Conservation agriculture in Africa: An analysis of the role of social systems in the adoption of conservation agriculture technologies in selected areas of Zambia and Zimbabwe

by

Putso Nyathi

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DECLARATION

I, Putso Nyathi, declare that the thesis, which I hereby submit for the degree Doctor of Philosophy (Rural Development) at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution. Any references to the work of others are acknowledged and properly referenced.

Signature……

Date……

DEDICATION

To Mkhululi, Nomasiko, Manqoba and Nomalungelo Moneoa

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ABSTRACT

Conservation agriculture in Africa: An analysis of the role of social systems in the adoption of conservation agriculture technologies in selected areas of Zambia and Zimbabwe

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Putso Nyathi

Degree: Doctor of Philosophy (Rural Development)

Department: Agriculture Economics, Extension and Rural Development

Supervisor: Dr Joe Stevens

Conservation Agriculture (CA) involves the practice of three interlinked principles of minimum soil disturbance, a permanent soil cover and crop rotation. CA has been promoted in Africa to address food security and environmental challenges. However, adoption of the technology has been slow. Although several studies have been done to understand the factors that affect CA adoption, only a few have investigated the role played by social systems in adoption. Further to this, these adoption studies have methodological limitations, which fail to evaluate farmers' attitudes to the technology and their perceived effects of social and institutional factors on CA adoption.

This study investigated the effects of the social system (represented by attitudes, by-laws, customs and social influence) in the decision to adopt the three CA principles. It also further sought to determine the influence institutional factors (access to markets, implements, credit and extension services) on adoption. The effects of the same predictor variables on the area under CA were also explored. The study applies the Theory of Planned Behaviour. Further, the study also compared the adoption of CA principles between female and male farmers and between the rich and the poor. The study targeted CA adopters in Nkayi, Zimbabwe and Choma, Zambia.

The study found differences in attitudes to CA benefits between the two districts, suggesting that the farmers' perceptions of CA depend on the perceived performance of the CA options promoted

in a particular context. The effects of the social system factors and institutional factors on CA adoption and on the area under CA had mixed results. By-laws had a significant positive relationship with the practice of minimum soil disturbance but negative relationship with the practice of soil cover and crop rotation. Social influence and customs had significant positive correlation with the area under CA but no significant effects on the adoption of CA principles. Institutional factors had a significantly negative relationship with practice of minimum soil disturbance but a positive relationship with the practice of crop rotation and the area under CA, which suggests that more institutional support is required for the practise of minimum soil disturbance than for crop rotation and area allocated to CA.

The study found no significant difference in adoption of CA principles between male and female farmers, although female farmers adopted two or more CA principles than male farmers. Despite this, female adopters had significantly lower yields from their CA fields than male farmers. The study also found that a significantly higher number of poor farmers adopted two principles (which involved the practice of minimum soil disturbance with either soil cover or crop rotation) than rich farmers. No significant difference between the rich and the poor were found in the adoption of the principle of minimum soil disturbance and adoption of all three CA principles. However, more poor households adopted the minimum soil disturbance principle, while more rich farmers adopted all three CA principles.

The conclusions drawn for these findings are that the effects of the social system components and institutional factors on the uptake of CA depend on how the particular CA principle fits into the social and institutional environment and if the CA principle can be adapted to the local environment. The lack of significant effect of social influence on adoption of CA principles suggested that other factors within the social system, such as alternative sources of information, trust, technology complexity or community values may prohibit social learning. The study recommends agriculture extension services and policymakers to pay more attention to these issues in the promotion of CA by addressing the barriers and adapting CA to local contexts. The study also concluded that the deliberate targeting of the poor and women can help them adopt CA principles. However, there is still need to address challenges that may limit poor farmers from adopting the full CA package; and women from achieving high CA yields.

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ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ASP	Agriculture Support Programme
BICC	Brethren in Christ Church
CA	Conservation Agriculture
CATF	Conservation Agriculture Task Force
CC	Christian Care
CFGB	Canadian Food Grains Bank
CFU	Conservation Farming Unit
CLUSA	Cooperative League of the USA
FAO	Food and Agriculture Organisation of the United Nations
FGD	Focus Group Discussion
GART	Golden Valley Research Trust
GDP	Gross Domestic Product
GoZ	Government of Zimbabwe
GRZ	Government of Zambia
GTZ	German Agency for Technical Cooperation
ha	Hectares
HIV	Human Immunodeficiency Virus
IFAD	International Fund for Agriculture Development
IPCC	Intergovernmental Panel on Climate Change
ITDG	Intermediate Technology Development Group
MACO	Ministry of Agriculture and Co-operatives
MSD	Minimum Soil Disturbance
NEPAD	New Partnership for Africa's Development
NFU	National Farmers' Union
NGOs	Non-governmental Organisations

NORAD	Norwegian Agency for development Cooperation
OECD	Organisation for Economic Co-operation and Development
PBC	Perceived Behaviour Control
RAA	Reasoned Action Approach
TPB	Theory of Planned Behaviour
Sida	Swedish International Development Cooperation Agency
SPSS	Statistical Package for the Social Sciences
TLU	Total Livestock Unit
UNEP	United Nations Environment Programme
USA	United States of America
ZMAL	Zambia Ministry of Agriculture and Livestock
ZIMSTAT	Zimbabwe National Statistics Agency
ZIMVAC	Zimbabwe Vulnerability Assessment Committee
ZNAP	Zambia National Agriculture Policy
ZNFU	Zambian National Farmers' Union

CHAPTER 1

INTRODUCTION

1.1 Background

Sub-Saharan African agriculture is dominated by smallholder farmers, who constitute 80% of farmers and are the main producers of food (Johansen *et al*., 2012). The sector contributes 15% to Gross Domestic Product (GDP) and employs 80% of the population (OECD and FAO, 2016). Because of the importance of this sector, African governments have through the Comprehensive African Agriculture Development Programme of the New Partnership for Africa's Development (NEPAD) committed themselves to allocating 10% of their budgets to agriculture, aimed at stimulating production and food security (OECD and FAO, 2016). Although agricultural production has increased over time, it has not kept pace with population pressure and food insecurity consequently remains a challenge (NEPAD, 2014). In addition, smallholder farmers face challenges of climate variability, poor access to markets (FAO, 2017), reliance on family labour, poor soil fertility and lack of land tenure security (NEPAD, 2014). The effects of climate change are already being felt, with a 10% decline in production reported in the 2015 cropping season in east and southern Africa as a result of rainfall variability (OECD and FAO, 2016). These challenges are further exacerbated by high poverty levels, which limit the adaptive capacity of farmers (IPCC, 2014). Achieving food security remains a major concern in sub-Saharan Africa.

In Zimbabwe, the agricultural sector contributes 14% of GDP, is the source of livelihood for 60% of the population (FAO, 2016) and thus plays a significant role in food security and poverty reduction (GoZ, 2011). However, smallholder farmers face challenges of low productivity, as they cultivate less than 5 hectares (ha) and rely on rain-fed agriculture. They also farm in marginal areas where soils are poor and rainfall is unreliable (Marongwe *et al*., 2012). The average maize yield for smallholder farmers in Zimbabwe is less than one tonne per hectare (Marongwe *et al.*, 2012).

In Zambia, 48% of the population rely on agriculture and the sector contributes 5% to GDP (Chapoto *et al*., 2017). Although 58% of the land is considered to have medium to high potential

(MACO, 2004) and the country produces a surplus, 50% of the population is food-insecure (Chapoto *et al*., 2017). Smallholder cereal production is constrained by inappropriate farming methods and vulnerability to drought, with farmers getting yields of between one and four tonnes per hectare (Tembo and Sitko, 2013). There is also the challenge of limited access to markets (*Ibid*).

Addressing production challenges faced by smallholder farmers require technologies that sustainably conserve the environment and increase the adaptive capacities of farmers to climate change, while increasing productivity. Conservation agriculture (CA) is one such technology that has been promoted in sub-Saharan Africa to address the challenges of land degradation and food insecurity faced by smallholder farmers (Anderson and D'Souza, 2014) and has received support from international organizations including NEPAD (Kassam *et al*., 2018). CA is a concept for resource-saving agricultural crop production that strives to achieve acceptable profits as well as high and sustained production levels, while concurrently conserving the environment (FAO, 2010). This is achieved through improved management and application of three key principles: minimum soil disturbance (MSD), permanent soil cover and diversified crop associations or rotations. CA has the potential to increase productivity (Wall, 2007; Twomlow *et al*., 2008 Rockstrom *et al.*, 2009; FAO, 2014), reduce susceptibility of farmers to dry spells (Thierfelder and Wall, 2010a), increase soil fertility (Mazvimavi *et al*., 2008) and lift farmers out of poverty (Abdulai, 2016).

Zimbabwe and Zambia are some of the leading countries in Africa in terms of area put under CA, with about 316 000 and 100 000 ha put under CA in Zambia and Zimbabwe respectively in 2015/2016 (Kassam *et al.*, 2018). However, the area under CA is still generally very low in Africa compared to the rest of the world. Africa has about 1.1% of the continent's total arable land under CA, while South America has about 63% of the region's crop land (ibid). Although CA in Zimbabwe and Zambia dates back to the 1980s, wide-scale promotion to smallholder farmers began in the 2003/2004 cropping season in Zimbabwe, spearheaded by non-governmental organisations (NGOs) and the government (Marongwe *et al*., 2011). In Zambia, CA was widely promoted to smallholder farmers by the Conservation Farming Unit (CFU) of the Zambian National Farmers' Union (ZNFU) in 1995, while the Golden Valley Research Trust (GART)

developed packages for smallholder farmers (Haggblade and Tembo, 2003: Arsalan *et al*., 2013; Wall *et al*., 2013).

Several studies, including ones undertaken in Zambia and Zimbabwe, have tried to identify factors that influence the adoption of CA (Mazvimavi & Twomlow, 2009; Nyanga, 2012; Arsalan *et al.*, 2013; Ngwira *et al.*, 2014; Pedzisa *et al*., 2015). The effects of these factors on adoption were not consistent and the studies provided limited information on the role of social factors in the uptake of CA (Knowler & Bradshaw, 2007). This research is driven by the limited availability of information that explains the role of social system factors in the uptake of CA and the direct role institutional factors in adoption. Understanding these factors could assist extension services in the promotion and adaptation of CA, and in the development of policies to support the upscaling of CA.

1.2 Research problem

With the current global challenges of meeting food security while protecting the environment, CA is perceived as one of the technologies that can contribute to achieving both objectives (Corbeels *et al.*, 2014). However, despite more than a decade of promotion in southern Africa, the upscaling of CA in the smallholder sector is still minimal (Kassam, 2014).

Adoption studies have identified biophysical factors (agro-ecological region), household characteristics (age, level of education, experience, farm size and livestock ownership) (Mazvimavi and Twomlow, 2009; Arsalan *et al.*, 2013; Ngwira *et al.*, 2014; Pedzisa *et al*., 2015), institutional factors such as access to credit, markets and extension services (Nyanga, 2012), and the ease with which a technology can be applied (Prager and Posthumus, 2010) as factors that affect adoption. Further to this, most adoption studies on CA rely on household data models to explain adoption, which tend to miss important social, cultural and institutional factors that may influence the process (Feder *et al.*, 1985; Anderson and D'Souza, 2014). These models use the socio-economic status of the household to explain adoption. As such, they fail to evaluate the direct role of farmers' attitudes to the technology and the perceived effects of social and institutional factors on CA adoption.

The role of the social system, which includes social norms, attitudes, the social structure, the individuals and organisations in the system (Rogers, 2003), has rarely been studied particularly as it related to the adoption of CA (Knowler and Bradshaw, 2007). Most of the studies on the social system factors are limited to the influence of social networks (social capital) on the adoption of agricultural technologies (Katungi, 2006; Mashavave *et al.*, 2013; Ramirez, 2013). However, social capital only forms part of the social system, measured through membership of organisations (Rogers, 2003). This method therefore excludes other social system elements such social norms, individuals attitudes, sentiments, goals, role, power and status, and by-laws within the system. These elements play a role in the dissemination and adoption of technologies through informal sharing of information (Shaw, 1987; Pannell *et al*., 2006) and the pressure they exert on an individual to conform to certain socially expected norms (Azjen and Fishbein, 1980; Kate *et al*., 2010). Adoption is a process that includes technological, organisational and institutional aspects (Stevens and Letty, 2014).

This study aims to fill the gap in literature by focusing on the role of elements of a social system play in CA adoption and upscaling of CA technologies in Nkayi, Zimbabwe and Choma, Zambia. An understanding of how these factors influence adoption directly will help guide extension dissemination strategies to be tailored to the different social and institutional settings in which they are implemented. .

1.3 Objectives of the study

The main purpose of the research was to assess how the social system elements influenced the adoption of CA practices by smallholder farming communities of Nkayi, Zimbabwe and Choma, Zambia.

The specific objectives were:

1. To map the social system and economic environment of smallholder farmers in Nkayi, Zimbabwe and Choma, Zambia
2. To investigate the influence of the social system (attitudes, social influence, customs, by-laws) on the adoption of CA principles

3. To determine the influence of institutional factors on the adoption of CA principles
4. To investigate how social status influences the practice of CA principles

1.4 Hypotheses

H1: The social system of smallholder farmers significantly influences the adoption behaviour of farmers.

Attitude is defined as the predisposition to respond favourably or unfavourably to an object, person, event or institution (Ajzen and Fishbein, 1988). Attitude measures the belief that the behaviour will have expected outcomes and can be influenced by the social system. This research sought to understand if farmers' attitudes had a significant influence on the adoption of CA. Talkuder and Quazi (2011) found that perceived usefulness of the technology positively affected acceptance of the technology.

Social influence influences behaviour through the pressure exerted on individuals to conform to certain society expectations or rules that influence decision-making (Azjen and Fishbein, 1980; Kate *et al.*, 2010). Influential people such as local leaders and opinion leaders in communities are often perceived as sources of information and custodians of local rules. They have greater influence on the behaviour of other farmers. Farmers learn from one another through informal social networks and through membership of formal organisations. Interpersonal communication is important in the persuasion to adopt a technology (Rogers, 2003). In areas where decisions are communally made, adoption is higher than in communities with little social cohesion, because of information sharing (Rogers, 2003).

The rules and norms of communities can also influence adoption and diffusion of technologies, as they form part of the social system (ibid).

H2: The institutional environment of farmers significantly influences their adoption behaviour.
The objective was to measure the role of institutional factors in CA adoption because these factors provide useful information that can help design extension and support systems that can be tailor-made to the needs of farmers. Institutional factors in this research refer to access to extension services, credit, access to minimum tillage implements and markets. The belief about the perceived

control of the environment to practise CA provides a measure of institutional factors and is termed PBC (Ajzen, 1991). Hulst and Posthumus (2016) found that perceived ability and control had a positive and significant influence on adoption in Kenya.

H3: Social status (poor and rich, men and women) influences the adoption behaviour of farmers. It is expected that adoption of CA principles will differ between men and women and between rich and poor households. Studies have reported higher adoption of new technologies by men (Dorris and Morris 2001) and by rich households (Awotide *et al*., 2012) than by women and the poor respectively. Fisher and Carr (2015) argued that women, particularly in the smallholder sector, have less decision-making power, which limited their adoption of new technologies. Richer households have access to resources and were therefore better able to adopt technologies than the poor (Mazvimavi and Twomlow, 2009).

1.5 Thesis outline

The remainder of the thesis is organized as follows: Chapter 2 provides an overview of CA and its adoption globally and in Africa. Chapter 3 discusses smallholder farmers, their farming systems and their constraints. It further provides an overview of the social system and a review of literature on how social factors influence adoption of technologies in general. Chapter 4 reviews agriculture extension approaches, how they have evolved over time and how they influence technology transfer as it relates to access to information, markets and credit, with a particular focus on farmer-led approaches. The review includes specific extension approaches used in the dissemination of CA in the study areas. A description of the study areas and the rationale for their selection is found in Chapter 5. Chapter 6 outlines the methods used for data collection, the conceptual framework of the study and analytic methods. An analysis of the demographic characteristics and asset endowments of respondents is found in Chapter 7. The chapter also analyses the effects of these factors on adoption. Chapter 8 analyses the socio-economic environment and farming systems of the study areas. Chapter 9 analyses the effects of social system and institutional factors on the adoption of CA. The chapter further compares adoption of CA between men and women and between the rich and the poor. Chapter 10 presents a summary of the study, conclusions drawn and recommendations for policy and future research.

CHAPTER 2

CONSERVATION AGRICULTURE OVERVIEW

2.1 Introduction

This chapter provides an overview of CA, which includes a description of the principles of CA, its origins, adoption in the world and in Africa in general and limitations to adoption. The last section of Chapter 2 narrows down to CA in Zambia and Zimbabwe, the countries of study.

2.2 History and definition of conservation agriculture

The history of reduced tillage dates to the 1930s in America in response to dust bowls as a soil conservation strategy (Anderson and Giller, 2012; Kassam *et al*., 2014a). The Food and Agriculture Organisation (FAO) of the United Nations (2010) defines CA as a technology that seeks to maximise production and environmental protection by following three principles - minimum tillage, at least 30% of permanent soil cover and crop rotation or intercropping with legumes. The benefits of employing these principles simultaneously include reduced soil erosion and reduced labour requirements where mechanised methods are used (Kassam *et al*., 2014a). In the long term higher and more stable yields are achieved, soils are improved, and farmers become more resilient to adverse climatic conditions (Corbeels *et al*., 2014).

In America CA is referred to as zero tillage and involves planting without ploughing and leaving crop residues (Kassam *et al*., 2014a). Although crop rotation is part of the package, it may not always be practised. Generally, the principles of no-till and CA are the same: minimising disturbance of the soil, maintaining soil cover and practising crop rotation.

2.3 Adoption of conservation agriculture: A global perspective

CA is practised on 180 million ha worldwide, representing 12.5% of the total global arable area (Kassam *et al*., 2018). CA is practised in varying conditions, from very dry areas receiving 250

mm of rain per year to wet regions receiving 2 500 mm per year (Friedrich *et al*., 2012). It is also practised in soil types that range from 90% sandy soils in Australia to heavier clay soils in Brazil (Wall, 2007; Kassam *et al*., 2018). CA has mainly been adopted in the USA, Canada and South America. In South America, 63.2% of total cultivated land is under permanent CA (Kassam *et al*., 2018). In China and Kazakhstan, CA is practised on more than a million hectares. Australia and New Zealand have 45.4% of their total area under CA and Asia currently has 4.1 % of its total agricultural land under CA (ibid). Europe and Africa although having shown area increases under CA of more than 100% since 2008, they have only 5% and 1.1% of the continents' arable land under CA respectively (Kassam *et al*., 2018).

In Brazil, the adoption of no-till methods was driven by farmers and adapted to their own situation (Ekbor, 2003). Farmers tried and tested minimum tillage because they had perceived an environmental problem. Suppliers saw the opportunity to supply minimum tillage implements and made them available. Research and public institutions only came on board when farmers had already tried the technology (ibid). In Africa, CA was promoted mostly by donor agencies, initially to address soil degradation issues, but the focus later changed to incorporate food security challenges (Anderson and D'souza, 2014).

The adoption of CA in some parts of America did not happen without challenges. In places such as the Central America and Andean regions, CA adoption started slowly owing to institutional and technical factors (Speratti *et al*., 2015). However, the involvement of various stakeholders, including farmers, through an innovation systems approach was crucial to addressing the challenges and improving adoption (ibid).

2.4 Adoption of conservation agriculture in Africa

The adoption of CA has been slow in Africa because of institutional, technical and socio-economic factors, which include competition for crop residues from livestock, lack of markets, labour challenges, especially in terms of weed control, risk averseness of farmers, lack of supportive institutions and top-down approaches to CA promotion (Giller *et al*., 2009; Anderson and Giller, 2012; Anderson and D'Souza, 2014). The scaling up of CA has also been hampered by lack of

adaptation to local context (Giller *et al*., 2009; Kassam, 2014) and fragmented institutions, resulting in lack of coordination among rural development players (Hobbs *et al*., 2014). CA has remained tied to projects, which is characterised by abandonment of CA when projects end (Giller *et al*., 2011; Arsalan *et al*., 2013; Pedzisa *et al*., 2015) due to top down approaches and lack of adaptation to the local environment. Because of low adoption rates in Africa, most researchers have realised that CA should be adapted to local context (Giller *et al*., 2011; Cobeels *et al*., 2014).

2.5 Overview of conservation agriculture in Zimbabwe and Zambia

Zimbabwe is a landlocked country, where 60% of the population is rural (FAO, 2016) and agriculture plays a significant role in food security and poverty reduction (GoZ, 2011). CA in the country dates back to the 1980s when Brian Oldrieve was experimenting with CA on a farm in the northern part of the country (Wall *et al*., 2013). CA was later promoted by River of Life Church as Operation Joseph in the 1990s, using planting basins (Twomlow *et al.*, 2008). Other CA techniques were promoted in the 1980s, which included no-till tied ridges, mulch ripping, no-till strip cropping, clean ripping, hand hoeing and open plough furrow planting (Nyagumbo 1988; Mupangwa *et al*., 2006). Wide-scale promotion of CA only started in the 2003/2004 cropping season, targeting smallholder farmers. It was spearheaded by NGOs owing to the then economic meltdown and was accompanied by input support (Marongwe *et al*., 2011). CA targeted the vulnerable, hence the promotion of the hand hoe option for planting basins. Making planting basins entails digging holes in the ground using hand hoes during the dry season in spots where crops and fertilizer are to be placed (Kasalu-Coffin *et al*., 2012). These are normally 15 cm deep, 15 cm long and 15 cm wide. In Zimbabwe, the use of planting basins as the minimum tillage method, applying soil cover plus practising crop rotation, is termed conservation farming (Twomlow *et al*., 2008). CA on the other hand includes use of other minimum tillage methods such as jab planters, direct seeders and rippers as minimum tillage methods, in addition adhering to the other two principles of covering the soil with mulch and practising crop rotation (Twomlow *et al*., 2008).

Poor coordination among stakeholders, necessitated the formation of the Conservation Agriculture Task Force (CATF) to coordinate CA implementation in the country and to harmonise extension messages (Marongwe *et al.*, 2011). Although this was not driven by the government, the role of

the Ministry of Agriculture was to chair the task force, which comprised NGOs, research organisations, government and the FAO of the United Nations (Marongwe *et al*., 2011; FAO, 2012). Apart from coordination, the CA task force's role also included capacity building, monitoring and evaluation and information dissemination.

CA in Zambia dates back to the 1990s, soon after the implementation of the structural adjustment programmes (Haggblade and Tembo, 2003). In 1999, the government of Zambia (GRZ), through the Ministry of Agriculture and Cooperatives (MACO), declared CA and its promotion by CFU and GART a priority (Shula *et al*., 2012). Since 1999, when the GRZ declared CA to be a government priority, the MACO has partnered with various stakeholders in the promotion of CA, which included the FAO from 2009 to 2011. From 2009 to 2011 CA was promoted with funding from Norway and implemented through the CFU. The project was named the CA programme and was followed by the Farmer Input Support Response project, which was funded by the European Union. Currently institutional arrangements for CA implementation in Zambia are the responsibility of the national CATF, which was introduced in 2007 and has similar functions to the CATF in Zimbabwe for building capacity, influencing policy and disseminating information (Shula *et al*., 2012).

2.6 Conclusion

This chapter provided an overview of CA and its adoption in the world and in Africa. Generally, CA uptake has been slow in Africa because of several factors, which include the applicability of CA to the context of smallholder farmers in Africa and lack of institutional support in terms of developing markets and extension and credit support. In the rest of the world, CA has been driven by farmers, yet in Africa it is mainly driven by governments and donors. Different packages of CA are promoted in Zimbabwe and Zambia, with the focus on the hand hoe option in Zimbabwe and on ox-drawn options in Zambia. These governments have partnered with international organisations to promote CA in the two countries.

CHAPTER 3

OVERVIEW OF SMALLHOLDER SOCIAL AND FARMING SYSTEMS AND THEIR IMPLICATIONS FOR CONSERVATION AGRICULTURE ADOPTION

3.1 Introduction

This chapter provides an overview of smallholder farming systems and social systems in Africa. Understanding smallholder farming and social systems is crucial for adapting CA to the local context. The first part of the chapter describes the characteristics and constraints of the smallholder farming systems. The second part focuses on what smallholder social systems entail and how these systems affect the adoption of agricultural technologies.

3.2 Definition of smallholder farmers and farming system

Smallholder farmers in Africa are farmers who produce crops mainly for subsistence needs and cultivate using family labour (Johansen *et al*., 2012). Smallholder farmers represent 80% of all farmers in sub-Saharan Africa (Livingston *et al*., 2011) and contribute 90% of total production in some countries (Wiggins, 2009). This means that they play a significant role in food security in most African economies. Smallholder farmers live in varying climatic and soil conditions, ranging from humid to arid regions (Livingston *et al*., 2011).

There are various farming systems in the smallholder sector of Africa. A farming system is defined as ‘a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. Depending on the scale of analysis, a farming system can encompass a few dozen or many millions of households’ (Dixon *et al*., 2001). The systems are classified based on natural resources, enterprises, livelihood strategies and technologies used. There are 15 farming systems in sub-Saharan Africa, of which maize-mixed systems are the most important in east and southern Africa (Dixon *et al*., 2001).

