Journal of Social and Development Sciences (ISSN 2221-1152)
Vol. 14, No. 4(2024), pp. 35-48

Conservation Agriculture Adoption Among Maize and Beans Farmers in Maseru, Lesotho: A Look at the Adoption Gradients

Falimehang Daniel Rameno, *Brian Muroyiwa
Agricultural Economics and Extension, Faculty of Agriculture, National University of Lesotho, Maseru, Lesotho
falimehangrameno@gmail.com, b.muroyiwa@nul.ls, *bmuroyiwa@gmail.com
Corresponding Author: Brian Muroyiwa

Abstract: Despite the widespread promotion and investment in Conservation Agriculture (CA) by development partners and governments in Southern Africa, the biggest challenge is low adoption rates. This study looks at the CA adoption among maize and beans farmers in Lesotho. The study seeks to enhance the appreciation of factors driving CA adoption. They utilized a multi-stage sampling approach to select the study respondents. The study used purposive sampling to select districts and prominent CA farmers. Simple random sampling was the preferred method to select ordinary CA farmers and conventional farmers to include in the research. The study utilized a structured questionnaire to collect data from 136 households, 37 were CA adopters and 99 were non-CA adopters. The study applied the multinomial logistic regression model to analyze the factors influencing the adoption of CA in Maseru. The study findings show that age, gender, income, training, and field size influence farmers' decision to adopt CA at various adoption gradients while farming experience, land ownership, farmer group membership, access to extension services, soil fertility perceptions, education literacy, occupation, and household size do not influence the adoption of CA. The study concludes that age, gender, income, training, and field size influence farmers' decision to adopt CA at various adoption gradients. The study recommends the capacitation of extension services to improve their competencies as they should be at the center of the promotion of the adoption of sustainable farming practices. Targeted interventions for female farmers are important since the study results showed males have more chances of adopting CA compared to female counterparts.

Keywords: *Conservation Agriculture, Adoption Gradients; Maize, Beans*

1. Introduction

The Sub-Saharan Africa (SSA) region faces significant challenges from climate change, extreme weather, declining soil fertility, and food insecurity with twenty-three percent (23%) of its population undernourished and more than 35 million people predicted to experience food insecurity by 2050, (FAO and ECA, 2018). Agricultural production continues to be affected negatively, due to heavy impacts from increasing soil erosion and pest infestation further worsening this situation. These issues can be addressed through the adaptation of farming systems that are resilient to climate change and climate extremes (Altieri *et al*., 2015). Conservation Agriculture (CA) is a Climate Smart Agriculture (CSA) practice that has three major principles, which are; minimum mechanical soil disturbance, permanent soil organic cover, and crop species diversification through varied crop sequences and associations (FAO, 2019). Fredenburg *et al*. (2015) assert that the key innovation in CA is a reduction in soil disturbance. Reducing soil disturbance saves time, energy, and labor while also promoting soil, water, and nutrient preservation for higher crop yields. Soil interventions such as mechanical tillage are reduced to an absolute minimum or avoided, and external inputs such as agrochemicals and plant nutrients of mineral or organic origin are applied optimally and in ways and quantities that do not interfere with, or disrupt, the biological processes and this enhances biodiversity and natural biological processes above and below the ground surface (FAO, 2014). Moreover, minimum tillage improves soil organic matter accumulation, which increases soil fertility and decreases soil erosion (Seitz *et al*., 2019; Kiboi *et al*., 2019; Kiboi *et al*., 2017; Alam *et al*., 2014). Crop productivity is increased by enhanced soil fertility and properties (Thierfelder *et al*., 2015; Grabowski e*t al*., 2016).

Development partners, governments, and extension officers promote the three principles of conservation agriculture together because they are complementary in that, under certain circumstances, the advantages rise sharply if farmers combine more principles/components (Thierfelder *et al*., 2012). FAO (2014) asserts that the permanent soil organic cover CA principle promotes the use of crop residues and live mulch to create permanent soil cover. The permanent soil cover by living or dead plant biomass and minimum soil disturbance reduces topsoil displacement and restores organic carbon content, improves water use efficiency, and helps to keep soil moisture levels high (Pittelkow, 2015; Liang *et al*., 2015; Thierfelder *et al*., 2015). Mulch with crop residues creates soil cover which lowers water loss from the surface in addition to shielding the soil from erosive forces and raindrop action, soil cover also helps to moderate soil temperature and control weed growth (Nyamagara *et al*., 2013). Live mulch or a variety of crops known as 'cover crops' are grown in between successive crops and are prone to supply nutrients like nitrogen and phosphorus, as well as cover the soil and stop soil erosion; thus, cover crops should be planted on arable land to reduce synthetic fertilizer use without lowering crop yields and to mitigate the effects of climate change (Qaswar *et al*., 2019, Toma *et al*., 2019; Kaye and Quemada, 2017). FAO (2012) argues that to embrace the crop diversification principle of CA, farmers use crop rotation and intercropping. Intercropping is defined as the simultaneous presence of two or more crops in the same field at the same time, while crop rotation is the practice of alternating different crops in the same field, preferably cereals (maize and wheat) followed by legumes (beans) (Wezel *et al*. 2014). Crop diversification improves soil fertility, nutrient cycling, pest control, and water, and biodiversity regulation without sacrificing yields (Tamburini *et al*. 2020).

Despite the promise of benefits associated with the adoption of CA and its widespread promotion in SSA, it is still not widely adopted (Sakala *et al*., 2021; Anderson and D'Souza, 2014; Giller *et al*., 2009). The low adoption of CA by smallholder farmers in Southern Africa can be attributed to several challenges, some of which are biological, for example, competing uses of crop residues, increases in weeds in the early years after conversion from conventional farming to conservation agriculture, some pests and diseases specific to CA and limited land area to practice crop diversification. Other farmers associate low adoption with economic factors, such as cash constraints, risk aversion, limited access to markets for inputs and outputs, a lack of appropriate tools, and insufficient information and knowledge about CA (Holden and Quiggin, 2017; Thierfelder *et al*., 2015; Holden and Lunduka, 2014). Among the range of incentives that might motivate farmers to adopt sustainable practices like CA, markets could play a significant role in the transition towards sustainable agriculture. An emerging, body of research suggests that demand for sustainable products is rising in the domestic markets in least-developed countries (LDCs) (Oudewater *et al*., 2013; Sherwood *et al*., 2013). Today's consumer wants to know the source of their food, seek transparency regarding production, and want to eat healthier foods (Dimitri and Gardner, 2018). Consumers are also conscious of sustainable farming practices and they demand produce that has been produced sustainably over conventionally produced food.

