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Conservation Agriculture, Climate Change Adaptation and the Environment:

Analysis of the Determinants of Adoption, Non-Adoption and Dis-Adoption of Conservation Agriculture - The Case of Smallholder Farmers in Zambia

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Patrick Mungaila

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Members of the Examining Committee:

Dr. Murat Arsel

Dr. Oane Visser

The Hague, The Netherlands
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Disclaimer:

Inquiries:

International Institute of Social Studies
P.O. Box 29776
2502 LT The Hague
The Netherlands

t: +31 70 426 0460
e: info@iss.nl
w: www.iss.nl
fb: http://www.facebook.com/iss.nl
twitter: @issnl

Location:

Kortenaerkade 12
2518 AX The Hague
The Netherlands

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List of Acronyms

ACT	African Conservation Tillage Network
ADP	Animal Draft Power
AEZ	Agro-Ecological Zone
AGRA	Alliance for a Green Revolution in Africa
CA	Conservation Agriculture
CASU	Conservation Agriculture Scaling-Up
CF	Conventional Farming
CFS	Crop Forecast Survey
CFU	Conservation Farming Unit
CGIAR	Consultative Group for International Agricultural Research
CLUSA	Cooperative League of the USA
CSA	Climate-smart Agriculture
CSO	Central Statistical Office
CT	Conservation Tillage
CWWZ	Concern Worldwide Zambia
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FISP	Farmer Input Support Program
FF	Follower Farmer
GART	Golden Valley Agricultural Research Trust
IAPRI	Indaba Agricultural Policy Research Institute
IFAD	International Fund for Agricultural Development
IIRR	International Institute of Rural Reconstruction
IMAG	Institute of Agricultural and Environmental Engineering
ISS	International Institute of Social Studies
LF	Lead Farmer
LM&CF	Land Management and Conservation Farming
MACO	Ministry of Agriculture and Cooperatives
MAL	Ministry of Agriculture and Livestock

MCDMCH	Ministry of Community Development, Mother and Child Health
MCDSW	Ministry of Community Development and Social Welfare
MoA	Ministry of Agriculture
MT	Minimum Tillage
NAIP	National Agriculture Investment Plan
NAP	National Agricultural Policy
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
PAM	Programme Against Malnutrition
PHS	Post Harvest Survey
RALS	Rural Agricultural Livelihoods Survey
RNE	Royal Norwegian Embassy
SCAFE	Soil Conservation and Agroforestry Extension
7th NDP	Seventh National Development Plan
SSA	Sub-Saharan Africa
WFP	World Food Programme
ZNFU	Zambia National Farmers Union

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Abstract

Smallholder farming in Zambia has been negatively affected by low agricultural productivity due to declining soil fertility and land degradation caused by unsustainable agricultural practices and the adverse impacts of climate change and variability. In recognition of these challenges, the government and other stakeholders in Zambia have been putting up measures to address these problems by investing more in sustainable agriculture and Climate-Smart Agriculture practices such as Conservation Agriculture and Agroforestry. Over the past three decades, Conservation Farming has been vigorously promoted by the government, donors, international agencies, NGOs and other stakeholders in Zambia. Despite several years of promotion, the adoption of Conservation Farming practices by smallholder farmers has been generally low, whereas non-adoption and dis-adoption of this farming innovation have also been reported. This study was undertaken to examine the factors influencing the adoption, non-adoption, and dis-adoption of Conservation Farming among smallholder farmers in Zambia and to understand how peasant farmers make their decisions regarding the adoption of Conservation Farming practices within their socio-economic and agro-ecological contexts. The study employed the cross-case study methodology to collect and analyse both qualitative and quantitative data by reviewing several single-case studies and making comparative analyses between cases. This study has established that the factors triggering adoption, non-adoption, and dis-adoption of Conservation Agriculture in Zambia are caused by a convergence of determinants mainly agro-ecological, institutional, socio-economic and cultural contexts of smallholder farmers in Zambia. Household characteristics such as age, gender, household size, land size, and household assets tend to have positive influences on the adoption of Conservation Farming among smallholder farmers. Therefore, this study argues that future Conservation Agriculture projects could benefit more smallholder farmers by addressing the major constraints to full CA adoption which farmers are facing, in ways that take into account their socio-economic and cultural contexts as well as smallholder farmers' adoption decisions.

Relevance to Development Studies

The adverse impacts of climate change and variability are causing major challenges to smallholder agricultural productivity and household food security, and consequently affecting rural livelihoods in most Sub-Saharan African countries including Zambia. This has prompted policymakers and development practitioners to advocate for Climate-Smart Agriculture (CSA) practices. Many governments in Sub-Saharan Africa and international donors have developed substantial efforts and initiatives to scale-up CSA technologies including Conservation Agriculture practices to increase agricultural productivity, improve household food security and incomes and facilitate adaptation to climate change in smallholder farming.

Over the past decades, Conservation Agriculture (CA) has gained prominence and is increasingly recognized as an important paradigm in development projects and policy debates on sustainable agricultural development. From this perspective, this study examined the underlying determinants of adoption, non-adoption, and dis-adoption of Conservation Agriculture among Smallholder Farmers in Zambia to explain the reasons why adoption of this agricultural innovation has remained low despite several potential benefits that CA promises and the vigorous CA promotional projects by government, donors, NGOs and the private sector in Zambia. It is envisaged that the findings from this study will contribute to the wider debates surrounding CA adoption among smallholder farmers in Zambia.

Keywords

Conservation Agriculture, Conservation Farming, Minimum Tillage, Climate-Smart Agriculture, Adoption, Dis-Adoption, Climate Change Adaptation, Zambia.

Chapter One: Background and Context of the Study

The first chapter provides the background information which sets the analytical basis for the subsequent chapters in this research paper. It highlights the overall context and situates Conservation Agriculture in Sub-Saharan Africa in general and specifically focuses on the promotion and adoption of Conservation Farming among smallholder farmers in Zambia. The chapter also discusses the agricultural sector and the policy actions related to Conservation Agriculture in Zambia. This chapter also highlights the research problem, rationale of the study and sets out the objectives of this research and the research questions. It further outlines the study areas, the methodology used as well as data sources, the methods of data analysis, limitations of this study and an overview of chapters.

1.1 Conservation Agriculture in Sub-Saharan Africa

The overriding problem of widespread soil degradation in Sub-Saharan Africa has been attributed to human-induced activities resulting from unsustainable land-use practices by resource-poor farmers and consequently their failure to integrate appropriate and sustainable soil conservation practices in farming systems (Umar et al. 2011, Mortimore & Harris 2005). Some studies have shown that Conventional Tillage methods cause deterioration of soil organic matter, water run-off and soil erosion (Umar et al. 2011, Hobbs, 2007). Consequently, soil fertility depletion has become one of the major biophysical causes of low per-capita food production in Africa (Umar et al. 2011, Sanchez 2002). This situation is exacerbated by climate change impacts which are adversely affecting agricultural productivity especially smallholder farmers who are most vulnerable to climate change and variability (Murray et al. 2016).

Climatic models predict that most regions in Southern Africa will be adversely affected by future climatic changes due to higher temperatures, intensified heat, increased frequency and severity of drought which affects crop production if adaptation measures are not integrated into farming systems (Thierfelder and Wall 2010:113). Therefore, future threats of climate change and variability in Southern African countries, coupled with accelerated soil degradation in these regions require more concerted efforts for sustainable Climate-Smart Agriculture (CSA) practices (Thierfelder et al. 2016).

Due to the adverse climatic conditions, several studies have suggested that there is "need to simultaneously improve agricultural productivity and reduce yield variability over time" and the Food and Agricultural Organisation proposes that this could be achieved through increased use of CSA practices (Kaczan et al. 2013:3, FAO 2010). FAO has been actively promoting Conservation Agriculture in many countries as one of the Climate-Smart Agriculture technologies and practices aimed at increasing farmers' agricultural productivity and farm profits, improving food security and environmental sustainably (Arslan et al. 2013, FAO

2013). Therefore, Conservation Agriculture is considered as a farming innovation[1] that helps to address key challenges faced by smallholder farmers by increasing agricultural productivity and incomes, improving household food security, restoring soil fertility, reducing land degradation and adapting to climate change (FAO 2001, Haggblade and Tembo 2003, Giller et al. 2009, IIRR and ACT 2005, Mazvimavi 2011). From this perspective, Conservation Agriculture has been vigorously promoted by several governments, donors and NGOs for offering potential solutions of tackling soil fertility decline, improving crop productivity and household food security, and mitigating the effects of seasonal drought (Thierfelder and Wall 2010, FAO 2001, CFU 2006).

In Sub-Saharan Africa, Conservation Agriculture emerged during the early 1990s and has since been vigorously promoted by several international and national organizations among smallholder farmers to address soil fertility degradation and low agricultural productivity (Arslan et al. 2013, Giller et al. 2009, IIRR and ACT 2005, Mazvimavi 2011). While Conservation Agriculture has been commended as a panacea to increase agricultural yields, help mitigate the effects of climate change and reverse land degradation in Sub-Saharan Africa, its low levels of adoption have raised concerns about its suitability for smallholder farming systems (Grabowski et al. 2016, Giller et al. 2009). Studies have shown that the adoption of Conservation Agriculture among smallholder farmers in Sub-Saharan Africa has been generally low despite showing benefits of increased yields after the restoration of soil fertility in the medium to long-term of continuous usage of Conservation Farming practices (Giller et al. 2009, Goeb 2013).

1.2 Conservation Agriculture in Zambia

Compared to other countries with similar climatic conditions in Southern Africa, Zambia is generally considered successful in the way smallholder farmers have embraced and adopted Conservation Farming although adoption rates have also remained low considering its potential benefits and large amounts of resources spent on CA promotion (Arslan et al. 2013, Haggblade and Tembo 2003, IFAD 2011, Baudron et al. 2007).

Since the early 1990s, Conservation Agriculture has been widely promoted in Zambia as *Conservation Farming*[2] by the government, donors, NGOs, the private sector and other stakeholders as a farming innovation that has the potential to increase crop productivity, improve household food security and incomes whilst restoring soil fertility, reducing soil degradation and adapting to climate change (FAO 2001, Haggblade and Tembo 2003, CFU 2009, Ngoma et al. 2014). The

[1] *'Innovation'* is "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" (Rogers 2003:12).

[2] *Conservation Farming* refers to the specific form of Conservation Agriculture promoted by CFU in Zambia (CFU 2007). The terms '*Conservation Agriculture*' and '*Conservation Farming*' have often been used interchangeably in general literature (Mazvimavi and Twomlow 2009).

Conservation Farming Unit (CFU) in Zambia has been in the forefront promoting Conservation Farming as a combination package of farming practices comprising;- "(i) reduced tillage or minimum tillage of not more than 15% of the cultivated field area without soil inversion, (ii) precise digging of permanent planting basins using hand-hoes or ripping the soil using a *'Magoye Ripper*[3]*'*(applicable where farmers use animal draft power), (iii) retention of crop residues on the fields (no burning) (iv) crop rotations of cereals with legumes and (v) early dry season land preparation before the onset of the rainy season" (CFU 2007, CFU 2009).

1.3 The Agricultural Sector in Zambia

The agricultural sector in Zambia has a huge potential for promoting economic growth. The country has an estimated total land area of 74 million hectares, out of which about 42 million hectares (58 % of total land area) are suitable for agriculture (Braimoh et al. 2018, World Bank 2018). However, only 14% of the land suitable for agriculture is cultivated for agricultural production (Braimoh et al. 2018, NAP 2012-2030). Agriculture in Zambia is predominantly rain-fed. This implies that "natural disasters such as excessive rains, flooding, and droughts or prolonged dry spells drive agricultural production failures that are the most common cause of food insecurity" (FEWS NET 2014:10).

Agriculture is a key priority sector recognized by the Government of Zambia for promoting economic growth, reducing poverty and creating employment for most of the country's population (Chapoto et al. 2017). Some of the main objectives of the National Agricultural Policy in Zambia are to achieve national and household food security and generate income and employment (NAP 2004-2015, NAP 2012-2030). According to the Central Statistical Office, the agriculture sector provides the main source of livelihood for 89.4% of rural households who are mostly engaged in agricultural activities (CSO 2015:68). Statistics also indicate that an estimated 49% of Zambia's population is dependent on agriculture through engagement in smallholder agricultural production which is the major source of livelihoods and employment in rural areas (Chapoto et al. 2017, CSO 2015).

According to the Ministry of Agriculture, Zambia's agriculture comprises three (3) categories of farmers who are characterized based on the 'size of farmland' that they own and cultivate (MAFF 2000). These categories are; small-scale farmers, medium-scale farmers, and large-scale commercial farmers. Small-scale farmers constitute most of the farming population and cultivate up to 5 hectares of land. Medium-scale farmers cultivate between 5 to 20 hectares of land while large-scale commercial farmers who constitute the smallest proportion of farming population cultivate more than 20 hectares of land (MAFF 2000, CSO 2001).

[3] *Magoye Ripper* is a CF implement used for "ripping or opening a narrow furrow in the soil surface (about 5-10cm deep, ripped lines are spaced 75-90cm apart) for sowing seeds either by hand or a mechanical planter attached to a ripper" in Zambia (CFU 2007)

Therefore, Zambia's agriculture is dominated by smallholder[4] farmers who account for more than 70% of the total farming population. Most of the smallholder farmers are subsistence producers who grow maize and other crops under rainfed conditions for consumption and sometimes produce maize surpluses and a few cash crops for sale in the markets. About 89.4% of farming households in Zambia grow maize (the country's staple food crop) followed by other significant crops such as cassava, groundnuts, cotton, mixed beans, millet and sweet potatoes (RALS 2015:27). Therefore, the largest share of maize in the country is produced by smallholder farmers who play a significant role in Zambia's agriculture sector (CSO 2015; RALS 2015).

However, the performance of the agriculture sector and its contribution to the Gross Domestic Product (GDP) in Zambia has declined since 2004 (Chapoto et al. 2017). For example, the agriculture sector's contribution to GDP decreased from 15% to 12.5% between 2004 and 2009 (NAP 2012-2030). In addition, there have been fluctuations in the output of major crops grown by smallholder farmers especially rain-fed maize which is the country's staple food crop. This has been attributed to several factors such as declining soil fertility and the impacts of climate change (droughts, floods, and high temperatures) which have continued to adversely affect Agriculture in Zambia. These factors have affected the food security situation despite occasional surpluses which the country produces during favourable farming seasons. Household food insecurity is more prevalent among the rural population with poverty rates remaining persistently high at 76.6% in the rural areas (CSO 2015:104).

1.3.1 Agricultural Policy and Conservation Agriculture in Zambia

The Government of Zambia recognizes the importance of Conservation Agriculture in the agriculture sector. For instance, in 1998 the Ministry of Agriculture, Food and Fisheries (MAFF[5]) officially declared that Conservation Agriculture was significant for increasing agricultural productivity and improving food security in Zambia and it was later adopted in the national agricultural policy (Haggblade and Tembo 2003, MAFF 2001, Baudron et.al 2007). Since then, the Zambian Government has been supporting Conservation Farming activities through the Ministry of Agriculture by promoting Conservation Agriculture and climate-sensitive agriculture (FAO 2018, CASU 2017). This is evident through Government support on Conservation Agriculture in Zambia such as policy pronouncements, the formation of the National Conservation Agriculture Task Force (in 2008), facilitation of various workshops and conducting demonstrations and field day activities on Conservation Farming (Baudron et.al 2007, Whiteside 2011).

[4] *Smallholder farmers* comprise both small-scale and medium-scale farmers in Zambia (Chomba 2004). See the above definitions for each category of farmers.
[5] *MAFF* was later restructured by the Government of Zambia into Ministry of Agriculture and Cooperatives (MACO), later changed to Ministry of Agriculture and Livestock (MAL) and recently into Ministry of Agriculture (MoA).

