests are not only threatened by agricultural expansion but also by charcoal production as an off-farm activity resulting from labour saving from ripping. This is contrary to the expectation from Campbell *et al.*, (2011) regarding the lack of involvement of CA farmers in supplementary but unsustainable income sources such as charcoal production because of sustainable agriculture intensification.

These findings from FGDs are in line with the claim of the key informant from the Forestry Department who described the state of forests in Chibombo as being depleted mainly due to increasing demand for agricultural land from the fast growing population. Furthermore, the findings of this study are similar to those of Angelson and Kaimowitz (2001); Sasaa (2003), and Rudel *et al.*,(2009) who claimed that raising incomes and the returns to agricultural activities can also provide incentives to convert forests to farmland and that technologies that are labour intensive can reduce the need to expand agricultural land. The results also fit into the *Jevon's paradox* (Blaike, 2008) which suggests that when technological progress increases the efficiency with which a resource is used, the rate of consumption of that resource rises because of increasing demand. For instance, as the efficiency of coal use by industry improved, thereby allowing for the production of more goods per unit of coal, total coal consumption increased. The findings about the narrative of intensification therefore suggest that social and economic systems may need to be modified if CA is to be translated into forestry conservation.

On the other hand, the main message of the agro-forestry narrative relates to the use of selected trees for soil fertility, food security, fire wood, folder, living fences and medicine. However, it was found that messages on soil fertility improvements were more dominant than those on forestry conservation in the promotion of CA. Additionally, CFU focussed more on the growing of *faidherbia albida* for soil fertility improvement than other types of trees such as; *sesbania sesban*, *tephrosia vogelii*, *gliriccidia sepium* among others. One key informant from CFU narrated that:

> *Faidherbia albida* improves soil structure by breaking the hard pan and it improves soil fertility when leaves drop and decompose thereby fixing nitrogen into the soil...

Conversely, discussions with farmers revealed that the sustainability of practicing agro-forestry is less likely despite them receiving training and tree species for free from CFU and the Forestry Department. There are many factors discouraging farmers to undertake agro-forestry. One male participant from the FDG comprising men and women noted that:

> Most of us here have not planted the trees being promoted by CFU because trees take long to mature, fires by unknown people are common and are a threat, growing trees is labour intensive as it involves watering and protecting them from damage by livestock and competes with land preparation activities…..

Kaumbutho and Kienzle (2007) also found that one of the restrictions to up scaling CA adoption among smallholder farmers in Kenya was that it takes several years for farmers to see benefits. In a study on the effects of *Faidherbia albida* on soil fertility in smallholder conservation agriculture systems in Eastern and Southern Zambia, Umar *et al* (2013) also established that the households found it challenging to achieve the recommended 100 trees per hectare due to among other reasons that it takes several years before full benefits can be reaped.

In addition, some of the female participants pointed out that tree planting is a domain for men. This gender perspective on tree planting can be attributed to the local culture in which men take a dominant role in decision making in certain activities such as natural resource management. That is why, despite being trained together with men on tree planting, it was unlikely that women would be actively involved in planting trees. The long maturity period for trees also precludes women involvement as traditionally, women do not own land in their own right. For married women, the norm is that they access land belonging to the husband, invariably from his family.

These results slightly differ from a study by Dodo (2007) on gender mainstreaming in forestry in Africa in which she found that although men dominated in decision making on farming practices starting from land preparation to marketing of tree products such as timber in Tanzania, both men and women participated equally in tree planting and maintenance. Therefore, the general negative attitude on agro-forestry coupled with the problems of residue retention in Chibombo district; implies that farmers will continue to depend more on

mineral fertilizer applications rather than on natural soil fertility improvements from *faidherbia albida.*

5.2.3. Climate change and adaptation narrative

The climate change and adaptation narrative linked CA and environmental conservation through better soil moisture management. Key informants from CFU reported that CA increases resilience of the agricultural system to extreme weather events through its principles of minimum tillage and retention of crop residues. For example, one key informant narrated that:

> While conventional tillage has no mechanism to harvest water and to use the water efficiently, CA through planting basins and ripped lines retains a lot of water. Water wastage through runoff and evaporation in CA is reduced through high infiltration capacity and crop residues which keep ground temperature low…

This narration is in line with the publications by CA supporters e.g. CFU (2007) and CFU (2009) in which CA is perceived as a mitigation and adaptation mechanism to climate change. However, farmers in FGDs reported that retaining crop residues was a problem because fields were often burnt by unknown people but occasionally also by the farmers themselves as a way to destroy stubborn weeds. Furthermore, some farmers reported that the need to retain crop residues competed with that of pasture for livestock reared by some famers. One male participant in the male only FGD for instance reported that:

> Pasture is difficult to find especially during the dry season so I bring residues of ground nuts, soya beans and sunflower home for my livestock...

The challenge of residues has also been reported by authors such as Baudron *et al.,* (2007) and Nyanga (2011). However, CA promoters still insist on residue retention through their framing which is centred on the positive effects of residues. Although this reflects the prioritisation of scientific knowledge and external expertise over local ecological knowledge, priorities and action, results also imply that the trade-off between livestock feed and residue retention will not be easy to resolve since livestock are generally an important part of the farming system in Chibombo district and Zambia at large.

On the other hand, farmers' experiences in this study supported CA's suitability as an adaptation to water deficit conditions, but not in times of excess rainfall. Focus group discussants for instance reported that during the dry spells of the 2013/2014 agriculture

season, CA fields were least affected by wilting and crop failure as opposed to fields where conventional tillage was maintained. But hand hoe based CA planting basins were reported to be more suitable than CA involving Animal Draft Power (ADP) ripping during years with less rainfall. In addition, some farmers observed that water holding capacity depended on soil type. One male participant from the male only FGD for instance reported that:

> Clay soil retains more moisture than sand soil and that yields are less affected in clay soil during dry spells…..

Farmers disagreed with the claim of CA's suitability in wetter years. For example, they reported that fields where CA was maintained became water logged and that the situation was worse in clay soil than sandy soil. Some of the farmers also observed that ripped fields were more resilient to flooding than those with planting basins. This can be attributed to the fact that in ripped fields, water drains away easily in the existing ripped lines as opposed to planting basins in which water collects and overflows. Besides, sandy soil does not retain more water than clay because it is more porous than clay soil and water percolates very easily.

To deal with the flooding situation in CA, some male participants reported that they make ridges in planting basins so that the water drains away through furrows between the ridges. However, some farmers did not do anything about the flooding problem. On the other hand, there was consensus between focus group discussants and key informants from CFU about yields being significantly reduced in water logged conditions except on anthills. This is because flooding least affects anthills in that water flows down the anthill to surrounding lower areas of the field. These findings suggest that the resilience of CA to extreme weather conditions through soil water management is likely to vary in accordance with the nature of the topography within and between CA fields. This is the more reason why yields are also likely to differ.

In addition, the finding on flooding in CA fields implies that its application in clay soils and in the very humid agro-ecological zone of Zambia is likely to be problematic. This is in line with Baudron *et al.*,(2007)'s position in which they argued that conservation agriculture as it stands today in Zambia is a technology of water harvesting and drought mitigation adapted to arid and semi-arid areas but not suited to wetter climatic conditions where it would lead to water logging. The findings are also comparable to those of Thierfelder and Wall (2010a)

who found that moisture retention was higher in CA fields than in ploughed fields and that water logging in the wetter years prevented better crop performance in Zambia and Zimbabwe field trials. On the other hand, the results of this study revealed a departure from the claim by Kassam *et al.,* (2015) of CA's suitability in very humid conditions with clay soil. These differences imply that CA's suitability should not be generalised but rather measured from local contexts.