The pioneer of the promotion of CA in Lesotho is Rev. Basson who was passionate about improving local agriculture and he set out to identify farming practices that relied on low external inputs but were suitable to the local socio-economic conditions. He traveled to South Africa in 2000 where he learned more about CA, which he eventually started to promote in Qacha's Nek with a Sesotho name 'Likoti', through an NGO called Growing Nations (Silici, 2010). Since 2002 conservation agriculture captured the interest of more NGOs, and local and international actors – that included, among others, the Food and Agricultural Organization (FAO), the World Food Programme (WFP), the National University of Lesotho (NUL) and several NGOs. The promotion of CA adoption is on the basis that conservation farming is a strategic means to increase and stabilize agricultural production as well as to prevent and reverse soil erosion. Farmers have received different kinds of incentives to encourage the adoption of water and soil conservation technologies and facilitate the exchange of knowledge among different actors and the associated outcomes of the adoption of CA practices. In 2012 the Food and Agriculture Organization in response to the 2012 food insecurity crisis in Lesotho working with the Ministry of Agriculture and Food Security designed a three-year cycle Programme to assist 18500 households with agricultural technologies helping communities to adapt to climate change (FAO,2014). The Programme promoted CA and improved home gardening and nutrition in all ten districts of Lesotho. Despite all these efforts to promote CA, to the best knowledge of the author, no study has investigated the adoption of CA by farmers in Lesotho and a study seeks to understand factors that inhibit CA adoption by local farmers. Therefore, this study investigated farmer's CA adoption and factors that hinder CA adoption.

2. Materials and Methods

The study area is the Maseru district, which is located on Lesotho's western border to South Africa's Free State Province, with the Caledon River (Mohokare) serving as the boundary. The district's total area is 4 279 km^2, accounting for 14.10 percent of the country's total area (BoS, 2006). Maseru is bounded on the north by Berea, on the east by Thaba-Tseka, on the south by Mohale's Hoek, and on the southwest by Mafeteng. Lesotho's western districts are predominantly lowland, rising from 1 500m (4900 ft) to 1 800m (5900 ft) above sea level. With 49% of all Small, Medium, and Micro Enterprises (SMMEs) established in Maseru as per the distribution of districts, Maseru is the largest entrepreneurial hub in Lesotho, and most of these SMMEs are engaged in the agricultural and retail sectors (Tau, 2020). Agriculture in Maseru, like the rest of the country, is characterized by low productivity. This is due to high climate variability, severe land degradation, and the use of traditional agronomic practices, which results in low adoption of labor-intensive practices such as CA (CIAT and World Bank, 2018). Crop production is the main agricultural activity for the people of Lesotho, and the country's important crops include maize, wheat, sorghum, beans and peas, potatoes, fruit trees, and fresh vegetables such as tomatoes and cabbage. Maize and sorghum are the most important staple food crops, accounting for more than 60% and 10% of all cultivated land, respectively. Maize frequently receives policy and financial assistance, through input subsidies (CIAT and World Bank, 2018; FAO, 2017). Drought and floods are the leading causes of crop failure in Lesotho (Government of Lesotho, 2015).

The study used a cross-sectional quantitative research design, meaning numerical data was collected at one point in time (Sesoai *et al.*, 2019). The study collected quantitative data and adopted a survey research technique to obtain data from farmers. A structured interview schedule with close-ended questions was used to collect data, administering questions face to face to the respondents, to allow the researcher to clearly explain and interpret questions that the respondents may find difficult to understand to obtain correct and truthful answers (Nxumalo, *et al*., 2019). The interview schedule was pre-tested to identify and clear up any unintended confusion and the participants in the pilot trial were randomly selected from the study population, this group was not part of the study respondents (Abawi, 2017). The respondents to this study were selected through multi-stage sampling. The first stage of sampling involved the selection of regions of Maseru where there is active practice of Conservation Agriculture. A purposive sampling method was used to select those regions as recommended by the Department of Agricultural Research in the Ministry of Agriculture and Food Security (MAFS) and District Agricultural Administrators in the Department of Field Services. In the second stage, respondents from different villages were selected, whereby purposive sampling was used to select prominent CA adopters, based on the information provided by the Ministry of Agriculture and Food Security (MAFS) since this group of farmers is difficult to identify as they are not many prominent and successful CA farmers. The study used simple random sampling to select average CA farmers and conventional farmers. Respondents were randomly selected from the list of crop farmers in the chosen areas. Randomization was performed using Microsoft Office Excel to select the respondents from the available list. A representative sample size of the farmers selected by the simple random sampling technique was determined using Slovin's formula (Oduniyi et al., 2022):

$$n = \frac{N}{1+N(e)^2} \quad (1)$$

Where n is the sample size
N is the total population of the maize and beans farmers in the district and
e is the margin of error estimated at 5%

The sample for the study according to Slovin's formulae was 136 households, 37 were CA adopters and 99 were non-CA adopters. The multinomial logistic regression model was used to identify factors influencing CA adoption in the study area. Logistic regression, or as it is alternatively called, the logit model or logistic model examines the relationship between a categorical response variable and multiple explanatory variables and estimates the likelihood of an event occurring by fitting data to a logistic curve. Logistic regression is one of the most used statistical techniques in research. A multinomial logistic regression model can be used when the dependent variable is comprised of more than two categories (Park, 2013). According to Bazezew *et. al.* (2015), there is no ordering in the decision process of adoption of CA practices, therefore unordered choice models such as the multinomial logistic regression model can be used. The study applied the multinomial logistic regression model to analyze the factors influencing the adoption of CA in Maseru.