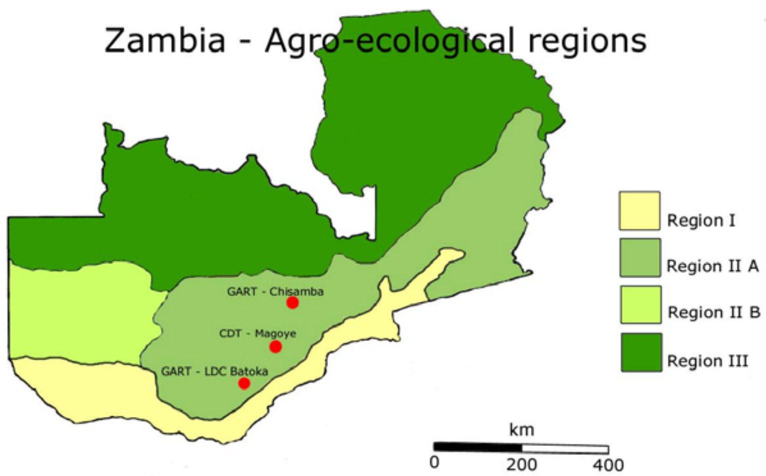
Efforts to promote CA were further substantially increased with the integration of CA into Zambia's National Development Plan (2011-2015) as part of government's strategy for climate-change adaptation and mitigation (Chuluunbaatar and Vishnu 2018). In 2013, Zambia also launched the 2014-2018 National Agriculture Investment Plan (NAIP) which set a target to raise 25% of small-scale farmers adopting Conservation Agriculture by 2018 from a baseline of 10% in 2013 (Chuluunbaatar and Vishnu 2018, FAO 2018). The Seventh National Development Plan also emphasizes the need to put more efforts on climate change adaptation and mitigation strategies to minimize the impacts on the agriculture sector in Zambia (7thNDP 2017-2021). In this perspective, the Zambian Government has been actively promoting the adoption of sustainable agriculture and environmentally friendly practices such as Conservation Farming and Agroforestry. Conservation Agriculture fits into the broader framework of Climate-Smart Agriculture and with FAO's support, Zambia has incorporated CSA technologies in the Seventh National Development Plan 2017-2021 for climate change adaptation and mitigation (Chuluunbaatar and Vishnu 2018, FAO 2018).

1.3.2 Zambia's Agro-Ecological Zones

Agro-Ecological Zones (AEZ) are defined as areas with "similar combinations of climate and soil characteristics, and similar physical potentials for agricultural production" (FAO 1996:9). FAO developed the AEZ methodology which generates data about "an evaluation of biophysical limitations and crop production potential of major food and fibre crops, under various levels of inputs and management conditions" (Fischer et al. 2002:4).

Zambia is divided into three (3) distinct Agro-Ecological Regions; Region I, Region II and Region III as shown in Figure 1. In Zambia, the criteria for Agro-Ecological Zoning are based on climatic characteristics largely the amount of rainfall received per year (Jain 2007). Agro-Ecological Zone II is further divided into two: Region IIa and Region IIb based on similar rainfall patterns but with different soil characteristics (see Appendix 1 for details of the major characteristics of Zambia's Agro-Ecological Zones).

Figure 1: Map of Zambia's Agro-Ecological Zones



Source: thezambianagropreneur.files.wordpress.com

1.4 Problem Statement

The agricultural sector in Zambia especially smallholder farming has been negatively affected by low agricultural productivity due to declining soil fertility and land degradation (NAP 2004-2015, NAP 2012-2030). Soil degradation has mainly been caused by unsustainable agricultural practices such as intensive Conventional Tillage methods during continuous ploughing causing plow pans and soil erosion; inadequate soil cover crops; burning of crop residues therefore reducing soil organic material; continuous high-input application of chemical fertilizers for maize mono-cropping and not practicing crop rotations (Andersson and D'Souza 2014:118, Aagaard 2010:1, Baudron et al. 2007:7, Haggblade and Tembo 2003b:8). In recent years, smallholder farmers have been severely affected by the adverse impacts of climate change which have exacerbated their agricultural production and productivity due to erratic rainfall conditions such as drought, floods and rising temperatures especially in the Southern, Central, Eastern and Western Provinces of Zambia which receive low to moderate rainfall (NAP 2012-2030, 7thNDP 2017-2021). These factors have contributed to the decline in agricultural productivity and consequently increasing poverty and food insecurity among rural households in Zambia.

Despite several years of vigorous promotion of Conservation Farming by the government, donors, international agencies, NGOs and other stakeholders in Zambia, the adoption[6] of Conservation Farming practices by smallholder farmers has been generally low, whereas non-adoption and dis-adoption[7] of this farming innovation have also been reported (Arslan et al. 2013, Baudron et al. 2007, Haggblade and Tembo 2003, Ngoma et al. 2014, Zulu-Mbata et al. 2016). This phenomenon raises questions why Conservation Farming adoption among smallholder farmers in Zambia has remained low despite its potential agricultural and environmental benefits and the vigorous promotional efforts of CA by various stakeholders.

1.5 Rationale of the Study

In recognition of the challenges of low agricultural production and productivity coupled with the impacts of climate change, the government and other stakeholders in Zambia have been putting up measures to address these agricultural and environmental problems by investment more in sustainable agriculture practices that conserve natural resources, improve soil fertility and help farmers to adapt to climate change so that farmers develop more sustainable and higher agricultural yields (NAP 2012-2030, 7thNDP 2017-2021).

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[6] *Adoption* refers to "a decision to make full use of an innovation as the best course of action available" (Rogers 2003:177).

[7] '*Dis-adoption' or* '*relapse'* refers to a *discontinuation* of Conservation Farming practices after farmers adopted it.

In Zambia, several studies have shown the potential benefits of Conservation Farming especially in the medium to long-term such as increased yields in smallholder farming whilst rebuilding soil fertility (CFU 2009, Haggblade and Tembo 2003, Langmead 2002) and have established the agro-ecological conditions suitable for Conservation Farming in Zambia (CFU 2009, Langmead 2002). While most studies have focused on the agronomic and technical aspects to demonstrate the agricultural and environmental benefits of Conservation Farming, not much research has been done to fully understand and explain the factors influencing the *'adoption', 'non-adoption' and 'dis-adoption' (or relapse)* of Conservation Farming that is being vigorously promoted among smallholder farmers in Zambia. This study is motivated by the need to identify and examine these factors and it is envisaged that this study will contribute to the existing repository of knowledge on the emerging debates regarding the role of Conservation Farming as a pathway to increasing agricultural productivity and adaption to climate change among smallholder farmers. It is envisaged that the findings and recommendations from this study will be useful for informing future exploratory research by other scholars, development practitioners, and policy-makers.

1.6 Research Objectives

The main study objective was to examine the factors influencing the *adoption, non-adoption, and dis-adoption* of Conservation Farming among smallholder farmers in Zambia by analyzing the factors that determine peasant farmers' decisions in the adoption of Conservation Farming practices.

The specific objectives of the study were;

1. To examine the factors influencing the adoption, non-adoption, and dis-adoption (or relapse) of Conservation Farming among smallholder farmers in Zambia.
2. To examine the implications of Conservation Agriculture programmes and projects supported by the government, donors, NGOs and the private sector in Zambia and how these interventions influence the adoption of Conservation Farming among smallholder farmers in Zambia.

1.6.1 Research Questions

This study focused on answering the following fundamental research question; "What are the factors influencing the 'adoption', 'non-adoption' and 'dis-adoption' of Conservation Farming among smallholder farmers in Zambia?"

Specifically, this study focused on answering the following sub-research questions;

1. To what extent do Conservation Agriculture programmes and projects supported by the government, donors, NGOs and the private sector in Zambia influence the adoption of Conservation Farming among smallholder farmers?
2. What are the adoption trends in Conservation Farming among smallholder farmers in Zambia – and in which agro-ecological regions?
3. What factors influence the adoption, non-adoption and dis-adoption of Conservation Farming practices among smallholder farmers in Zambia?

1.7 Research Methodology

This study used the *cross-case study* methodology to generate relevant data which enabled the researcher to make comparative analyses by drawing evidence based on *document analysis* from selected *single-case studies*. Gerring (2011:12) illustrates the value of using the *cross-case study* approach – that it tends to be "more representative of the population of interest…which is good for external validity than research using a *single-case study*". Furthermore, the *cross-case study* method is not limited to only one study area and therefore, it offers a broader understanding and in-depth analysis of the research problem which allows a broader scale generalization" (ibid.). From this perspective, this study used the *cross-case study* method to examine several *single-case studies* and three major Conservation Farming projects in Zambia that have been implemented in Agro-Ecological Regions I and II. Relevant *single-case studies* were selected while conducting a literature review. The selection criteria were based on (i) those *cases* that were conducted in the needy areas in Agro-Ecological Regions I and II (ii) *case studies* with relatively large and representative samples and (iii) the methodology used in data collection and analysis. Similarly, the selection criteria of Conservation Farming projects were based on *relatively* large-scale CA projects with more beneficiary coverage and those that were geographical spread within Agro-Ecological Regions I and II where CA activities have mostly been implemented since the early 1990s.

The use of *cross-case studies* enabled the researcher to make a comparative inquiry between *cases* and to explore the commonalities and disparities to capture the multiple factors that affect smallholder farmers' decisions in the adoption, non-adoption, and dis-adoption of Conservation Farming.

1.7.1 Data Collection Sources and Methods of Data Analysis

This study used mixed methods for social development research by collecting and analyzing both quantitative and qualitative data. First, data was collected by conducting a diagnostic synthesis of reviewing a wide range of relevant literature on Conservation Agriculture among smallholder farmers in Sub-Saharan Africa in general, and specifically in Zambia. To narrow down the scope of this study, more emphasis was rooted in analyzing the prevailing situation and trends in Conservation Farming among smallholder farmers in Zambia. Therefore, this study relied heavily on *secondary data analysis*[8] through the desk study method which involved a critical review of evidence-based quantitative and qualitative data on case studies that were collected from published secondary data sources on Conservation Agriculture and Conservation Farming projects in Zambia. For triangulation and validation purposes, where necessary, secondary data sources were further augmented with some follow-up skype and telephone interviews with key informants from CA projects and other stakeholders in Zambia. This process was important to gain an in-depth analysis of views from key informants to investigate the research problem.

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[8] *Secondary data analysis* refers to "research-based upon re-analysis of data collected during previous research projects for researchers to carry out research of their own" (David and Sutton 2004:370).

Relevant secondary data was collected from the following institutions: - Central Statistical Office, Ministry of Agriculture, Ministry of Community Development and Social Welfare, Indaba Agricultural Policy Research Institute and other organizations involved in promoting Conservation Agriculture in Zambia such as Conservation Farming Unit, NGOs and private sector companies. Data was also collected from UN agencies; FAO's funded Conservation Agriculture Scaling-Up Project.

Furthermore, internet websites and the International Institute of Social Studies (ISS) Library were used to search relevant information on Conservation Agriculture. Data collection and analysis were done in phases; first, a broad range of the relevant literature was reviewed; second, qualitative and quantitative data were collected and analyzed using *descriptive statistics* and *case study review method.*

1.7.2 Study Areas

This study focused on Zambia's Agro-Ecological Regions I and II which receive low to moderate rainfall <1,000mm per year and occasionally experience frequent droughts and dry spells during certain farming seasons. These are the areas where Conservation Farming projects have been vigorously promoted by various organizations and stakeholders since the early 1990s (see details in Figure 1.1).

1.7.3 Research Ethics

This study addressed ethical considerations throughout the study period. A student endorsement letter from ISS explaining my role as an MA Development Studies researcher enabled me to request data from relevant institutions and to have access to key reports and publications on secondary data sources from relevant institutions in Zambia. Consent was given for me to collect data from relevant institutions and to conduct some follow-up skype and telephone interviews to gather important responses from key informants during the data collection period. The privacy and confidentiality of key informants were upheld, and anonymity of respondents was guaranteed.

1.7.4 Limitations of the Study

Due to financial constraints, this study could not conduct a *single*-case study of one selected district in Zambia as initially planned to collect primary data from smallholder farming households using questionnaires and focus group discussions. In view of the above limitation, the desk study method was used which relied heavily on reviewing existing secondary data sources which was complemented with some follow-up skype and telephone interviews with key informants involved in promoting Conservation Farming projects in Zambia. This study also encountered the challenge of unavailability of certain data from secondary data sources. Despite these limitations, the researcher managed to conduct the study which has generated interesting information on the factors determining the adoption, non-adoption, and dis-adoption of Conservation Farming among smallholder farmers in Zambia.

1.8 Overview of Chapters

This research paper is organized into Six Chapters as follows; Chapter One provides the background information which sets the analytical basis for the subsequent Chapters. Chapter Two highlights the theoretical and conceptual frameworks applied to guide the analysis of results and discussions in the entire paper. Chapter Three presents a detailed literature review on previous studies done on the research topic. Chapters Four and Five present the main findings and analysis of data collected in this study and finally, Chapter Six gives a summary of the discussions in this research paper and provides the main conclusion.

Chapter Two: Theoretical and Conceptual Framework

2.0 Conceptualizing Peasant Farmers and the Peasant Economy

This study critically engages key theoretical concepts that analyze peasant farmers' behavior and characteristics in terms of their logic of production, social differentiation, rationality and agency within the broad framework of the peasant economy in agrarian studies. These theoretical concepts are applied to understand how the decisions of peasant households are shaped and re-shaped by socio-economic, institutional and agro-ecological factors within their local contexts. This study considers peasant farmers' behavior and characteristics as critical factors influencing the adoption of Conservation Farming practices in Zambia. From this perspective, the conceptualization of peasant farmers and the peasant economy is valuable in understanding peasant farmers' logic of production and functioning at the household level and how these attributes influence smallholder farmers' decisions and responsiveness towards the adoption of new technologies and innovations such as Conservation Farming.

2.1 Chayanov's Theory of Peasant Economy

In recent years, many scholars who have analyzed 'peasant farmers' and the 'peasant economy' in agrarian studies have relied on the work of Chayanov's 'theory of peasant economy'. Thorner (1966) argues that while Chayanov's definition of peasant family farms may offer a narrow characterization of peasants based on the Russian peasantry conditions, the Chayanovian theory has wider relevance in understanding the economic behavior of peasants in other countries. Heynig (1982:113) also argues that despite some criticisms, Chayanov's work offered a "more coherent theory of the phenomenon of small-scale peasant production regarding its internal structure and its capacity for survival in a capitalist system".

Several definitions and characterizations of *'peasants'* have been embraced by scholars to describe the economic behavior of peasant farmers and their logic of production. However, Heynig (1982:114) argues that most of 'peasant' definitions seem to agree that "peasant production is based on the exploitation of family labour". According to Chayanov, peasant farmers are regarded as *'farm families'* which refer to "peasant households that relied almost exclusively on the labour of family members" (Chayanov cited in Thorner 1966: xiii). Chayanov's work on the peasant economy described *'peasant farm families'* as peasant households that relied entirely on *unpaid family labour* provided by their own family members (Thorner 1966: xiii). According to Chayanov, peasant farms which are mostly based on family labour have a different logic of production and economic structure which can be distinguished from capitalist enterprises. From this perspective, Chayanov established "a systematic theory of peasant economy based on the specific structure of peasant economy - the application of non-wage family labour to the family household farm" (Harrison 1977:329).

Teodor Shanin further defines the 'family farm' as "the basic multi-functional unit of social organisation, land husbandry and usually animal rearing as the main means of livelihood, a specific traditional culture closely linked with the way of life of small rural communities and multi-directional subjection to powerful outsiders" (Shanin 1973 cited in Edelman 2013:6). Ellis also describes peasants as farm households who derive their livelihood from farming activities arguing that peasant farmers have access to land and usually depend on unpaid family labour to engage in both production and consumption within their household units (Ellis 1992:9-10). The larger proportion of the output is consumed in their households and the surplus is what is sold in the markets. Ellis further argues that this subsistence mode of production is what makes peasant farmers to be partially integrated into the markets (Ellis 1992).