3.2.1 Maize-mixed farming systems

This section briefly describes maize-mixed farming systems. Maize-mixed systems are practised by 95 million people and are mostly found in the dry sub-humid areas, as shown in Table 3.1**Error! Reference source not found.**. In these systems, irrigated farming is limited to less than half a million hectares.

Table 3.01: Maize-mixed farming system in sub-Sahara Africa

Total population (m)	95
Agricultural population (m)	60
Total area (m ha)	246
Agri-ecological zone	Dry sub-humid
Cultivated area (m ha)	32
Irrigated area (m ha)	0.4
Cattle population (m)	36

Source: Dixon *et al*., 2001

In maize-mixed systems, maize is the main crop. Livestock play a critical role in the smallholder farming sector, as cattle provide a measure of wealth, manure, milk, draught power and transport and spread the risk in case of crop failure (Hobbs, 2007). This is the case in semi-arid areas, where droughts have become more frequent (Cooper *et al*., 2008). While livestock provide manure and draught power for land preparation, crop residues are used for feeding livestock in the dry season when most of the grazing areas are limited (Wall, 2007; Corbeels *et al*., 2014). A typical mixed farming system is described by the FAO in Box 1.

Box 1: Description of a typical mixed farming system household

A typical middle stratum household would include a husband, wife and four of their own children plus an older relative and several orphans left by one of the husband's deceased brothers. They would live directly on their farmland in a dispersed homestead. It would have a cropped area of 1.6 ha of which one ha would be planted to maize and some sorghum, 0.1 ha to cassava, 0.1 ha to cotton and the rest to a wide range of other crops. The family would own 2 or more cattle and use its oxen to plough the land. It would obtain average yields of 1.2 t/ha for maize and around 900 kg/ha for sorghum, 800 kg/ha for millet and 500 kg/ha for pulses. Maize and other cereals would account for 80 percent of total food production, pulses for nine percent, cassava for eight percent and oilseeds for the rest. The household would be food self-sufficient in average to good years and in deficit during drought years. One son works outside the farm and sends occasional remittances, used to pay for school fees and clothes. Home-grown maize is the main source of subsistence and cash is obtained either from off-farm activities or from the sale of agricultural products, such as maize, tobacco or coffee and milk. Income would formerly have been above the poverty line.

A poor household in the same community would have less than 0.5 ha of land and its main source of livelihood would be casual labour for other farmers and beer brewing by the wife. It would have no cattle but might own a goat and a couple of chickens. Women, often widows of migrant workers who died of AIDS and left them with children to support, would head many such households.

Source: Dixon *et al.*, 2001 http://www.fao.org/docrep/003/Y1860E/y1860e04.htm#P412_45204

3.3 Major constraints faced by smallholder farmers in Africa

Smallholder farmers face numerous constraints that limit their production. These constraints include markets, security of land tenure, climate change, infertile soils, labour shortages and poor yields. These constraints and their effect on the adoption of technologies are discussed in the sections that follow.

3.3.1 Markets

Most smallholder farmers live in the rural and marginal areas with limited infrastructure in terms of roads and markets (Livingston *et al.*, 2011). This makes it difficult for farmers to access input and output markets. For example, it costs five times more to travel the same distance in Africa as in Pakistan (Livingston *et al.*, 2011). In fact, the cost of fertilizer in Africa is reported as two to four times higher than in developed countries (Bationo *et al.*, 2006). The limited adoption of CA by most smallholder farmers has also been due to limited access to inputs and equipment (Wall, 2007; Mazvimavi *et al.*, 2008; Giller *et al.*, 2009; Nyanga, 2012). The lack of inputs contributed

to land degradation as well, as hardly any nutrients are returned to the soil (Bationo *et al*., 2006; Johansen *et al*., 2012).

3.3.2 Land tenure

The land tenure system implies that most smallholder farming systems are communally owned; farmers do not have clear title to the land (Wall, 2007). Farmers are generally reluctant to invest in soil improvement where they have no clear rights to land (FAO, 2010). Because land is communally owned, in maize-mixed farming systems, livestock is only tethered during the cropping season and allowed to roam during the dry period. This makes it difficult for farmers to own crop residues exclusively (Erenstein, 2003). Long-term investment in improving land productivity is constrained by the lack of ownership.

3.3.3 Labour

Smallholder farmers rely on family labour to work on their farms (IFAD and UNEP, 2013). Lack of mechanisation and the availability of labour affects the area of land cultivated (Livingston *et al*., 2011). Technologies that increase the labour demand may not be appropriate for smallholder farmers (FAO, 2011b). Labour challenges have been reported as hampering the adoption of CA in Zimbabwe (Marongwe *et al*., 2011).

3.3.4 Climate change

Rain-fed systems in Africa are facing a challenge of water scarcity (Johansen *et al*., 2012). Rainfall distribution has become variable in both time and space (OECD and FAO, 2016). In most of these systems, extreme weather conditions such as drought and floods have become more frequent, making smallholder production vulnerable to these weather changes (Cooper *et al*., 2008) due to their limited capacity to adapt (IPCC, 2014). Planting time therefore becomes crucial in rain-fed systems in order to make maximum use of limited rainfall. Farmers who plant earlier benefit from

the first nitrogen flush (Giller *et al*., 2011), and obtain higher yields. Any technology that could reduce vulnerability to extreme weather conditions is important to smallholder farmers. There is documented evidence that CA can mitigate the impact of climate change through carbon sequestration, increased water infiltration and reduced soil erosion (Thierfelder and Wall, 2010a and b).

3.3.5 Poor soils

Although Africa has a wide range of soils, smallholder farmers are located mostly in poor, degraded soils (Kasalu-Coffin *et al*., 2012). Extensive use of the plough to prepare land, achieve a fine tilth and control weeds has contributed to land degradation (Twomlow *et al*., 2008; Johansen *et al.*, 2012). The low use of fertilizer also exacerbates the challenges of soil fertility (Bationo *et al.*, 2006).

3.3.6 Low yields

Although agricultural production is improving in places such as America and the rest of the world, smallholder production in Africa is still lower, with yields of less than one tonne per hectare for major cereals like sorghum, millet and maize (Dixon *et al*., 2001;Bationo *et al*., 2006). CA is therefore being introduced to address low farm productivity. Yield benefits from CA have been reported to be more than double (Twomlow *et al.*, 2008) and more pronounced where fertilizer and mulch were applied (Nyathi, 2009; Nyamangara *et al*., 2013 Thierfelder *et al*., 2013). Yield gains from CA were, however unstable in low rainfall areas (Rusinamhodzi *et al*., 2011). This poses a challenge to farmers that normally produce for household consumption. Yield increase was expected to be a major driver in the adoption of CA (Giller *et al.*, 2009).

3.4 The social system and adoption of technologies

This section defines and describes the social system and the way in which social systems influence the adoption of agricultural technologies.

3.4.1 What is a social system?

A social system is defined as a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal (Rogers, 2003). A social system comprises individuals, informal groups, organisations, norms, attitudes, goals, roles and subsystems. A social system has structures and norms, which may facilitate or impede the diffusion and adoption of technologies (ibid). Social norms refer to the way decisions are made while structure refers to the way the system is organised and the way in which communication is structured (Isham, 2000). Understanding the social values and norms can help to determine effective means of communication in the diffusion and adoption of innovations (Shaw, 1987). Technologies can be adopted or rejected by individuals in a system or by the entire system (Rogers, 2003). Smallholder agricultural systems are in themselves social systems, as decisions are usually communally made (Grabowski, 2012).

3.4.2 Social factors and the adoption of technologies

Literature on the adoption of CA often focused on personal attributes, economic variables and other physical and technological factors to explain adoption. However, it is increasingly being recognised that these variables on their own cannot explain adoption, as they only provide a limited explanation of the adoption of innovations (Shaw, 1987: Knowler and Brashaw, 2007). Prager and Posthumus (2010) revealed that the role of social factors in the adoption of CA practices is as important as other factors.

There is a wide range of literature on the role of social capital, social networks and the role of opinion leaders in the adoption of technologies (Isham, 2000; Swinton, 2000; Katungi, 2006; Kris *et al*., 2007; Ghane *et al*., 2011; Ramirez, 2013; Bell and Ruhanen 2016; Mashavave *et al*., 2013). Social capital is defined as the interrelationships among smallholder farmers (Rogers, 2003;

Kassam *et al*., 2014 b). In these studies, the role of social influence, defined as the pressure to conform to particular behaviour as expected by others in the social system (Azjen and Fishbein, 1980; Kate *et al*., 2010), has often been tied to the social influence of the network group. Social influence from networks has been reported to have a positive effect on the diffusion and adoption of technologies by several of the studies (Isham, 2000; Swinton, 2000; Katungi, 2006; Ghane *et al*., 2011; Bell and Ruhanen, 2016). It is strongly believed that through social networks, information-sharing is the major contributor to adoption of new technologies and pressures to conform to a group results in increased adoption. However, the influence of a social system can also emanate from individuals or groups or expectations created by the system in a community (Rogers, 2003). Individual influence includes that of opinion leaders and peers. The role of opinion leaders in influencing decision-making has often been positive. Opinion leaders possess more information and tend to belong to more networks than others and hence influence adoption (Isham, 2000; Rogers, 2003). The role of peers and social networks in the adoption of technologies in the workplace was explored by Talukdar and Quazi (2011), who found that peers had no significant influence on adoption, while social networks did. They concluded that the lack of influence of peers was related to the general work conditions. Bell and Ruhanen (2016) also found that the adoption of eco-innovations was influenced more strongly by professional sources of information (change agents) than by peers. However, Ramirez (2013) and Kris *et al*. (2007) found that peers were the main source of knowledge and contributed to the adoption of innovations. A similar finding by Katungi (2006) in Uganda indicated that farmers relied more on their own experience or informal sources for their knowledge than on knowledge gained from extension agents in the application of new banana technologies.

According to Rogers (2003), in communities with more traditional norms, social influence is likely to be lower than in communities with more innovative social norms owing to the conservative nature of traditional communities. This agrees with Davis (2008), who argues that farmer-to-farmer communication leads to extension through farmer field schools being successful in places where there is strong social cohesion. Isham (2000) also found that communities that exercised participatory decision-making had an influence on the adoption of technologies. Hulst and Posthumus (2016) found no influence of social pressure on the intention to adopt CA by using the Reasoned Action Approach (RAA) in communities that had limited cohesion.

The decision-making process in a community is influenced by socio-cultural factors and personal influences (Pannell *et al.*, 2006). Seeking the opinion of others in decision-making can also be influenced by how significant the impact of the new technology will be and by the need to conform to certain norms that are socially acceptable in a community (ibid).

Social factors were reported to affect adoption of specific components of a technology. A study by Katungi (2006) revealed that participatory norms had a positive effect on the decision to apply manure and mulching. Kris *et al*. (2007) found that farmers who received information from peers adopted different components of integrated pest management from those exposed to training on this by change agents.

Prager and Posthumus (2010) also found that the adoption of conservation technologies was influenced by peer pressure, land management ethics and the traditions of a system, own initiatives, compensation and legislation. Traditions, compensation and legislation are pressures influencing adoption that are normally brought to bear by government policies.

3.5 Conclusion

The chapter provided an overview of smallholder farming systems and their challenges. The literature review highlights that the social system is an important component in the adoption of technologies. It also highlights mixed effects of social system components in influencing decision-making. The chapter also highlights conditions that may favour social learning which included community values and individual preferences.

CHAPTER 4

AGRICULTURE EXTENSION AS DRIVER OF INSTITUTIONAL SUPPORT

4.1 Introduction

This chapter gives a brief overview of the history of agriculture extension and its purpose in technology adoption and as a driver of other institutional support aspects such as access to markets and credit by farmers. The chapter further describes extension approaches and role of agriculture extension in the adoption of technologies. The chapter is concluded by an overview of agriculture extension strategies used in the promotion of CA in Zambia and Zimbabwe.

4.2 What is agriculture extension?

Agriculture extension has evolved over the years from top-down to participatory approaches. In the past agriculture extension was a way of transmitting information from researchers to farmers. Literally this meant extending knowledge to farmers (Davis, 2008). Over the years agriculture extension has been transformed from teaching to more participatory ways that consider farmers as clients (ibid). It is a non-formal education system that supports and facilitates people engaged in agriculture production to solve problems, obtain information, skills and technologies to improve livelihoods (Swanson, 2008). Other than providing knowledge, extension helps to link farmers to markets, promotes sustainable agricultural technologies (Anderson, 2007) and information relating to farming, such as credit facilities. The goal of agriculture extension is to facilitate adoption of innovations and to improve livelihoods (Anderson, 2007; Taye, 2013).

Agriculture extension services have also evolved from being solely a public good to being pluralistic, involving several stakeholders in technology dissemination. This has largely been due to the inefficiency of the public extension system, which has forced most African governments to allow pluralism in extension (Saliu *et al*., 2009). The promotion of CA has been done by various stakeholders in Africa, which include the public sector, universities, NGOs and the private sector.

Popular extension approaches include farmer-to-farmer extension and agriculture innovation systems, which are described briefly in the next section.

4.3 Extension approaches

Extension approaches refer to the methods through which information is disseminated to the intended beneficiaries (Anderson, 2007). In earlier years, information was passed from the extension agent directly to a farmer. Over the years, the use of other farmers in the dissemination of new technologies, the use of information communication technologies and the application of innovation systems approaches have become popular.

4.3.1 Participatory extension approaches

Participatory approaches were introduced after the realisation that conventional approaches elicited limited involvement from farmers. Taking this approach, the farmer becomes part of the decision-making process by being actively involved in the identification of problems and possible solutions. The most common types under these are; farmer field schools (Anderson, 2007), contact farmer, farmer-to-farmer extension (Taye, 2013) and a participatory, demonstration and training extension system (Davis, 2008). Participatory approaches can also be referred to as demand-driven, community-based, bottom-up or farmer-first approaches (Place, 2003). A farmer field school is an approach through which farmers learn by experimenting, identifying their own problems and coming up with their own solutions. It takes a whole seasonal cycle of experimentation and graduation (Anderson, 2007). Contact farmers or lead farmers are farmers who are identified and trained to train other farmers and help extension agents to reach a wide number of farmers faster and at low cost (Kiptot and Franzels, 2015).

4.3.2 Information communication technologies

The use of mobile cell phones has become an important tool in the dissemination and promotion of technologies (Anderson, 2007). Cell phone use was initially low in Africa (Anderson, 2007),

but more and more countries are beginning to use cell phones in the promotion of new technologies, with good results (Kiptot and Franzels, 2015). Cell phones help in reducing the cost of having to travel to meet farmers, a challenge that most public extension systems are facing in Africa. Their use requires investment in infrastructure and access to information and communication technology equipment (ibid) such as radios, television sets, cell phones and computers.

4.3.3 Agricultural innovation systems

An innovation system approach encompasses all stakeholders in the promotion, knowledge creation or adaptation of a technology (Puskur, 2007; World Bank, 2011). This new thinking focuses not only on the technical side of technology generation, but also on understanding the various stakeholders that participate in rural development, which include government, the private sector, farmers and NGOs, and fostering inter-linkages with one another, as each of these has an influence on technology transfer (Agwu *et al*., 2008). There is a general understanding that technology transfer is not linear, but is affected by many interrelated factors such as context, available resources and needs, which should be considered during investments (World Bank, 2011). Understanding these factors, which include policy, the private sector, farming context and social systems, to name just a few, is critical when promoting a technology. The role of agriculture extension services is to ensure that farmers are part of these innovation platforms.

4.4 The role of agriculture extension in the adoption of agriculture technologies

CA adoption studies by Mazvimavi and Twomlow (2009), Arsalan *et al*. (2013) and Ngwira *et al.* (2014) in Zimbabwe, Zambia and Malawi respectively, found a positive relationship between CA adoption and extension support services. Mazvimavi and Twomlow (2009) measured extension interventions as the number of times farmers met extension agents in a growing season and found a positive relationship between CA adoption and the number of meetings with extension agents. Ngwira *et al.* (2014) used group membership to measure access to extension services and found a positive correlation between membership of a group and adoption of CA. Arsalan *et al.* (2013)

used qualitative and quantitative methods to evaluate CA adoption, and their findings revealed that the quality of extension and strategies used by the CFU, through lead farmers and field days, positively influenced CA adoption in Zambia.

Studies on the effectiveness of farmer-led approaches, such as farmer field schools, reveal that farmers' characteristics and the type of technology influence its diffusion (Davis, 2008). The simpler the information or technology, the higher the chances of being passed on; family and close associates are often beneficiaries of new technologies from the farmer-led extension (Kiptot *et al.*, 2006). Farmers with stronger network ties or those in influential positions are likely to pass on their knowledge to others (Sinja *et al*., 2004; Nathaniels, 2005; Kiptot *et al*., 2006).

There are some limitations restricting farmer-led approaches. For example, with farmer field schools, information flow to other farmers outside the farmer field schools has been minimal (Anderson, 2007; Davis, 2008). However, farmer field schools result in the formation of economic interest groups and can be incorporated into existing systems of entrepreneurial activities, thus becoming a driver of institutional strengthening (Simpson and Owens, 2002; Nathaniels, 2005). Davis (2008) also argues that there is limited evidence to support the notion that participatory approaches influence the adoption of new technologies. Taye (2013) has suggested that it is often difficult to link adoption to extension strategies, because of many interacting factors that affect adoption. The success of farmer-led extension systems, therefore depends on community cohesion and the type of technology.

4.5 Overview of agriculture extension in Zimbabwe and Zambia

Just like other African countries, Zambia and Zimbabwe have transitioned from public to pluralistic extension systems where government, the private sector, NGOs and farmer organisations play an important role in providing advisory services. In both Zambia and Zimbabwe, the public extension system has structures from national to field level. In Zambia there are 10 provinces, headed by provincial subject matter specialists. Below the subject matter specialists are extension representatives at the district level and then block extension officers at the field level (Oladele *et al*., 2009). In Zimbabwe there is a national director, a provincial

agricultural officer, provincial subject matter specialists, district officers and then frontline extension officers at ward level. The main service provider of extension support is the Department of Agricultural, Technical and Extension services and the private sector input suppliers provide extension support on specific inputs they supply (Hanyani-Mlambo 2002).

In both Zimbabwe and Zambia, extension approaches have generally shifted from top-down training and visit to more participatory approaches. Zambia applies participatory extension approaches such as farmer field schools (Davis, 2008). In Zimbabwe, Hanyani-Mlambo (2002) reported that several approaches had been applied from the early 1930s to 1960, focusing on promoting technology transfer either through groups or a master farmers' training scheme. Under the master farmers' training scheme, direct contact made by the extension staff was with innovative farmers, who in turn were expected to pass on what they had learnt to other farmers. The training and visiting system developed for the World Bank encouraged farmer visits was abandoned because of its high cost. New approaches, such as farmer field schools and the lead farmer approach, were introduced recently. Farmer field schools were widely promoted in Zimbabwe and Zambia among cotton and tobacco farmers, starting in 1997 in Zimbabwe and in 1999 in Zambia. The success of this approach lay in empowering farmers. However, the pest management context was not appropriate for most African farmers (Braun and Duveskog, 2008).

The successes of participatory extension systems were reported by the Intermediate Technology Development Group (ITDG) and German Agency for Technical Cooperation (GTZ) project in South-eastern Zimbabwe, where adaptation of new technologies (specifically the use of conservation methods such as contours) and empowerment of farmers to make decisions gave farmers the confidence to demand specific services (Hanyani-Mlambo, 2002). The strengths of the participatory approaches lay in empowering farmers to make decisions and the involvement of the private sector and NGOs in extension (Oladele *et al.*, 2009).

4.6 Extension approaches used in the promotion of CA

When CA was first introduced in Zambia, the promotion of CA had often been top-down and was accompanied by input support. In some cases farmers were expected to adopt compulsory practices (Baudron *et al*., 2007). The key stakeholders in the diffusion of CA in Zambia and their roles are summarised in Table 4.1. This table shows the involvement of various stakeholders, such as research institutions, the government and NGOs, in supporting CA. In Zimbabwe, 39 organisations were involved in the promotion of CA, as listed by Marongwe *et al.* (2012). The organisations included the government, research organisations, farmers' organisations, NGOs, universities and the private sector.

Table 4.001: Stakeholders involved in CA promotion in Zambia

Activity	**Lead stakeholders**
Awareness creation	Agricultural Support Programme (ASP), MACO
On-farm demonstrations	CFU
Research on-station	GART
Field days	CFU, GART, MACO
Exchange visits	FAO
Training of extensionists	CFU, MACO
Farmer training	CFU, MACO
Formal extension and technical assistance	ASP, DUNAVANT, Sida and Cooperative League of the USA
Input supply	Sida, Norad, FAO, WFP
Policy	MACO

Source: Adapted from Baudron et al. (2007).

In both Zimbabwe and Zambia, CA promotion involved the use of lead farmers to disseminate CA (ZCATF, 2012; Nyanga, 2012). These farmer trainers were called lead farmers. Lead farmers supported a group of 10 farmers by training them and monitoring their adoption of CA components. In some cases, these lead farmers established demonstration fields to showcase the benefits of CA. Farmer field days were often organised, which farmers in the area attended and where they learnt more about the technology and shared their knowledge with one another. A recent study by Nyathi *et al*. (2019, in press) on the role of lead farmers in CA promotion revealed that lead farmers were considered important sources of information on CA through informal consultations by their peers, but without project support, these lead farmers were unable to initiate

field days and demonstration fields unless they were integrated into the government extension support system.

4.7 Conclusion

A review of extension literature revealed the importance of agriculture extension services in enhancing institutional support, through linking farmers to information, markets and other agriculture services. There were mixed views on the effectiveness of agriculture extension approaches in technology adoption. Participatory extension approaches, use of information communication technologies and innovation systems offer opportunities for wide-scale diffusion of innovations, but need to be contextualised to local social systems. Extension has evolved over time and governments are moving towards pluralistic extension services. Extension approaches used in the promotion of CA in Zimbabwe and Zambia have often used lead farmers as extension agents.

CHAPTER 5

OVERVIEW OF STUDY AREAS

5.1 Introduction

The chapter provides an overview of the study areas, the Nkayi and Choma districts. The chapter starts with the rationale for carrying out a study in the Nkayi and Choma districts. A description of the location, socio-economic system, livelihoods and farming system of the study areas is presented.

5.2 Nkayi district – Zimbabwe

Nkayi district is in North-western Zimbabwe in Matabeleland North Province (Figure 5.1). The district has a population of approximately 109 135 people, 40% of whom are female-headed households (ZIMSTAT, 2013). The district is a semi-arid area receiving unimodal rainfall of less than 650 mm/annum (Vincent and Thomas, 1960). The district has poor soils, which are predominantly Kalahari sands with low nitrogen, phosphorus and potassium, and low water-holding capacity (FAO, 2006). Crop production is often limited by frequent dry spells, poor soil fertility and lack of access to soil fertility amendments, such as manure and inorganic fertilizers (Masikati, 2011).

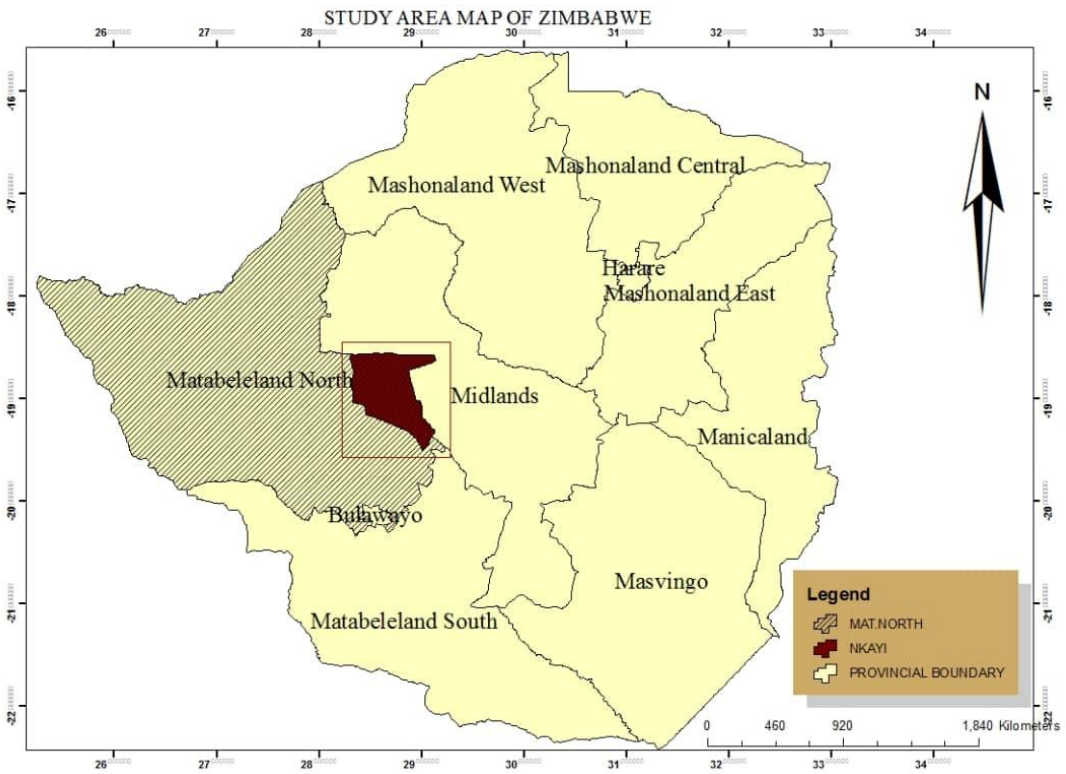

Figure 05.01: Location of Nkayi district in Zimbabwe

5.2.1 Socio-economic system

Nkayi is a favourable area for semi-extensive production, with crop-livestock systems being the major farming enterprises. Livestock and crop production are considered important sources of household income. Although crop production and livestock are equally important to farmers' livelihoods, wealth status is determined by livestock numbers (Dube *et al*., 2014). Crops grown in the area include maize, legumes (groundnuts, bambara nuts and cowpeas) and small grains such as sorghum (Dube *et al*., 2014). More than 75% of cultivated land is usually put under cereal and in most cases, farmers cultivate less than 2 ha, which represents three quarters of their land (Masikati, 2011). Most farmers in Nkayi use ox-drawn ploughs to prepare their land for farming (Dube *et al*., 2014). Apart from farming, brick moulding and vegetable production are some of the off-season activities. Land is communally owned, and free grazing is the normal practice during the dry season. Food insecurity is a chronic problem in the district and Nkayi is considered one of

the least food-secure districts in Zimbabwe, with 39% of the population being food-insecure (Zim Vac, 2013).