To analyze factors influencing the adoption of CA in the study area the model explored the socioeconomic, biophysical, and demographic variables affecting CA adoption. In this study, an adopter was defined as someone who used at least one of the three core principles of CA: minimum soil disturbance, permanent soil cover through cover crops and mulching, and crop diversification through crop rotation and intercropping (Nkhoma, Kalinda, and Kuntashula, 2017). There must be an incremental benefit when compared to current technology or practices for a smallholder farmer to adopt new or improved practices (Jacobs *et al*., 2018). If anticipated benefits outweigh those under conventional tillage practices, smallholder farmers would adopt the full CA package or more of its components. Some studies on CA (for example, Thierfelder *et al*., 2013) found that smallholder farmers tend to adopt some of the components, typically crop rotation, intercropping, and crop residues (Chichongue *et al*., 2020).To capture the relationship between the CA adoption (dependent variables) and socioeconomic, biophysical, and institutional factors (independent variables) influencing adoption, the multinomial logit model was used as it allows the analysis of farmers' decisions across more than two categories in the dependent variable. Furthermore, it is possible to determine the probabilities for the adoption of different CA practices (Ayuya *et al*., 2012). This probability is given by:

$$Prob\ (Y_i = j) = \frac{e^{ß'_j x_i}}{\Sigma_{k=0}^{j} e^{ß'_j x_i}},\ j= 0, 1, \ldots, j \qquad (2)$$

Where Y_iIs the farming practice adopted by a household *I*, $ß'_k$ are the set of coefficients to be estimated and X_iIs the set of explanatory variables, and:

$$Prob\ (Y_i = j) = \frac{e^{ß'_j x_i}}{1+ \Sigma_{k=0}^{j} e^{ß'_j x_i}},\ j= 0, 1, \ldots, j,\ ß_0= 0 \qquad (3)$$

Prob $(Y_i = j)$ is the probability of being in each of the groups compared to the reference group. *Prob* (0) is the probability of being in the reference group. The reference group's coefficients are normalized to zero when the model is estimated. This is due to the requirement that all other group's probabilities add up to one. One of the outcome variables (for example, full CA or conventional farming) must be excluded and used as the reference, leaving six unique sets of parameters to be identified and estimated (Zulu-Mbata *et al*., 2016). For this model, conventional farming was selected as the reference against which to compare all other farming practice groups. The variables that the study considers to be crucial for the adoption of CA practices are listed in Table 1 and each one is explained. These variables were used in the multinomial logit model to estimate the factors influencing the adoption of CA practices and the model equations are as follows:

$$Y = \alpha + ß_1X_{1i} + ß_2X_{2i} + ß_3X_{3i} + ß_4X_{4i} + ß_5X_{5i} + ß_6X_{6i} + ß_7X_{7i} + ß_8X_{8i} + ß_9X_{9i} + ß_{10}X_{10i} + ß_{11}X_{11i} + ß_{12}X_{12i} + ß_{13}X_{13i} + ß_{14}X_{14i} + ß_{15}X_{15i} + \varepsilon_i \quad (4)$$

Table 1 below shows how the independent variables are predicted to influence farmers' decision to adopt CA in Maseru.

Table 1: Description and units of variables used in the logistic regression model (logit model)

Dependent variables	Variable description	Expected effect
Y*	Non-CA adopter (Conventional Farmer)	Determined by
Y**	Partial CA adopter	Explanatory Variables
Y***	Full CA adopter	
	Explanatory variables	
	Socio-economic characteristics	
Age (X_1)	Age of household head (years)	+/-
Gender (X_2)	Gender of the household head (1 = Male 0 = female)	+
Household size (X_3)	Number of youths and adults in household (≥ 15 years)	+
Education (X_4)	Household head's education level (1 = literate 0 = otherwise)	+
Experience (X_5)	Adequate farming experience of the household head	+/-
Occupation (X_6)	The household head's primary occupation is agriculture (dummy: 1 = yes 0 = otherwise)	+/-
Income (X_7)	Average monthly household income (measured in Maluti)	+/-

Animal ownership (X_8)	Animal ownership (dummy: 1 = yes 0 = otherwise)	+
Information Access (X_9)	Means to access information (dummy: 1 = yes 0 = otherwise)	+
Farmer associations (X_{10})	Participation in farmer associations (dummy: 1 = yes 0 = otherwise)	+
	Biophysical Characteristics	
Farm size (X_{11})	Farm size (acres)	+
Fertility (X_{12})	Farmers' perception of soil fertility and soil erosion (dummy: 1 = Fertile 0 = Infertile)	+
	Institutional Characteristics	
Land tenure (X_{13})	Lack of land tenure security (1 = if secure 0 = otherwise)	+
Extension Access (X_{14})	Access for extension services (1 = yes 0 = otherwise)	+
Training (X_{15})	Limited access to research and technical assistance (dummy: 1 = yes 0 = otherwise)	+
β1... βn	Coefficients of independent variables X1 ....Xn	
α	Intercept	
ε	Random error term	
ί	ith observation in the sample	

Source: Adopted from Chichongue *et al*., 2020

3. Results of the Study

A multinomial regression model was used to determine the factors influencing CA adoption in Maseru. After conducting various tests for multicollinearity, the variables were found to be free from the problem of multicollinearity. The chi-square results show that the likelihood ratio statistics are highly significant (ρ< 0.001), indicating that the model has a reliable explanatory power for CA adoption. This confirms that the variables included in the model are relevant in explaining the factors influencing CA adoption. The value of Pseudo Nagelkerke R^2As at 0.660, suggesting that 66% of the variability in the dependent variable is explained by the set of variables used in the model. The effect of the coefficients was estimated concerning the 'Non CA-adopters' category, as the base category (reference group). Therefore, the influence from the estimated coefficients for each choice category is made concerning the base category. Table 2 presents the results of the multinomial regression model for the factors that influence CA adoption in Maseru.

Table 2: **Parameter estimates of the multinomial logit model**

Adoption category		**B**	**Odd**	**Wald**	**Sig.**
Non-adopters	(Reference Group)				
	Intercept	-37.871		0.000	0.985
	Age	0.065	1.067	3.458	**0.063****
	Gender				
	1 (Male)	1.395	4.037	4.215	**0.040****
	0 (Female)	0^b			
	Household Size	-0.075	0.928	0.360	0.548
	Field Size	0.047	1.048	0.254	0.614
	Education Literacy				
	1 (Literate)	15.846	0.972	0.007	0.932
	0 (Illiterate)	0^b			
	Occupation				
	1 (Farming)	-2.066	0.127	2.662	0.103