In recent studies, Van der Ploeg posited that the conditions of *'peasantry'* and *'re-peasantization'* in the present-day peasant agriculture in the Global North are similar with peasant farmers in the Global South. Van der Ploeg argues that "farming is increasingly being restructured in a peasant-like way" and further situates "peasant farming on a continuum - rather than as a contrasting category - with entrepreneurial farming" Edelman (2013:9). From this perspective, peasants progressively engage in market-orientated production like entrepreneurial farmers and according to Van der Ploeg, the main features of the 'peasant condition' include minimizing monetary costs, diversifying crops to reduce economic and environmental risks, engaging in cooperative relations as an alternative to monetary relations to sustain autonomy, engaging in market exchange and non-money forms of obtaining inputs and labour, and increasing both subsistence production and non-farm income (Van der Ploeg 2009 cited in Edelman 2011:112).

This study utilizes two main concepts of the *Chayanovian balances* (*labour-consumer balance* and *utility-drudgery balance)* which, arguably, are still dominant in analyzing the peasant economy and peasant family households' logic of production. The *labour-consumer balance* describes the "balance between the satisfaction of family needs and the drudgery (or irksomeness) of labour" in a peasant household (Chayanov cited in Thorner 1966: xv). From this perspective, the peasant household tends to increase labour input in production which Chayanov described as the "degree of self-exploitation of family labour" until the output satisfies the consumption needs of its family members (Thorner 1966: xvi). In this view, the labour-consumer balance typically depends on the household's demographic characteristics such as family size and the ratio of the actual number of members providing labour-input for production to non-working members in that family (Thorner 1966). Heynig (1982:127) also argues that a peasant family farm's decision to introduce innovations depends on the effect that these innovations might have on the labour-consumer balance. The *utility-drudgery balance* explains the balance between extra benefits or degree of satisfaction (*utility*) for each family and the extra efforts of labour (*drudgery*). From this perspective, each family member strives to put in extra effort if they believe it would produce increased output which could be dedicated to "greater family consumption or enlarged investment increase in the farm" until the balance is reached where any possible increase in output does not outweigh the irksomeness of the extra work (Chayanov cited in Thorner 1966: xvi).

2.1.1 Risk, Uncertainty and Risk-Aversion

Some studies show that farmers have perceptions about production risks associated with agricultural production systems which tend to influence the adoption of new technologies. *Risk* and *uncertainty* are considered as factors reducing the adoption of new technologies (Lindner et al. 1982, Lindner 1987 cited in Marra et al. 2003:215). *Uncertainty* also tends to be more for a new technology than for old technology which would dampen adoption by risk-averse farmers (Marra et al. (2003:227). Sahin (2006:14) also argues that "uncertainty is an important obstacle to the adoption of innovations".

Other studies on peasant farmers have revealed that *risk aversion* is one of the factors attributed to time-lag between innovation and adoption of new technologies (Ellis 1992). In peasant agriculture, the concept of 'risk-aversion' is significant since agricultural production involves risks and uncertainties especially weather-related including the adverse impacts of climate change such as drought and floods. From this perspective, climate change increases uncertainty and risk among farmers and policymakers that require more flexible and rapid response capacity to build resilience by "reducing the risk of becoming food insecure and increasing the adaptive capacity to cope with risks and respond to change" (Lipper et al. 2014:1069-1071).

Peasant farmers are "risk-averse" which influences their decisions likely to inhibit the diffusion and adoption of innovations (Ellis 1992:95). As Marra et al. (2003:227) argue, the consequences of risk-aversion for adopting new technology depend on the perceptions of farmers on the "relative riskiness of old and new technologies and the levels of uncertainty faced". However, peasant farmers may adjust their farming practices by engaging in crop diversification and mixed-cropping to reduce adverse impacts of weather conditions as a way of maintaining their household food security rather than maximizing profits (Ellis 1992).

2.2 The Concept of Climate-Smart Agriculture and Conservation Agriculture

The concept of Climate-Smart Agriculture (CSA) was introduced and later developed by FAO on the "assumption of *'triple wins'* and synergies between agriculture-based efforts to enhance adaptation to climate change and support efforts to reduce carbon emissions, while simultaneously increasing food security" (Karlsson et al. 2018:150, FAO 2010). From this perspective, CSA comprises three main pillars: (i) sustainably increasing agricultural productivity, food security and incomes; (ii) adapting and building resilience to climate change, and (iii) reducing emissions of greenhouse gases from agriculture activities (Kaczan et al. 2013, Lipper et al. 2014:1069; FAO 2013). Arguably, CSA can be defined by its *'triple-win'* approach of increasing agricultural productivity, adaptation, and mitigation to climate change all in one rubric (Taylor 2018). However, Lipper et al. (2014) argue that although CSA aims to achieve all the three objectives, not every CSA practice applied in every location and situation generates '*triple wins'*.

CSA embraces a wide range of technologies and practices based on crops and livestock production, forestry and fisheries such as *Conservation Agriculture*, *Agroforestry* and other carbon sequestration practices (Karlsson et al. 2018:150, FAO

2013). Arguably, agricultural production is threatened by climatic changes, therefore increasing the vulnerability of people especially the world's poor who depend on agriculture for their livelihoods.

From this perspective, Climate-Smart Agriculture practices emphasize on "transforming and reorienting agricultural systems to support food security under the new realities of climate change" whilst increasing the adaptive capacity of farmers and building on existing experience and knowledge of sustainable agricultural production systems (Lipper et al. 2014:1068).

2.3 Diffusion of Innovation Theory - Rogers (2003)

This study utilizes the 'Diffusion of Innovation theory' to understand the processes of adoption and diffusion of new technologies and innovations, and the characterization of individual's likelihood to adopt a new technology (Sahin 2006, Rogers 2003). *Adoption* is defined as "a decision to make full use of an innovation as the best course of action available" and *rejection* refers to "a decision not to adopt an innovation" (Rogers 2003:177). Rogers further defines the *rate of adoption* as "the relative speed with which an innovation is adopted by members of a social system" which can be measured by the number of individuals who adopt that innovation over a specified time (Rogers 2003:221).

Similarly, Rogers defines *diffusion* as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (Rogers 2003: 5) while *innovation* is defined as "an idea, practice, or project that is perceived as new by an individual or other units of adoption" (Rogers 2003:12) and since innovation introduces new ideas, "some degree of uncertainty is involved in diffusion" (Rogers 2003:6).

2.3.1 The Innovation-Decision Process

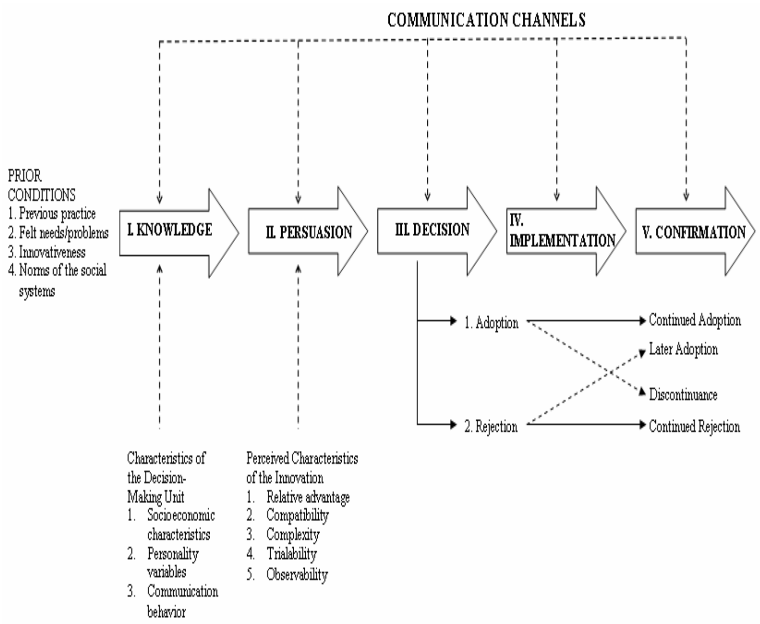
According to Rogers (2003), five stages are involved in the innovation-decision process and these are; (i) knowledge (ii) persuasion (iii) decision (iv) implementation and (v) confirmation. These stages follow each other with time as shown in Figure 2.1. Rogers' Diffusion of Innovation theory identified *information* and *communication channels* as important factors influencing adoption decision making (Sahin 2006, Rogers 2003).

In the *innovation-diffusion* process Rogers (2003) "proposes five attributes of innovations that help to decrease uncertainty about the innovation" (Sahin 2006:17). These characteristics of innovations are (i) relative advantage (ii) compatibility (iii) complexity (iv) trialability and (v) observability.

1. *Relative Advantage* – is "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers 2003:229). Rogers (2003) argues that an innovation can have a *relative advantage* in terms of economic, social or other benefits.

2. *Compatibility* –is defined as "the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters" (Rogers 2003:15). Rogers (2003:15) argues that "an idea that is incompatible with the values and norms of a social system will not be adopted as rapidly as an innovation that is compatible".

Figure 2: A Model of Five Stages in the Innovation-Decision Process



Source: Sahin (2006) adapted from Rogers (2003).

3. *Complexity* – is "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers 2003:16). Rogers (2003) argues that new innovations that are simpler to understand and practice are more adopted than innovations where adopters have to learn and develop new skills.

4. *Trialability* – is "the degree to which an innovation may be experimented with on a limited basis" (Rogers 2003:16). Innovations that can be demonstrated and tried will usually be adopted more rapidly (Rogers 2003).

5. *Observability* – is "the degree to which the results of an innovation are visible to others" implying that individuals who can easily see the results of an innovation are more likely to adopt that innovation (Rogers 2003:16).

Therefore, Rogers (2003) argues that innovations that have greater *relative advantage, compatibility, less complex, trialability, and observability* will be adopted more rapidly than an innovation with less attributes of innovations.

Chapter Three: Literature Review

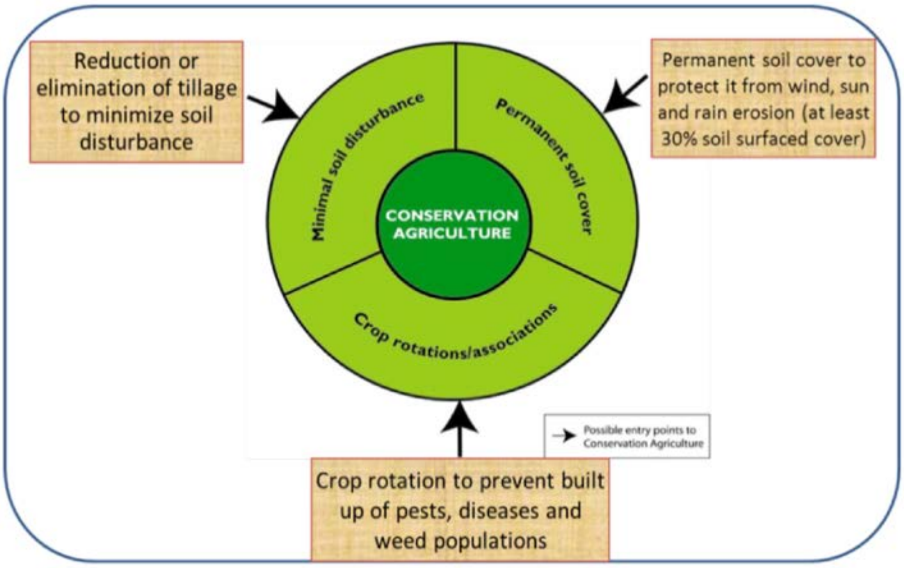
This chapter outlines a detailed literature review from various information sources on previous studies undertaken that provide empirical evidence on the concept of Conservation Agriculture and its applications, and linkages with *climate change adaptation* from the global, national and local perspectives. First, this chapter provides definitions of key concepts used in this study and explains Conservation Agriculture's contributions in sustainable agriculture and natural resource management. Based on previous studies, this chapter reveals key findings and highlights the prevailing situation on CA adoption among smallholder farmers in Sub-Saharan Africa with a specific focus on Zambia.

3.0 Conceptual Definitions

3.1 Conservation Agriculture

Conservation Agriculture is defined as a combination package of farming practices based on three main agronomic principles which are simultaneously applied namely: (i) continuous minimum mechanical soil disturbance (zero tillage or minimum tillage); (ii) permanent organic soil cover (crop residues retention, cover crops) and (iii) diversified crop rotations (FAO 2001, 2008, Haggblade and Tembo 2003, Derpsch et al. 2010). Conservation Agriculture is considered one of the Climate-Smart Agriculture (CSA) technologies (FAO 2013).

Figure 3: A Model of Five Stages in the Innovation-Decision Process



Source: Ndah 2014 adapted from Calgeri and Ashburner 2006

3.2 Evolution of Conservation Agriculture from the Global Perspective

The concept of *'Conservation Agriculture'* originally developed in the USA which spearheaded several research and policy interventions in soil conservation and minimum tillage farming systems after the 1930s' dust bowl in the US mid-west which was caused by recurrent droughts, soil erosion and excessive soil disturbances due to continuous ploughing (Aagaard 2009, Arslan et al. 2013:2, CFU 2009, Haggblade and Tembo 2003, Thierfelder et al. 2016). Due to the devastating environmental problems coupled with economic hardships resulting from rising fuel prices during the 1970s, the concept of *'no-tillage'* farming, synonymous of *'zero tillage'* or *'Conservation Agriculture'* started gaining momentum (Derpsch et al. 2010). Conservation Agriculture became more widespread among large commercial farmers in the USA who adopted minimum tillage practices to mitigate the impacts of drought, combat soil erosion and save on high fuel costs (, Arslan et al. 2013:2, Haggblade and Tembo 2003). Later, Conservation Agriculture spread to other countries in South America which experienced the fastest adoption rates of about 70% of the total cultivated area under no-tillage farming systems (Derpsch et al. 2010).

The impressive results in South America and the US made CA to spread to Sub-Saharan African countries especially in Eastern and Southern Africa, where it has been promoted by international organizations such as FAO, ACT, ICRAF, CIMMYT, ICRISAT, IITA (Baudron et al. 2007, Haggblade & Tembo 2003, Kassam et al. 2009). "CA has also been incorporated into regional agricultural policies by NEPAD and more recently by AGRA in Sub-Saharan Africa" (Kassam et al. 2009:314).

By 1999, Conservation Agriculture was adopted on approximately 45 million hectares of land worldwide, grew to 72 million hectares in 2003 and increased further to 111 million hectares in 2009 (Derpsch et al. 2010). Recently, FAO estimated that there are now about 156 million hectares of arable land worldwide under crops grown every year using minimum tillage in Conservation Agriculture systems (Mlenga and Maseko 2015; FAO 2015).

3.3 Climate-Smart Agriculture and Conservation Agriculture

In recent years, CSA has emerged as a paradigm to address the impacts of climate change by aiming at sustainably increasing agricultural productivity, enhancing resilience and adaptation to climate change and reducing greenhouse gases to achieve national food security, reduce poverty and hunger especially in developing countries (FAO 2010, Murray et al. 2016, Newell and Taylor 2018). Over the years, CSA has received substantial funding from major institutional donors such as FAO, World Bank, IFAD CGIAR and private sector actors (Newell and Taylor 2018). From this perspective, several governments, bilateral donors, NGOs and research institutions have made several efforts and initiatives to promote *Climate-Smart Agriculture* practices (e.g. *Conservation Agriculture, Agroforestry* etc.) to enhance the resilience of smallholder farming systems in view of climate change and variability shocks particularly in rainfed agriculture (Murray et al. 2016:125). Furthermore, Conservation Agriculture's importance on "sustainable intensification, climate change and as a form of *Climate-Smart Agriculture*, is further evidence of the paradigm's prominence in global agricultural development policy" (Andersson and D'Souza 2014:116, FAO 2011a).