5.2.4 The labour saving narrative on weed management

Key informants from CFU reported reduced labour costs on weed management. They pointed out that weed pressure was often lower in fields where CA was maintained than where conventional tillage was practiced because of the emphasis on use of herbicides such as *glyphosate* (N-(phosphonomethyl) glycine). For instance, one of the key informants pointed out that:

> Glyphosate is a non-selective herbicide which enables fast control of most annual and perennial plants over a large area. The use of herbicides in conjunction with crop residues reduce weed seed bank significantly as well as labour costs on weeding in the long run….

The narrative by key informants from CFU was supported by some of the farmers with the experience of herbicide use. However, farmers raised the concern that some weeds such as witch weed locally called *mulungwe* had built up resistance to *glyphosate* and explained that without herbicides, weed pressure was more in CA system than in conventional agriculture system. Moreover, farmers complained of herbicides being relatively expensive and requiring specialized equipment to apply. When asked on who was responsible for weeding, what came out from all the FGDs was that if it involved herbicides, men were responsible while women and children helped in fetching water for diluting herbicides accordingly and for bathing afterwards. But without herbicides, men were said to be less involved than women and children.

Although use of herbicides would make males get more involved in weed control than before, the findings in this study entail that herbicide use and hiring labour for weeding is unlikely. This is not only due to financial constraints among smallholder farmers but also lack of effective supply chain. Since weeding is culturally perceived as being a role of women (CFU, 1996), inadequate herbicide use implies an increase in the work load for women. In fact, it was found that more time was being spent on weeding in CA fields than

conventional fields in the absence of herbicides as revealed in the discussions with farmers. For example, one female participant in the female only FGD explained that:

> I used to take 2-3 days using conventional weeding methods on a 50m X 50m (1Lima) but now I take 3-7 days where I have maintained CA.

Additionally, even the accounts of participants in in-depth interviews showed that without herbicides, weeding was a challenge. For example, one male participant said:

> When I have access to herbicides, weed control in the whole field which is about 6 hectares takes me 3-4 days but without herbicides, three quarters of the field remains not weeded.

This result is comparable with that of Silici (2010) who found that the amount of labour required to weed the CA (*likoti*) fields using hoes was considerably higher than in conventional fields in Lesotho. Discussions with farmers also revealed that some farmers often reverted to conventional weeding methods which did not attract financial costs such as ploughing (locally called *kukofela*) and burning of fields during land preparation. This result is contrary to the assumption by CA promoters who claimed that farmers would eventually stop burning fields because herbicides would reduce weed infestation in the long run (CFU, 1996). On the other hand, some farmers engaged in cotton production reported that fields needed to be cleaned by fire to avoid the carry-over of pests and diseases. Thierfelder and Wall (2010b) also observed that by law, in most Southern African countries, cotton residues must be uprooted and burned after harvest but they maintained that these laws were developed based on conditions of conventional agriculture.

The actions of farmers, as part of CA stakeholders suggest a sense of urgency among them. They had a problem of weed pressure at hand that needed immediate action in order to reduce the risk of crop failure. Quite alright, they supported the priority of CA promoters to reduce labour costs related to weeding through herbicides but this good idea did not necessarily give them the push because they could not meet financial costs. These practices of farmers also reflect how difficult it is for financially constrained farmers to fully transform their practices from conventional to CA practices but rather to integrate the practices according to what they see fit based on their dominant indigenous knowledge, values and experiences.

Conversely, results show that the use of *atrazine* (2-chloro-4-ethylamino-6-isopropyl-amino-1-s-triazine) herbicide compromises with sustainable agriculture. For instance, farmers reported that *atrazine* remained active in the soil for a period of about 18 months and thus making it difficult for them to practice crop rotation and inter-cropping because it affected non-targeted plants. Moreover, farmers pointed out that some of plants which were also essential components of food security such as *Amaranthus hybridas* (*Bondwe*) and *Black jack* (*Kanunkha*) could not thrive.