	0 (Otherwise)	0[b]			
	Household Income				
	4 (More than M5000)	3.510	33.439	3.717	**0.054****
	3 (M2001 to M5000)	3.628	37.626	4.652	**0.031***
	2 (M1000 to M2000)	-0.074	0.928	0.010	0.919
	1 (Less than M1000)	0[b]			
Partial CA adopters	**Farming Experience**				
	4 (More than 20 years)	17.813	0.872	0.000	0.993
	3 (11 to 20 years)	17.240	1.412	0.000	0.993
	2 (6 to 10 years)	18.305	1.579	0.000	0.993
	1 (5 years or less)	0[b]			
	Land Ownership				
	1 (Secure)	-0.157	0.839	0.041	0.839
	0 (Not secure)	0[b]			
	Soil Fertility Perception				
	1 (Fertile)	0.662	0.309	1.037	0.309
	0 (Not fertile)	0[b]			
	Training				
	1 (Received)	4.290	72.991	13.480	**0.000*****
	0 (Not received)	0[b]			
	Farmer Group				
	1 (Member)	-0.059	0.932	0.007	0.932
	0 (Non-member)	0[b]			
	Extension Access				
	1 (Access)	-1.816	0.163	2.037	0.154
	0 (No access)	0[b]			

Adoption category		**B**	**Odd**	**Wald**	**Sig.**
Non-adopters	(Reference Group)				
	Intercept	-72.043		0.000	0.991
	Age	-0.41	0.960	0.181	0.671
	Gender				
	1 (Male)	2.139	8.494	1.257	0.262
	0 (Female)	0[b]			
	Household Size	-0.075	0.927	0.079	0.779
	Field Size	0.472	1.603	3.189	**0.074****
	Education Literacy				
	1 (Literate)	-0.119	0.887	0.080	0.778
	0 (Illiterate)	0[b]			
	Occupation				
	1 (Farming)	15.167	3862067.0	0.000	0.997
	0 (Otherwise)	0[b]			
	Household Income				
	4 (More than M5000)	4.171	64.806	0.000	0.999
	3 (M2001 to M5000)	-14.898	3.387	0.000	0.997
	2 (M1000 to M2000)	-1.505	0.222	0.532	0.466
	1 (Less than M1000)	0[b]			
Full CA adopters	**Farming Experience**				
	4 (Over 20 years)	17.704	488416.20	0.000	0.996
	3 (11 to 20 years)	5.372	215.309	0.000	0.999
	2 (6 to 10 years)	-1.430	0.239	0.000	1.000
	1 (5 years or less)	0[b]			

Land Ownership				
1 (Secure)	17.954	62688652	0.000	0.994
0 (Not secure)	0[b]			
Soil Fertility Perception				
1 (Fertile)	1.413	4.108	0.603	0.437
0 (Not fertile)	0[b]			
Training				
1 (Received)	21.480	213029648	0.000	0.992
0 (Not Received)	0[b]			
Farmer Group				
1 (Member)	1.837	6.276	1.175	0.278
0 (Non-member)	0[b]			
Extension Access				
1 (Access)	-20.912	8.283	0.000	0.992
0 (No Access)	0[b]			

*****, **, and * indicate statistical significance level at 1%, 5% and 10%, respectively.**

As shown in Table 2 above, among all the 13 variables that were considered to influence CA adoption, 5 were considered to have a significant impact on the decision to adopt CA. These variables are Age, Gender, Income, Field Size, and Training. The training was found to have a significant impact on the decision to accept CA for the partial CA adopters group at a 1% significance level. Gender was found to have a significant impact on CA adoption for the partial CA adopters group at a 5% significance level. Age and income were found to have an impact on CA adoption for the partial CA adopters group at a 10% significance level, while Field Size was found to have a significant impact on the decision to accept CA for the full CA adopters group at a 10% level of significance. The effect of some significant variables is not similar for the different categories; some may be highly significant to affect the choice decision for a particular category and may be insignificant for the other category.

Age: The coefficient of the variable age is positive (0.065) and is significant at a 10% significance level of significance. This implies that age has a positive influence on the decision of the farmer to partially adopt CA but is insignificant for full CA adoption. The positive coefficient of the variable and the odds ratio of 1.067 in the partial adopters group indicates that a 1-year increase in age increases the odds of a farmer becoming a CA adopter rather than a non-adopter (conventional farmer) by 1.067 holding all the other variables constant. Previous studies have shown that a person's age affects their mental attitude towards a new technology, and this influences adoption in a variety of ways. Owomboh and Idumah (2015) argue that older farmers are less likely to engage in long-term perspective activities such as land conservation and are less likely to adopt CA than younger farmers.

Gender: The coefficient for gender is positive and significant at a 5% level of significance. This indicates that gender affects the decision to partially adopt CA but not full CA adoption. The coefficient of this variable is positive and the odds ratio is 4.037. This indicates that relative to females, males are 4.037 times more likely to be CA adopters instead of non-adopters (conventional farmers), holding all the other variables constant. The reason for this could be that due to social barriers, access and control of resources and cultural barriers such as male extension agents tend to address male-headed households. Also, female-headed households, who are mainly widows, divorcees, and unmarried women, have limited access to production resources such as land (Gilbert, 2013).

Income: The coefficient of the variable income is positive and at a 10% significance level for the partial CA adopters group with an income of more than M5000 monthly, and at 5% for the partial adopters group earning between M2001 and M5000 monthly but is insignificant for full adopters group. The positive coefficient and an odd ratio of 33.439 for respondents' incomes of more than M5000 monthly suggests that holding other variables constant, farmers who earn more than M5000 monthly are 33.439 times more likely to adopt CA instead of practicing conventional farming than farmers who earn less than M1000 monthly.

Again, the positive coefficient and an odds ratio of 37.626 for the category of farmers who earn between M2001 and M5000 indicates that holding other variables constant, farmers earning between M2001 to M5000 are 37.626 times more likely to become CA adopters instead of conventional farmers (non-adopters) than farmers earning less than M1000 monthly. These results are similar to those of Gilbert (2013) who found that farmers with high income are more likely to adopt CA compared to farmers with low income. A high household income increases the capacity to accept and utilize an innovation because high-income farmers can afford the costs of implementing CA practices (Hanitriniaina, 2017).

Training: The coefficient of this variable is positive and significant at a 5% level of significance. This implies that training affects the decision to partially adopt CA but not the full adoption decision. The sign of the coefficient is positive and the odds ratio is 72.991. This indicates that the odds of farmers who have received training to become CA adopters instead of non-adopters are 72.991 times more than farmers who have not received training, holding other variables constant. Access to farmer training increases participation in improved technology and participation in farmer training programs positively influences adoption as it facilitates the uptake of new technologies (Abdoulaye *et al*., 2014). Training is a key variable in the promotion of the adoption of technologies. It builds the capacity of the farmers to use the technology effectively.