However, CSA has been contested due to the political and institutional power surrounding it and the way "power relations manifest themselves in the particular institutional spaces where climate change and agriculture overlap asking questions whose agendas are represented and advanced by CSA" (Newell and Taylor 2018:115). Karlsson et al. (2018:150) also argue that 'equity' is one of the contested areas surrounding CSA, including "who wins and who loses, who is able to participate, and whose knowledge and perspectives count in the process". This implies that while CSA aims at increasing agricultural productivity and food security, and improving adaptation and mitigation, however, it "affects diverse groups differently and involves winners and losers, and therefore CSA's political nature makes it a concept adopted by a variety of institutions, re-articulated in policy and translated into practice" (Karlsson et al. 2018:157). Others argue that CSA lacks a firm participatory mandate that gives enough space for farmer-driven expertise and innovation (Taylor 2018; Whitfield 2015) "…under which the increasing corporatization of global agriculture can be hastened" (Taylor 2018:90; Via Campesina 2015).

Similarly, Conservation Agriculture has been contested raising questions whether this farming innovation can achieve the many benefits that CA promoters proclaim. For instance, the universal applicability of the three CA principles which need to be applied simultaneously has been criticized, with some researchers and practitioners advocating more practical and context-specific approaches rather than the strict implementation of CA principles such as no-till (Andersson and D'Souza 2014:116) while others question the applicability of CA principles in the local context of diverse smallholder farming systems (Andersson and D'Souza 2014, Giller et al. 2009).

Some studies have also revealed that farmers often find it difficult to adopt full CA because it is "a complex and knowledge-intensive system" whose full benefits are better appreciated when farmers simultaneously combine all the three principles of Conservation Agriculture (Kassam et al. 2009:316; Andersson and D'Souza 2014:128). Furthermore, wealthier farmers tend to develop and sustain their investments in CA required to achieve long-term productivity growth while poor farmers face several challenges to sustain CA adoption (Andersson and D'Souza 2014:122)

3.4 Climate Change Adaptation and Conservation Agriculture

Scholars have embraced several definitions of adaptation to climate change which all seem to have common elements. Dawson and Spannagle (2008:1) define *adaptation* as "all responses, adjustments, or actions by humans and natural systems to accommodate and/or reduce their vulnerability to the impacts of climate change" arguing that adaptation measures will not reduce climate change per se but can reduce vulnerability to the impacts of climate change. Burton 1992 cited in Schipper 2007:5) also defines *adaptation to climate change* as a "process through which people reduce the adverse effects of climate on their health and well-being and take advantage of the opportunities that their climatic environment provides".

Several studies have revealed the close linkages between *Conservation Agriculture* and *climate change adaptation.* While full adoption of Conservation Agriculture has demonstrated its potential to increase agricultural productivity, improve soil fertility and reduce soil degradation, farmers have also used CA as a climate change adaptation strategy where climatic risks are high (e.g. drought or dry spells) by retaining water and conserving soil moisture (FAO 2001, Giller et al. 2009, Haggblade and Tembo 2003, Ngoma et al. 2014, Thierfelder and Wall 2010). From this perspective, farmers can use CA to adjust their farming practices to adapt to climate change and variability. Kassam et al. (2009:306) also argue that CA systems reduce vulnerability to climate change effects such as drought due to greater soil moisture-holding capacity and less soil erosion during floods due to higher water infiltration thereby minimizing flooding and soil erosion. Arguably, Conservation Agriculture when appropriately adapted to climate change effects can reduce vulnerability to the effects of drought and soil erosion in the occurrences of drought and floods (Kassam et al. 2009; Mlenga and Maseko 2015:17).

3.5 Conservation Agriculture Adoption from previous studies

Several studies done on Conservation Agriculture and the adoption of new agricultural technologies in Sub-Saharan Africa and Zambia in particular, suggest that the adoption of CA practices among smallholder farmers has generally remained low (Andersson and D'Souza 2014, Arslan et al. 2014, Giller et al. 2009, Grabowski et al. 2014, Rockström et al. 2009). In Swaziland, Mlenga and Maseko (2015) found that despite the extensive provision of extension services and large investment in Conservation Agriculture, smallholder farmers did not widely adopt CA practices because they face some constraints to adopt Conservation Agriculture.

Some studies done in Sub-Saharan Africa have identified *labour constraints* as the major limitation to CA adoption among smallholder farmers experienced during dry-season land preparation and weeding (Baudron et al. 2007, Haggblade and Tembo 2003, Umar et al. 2011, Mazvimavi 2011, Mazvimavi and Twomlow 2009). In Zambia, Haggblade and Tembo (2003) found that there was increased weed burden in the early years of CA adoption by smallholder farmers. Similarly, in Zambia and Malawi Andersson and D'Souza (2014) found that smallholder farmers face labour constraints especially when adopting *planting basins* and for *weeding.* Other constraints include high initial costs of CA implements (Knowler and Bradshaw 2007; Andersson and D'Souza 2014). In Zimbabwe, Marongwe et al. (2011:157) found that the area of land cultivated under CA has often not increased due to labour constraints faced by farmers during land preparation when using *planting basins* and for *weeding.*

Conservation Agriculture is perceived to be "a complex set of crop management practices" (Giller et al. 2009:30) and it is seen as "a knowledge-intensive and complex system to learn and implement by smallholder farmers" (Kasaam et al. 2009:316). In Zambia, some studies have revealed that CA adoption tends to be *partial* and *incremental* with most farmers adopting *minimum tillage* with *less or no crop rotations and crop residue retention or cover crops* (Andersson and D'Souza 2014, Umar et al. 2011, Arslan et al. 2013). Arslan et al. (2013) also argue that being a new technology, CA is perceived as a risky investment since farmers need to learn new practices and most farmers cannot afford the initial high investment costs of purchasing rippers, herbicides, sprayers, cover crops etc. because they lack access to credit insurance and insurance which limits CA adoption. In Malawi, Murray et al. (2016:140) also found that women smallholder farmers have limited access to productive resources such as capital, animal draft power, extension, irrigation and credit facilities to adopt Climate-Smart Agriculture practices.

In Swaziland, a study done on 200 farmers by Mlenga and Maseko (2015) revealed that household characteristics such as age, gender, levels of education, family size, institutional factors (e.g. access to extension) and wealth of farmers had positive influences on the adoption of Conservation Agriculture. In Zimbabwe, a study done on 232 households practicing Conservation Farming usinh hand-hoe *planting basins* revealed that agro-ecological conditions and institutional support from the government and NGOs in the form of extension support and agricultural inputs have a strong influence on the intensity of CF adoption (Mazvimavi and Twomlow 2009). In Malawi, Zambia, and Zimbabwe, Andersson and D'Souza (2014:121) also found that adoption of new technologies and practices including Conservation Agriculture is often shaped by contextual factors such as input support, subsidies, agricultural policies, and markets arguing that CA uptake and adoption rates often tend to increase when farmers receive farming inputs and implements provided by CA promotional projects. In this regard, some studies done in Zambia have revealed substantial evidence of *dis-adoption* after CA promotional projects are phased out or when incentives are discontinued (Haggblade and Tembo 2003a).

In Zambia, other studies found that the factors influencing CA adoption include institutional support, CA project interventions, extension services and rainfall variability (Arslan et al. (2013); household/family size and land size (Chomba 2004, Knowler and Bradshaw 2007); household labour availability (Haggblade and Tembo 2003; Umar et al. 2011); information, training and extension services (Chomba 2004, Nyanga et al. 2011, Nyanga 2012); farmers' perception of increased climate variability (Nyanga et al. 2011); incentives - subsidies and free farming inputs (Nyanga et al. 2011, Baudron et al. 2007) and household ownership of CA implements such as rippers (Chomba 2004, Umar et al. 2011).

In Zambia, CF adopters were mostly challenged by weeds, inadequate retention of crop residues and lack of reliable access to animal draft power, and most CA adoption was partial and incremental with farmers practicing both Conventional and Conservation Agriculture on different plots (Umar et al. 2011, Arslan et al. 2013).

Customary tenure system makes it difficult for individual farmers to retain crop residues on their fields due to competing uses of crop residues as fodder in crop-livestock farming systems through communal grazing in most parts of Africa (Andersson and D'Souza 2014, Arslan et al. 2013, Umar et al. 2011) as well as the burning of crop residues on harvested fields thus depleting the much-needed permanent soil cover for CA (Arslan et al. 2013).

On-farm research trials done in Southern Africa have demonstrated the benefits of Conservation Agriculture namely: improved yields especially for maize and cotton compared to Conventional Tillage due to early planting, water conservation and better precision of fertilizer applications in *planting basins* (Andersson and D'Souza 2014, Giller et al. 2009, Haggblade and Tembo 2003, IIRR and ACT 2005, Kassam et al 2009, Langmead 2002, Rockström et al. 2009, Umar at al. 2011); reduced water stress through water retention and soil moisture conservation (FAO 2001, Giller et al. 2009, Haggblade and Tembo 2003) and long-term reduction in input use e.g. fertilizers when soil fertility has been restored (Hobbs 2007, Kaczan et al. 2013, Knowler and Bradshaw 2007). When herbicides and fertilizers are used, on-farm research trials show solid evidence that CA improves soil fertility, resulting in improved maize yields compared to conventional tillage (Grabowski et al. 2016, Thierfelder et al. 2015). Other studies have also shown that Conservation Farming adopters tend to achieve medium to long-term benefits over Conventional Tillage (Goeb 2013, Haggblade and Tembo 2003, Marongwe et al. 2011). However, some studies done in SSA have shown that CA has not performed well in other areas to give clear *relative yield advantages* over Conventional Tillage methods.

CHAPTER FOUR: ANALYSIS OF FINDINGS AND DISCUSSIONS

This chapter presents the first part of the main findings and analysis of data collected in this study. First, it examines the three selected major major Conservation Farming projects supported by the government, donors and NGOs in Zambia and examines how these projects and programmes have influenced the adoption, non-adoption and dis-adoption of Conservation Farming practices among smallholder farmers in Zambia. Second, this chapter examines the different tillage methods used by smallholder farmers, then presents the analysis on the adoption trends of Conservation Farming practices in Zambia.

4.1 Government, Donors, NGOs and Private Sector Conservation Agriculture Support Programmes in Zambia

4.1.1 Mapping Conservation Farming Promoters in Zambia

Since the 1990s, a coalition of stakeholders comprising the government, donors, NGOs and the private sector have been actively involved in promoting Conservation Farming in Zambia (Haggblade and Tembo 2003, Umar et al. 2011). For instance, large-scale CA projects funded by FAO and the Norwegian Government in Zambia have provided farming inputs support to smallholder farmers ranging from seeds and fertilizer to the provision of *Faidherbia Albida*[9] seedlings and CA implements (Andersson and D'Souza 2014). Baudron et al. (2007) also argue that between 1999 and 2003, there was a tremendous increase in the adoption of Conservation Farming among smallholder farmers in Zambia mainly due to the government and donor push.

The dominant promoters of Conservation Farming in Zambia are;

i. *Government* – through the Ministry of Agriculture and Ministry of Community Development, Mother & Child Health which implemented the Expanded Food Security Pack (EFSP) Programme from 2012 to 2016.
ii. *Research Institutions* - Golden Valley Agricultural Research Trust has collaborated with the Institute of Agricultural and Environment Engineering Project to develop animal draft powered rippers.
iii. *Farmer Organizations* - Zambia National Farmers Union (ZNFU) initiated the establishment of Conservation Farming Unit (CFU) in 1996.
iv. *Donors* – have provided funding for major Conservation Farming projects in Zambia e.g. FAO with financial support from the EU has funded the Conservation Agriculture Scaling-Up (CASU) Project from 2013 to 2017, Norwegian Embassy funded the Expanded Food Security Pack (EFSP) Programme, UN World Food Programme (WFP) is currently

[9] *Faideherbia Albida* is a scientific name for *Musangu tree* locally found in Zambia. GART supplies Musangu seeds to farmers to plant in agroforestry for soil fertility improvement as a nitrogen-fixing tree (CFU 2009).

funding the Rural Resilience Project which is implementing Conservation Farming activities in Pemba district of Southern Province of Zambia.

v. *NGOs* – Concern Worldwide Zambia, CLUSA, PAM, Land Management and Conservation Farming Project, SCAFE Project etc. have implemented Conservation Farming projects with smallholder farmers in Zambia.

vi. *Private Sector* – CFU and other institutions have collaborated with the private sector e.g. Cotton companies such as Dunavant Cotton and Cargill, and agro-input dealers in supplying farming inputs and implements to smallholder farmers in Zambia which has boosted the adoption of Conservation Farming in low to moderate rainfall Agro-Ecological Zones I and II (Andersson and D'Souza 2014:118, Baudron et al. 2007, Haggblade and Tembo 2003a, Umar et al. 2011).

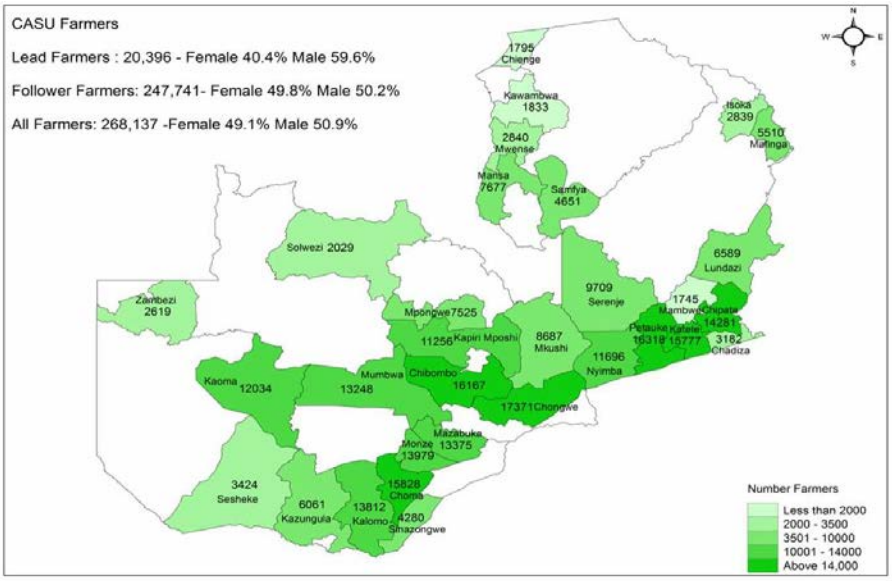
4.1.2 Major Conservation Farming Projects in Zambia

This study focused on analyzing three major Conservation Farming projects in Zambia namely: (i) Conservation Agriculture Scaling-Up Project (CASU), (ii) Expanded Food Security Pack Programme (EFSP) and (iii) Conservation Farming Unit (CFU).

4.3 Conservation Agriculture Scaling-Up Project

The CASU Project was implemented by FAO in Zambia with funding from the EU during the period 2013 to 2017 targeting a total of 50 districts in nine provinces of Zambia (see Figure 4). The overall objective of the CASU Project was to "contribute to reduced hunger and improved food security, nutrition and income in Zambia while promoting the sustainable use of natural resources" (FAO 2018:1).

Figure 4: Map of Zambia showing CASU Project's Operational Areas and Geographical Concentration of Farmers



Source: CASU 2017, FAO 2017.

4.3.1 Review of CASU's Project Design and its Achievements

CASU project was designed to target at least 21,000 new or existing Conservation Agriculture Lead Farmers (LF) and about 315,000 smallholder Follower Farmers (FF) in 50 districts in nine provinces of Zambia. CASU Project aimed at increasing crop production and productivity for the targeted farmers, of which at least 40 percent were to be women (FAO 2018). FAO provided funding and overall coordination of CASU Project while all field activities were implemented through the Ministry of Agriculture and Livestock (MAL) using the government's widespread agricultural extension system in Zambia (CASU 2017; FAO 2018).

Although CASU Project was implemented across all the three Agro-Ecological Regions (AER I, II and III) in 50 districts spread in nine provinces of Zambia, CASU farmers were more concentrated in Eastern and Southern Provinces which are in AER IIa, and where CA has been practiced and promoted by various organizations for many years in Zambia (FAO 2018:12).

Under the CASU Project, a total of 20,396 Lead Farmers and 247,741 Follower Farmers of which 49.1 percent were women farmers, participated as adopters of Conservation Agriculture in Zambia between 2013 and 2017.