5.2.2 Brief overview of CA projects in Nkayi

CA was introduced in Nkayi in 2004, when there was a massive CA promotion by various organisations, as listed by Marongwe *et al.* (2012). These organisations included government, research organisations, farmer organisations, NGOs, universities, bilateral organisations, faith-based organisations and the private sector. Among the NGOs listed were Christian Care (CC), World Vision, German Agro Action, the Dabane Trust and Oxfam. The target farmers for CA interventions were vulnerable households that had limited access to farming implements. The CA package promoted was dry season digging of planting basins (holes dug by hand hoes) as an MSD method, application of soil cover, crop rotation with legumes, winter weeding, manure and fertilizer application (Mazvimavi *et al.*, 2008; Marongwe *et al.*, 2011). Extension approaches and methods used to disseminate CA included the establishment of demonstration plots, use of lead farmers to train other farmers and having both NGO and government extension agents providing extension support (ZCATF, 2012). This study focuses on farmers who were supported by CC in Nkayi.

CC in Zimbabwe is a faith-based NGO that has been promoting CA with smallholder farmers in Zimbabwe. CC was formed in 1967 by the Zimbabwe Council of Churches and registered as a welfare organisation (WO 79/67); it is now registered as private voluntary organisation (79/67). CC was initially involved in relief aid in Zimbabwe before independence in 1980. Today CC works in relief, recovery and development work across the country and is funded by various donors. The organisation has positioned itself strategically to respond effectively and efficiently to people`s needs throughout the whole country.

CC implemented two three-year CA projects with support from the Canadian Food Grains Bank (CFGB) from 2006-2012. The first CA project with CFGB was implemented in five wards of Nkayi district, wards 10, 11, 13, 14 and 25, and was named the 'Agriculture Recovery Programme'. Project participants were trained to train other farmers in turn (farmer-to-farmer training). The project started with 50 farmers in the first year and by the third year more than 200

farmers were implementing some form of CA. According to the CC evaluation report of (2011), 83 percent of households interviewed were applying mulching, while 100% were applying MSD. Crop rotation was not practised at all in Nkayi district during this evaluation.

A follow-up project was implemented from 2009 to 2012, targeting 12 wards, including the five that had previously participated. This project was termed 'Nkayi Food Security Project' and operated in wards 15, 17, 18, 23, 27, 28 and 29, plus the previous five. In Figure 5.2, the wards participating in the first and second CA interventions are highlighted.

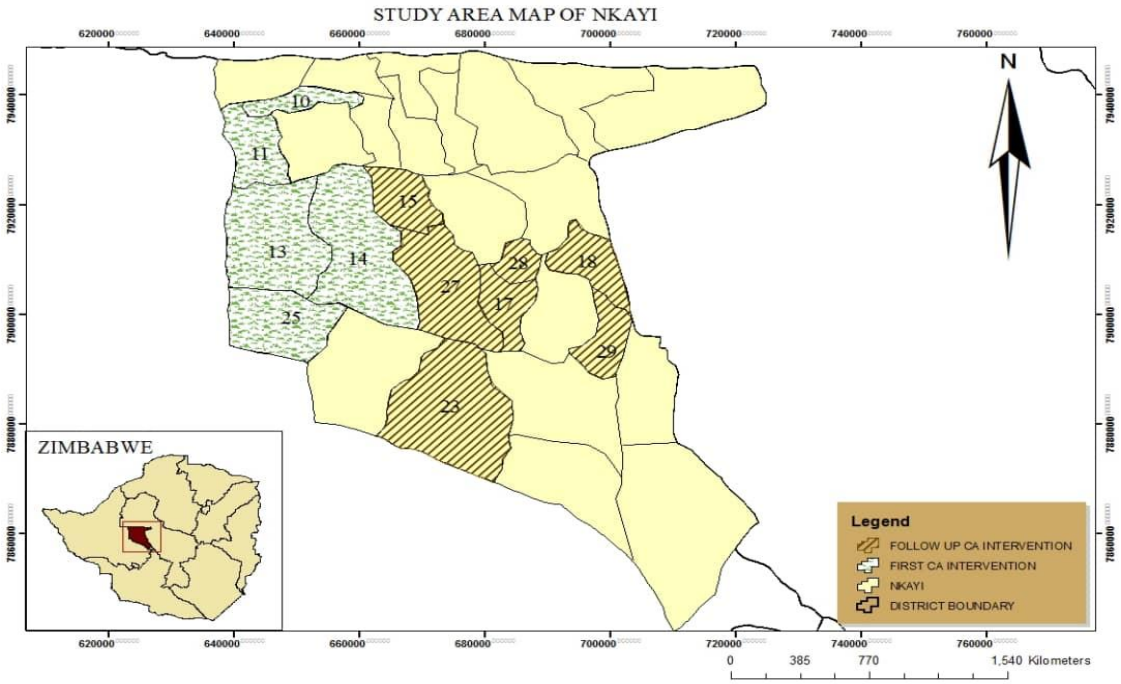

Figure 5.02: Christian Care project areas in Nkayi district

At the end of the second phase, 788 women and 482 men had adopted some CA principles (Table 5.1). Adoption of CA captures farmers that practised at least minimum tillage and soil cover.

Table 5.01: Number and gender of farmers practising CA in Nkayi district

Ward	Female	Male	% Women
15	87	56	61
17	85	58	59
18	76	67	53
23	78	65	55
27	86	57	60
28	84	59	59
29	88	54	62
10	41	9	82
11	39	11	78
13	42	8	84
14	40	10	80
25	42	8	84
Grand Total	**788**	**462**	**63**

Source: CC end of project report 2012

5.3 Choma district - Zambia

Choma district is situated in the southern province of Zambia (Figure 5.3) and represents an area where CA was initially introduced by donors, which included the ZNFU and/or the CFU, Cooperative League of the USA, Dunavant Cotton Company, Land Management and Conservation Farming (now Agriculture Support Programme) and the MACO in the late 1980s to early 2000 (Hagbladde *et al*., 2011). The southern province is home to 12% of Zambia's population of 13 092 666 people (Central Statistical Office, 2012).

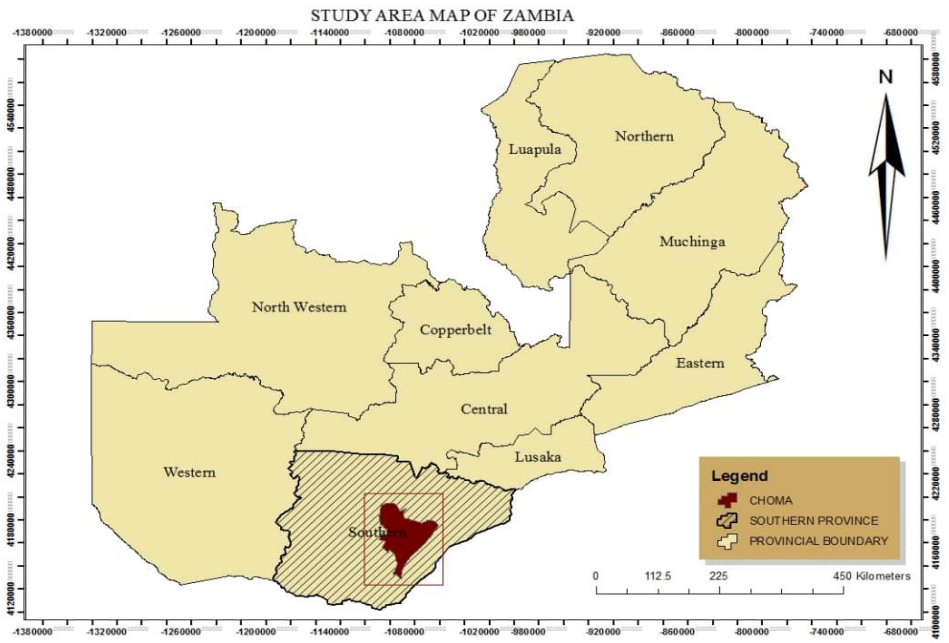

Figure 5.00003: Location of Choma district in Zambia

Zambia is divided into agro-ecological regions I, IIa, IIb and III (Figure 5.4). Region I receives the least rainfall of less than 800 mm per annum, regions IIa and IIb receive between 800 and 1000 mm and region III receives more than 1000 mm per annum. Choma falls under agro-ecological region IIa, which is classified as semi-arid. The area, which experiences a unimodal rainfall pattern from December to March (Baudron *et al*., 2007), has relatively fertile soils; sandy loams and clay loams are the most prevalent. Rainfall has, however, become unreliable, with Choma recording as low as 500 mm per annum in some years, which has had negative effects on crop production (Baudron *et al*., 2007).

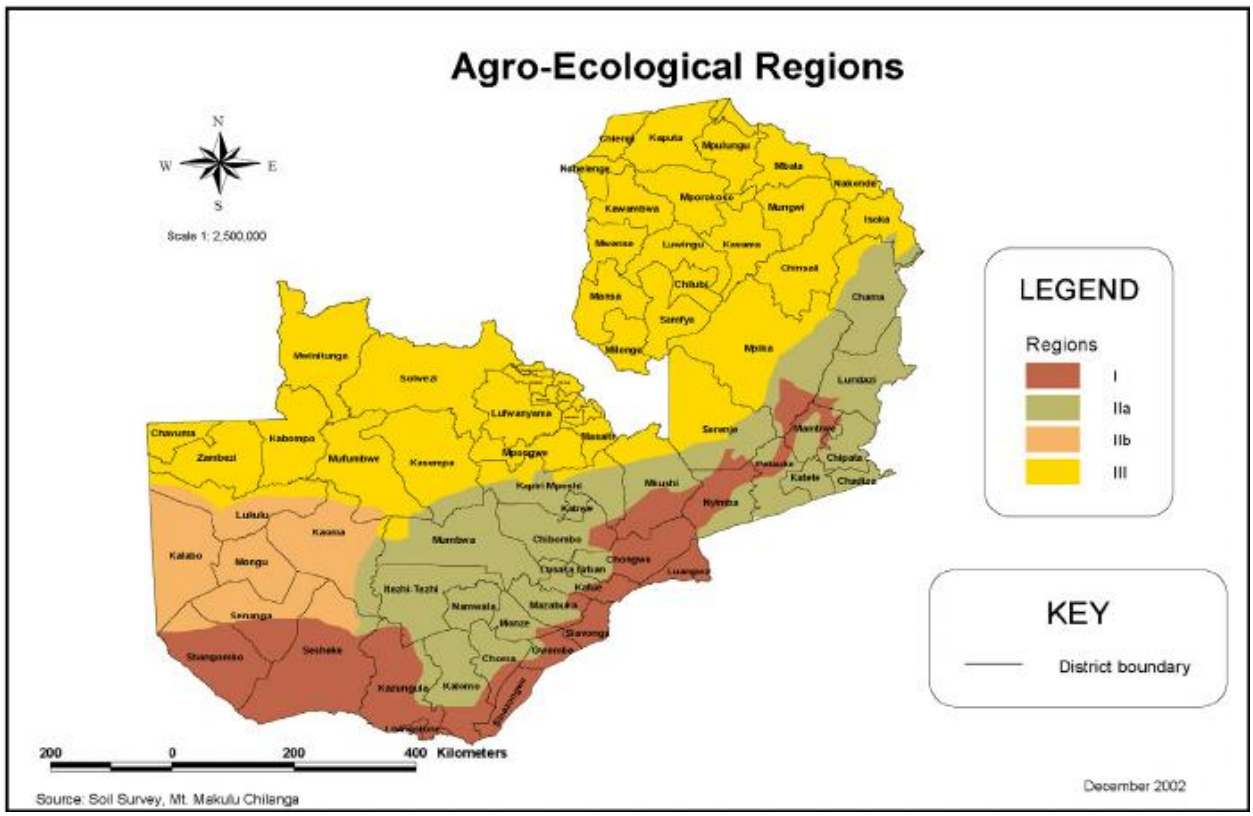

Figure 5.4: Agro-ecological regions of Zambia.

Source: Research Gate, uploaded by Arsalan

5.3.1 Farming system and socio-cultural setting

The predominant farming system is maize-mixed, and small livestock such as goats and sheep play a crucial role in addressing immediate family needs (Baudron *et al.*, 2007). Landholding averages 1-5 ha, which represents a typical smallholder farming unit as described by Livingston (2011). The major crops grown are maize, cotton, groundnuts and cowpeas. The conventional method of land preparation is the use of ox-drawn ploughs; weed management is also done by ox-drawn cultivator. However, owing to droughts and dwindling livestock numbers, most farmers rely on manual implements such as the hand hoe (Baudron *et al.*, 2007). Land is communally owned and there is free grazing in the dry season. Under communal land ownership, land is given to families or individuals permanently or temporarily and can be inherited. Land is open to communal grazing or community use in the dry period when the cropping season ends. Most families are male-headed,

although the proportion of female- and child-headed families is increasing in response to the human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS) pandemic in Zambia (Baudron *et al*., 2007).

5.3.2 History of CA in Choma district

Although CA activities in Zambia date back to the 1980s, wide-scale promotion through donor support and the government began in 1999. In 1999, the GRZ, through MACO, declared CA promotion by CFU and GART a priority (Baudron *et al*., 2007; Shula *et al*., 2012). Generally, CA adoption has been highest in the semi-arid areas of agro-ecological regions I and IIa, where the southern province is situated. The research focuses on CA initiatives by Brethren in Christ Church - Zambia (BICC), which was started in 2013. The areas covered by the project were Mbabala, Siaskobole and Singani, as shown in Figure 5.5. BICC is an evangelical denomination that was founded in 1906 and only started its Compassionate Ministries Development office to address HIV and AIDS in 2003 and later expanded to community development efforts to address food and water security in 2005.

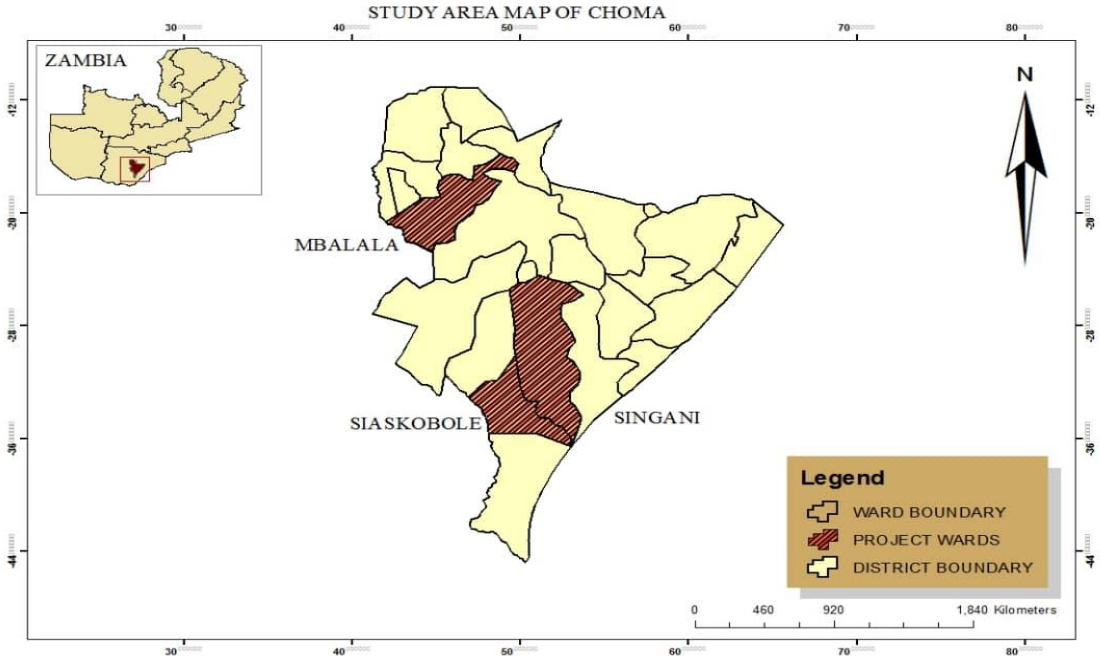

Figure 5.0005: Project areas for BICC

The project promoted CA and other food security initiatives that included livestock production, horticulture, food storage and preservation, village savings and bee-keeping. The number of people who adopted CA is indicated in Table 5.2. Adoption in this regard referred to farmers that practised at least one principle of CA, which in most cases is the practice of minimum soil disturbance. The adoption percentage is higher in Mbabala, which is closer to Choma city than the other two, and lowest in Siaskobole, which is furthest from Choma city.

Table 5.2: CA adopters of the food security project in Choma, Zambia

Area	Number trained	Number adopted	% adoption
Singani	50	20	40
Siaskobole	45	16	36
Mbabala	80	44	55
Total	**175**	**80**	**46**

Source: BICC Annual project report 2016

5.4 Rationale for selecting Nkayi and Choma

The two districts were selected because although studies on CA adoption have been done before, the role of social systems in the adoption of CA has not been done. Mazvimavi and Twomlow, 2009; Nyanga, 2012; Arsalan *et al.*, 2013; Pedzisa *et al*., 2015 studied effects of household characteristics, biophysical and institutional factors on adoption of CA in areas that included Nkayi and Choma. The only social factors considered in CA adoption where household characteristics. Although CA has been promoted in a very similar way, mainly through donor support, the two areas differ in that the Nkayi project only promoted the hand hoe option for minimum soil disturbance, while in Choma farmers were exposed to animal-drawn rippers. Secondly, the project in Choma provided training and technical support only, while in Nkayi the project was accompanied by some production input support in the first year of CA promotion. Thirdly, adoption studies done in Zimbabwe and Zambia which mainly focused on the role of technological, agro-ecology, household characteristics on adoption have shown variations in the influence of some factors of adoption. For example, farmers in low-rainfall areas of Zambia are more likely to adopt CA (Arsalan *et al*., 2013), while in Zimbabwe, CA is most likely to be adopted in high-rainfall areas (Pedzisa *et al*., 2015). Access to credit was not reported as a driver of adoption in Zambia (Nyanga, 2012), yet Mazvimavi and Twomlow (2009) argued that access to credit stimulated adoption in Zimbabwe**.**

5.5 Conclusion

The chapter provided a brief description of the study areas and described the approaches used to promote CA. The two districts have both similarities but differences, which may influence the adoption of CA. CA was promoted differently in these two districts in terms of the approach followed to introduce CA to farmers and the 'package' that was offered. Previous research showed differences in adoption between the farmers in Zimbabwe and those in Zambia. The Chapter identified that the role of the social system effects on adoption has not been documented in previous studies on CA adoption in the selected districts.

CHAPTER 6

METHODOLOGY

6.1 Introduction

The chapter describes the methodology used in the research. The first part focuses on how data was collected, which includes the research design and sampling procedures used for selecting respondents and the theoretical and conceptual framework that guided the data collection methods. The second part of the chapter focuses on data analysis methods, a summary of the variables to be included in the analysis and expected outcomes.

6.2 Research design

The research employed both qualitative and quantitative methods in the data collection process to understand the influence of social systems in CA adoption and the role that institutional support play in the adoption of CA practices. Qualitative research is important in getting information that can be used to explain some quantitative findings, while quantitative data collection methods are important in determining relationships (Bryman, 2008). In this research, relationships between attitudes, social system and institutional factors and adoption of CA are to be explored, hence the use of quantitative methods. Quantitative methods used were semi-structured questionnaires, which were administered through face-to-face, and self-administered questionnaires. Qualitative methods used were focus group discussions (FGDs). The advantage of using mixed methods is that they complement each other; quantitative methods provide scale, relationships and patterns, while qualitative methods are useful in understanding context (Nyanga, 2012) and interpretation of the world (Bryman, 2008), especially when dealing with social system research.

6.3 Sampling method and size

The sample consisted only of CA adopters. The research specifically targeted CA adopters, as the focus of the research was to gain understanding of what influenced adopters in making the decision to practise CA and also because adopters generally do not adoption all three principles. The main thrust of the study was to understand how the social system influence the adoption of each of the three CA principles. Based on the figures from project reports from BICC and CC on farmers who practised CA and information received from key informants, the sampling procedures described below were selected.

Random or stratified sampling was done, depending on the sample. Stratified sampling was done in Nkayi, where there was no proportionate adoption to enable proportionate representation of CA farmers in terms of the social systems and location in relation to markets, while random sampling was applied in Choma, where there was not much variation in adoption and the sample population was small. Stratified sampling involves dividing the population into groups or strata and selecting a random sample in each stratum. The purpose of this sampling technique is to reduce variability and ensure proportionate representation of respondents (Henry, 2011). From adoption figures in Nkayi CC reports, it was clear that there were differences in adoption between the first cycle and second cycle project and between men and women and thus a stratified sample was employed to represent each of these groups proportionally. The stratified sample was also meant to represent farmers from different socio-economic backgrounds.

In Nkayi, Zimbabwe, four wards (wards 14, 17, 25 and 29) out of 12 where CC operated were selected by making use of a stratified sampling technique. This was done by clustering the wards into first and second CA interventions. As mentioned earlier, five wards were selected in the first CA programme, while seven wards were added in a second intervention. After clustering the wards according to CA intervention phases, four wards were selected, two from each phase of intervention. These two wards were purposively selected to represent the different socio- economic environments and distance from Nkayi centre, which is the main hub of social and economic activities. In each cluster, there was a ward that was far from Nkayi centre and a ward that was relatively closer. The assumption applied for this decision was that proximity to Nkayi centre would influence the socio-economic and social system of a specific ward, since Nkayi centre

represents more urbanisation. On the other hand, the further away from the Nkayi centre, the more likely communities to be conservative and traditional in their decision-making. Moreover, access to services such as markets and extension support was likely to be higher closer to the Nkayi centre than further away.

In deciding on the sample size per ward, a proportional stratified sampling procedure was used that considered total adoption figures per ward, but also specifically attempted to include proportional representation of men and women practising CA. Because of these parameters, more people were interviewed from the second intervention wards than the first ones and more women were interviewed than men (Table 6.1). In total 61 farmers were interviewed in Nkayi.

Table 6.001: Actual adopters and sampled number of farmers in Nkayi district

	Actual adopters		Sample	
Ward	**Female**	**Male**	**Female**	**Male**
First intervention wards				
14	40	10	8	4
25	42	8	7	3
Subtotal	**82**	**18**	**15**	**7**
Second intervention wards				
17	85	58	12	7
29	88	54	15	5
Subtotal	**173**	**112**	**27**	**12**
Grand total	**255**	**130**	**42**	**19**

Source: CC end of project report 2012

In Choma district, Zambia BICC operated in Mbabala, Siskobole and Singani wards. Data was collected in all three operational areas and 41 respondents were randomly selected, which comprised 50 percent of the sample size (Table 6.2). Random sampling was applied because of a relatively small population; random sampling is simple to do with small populations and every member of the population has a chance to be picked (Henry, 2011).

Table 6.2: Detailed sample for Choma district, Zambia

Ward	Number of farmers who adopted CA	Number of respondents sampled	Number of women sampled
Singani	20	12	5
Siaskobole	16	10	3
Mbabala	44	19	7
Total	**80**	**41**	**15**

Source: BICC annual report 2016

6.4 Data collection

Data collection was guided by a conceptual framework adapted from the TPB described in the next paragraph. Data was collected through primary and secondary data collection methods. Primary data collection methods used structured and semi-structured household interviews and FGDs. Interviews were conducted with key informants and CA adopters. Secondary data sources were obtained from project reports for CC and BICC, previous studies related to the research topic, books and journal articles to explain some relevant issues.

6.4.1 Theoretical framework

The theoretical framework was derived from the TPB developed by Ajzen (1991). The theory is a modification of the Reasoned Action Approach (RAA), which was developed by Ajzen and Fishbein in 1975 (Ajzen and Fishbein, 1980). In the TPB, intention is perceived as a predictor of specific behaviour, and determined by three central constructs, attitude, subjective norms and perceived behavioural control (Ajzen, 1991). According to the theory, intention is determined by personal attitudes to the expected behaviour and by the belief that others expect one to behave in a specific manner (normative beliefs) and the motivation to comply with expectations (subjective norms). Perceived behavioural control refers to the beliefs about one's capabilities and environmental contributions to this ability. The reason for including subjective norms in the model was that individuals do not act independently of culture and social influences, but are continuously

referring to important reference groups. These three constructs influence one's intention to practise a certain form of behaviour. Intention and behavioural control (behavioural control is a fourth factor that is believed to influence behaviour directly) lead directly to behaviour. However, there have been no defined ways of measuring behavioural control and hence perceived behavioural control is normally used as a proxy for behavioural control (Ajzen, 1991). Together attitude, subjective norms and PBC lead to a positive or negative intention to apply certain technologies or adopt certain practices.