This finding agrees with the studies by Solomon *et al.* (1996) and Ribaudo and Bouzaher (1994) that uncovered the impact of *atrazine* on non-target soil organisms and plants that were integral parts of ecosystems in the United States of America. According to these studies, the United States of America restricted the use of *atrazine* to prevent further environmental degradation. But in this study, *atrazine* was one of the herbicides farmers cited as being popular on the Zambian market. This implies that CA promoters such as CFU do not pay attention to negative effects of herbicides in their narratives. It further shows how crucial language is in influencing agricultural practices in that certain phrases such as 'herbicides reduce weed pressure' are not only appealing to agro-dealers' interests of having customers for profit making but also to farmers who would not want to struggle with weeds. However, the negative experiences of farmers with herbicides require that laws restricting use of herbicides that are not environmentally friendly should be upheld not only in the study area but also the whole country.

The results also show how processes of local participation in agricultural innovations can be seen as a power struggle among actors. By urging the farmers to adhere to all the CA practices including use of herbicides for weed control, actors stand out as the only ones with the necessary knowledge and expertise to develop achievable strategies concerning local agricultural practices. Their power and networking as government officials and politicians, donors and the research community helps them to legitimise their versions of reality on sustainable agricultural practices while undermining indigenous knowledge and experiences of the local farmers. However, the framing on herbicides ironically produced outcomes counter to the goals of conservationists. This is in line with Bixler (2013) who argued that any intervention that is inattentive to historical and geographical specifications, local conditions and local knowledge is likely to fail and stressed the need to engage local people and their knowledge in resource governance.

5.2.5 The narrative of diversified annual crop rotation

Key informant reports from CFU CA promoters supported the diversified annual crop rotation narrative involving a cereal, cash crop and a legume for increased agro-biodiversity. One of the key informants explained that such a combination of crops will result into increased food security, income and soil fertility. Discussions with farmers revealed that farmers have a diversified cropping system in which crops such as maize, groundnuts, beans, cotton, sunflower, soybeans, peas, sweet potatoes and cassava are grown.

Results further show that farmers practiced crop rotation though not on an annual basis and not on evenly proportioned areas. Crops such as maize always dominated each year due to farmers' preference for food crops and markets that favour particular crops such as maize and cotton. For instance a male farmer from the mixed FGD pointed out that:

> I cannot do without maize, so I grow maize every year and exchange it with cotton or ground nuts sometimes after a year or two years....

The inadequacy of crop rotation has also been reported by several authors such as Baudron *et al.,* (2007) in Monze-Choma area, Ngwira *et al.,* (2014) in Malawi and Umar and Nyanga (2014) in Central, Eastern and Southern provinces of Zambia in which farmers prioritized food security concerns and allocated larger proportions to Maize which is a staple food. To some extent, this practice by farmers is being influenced by government agricultural policies which have continued to concentrate more on maize marketing than other crops by making available maize seed and fertilizer through the Farm Input Support Programme (FISP) and the procurement of maize through the Food Reserve Agency (FRA).

Not practicing crop rotation consistently implies that crop yield is likely to reduce partly because the system becomes vulnerable to pests and diseases and due to inconsistent nutrient replacement. Additionally, the fact that fertilizer was reported to be costly by farmers means that its application will be limited. The *Faidherbia albida* tree which is the focus of soil fertility improvement also takes long to start producing the intended benefits. Focussing exclusively on one crop also has negative implications on the diversity of nutrients available in food which in fact; the FRA is supposed to promote by procuring a diversity of food crops.

Selective herbicides were also found to be incompatible with inter-cropping and crop rotation thus compromising with increase in agro-biodiversity and its intended environmental and economic benefits. This implies that smallholder farmers are likely to use mechanical weeding that is in less conflict with crop rotation as compared to herbicides. Below is a table that summarises the expected CA impact on the environment and smallholder farmer's practical experiences.