Field Size: The variable field size has a positive coefficient and is significant at a 10% level of significance to affect the decision to not partially but fully adopt CA. The sign of the coefficient is positive and the odds ratio is 1.603. This suggests that a unit increase in field size raises the odds of a farmer becoming a CA adopter instead of a non-adopter by 1.603, holding other variables constant. The findings are in line with those of a study from Zimbabwe which showed farm size to have a positive effect on CA adoption (Kunzekweguta *et al*., 2017). However, these findings contradict those of Ntshangase *et al.* (2018) whose study found that farmer adoption of CA is negatively correlated to farm size.

4. Discussion of Findings of the Study

The study results indicate farmers perceive training as a key enabler and influencer in the decision to partially adopt CA. In most cases, farmers receive training from the extension officers, and in Lesotho, there have been some projects that have also contributed to the training of farmers. Farmers that have received training tend to adopt as they understand the correct CA implementation as well as its benefits, however, they will also tend to adopt principles that would have been emphasized by their trainers. For instance, in Lesotho 'Likoti' was widely promoted, which tends to be attributed to a negative perception of CA by farmers as they view CA as laborious. It is possible farmers partially adopt as they decide based on the resources they have and the type of farming system they operate on their farm. For example, the issue of crop residue is always contested in Lesotho where rangelands are easily depleted due to over-exploitation and climate change-related challenges. The study findings indicate that age has a positive influence on the decision of the farmer to partially adopt CA. Younger farmers have more potential and incentives to engage in land conservation activities, therefore they are more likely to adopt CA. Partial adoption could be the result of a lack of results to fully adopt or ignorance of the benefits of full adoption. Training programs targeting the youth to increase awareness and also financing such as targeted grants and loans could assist young farmers in fully adopting CA.

Development programs and interventions need to be gender sensitive to contribute towards the achievement of Sustainable Development Goal 5 which focuses on gender equality. CA as a sustainable agriculture practice needs to be gender-neutral for wider adoption by farmers. The study results indicate that gender affects the decision to partially adopt CA. Males tend to adopt CA compared to their female counterparts. This could be due to resource constraints common among female farmers compared to male farmers. Household chores in most cases and some of the unique responsibilities of women such as nursing babies which at times is the reason they are not able to attend trainings or gatherings that may benefit them. It can be argued that the use of information communication technologies is inclusive and women can benefit from this as well as youth who spend most of their time on the internet and their electronic gadgets.

The age of the farmer is an important variable in the adoption decision, young people tend to be risk takers in contrast to older and mature farmers who are more risk averse. This behavior is evident in the adoption of new technologies, it was concluded from the results of this study that age has a positive influence on CA partial adoption. Since the coefficient is positive this implies that chances of partially adopting CA increase as farmers get older. This result could be due to farming experience that increases knowledge and skills. Older farmers have more exposure and opportunity to experiment with many different farm practices, therefore they are in a better position to partially adopt fully knowing the benefits. They also in most cases have assets and finance to implement new technologies compared to young farmers that have no finance and capital in most cases.

The income of the farmers for this study was presented in category 4 categories that included more than M5000; M2001 to M5000; M1000 to M2000 and less than M100. Farmer incomes are generally low hence the categories stated from less than 1000 and the highest income category was M5000 and above. The study concludes that farmers who earn higher incomes have higher odds of adopting CA compared to farmers who earn lower incomes. Income is a key determinant of the adoption of technologies. Adoption of technologies requires some level of investment. The study results showed a relationship between income and adoption of CA for partial CA adopters, however for full CA adopters income is not significant. Since the full CA adopters are already on the full CA adoption gradient income levels no longer influence CA adoption. Income is critical for adoption since in the early years of adoption yields may decline and a safety net is important before production levels increase over time as soil fertility improves.

The study concludes that **field size** has a significant impact on the decision to adopt CA for those farmers operating at the full CA adoption gradient. Lesotho smallholding farming is associated with small holdings of 0.4-3.2 ha, and this affects production levels negatively since these farmers are resource-constrained. Most of these farmers rely on rain-fed agriculture and they are not able to practice intensive agriculture. Interestingly, this study's results show that there is a relationship between field size and CA full adoption, which suggests that farm size has a positive relationship with full CA adoption. Farmers with large forms or plots have the luxury to commit part of their land or plots to CA since they will not suffer the initial setbacks of CA of low yields. Yields from CA plots increase over time and farmers with small plots or farms may not be comfortable or may not have the capacity to absorb the initial decreases in yields. In most cases, farmers with bigger farms/plots have more resources and therefore can adopt new technologies with ease.

The training was found to have a significant impact on the decision to accept CA for the partial CA adopters group at a 1% significance level. Gender was found to have a significant impact on CA adoption for the partial CA adopters group at a 5% significance level. Age and income were found to have an impact on CA adoption for the partial CA adopters group at a 10% significance level, while Field Size was found to have a significant impact on the decision to accept CA for the full CA adopters group at a 10% level of significance. The effect of some significant variables is not similar for the different categories; some may be highly significant to affect the choice decision for a particular category and may be insignificant for the other category.

5. Conclusion and Recommendations

Essentially, the study set out to evaluate the characteristics of CA adopters and non-adopters. The majority of farmers in the research were non-CA adopters, with fewer partial CA adopters and even fewer full CA adopters. This suggests that CA is still not well understood among farmers in Maseru. Female farmers outnumbered male farmers. This is because women tend to handle the majority of farm work in addition to other household tasks such as fetching water, caring for children, and cooking. None of the full CA adopters had rented or borrowed their fields and none of the partial CA adopters had rented land. Most land tenants are unwilling to implement conservation methods. This is because once soil fertility and agricultural productivity have improved considerably the landowner may reclaim the land. When compared to non-adopters, CA adopters have greater access to the extension. Extension personnel and fellow farmers are crucial in disseminating knowledge about new technologies. When compared to non-adopters, CA adopters are more likely to be members of farmer groups. A farmer who joins an association receives access to information about prospective economic and leisure gains from using CA, which can affect adoption rates. Considerably more CA adopters had received training on CA than non-adopters. This demonstrates that CA adoption is favorably related to training. Farmers learn how to use CA through demonstrations by extension personnel.