The theory has been applied to study the adoption of information technologies (Talukder and Quazi, 2011), soil conservation (Wauters et al, 2010) and specifically CA adoption in Kenya (Hulst and Posthumus, 2016).

6.4.2 Conceptual framework based on the TPB

The framework was modified by directly linking attitudes, subjective norms and PBC to adoption. In this framework, beliefs about the performance of a technology, subjective norms and perceived capability were mediated by background factors (household characteristics, learning environment and farming goals), as shown in Figure 6.1 Personal characteristics mediate attitudes, while the social context (gender, social customs etc.) mediate normative beliefs and the learning process and farming goals mediate the PBC, which then has an impact on the decision to adopt or reject CA.

The assumptions made in the framework were that:

- Beliefs about expected outcomes (good or bad outcome beliefs), also referred to as attitude to CA, influence the actual adoption of CA practices.
- Social influence, measured through beliefs that influential individuals within the social system expect a certain type of behaviour, will influence adoption.
- The PBC, measured as the individual's perceived need/importance of the institutional environment, will affect CA adoption.
- In addition to social influence from individuals, the perceived influence of by-laws and customs on the practice of CA principles is assessed as part of the social system in which CA is promoted.

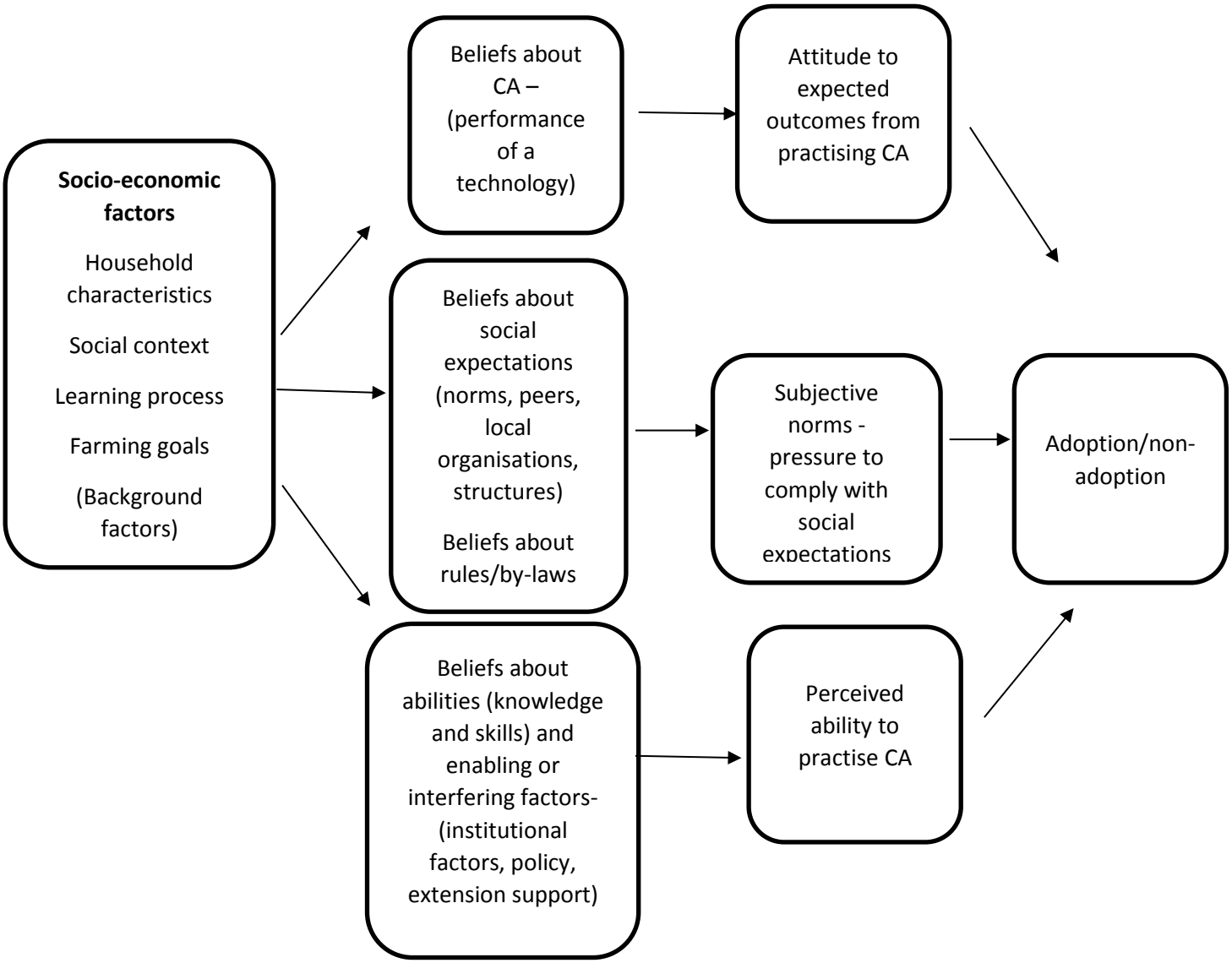

Figure 6.1: Conceptual framework for adoption of CA, adapted from Ajzen, 1991

6.4.3 Key informant interviews

Key informant interviews were conducted to gather information about social and institutional factors present in the areas of study. A semi-structured questionnaire was developed to capture beliefs that exist among households about CA, social factors that are crucial in decision-making processes related to farming and institutional support systems in terms of rules and regulations, extension support systems and stakeholders that are present in the study districts to support CA. Key informants were government extension staff, CC and BICC project staff, traditional leaders and the CFU representatives. Key informants are often people who are selected based on their knowledge of the social or organisational system (Young and Young, 1961) and generally have more information about the subject (Houston and Sudman, 1975). The selection of key informants was based on knowledge of the areas under study in terms of the social and economic contexts. Ten respondents were interviewed through face-to-face, email and telephonic interviews.

Key informants helped identify influential individuals, important and substantial social institutional factors and beliefs in communities that were used in the design of household questionnaires.

6.4.4 Household interviews

Household data was collected using structured and semi-structured questionnaires administered face-to-face to members of households that adopted CA in the two areas of study. A questionnaire was developed and piloted with 10 households in Zambia. Changes to the questionnaire were made to questions that seemed repetitive. The questionnaire was also adjusted to avoid taking too long per household. The questions were semi-structured, with open- and closed-ended questions. Closed-ended questions were always succeeded by a follow-up question to substantiate the response given.

The questionnaire was designed to collect socio-economic information on household characteristics, stakeholders with whom farmers network, current land tenure systems and communal by-laws, the social norms, markets, existence of farmer groups and their importance,

number of years a farmer has been practising CA, the components of CA that are being applied and the sources of knowledge on CA. An adopter is a farmer who practises at least one principle of CA.

Two enumerators were used in each district and were trained on how to administer the questionnaire, emphasising the purpose and confidentiality of the process. The training also focused on making sure enumerators understood the questions. The enumerators were fluent in the local languages spoken in the two study areas. The lead researcher also participated in household interviews and only needed interpretation in Choma, as she could not speak Tonga. Interviews were targeted at farmers that were practising CA under the projects supported by CC and BICC.

6.4.5 Definition and measurement of variables

To collect information on farmers' attitudes to CA and the role of the social system and PBC in influencing adoption of CA principles, as described by Fishbein and Ajzen (2010). On determining the attitude of farmers, respondents were asked to respond to a list of five questions that reflected possible attitudes to CA, which were measured on a five-point Likert scale, where 1 represented complete disagreement and 5 represented complete agreement. The rankings for the five questions representing attitude were averaged to get an overall score on attitude. The lower the ranking, the more negative the attitude of a respondent was.

The variable 'social system' effects on adoption were captured through questions that addressed the likelihood of social factors (local leaders, peers, spouses, groups) influencing the practice of CA. Respondents were also asked to rate the extent to which the practice of CA by others in the system contributed to their decision to practise CA components on a scale of 1 to 5, where again 1 was strongly disagree and 5 strongly agree. Weights for the different statements that represent social influence were computed to get an average strength for social influence. The higher the weight, the greater the social influence.

In addition, respondents were asked questions related to by-laws and norms and how they perceived these social factors affecting their adoption of CA. These questions were based on a yes

or no answer. The questions were in essence asking if farmers perceived by-laws or customs/norms to affect the practice of CA.

On institutional factors, which are measured through PBC, respondents were asked whether they believed that access to credit, extension services, markets and implements was necessary in their practice of CA. On a Likert scale of 1 to 5, where 1 represented strong disagreement and 5 meant complete agreement, respondents were expected to say whether they agreed or disagreed with the statement on the perceived need or importance of each environmental factor for CA practice. Weights for the different statements that measure the factor were averaged to get a single weight for PBC; the higher the PBC, the higher the perceived need for institutional support or perceived lack of support.

6.4.6. Focus group discussions

FGDs are a data collection method that involves the use of a group of 10 or more people to explore a topic of interest. The main advantages of an FGD are that it allows for diverse views that would not normally be revealed by a household questionnaire, helps to get a range of perspectives on an issue and may uncover other underlying issues (Hennick, 2014).

FGDs were conducted to understand the social environment of smallholder farmers in Choma and Nkayi. In each of the sampled wards, one FGD was held. Seven FGDs were conducted in total, three in Choma and four in Nkayi. Attendance was higher in Choma, with an average of 20 participants, compared to an average of 10 per focus group in Nkayi. Selection of participants was purposeful to ensure diversity of views on the social system. Kitzinger (1995) encourages heterogeneity in focus groups if it is necessary to explore the subjects from different angles. The groups comprised local leaders, CA farmers, men, women and some non-adopters. The information from FGDs was triangulated with data from key informants and from household interviews in the analysis. Seventy-one women and 44 men participated in FGDs in the Nkayi and Choma districts, as shown in Table 6.3.

Table 6.003: Focus group participants

Area	Men	Women
Mbabala	10	12
Siaskobole	13	8
Singani	11	16
Total Choma	**34**	**36**
Ward 14	3	7
Ward 17	1	9
Ward 25	2	8
Ward 29	4	11
Total Nkayi	**10**	**35**
Grand Total	**44**	**71**

Source: Focus group discussions data, 2017

6.5 Data analysis

Qualitative data analysis was guided by Bryman (2008) and Newing (2011); themes where identified from the responses of focus group participants and grouped into categories. In some cases counting of respondents that supported a view was done and relevant statements that were emphasised during the FGDs were quoted.

Data analysis for key informant interviews was done using Excel to find frequencies for identified social and institutional factors, which were then used in the development of the household questionnaire. Analysis of quantitative data from household surveys was done by using the Statistical Packages for Social Sciences (SPSS). The next sections describe the specific analysis methods for the each objective of the study.

Objective 1: Mapping the socio-economic environment of Nkayi and Choma districts

To map the socio-economic environment of smallholder farmers in Choma and Nkayi, descriptive analysis of the socio- economic environment was done through using SPSS Version 25 to conduct t-tests, chi-square tests and frequencies. Descriptive analysis included demographic characteristics (gender, age, years of schooling, land ownership, livestock ownership), economic factors or drivers (distance to markets, access to credit) and social system factors (by-laws, customs and influential individuals in the system).

A logistic regression analysis was conducted to determine the effects of demographic and socio-economic characteristics on the adoption of CA principles. The regression equation used was as follows:

Adoption of CA principles is a function of age (A), income (I), household headship (HH), distance to markets (D), location (L), labour (FL), farm size (FS) and years of schooling (YS) and is given by:

$$Ad_i = \alpha + \beta A_i + \beta I_i + \beta HH_i + \beta D_i + \beta L_i + \beta FL_i + \beta FS_i + \beta YS_i + \varepsilon$$

where Ad represents adoption of CA principles and α is a constant.

Objectives 2, 3 and 4: Investigating the influence of attitudes, the social system and institutional environment in the adoption of CA principles

The first step was to determine the reliability of the scales in representing attitude, social influence and PBC. The internal reliability and consistence of the scales were tested using Cronbach's alpha coefficient (Cronbach, 1951). Cronbach values greater than 0.7 are considered ideal but could also reflect redundancy of some Likert items (ibid.) while low alpha levels can still be acceptable if they cover meaningful content for a domain and have reasonable uni-dimensionality (Schmitt, 1996). The constructs for social influence and PBC were reasonable, at 0.68 and 0.71, respectively, indicating that questions meant to measure these constructs were acceptable. However, Cronbach's alpha for attitude was low and hence was not included in the regression. A binomial logistic regression analysis was then done to investigate the effects of social influence, by-laws, norms and institutional factors in the adoption of CA principles.

A binary logistic regression predicts the probability that an observation falls into one of two categories of the dichotomous dependent variable (adoption of CA principles, where Yes=1, or 0=Otherwise), based on independent variables Social Influence, By-laws, Customs and PBC. By applying logistic regression, CA adoption was measured as a binary variable and the explanatory variables were either binary too (i.e. By-laws, Customs) or ordinal (i.e. Social influence, Perceived Behaviour Control).

The equation shows a mathematical representation of the binomial regression model derived from O'Connell, (2011).

$$Ad_i = \alpha + \beta SI_i + \beta BL_i + \beta C_i + \beta PBC_i + \varepsilon$$

where Ad represents adoption of CA principles i, α is the constant, SI is the social influence, BL is by-laws, C is customs and PBC is perceived behaviour control on the adoption of CA principles i, β is the regression coefficient and ε is the error term. The analysis focused on all three CA principles as dependent variables.

Ordinary least square regressions were done to investigate the effects of demographic factors as well as social and institutional factors on the area where CA was practised. The independent variables used in logistic regressions for CA adoption regressions were used as independent variables for predicting the area put under CA.

The area used for CA is a useful indicator in measuring adoption of CA, as it represents scaling up. In most literature on CA adoption, scaling up refers to an increase in area under CA, which could be due to an increase in the number of farmers practising it or individual farmers expanding the area they use (FAO sub-regional office for East Africa, 2009). What Works Scotland (2015) argues that scaling up can refer to spread, diffusion or adoption and thus no standard definition is used. In this research, scaling up refers to the area that is used for CA, which has been a useful indicator in assessing global adoption of CA (Kassam, 2014). The variables for the regressions are summarised in Table 6.4.

To measure attitudes an analysis of each individual Likert question that represented attitude was done through a Mann-Whitney-U test to compare attitudes between districts. The test was also use to compare social influence and PBC between the two districts. The Mann-Whitney U test has similar predictive power like the t-test to compare two groups even with small sample sizes and is especially applicable for single Likert scale statements (De Winter & Dodou, 2010).

Table 6.4: Independent and dependent variables for the study

Variables	Expected outcome	Comments
Dependent variables		
Adoption of one principle/minimum tillage		Practise MSD through digging basins or ripping
Adoption of mulching		Application of at least 30% soil cover
Adoption of crop rotation		Rotating legumes and cereals on the same piece of land
Adoption of two CA principles		Practice MSD with either soil cover or crop rotation
Adoption of three CA principles		Application of MSD, soil cover and crop rotation
Area under CA		Hectares
Independent variables		
Demographic and socio-economic factors		
Age (years)	+	The more experience farmers gain of farming, the more principles they will apply and the greater the area under CA
Off-farm income ($)	-	Off-farm income may limit adoption of CA principles and area under CA as people find other livelihood sources
Location (district) 1= Nkayi, 0=Choma	+	Nkayi is likely to adopt more principles than Choma. Districts have different land holdings per household, which will affect area put to CA
Farm size - area ha	+	The greater the farm size, the higher the adoption
Years of schooling	+	More education will increase adoption
Labour (number of people contributing to farm labour)	+	The higher the number of people, the greater the adoption of CA principles and area under CA
Access to markets (distance km)	+	Access to markets with influence adoption of CA. The shorter the distance, the higher the adoption
Adoption of CA by male and female and by the rich and the poor	Chi-square tests will be significant	Men and rich households will adopt more CA principles than women and the poor
Social system and institutional factors		
Social influence	+	Learning from others will influence adoption positively
By- laws 1=yes, 0= no)	-	Will hinder adoption of some principles such as soil cover
Social customs/norms 1= yes, 0=no	-	Social customs/norms affect CA practice negatively
Institutional system	-	Limited access to services will affect adoption of CA principles and area under CA negatively

6.6 Conclusion

This Chapter provided a description of the methodology used in data collection including the sampling methods, theoretical and conceptual framework that guided the data collection process. The sampling methodology used was meant to be representative in the selection of respondents. The conceptual framework was based on the theory of planned behaviour. Data analysis included both parametric and non-parametric methods. Binary logistic and ordinary least square regression methods were used to determine relationships between variables while descriptive statistics were used to compare variables between the two districts.

CHAPTER 7

INFLUENCE OF DEMOGRAPHIC CHARACTERISTICS AND ASSET ENDOWMNETS ON CONSERVATION AGRICULTURE ADOPTION

7.1 Introduction

This chapter discusses the demographic characteristics and asset endowments of CA farmers in Nkayi and Choma and the effects on CA adoption.

7.2 Demographic characteristics

Demographic characteristics determine participation and decision-making in relation to new technologies and have been found to influence the adoption of new technologies, including CA (Mazvimavi and Twomlow, 2009). This subsection of the chapter explored the differences in demographic and socio-economic characteristics of respondents in Nkayi and Choma districts.

Table 7.1 shows the mean differences in age, years of schooling, household size, household labour, annual income and percentage of female-headed households in each district. A one-way t-test was conducted to compare means, while a Pearson chi-square test of independence was conducted to compare frequencies of female-headed households in Nkayi and Choma districts.

Age comparisons of respondents indicated that the mean age was significantly higher in Nkayi (54 years) than in Choma (43 years) at p=0.000. In Nkayi, the ages of respondents ranged from 20 years to 79 years, while in Choma the youngest person was 20 years old and the oldest 72. These findings indicate that although there is a significant difference in age between the two districts, farmers in both districts are still in their productive years and as such capable of doing tasks required in farming.

Household size is an important indicator of the availability of labour in a household (Pedzisa *et al.*, 2015). This is essential in smallholder farming systems that rely on family labour for production (IFAD and UNEP, 2013). The mean household size and number of people who contribute to full-time labour were found not to be statistically different in the two districts. The

two districts had mean household sizes of seven and a half persons, with almost half of the members of the household contributing to full-time labour (Table 7.1).

Educated farmers tend to be more knowledgeable (Knowler and Bradshaw, 2007) and receptive to new technologies than those who are less educated (Mazvimavi *et al*., 2008). The education level of households was represented by the number of years of schooling. In Zimbabwe and Zambia, primary education takes seven years, while secondary education takes five years in Zambia and six years in Zimbabwe. The mean number of years of schooling was seven years for both districts (Table 7.1). The years of schooling ranged from none to 12 years in Choma and from none to 11 years in Nkayi. Only 5% of the respondents in both districts had not gone to school. The majority of respondents (31%) studied up to grade 7, while 29% had studied up to secondary education in the two districts. These findings illustrate a relatively high level of literacy among respondents, which could result in moderate chances of adopting CA.

In Nkayi district, the number of female-headed households was significantly higher (37%) than in Choma district (7%) (X^2=6.570, df =1, p=0.010). It is not surprising to see a high percentage of female-headed households in Nkayi district, as most men tend to leave their homes in search of employment elsewhere (ZIMSTAT, 2013; Zikhali, 2017).

Annual mean incomes from both off-farm and on-farm sources between the two districts were compared through a t-test. Off-farm income was derived from activities such as petty trade, bricklaying and casual labour, while on-farm income was derived from selling crops and livestock. The study found that Nkayi farmers had higher incomes from non-farm activities ($300.18) and from livestock production ($166) than those in Choma, although the difference was not statistically different. Farmers in Choma had relatively higher incomes from crop production ($256.69) and total on-farm income ($387) than those in Nkayi, but the difference was not statistically significant. The income differences reflect more reliance on off-farm activities and livestock in Nkayi and higher reliance on both livestock and crop production in Choma. The difference could be due to the risky nature of crop production in Nkayi and conducive environment for livestock (Dube e*t al*., 2014) and the potential for crop production as a source of income in Choma (Baudron *et al*., 2007).

Table 7.001: Household characteristics per district

Household characteristics	Nkayi	Choma	p-value
Mean age (yrs)	54 (11.135)	43 (13.471	0.000
Mean years of schooling	6.9 (2.893)	6.6 (2.597)	0.666
Mean household size (n)	8 (2.982)	7 (2.597)	0.281
Mean number performing full-time labour (n)	2.8 (1.463)	3.4 (2.480)	0.137
Female-headed households (%)	37	7	0.010
Household income from off-farm activities (US$)	300.18 (502)	145.13 (216)	0.073
Income from crop production (US$)	139.26 (399.14)	256.59 (484)	0.190
Income from livestock production (US$)	166.15 (253.65	150 (211.76)	0.099
Household income from farming activities (US$)	300 (465)	387 (601)	0.222

Source: Survey data 2017, Figures in parenthesis are standard deviations

7.3 Households assets

Asset endowments in the smallholder sector provide opportunities for farmers to engage in farming activities (Dixon *et al.*, 2001). Land, farm implements, livestock and information communication technology such as cell phones play an important role in enabling farmers to engage in farming activities. This includes the ability to till the land, transport farm inputs and produce, and access information on farming. The section reveals some of the asset endowments among CA farmers, which include land and livestock ownership, farm implements and equipment for information and communication.

7.3.1 Land ownership

Land is an important resource for smallholder farmers, as it provides means and security of production. Land sizes were compared among districts and wards in the study areas. The average farm sizes in Nkayi and Choma districts were 2 ha and 6 ha respectively. A one-way analysis of variance found the difference in area to be statistically significant (p=0.000). Table 7.2 shows a breakdown of land access between wards in the two districts. A two-way t-test of comparison of means using the least significant difference was conducted to compare farm size between wards and a Pearson chi-square test was conducted for farm size frequencies.

There were no significant differences in farm sizes between wards of the same district, but significant differences between wards in Nkayi and those in Choma (p=0.000), as shown in Table 7.2. There were significant differences in the number of farmers that had access to 1 ha or less (Category 1), between 1 and 5 ha (Category 2) and above 5 ha (Category 3) (X^2= 48.689, df= 24, p=0.001) between the various wards. The majority of farmers in Nkayi wards fell within the first (38% in ward 14; 18% in ward 17; 20% in ward 25 and 17% in ward 29) and second categories of land access (56% in ward 14; 82% in ward 17; 60% in ward 25 and 83% in ward 29), while in Choma CA farmers mainly fell in the second (63% in Mbabala; 58% Singani and 60% in Siaskobole) and third category (37% in Mbabala; 34% in Singani and 40% in Siaskobole). Although variations in farm sizes were found, the findings revealed relatively large farm sizes in these two study areas in comparison with some African countries such as Kenya (0.47 ha) and Ethiopia (0.9 ha) (Rapsomanikis, 2015). The findings on farm size concur with those of Kalinda *et al.* (1998) and Masikati (2011), who reported similar averages. Kalinda's research in Choma found that the average farm size was 6 ha, while Masikati (2011) reported average land sizes of 2 ha in Nkayi.

Table 7.2: Land ownership

	Nkayi				Choma		
	Ward 14 (n =16)	**Ward 17 (n =17)**	**Ward 25 (n=10)**	**Ward 29 (n=18)**	**Mbabala (n= 19)**	**Singani (n =12)**	**Siaskobole (n=10)**
Mean farm size (ha)	2.3a	2.6a	1.9a	2.1a	5b	7.7b	5.9b
% respondents with 1 ha and below (Category 1)	38	18	20	17	0	8	0
% respondents with 1.1-5 ha (Category 2)	56	82	60	83	63	58	60
% respondents with >5 ha (Category 3)	6	0	20	0	37	34	40

Source: survey data 2017. For mean farm size, figures with the same letter are not statistically significant at the 5% level

7.3.2 Farm implements and communication technologies

Farm implements owned by CA farmers in Nkayi and Choma included ploughs, scotch carts, wheelbarrows and cultivators. During FGDs held, farmers indicated that wheelbarrows and scotch carts were essential in the transportation of farm inputs such as seed, fertilizer, manure and farm produce. Over and above these direct farming implements or equipment, this research also sought to understand household ownership of information and communication equipment such as cell phones, radios and television sets. While these are not direct agricultural equipment, these assets are important in accessing information on agricultural technologies. Radios have frequently been used as an extension tool in countries such as Malawi (Khaila *et al.*, 2015) and Zimbabwe (Pazvakavambwa and Hakutangwi, 2006). Research has also shown the potential of cell phones in improving access to agricultural information for rural farmers (Aker, 2011). A Pearson chi-square test was conducted to compare asset ownership between the different wards. Table 7.3 provides a comparison of plough, wheelbarrow, scotch cart, cultivator, radio, television and cell phone ownership between the wards.