Table 2: Expected CA impacts on the environment and smallholder farmers' practical experiences

Expected CA impacts on the environment	**Smallholder farmers practical experiences**
Reduces loss of forests to agriculture due to increased production per hectare	Forests continue to be cut because of population increase and charcoal burning.
Agro-forestry increases forest cover and ecosystem services	Most farmers were not planting the trees recommended by CA promoters.
Increased resilience of crops to extreme climate and weather events.	Farmers reported high crop resilience in CA in the face of droughts and dry spells only.
Reduces weed seed in the soil	Weed pressure increased when herbicides were not used. Some farmers also reported an increase in weed resistance against herbicides
Increased agro-biodiversity and improved soil health	Farmers reported a reduction in biodiversity with herbicides use. Most crop residues are used as fodder and some are burnt

Source: Field data (September, 2015)

5.2.6 Sustainable livelihood through conservation agriculture

When asked about the benefits of CA for farmers, key informants from CFU pointed out that CA is designed to achieve a win-win situation for the environment and the farmer. One of them explained that by adhering to the three principles of minimum tillage, retention of crop residues and diversified crop rotations, soil health is maintained resulting into high yield for food security and income. He concluded that in this way, agriculture becomes a sustainable livelihood.

On the contrary, evidence from FGDs and in-depth interviews with farmers regarding CA as being a sustainable livelihood was mixed. Some farmers with productive assets such as rippers and oxen pointed out that CA has helped them to improve their welfare. The study shows that such farmers engaged in non-farm income earning activities including charcoal production, making bricks, sweet beer brewing and piece work. One male participant pointed out that:

> I can now pay school fees for my two children in boarding school, provide for my family adequate meals and take care of things such as soap, clothes….but was unable to do so before I started CA.

He further explained that labour saving in ripping enabled him to engage in surplus income earning activities such as trade in second hand clothes.

On the contrary, some farmers pointed out that lack of money for productive assets and agricultural inputs such as fertilizer and herbicides were major limitations to improving their welfare through CA. Results show that farmers with inadequate agricultural resources were restricted to digging planting basins as a form of tillage with a *Chaka* hoe and hand hoe weeding which were reported as being labour intensive. This finding is more certain than not going to make it very difficult for smallholder farmers to do away with relatively cheap but environmentally damaging practices such burning fields during land preparation. Similarly, Kaumbutho and Kienzle (2007) found that inaccessibility, unavailability and high cost of equipment for conservation agriculture were the biggest hindrances among smallholder farmers to adopt CA practice and break the cycle of poverty in Laikipia district. This shows how necessary it is for actors involved in CA promotion to provide an enabling environment in which smallholder farmers can switch to CA fairly easily.

Therefore, despite some authors such as CFU (2007; 2009) and Kassam *et al*., (2009) claiming that CA is a sustainable livelihood suitable for all farmers including the poor and vulnerable with limited access to ADP, these findings entail that CA can be a sustainable livelihood when farmers have access to and control over various forms of capital such as appropriate production assets, timely access to inputs and viable credit facilities.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

This study examined the linkages between conservation agriculture narratives and environmental conservation in terms of forest conservation; soil moisture; weeds and agro-biodiversity in Chibombo District. Results show that CA and environmental conservation are linked through narratives of agro-forestry, agricultural intensification, climate change and adaptation; agricultural labour saving related to weeding and agro-biodiversity. These narratives are being supported and reinforced by a diverse range of actors who have the resources to push their agendas in agricultural development.

Although these narratives imply increased environmental conservation through CA, the evidence based on farmers' experiences show some variances from the narratives. For example, farmers had negative attitudes towards agro-forestry and they continued to expand agricultural land. Additionally, although CA was being framed by the promoters as being suitable in all climatic regions of the world including very wet regions, the farmers' narrative was that CA was suitable only during rainfall deficit. This is because they experienced water logging and low yields when rains were excessive.

Reduced labour related to weeding was also only limited to farmers who used herbicides while some weeds were reported as having built up resistance to herbicides. Farmers also found herbicides relatively expensive and ended up reverting to conventional weed control methods such burning during land preparation. This implies that smallholder famers do not see CA as a substitute to conventional agricultural systems but as a complement.