The study also intended to identify factors influencing the adoption of CA in Maseru. Age, gender, income, field size, and training all played a role in the decision to adopt CA. A farmer's age improved his or her chances of being a CA adopter rather than a non-adopter (conventional farmer). Males were more likely than females to be CA adopters rather than non-adopters (conventional farmers) as female farmers have limited access to production resources such as land. Farmers with higher incomes were shown to be more likely to use CA than those with lower incomes. A high household income may boost the capacity to embrace and use innovation since high-income farmers can afford the costs of adopting and practicing CA. Farmers who have received training were more likely to become CA adopters instead of non-adopters. This is because access to farmer training promotes involvement in improved technology, and participation in farmer training programs positively influences the uptake of new technologies. Finally, an increase in field size was discovered to improve the likelihood of a farmer becoming a CA adopter rather than a non-adopter since farmers with big land sizes can spare a piece of their land to try out CA.

Additionally, the study aimed to describe the constraints to the adoption of CA in Maseru. Respondents identified a lack of knowledge of CA concepts as the most significant limitation. A huge number of farmers are aware of CA but lack sufficient information about how it works. This demonstrates that a lack of understanding of CA as a package is a fundamental barrier to CA adoption. The tedious nature of CA was recognized as the key barrier impacting farmers' negative perceptions of it. A significant demand is the development and availability of machines and equipment designed to alleviate the effort associated with practicing CA. The majority of CA adopters stated that they did not incur any significant costs while practicing CA, demonstrating that CA is generally less expensive than conventional agriculture. Increased weeds and soil compaction were the challenges encountered with minimum tillage, the difficulty of digging basins was the major challenge with planting basins, and the infestation of pests and diseases was a major challenge regarding mulching.

Finally, the study sought to determine the factors affecting the selection of maize and beans marketing outlets by farmers in Maseru. The vast majority of farmers sold their produce to consumers, followed by street vendors, retailers, and finally collectors. Just a few farmers used cooperatives and wholesalers as their marketing channels. Households with bigger land sizes were found to be likely to sell to consumers. Older farmers seem to prefer rural markets over urban ones. Transaction costs rise as the distance between farmers and improved markets increases, which makes it difficult for rural smallholder farmers to select market channels of their choice for their produce. It was also discovered that households with larger plots of land are more inclined to choose the consumer's market outlet.

Recommendations

Based on the findings, the study makes the following recommendations:

Improving the effectiveness of the extension system.

The study concluded that extension services are essential for distributing information about new technology based on the study findings, therefore the government must improve the effectiveness and outreach of extension services to rural farmers to train them about Conservation Agriculture and help them address the challenges relating to its implementation.

Establish effective and more frequent training programs for farmers.

The poor educational background of farmers necessitates regular training; therefore, NGOs and extension personnel should hold frequent training programs. The study findings and conclusions suggest that access to farmer training has a positive influence on CA adoption and encourages participation in the use of improved technology. Farmers that participate in farmer training programs are more likely to adopt new technologies. In addition, since the majority of the farmers had a low level of education, CA adoption by farmers is mostly influenced by NGOs and extension services that provide training to farmers.

Establish and strengthen farmer groups/ associations.

Farmers should be encouraged to form or join existing farmer groups and associations to enhance their capacities to learn from each other and exchange reliable information. The study found that CA adopters are more likely to be members of farmer groups than non-adopters. A farmer who joins an association obtains access to information about the potential environmental, agronomic, and economic benefits of utilizing CA, which can influence adoption rates positively.

Mechanization of Conservation Agriculture.

The study recommends the improvement of mechanization of Conservation Agriculture by encouraging, equipping, and providing incentives for local entrepreneurs to offer mechanization services. This is likely to increase the availability of CA machinery, making it feasible for farmers to implement it on large fields. Since most farmers associate CA laboriousness as the major constraint influencing the negative perception that farmers have against it, the development and availability of machines and equipment designed to alleviate the work associated with CA is a big requirement.

Simultaneous adoption of minimum tillage and permanent soil organic cover principles of CA.

The study encourages farmers to adopt the minimum soil disturbance principle of CA together with the permanent soil organic cover principle to prevent soil compaction, suppress weeds, and enhance water infiltration into the soil in their gardens and fields. The study findings identified increased weeds and soil compaction as the main challenges encountered with minimum tillage. Soil compaction is caused by the decline in soil organic matter which is brought about by excessive intensive tillage. Therefore, permanent soil organic cover through mulching or by cover crops adds organic matter to the soil and suppresses weeds.

Linking smallholder farmers to the different marketing channels.

According to the study findings, most farmers sell their produce to consumers. Some sold to street vendors and retailers, and a few sold to collectors. Even fewer farmers sold their produce to cooperatives and wholesalers. Therefore, farmers must be informed of the different marketing channels and be linked to such markets to motivate them to increase the quantity and quality of their produce and sell more.

Improve transportation and infrastructure in the country.

Because of the distance between farmers and improved markets, transaction costs rise, making it difficult for rural smallholder farmers to select market channels of their choice for their agricultural produce. The government must improve transportation and infrastructure to facilitate the marketing of agricultural produce in the country and provide utilities and services essential for business.

References

Abawi, K. (2017). Data collection methods (Questionnaire and Interview). Training in Sexual and Reproductive Health Research.

Abdoulaye, T. (2014). Awareness and Adoption of Improved Cassava Varieties and Processing Technologies in Nigeria. *Journal of Development and Agricultural Economics* 6(2), 67-75

Altieri, M.A., Nicholls, C.I., Henao, A. & Lana, A. M. (2015). Agroecology and the design of climate change-resilient farming systems. Agron. Sustain. Dev. 35(3), 869-890.

Anderson, J. A. and D'Souza, S. (2014) 'From adoption claims to understanding farmers and contexts: A literature review of conservation agriculture (CA) adoption among smallholder farmers in Southern Africa.' *Agriculture, Ecosystems and Environment*, 187, 116-132.

Asrat, P. and Simane, B. (2018). Farmers' Perception of Climate Change and Adaptation Strategies in the Dabus Watershed, North-West Ethiopia. Ecological Processes, 7, 7.

ATPS (2013). Farmer's Response and Adaptation Strategies to Climate Change in Mafeteng District, Lesotho. ATPS Working Paper No. 74.