Table 7.3: Comparison of farm communication assets across wards

	Nkayi				Choma				
Household Assets	**Ward 14 (n =16)**	**Ward 17 (n =17)**	**Ward 25 (n=10)**	**Ward 29 (n=18)**	**Mbabala (n= 19)**	**Singani (n =12)**	**Siaskobole (n=10)**	**X^2**	**p-value**
HH with plough (%)	100	76	90	72	68	66	80	7.762	0.228
HH with wheelbarrow (%)	50	53	60	30	11	25	10	18.715	0.005
HH with scotch carts (%)	62	29	90	28	16	25	40	21.686	0.001
HH with cultivator (%)	25	6	30	11	11	23	0	12.730	0.6815
HHs with cell phone (%)	100	88	90	94	63	58	40	20.215	0.005
HH with radio (%)	73	61	90	28	42	42	40	21.937	0.001
HH with television (%)	19	12	40	22	26	0	0	16.288	0.133

Source: Survey data, 2017

Ownership of ploughs was high in all the areas, and no statistically significant difference was found between wards. The highest plough ownership was found in ward 14, Nkayi (100%) while the lowest plough ownership was found in Singani, Choma (66%). These figures could be related to the general wealth status of farmers in that particular locality. Ownership of wheelbarrows was generally significantly higher in all Nkayi wards (except ward 29), than in Choma (X^2=18.715, df =6, p=0.005). Low wheelbarrow ownership in ward 29 could be because the ward is located closest to Nkayi centre where other forms of equipment may be available for transport. Scotch cart ownership was significantly different between wards (X^2=21.6865, df =6, p=0.001), with very high ownership in wards 14 (62%) and 25 (90%) of Nkayi compared to other wards in the two districts. The high prevalence of scotch carts in wards 14 and 25 of Nkayi district was perhaps because the two wards are further away from the Nkayi district centre than other wards, thus necessitating the use of scotch carts as means of transport for farm inputs and produce. Further to this, scotch cart ownership was consistently higher in Nkayi wards than in Choma owing to the remoteness of the district compared with Choma, as well as poor infrastructure. Cultivator ownership was generally low in both districts and not significantly different between wards. Variations in households that owned cultivators ranged from no households in Siaskobole, Choma to 30% of households in ward 25 of Nkayi.

Cell phone ownership was significantly higher in all areas of Nkayi than in Choma (X^2=20.215, df = 6, p=0.001). Likewise, radio ownership was significantly higher in all wards in Nkayi, except ward 29, than in Choma (X^2=21.937, df =6, p=0.001) (Table 7.3). Few households in all wards in the two districts had television sets and no significant difference at the 5% level was found. Based on asset ownership trends of both farm assets and information communication technologies, adoption of CA is expected to be higher in Nkayi than in Choma owing to presumed access to the means of production and information.

7.3.3 Livestock ownership

Nkayi and Choma districts can be classified as mixed systems where crops and livestock play a complementary role (Dixon *et al*., 2001). Crop residues are usually used for livestock feeding, while animal manure is used to fertilise the soil, and oxen are used as draught power. In the two

districts, farmers kept cattle, goats and chickens as livestock. Farmers in Choma did not keep any donkeys, while farmers in Nkayi kept donkeys for the transportation of farm goods, either using donkey pulled scotch carts or loading the donkey. In Nkayi, donkeys are also used as draught power.

Figure 7.1 compares ownership of different types of livestock between wards. In Nkayi, wards 14 and 25 consistently had higher numbers of each of the livestock types, while in Choma, Mbabala had the highest mean number of cattle (6.3) and chickens (14.8). A t-test for comparison of means showed a significant difference in cattle ownership (p=0.043) and goat ownership (p=0.005) between wards. There were no significant differences in chicken numbers between the wards, but again ward 14 (Nkayi) had the highest average of 18.8 chickens compared with a low of 11.6 chickens in ward 29. Ward 14 in Nkayi also fared well in ownership of farming assets described in section 7.3.2.

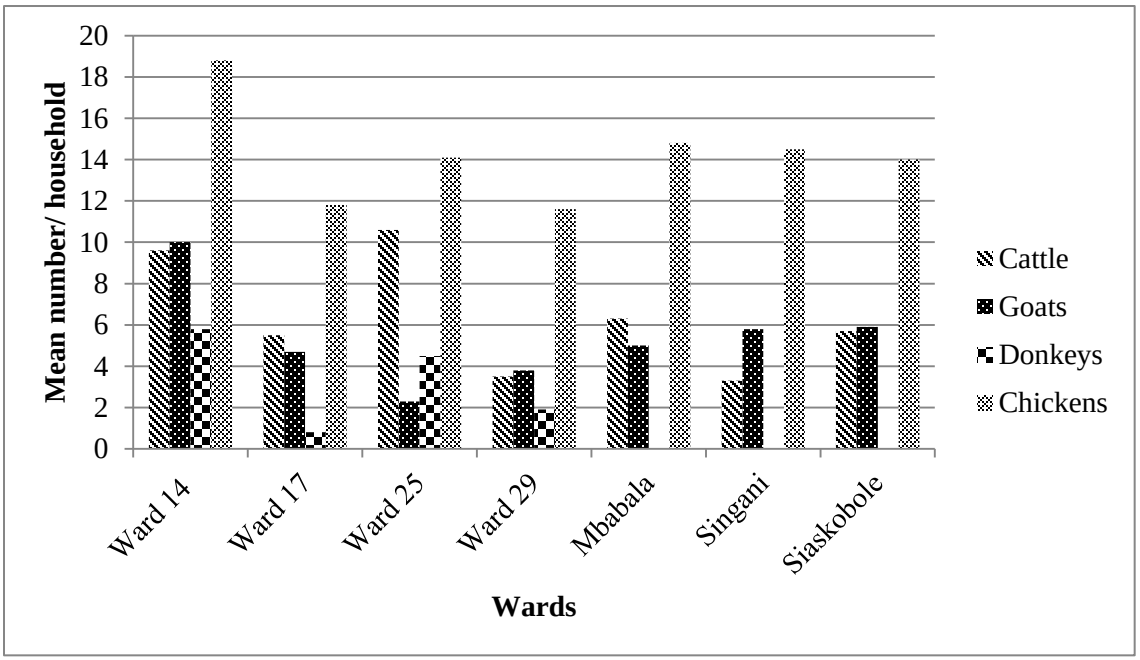

Figure 7.1: Mean livestock numbers as per ward

Source: Survey data, 2017

In addition to establishing livestock numbers, the study sought to establish the reasons for keeping livestock. Livestock were kept for cash income, meat, draught power, manure and milk. Table 7.4

summarises livestock uses for the various wards in the two study districts. A Pearson chi-square test of independence found a significant difference in the use of livestock for milk production, which was generally lower in Nkayi wards than in Choma (X^2= 21.321, df=6, p=0.001). A possible reason for this could be cultural. No significant differences were found in the use of livestock for draught power, although very few farmers (9%) in Singani ward in Choma kept livestock for draught power use. This was the same ward that had the lowest number of cattle (Figure 7.1), as well as the lowest proportion of households with ploughs (Table 7.3), which could explain the reason for the low use of livestock for draught power.

Table 7.004: Reasons for keeping livestock

Reason	Ward 14	Ward 17	Ward 25	Ward 29	Mbabala	Singani	Siaskobole	X^2	p-value
Meat	19	25	15	18	24	25	22	6.359	0.631
Milk	4	2	0	10	13	11	11	21.321	0.001
Manure	13	10	26	18	11	17	26	8.824	0.184
Draught power	28	23	19	18	19	9	26	8.037	0.235
Cash	30	29	22	31	32	31	22	11.352	0.078

Source: Survey data, 2017

7.5 Influence of demographic factors on the adoption of CA

Demographic factors are important in that they help plan interventions that would address the needs of different groups (Mazvimavi *et al*., 2008). A binomial logistic regression analysis was used to investigate the effects of demographic factors on the adoption of CA principles either in combination or as a single principle. A multiple linear regression was conducted to investigate the effects of demographic variables on the area put under CA. The decision to focus on specific CA principles was taken because adoption of CA as a package has often been minimal, as farmers mainly adopt a single principle (Baudron *et al*., 2007; Mazvimavi and Twomlow, 2009). For instance, adoption of crop rotation is limited by the availability of legume seed in the markets, a

preference for cereals over legumes (Haggblade and Tembo, 2003; Mazvimavi and Twomlow, 2009) and the prescribed spacing for CA planting basins, which does not fit legume spacing (Baudron *et al*., 2007). Soil cover, on the other hand, is limited by multiple uses of crop residues and low biomass production (Giller *et al.*, 2011).

Table 7.5 shows the effects of demographic factors on the adoption of CA principles. The independent variables considered were age, years of schooling, household headship (female- or male-headed), location (district), labour, off-farm income and farm size. The effect of demographic factors on adoption of all three principles and soil cover was not significant and was therefore not included in the table.

Table 7.005: Effects of demographic factors and asset endowments on adoption of CA principles

Factor	Minimum tillage	Crop rotation	Two principles	Area under CA (OLS)
Location (Nkayi=1, Choma=0)	1.996**	2.589**	-1.529	0.951**
Education (yrs)	-0.603	1.230*	-0.375	0.456*
Availability of labour (n)	-0.283	0.297	0.547**	0.073
Age (yrs)	-0.003	0.014	0.013	-0.015
Off-farm income ($)	0.152	-0.082	-0.160	0.000
Farm size (ha)	0.508	-0.416	-0.209	0.354
Goodness of fit	40.939***	47.376***	21,715*	R^2= 0.34

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: Survey data, 2017

Table 7.5 shows that location had a significantly positive effect on the adoption of MSD, crop rotation and the area put under CA ($p<0.05$). This means that Nkayi farmers were more likely to adopt MSD and crop rotation and to apply CA on larger areas than in Choma. This could be because farmers in Nkayi had practised CA longer than farmers in Choma and had probably seen the benefits of CA over time. Previous studies on the effect of location on adoption have shown significant effects of location on the adoption of CA (Knowler and Bradshaw, 2007).

In this study, education level only had a significantly positive effect on the adoption of crop rotation and area under CA ($p<0.10$), which suggests that the principle of crop rotation requires more understanding than other principles. The effects of education on adoption have generally been found to be mixed (Knowler and Bradshaw, 2007). Ngwira *et al*. (2014), in a study in Malawi,

and Arsalan *et al*. (2013) in Zambia found the level of education not to affect adoption of CA. However, Mazvimavi (2016) found the adoption of all three principles of CA to be positively influenced by the level of education. In Nkayi and Choma, the findings also illustrated that education levels of farmers influenced the total area under CA, which was supported by Arsalan *et al.* (2013).

The availability of labour is normally represented by household size (Pedzisa *et al*., 2015), since family labour is used in the smallholder sector (IFAD and NEPAD, 2014). The regression analysis for labour was significantly positive in respect of the adoption of two CA principles ($p<0.05$), as shown in Table 7.5. This illustrated that for farmers to apply more than one principle, they needed to have more labour than when only the MSD principle was applied. FGDs with farmers reported that farmers formed groups to help one another in the preparation of planting basins, which could have helped reduce labour requirements for minimum tillage. More labour may have been required to apply soil cover in cases where farmers had to transport mulching material from outside their farms, as resources were normally pooled for land preparation. Subsequent activities such as mulching, weeding and harvesting were mostly taken care of individually. Mazvimavi and Twomlow (2009) and Arsalan *et al*. (2013) found no relationship between the availability of labour and the adoption of CA, even though farmers stated that CA was labour-intensive.

Off-farm income, age and farm size did not significantly affect the adoption of CA principles, nor the area under CA (Table 7.5). These findings on the effects of off-farm income on CA adoption suggest that farming is still the main source of income in the study areas. The findings are in contrast to those of Corbeels *at al.* (2014), who found a negative influence of off-farm income on the adoption of CA technologies.

The influence of age suggests that the probability of adopting CA decreased with farmers' age, although not statistically significant. Age has generally produced mixed effects on adoption. A non-significant influence of age on CA adoption was reported by Mazvimavi and Twomlow (2009), Arsalan *et al*. (2013) and Ngwira *et al.* (2014) while Nyanga (2012) found age to positively correlate with adoption of CA.

Previous studies have also shown variations on the influence of farm size on adoption of CA; Mazvimavi and Twomlow (2009), Nyanga (2012) and Ngwira *et al*. (2014) found a significantly positive influence, while Arsalan *et al*. (2013) found a significantly negative effect. The effects of

age and farm size on adoption cannot be universally explained (Knowler and Bradshaw, 2007), as there are variations in the impacts of these factors. Although the effect of farm size on CA adoption was not statistically significant, it clearly showed tendencies that as farm size increased, farmers found it more difficult to apply crop rotation and two CA principles.

7.6 Conclusion

This chapter provided an overview of the demographic characteristics and asset endowment and CA farmers in Nkayi and Choma. These two districts differed in terms of farm size, household income, female-headed households and asset endowments. Farm size and farm income were generally higher in Choma than in Nkayi, while Nkayi had higher off-farm income and a higher proportion of female-headed households. On asset endowments, the study found generally higher ownership of farm implements and communication assets among Nkayi farmers. An analysis of the effects of some of the demographic and socio-economic factors on the adoption of CA revealed significant effects of location (district), education and labour on the adoption of CA principles and the area put under CA.

CHAPTER 8

MAPPING THE SOCIO-ECONOMIC ENVIRONMENT AND FARMING SYSTEMS OF SMALLHOLDER FARMERS IN NKAYI AND CHOMA DISTRICTS

8.1 Introduction

The first objective of this study was to map the socio-economic environment of smallholder farmers in Nkayi and Choma. This chapter provides a background on the environment of smallholder farmers in the study areas. This chapter discusses the smallholder farmers' economic, institutional and social environment in the study districts, with the focus on input and output markets, credit facilities, extension services, community norms/customs and by-laws, on-farm decision-making processes, influential people and social connectedness of farmers in the districts. The socio-environment is important, as it could either enable or hinder the adoption of CA by smallholder farmers (Rogers, 2003).

8.2 Economic environment

Economic environmental factors include access to input and output markets and credit facilities, which are crucial in the adoption of CA (Wall, 2007; Mazvimavi *et al*., 2008). Access to credit enables farmers to buy inputs and is therefore an important economic factor (Nyanga, 2012; Murage *et al.*, 2015). Access to inputs is crucial since the promotion of CA in Zambia and Zimbabwe was associated with the use of external inputs such as fertilizers, improved seed varieties and in the case of Zambia also herbicides. Furthermore, it was important that these inputs were used precisely (in the planting basins or rip lines) and on time (Haggblade and Tembo, 2003; Mazvimavi and Twomlow, 2009; Giller *et al.*, 2011). Timely planting ensured that farmers benefited from the first nitrogen flush (Haggblade and Tembo, 2003; Giller *et al*., 2011), resulting in high yields. The high use of external inputs such as fertilizer was necessary to achieve higher yields in the short term, as the benefits associated with the application of the three CA principles are often long-term (Nyathi, 2009 unpublished; Rusinamhodzi *et al.*, 2011; FAO, 2014). Studies

on CA adoption have reported dis-adoption of CA where no external input support was offered (Pedzisa *et al*., 2015) or owing to increased labour demands where no herbicides were provided (FAO, 2014). Access to input markets is therefore important for farmers to ensure the adoption of CA (Mazvimavi *et al*., 2008; Nkala *et al*., 2011; Giller *et al*., 2011).

In both Zimbabwe and Zambia, governments have input schemes meant to alleviate the challenges of market access to smallholder farmers and to boost production. The input schemes date back to 1991 and 2002 in Zambia and Zimbabwe respectively and have evolved over the years, from direct distribution to involvement of the private sector (Jayne *et al*., 2016). The input scheme in Zambia targets farmers with less than 5 ha who are members of a farmers' organisation (ZMAL, 2015), while in Zimbabwe, farmers are categorised according to farm size and resources to qualify for this input scheme (FAO, 2012). Extension officers, traditional leaders and farmer organisations are involved in beneficiary selection (Moyo *et al*., 2014; Jayne *et al*., 2016). The following section discusses access to inputs and credit by the CA farmers in Nkayi and Choma districts.

8.2.1. Access to input markets

Distance to markets is often used as a measure of access to markets in many adoption studies (Mazvimavi and Twomlow, 2009; Kunzekweguta *et al*., 2017). A t-test for comparison of means showed that farmers in Nkayi travelled a significantly longer distance (57 km) to the nearest agro dealer shop compared to those in Choma (37 km) ($p=0.000$). The study also found significant differences in seed sources used for conventional farming between the two districts ($X^2= 23.779$, df =3, $p=0.025$). Table 8.1 shows that Nkayi farmers relied more on government sources ($X^2= 11.5$, df =1, $p=0.000$) and distant shops ($X^2= 20$, df=1, $p=0.002$), while Choma farmers relied only on local shops ($X^2=6.52$, df=1, p=0000) for sources of seed for conventional planting. Distant shops in Nkayi referred to shops situated in the nearest major city, which was about 150 km away. In the case of CA fields, the differences in the sources of seed were only statistically significant for NGOs, which provided more seed to Choma (26%) than to Nkayi (2%) ($X^2=20.57$, df=1, p=0001). Farmers in both districts were using their own seed stock in their CA fields, compared to conventional fields. This tendency could have been due to the training provided by BICC and CC that encouraged farmers to use open pollinated varieties, which could be saved at harvest and used for three seasons. In both districts very few farmers benefited from government support for

either CA or conventional fields, although Nkayi showed a higher number of farmers (7.4% and 11.5 %) deriving benefit, compared to 2% and 0% in Choma. The relatively low percentage of farmers benefiting from government input schemes could be due to biased selection criteria used at the village level, where traditional leaders selected beneficiaries (Napier, (1991), or due to inefficiencies of input schemes, which usually result in inputs not reaching the intended beneficiaries (African Centre for Biodiversity, 2016). Seed banks were also not a major source of seed in both districts. Seed banks are community-owned seed stores where farmers bring in seed selected from their fields for storage and distribution among members. Cultural issues of trust, poor storage and quality variations were cited as major reasons for the low participation in seed banks and use of seed from local seed banks.

Table 08.01: Sources used for seed supply

	Source	**Nkayi (%)**	**Choma (%)**	**X^2**	**p-value**
Conventional field	Local shop	67	100	6.52	0.000
	Own stock	1.6	0		ns
	Government	11.5	0	11.5	0.025
	Distant shop	20	0	20	0.002
CA field	Local shop	44	28		ns
	Own stock	44	39		ns
	Government	7.4	2		ns
	NGO	2	26	20.57	0.001
	Seed bank	2	6		ns

Source: Survey data, 2017

In addition to seed sources, farmers were asked to indicate if they had purchased fertilizers, crop chemicals and livestock feed during the previous cropping season of 2016/2017. A Pearson chi-square test showed a significant difference between districts in the purchase of fertilizer (X^2=13.06, df=1, p=0.0003), crop chemicals (X^2 =7.211, df=1, p=0.007) and livestock feed (=33.92, df=1, p=0.001), which is shown in Table 8.2. A significantly higher number of farmers from Choma purchased fertilizer and crop chemicals than in Nkayi. The reasons for this difference could be the higher crop production potential due to relatively good soils in Choma. Fertilizers were perceived

by many farmers in Nkayi as too expensive and thus beyond the reach of farmers. Another reason for the relatively low use of fertilizers and crop chemicals in Nkayi could be relatively longer distances to markets compared Choma. A shorter distance to markets was found to be positively linked the use of fertilizers (Abdulai, 2016). The higher rate of purchasing livestock feed in Nkayi (47%) than in Choma (5%) could be due to the value attached to livestock production in this district (Dube *et al*., 2014). Access to input markets was therefore higher in Choma than in Nkayi.

Table 8.02: Percentage respondents that purchased farm inputs

Input	**Nkayi %**	**Choma %**	**Total %**	**X^2**	**p value**
Fertilizer	55	100	77.5	13.06	0.0003
Crop chemicals	59	92	75.5	7.211	0.007
Livestock feed	47	5	26	33.92	0.001

Source: Survey data, 2017

Respondents were asked to offer suggestions on how challenges with markets could be addressed (Figure 8.1). Improving agro dealer support was the most frequent suggestion, comprising 37% of responses in Choma and 29% in Nkayi. However, a good number of respondents in Nkayi could not offer suggestions (44%). Credit and subsidies were common suggestions in Choma (29%), compared to Nkayi (8%). Choma farmers also suggested improvement of the road network (21%), while in Nkayi they suggested commodity groups (12%) where farmers can buy as a group for a specific crop.

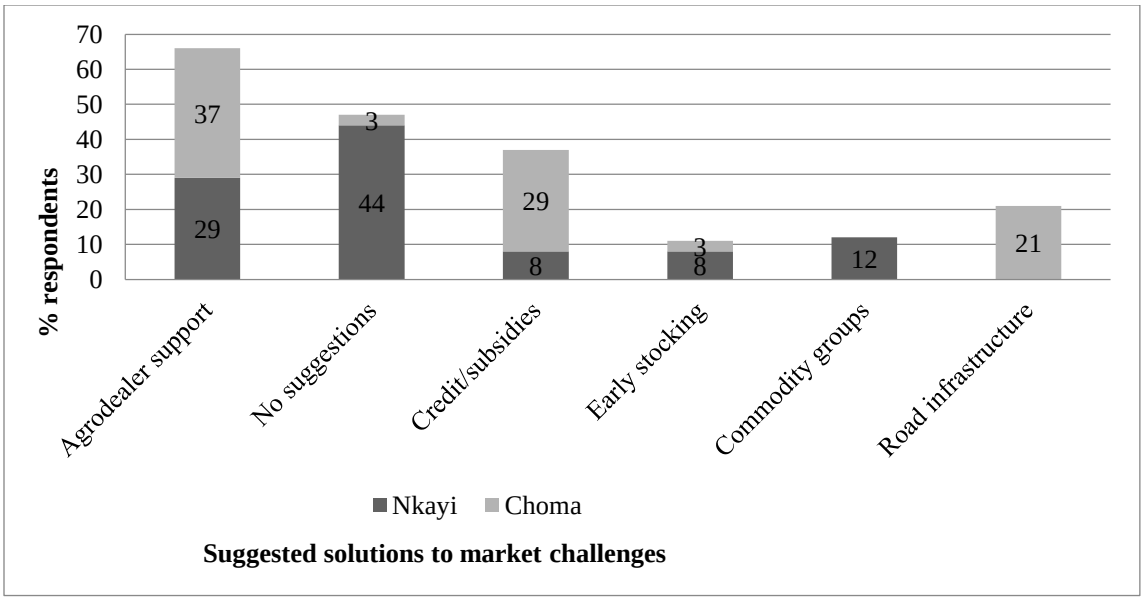

Figure 8.0001: Suggested solutions to market challenges

Source: Survey data, 2017

8.2.2 Access to output markets

Conservation agriculture is promoted to increase food production for smallholder farmers. Increased production should be accompanied by availability of markets so that farmers are able to earn income from increased production. In most of Sub Sahara Africa, undeveloped markets often hinder smallholder farmers from participating in markets (IFAD and UNEP, 2013). In Zimbabwe, although marketing of staple crops such as maize is deregulated, the Grain Marketing Board (GMB) determines a floor price for the sale of maize (GoZ, 2012). In Zambia the Food Reserve Agency (FRA) is mandated to ensure reliable supply of commodities and ensures price stability of the same commodities (www.fra.org.zm). The floor price set by the agencies are normally criticized for being too low for farmers to make profit (Moyo, 2011; Chapoto, *et al.*, 2017). In addition, late payment for produce has been a major issue in marketing produce through the GMB in Zimbabwe (Moyo, 2011)

To understand the output marketing environment of farmers, respondents were asked if they have ever sold their produce in the past two years. Seventy percent of respondents had sold part of their produce at some point in the past two years. In Nkayi, 89% of respondents were selling produce

to other farmers whilst in Choma the majority sold to the private sector (70%). Only 14 percent and 23 percent of respondents in Nkayi and Choma respectively sold their produce to the GMB or FRA. Of those that were selling their produce, maize (100% in Choma, 78% in Nkayi), and cowpeas (40% in Choma and 22% in Nkayi) were the main crops sold. In Nkayi there were a handful of farmers that marketed pearl millet (34%) and sorghum (16%).

General challenges to marketing as shown in Figure 8.2 were low prices stated by 59 percent of responses in Choma and 56 percent in Nkayi and transport challenges were stated by 32 percent of responses in Choma and 11 percent in Nkayi. Other challenges included failure to meet quality standards by farmers due to poor storage (16%) in Nkayi and (7%) in Choma.