Although farmers grew several types of crops, their practice of annual crop rotation was inconsistent largely because of the residual effects of herbicides and government policies that have continued to attach more importance to input support programmes and marketing to maize than other crops. The variances found in this study will not only limit CA's contribution towards environmental conservation but also food security. Additionally, the

variances prove that CA ideas and practices from elsewhere are not all applicable among a diverse range of farming communities in Chibombo district and cannot be transferred blindly. Hence, this study recommends the following:

1. Policy makers should devise appropriate policies relating to CA that will target the right farming communities by scrutinizing narratives and not just repeat the claims even when they do not fit with the local context.
2. Future policies and donor projects should allow flexibility in CA packaging because farmers make decisions to adopt or not; based on individual components of CA and not CA as a package.
3. CA supporters should link agricultural transformation efforts to markets.
4. Research into herbicides with minimal residual effects should be encouraged by both public and private actors promoting CA so that the principle of crop rotation is not compromised.
5. Allow mutual learning between smallholder farmers and scientists as they adapt the CA practices to local contexts.

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APPENDICES

Appendix 1: Focus group discussions

Date: _____Village:_____

Section A:

1.0. Focus Group Introduction

Welcome

Thanks for agreeing to be part of the focus group. We appreciate your willingness to participate.

Introductions

Moderator; assistant moderators

1.1. Purpose of Focus Groups

The reason we are having these focus groups is to find out your experiences on Conservation Agriculture.

We need your input and want you to share your honest and open thoughts with us.

1.2 Ground Rules

1**. We want you to do the talking.**

We would like everyone to participate.

You may be called upon if you haven't said anything in a while.

2. **There is no right or wrong answer**

Every person's experiences and opinions are important.

Speak up whether you agree or disagree.

We want to hear a wide range of opinions.

3. **What is said in this place stays here**

We want people to feel comfortable sharing when sensitive issues come up.

4. We will be tape recording the group

We want to capture everything you have to say.

We don't identify anyone by name in our report. You will remain anonymous.

Section B:

Discussion Questions

OBJECTIVE I: To examine the dominant narrative linking conservation agriculture and environmental conservation.

What farmers are taught:

1. Which organisations are promoting CA in this area?
2. Tell us about what you have been taught concerning characteristics that make up Conservation Agriculture (CA)?
3. Describe CA tillage methods promoted in this area?
4. How is knowledge about CA being promoted? Probe on recruitment of farmers, number of training, incentives if given e.g. type, whether it is indefinite/ not and reasons[farmers to give details]
5. What do promoters teach you about the benefits of CA? [probe on CA positive impact on the following if not mentioned]
    a) Forest conservation?
    b) Weed pressure?
    c) Soil moisture?
    d) Agro-biodiversity?

OBJECTIVE 2: To assess the evidence associated with the linkages between Conservation Agricultural practices and environmental conservation.

Experience/Practice in Relation To:

A. Forest conservation

6. In what ways have you contributed to forest conservation? Probe on tree planting in fields, species planted and why those species
7. Have any of you expanded the area under CA since you came to know about it? Probe on drivers of expansion and where land for expansion came from.
8. Have any of you reduced the area under CA since you came to know about it? Probe for reasons.

B. Weed pressure and labour

9. At what time of the year do you do land preparation for farming? Probe for reasons.
10. How do you get rid of weeds in your fields?
11. Who is responsible for weeding? Probe for reasons.
12. What is your assessment on weed pressure in your fields from the time you started practicing CA as compared to before? Probe for reasons.

C. Soil moisture

13. What is your experience in fields under CA when there is:
    I. Excessive rainfall?
    II. Dry spell?
    III. Normal rainfall?
14. What do you attribute your experiences in 13 to?
15. Do you leave crop residue on your fields? Probe for reasons
16. Do you have people practicing conservation agriculture in this village who still burn crop residue? Probe why/why not

D. Agro-biodiversity

17. Tell us about the types of crops you grow and why?
18. Do you practice crop rotation? Probe on frequency of rotation, extent of rotation, crops used and reasons of rotation.