Table 1: Targeted versus Actual Farmers' Participation under CASU Project

Type of Farmer	Projected Target	Actual No. of Farmers Reached	Percentage Achievement
Lead Farmers (LF)	21,000	20,396	97
Follower Farmers (FF)	315,000	247,741	79
Total	336,000	268,137	80

Source: CASU 2017, FAO 2018

The final evaluation report for CASU indicates that the project has positively increased farm yields and increased the production and consumption of legumes through the adoption of CA practices which has contributed to improved nutrition and food security among participating farmers (FAO 2018).

4.4 The Expanded Food Security Pack (EFSP) Programme

The EFSP Programme was an innovative Conservation Farming input support programme implemented by the Ministry of Community Development, Mother and Child Health with funding from the Royal Norwegian Embassy. The programme was implemented from 2012 to 2016 in three pilot districts namely (i) Itezhi-tezhi in Central Province and (ii) Nyimba and Chadiza in Eastern Province. EFSP field operations were jointly implemented with Conservation Farming Unit and Ministry of Agriculture and Livestock. The overall goal of EFSP Programme was to reduce poverty and hunger among 27,000 vulnerable small-scale rural farming households in Zambia through increased agricultural productivity and household food security and improved crop diversification by growing legumes and drought-tolerant crops through the adoption of Conservation Farming practices among targeted beneficiaries (EFSP 2014, 2015).

4.4.1 Review of EFSP Programme Design and Achievements

EFSP programme was designed to gradually wean off the selected beneficiaries after they received farming inputs for two consecutive farming seasons. Furthermore, EFSP programme only targeted "vulnerable but viable" small-scale farmers in the rural areas who owned at least 1 hectare of land with available family labour to adopt Conservation Farming activities. As a pre-condition, these farmers must be willing *to adopt minimum tillage* to become eligible as programme beneficiaries for them to receive farming inputs under the EFSP programme. Therefore, this farming input package was combined with intensive training and extension support in Conservation Farming technologies to enable farmers to adopt CA (EFSP 2014, 2016).

During its implementation period, EFSP programme managed to reach 18,050 CA adopters against the targeted 27,000 small-scale farming households in the three districts between 2012 and 2016, representing 67% achievement (EFSP 2016). Furthermore, EFSP Programme participants who adopted Conservation Farming practices attained improved yields and household food security (Munguzwe et al. 2014, EFSP 2016). However, EFSP also faced some challenges during its implementation. In a follow-up telephone interview, Mr. Kebby Chileka (*EFSP Programme Officer)* for Chadiza district said this;

> *"Some farmers that were graduated from EFSP Programme did not adhere to Conservation Farming practices, hence decided to 'dis-adopt' and revert to Conventional Tillage methods after they stopped receiving free farming inputs (incentives) which motivated farmers to adopt minimum tillage in the initial stages" (10/08/2018 interview).*

4.5 Conservation Farming Unit

The Conservation Farming Unit (CFU) was established in 1996 under the Zambia National Farmers Union. CFU has been in the forefront of promoting Conservation Farming across the country through the provision of technical training and extension services to all categories of farmers (i.e. small-scale, medium-scale and large-scale) to adopt Conservation Farming technologies in Zambia (CFU 2005). However, CFU activities are restricted to Agro-Ecological Regions I and II where CA is mostly being practiced by farmers due to erratic rainfall (CFU 2001, 2007). CFU trains farmers in CA practices and regularly conducts field demonstrations and field days on different tillage methods (e.g. hand-hoe planting basins, ripping using ADP or mechanized ripping using tractors), and how to use herbicides on CF fields to reduce labour demands for weeding. Furthermore, CFU promotes the planting of *Faidherbia Albida (Musangu trees)* in farmers' fields (CFU 2007, 2009; Mayer 2015). CFU reports that every year, it provides free extension training to about 200,000 farmers in collaboration with the Ministry of Agriculture across the country (CFU 2007).

4.6 Summary of Findings on Major Conservation Farming Projects in Zambia

A critical review of the major Conservation Farming projects in Zambia has revealed some similarities and differences in project designs and approaches which tend to have some implications in the way Conservation Farming is adopted by smallholder farmers in Zambia.

This study has established that while several Conservation Farming projects in Zambia vary in terms of scale and beneficiary coverage, all CA project promoters seem to adhere to the three principles of Conservation Agriculture which they encourage their farmers to practice. Another striking feature of similarity is that, all Conservation Farming projects in Zambia have adopted the same approach of providing subsidized or free farming inputs as incentives to those farmers who are willing to adopt Conservation Farming practices.

However, this study has also noted some divergences in the implementation of CA activities due to differences in CF project designs and approaches of individual organizations as follows; (i) CA project promoters in Zambia have different approaches of targeting beneficiaries in their project designs, with most organizations especially NGOs (e.g. PAM, CLUSA, CWZ, CARE) have targeted and provided incentives to *'vulnerable, resource-poor, or female-headed households'* who in most cases own smaller land-sizes. Moreover, government and donor-supported projects such as EFSP programme strictly targeted *"vulnerable but viable"* small-scale rural farmers as the basis for its beneficiary selection criteria, therefore excluding wealthier farmers. Consequently, wealthier farmers who are not given incentives under CA projects, tend not to participate in Conservation Agriculture training and field activities. In contrast, CFU targets all categories of farmers across Zambia through the provision of technical training and extension support in Conservation Farming technologies. Under the CASU project, only Lead Farmers (LFs) receive inputs (e.g. seeds, fertilizers, agro-chemicals, and sprayers) using e-vouchers as incentives for them to conduct Conservation Farming training and field demonstrations to Follower Farmers (FFs) within their communities. Follower Farmers are then linked to receive subsidized or free inputs from either FISP or CASU project itself (CASU 2017).

From the above analysis, it can be noted that the project designs and approaches, and beneficiary selection criteria of Conservation Farming Projects in Zambia have implications on the way smallholder farmers decide whether to adopt, dis-adopt or not to adopt Conservation Farming practices.

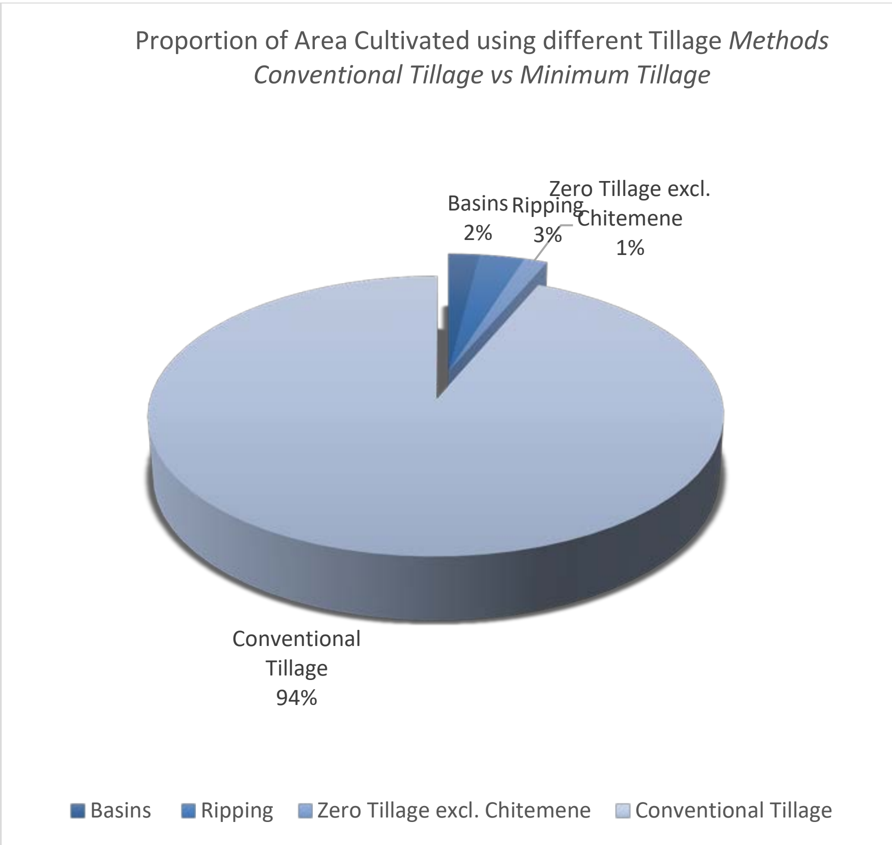
4.7 Tillage Methods in Zambia

As discussed earlier, Conservation Agriculture requires that farmers adopt and simultaneously implement all the three principles of CA for farmers to achieve its full benefits. This study has established that some farmers do not follow the strict definition of CA principles, therefore *partial adoption* of CA using *minimum tillage* as the "minimum requirement for Conservation Farming" has been observed in Zambia (Umar et al. 2011; CFU 2007, EFSP 2014). Similar findings results were found in other African countries by Ndah et al. (2015). Zulu-Mbata et al. (2016) also found that in Zambia, *minimum tillage* is the core for CA adoption compared to the other CA principles i.e. organic soil cover (crop residue retention) and crop rotations. This implies that the usage of the other two principles of CA (i.e. organic soil cover and crop rotations) varies widely among smallholder farmers. Moreover, diversified crop rotations among smallholder farmers in Zambia is not widespread due to land constraints. Only smaller proportions of land are allocated to legumes compared to the dominance of *maize mono-cropping* (the main staple food crop) in Zambia. Therefore, from the above discussion, this study confines the analysis of adoption trends in Conservation Farming in Zambia to the usage of*'minimum tillage'*.

4.7.1 Conventional Tillage

Using nationwide survey data conducted by RALS (2015), Figure 5 shows that 94% of the total area cultivated by smallholder farmers in Zambia is tilled under *Conventional Tillage* methods using three most popular tillage methods namely: *ploughing, ridging, and conventional hand-hoeing***.** At the national level, ploughing which represents 35.8% of the area cultivated is mostly practiced in areas with high cattle population in Southern, Central and Western provinces of Zambia. Ridging (27%) comes second and is widely practiced in Central, Lusaka, Southern and Western provinces then followed by conventional hand-hoeing (22.3%) which is used across all districts in Zambia (RALS 2015:18).

Figure 5: Percentage distribution of Area Cultivated using different tillage methods in Zambia



Source: Author's computations based on data from RALS (2015)

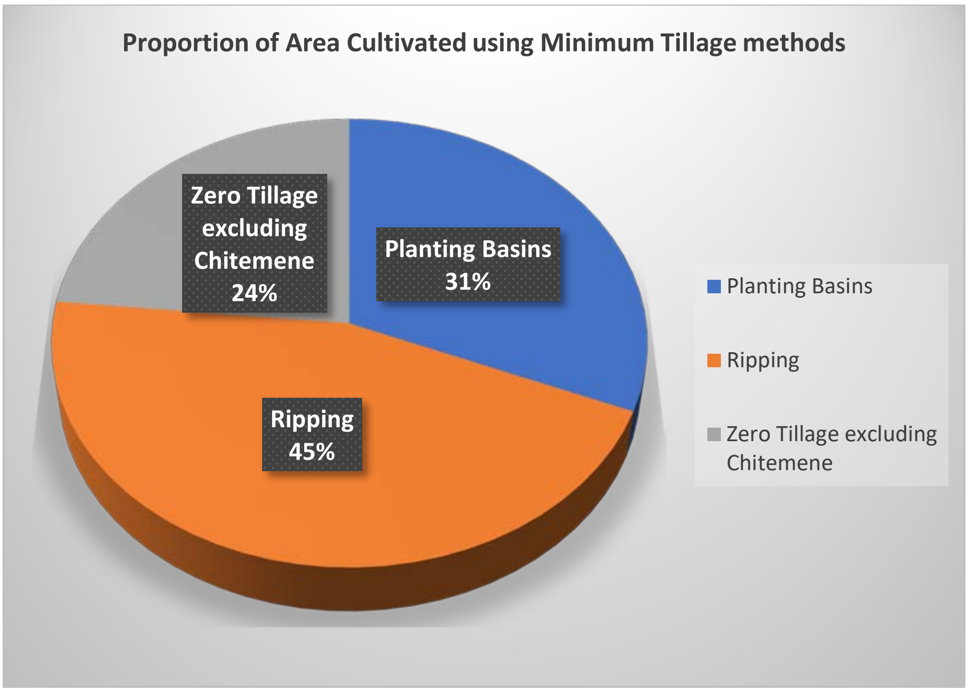
4.7.2 Minimum Tillage

As shown in Figure 5 only 6% of the area cultivated for crop production is tilled using *minimum tillage* methods by smallholder farmers in Zambia (RALS 2015). Using the principles of Conservation Farming in Zambia, dry-season land preparation is done by farmers before the onset of the rainy season. In minimum tillage, farmers use three main methods i.e. (i) *planting basins* (ii) *ripping* and (iii) *zero tillage* (*without using the Chitemene system*[10]*)*. The most practiced minimum tillage methods in Zambia are *ripping* (3%) and *planting basins* (2.0%) which are mostly used in Central and Eastern provinces (RALS 2015).

The above analysis shows that the larger proportion of the area cultivated by smallholder farmers in Zambia is still under *Conventional Tillage* (94%), with most farmers using *ploughing* (35.8%) compared to the area cultivated under *Conservation Farming* (6%). This suggests that most smallholder farmers in Zambia are still cultivating their land using Conventional Tillage methods rather than Conservation Farming practices, signifying low levels of adoption.

Figure 6 compares the proportion of the different types of minimum tillage methods used by smallholder farmers at the national level. The results show that *ripping* using animal draft power is the most widely used method in Zambia representing 45%, followed by planting basins at 31% whereas zero tillage (*without using the Chitemene system*) is the least used minimum tillage method at 24%.

Figure 6: Percentage distribution of area cultivated using minimum tillage methods in Zambia



Source: Author's computations based on data from RAL 2015

[10] *Chitemene system* refers to a shifting cultivation method involving *slash* and *burn* of vegetation to produce mineral ash into the soil, mostly practiced by small-scale farmers in the northern parts of Zambia (Zulu-Mbata et al.2016).

4.7.3 Adoption Trends in Conservation Farming in Zambia

This section analyzes the adoption trends in Conservation Farming among smallholder farmers in Zambia by answering the following research question: "What are the adoption trends in Conservation Farming among smallholder farmers in Zambia - and in which agro-ecological regions? In this study, trends analysis was used to examine the responsiveness of smallholder farmers towards the adoption of Conservation Farming technologies in Zambia. Descriptive statistics were used to analyze the adoption trends in *minimum tillage* as the 'minimum requirement' for Conservation Farming among smallholder farmers in Zambia over the specified periods.

4.7.4 Trends in the Adoption of Minimum Tillage in Zambia

As discussed earlier, the analysis of the adoption trends in Conservation Farming is confined to 'minimum tillage' methods used by smallholder farmers in Zambia. Therefore, this study focused on analyzing the two main indicators of adoption of Conservation Farming i.e. (i) the number of smallholder farmers adopting minimum tillage methods using Conservation Farming and (ii) the area cultivated using minimum tillage methods.

4.7.5 Statistics of Smallholder Farmers adopting Minimum Tillage in Zambia

Based on the available data on nationwide Crop Forecast Surveys[11] which are jointly conducted by Central Statistical Office and Ministry of Agriculture and Livestock, Table 2 shows the number of smallholder farmers in Zambia that used the two commonly practiced minimum tillage methods (i.e. *planting basins* and *ripping*) between 2008 and 2012.