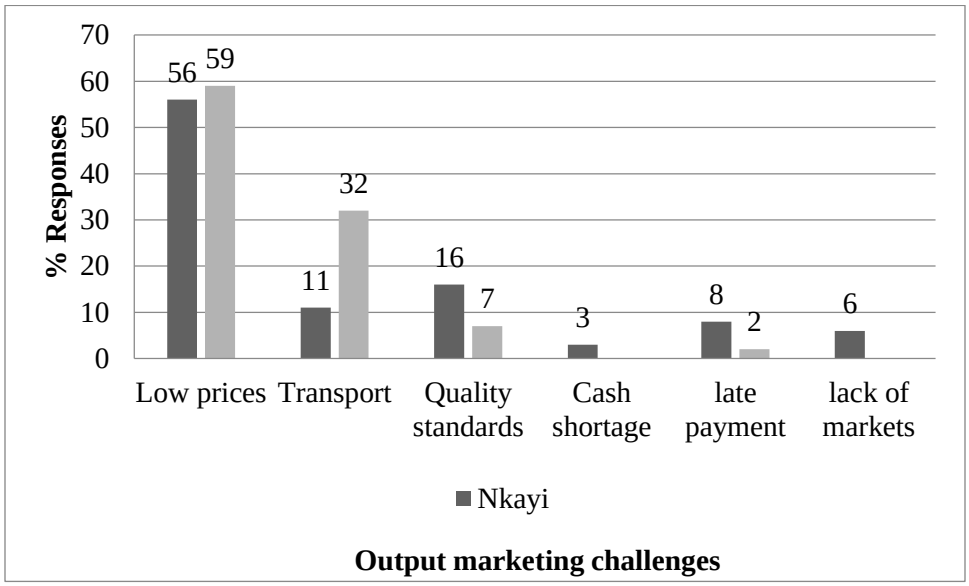

Figure 08.002: Challenges to marketing of produce

8.2.2 Access to credit

Access to credit among farmers was lower in Nkayi (20%) compared to Choma (48%). Table 8.3 shows the various sources and types of credit accessed by farmers in Nkayi and Choma districts. A Pearson chi-square test of independence showed a significant difference in sources of credit (X^2= 30.7, df 3, p=0.000) and types of credit accessed (X^2= 28.22, df 2, p=0.000) between districts. Sources of credit for farmers included village savings, borrowing from fellow farmers, loans from farmer organisations and microfinance institutions. Types of credit included cash, contract farming

and government input schemes. Informal sources, such as borrowing from fellow farmers, were more prevalent in Nkayi than in Choma. This could largely be due to undeveloped formal markets in Nkayi and the remoteness of the district. Cash was the main type of credit accessed by respondents in Choma (34%) and Nkayi (14%). No farmers in Nkayi and only 2% in Choma benefited from the government input scheme, which may suggest inefficiencies in the implementation of government input schemes (African Centre for Biodiversity, 2016; Jayne *et al*., 2016). Contract farming credit supply was more prevalent in Nkayi (13%) than in Choma (3%), probably due to the production of commercial crops such as sorghum grown in this area.

Table 8.003: Sources and type of credit accessed

	Nkayi (%)	Choma (%)	Total (%)	X^2	p-value
Source of Credit				30.7	0.000
Village savings	12	23	18		
Other farmers	**7**	0	3.5		
Microfinance institution	5	13	9		
Registered farmers' organisation	0	16	8		
Type of credit				28.2	0.000
Cash	14	35	26		
Contract farming	13	3	8		
Government input scheme	0	2	14		

Source: Survey data 2017

8.2.2.1 Challenges in accessing credit

Farmers that had never accessed credit in the past were asked why they had not been successful. Figure 8.3 shows the challenges faced by these farmers in accessing credit. A Pearson chi-square test showed a significant difference between districts in reasons provided for not being able to access credit (X^2 =29.7, df 5, p=0.001). In Nkayi, the major limitations to accessing credit were fear (54%) and lack of knowledge about the availability of credit facilities (37%). In Choma, farmers found the unavailability of credit services the most limiting constraint (77%). This is a

surprising finding, as the presence of formal markets in this district raised the expectation that credit would be available. A possible reason may be the criteria used to access credit, such as the need for collateral or the need to belong to farmers' organisations, which may have inhibited farmers to access credit. There were also farmers in both districts, Nkayi (23%) and Choma (14%), who indicated that they did not need credit facilities and showed no intention to access these. Although smallholder farmers in sub-Saharan Africa usually complain about conditions to access credit, very few farmers in both districts cited this as a major challenge. Lack of knowledge, fear and perceived lack of need could indicate challenges with output markets or not producing enough to seek lines of credit. These findings are supported by Wall (2007), who reported low access to credit for smallholder farmers in Africa.

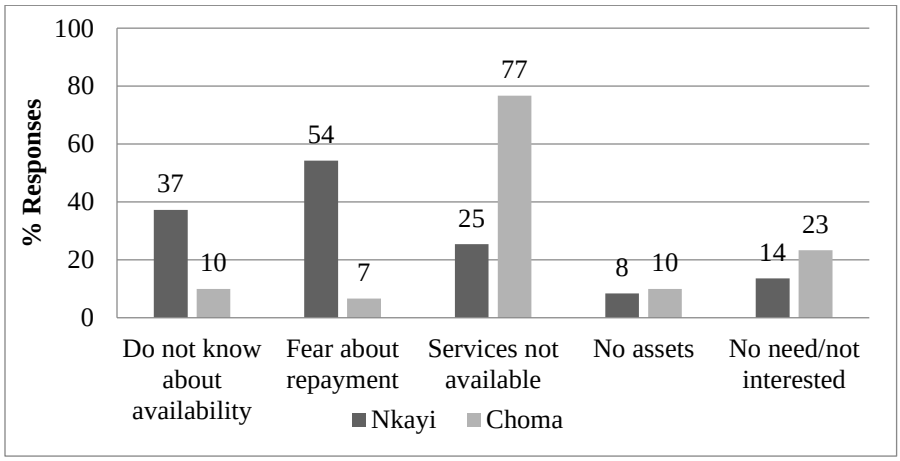

Figure 8.03: Challenges to accessing credit

Source: Survey data, 2017

8.3 Extension support

Agriculture extension plays a role in the adoption of new technologies (Mazvimavi *et al*., 2008, Awotide *et al*., 2012; Pedzisa *et al*., 2015) and because CA is a knowledge-intensive technology, smallholder farmers need access to extension services (Wall, 2007). Agriculture extension provides an enabling environment necessary for the successful promotion of CA. Government policies for both Zimbabwe and Zambia propose to improve research and extension services (MACO, 2004; GoZ, 2011), although most of the budget for agriculture in the two countries goes

towards input support schemes at the expense of extension support (African Centre for Biodiversity, 2016; Chapoto *et al*., 2017).

Extension services in Zimbabwe and Zambia are pluralistic, meaning that the private sector, public sector and NGOs provide extension services to smallholder farmers (Hanyani-Mlambo, 2002; GRZ, 2016). This is to complement low staffing levels in the public sector and high staff turnover due to poor working conditions, such as lack of transport and accommodation in the public extension system in the two countries (Hanyani-Mlambo, 2002; GRZ, 2016). However, pluralistic extension services in these two countries face a challenge of poor coordination between service providers, which leads to the duplication of efforts and conflicting information being provided to the same farmers (GRZ, 2016). The limited presence and specific focus of private sector players also pose a major setback to the sustainability of extension services (Hanyani-Mlambo, 2002).

8.3.1 Extension services

This section compares sources of extension support for CA farmers in Nkayi and Choma districts. Figure 8.4 shows multiple sources of extension support used by farmers in the two districts, with public support being prominent in Nkayi (90%) and NGO extension services in Choma (93%). During FGDs with farmers in Choma, 90% of respondents revealed that public extension officers were not always available to help them in their farming activities. One explanation put forward by respondents for the situation was that extension staff members stay in Choma town rather than in their designated duty stations in the communities. On the contrary, in Zimbabwe the public extension system is still well coordinated and staffing levels were improved after the government introduced fast-tracked training of high school graduates. These students underwent six months of training as agriculture extension agents and were subsequently posted at their own home duty stations. In addition to the new recruits, coordination between NGOs and public extension agents was encouraged to ensure harmonisation of extension messages.

Lead farmers also played an important role in extension support to CA farmers in Choma (33%) and Nkayi (14%). Lead farmers are early adopters of technologies who are trained, usually as part of the project, to train other farmers. The aim is to reach a wider number of farmers at low cost (Kiptot and Franzel, 2015). Lead farmers are particularly important in areas where extension staff is limited, for example in Choma. Although the role of other players, such as input suppliers,

traditional leaders and fellow farmers was relatively small in the support of farmers, it illustrated the pluralistic nature of extension support in these districts.

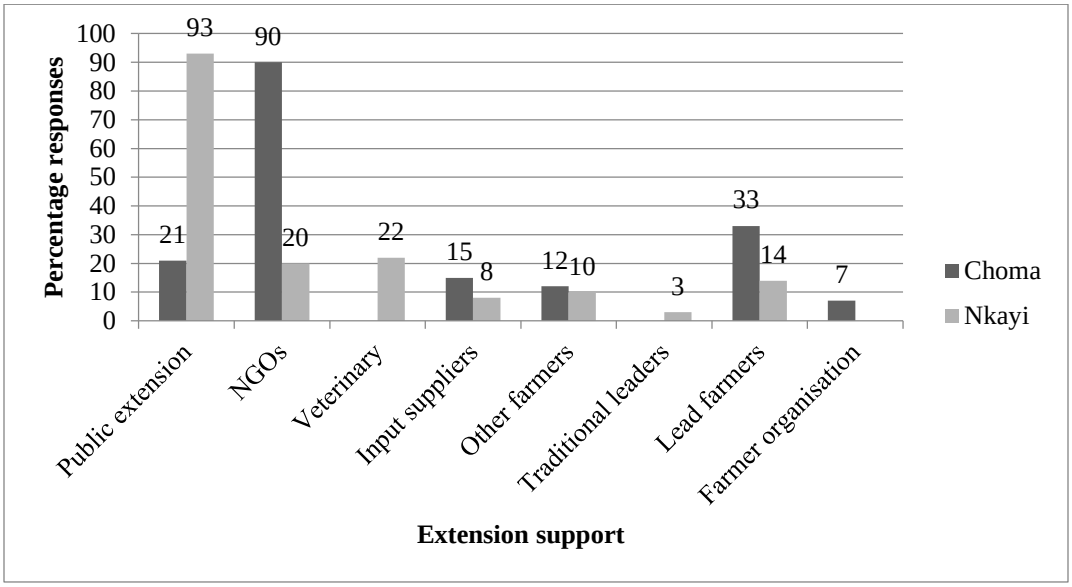

Figure 8.004: Sources of extension support used by farmers

Source: Survey data, 2017

In addition to sources of extension support, respondents were asked to indicate agencies that provided CA training in these two districts. A Pearson chi-square test showed a significant difference in the sources used for CA training between districts (X^2= 24.6, df=3, p<0.000). In Nkayi district, training on CA was offered by public extension (44%) and NGOs (56%), while in Choma district, it was mainly provided by NGOs (95%). The findings in Nkayi confirmed the report by Hanyani-Mlambo (2002) which stated that the public extension system in Zimbabwe backstopped NGO activities.

The extension agents who provided training were ranked using a Likert scale of 1 to 5 (1 - poor, 5 - very good) concerning the effectiveness of training. Ninety percent of respondents ranked the training received as very good and there were no significant differences in the ranking between districts. The training provided by BICC and CC in Choma and Nkayi respectively included demonstration plots and practical training, which could have contributed to the high ranking awarded by farmers. In Nkayi NGO staff always provided extension support with public extension

agents, as this was a government requirement. In addition, frequent contact with farmers was the norm during project implementation, with farmers being trained at least twice a year (54%) or even three times a year (7%) in Choma, while in Nkayi some farmers were trained three times a year (38%) and others twice in year (19%) or monthly (16%). Farmers also regularly met with extension agents weekly (19% Nkayi and 23% Choma) and monthly (31% Nkayi and 14% Choma).

8.3.2 Stakeholders and their influence as perceived by farmers

In addition to extension services, the study sought to understand how respondents perceived the influence of the various stakeholders found in the smallholder sector. Table 8.4 shows a list of stakeholders perceived as influential by farmers. A Pearson chi-square comparison between districts was performed on the perceived influence of traditional leaders, government extension services, lead farmers and opinion leaders. The findings showed that traditional leaders were perceived to be more influential in Choma (X^2=5.22, df =1, p=0.001), while government extension services were more influential in Nkayi than in Choma (X^2 =44.5, df=1, p=0.001). The higher influence of government in Nkayi could be due to the consistent presence of public extension agents in this district, which had built trust between extension agents and farmers. Peers such as lead farmers (X^2=8.25, df =1, p=0.014) and opinion leaders (X^2=21.77, df=1, p=0.001) were more influential in Choma than in Nkayi, which suggests higher community cohesiveness and peer trust in Choma than in Nkayi. These findings reflect the importance of the role of traditional leaders, lead farmers and peers in Choma. The trend is also reflected in the source of extension support on CA in Figure 8.4. Surprisingly, the influence of NGOs was perceived to be low (16%), despite them being the major source of CA information in Choma. This could be due to the project-based presence of NGOs in communities, which limits opportunities for building sustainable relationships with farmers, a weakness that was identified by Hanyani-Mlambo (2002).

Table 8.004: Influence of various stakeholders on farmer decision-making

Stakeholder	Nkayi (%)	Choma (%)	X^2	p-value
Traditional leaders	66	95	5.22	0.001
Government departments	65	8	44.5	0.001
NGOs	23	16		0.873
Lead farmers	9	26	8.25	0.014
Opinion leaders	4	32	21.77	0.001

Source: Survey data, 2017

8.4 Social environment of smallholder farmers

The social environment of smallholder farmers encompasses society beliefs, customs, practices and behaviours that are important in understanding adoption behaviour (Rogers, 1983). CA adoption studies have rarely focused on understanding the role of social factors in adoption (Knowler and Bradshaw, 2007), yet there is evidence that social factors, such as social networks, social influence and social structures, could influence adoption of technologies (Isham, 2000; Swinton 2000; Katungi, 2006. Social influence depends on community cohesiveness (Rogers 1983), which generally determines individualism or communalism. Understanding the social values and norms of communities can help to determine the means of communication that are most effective in the diffusion and adoption of innovations (Shaw, 1987). This section focuses on customs, rules, decision-making and social connectedness of farmers in these two districts.

8.4.1 Customs and by-laws

Customs refer to the way things are done in particular communities while by-laws refer to regulations that govern communities (Rogers, 1992). The study focused more strongly on customs and by-laws that were related to farming activities. A Pearson chi-square test of independence showed significant differences in customs between districts (X^2= 25.95, df =4, p= 0.000), but no significant difference in by-laws.

Table 8.5 provides a list of customs and by-laws in the two districts. In Nkayi, the most important customs highlighted were respecting sacred days (75%), when people are not allowed to enter their

fields (after a heavy storm, when there is a funeral, when it is a full moon and on a day that a community has set aside as a resting day). Such customs tend to delay timely fieldwork, especially if many sacred days are observed in a season.

In Choma the main customs that were highlighted were the prohibition of fencing of fields (38%) and prohibiting women from owning land (24%). The prohibition of fencing of fields limited farmers' aspirations to practice mulching, whilst restricting land ownership to men may affect adoption of new technologies by women. During FGDs held in Choma, it was revealed that the eldest son takes control of the family farm in a female-headed household. In Nkayi, non-ownership of land by women was not raised as a custom, but lack of decision-making by married women was raised by 80% of respondents during FGDs. The two districts had similar customs on the protection of grazing areas, with a higher number of respondents in Nkayi (10%) than in Choma (2.2%). In Nkayi farmers reiterated that CA farmers were not allowed to cut grass for mulching in areas reserved for livestock grazing. Such a custom is likely to affect the soil cover principle of CA negatively.

The major by-laws perceived as influencing farming activities were communal grazing and the prohibition on entering fields during the dry season. The local rules were perceived to affect crop residue retention in CA (84% in both Nkayi and Choma) and delay land preparation for CA (6% Nkayi and 11% Choma).

Table 8.5: Customs and by-laws perceived to affect farming practices

	Nkayi n=88	Choma n=40
Customs		
Respecting sacred days %	75	0
Rain-making ceremonies %	13	0
No fencing to traditional land %	0	38
Women do not own land %	0	24
Protected grazing areas	10	2.2
By-laws		
No burning bushes %	5.1	18
No selling of traditional land %	0	18
Communal grazing in the dry season %	61	87
No entry into field in dry season %	3.4	8

Source: Survey data, 2017

8.4.2. On-farm decision-making

The researcher sought to understand which farming decisions could or could not be made exclusively at household level. Table 8.6 shows that farmers decided on what to grow (60.4%). In both districts farmers could also decide on the tillage method to use (10%) and some claimed that they could decide on fencing their fields (7%). Decisions that could not be made by farmers themselves included preventing livestock from entering the fields during the dry season (15%), fencing fields (34%) and selling traditional land (25%). Increasing land size was a decision that could not be made at household level in Nkayi (14%), while controlled burning could not be done in Choma (12%). Controlling livestock and fencing were mentioned by some as decisions that could be made at household level and by others as decisions that could not be made at household level, but were described more often as decisions that could not be made at household level. These findings suggest that although there maybe community by-laws that prohibit fencing and free grazing in the dry season, farmers are able to make certain decisions about these activities. In Choma it was mentioned during FGDs that fencing was not prohibited per se, but could result in social exclusion. Essentially this implies that a decision on fencing lies with the individual farmer, whose discretion would be influenced by the value he/she places on being part of the community.

Although fencing was mentioned as a decision that could not be made by farmers in Nkayi, respondents indicated that fencing was not prohibited for homestead fields and as such, did not severely influence CA practice on such fields.

Table 8.06: On-farm decision-making

District	Nkayi (%) n=55	Choma (%) n=36	Total (%)
Decisions than can be made regarding farming (%)			
What to grow	58	64	60.4
Fencing	6	8	7
Tillage method	6	17	10
Pass land to children	4	6	4.4
Control livestock	6	6	5.5
Decisions that cannot be made regarding farming (%)			
Increase land size	14	0	9.1
Control livestock	22	3	14.8
Sell land	9	51	25
Fencing	40	24	34
Control burning	0	12	4.5

Source: Survey data, 2017

8.4.3 Social connectedness

Respondents were asked to respond to questions related to group membership, which is a measure of social connectedness. Social connectedness is an important measure of social capital, which has benefits of collective work, information sharing, trust and learning (Collier, 2002; Poli, 2015). Group activities can also help in shaping local norms and networks (Poli, 2015) and in the management of common resources and marketing of produce (Njuki *et al*., 2008).

The majority of respondents in both districts were associated with a local group (Nkayi 78%, Choma 95%) in their district. Figure 8.5 shows the types of groups to which respondents belonged, which included the CA study groups, co-operatives, savings groups, farmer unions and social groups such as burial and women's groups. As expected, membership of CA study groups was dominant in both districts (Nkayi (58%) and Choma (61%). However, it was interesting to observe generally low membership of other groups such as cooperatives, farmer unions, savings and social groups. Comparisons of membership between the two districts showed no significant difference in

membership of savings groups, although Nkayi had a slightly greater proportion of farmers (15%) belonging to savings groups than Choma (7%). This could be because of economic meltdown in Zimbabwe that forced farmers to think of innovative ways to save money. In Nkayi none of the respondents belonged to a nationally recognised farmer organisation, while only 10% of farmers in Choma belonged to one. In Nkayi, farmers did not see any benefits in belonging to the National Farmers Union (NFU) owing to perceived lack of recognised membership benefits. In Choma, it was surprising to see such a low number of farmers belonging to the NFU, considering the benefits of membership, such as access to production inputs. The low participation of farmers was due to the unaffordability of membership fees, which was mentioned in FGDs. Membership of social groups was relatively low in both districts (Nkayi 6% and Choma 7%). This may need further enquiry, as farmers were only keen to talk about groups that were important for farming activities.

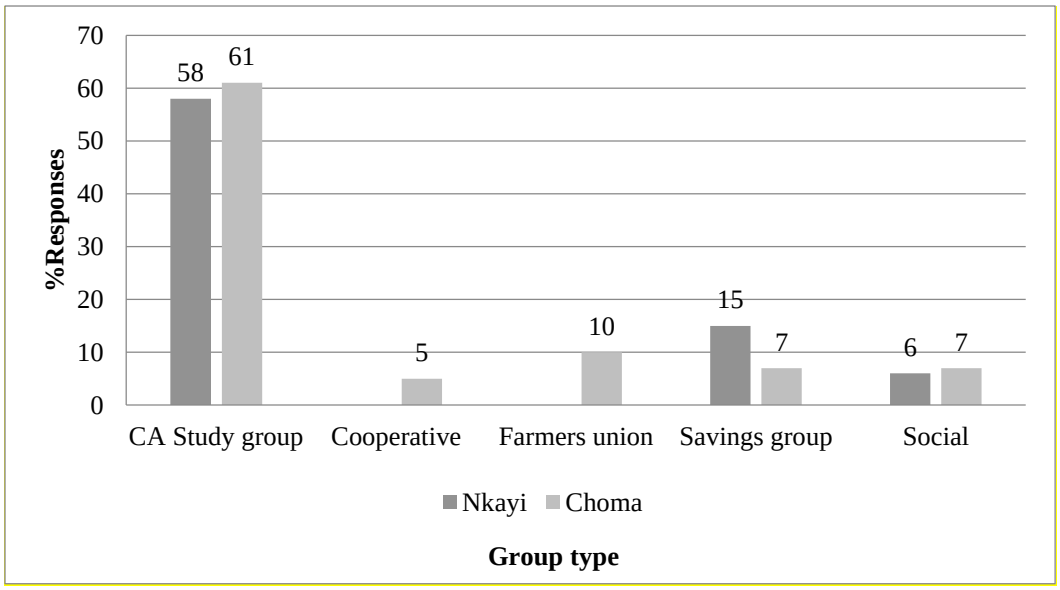

Figure 8.5: Types of groups to which farmers belonged

The findings reveal very few social connections for CA farmers outside CA study groups, particularly membership of groups that could help farmers to access government services. Membership of groups such as farmer unions and saving groups generally require payment of membership fees, which may not be affordable for poor farmers. Farmers also indicated that farmer

groups required commitment and sometimes meeting points were centralised and too far for some households to participate.

8.5 Farming systems in Nkayi and Choma districts

A farming system is defined by Dixon *et al*. (2001) as 'a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. The systems can be classified based on natural resources, enterprises, livelihood strategies and technologies used. In this section the study only focuses on crop production systems used by farmers in the two districts, as these relate directly to CA.

Crop production is one of the most important farming enterprises for smallholder farmers in sub-Saharan Africa, with more that 80 percent of farms being managed by smallholder farmers using family labour and simple hand or animal-drawn tools (IFAD and UNEP, 2013). Unsustainable practices and low use of fertilizers (Jama and Pizarro, 2008) have resulted in the depletion of soils and low production. This section looks at farmers' crop production objectives, methods of tilling land and the way crop residues are traditionally used in the study districts. These aspects are important to explore in a study on CA adoption, as CA represents a change in the way farmers grow crops.

8.5.1 Types of crops grown

The main crops grown in the two districts were maize (100%), groundnuts (50% Nkayi and 70% Choma) and cowpeas (50% Nkayi and 73% Choma) as shown in Figure 8.6. In Nkayi a considerable number of farmers were also growing drought-tolerant crops such as sorghum (59%) and pearl millet (31%). This could be due to the relatively poor rainfall in Nkayi compared to Choma or the availability of markets for sorghum. Sunflowers (22%) and sweet potato (21%) were grown by more farmers in Choma than in Nkayi (6%). Although cotton is a commercial crop, it was the crop grown least often in both districts, with fewer than 5% of farmers growing the crop.

The types of crop grown highlighted the dominance of maize, which is a staple crop in these two districts, and a dominance of two legumes, groundnuts and cowpeas, and shows very little production of commercially oriented crops.

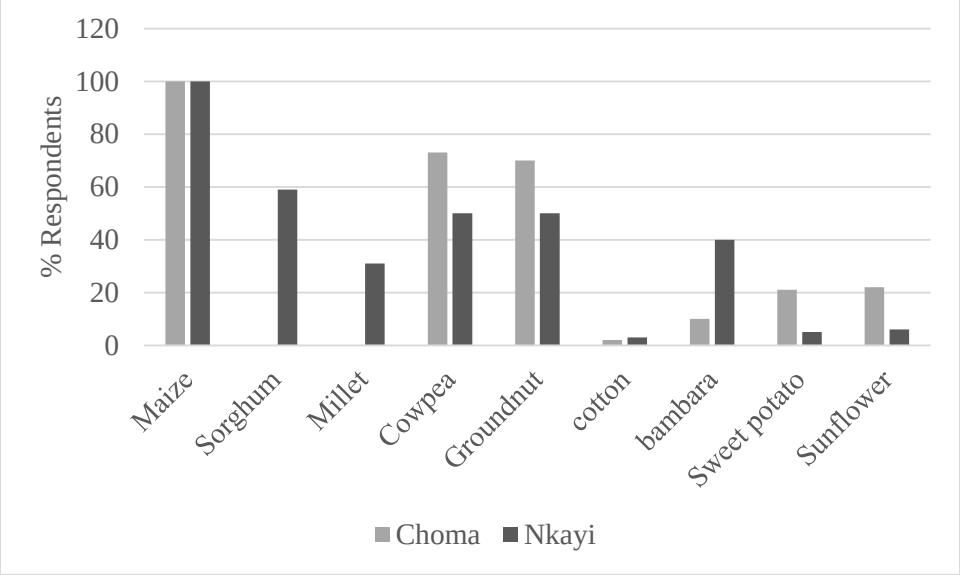

Figure 08.6: Types of crop grown in Nkayi and Choma

Source: Survey data, 2017

8.5.2 Production objectives

A review of production objectives helped to understand whether farmers were becoming commercially oriented or whether they still produce for home consumption. Figure 8.7 shows that farmers in the study districts were farming for either household consumption only or for both household consumption and for sale. In Nkayi farmers were mainly growing crops for home consumption (60%) and to sell (40%) in comparison to farmers in Choma, where more farmers were growing crops for both consumption and for sale (61%). A Pearson chi-square test showed these differences in production objectives to be significant between districts (X^2=8.069, df =2, p=0.041) These findings revealed that Choma farmers were more commercially oriented than their counterparts in Nkayi district. This concurs with findings in Table 7.1, indicating that Choma farmers were getting higher incomes from crop production than those in Nkayi. This could probably be due to the higher crop production potential of the district due to good soils (Baudron *et al.,* 2007) and access to markets.