Ayuya, O.I., Kenneth, W.S., & Eric, G.O. (2012). Multinomial Logit Analysis of Small-scale Farmers' Choice of Organic Soil Management Practices in Bungoma Country, Kenya' *Current Research Journal of Social Sciences*, 4(4), 314-322

Bazezew, H. A. (2015). Adoption of Conservation Agricultural Practices: The Case of Dangila District, Amhara Region, Ethiopia' *Global Science Research Journals*, 3(9), 295-307

Bhan, S. and Behera, U.K (2014). Conservation Agriculture in India- Problems, Prospects and Policy Issues' *International Soil and Water Conservation Research*, 91(4).

Bisangwa E. (2013). The Influence of Conservation Agriculture Adoption on Input Demand and Maize Production in Butha-Buthe, Lesotho.' Master's Thesis, University of Tennessee

BoS (2006). Population of Lesotho 2006. Retrieved 14 November 2022

Byamugu, W. M. (2018). Factors Influencing Adoption of Conservation Agriculture in the Democratic Republic of Congo. Master's Thesis, University of Arkansas.

Chichongue, O., Pelser, A., Tol, J., du Preez, C., & Ceronio, G. (2020). Factors Influencing the Adoption of Conservation Agriculture Practices Among Smallholder Farmers in Mozambique.' *Int. J. Agr*. Ext., 7(03), 277- 290.

Chisenga, C. M. (2015). Socio-economic Factors Associated with the Adoption of Conservation Agriculture Among Women Farmers in Balaka District, Malawi's Open Access Theses. 542

CIAT and World Bank (2018). Climate Smart Agriculture Lesotho. CSA Country Profiles for Africa Series. International Centre for Tropical Agriculture (CIAT); Washington D.C. 28Pp.

Conner, B. and Johnson, E. (2017). Descriptive Statistics.' Nursing Research 101, 12(11), 52-55.

Danso-Abbeam, G. et al. (2017) 'Adoption of Improved Maize Variety Among Farm Households in the Northern Region of Ghana' Cogent Economics and Finance, 5, 1

Esabu, A. and Ngwenya, H. (2019). Socio-economic Factors Influencing Adoption of Conservation Agriculture in Moroto District, Uganda' South African Journal of Agricultural Extension, 47(2)

Fadina, A.M.R. and Barjolle, D. (2018). Farmers' Adaptation Strategies to Climate Change and Their Implications in the Zou Department of South Berlin' Environments, 5, 15.

FAO, (2014). what is conservation agriculture? FAO CA website (http://www.fao.org/ag/ ca/1a.html) (accessed 15 May 2018).

FAO/INRA (2016). Innovative markets for sustainable agriculture–How innovations in market institutions encourage sustainable agriculture in developing countries, by Loconto, A., Poisot, A.S. & Santacoloma, P. (eds.) Rome, Italy

FAO (2019a). Conservation Agriculture. Food and Agriculture Organisation of the United Nations, Rome. https://www.fao.org/conservation-agriculture/en/ [Accessed on September 4, 2020]

FAO (2019b). Contributing to Agriculture, Food Security, Nutrition and Rural Development. Food and Agriculture Organisation of the United Nations.

FAO and ECA (2018). Regional Overview of Food Security and Nutrition. Addressing the Thread from Climate Variability and Extremes for Food Security and Nutrition. Accra, pp.116.

Fredenburg, P., Piggin, C. & Devlin, M. (2015). Conservation Agriculture: Opportunities for Intensified Farming and Environmental Conservation in Dry Areas. *International Centre of Agricultural Research in the Dry Areas* (ICARDA)

Giller, K. E., Witter, E., Corbeels, M. & Tittonell, P. (2009). Conservation agriculture and smallholder farming in Africa: The heretic's view.' Field Crops Research, 114(1), 23-24.

Grabowski, P. P (2016). Determinants of Adoption and Disadoption of Minimum Tillage by Cotton Farmers in East Zambia. *Agriculture Ecosystems and Environment*., 231, 54-67

Holden, S. and Lunduka, R. (2014). Do fertilizer subsidies crowd out organic manures? The case of Malawi.' *Agricultural Economics*, 43(3), 303-314.

Holden, S.T and Quiggin, J. (2017). Climate risk and state-contingent technology adoption: Shocks, drought tolerance and preferences. European Review of Agricultural Economics, 44(2), 285-308.

Karki, T.B, Gadal, N. and Shrestha, J. (2014). Studies on the Conservation Agriculture Based Practices Under Maize (Zea Mays L.) Based System in the Hills of Nepal. *International Journal of Applied Sciences and Biotechnology*. 2(2), 185-192

Kaye, J.P and Quemada, M. (2017). Using Cover Crops to Mitigate and Adapt to Climate Change. A Review' *Agronomy for Sustainable Development*, 37, 4.

Kiboi, M.N., Ngetich, K.F., Fliessbach, A., Muriuki, A. & Mugendi, D.N. (2019). Soil Fertility Inputs and Tillage Influence on Maize Crop Performance and Soil Water Content in the Central Highlands of Kenya. *Agric. Water Manage*., 217, 316-331

Kiboi, M. N., Ngetich, K.F., Diels, J. & Mucheru-Muna, M. (2017). Minimum Tillage, Tied Ridging, and Mulching for Better Maize Yield Stability in the Central Highlands of Kenya. *Soil Tillage Res*. 170, 157-166

Kunzekweguta, M.O.N. (2016). Drivers of Smallholder Adoption and the Intensity of Conservation Agriculture in Masvingo District of Zimbabwe.' Master's Thesis, Lincoln University

Marenya, P.P. (2021). Community-Embedded Experiential Learning and Adoption of Conservation Farming Practices in Eastern and Southern Africa. *Environmental Development*. 40

Ministry of Agriculture, Irrigation and Water Development (2016) 'Agriculture Sector Performance Report 2015/2016 Fiscal Year' Government of Malawi, Lilongwe, Malawi

Mmbando, F.E., Wale, E. Z. & Baiyegunhi, L.J.S. (2017). The welfare impacts of market channel choice by smallholder farmers in Tanzania. Dev. Pract., 27, 981–993.

Mutsamba, E., Nyagumbo, I., and Mafongoya, P. (2016). Termite Prevalence and Crop Lodging Under Conservation Agriculture in Sub-Humid Zimbabwe' *Crop Protection* 82, 60-64

Njeru, E.K. (2016). Factors Influencing Adoption of Conservation Agriculture by Smallholder Farmers in Kenya: A Case of Laikipia East Sub-County: Kenya. Master's Thesis. University of Nairobi.