Table 2: Statistics of Smallholder farmers using minimum tillage methods in Zambia (2008-2012)

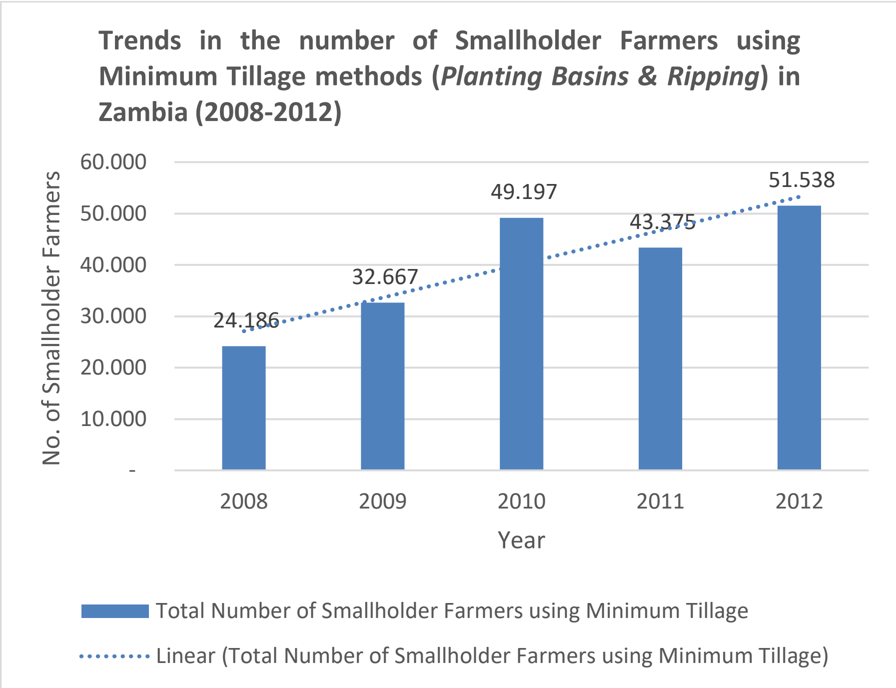
Year	No. of farmers using Planting Basins	No. of farmers using Ripping	Total No. of farmers using Minimum Tillage methods (Planting and Ripping)
2008	17,394	6,792	24,186
2009	25,650	7,017	32,667
2010	33,386	15,811	49,197
2011	32,676	10,699	43,375
2012	39,466	12,072	51,538

Source: Adapted from Ngoma et al. 2014, CSO 2008-2012

[11] *Crop Forecast Surveys* are representative at national, provincial and district levels in Zambia providing comprehensive and more accurate estimates of statistical information on agricultural activities (Ngoma et al. 2014, CSO 2015).

Based on the available data, comparisons were done to show the trends in the number of smallholder farmers in Zambia that used *planting basins* and *ripping* using minimum tillage under Conservation Farming between 2008 and 2012.

Figure 7: Trends in the number of Smallholder Farmers using Minimum Tillage methods in Zambia between 2008 and 2012.



Source: Author's computations based on data from Ngoma et al. 2014, CSO 2008-2012

The results in Figure 7 show a positive (upward) linear trend in the statistics of smallholder farmers who were practicing the two commonly used minimum tillage methods (*ripping* and *planting basins*) between 2008 and 2012. From the above graph, it can be noted that the number of smallholder farmers using minimum tillage in Zambia increased from 24,186 in 2008 to 49,197 in 2010, then dropped slightly to 43,375 in 2011 and then rose dramatically to 51,538 in 2012. This study has established that the was an upward steady increase in the linear trend between 2008 and 2012 in the number of smallholder farmers using *minimum tillage methods*. This is attributed to the intensification of Conservation Farming projects implemented by the government, NGOs and other stakeholders in Zambia during this period. These results are consistent with the study done in Malawi, Zambia, and Zimbabwe by Andersson and D'Souza (2014) who found that CA uptake and adoption rates often tend to increase when farmers are incentivized by farming inputs support (e.g. seeds, fertilizers, herbicides, sprayers etc.) provided by Conservation Agriculture promotional projects. This also explains the fluctuations and sudden drops in the adoption figures during certain periods especially when CA promotional projects are phased out or when incentives are no longer provided.

Another study conducted by RALS (2015) in Zambia, confirms that adoption rates of Conservation Agriculture in Zambia increased from 6.4% in 2010/11 farming season to 11.7% in 2013/14 farming season in Agro-Ecological Zones I and II (Zulu-Mbata et al. 2016). This increase in the adoption rates is attributed to the intensification of CA promotional projects during this period. For instance, CFU reported that about 170,000 farmers out of 1.2 million small and medium-scale farmers had adopted some form of CF on their land in 2011 (Arslan et al. 2013). In 2015, it was estimated that around 215,000 smallholder farmers practiced Conservation Farming in Zambia (Sitambuli and Sinyinza 2016) and in 2017, FAO reported that under the CASU Project, about 268,137 smallholder farmers in Zambia had adopted Conservation Agriculture practices on their fields (CASU 2017, FAO 2018). From these results, it can be noted that the adoption trends in Conservation Farming among smallholder farmers has been increasing over the years due to the intensification by CA projects in Zambia. However, this increase in the number of CA farmers in Zambia has not been sustained and therefore, figures on CA adopters have been fluctuating especially during periods when some CA projects phased out.

4.7.6 Total Area Cultivated using Minimum Tillage (MT) in Zambia

Based on the available data from CSO's Post Harvest Surveys (PHS), Table 3 shows the total area cultivated by smallholder farmers in Zambia using minimum tillage methods between 2012 and 2015 farming seasons.

Table 3: Area cultivated by Smallholder Farmers using Minimum Tillage in Zambia (2012-2015).

Year/ Farming Season	Total Area (hectares) Cultivated using Conventional Tillage	Total Area (hectares) Cultivated using Minimum Tillage	Area Cultivated using Minimum Tillage (MT) Methods in hectares		
			Planting Basins	Zero Tillage	Ripping
2011-2012	2,430,878	146,940	64,445	43,828	38,667
2013-2014	2,264,731	109,201	45,105	23,739	40,357
2014-2015	2,517,290	138,079	21,243	50,452	66,384

Source: Author's computations based on data from CSO's Post Harvest Surveys (2012-2015)

Using statistical data from CSO's Post Harvest Surveys, Table 3 shows that between 2012 and 2015, most of the area cultivated by smallholder farmers in Zambia was under Conventional Tillage (2,517,290 hectares) compared to Minimum Tillage methods (138,079 hectares).

Figure 8 shows a slightly downward (negative) linear trend in the total area cultivated by smallholder farmers in Zambia using minimum tillage methods between 2012 and 2015. This slight reduction in the area cultivated could be attributed to the phasing out of some Conservation Farming projects in the targeted areas during this period.

Figure 8: Trends in the total area cultivated by Smallholder Farmers using Minimum Tillage in Zambia between 2012 and 2015

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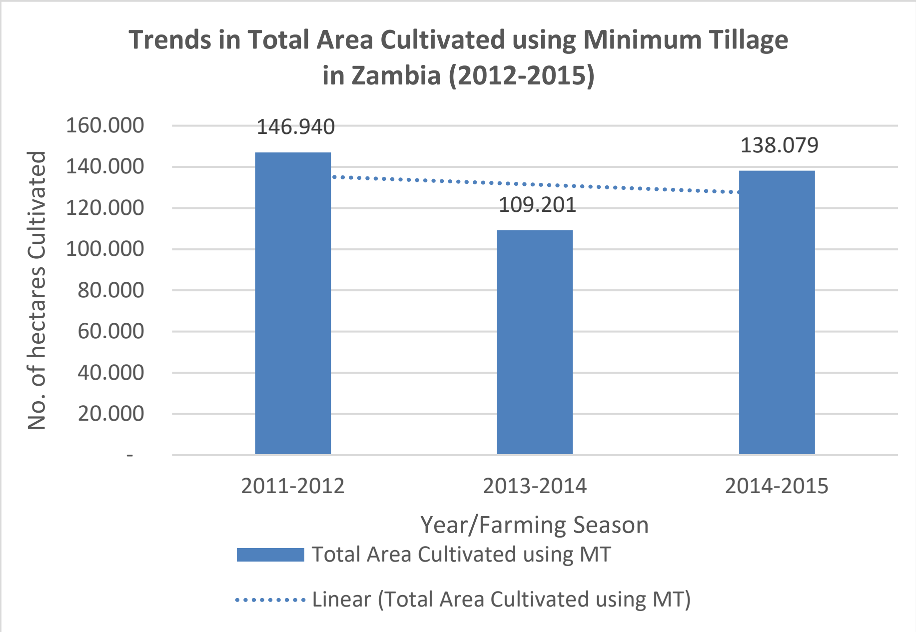


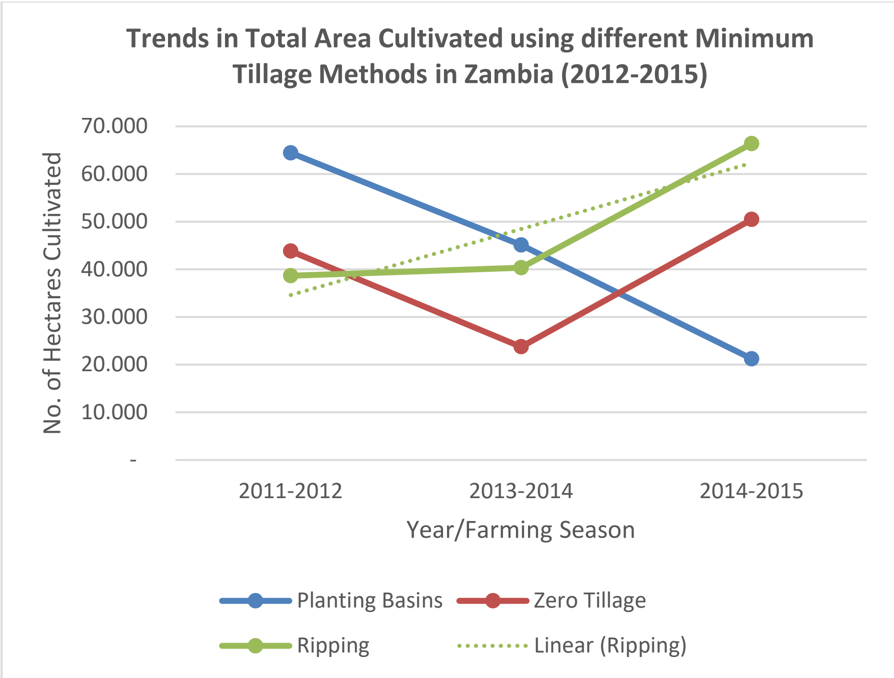
Source: Author's computations based on data from CSO Post Harvest Surveys (2012-2015)

Further analysis was done to determine the trends in the total area cultivated using different minimum tillage methods by smallholder farmers in Zambia between 2012 and 2015. The results in Figure 9 show a general increase in the area cultivated using *ripping* method compared to other minimum tillage methods between 2012 and 2015. This is depicted in the positive (upward) linear trend in the usage of the *ripping* method compared to *planting basins* and *zero tillage*. During the same period, it can be noted that there is a reduction in the usage of *planting basins* due to several factors. Some studies have revealed that Conservation Farming using '*planting basins'* is more labour-demanding especially during dry-season land preparation using the *Chaka-hoe*[12] (Umar et al. 2012; Haggblade and Tembo 2003), hence farmers are opting for the *ripping* method using *animal draft power* (ADP) which smallholder farmers perceive to be less labor-demanding

[12] *Chaka-hoe* is a heavy hoe that can be swung to reduce the effort in the preparation of planting basins during dry-season preparation, it was developed by Conservation Farming Unit (Baudron et al. 2007).

than using planting basins or ploughing (Habanyati et al. 2018; Nyanga et al. 2012).

Figure 9: Trends in the total area cultivated by smallholder farmers using different minimum tillage methods in Zambia between 2012 and 2015.



Source: Author's computations based on data from CSO Post Harvest Surveys (2012-2015)

Chapter Five: Determinants of Adoption, Non-Adoption, and Dis-Adoption of Conservation Farming among Smallholder Farmers in Zambia

This chapter presents the second part of the main findings and analysis of data collected in this study. This chapter addresses the following research question: "What factors influence the adoption, non-adoption and dis-adoption of Conservation Farming practices among smallholder farmers in Zambia?" Therefore, this chapter provides an in-depth *cross-case study* analysis after reviewing and making comparisons of several *single-case studies* done in Zambia's Agro-Ecological Zones I and II on the important variables that influence the adoption, non-adoption, and dis-adoption of Conservation Farming among smallholder farmers in Zambia.

This study disaggregated smallholder farmers into three different *pathways or categories* based on smallholder farmers' decisions whether to adopt, not to adopt or dis-adopt Conservation Farming practices in Zambia.

i) Pathway/Category 1 - Adoption (or Acceptance)
ii) Pathway/Category 2 - Non-Adoption (or Rejection)
iii) Pathway/Category 3 - Dis-Adoption (or Relapse)

5.1 *Pathway/Category 1:* Factors influencing the Adoption of Conservation Farming among Smallholder Farmers in Zambia

5.1.1 Agro-Ecological Factors

Zambia's agriculture is predominantly rain-fed since many smallholder farmers depend on rainfall for their farming activities. Therefore, the rainfall pattern in Zambia is the major determinant of agricultural production among smallholder farmers. Climatic conditions especially drought and dry spells tend to influence the usage of *minimum tillage* methods in CA among smallholder farmers in Agro-Ecological Regions 1 and II which generally receive low to moderate rainfall <1,000mm per annum (Arslan et al. 2013, Haggblade and Tembo 2014, Ngoma et al 2014). These results are consistent with Zulu-Mbata et al. (2016) who found that unfavourable weather conditions such as drought and dry spells experienced by farmers in the preceding season increase their likelihood of adopting Conservation Agriculture in the subsequent seasons.

Farmers' perceptions of the changing climate such as drought and floods were found to be more associated with the adoption of *minimum tillage practices* in Conservation Farming (Mulenga and Wineman 2014, Nyanga et al. 2011). These findings agree with Arslan et al. (2013:84) who argue that smallholder farmers in Zambia use *minimum tillage* as "a strategy to mitigate the risk of rainfall variability" hence showing some evidence of adaptation to climate change and variability. From this perspective, Haggblade and Tembo (2003:13) argue that farmers adopt Conservation Farming as a risk diversification measure which provides farmers with "insurance against drought and famine" and "portfolio diversification to ensure their household food security" to avoid starvation.

From the above analysis, it becomes clear that the adoption of Conservation Farming by smallholder farmers tends to be influenced by agro-ecological factors in Zambia. These results suggest that smallholder farmers in Agro-Ecological Zones I and II are motivated to adopt Conservation Farming practices as a way of improving crop yields and reducing the risk of crop failure during drought and dry spells. From this perspective, CA can be seen as a climate change adaptation strategy to counter the effects of climate change and variability in situations when there is uncertainty about rainfall patterns.

5.1.2 Household Characteristics

This study has established that household characteristics such as age, gender, household size, farm/land size, and household assets tend to have positive influences on the adoption of Conservation Agriculture among smallholder farmers in Zambia (Arslan et al. 2013, Grabowski et al. 2016, Ngoma et al. 2014, Zulu-Mbata et al. 2016). *Age of the household-head* was found to influence CA adoption as older household-heads were more likely to take up new technologies due to their farming experiences and ownership of productive assets (Chompolola and Kaonga 2016, Zulu-Mbata et al. 2016).

The theoretical framework of *Chayanovian balances* (i.e. *labour-consumer balance* and *utility-drudgery balance*) help to explain functioning of peasant farmers, their household characteristics and economic behavior, and their logic of production. In peasant studies, the Chayanovian approach argues that most rural peasant households depend on *unpaid family labour* to engage in farming activities, which is mostly determined by household size. Arguably, household size has a direct effect on labour supply in farming and consequently on smallholder farmers' decisions to adopt or not to adopt certain innovations.

This study has also established that the *gender of the household-head* influences CA adoption and farmers' decisions on the type of minimum tillage method to be used. In Zambia, "male-headed households are more likely to take up new technologies due to larger endowments compared to their female counterparts" (Namonje-Kapembwa and Chapoto 2016 cited in Zulu-Mbata et al. 2016:10). In a study done in Malawi, Murray et al. (2016:121) argue that "gender roles, access to and control of productive assets and power relations" tend to affect agricultural technology adoption especially women farmers who continue to experience barriers to the adoption of CSA technologies. Similar results were found in Zambia by Namonje-Kapembwa and Chapoto (2016) who observed that there is low adoption of improved technologies by *'women farmers in female-headed households'* compared to *'women farmers in male-headed households'* and *'male farmers'* due to limited access to productive resources such as credit, land and agricultural extension services.