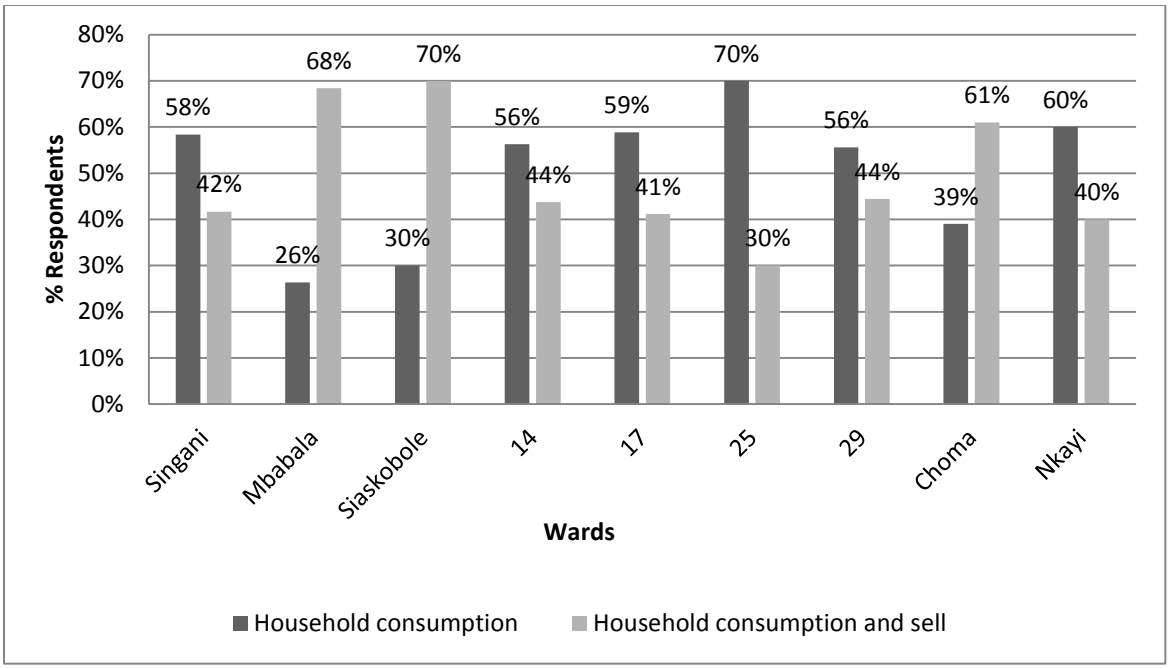

Figure 0.7: Reasons for farming

Source: Survey data, 2017

8.5.3 Tillage methods

Tillage is described by Hobbs (2007) as an act of disturbing the soil either manually, or with animal- or tractor-drawn implements. This action includes digging, cultivation and ploughing. Soil tillage has many purposes, including the preparation of a seedbed, incorporation of crop residues from the previous crops to enhance soil texture and fertility and the control of weeds (ibid). The use of a plough for tilling land is blamed for destroying the soil through soil loosening, disruption of soil life and breaking down of organic matter (ibid). Because of these challenges associated with conventional tillage, CA techniques such as MSD aim to minimise the damage caused by traditional ploughing.

Table 8.7 shows that main methods of tillage in the two districts were dominated by the plough (71%), followed by hand-hoe use (17%) and tractors (11%). The highest plough use was in ward 25 of Nkayi district (82%) and were lowest in Singani ward (33%) of Choma district. Farmers in Singani (50%) and Siaskobole predominantly used hand-hoes. The use of mechanical ploughing

with tractors was relatively low in all areas, meaning that farmers in the districts had still not fully mechanised their activities, as reflected by Dixon *et al*. (2001).

Table 8.07: Tillage methods

	Hand hoe (%)	**Plough (%)**	**Tractors (%)**
Choma (n=41)			
Singani	50	33	17
Mbabala	5	74	21
Siaskobole	30	70	0
Nkayi (n=61)			
Ward 14	19	63	19
Ward 17	12	82	6
Ward 25	10	90	0
Ward 29	11	83	6
Total	**17**	**71**	**11**

Source: Survey data 2017

These findings reveal that promotion of hand hoe-based CA systems by NGOs in Zimbabwe was not contextually appropriate, considering that few farmers used this tillage method. In Choma, it was surprising to witness that most farmers were still using ploughs, despite receiving training on how to use rippers. This could be because with ripping farmers experience higher weed pressure if herbicides are not used (Kasalu-Coffin *et al*., 2011). Farmers also lamented the challenge of accessing rippers. Farmers supported by BICC were given rippers to share among a group of 10 farmers. The relatively high usage of the hand-hoe in Singani and Siaskobole wards of Choma could be due to lack of draught power, as the wards had the lowest livestock numbers (Figure 7.1). Baudron *et al.*, 2007 also reported shifting to hand hoe use in Choma following the droughts, which had greatly reduced livestock numbers during the 1990s.

8.5.4 Use of crop residues

It was prudent to identify the use of crop residue in the study areas, considering that one of the CA principles is to promote soil cover using crop residues. The benefits of soil cover include moisture

retention, weed suppression and organic matter build-up (Twomlow *et al.* 2008). However, despite the many benefits of using crop residues as mulch, there has been a lot of criticism on the feasibility of achieving soil cover in smallholder farming systems (Giller *et al*., 2011). In the developing world, cereal residues are mostly used to feed livestock (Prasad and Power, 1991) and studies have shown that it is more economically beneficial to feed livestock than to improve the soil with crop residues (Rusinamhodzi *et al*., 2015).

In Nkayi and Choma, it was found that crop residues had two main uses, namely for livestock feeding or for soil fertility improvement. Table 8.8 shows a comparison of crop residue uses between districts through a Pearson chi-square test of independence. In Nkayi, crop residues were mainly used as livestock feed, either by leaving the crop residues in the field (47% responses) or by removing and storing them to feed livestock (21.3% responses). In Choma, the practice of leaving crop residues in the field for livestock feeding (73.2% responses) was more prevalent than removing residues to feed livestock elsewhere (12%). The difference between districts in crop residue removal to feed livestock was significant (X^2= 9.784, df =1, p=0,002), with Nkayi farmers more likely to remove crop residues to feed livestock. In Choma crop residues were left in the field for livestock, which was significantly different from the practice in Nkayi district (X^2= 6.605, df= 1, p=0,010). Possible reasons for Choma farmers leaving residues for livestock feeding rather than removing it to feed stock elsewhere could be a social, where farmers feel compelled to leave residues for communal grazing. During an FGD held in Mbabala, a woman said, *'... if you fence your field where will your livestock feed when your residues are depleted? In fact, if you fence, you are considered an outcast …*'

Table 8.08: Crop residue use

Crop residue use	Nkayi	Choma	X^2	p value
Left in the field for livestock	47.5	73.2	6.605	0.010
Left in the field for soil improvement	21.3	26.8	0.415	0.519
Incorporated into the soil	4.9	0	2.077	0.140
Removed to feed livestock	21.3	0	9.784	0.002

Source: Survey data, 2017

These findings concur with reports by Giller *et al*. (2011) that the main use of crop residues in the smallholder sectors of Africa is livestock feeding. During FGDs in Mbabala, Choma, respondents indicated that there was benefit in having neighbours' cattle feed on crop residues, especially for those without livestock, as they could borrow livestock for draught power and benefit from manure and urine deposited in the field during grazing. This practice is mainly due to the land tenure system where the land belongs to the community (Theodor and Kassam, 2009). This type of community relationship contributes to some form of social capital, which is important in the management of common resources and access to resources (Njuki *et al.*, 2008).

8.6 Conclusion

This chapter discussed the socio-economic, institutional environment and farming system of CA farmers in Nkayi and Choma districts. The economic environment of the two districts varied in that in Choma, farmers have access to closer markets and participated more actively in formal markets than in Nkayi. In both districts, access to government input schemes was very low and farmer faced low prices when marketing their produce. Access to credit and knowledge about credit availability were very low in both districts. Farmers perceived access to extension and the quality of extension services as very good in both districts. There was evidence of government and NGO involvement in CA promotion in Nkayi, while in Choma NGOs were perceived as the main source of CA training. Traditional leaders were viewed as very influential people in communities, although their role in CA promotion was very low. Social customs in Nkayi were mainly related to respect for sacred days by abstaining from farming activities. In Choma customs mainly concerned the prohibition of land ownership by women and prohibition on fencing of traditional land. The two districts had similar by-laws, which mainly allowed free grazing in the dry season and prohibited field work during this time. These by-laws were perceived to affect the practice of soil cover for CA farmers negatively. Social connections of the farmers who were interviewed were very low. Farmers were members of CA groups formed by the projects that supported CA. This could highlight that there were barriers that limited farmers from participating in nationally recognised farmers' unions.

On the farming systems, the methods of tilling the land were very similar in the districts dominated by animal-drawn ploughing. Maize is the dominant crop in both districts. Nkayi farmers also grow pearl millet and sorghum. Crop residues were used mainly for livestock feeding, but the way residues were fed to livestock was different in the two districts. In Choma, leaving crop residues for communal grazing was more common, while in Nkayi, removing crop residues to feed livestock was prevalent.

CHAPTER 9

ROLE OF THE SOCIAL SYSTEM, INSTITUTIONAL FACTORS AND SOCIAL STATUS IN THE ADOPTION OF CONSERVATION AGRICULTURE PRINCIPLES

9.1 Introduction

In Chapter 8 the socio-economic environment and farming system of smallholder farmers in Choma and Nkayi was discussed to provide a better understanding of smallholder farmers in the study areas. The scope of this chapter is to investigate the influence of the social system and institutional factors in the adoption of CA principles. The chapter also compares adoption of CA principles between women and men and between rich and poor households. The chapter is structured as follows: the first section presents adoption of CA in the two districts, followed by a comparison of farmers' attitudes to CA in the two districts and an exploration of the relationships between the adoption of CA and the area under CA with social system and institutional factors. The second part of the chapter provides a comparison of CA adoption between people of different gender and wealth status.

9.2 Adoption of CA principles in the Nkayi and Choma districts

Respondents were asked to indicate the CA principles they had practised in the 2016/2017 cropping season. Figure 9.1 provides a summary of adoption of the three principles of CA in the two districts. MSD was the most frequently adopted principle in both Choma and Nkayi. Crop rotation (of cereals with mainly cowpeas or groundnuts) and soil cover were adopted more in Nkayi compared to Choma. The difference in adoption levels could be because farmers in Nkayi had practised CA for longer (nine years) than in Choma (five years).

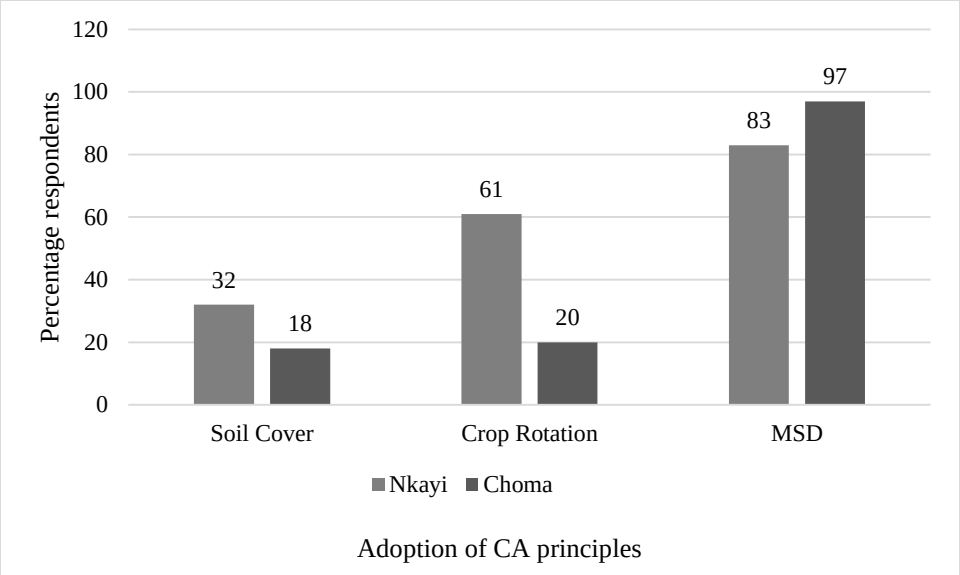

Figure 9.1: Adoption of CA principles in Nkayi and Choma districts in 2016/2017 season

Source: Survey data, 2017

These findings reflected a major challenge in the practice of soil cover and crop rotation, which has been reported in many CA studies (Mazvimavi *et al*., 2008; Kunzekweguta *et al*., 2017). Poor markets and preference for staple crops were the major barriers to the practice of crop rotation with legumes (Mazvimavi *et al*., 2008; Hulst and Posthumus 2016), while competition for crop residues to feed livestock was a major hindrance to the practice of permanent soil cover (Giller *et al*., 2009; Kassam *et al*., 2014a).

9.3 Attitude of farmers to CA

The TPB as described by Ajzen (1991) was used as a basis for understanding farmer's adoption behaviour. According to Ajzen (1991), behaviour is influenced by attitude, subjective norms and PBC. Attitude measures one's perception about a specific form of behaviour. In this case, the adoption of CA can be perceived as either positive or negative. Subjective norms measured the combined effects of significant others' (peers, groups, traditional leaders and spouses) influence on behaviour, while PBC measured the perceived importance of the environment (access to implements, markets, credit and extension services) in practising CA.

Logistic regression analysis was used to measure the effects of social influence (subjective norms) and PBC on the adoption of CA principles. Other social system factors, such as by-laws and customs, were also taken into consideration in measuring the adoption of CA. Attitude was excluded in the adoption regression owing to the low reliability of attitude constructs (Cronbach, 1951) as described in Chapter 6. A comparison of attitude statements was instead made for the two districts to understand the general perception of CA by adopters. Each statement on attitude was measured on a Likert scale, which allowed non-parametric tests (the Mann Whitney U test) to compare differences between districts. The statements on attitude that were used to compare respondents practising CA were: CA increases yield; CA reduces labour; practising CA is not taking a risk and CA is not for the poor. Respondents were expected to either agree or disagree with these statements in order to measure their attitudes.

In Table 9.1, the attitude of farmers to the ability of CA to improve crop yields was significantly more positive in Nkayi than in Choma (z=-385; p=0.000). The difference in attitude could be because farmers in Nkayi were planting crops in planting basins, which have proven to increase yields significantly compared to ripping (Nyamangara *et al.,* 2013). Choma respondents showed a significantly positive attitude to the potential of CA to reduce labour (z=-2.11; p=0.035) and the belief that practising CA did not necessarily involve taking more risk (z=-2.17; p=0.030) than those in Nkayi. The significant differences in attitudes of farmers to the belief that CA was labour-saving could have been due to the use of rippers for the preparation of CA fields in Choma. The use of rippers were found to be labour saving by Nyanga (2012), compared to the hand-hoe system that was used by farmers in Nkayi.

Table 9.1: Comparison of attitudes to CA in the two districts

Attitude statement	District	N	Mean rank	*Z-value*	*p*-value
CA increases yield	Choma	41	41.32	-3.85	0.000***
	Nkayi	61	58.34		
CA requires less labour	Choma	41	58.57	-2.11	0.035**
	Nkayi	61	46.75		
Practising CA is not a risk	Choma	41	58.72	-2.17	0.030**
	Nkayi	61	46.65		

*Source: Survey data, 2017. ** means significant at 5%, *** means significant at 1% significance levels*

9.4 Influence of social systems and institutional factors in the adoption of CA principles

A logistic and regression analysis was done to investigate the effects of social influence, by-laws, customs and PBC on the adoption of CA principles. Ordinary least squares was used to measure the effects of social influence, by-laws, customs and PBC on the total area under CA. Area under CA in the study reflected the total area of the farm that was dedicated to CA. The study used the total area under CA instead of the proportion of the farm under CA because the total area under CA has been used before to measure adoption (Nyanga, 2012) and the proportion of land allocated to new technologies does not always positively correlate with farm size (Arsalan, *et al.*, 2013). In Chapter 7 the researcher also found no significant effects of farm size on CA adoption, which therefore justifies the use of total area under CA as a dependent variable. Table 9.2**Error! Reference source not found.** illustrates the relationship between social influence, by-laws, customs and PBC on the adoption of CA principles and on the total area under CA.

Table 9.02: Influence of the social system and institutional factors on the adoption of CA

Factor	Minimum soil disturbance	Soil cover	Crop rotation	Area under CA
	b/se	b/se	b/se	b/se
PBC	-0.576***	0.284	0.536**	0.431**
	(0.212)	(0.211)	(0.215)	(0.186)
Social influence	0.156	0.166	-0.083	0.347***
	(0.131)	(0.137)	(0.126)	(0.120)
By-laws	0.880***	-0.522*	-0.528*	0.039
	(0.324)	(0.303)	(0.295)	(0.284)
Customs	-0.017	-0.129	-0.089	-0.268**
	(0.284)	(0.289)	(0.277)	(0.132)
Constant	0.992	-1.923*	-1.758*	-0.672
	(0.948)	(1.005)	(0.982)	(0.831)
n	102	102	102	100
p- value	0.008***	0.255	0.073*	0.002***
Log Likelihood	-60.921	-57.279	-65.453	-158.703

*Source: Survey data, 2017, * p < 0.10, ** p < 0.05, *** p < 0.01, Figures in parentheses are the standard errors*
n=number of respondents b is Beta coefficient, se is the standard error

Social influence had a significant and positive effect on the area under CA ($p<0.01$) and a positive relationship with the adoption of MSD and soil cover and negative relationship with crop rotation, although not statistically significant. The lack of a significant effect of social influence on adoption in this study could be due to the availability of extension services from official sources, as shown in Chapter 8. During FGDs, farmers emphasised the importance and value of the training provided by extension staff in convincing them to practise CA. The findings may also suggest that the communities in the study districts valued expert knowledge more than that of peers (Bell & Ruhanen, 2016), or may mean that the technology was too complex to be learnt from peers (Kiptot *et al*., 2006). It could also be due to low social cohesion and lack of trust (Rogers, 2003). The positive effects of social influence on the area under CA could be due to a recommended area on which farmers collectively agreed to practise CA in the two districts and the pooling of labour

during land preparation (Nyanga, 2012), where farmers worked in groups to prepare land for each member, which would have influenced the size of land used for CA.

The by-laws in the two districts had a significant and positive influence on the adoption of MSD ($p<0.01$) and a significantly negative effect on the adoption of soil cover ($p<0.10$) and crop rotation ($p<0.10$). The main by-laws in the two districts allowed free grazing during the dry season and prohibited farmers from entering their fields during the same period. The negative relationship between the by-laws and soil cover complements other findings that report conflicts of the soil cover principle with the farming system (Giller *et al.*, 2011), and farmers' preference to feed livestock with crop residues (Mazvimavi and Twomlow, 2009) as factors that affect soil cover adoption negatively. These findings reflect that the need to conform to communal laws is preventing farmers from practising soil cover. In Choma, for example, fencing is not prohibited by the law, but during FGDs farmers indicated that it was not socially acceptable to fence fields, as one could be regarded as excluding oneself from the community. In Nkayi, farmers indicated that communal by-laws gave preference to livestock feeding because of the seasonal availability of feed.

The expectation was that by-laws would affect the adoption of the MSD principle negatively, since free grazing could possibly delay CA land preparation, which should ideally be done during the dry season (Twomlow *et al.*, 2008). The possible reason for this finding could be that with more experience, farmers were no longer doing land preparation in the dry season, as it is reportedly easier to prepare planting stations over time (Mazvimavi *et al*, 2008). During FGDs with farmers, they also confirmed that it had become easier to prepare planting stations, as they returned to the same planting stations in subsequent seasons. In Choma farmers were not practising MSD during the dry season as livestock was weak and the soil hard at that time to do ripping. This may explain the positive relationship that exists with the by-laws. Such practices cited by Choma respondents were also reported by Nyanga (2012). It is not clear why by-laws negatively affected crop rotation as none of the by-laws had any relationship with the principle.

Customs such as the observance of sacred days, protecting grazing areas and not fencing land had a significantly negative effect on the area under CA ($p<0.05$) and a negative relationship with the adoption of the three CA principles, although this was not statistically significant. Generally, farmers in Nkayi (67%) and Choma (69%) indicated that customs were not affecting the practice

of CA, as most of them were no longer being strictly enforced, which could explain the lack of any significant impact on adoption of CA principles. The negative relationship though shows the potential of these customs in impacting CA adoption. The significantly negative relationship of customs with area under CA could be because some customs delayed farm activities, as these prohibited working in fields on sacred days (funerals, rain-making ceremonies and days set aside as rest days by the community) which could have affected farmers ability to practice CA on bigger areas.

PBC (reflected as perceived importance of access to implements, markets, credit and extension services) had a significantly negative correlation with the practising of MSD ($p<0.01$), while it showed a significantly positive correlation with the practising of crop rotation ($p<0.05$) and area under CA ($p<0.05$). The significantly negative relationship between MSD and PBC implies that farmers perceived a need for institutional support to practise MSD. Inaccessibility of minimum tillage implements such as rippers, wheelbarrows for manure transportation, herbicides and lack of credit lines for farmers were reported as major setbacks to adoption of the MSD principle during interviews with farmers. In the adoption literature, Nyanga (2012) found that ownership of a ripper or a Chaka hoe influenced the adoption of CA in Zambia positively. Secondly, the practice of MSD using rippers is nearly always associated with the use of herbicides (Nyanga, 2012; Ndiritu *et al.*, 2014), which most farmers may find difficult to access (Giller *et al*., 2011).

The significantly positive relationship between crop rotation and PBC could be because farmers were able to rotate crops by planting traditionally grown legumes (cowpeas and groundnuts) and institutional support in the form of markets was not so important in the adoption of crop rotation. The findings could suggest that access to institutional support such as extension services can help farmers adopt crop rotation. In addition, FGDs revealed that extension agents encouraged farmers to use locally available legume crops and trained farmers on incorporating legumes into the CA permanent planting stations, which had in previous studies negatively influenced the adoption of crop rotation (Baudron *et al*., 2007; Mazvimavi *et al*., 2008).The findings are in contrast with reports that point to the importance of markets to practice crop rotation (Wall, 2007; Mazvimavi *et al.*, 2008).

The perceived need for institutional support correlated positively with the area under CA. However, it would be expected that the perceived need for institutional support in the form of

access to markets for CA equipment would affect the area under CA negatively. The findings could be because in these two districts, farm size and labour were not limiting factors (as shown in Chapter 7) and farmers had experience with CA, having practised it for at least five years and so institutional support was not a major limiting factor in area allocated to CA. Ngwira *et al*. (2014) found a positive correlation between the area allocated to CA and the number of years farmers had practised CA, while Arsalan *et al*. (2013) reported that the availability of labour was an important determinant of the area allocated to CA.

9.4.1 Comparing social influence and PBC between Nkayi and Choma districts

A further comparison of social influence and PBC between districts was done using a Mann Whitney U test. Table 9.3 shows a significant difference in social influence between the two districts (z = -2.51: p=0.01), suggesting that the people of Choma were more influenced by society than those of Nkayi. During FGDs, communities in Choma showed more social cohesion and stronger beliefs in strictly following traditional rules, such as consultation or pressure to adhere to the views of spouses, peers, opinion leaders and influential people in decision-making. An analysis of the social environment in Chapter 8 also revealed lead farmers and other farmers to be important sources of information on CA in Choma. No significant differences in PBC on CA adoption between the two districts were found, probably because of very similar opportunities to access to credit and extension services in these two districts.

Table 9.03: Comparison of perceptions on social influence and PBC on adoption between Choma and Nkayi districts

Factor	District	Mean	Z value	P values
Social influence	Nkayi Choma	46 60	-2.51	0.01**
PBC	Nkayi Choma	51 47	-0.69	0.5

Source: Survey data, 2017. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

9.5 The role of social status (gender and wealth) in the adoption of CA

One of the objectives of the study was to determine if there were differences in the adoption of CA principles between people of differing status. The hypothesis was that gender and wealth status would influence the adoption behaviour of farmers. Gender comparisons were based on whether the adopting farmer was male or female, without necessarily disaggregating women in female and male-headed households.

Wealth computations were based on FGD with farmers on how wealth is measured. Farmers revealed that wealth in the study districts is measured by the number of cattle one has, the area cultivated and the ability to send children to school. Livestock use as a measure of wealth is supported by Makate *et al*. (2017) and livestock was therefore used as a measure of wealth in this study. According to FGDs with farmers, wealthy farmers are considered to have at least 16 head of cattle in the study districts, while poor households were those farmers with no livestock at all. The wealth indicator was developed by converting the total number of different livestock classes (cattle, goats, chickens, etc) owned by a household to total livestock units (TLU) using conversion factors for sub-Saharan Africa described by the FAO (2011a) (Table 9.4). Poverty classification was computed according to the measure of wealth provided by farmers, where farmers with no livestock were considered poor and those with at least the equivalent of 16 head of cattle (or 16* 0.5 livestock units) were considered rich. Any farmer who had more than this number of TLU after converting all available livestock in a household to livestock units was considered rich. Any farmer with no livestock at all was considered poor.