OBJECTIVE 3: To identify implications of the linkages between conservation agriculture and environmental conservation on the livelihoods of smallholder conservation farmers in Chibombo District.

19. Think back over all the years that you have participated in CA and tell us how you have benefitted.
20. If you were inviting a friend to participate in CA, what would you say in the invitation?
21. Tell us about disappointments you have had with CA.

THANK YOU

Appendix 2: Interview guide for key informants

A. Conservation agriculture regional coordinator

Dominant narratives

1. Why is CA being promoted in Chibombo? Probe on when promotion started and other organisations that promote CA and how they collaborate.
2. What do you teach farmers in this area? Probe on the following if not mentioned
    a) Forest conservation and consider species they recommend and why
    b) Weed control and labour requirements.
    c) Soil moisture (Probe on CA performance when there is excessive rainfall, dry spell, normal rains across tillage types and compared with conventional).
    d) Agro-biodiversity. (Consider crops they encourage and why).
3. How do you ensure that farmers do what you teach them? (Probe on why some farmers are not adopting CA, how CA messages are conveyed to farmers, recruitment of farmers, incen**t**ives, number of trainings).

Evidence/ practices

4. What forms of minimum tillage are common among farmers in this area? Probe for reasons, how much labour is involved, also find out about farmers who do both CA and conventional and why
5. What is your assessment regarding planting of trees on farms in this area? (Probe for reasons, types of trees and why, and on collaboration with forestry department).
6. What crops do farmers who practice CA grow in this area? (Probe on profitability of crops, susceptibility to pests and diseases and control, type of weeds and how they are controlled, how much labour is involved).
7. What is your assessment on weed pressure in fields where CA is practiced? (Probe for associated reasons).
8. How would you compare maize yields from CA fields with those under conventional tillage when there is excessive rainfall, dry spell and normal rains? Probe also on yield variations if any within CA tillage and reasons.

Implications on livelihoods

9. How has CA in this area benefitted the smallholder farmers?

B. Forestry Department

Dominant narrative

1. Describe the major threats to forest conservation in this area?
2. What measures have you put in place to deal with these threats? (Probe on collaboration with other organisations / institutions).
3. In what ways could agriculture and forest conservation co-exist to enhance the benefits of both?

Practices/evidence

4. How would you describe the practice of agro-forestry in this area? (Probe on people's attitudes, species involved and why, who supplies, and what criterion is used to supply; and on effects if more / less trees are planted).

Implication on livelihoods

5. In what ways has agro-forestry as practiced in this area affected the livelihoods of the people?

C. Field Officer

Dominant narrative

1. Why is CA being promoted in *Chibombo* District? (Probe on when promotion started and other organisations that promote CA and on collaboration).

2. What do you teach farmers in this area? Probe on the following if not mentioned

a) Forest conservation. (Consider agro-forestry, species they recommend and why).
b) Weed control and labour requirements (Probe on the effects of herbicides on the environment)
c) Soil moisture (consider productivity variations when there is excessive rainfall, dry spell, normal rains within CA and in conventional).
d) Agro-biodiversity .(consider crops they encourage and why)

3. How do you ensure that farmers do what you teach them? (Probe on how CA messages are conveyed to farmers, recruitment of farmers, incentives, number of trainings).

Evidence/practice

4. What forms of minimum tillage are common among farmers in this area? (Probe for reasons, also find out why farmers do both CA and conventional and even stop CA).
5. What is your assessment regarding agro-forestry in this area? (Probe on types of trees involved and why and on collaboration with forestry department).
6. What crops do farmers who practice CA mostly grow in this area? Probe on market for crops, crop rotation and its extent and associated reasons).
7. How would you compare maize yields from CA fields with those of conventional tillage when there is excessive rainfall, dry spell and normal rains? (Probe for variations if any within basin CA tillage and ripping and reasons).
8. What is your assessment on weed pressure among the farmers who practice CA compared to those under conventional tillage system? (Probe for associated reasons).

Implications on livelihoods

9. What positive impact have you seen in the lives of farmers who practice CA?

THANK YOU.