In Zambia, Zulu-Mbata et al. (2016:19) argue that male-headed households were more likely to use the *ripping* method in minimum tillage whereas women were more associated with the use of hand-hoe *planting basins*. This phenomenon could be attributed to the traditional practice of women using *hand-hoes* as a woman's domain (Nyanga et al. 2012). These findings suggest that male-headed households are more likely to adopt *ripping* using animal draft power which is considered as *males' chores* in many cultures and conversely, female-headed households are more likely to adopt *planting basins* which are predominantly women's domain of using hand-hoes. In Malawi, Murray et.al (2016:136) noted that most women smallholder farmers did not have ready access to draught animals, therefore raising significant gender issues in the use of animal draft power in CSA practices.

Since CA is perceived to be labour intensive, the *household size* which represents labour availability was found to have positive influences on a household's decision to adopt CA (Haggblade and Tembo 2003, Nyanga et al. 2012, Zulu-Mbata et. al 2016). Specifically, Zulu-Mbata et. al (2016:13) analyzed labour availability in a household and found that "households with the larger number of adult equivalents are more likely to adopt CA compared to Conventional Farming" due to the perceived benefits of Conservation Agriculture. Similar results were revealed by Chompolola and Kaonga (2016:82) who found that the variable *'household size'* had a positive effect on CA adoption, implying that "households with more labor were more likely to adopt Conservation Agriculture than those with less amount of labor".

Some case studies in Zambia show that *household farm assets* and *land size* tend to positively influence the adoption of Conservation Agriculture. Farming households owning large farm/land sizes are more likely to try CA practices on their land portions than households with smaller land sizes (Chomba 2004, Zulu-Mbata et al. 2016), and yet most CA Projects in Zambia target *'vulnerable'* farmers who own smaller land sizes. Arguably, farmers with large farm sizes do not usually seem to face land constraints, hence they tend to practice all the three principles of CA (i.e. *minimum tillage, crop rotations, and cover crops*) compared to farmers with smaller land sizes who generally practice *partial* CA adoption.

5.1.3 Incentivized Conservation Agriculture Projects

Fundamentally, all Conservation Farming promotional projects in Zambia have adopted a similar approach of providing subsidized or free farming inputs (e.g. seeds, fertilizers, herbicides) as incentives to farmers willing to adopt Conservation Farming practices (Baudron et al.2007). The provision of incentives to farmers is often justified by CA promoters as a risk-sharing mechanism in view of the benefits from CA which only materialise in the medium to long-term coupled with the high initial investment costs for CA adoption which most farmers cannot afford (Giller et al. 2009, Nyanga 2012:37). From this perspective, it can be noted that most smallholder farmers have increasingly adopted Conservation Farming due to the provision of subsidized or free farming inputs by government and donor-funded CA projects. This agrees with the findings from Mazvimavi and Twomlow (2009) who observed that farmers' access to seeds and fertilizer from government and NGOs has increased the intensity of CF adoption in Zimbabwe.

5.1.4 Conservation Agriculture Policies and Institutional Support

This study has established that the institutional framework in Zambia is supportive of Conservation Agriculture in terms of policy formulation and implementation of CA projects through the Ministry of Agriculture and other partners. For instance, Conservation Agriculture was incorporated in the national agricultural policy in 2000; the National Conservation Agriculture Task Force comprising multi-stakeholders was formed in 2008 to advocate and influence policies related to Conservation Agriculture, to develop strategies for rolling-out the adoption of Conservation Agriculture and to facilitate capacity-building and networking of CA implementers (Chuluunbaatar and Vishnu 2018). In addition, the National Conservation Farming Steering Committee was formed in 2001 by the Technical Services Branch within the Ministry of Agriculture to facilitate coordination and collaboration among CA stakeholders in Zambia (ibid.).

Similarly, the implementation of major CA projects in Zambia has received funding from the government and international donors such as FAO, World Bank, EU, and others. Several NGOs in Zambia have played a significant role in promoting CA among smallholder farmers while private sector companies and agro-input dealers have also been supplying various agro-inputs to farmers (see details in Chapter 4). From this perspective, it can be argued that conducive agricultural policies and strong institutional support to farmers and private sector input suppliers provide an enabling environment for scaling-up the adoption of Conservation Agriculture technologies and practices among smallholder farmers in Zambia.

The vigorous CA promotional activities by several government institutions, donors, NGOs and the private sector in Zambia have had positive influences on CA adoption among smallholder farmers which, arguably, have positively influenced CA adoption among smallholder farmers (Grabowski et al. 2016, Zulu-Mbata et al. 2016). These findings suggest that adoption tends to be highly sensitive to CA promotional activities and smallholder farmers tend to positively respond to the on-going implementation of incentivized CA projects manifested through adoptions.

This study has also established that the *private sector* in Zambia has played a major role in supporting smallholder farmers to adopt Conservation Farming through the supply of agro-inputs, farming implements, and provision of extension services. For instance, CA promoters in Zambia collaborate with private sector outgrower cotton companies, agro-input dealers and suppliers of CA implements to facilitate improved access to private sector-driven agricultural inputs such as seeds, fertilizers, agro-chemicals, tillage equipment, sprayers, and purchasing farmers' agro-products (EFSP 2014, Haggblade and Tembo 2003a, Sitambuli and Sinyinza 2016). From the above analysis, it can be noted that institutional support to smallholder farmers plays a significant role in stimulating farmers' interests in adopting CA in Zambia. As William et al. (2015:11) argue, "strong institutional support is required to: promote inclusivity in decision making; improve the dissemination of information; provide financial support and access to markets; provide insurance to cope with risks associated with climate shocks and the adoption of new practices; and support farmers' collaborative actions".

5.1.5 Access to Training and Extension Support

Some studies have revealed that access to training and extension support tends to influence farmers' decisions to adopt new technologies and innovations. Farmers' access to extension services and membership to farmer groups and associations were found to be significant in the adoption of CA (Andersson and D'Souza 2014, Arslan et al. 2013, Chomba 2004, Haggblade and Tembo 2003).

In Zambia's Chongwe district, Chompolola and Kaonga (2016) found a positive correlation between extension contacts with farmers and CA adoption, implying that farmers who have more contacts with extension officers tend to have more chances of adopting Conservation Farming. As discussed earlier in Chapter 2, Section 2.1.1, farmers are *risk-averse* which makes them to plan carefully not to disrupt their household food security. Most smallholder farmers in Zambia were reluctant to switch from *Conventional Tillage* to *Conservation Farming* in the absence of strong extension support (Chompolola and Kaonga 2016).

From the above analysis, it can be noted that extension support serves as a platform for knowledge-transfer to smallholder farmers using extension agents, which tends to motivate farmers to adopt CA and other new technologies through participatory learning and action.

5.1.6 Access to CA Implements and Herbicides

As discussed earlier in Chapter 4, Section 4.7.6, the usage of animal draft powered *rippers* which reduces *drudgery* for smallholder farmers has been steadily increasing in Zambia. From this perspective, it is possible to enhance the adoption of CA in Zambia if minimum tillage implements (e.g. rippers) are readily accessible to smallholder farmers. This is consistent with the findings from other studies that access to CA implements and extension support services influence farmers' decisions to adopt Conservation Farming (Chomba 2004, Ngombe et al. 2014, Zulu-Mbata et al. 2016). The challenges of weeds and limited access to herbicides coupled with limited knowledge of how to correctly apply herbicides have contributed to the non-adoption and dis-adoption of CA among smallholder farmers in Zambia (Zulu-Mbata et al. 2016). These arguments are consistent with Sitambuli and Sinyinza (2016) who found that *only 26%* out of 129 interviewed farmers use herbicides while the rest of the farmers (74%) use *hand-hoes* to weed their fields because they cannot afford to buy herbicides. From this perspective, it can be noted that only few smallholder farmers can afford to buy herbicides hence limited use of herbicides is a barrier to successful weed management in CA. Furthermore, the high initial costs of CA equipment and herbicides tend to constrain smallholder farmers from expanding their area of land cultivated under CA since most peasant farmers depend on *unpaid family labour*. The high labour demands during dry-season land preparation and weeding could explain why many smallholder farmers in Zambia adopt *partial CA* components whereas the area cultivated under CA per farmer has remained stagnant (Andersson and D'Souza 2014:123).

5.1.7 Socio-Cultural Factors

This study has established that the adoption and diffusion of Conservation Farming practices among smallholder farmers are also influenced by socio-cultural and traditional beliefs and diversities which shape their perceptions about the way they adopt or not adopt certain new innovations and technologies (IIRR and ACT 2005, Zulu-Mbata et al. 2016). For instance, in Zambia the CA principle of *crop residue retention* as mulch on farmers' fields is mostly challenged in many rural communities as it is seen to conflict with peoples' cultures, traditions, and perceptions due to competing needs for crop residues in livestock dominated areas which are often used as fodder for communal grazing (Arslan et al. 2013, Umar et al. 2011). From this perspective, smallholder farmers in livestock dominated areas are restricted in retaining crop residues on their fields, and yet this is an important principle of CA. Furthermore, women farmers prefer to burn crop residues so that they can utilize the potash found in the ash to grow pumpkins and other indigenous squashes because traditionally farmers believe that indigenous squashes perform better in soil portions that are burnt (Sitambuli and Sinyinza 2016).

Other perceptions and beliefs about CA in Zambia include farmers' beliefs that the continuous use of herbicides on their fields under CA, wipes out and destroys certain indigenous vegetable species growing in their fields which women usually collect to use as relish in their homes (Sitambuli and Sinyinza 2016). These findings are consistent with Nyanga et al. (2012) who found that the use of herbicides was not *compatible (see Rogers 2003)* with farmers' practices of mixed cropping and growing of valuable wild vegetables, hence women farmers feared that the use of herbicides increases food insecurity during hunger peak periods because wild vegetables and mixed crops e.g. green beans and sweet potatoes leaves were important diets for rural households.

5.2 *Pathway/Category 2*: Factors influencing the Non-Adoption of Conservation Farming among Smallholder Farmers in Zambia

5.2.1 Design of Conservation Projects and Beneficiary Selection Criteria

This study has established that the reasons for the *non-adoption* of CA by some smallholder farmers in Zambia include the selection criteria used for eligible beneficiaries in most Conservation Farming projects which tend to target only *'vulnerable smallholder farmers'* as participants and recipients of incentives and excluding other relatively wealthier farmers (Ngoma et al. 2014, CASU 2017; EFSP 2014). From this perspective, farmers that are not targeted in CF Projects and those that are not given incentives (e.g. seeds, fertilizers etc.) are less motivated to adopt Conservation Farming practices and therefore, continue using *Conventional Tillage* methods.

5.2.2 Conflicting Evidence on CA's Relative Advantages at Farm-Level

The study findings also suggest that other farmers do not adopt CF because they are not convinced about the *relative advantages*[13] of *Conservation Farming* over *Conventional Tillage* in terms of yield differences after *observing (see Rogers 2003)* from their counterparts who are using Conservation Farming practices (Sitambuli and Sinyinza 2016). However, these perceptions maybe peculiar to certain areas because several studies conducted in Zambia and elsewhere in SSA indicate that farmers who use *full CA practices* achieve higher yields than those who use Conventional Tillage methods especially in maize and cotton production (Haggblade and Tembo 2003; Andersson and D'Souza 2014). Arguably, the full benefits of CA are better appreciated when farmers simultaneously combine all the three principles of CA in their fields rather than the *partial adoption of minimum tillage* (Kassam et al. 2009:300). As discussed earlier in Chapter 5, Section 5.5.2, some farmers do not adopt Conservation Farming practices because the *planting basins* method is more labour-intensive posing a serious challenge for farmers who do not have enough household labour to dig planting basins. Other farmers who did not attend Conservation Farming training sessions in the past feel they do not have adequate knowledge and skills to adopt CF practices (Habanyati et al. 2018, Sitambuli and Sinyinza 2016).

5.5 *Pathway/ Category 3:* Factors influencing the Dis-Adoption of Conservation Farming among Smallholder Farmers in Zambia

This study has also established evidence that there is CA *dis-adoption* soon after CA projects have phased out or when incentives to smallholder farmers are discontinued, making the sustainability of CA adoption problematic.

5.5.1 CA Project Phase Out and Weak Exit Strategies

Some case studies reveal that farmers *dis-adopt* Conservation Farming practices when they are graduated or weaned off from CF projects or after CF projects have phased out (EFSP 2014, Haggblade and Tembo 2003). These findings suggest that perhaps some farmers join CF promotional projects just to receive subsidized or free farming inputs which they cannot access elsewhere raising questions whether farmers adopt Conservation Farming just to have access to subsidized or free farming inputs or they adopt CF because they are convinced about its benefits (Baudron et al. 2007). As Ngoma et al. (2014) argue, the provision of subsidized or free farming inputs and implements by Conservation Farming promoters positively influenced CF adoption among smallholder farmers as "a *quid pro quo* arrangement where they are required to practice some form of CF to receive material support". From this perspective, *dis-adoption* is likely to occur if subsidized or free farming inputs support is discontinued.

In Zambia, *dis-adoption* of Conservation Farming practices is also attributed to the dynamics at institutional level of CF promotional agencies e.g. "NGOs --

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[13] See details on *relative advantages* by Rogers (2003)'s Diffusion of Innovation Theory

including World Vision, DAPP, SPHFSP and Monze Dioceses -- have all stopped their CF promotion efforts after a number of early experimental years" (Haggblade and Tembo 2003:13). Haggblade and Tembo argue that this institutional dis-adoption is attributed to: (i) the technical demands involved in Conservation Farming management and agronomic skills required by generalist NGO Project staff to adequately backstop farmers and (ii) most CF projects having reached their phase-out stage.

A critical review of most CA Projects in Zambia reveals some inherent weaknesses in their project designs and implementation that fail to sustain the adoption of Conservation Farming among smallholder farmers. These views are supported by Habanyati et al. (2018:3) who argue that "the strategies used to make farmers adopt CA are ineffective for sustaining CA practices beyond project implementation phases".

5.5.2 High Labour Demands in Conservation Agriculture

Conservation Farming is perceived to be labour intensive especially when using *planting basins* during dry-season land preparation just before the onset of the rainy season. Digging of planting basins requires very strong hand-hoes - the recommended *Chaka hoe* was found to be too heavy for women farmers (Sitambuli and Sinyinza 2016). Habanyati et al. (2018) also argue that the heaviness of the *Chaka hoe* poses a major challenge to smallholder farmers using *hand-hoe planting basins* during dry-season land preparation as soils are hard and therefore, small-sized families become more labor constrained than larger families. For this reason, smallholder farmers who perceive CA to be labor intensive often have a high likelihood of dis-adopting CA due to high labor demands especially those using *planting basins* (Habanyati et al. 2018).

Furthermore, some case studies suggest that high labour demands using planting basins under CA could be one of the reasons for dis-adoption especially in the early years of adoption if herbicides are not applied (Giller et al. 2009, Grabowski et al. 2016, Haggblade and Tembo 2003, Ngoma et al. 2014, Umar et al. 2012). From the above analysis, it can be argued that labour constraints restrict those farmers using planting basins under CA to only cultivate smaller portions of land while their larger fields are cultivated using *Conventional Tillage* methods. These findings correspond with Umar et al. (2011) who observed that almost 129 interviewed smallholder farmers in Southern, Central and Eastern provinces of Zambia simultaneously practiced both *Conservation Agriculture* and *Conventional Tillage* methods on different plots.

From this perspective, it can be noted that Conservation Agriculture, especially in the early stages, tends to disproportionately increase the labour burden on women who are regularly involved in farming activities such as planting and weeding. While smallholder farmers may be willing to use herbicides to reduce the labour burden and the amount of time spent on weeding for women, farmers are reluctant to use herbicides and sprayers because of the high purchase costs which is one of the reasons for non-adoption and dis-adoption (Namonje-Kapembwa and Chapoto 2016).