Table 9.4: Livestock units for sub-Saharan Africa

Livestock class	Cattle	Sheep	Goats	Pigs	Chickens
Livestock units (sub-Saharan Africa)	0.50	0.1	0.1	0.20	0.01

Source: FAO, 2011a

Literature reveals that men are more likely to adopt new technologies than women, because they tend to have more access to information and credit, and control resources such as land (Doss and Morris, 2001). Wealthier households have relatively more access to the means of production, have enough land, are less risk-averse than poor farmers and would therefore adopt technologies more

quickly that poor farmers (Awotide *et al.*, 2012). However, some research has found that wealthier farmers are less likely to adopt CA (Nyanga, 2012: Pedzisa *et al.*, 2015)

9.5.1 Gender demographics in the study areas

Table 9.5 illustrates the comparison of demographic characteristics of male and female farmers using a t-test for comparison of means and a chi-square test of independence for frequencies. The findings reveal no significant differences in number of years of schooling, mean number of livestock, access to extension and credit and food shortages experienced between men and women. However, men consistently fared better than women in all aspects. The only significant differences between male and female farmers were mean farm size (p=0.001) and on-farm income (p=0.028). A possible reason for the lack of significant differences in extension services may indicate that project interventions were able to breach the gap between men and women in accessing extension services, while the low disparities in education level could be due to government policies that promoted equal access to education for men and women. Kalinda *et al*. (1998) also found no significant difference in access to extension services or credit between men and women in Choma. However, Fisher and Carr (2015), and Katungi (2006) found women to have less access to credit than men.

Farm production was significantly higher in both conventional (p=0.004) and CA (p=0.047) fields for male than female farmers. This suggests that although the practice of CA reduces the yield gap between male and female farmers slightly, women farmers still face constraints in achieving CA yields equal to those of their male counterparts.

Table 9.5: Comparison of gender demographics in the two districts

Demographic information	Men	Women	t-test p value	X^2 test p value
Average area of land (ha)	5.7	2.4	0.001	
Years of schooling (years)	7	6	0.075	
% that have accessed credit	34	23	-	0.156
Mean number of cattle owned (n)	8	5	0.058	
% that met extension agent weekly	50	40	-	0.162
Average annual non-farm income US$	248	446	0.354	
Average annual on-farm income US$	469	240	0.028	
% that experienced food shortages in the past year	63	83	-	0.086
Yield for conventional fields (kg/ha)	1344	788	0.004	
Yield CA (kg/ha)	1481	957	0.047	

Source: Survey data, 2017

9.5.2 Comparison of adoption of CA principles by men and women

CA involves the practice of three principles that can be applied simultaneously: MSD, application of a permanent soil cover and crop rotation or associations. Adoption of one principle referred mainly to the practice of MSD, while two principles referred to the practice of MSD with either soil cover or crop rotation. A Pearson chi-square test of independence revealed no relationship between gender and adoption of CA principles. However, the general trend was that women tended to adopt more CA principles than men (Figure 9.2). There were more women that adopted two (32%) and three principles (26%), compared to 21% and 23% respectively for men. This is in contrast to reports by Doss and Morris (2001) and Awotide *et al*. (2012) who report more adoption my men. Mazvimavi and Twomlow (2009) also found that male-headed households were more

likely to adopt more CA principles than female-headed households owing to access to resources. However, Nyanga (2012) reported that the promotion of hand-based options for tilling land empowered women to adopt CA principles better than men in Zambia, although men were likely to adopt CA on a larger scale than women. The higher adoption rate could have been due to the deliberate targeting of women.

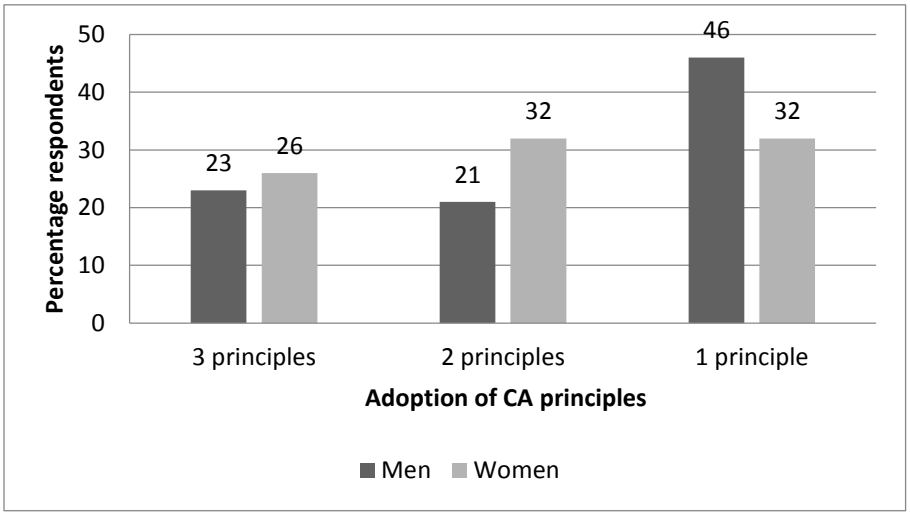

Figure 9.02: Adoption of CA principles according to gender

Source: Survey data, 2017

9.5.3 Demographic characteristics of wealthy and poor households

The study explored the effects of wealth on adoption by first comparing the demographics and access to resources between rich and poor households using TLU as a wealth indicator. Table 9.6 shows that rich households had significantly bigger farm sizes (p=0.036), higher on-farm income (p=0.001) and higher yield from conventional fields (p=0.012) and that they experienced fewer food shortages in the past two years ($X^2 = 6.352$, df =1, p=0.012) than poor households. However, access to extension services, credit and the education level were not statistically different between the rich and the poor, although there was generally better access to extension services and credit for the richer households. The generally low access to credit is probably due to lack of information on credit facilities available to smallholder farmers, which is exacerbated by poor social networks.

There were generally low CA yields for both rich and poor due to waterlogging experienced during the 2016/17 cropping season.

Table 9.6: Comparison between rich and poor farmers with regard to access to resources

Demographic information	Rich	Poor	t-test p value	X^2 p-value
Farm size (ha)	6.2	2.4	0.036	
Years of schooling (years)	6.29	6.8	0.075	
% that have accessed credit	18	17	-	1.000
% that meet extension agent weekly	41	36	-	0.489
Average annual non-farm income US$	653.58	191.94	0.073	
Average annual on-farm income US$	644.58	109.05	0.001	
% that experienced food shortages in past two seasons	63	83	-	0.012
Yields for conventional fields (kg/ha)	1502	765	0.012	
Yield for CA (kg/ha)	1059	1043	0.965	

Source: Survey data, 2017

9.5.4 Adoption of CA principles according to wealth status

A further descriptive analysis was done to understand how the rich and poor households adopted CA principles, as shown in Figure 9.3. A Pearson chi-square test of independence showed a significant influence of wealth on the adoption of two CA principles (X^2 =8.96, df =1, p= 0.002), suggesting that poor households were more likely to adopt two principles than the rich. Poor households also outnumbered the rich in the adoption of one CA principle (41%), although this was not statistically significant. The rich mostly adopted all three CA principles (25%). These findings are, however, contrary to research by Awotide *et al.* (2012), who found wealthier households to adopt new agricultural technologies more readily than poor ones. To encourage CA adoption by rich farmers, other than yield, reduced costs tillage and efficient use of inputs should be a major driver to CA adoption.

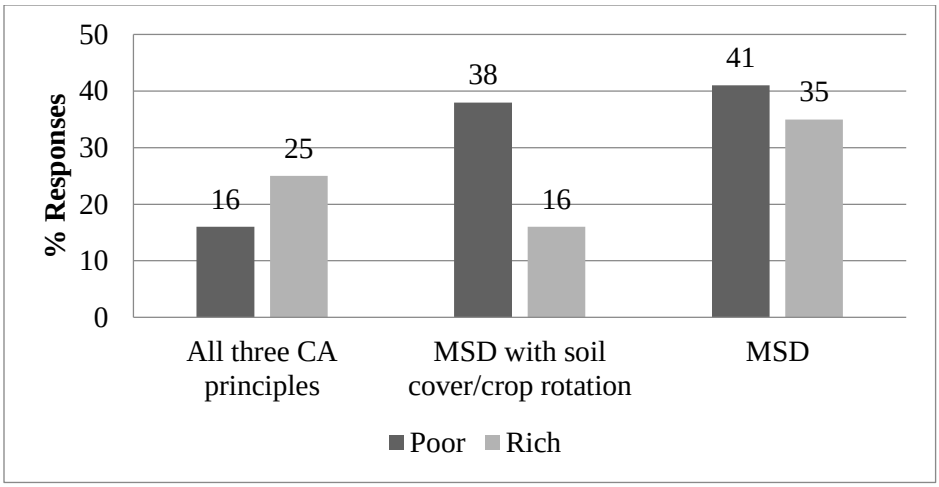

Figure 9.03: Adoption of CA principles according to wealth status

Source: Survey data, 2017

A comparison of CA adoption between males and females and between the rich and the poor do not support the hypothesis that men and rich households would adopt more CA principles than women and the poor respectively. Deliberately targeting the vulnerable in Nkayi and allowing participation by all in Choma could have provided an opportunity for people of differing status to learn and apply CA.

9.6 Conclusion

This chapter evaluated the effects of the social system and institutional factors on the adoption of CA principles. Farmers showed positive attitudes to CA practices. However, the attitudes varied significantly between districts depending on the CA package that was promoted and on the performance of the technology. Traditional by-laws and institutional factors were both positively and negatively correlated with the adoption of CA principles, meaning that adoption of each of the three CA principles was related to how the specific principle fit into a particular social system and institutional setting. By-laws were negatively correlated with the adoption of soil cover because this CA principle is in conflict with crop residue management in the local farming system. The negative impact of by-laws calls for the inclusion and involvement of custodians of local laws and customs, such as traditional leaders, in the promotion of CA. It also calls for development agents

to start training farmers to grow fodder crops to reduce the competing use of crop residues. The institutional factors were positively correlated with crop rotation and total area under CA, but negatively correlated with the practising of the MSD principle. This suggests that institutional support (e.g. access to implements, credit and herbicides) is more important in the practising of MSD than in the practice of other CA components. This could be due to the need for specific CA labour-saving implements to enable the application of the principle of MSD. The PBC effects on area under CA suggest that access to other factors such as labour and experience my play an important role in the area allocated to CA. Social influence and customs had no significant effect on CA adoption, but respectively had positive and negative effects on the area under CA. These findings suggest that the impacts of social influence and customs depend on other factors for them to have a significant impact of adoption. Social influence probable depends on the technology, access to alternative sources of knowledge or the local values while effects of customs depend on whether they customs are strictly adhered to.

The effects of gender on adoption were not significant, which may mean that the deliberate targeting of vulnerable groups such as women can bridge the gap between people of differing social status. However, the study still found significantly higher CA yields for male than female farmers, which suggests that there are some constraints that women face in achieving the full yield benefits of CA. Wealth status and adoption provided mixed results, indicating that the poor were more likely to adopt one or two principles, while the rich were more likely to adopt all three principles. The study also found that CA has the potential to bridge the yield gap between the rich and the poor. These findings suggest that targeting the poor could also help them adopt technologies, but there is still a need to address constraints that limit full adoption of CA by the poor households and the achievement of high CA yield potential by women farmers.

CHAPTER 10

CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

Sub-Saharan Africa is facing a double challenge of producing enough food for its growing population while conserving the environment (NEPAD, 2014). The effects of climate change, such as increases in temperature and the frequency of droughts and floods, are already being felt (1PCC, 2014). Agriculture on the continent is particularly vulnerable to climate change, since it is dominated by smallholder farmers who rely on rain-fed farming and cultivate small farms using simple tools (NEPAD, 2014). Poverty also limits their ability to adapt (IPCC, 2014). Smallholder farmers are also found in marginal areas with poor soil fertility. CA has the potential to help farmers in Africa adapt to climate change, improve soil fertility and ultimately increase yields. Results of CA promotion have been mostly positive, with yield increases being the major reported benefit of CA to smallholder farmers in Africa (Wall, 2007; Rockstrom *et al.*, 2009; FAO, 2014). However, yield benefits may vary due to agro-ecological region and weather variability. Yield penalties are reported when mulch is not used in semi-arid areas and in high rain fall areas where fertilizer is not used (Rusinhamhodzi *et al*., 2011). Research has shown the potential for CA to improve soil fertility (Mazvimavi *et al*., 2008), to improve soil moisture retention, thus sustaining crops during periods of droughts, (Thiefelder and Wall, 2010a) and to reduce poverty (Abdulai, 2016). Despite the documented benefits of CA, uptake in Africa has been very low (Kassam, 2014). In some countries there are cases where farmers have discontinued the practice of CA for a plethora of reasons (Pedzisa *et al.*, 2015). The low uptake of the technology has been a major concern among development players and researchers alike and is a major driver for carrying out this research.

This chapter gives a summary of the study. It begins with an outline of the study, followed by findings and conclusions drawn from the study. The chapter ends with a discussion of the implications of these findings for policy, the limitations and recommendations for future research.

10.2 Study objectives

This study sought to establish role of the social system in the adoption of CA principles. The specific objectives were to:

- To identify and map the socio-economic environment of smallholder farmers in Nkayi, Zimbabwe and Choma, Zambia
- To investigate the influence of the social system (attitudes, peers, spouses, groups, traditional leaders, customs and by-laws on the adoption of CA principles
- To Investigate the influence of institutional factors on the adoption of CA principles
- To investigate how social status influences the practice of CA principles

The assumptions made in the study were that attitudes would significantly influence CA adoption and the area under CA, social influence would positively influence adoption of CA and the area under CA, while by-laws and customs would have a negative effect (Hypothesis 1). The second hypothesis was that the perceived need for institutional support to practise CA would influence CA adoption and the area under CA negatively and the third hypothesis was that richer and male farmers would adopt CA better than poor and female farmers respectively.

10.3 Conclusions

The conclusions are drawn from the set objectives of the study and focus on the socio-economic environment of smallholder farmers and effects of demographic factors on CA adoption, the effects of attitudes, social systems, institutional factors and social status on the adoption of CA and on the area under CA.

a) *Objective 1:Socio-economic environment and farming systems of CA farmers in Nkayi and Choma districts*

The two districts had both similarities and differences in their socio-economic environment. The economic environment of the two districts varied in that in Choma, farmers have access to closer markets and participated more actively in formal markets than in Nkayi (p=0.000). Access to credit and knowledge about credit availability were very low in both districts. There was evidence of

public sector and NGO involvement in CA promotion in Nkayi, while in Choma NGOs were the main source of CA training. On the social environment, traditional leaders were viewed as very influential people in Choma than Nkayi (p=000), although their role in CA promotion was very low. Social customs significantly differed between districts (P=0.000). In Nkayi, customs were mainly related to respect for sacred days by abstaining from farming activities, while Choma customs mainly concerned the prohibition of land ownership by women and prohibition on fencing of traditional land. The two districts had similar by-laws, which mainly allowed free grazing in the dry season and prohibited field work during this time. Social connections of the farmers who were interviewed were very low. The faring system is predominantly maize based and crop residues are traditionally used for livestock feeding and the plough is used to tilling the land.

Demographic and socio-economic characteristics of respondents showed similarities in education levels, household size and incomes. These two districts significantly differed in terms of farm size ($p<0.000$) which was higher in Choma than Nkayi, proportion of female-headed households ($p=0.010$) and mean age of respondents ($p=0.00$), which was significantly higher in Nkayi than Choma.

An analysis of the effects of some of the demographic and socio-economic factors on the adoption of CA revealed significant effects of location (district), education and labour on the adoption of CA principles and the area put under CA. Nkayi farmers were more likely to adopt MSD and crop rotation and practice CA on larger areas than Choma and this was significant at ($p<0.05$). Education level had a significantly positive effect on the practise of crop rotation ($p<0.10$) while labour availability had a positive effect on the adoption of two CA principles ($p<0.05$). Off farm income, age and farm size had no significant influence on the adoption of CA principles.

b) *Objective 2:Effects of farmers' attitudes, social influence, by-laws and customs on CA adoption and area under CA*

This study found differing attitudes to CA outcomes among farmers in the two districts. Farmers in Nkayi were more positive about CA increasing yield (p=000), while farmers in Choma had a more positive attitude to CA reducing labour (p=0.035) and that the practicing CA was not risky (p=0.030). The findings revealed that the perceived benefits and constraints of CA depend on the specific CA package that was promoted in the particular district. This implies that farmers evaluate a technology based on its performance and the way it addresses their challenges. The study did not

evaluate the relationship between attitudes and CA adoption because of a low Cronbach's alpha of the statements meant to measure attitudes. The Hypothesis was therefore not tested.

Social influence had a generally positive relationship (but not significant) with the adoption of MSD and soil cover and a significantly positive relationship with area under CA ($p<0.01$), as expected in hypothesis 2. However, the study also found a non-significant negative relationship between social influence and the adoption of crop rotation, which was not supported by the hypothesis. A further comparison of social influence revealed that farmers from Choma could be influenced more easily by other people in the social system than in Nkayi ($p=0.01$). These findings imply that there are conditions necessary for social learning, which may include the personal conviction to adopt CA, the complexity of the technique, availability of alternative sources of information within a community, trust, community cohesion and values. It is also possible that expert knowledge from extension staff was more valued than what is learnt from peers in adoption. It is, however, not known why social influence was significant for area under CA. This could be because farmers worked together as groups during land preparation and were easily influenced the area under CA.

By-laws that allowed free grazing in the dry season and prohibited farm activities at that time had a significantly negative relationship with the adoption of soil cover and crop rotation ($p<0.10$) and supported hypothesis 2 of this study. By-laws also significantly and positively influenced the adoption of MSD ($p<0.05$), which was a surprise for the study. This implies that although MSD poses a shift in the farming system, especially considering that dry season land preparation is encouraged in CA, farmers were able to adapt this practice to their own situation. These findings imply that the application of CA principles in a particular social environment will depend on whether the specific CA principle fits or can be adapted to the local context. Clearly, the MSD principle could be better adapted by farmers than the soil cover principle. It is not clear though why by-laws negatively influenced the practice of crop rotation as there is no direct relationship between the by-laws and the practice of this principle.

Customs had a consistently negative but insignificant relationship with the practice of all three CA principles and were significantly negative for the area under CA ($p<0.05$), which supported

hypothesis 2 of the study. The findings imply that customs when enforced are likely to influence the upscaling efforts of CA. CA farmers are encouraged to be on time and any obstacle that prevents timeliness may have a negative impact on the area under CA and even on the adoption of CA principles.

c) Objective 3:Effects of institutional factors on the adoption of CA and the area under CA

Institutional effects on adoption were measured through PBC and had a significantly positive relationship with the adoption of crop rotation ($p<0.05$) and the area under CA ($p<0.05$), but related negatively with MSD ($p<0.01$). Hypothesis 3 implied that PBC would affect the adoption of CA principles significantly negatively and is not supported by these findings on the adoption of crop rotation and area under CA but is supported for the adoption of MSD. These findings revealed that more institutional support is required for the practice of MSD than for the practice of crop rotation and soil cover. The practice of MSD entails a shift in the way land is tilled and requires specific equipment. Farmers need access to implements such as rippers, jab planters and direct seeders, as well as access to herbicides to practise this principle effectively.

The positive relationship between PBC and the practice of crop rotation could reflect that other institutional factors, such as extension services, play a crucial role in the adoption of crop rotation. Crop rotation does not necessarily cause a shift in the farming system and contrary to popular research indicating that access to markets would be important for the practice of this principle, the study shows that access to information on this principle can enhance its adoption. These findings imply that institutional support requirements depend on the CA principle in question and become less important if the principle can be adapted to the local context. The perceived lack of need for institutional support to practice CA in bigger areas may suggest that other factors, such as labour, may be more important in the area allocated to a new technology than access to markets, credit and extension services.

d) Objective 4: Effects of gender and wealth status on adoption

The study found no significant difference between gender and the adoption of CA principles, although female farmers, unlike men, adopted two or more CA principles. The lack of a significant difference in adoption between men and women could have been due to access to extension

services and the targeting and promotion of pro-poor packages of CA. However, the study found that although female farmers adopted more principles, male farmers had significantly higher yields for CA than female farmers. The yield differences for CA between men and women could mean that other factors such as low incomes, labour challenges and low access to improved inputs may limit the production potential of female CA farmers.

The study also found that poor households were more likely to adopt two CA principles than richer households (X^2=8.96, df =1, p=0.002), while the richer households were more likely to adopt three principles than the poor, although this difference was not statistically significant. The high adoption of three CA principles by the rich implies that there are specific constraints that limit the poor from practising the full CA package. The conclusion from these findings is that the deliberate targeting of the poor and women can help them adopt CA. However, there is still a need to address the challenges that may limit these groups of farmers from adopting the full CA package and achieving high yields. Hypothesis 5 implied that adoption of CA principles will be higher for men and wealth households and as such, the hypothesis is rejected.

10.4 Key Recommendations for Policy

The findings from the study reveal that farmers perceived CA as a technology that can potentially address food security constraints. The active promotion of CA in Zimbabwe and Zambia has provided benefits, but also faced challenges to its adoption, depending on how CA fits into the social system and on the availability of institutional support. Based on the findings, the following policy recommendations are made:

- *Extension services should understand the social environment and adapt CA to it*

To address the negative effects of by-laws on soil cover adoption, CA should be promoted alongside interventions that address competing uses of crop residues. Such interventions could include the promotion of fodder production and cover crops that can be grown for both live cover and livestock fodder. Extension services need to pay attention to the social system and encourage farmers to adapt the CA package to fit into the social environment. Extension agents could also actively involve custodians of customs and by-laws to champion the promotion of CA. This would

ensure buy-in from local leaders and could influence changes in local customs and by-laws to enable the practice of CA.

Social influence was not important in influencing adoption of CA principles, but important for the area allocated to CA. The study found more social influence in Choma than in Nkayi, which could suggest different community values in the two districts. Extension approaches that promote farmer-to-farmer learning should take into consideration the social context, technology complexity and availability of extension services before introducing this approach. CA is considered a knowledge-intensive technology and social learning among peer farmers could consequently be a potential challenge. Trust within communities could also influence social learning and should therefore be considered in the use of farmer-to-farmer extension approaches.

- *Provide an enabling institutional environment for the adoption of CA*

There is evidence from the study that the practice of MSD is hampered by lack of access to implements such as rippers, jab planters and direct seeders. Minimum tillage implements are not always available in local shops and the facilitation of their production and affordability to small farmers should therefore be a priority in the promotion of CA as well. Access to input and output markets could be a push factor to adopt CA.

- *Social status and adoption*

The findings reveal that improving access to extension services and promoting packages that can be applied by the poor and women farmers, such as using locally available organic inputs and open pollinated varieties, can be instrumental in enabling the poor to adopt new technologies. Such initiatives and strategies should be scaled up to ensure that technologies reach farmers with differing resources. However, there is a need to address constraints that prohibit vulnerable groups from adopting all three principles and achieving yields as high as those of people with better social status. Access to farming resources, such as land and labour, as well as participation in markets, could be bottlenecks for women and the poor and prevent them from full adoption of CA. Land tenure issues should be addressed through legislation that protects the marginalised groups in society. Pro-poor strategies such as subsidies targeted at these groups to improve access to labour-saving equipment and improved inputs such as fertilizers could also help bridge the gap between well-off and poorly resourced farmers.

- *Consider an innovation systems approach in the promotion of CA.*

Clearly, CA cannot be promoted in a vacuum where the focus is on the technology rather than on the context. An innovations systems approach brings together value chain actors, farmers and government in the promotion, knowledge creation or adaptation of a technology. This approach does not focus only on technology dissemination, but also fosters inter-linkages between stakeholders as each one plays a part in addressing challenges. In this approach, there is a general understanding that technology transfer is not linear but is affected by many interrelated factors, such as social and economic context, available resources and needs, which should be considered during investments. Through this, social, institutional and technological factors that may impede adoption can be addressed by the relevant stakeholders.

10.5 Directions for future research

The study provides insights into the relationship between social systems and the institutional environment with the adoption of CA principles and the area under CA. Although the study was limited to two districts in only two countries of Africa, some of the findings provide meaningful insights on the role of the social system in CA adoption and could be applicable to countries that have similar social systems. However, more research should be done on social system effects in other countries, as this study was not exhaustive owing to methodological, time and resource constraints. Future research should consider the following:

One of the objectives of the study was to establish the relationship between attitude and the adoption of CA principles. However, owing to data challenges emanating from low reliability of individual Likert statements that were to collectively represent attitude, the relationship between attitudes and adoption of CA principles could not be explored. Instead of running regressions, individual Likert statements on attitude were compared between the two districts using non-parametric tests. Further exploration of the effects of attitude on CA adoption should be undertaken.

Social influence had no significant impact on the adoption of CA principles and the relationship with the practice of different CA principles was both negative and positive. Further research should be done to determine the conditions necessary for social learning and the factors that may affect social learning. These studies should look at how technology complexity, trust, personal conviction and access to alternative sources of extension support influence social learning. Further research should also explore which of the CA principles can be easily learnt from peers and which ones not

The study found that access to institutional support was not necessarily important in deciding the area under CA, while social influence was important. Since the area under CA is an important indicator of scaling up, studies should explore further how and why social influence affects the area under CA and explore important factors in decision-making on the area allocated to CA. The methodology of this research did not allow further exploration of these factors.

Gender effects on CA adoption revealed that women adopted more CA principles than men, but female farmers had lower yields from their CA fields than male farmers. The research did not explore other important factors that may enable women to increase their production in CA fields beyond adoption. Future studies should determine the role of the availability of labour, application of good agronomic practices, and use of improved inputs and access to labour-saving equipment in contributing to CA yield differences between female and male farmers.

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