5.5.3 High Costs of CA Implements and Herbicides

This study has found that high investment costs of CA implements (e.g. rippers, sprayers) and lack of draft animals are some of the reasons for non-adoption and dis-adoption of CA. Grabowski et al. (2016:64) found that while many smallholder farmers are keen to use *ox-drawn ripping* in CA, they could not afford to purchase rippers or own oxen for draft power.

Habanyati et al. (2018) also found that often the cost of rippers in Zambia was higher than the cost of ploughs and traditionally smallholder farmers owned ploughs while others owned cattle for animal draft power which gave them options to shift from the *drudgery of digging basins* to either *ploughing* or *ripping*. Sometimes, *rippers* were not readily available on the market, and when made available, some farmers cannot afford to buy them due to high purchase costs (Chompolola and Kaonga 2016, Giller et al. 2009, Habanyati et al. 2018). From this perspective, limited access to *rippers* which is supposed *to reduce drudgery*[14] poses a challenge for CA adoption.,

5.5.4 Discontinuance of CA Incentives

As discussed earlier in Chapter 5, Section 5.1.3, this study has established that the promotion of Conservation Farming in Zambia has been characterized by the provision of incentives (e.g. seeds, fertilizers, herbicides, implements) as a way of enticing farmers to adopt CA practices. Critics have questioned the sustainability of these incentivized CA projects arguing that once these projects phase out, farmers dis-adopt CA practices and revert to Conventional Tillage methods. A few studies in Zambia have shown that some farmers dis-adopt CA when they are not given incentives such as hybrid maize seed and fertilizer (Habanyati et al. 2018). In Southern Province, Baudron et al. (2007) found that 50% of the targeted smallholder farmers dis-adopted Conservation Farming practices when they stopped receiving farming inputs soon after CA projects phased out. In Zambia's Eastern Province, Grabowski et al. (2016:65) found that "dis-adoption was widespread once incentives stopped" showing a strong positive correlation between dis-adoption of minimum tillage and the removal of incentives arguing that "efforts to incentivize the use of new technologies should be aware of the potential distraction and long-term perverse effects on adoption". Similarly, Arslan et al. (2013) found that there was 88% dis-adoption of minimum tillage among smallholder farmers in Zambia attributed to the discontinuance of incentives. Some CA Projects in Zambia e.g. EFSP Programme were designed to gradually wean off the selected beneficiaries after receiving farming inputs for two consecutive farming seasons which, in most cases, the period is too short for smallholder farmers to be able to graduate and self-finance CA activities on their own (EFSP 2014).

5.5.5 Lack of Adequate Conservation Agriculture Knowledge

Since Conservation Agriculture is perceived to be a knowledge-intensive system (Kasaam et al. 2009), some farmers dis-adopt Conservation Farming due to in-

[14] See more details on *drudgery* in Chayanov's utility-drudgery balance.

adequate knowledge on Conservation Agriculture principles and practices. Habanyati et al. (2018:4) also argue that "inadequate training and extension visits to smallholder farming households increased their likelihood to dis-adopt CA". This implies that lack of adequate CA knowledge among farming households is mainly caused by inadequate or lack of regular training and extension visits to smallholder farmers. From this perspective, it can be noted that training sessions and extension visits to smallholder farmers are important sources of information and channels for knowledge-transfer on Conservation Agriculture technologies and practices.

Chapter Six: Summary of Discussions and Conclusion

Several critical issues and challenges have emerged in this study regarding the adoption, non-adoption, and dis-adoption of Conservation Agriculture by smallholder farmers in Zambia. First, the analysis presented in Chapters 4 and 5 indicate that despite many vigorous CA promotional efforts that have been undertaken by the government, donors, NGOs and the private sector in Zambia since the early 1990s, the adoption rates have generally remained low. This implies that most smallholder farmers in Zambia are still using Conventional Tillage methods on a large-scale more than Conservation Farming, signifying low levels of CA adoption.

While this study has established that the adoption trends in Conservation Agriculture among smallholder farmers in Zambia have been increasing, the statistics of farmer adopters keep fluctuating over time indicating that sustainability of CA adoption is still problematic especially when incentivized promotional projects are phased out. This study notes that the increasing number of CA farmer adopters and consequently the upward steady rises in the adoption trends are attributed to the increased Conservation Farming projects implemented by the government, NGOs and other stakeholders in Zambia. The major challenges and questions to be addressed, therefore, remain on how to ensure that the adoption rates of Conservation Agriculture, which are mostly based on incentivized CA project support to smallholder farmers, are sustained beyond the projects' life-spans.

This study has also established that the underlying determinants triggering adoption, non-adoption, and dis-adoption of Conservation Agriculture are caused by a convergence of factors which affect farmers' decisions over time, which either act as enablers to motivate them to adopt Conservation Agriculture or act as constraints that restrict farmers from adopting CA practices. This study has established that CA adoption among smallholder farmers in Zambia is mainly influenced by agro-ecological factors, household characteristics, agricultural policies, and institutional support, CA promotional projects, access to inputs and implements, access to training and extension support, and farmers' socio-economic and cultural contexts. Furthermore, the factors triggering dis-adoption among smallholder farmers include the phasing out of CA projects and weak exit strategies, discontinuance of incentives to farmers, lack of adequate CA knowledge, labour constraints and high cost of CA implements whereas non-adoption is mainly caused by inherent weaknesses in the designs of some CA projects and beneficiary selection criteria and lack of convincing evidence on the relative advantages of CA over conventional Tillage. Arguably, while incentivized projects have positively influenced the adoption of Conservation Agriculture among smallholder farmers, they often jeopardize the sustainability of adoption when CA projects are phased out (Giller et al. 2009:29, Umar et al. 2011:51).

This study has also identified that the major constraints to Conservation Agriculture adoption among smallholder farmers in Zambia are high labour demands which increase during dry-season land preparation and weeding when herbicides are not applied; high initial investment costs of fertilizers and CA implements and competing uses of crop residues for livestock fodder. The findings also show that Conservation Agriculture can potentially be locally adapted for adoption by both 'vulnerable and resource-poor farmers' and 'wealthier farmers' who can afford CA practices by incorporating this innovation in their agricultural production systems. However, despite several dynamic CA promotional projects and the many agricultural and environmental benefits that CA promises, the question that arises is; 'why is CA adoption among smallholder farmers still low in Zambia?'. As Kasaam et al. (2009:316) argue, Conservation Agriculture is "a knowledge-intensive and complex system which cannot be reduced to a simple standard technology especially when all the three CA principles have to be applied simultaneously" and therefore farmer adopters may face several challenges before the full benefits of CA can be achieved in the long-term. Furthermore, this study concludes that an innovation tends to be adopted at a faster rate - speeding up the innovation-diffusion process if that innovation offers more attributes of diffusion i.e. *relative advantage, compatibility, less-complex, trialability, and observability* (Rogers 2003, Sahin 2006). From this perspective, smallholder farmers who lack animal draft power and access to ripping implements still perceive CA as a labour-intensive innovation which increases *drudgery* especially when manual hand-hoe planting basins are used. This situation is further exacerbated by most smallholder farmers' perceptions of the lack of *relative advantages* of CA over Conventional Tillage methods in terms of achieving higher yields, especially in the short-term horizon. The partial adoption of CA's 'minimum tillage' is generally demonstrated as some farmers do not usually embrace the other CA principles such as permanent soil cover residues and crop rotations because these other two CA principles in most cases, tend not to be compatible with smallholder farmers' socio-economic and cultural contexts.

This study has also revealed that smallholder farmers are reluctant to invest their resources in CA technologies and practices because they are *risk-averse* about the risk and uncertainty surrounding CA as some of them are not fully convinced about the relative yield advantages while others may not want to incur high production costs involved during the initial stages of CA adoption. From the above perspectives, further research is needed by scholars, policymakers, and development practitioners to fully address the determinants of adoption, non-adoption, and dis-adoption of Conservation Agriculture among smallholder farmers in Zambia. As Lipper et al. (2014:1070) argue, more studies are needed to improve our understanding of how CA works, "where and why in different agro-ecologies and farming systems, facilitating identification of what constitutes 'climate smartness' in different biophysical and socio-economic contexts".

Finally, this study argues that socio-economic and institutional factors play significant roles in influencing CA adoption among smallholder farmers. Therefore, future Conservation Agriculture projects could benefit more smallholder farmers by addressing the major constraints to full CA adoption which farmers face in ways that consider their socio-economic and cultural contexts as well as farmers' adoption decisions. The findings in this study also suggest that behavioural change in the mindsets of farmers is needed for them to be convinced about the benefits of Conservation Agriculture for them to adopt this innovation on a sustainable basis and adapt CA to their local contexts.

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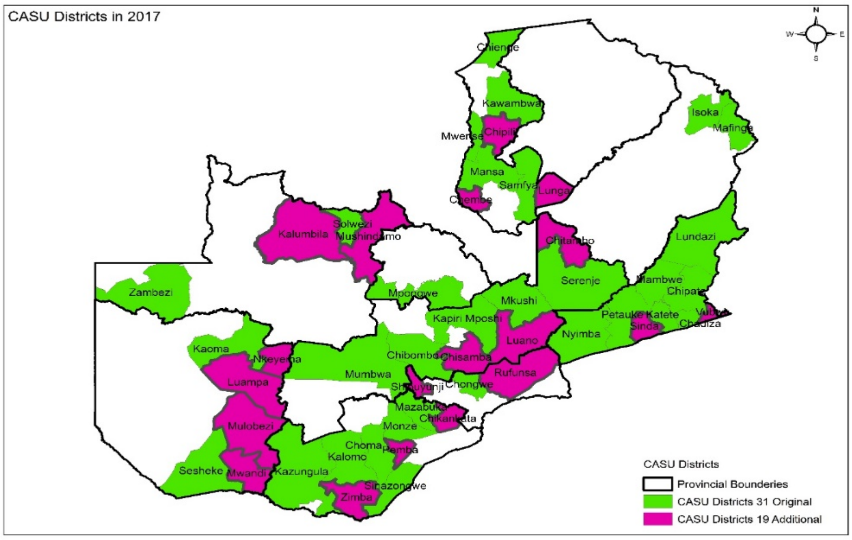
Maps

Map 1: Map of Zambia showing provincial boundaries and its location in Southern Africa

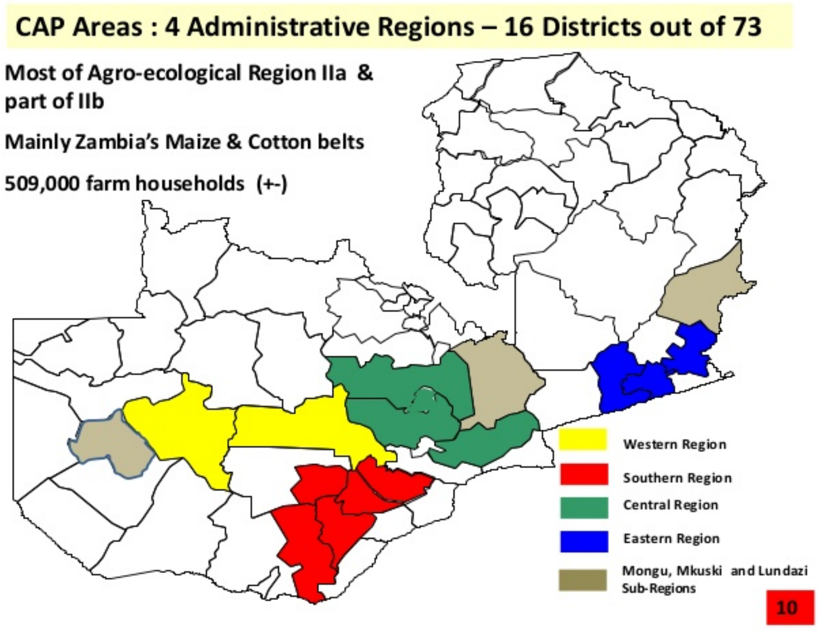
Source: www.mapsofworld.com/zambia/zambia-political-map.html

Map 2: Map of Zambia showing CASU Project's Operational Areas



Source: CASU 2017, FAO 2017.

Map 3: Map of Zambia Showing CFU Operational Areas



Source: www.slideshare.net/ACTIllage/conservation-farming-unit-cfu-and-conservation-agriculture

Appendices

Appendix 1: Major Characteristics of Zambia's Agro-Ecological Regions

AEZ I (Region l)	AEZ II (Region IIa & IIb)	AEZ III (Region III)
1. Situated in lower parts of Western, Southern and Eastern provinces along the Luangwa and Zambezi rift valley areas, covers 14% of total land area. 2. Characterized by low potential for agricultural production and receives <800mm of annual rainfall, unpredictable rainfall with recurrent droughts and floods, high (rainy season) temperatures can exceed 38 ^{o}C. 3. Short growing season ranging between 80-120 days 4. Suitable for sorghum, millet, bananas, paprika, cattle, dairy, goats, poultry and aquaculture.	**Region IIa** 1. Situated in Central, Southern and Eastern plateaus of Zambia, most productive agricultural areas with fertile soils for crops and livestock production. Covers 28% of total land area. 2. Receives between 800 - 1,000mm of annual rainfall with summer temperatures ranging from 20 - 33 ^{o}C. 3. Growing season of 120 - 160 days (Region IIa & IIb). **Region IIb** 1. Similar rainfall patterns with Region IIa but has different soil characteristics - situated in the semi-arid plains of Western province, with less fertile sandy and alluvial soils. Covers 12% of the land area. 2. Receives >800mm of annual rainfall. 3. Suitable for both crops and livestock production; maize, millet, sorghum, cassava, groundnuts, rice, cowpeas, soybeans, sunflower, irrigated wheat, tobacco, horticulture, cattle, goats, poultry and aquaculture.	1. Situated in northern parts of Zambia, soils are moderately fertile, acidic leached soils with low fertile, covers 46% of total land area. 2. Receives high annual rainfall above 1,200mm, with summer temperatures ranging from 18 - 30 ^{o}C. 3. Growing season of over 160 days 4. Suitable for maize, millet, rice, beans, sorghum, tea, cassava, coffee, groundnuts, pineapples, cattle, dairy, poultry and aquaculture.

Source: Adapted from CFU (2007), FEWS NET (2014) and GAP Report (2015:55).

Appendix 2: The Five Stages of the Innovation-Decision Process (Rogers 2003)

Box 1: Model of Five Stages in the Innovation-Decision Process

i. Knowledge: when a person becomes aware of an innovation, gets information and becomes knowledgeable about the innovation and how it works. The individual determines "what the innovation is and how and why it works" (Rogers 2003:21).
ii. Persuasion: when a person forms "a favourable or unfavourable attitude toward an innovation" and at this stage, "the individual has a negative or positive attitude toward the innovation" (Sahin 2006).
iii. Decision: when a person decides or chooses to engage in activities that lead to 'adoption' or 'rejection 'of the innovation. Adoption means "full use of an innovation as the best course of action available," while rejection refers to "not to adopt an innovation" (Rogers 2003:177).
iv. Implementation: when a person puts an innovation into use (or practice).
v. Confirmation: when a person evaluates the results of an innovation-decision already made and decides whether to continue using the innovation or abandon it (discontinuance).

Source: Adapted from Rogers (2003:170), Sahin (2006).

Appendix 3: List of Key Informants

Name	Position/ Responsibility
Mr. George Okech	FAO Representative, FAO Zambia
Mr. Geoffrey Ndawa Chomba	Deputy FAO Representative, FAO Zambia
Mr. Mtendere Mphatso	CASU Program Coordinator, FAO Zambia
Mr. Kebby Chileka	EFSP Programme Officer, Chadiza Zambia
Mr. Vincent Siakwale	EFSP Programme Officer, Itezhi-tezhi Zambia
Ms. Clara Kateule	MCDSW District Community Officer, Itezhi-tezhi Zambia
Dr. Emma Sitambuli	Consultant – Agriculture and Rural Development, Zambia
Mr. Munguzwe Hichaambwa	IAPRI Agricultural Researcher, Zambia