Nkhoma, S., Kalinda, T., and Kuntashula, E. (2019). Adoption and Impact of Conservation Agriculture on Smallholder Farmers' *Crop Productivity and Income in Luapula Province, Zambia' Journal of Agricultural Science*, 9(9): 168

Ntshangase, N. L. (2018). Farmers' Perceptions and Factors Influencing the Adoption of No-Till Conservation Agriculture by Small-Scale Farmers in Zashuke, KwaZulu-Natal Province' *Sustainability*, 10(2), 555

Nxumalo, K. K. S., Oduniyi, OS., Antwi, MA. & Tekana, SS. (2019). Determinants of Market Channel Choice Utilised by Maize and Sunflower farmers in the North West Province, South Africa' *Cogent Social Sciences*, 5(1), 1678451

Nyamangara, J., Chikowo, R., Rusinamhodzi, L. & Mazvimavi, K. (2013). Conservation Agriculture in Southern Africa. Conservation Agriculture: Global Prospects and Challenges, 14, 339.

Oduniyi, O.S, Chagwiza C., and Wade T. (2022). Welfare impacts of conservation agriculture adoption on smallholder maize farmers in South Africa. Renewable Agriculture and Food Systems 1-11. Htps://doi.org/10.1017/s1742170522000308.

Oudewater, N., De Vries, M., Renting, H. and Dubbeling, M. (2013). Innovative experiences with short food supply chains in (peri-)urban agriculture in the global south. ETC Foundation and RUAF Foundation.

Owombo, P.T and Idumah, F.O (2015). Determinants of Land Conservation Technologies Adoption among Arable Crop Farmers in Nigeria: A Multinomial Logit Approach. Journal of Sustainable Development. 8(2), 220- 229

Park, H. (2013). An Introduction to Logistic Regression: From Basic Concepts to Interpretation with Particular Attention to Nursing Domain. *J Korean Nurs.* 43(2), 154-164.

Pittelkow, C. (2015). When does no-till yield more? A global meta-analysis.' Field crops Research, 183, 156-168. https://doi.org/10.1016/j.fcr.2015.07.020

Qaswar, M. (2019). Long-Term Green Manure Rotations Improve Soil Biochemical Properties, Yield Sustainability and Nutrient Balances in Acidic Paddy Soil Under a Rice-Based Cropping System' *Agronomy Journal*, 9(12), 780

Sakala, I. C., Kalinda, T. H., Nkonde, C., & Burke, W. J. (2021). Adoption of ox-drawn Minimum Tillage ripping by Smallholder farmers in Zambia. *Agricultural Economics Research, Policy and Practice in Southern Africa, Agrekon,* 60(3), 335–351. DOI: 10.1080/03031853.2021.194612.

Seitz, S., Goebes, P., Puerta, L. V., Pereira, P. I., Wittwer, R., Six, J., Van der Heijden, M. A. & Scholten, T. (2019). Conservation Tillage and Organic Farming Reduce Soil Erosion. *Agronomy for Sustainable Development,* 39(1), 4.

Sesoai, P. D., Akintunde, M. A. & Keregero, J. B. (2019). Assessment of Adoption of Conservation Agriculture in Roma Valley, Lesotho. *International Journal of Science and Research* 89(2), 739-743

Sherwood, S., Arce, A., Berti, P., Borja, R., Oyarzun, P. & Bekkering, E. (2013). Tackling the new materialities. Modern food and counter-movements in Ecuador. Food Policy, 41, 1–10.

Silici, L. (2010). Conservation agriculture and sustainable crop intensification in Lesotho. Agricultural and Food Sciences, Environmental Science. Report number: 10

Tamburini, G., Bommarco, R., Wanger, TC., Kremen, C., van der Heijden, MGA., Liebman, M. & Hallin, S. (2020). Agricultural diversification promotes multiple ecosystem services without compromising yield. Sci. Adv. 6, 715.

Tau, M. (2020) The role of microfinance on entrepreneurial development: The case of urban Maseru.

Tefera, T. (2014) Analysis of chickpea value chain and determinants of market options choice in selected districts of southern Ethiopia. J Agric Sci 6(10):26

Thierfelder, C., Cheesman, S., & Rusinamhodzi, L. (2012). Benefits and challenges of crop rotations in maize-based conservation agriculture (CA) cropping systems of Southern Africa. *International journal of agricultural sustainability. 11(2), 108–124.*

Thierfelder, C., Rusinamhodzi, L., Ngwira, A.R., Mupangwa, W., Nyagumbo, I., Kassie, G.T., & Cairns, J.E. (2015). Conservation agriculture in Southern Africa: Advances in knowledge. *Renewable Agriculture and Food Systems*. 30(4), 328-348.

Thierfelder, C., Matemba-Mutasa, R., Bunderson, WT., Mutenje, M., Nyagumbo, I., Mupangwa, W. (2016). Evaluating manual conservation agriculture systems in Southern Africa. *Agriculture, Ecosystems and Environment*, 222, 112-124.

Thierfelder, C., Chivenge, P., Mupangwa, W., Rosenstock, T. S., Lamanna, C., and Eyre, J. X. (2017). How Climate-smart is conservation agriculture (CA)?–its potential to deliver on adoption, mitigation, and productivity on small-holder farms in Southern Africa. *Food Security*, 9(3), 537-560.

Toma, Y., Nufita Sari, N., Akamatsu, K., Oomori, S., Nagata, O., Nishimura, S., Purwanto, B. H., & Ueno, H. (2019). Effect of Green Manure Application and Prolonging Mid-Season Drainage on Greenhouse Gas Emission from Paddy Fields in Ehime, South-Western Japan' *Agriculture*, 9(2), 29

Vanlauwe, B. (2014) 'Sustainable Intensification and the African Smallholder Farmer' Current Opinion in Environmental Sustainability. 8, 15-22

Vasanthakumar, J. (2017). Constraints to Adoption of Conservation Agriculture Technologies Among the Farming Community in Tamil Nadu, India' *Int. J. Curr. Microbiol. App.Sci.* 6(1), 988-992

Vuntade D. and Mzuza, M.K (2022). Factors Affecting Adoption of Conservation Agriculture Practices in Mpatsa Extension Planning Area, Nsaje, Southern Malawi' Journal of Geoscience and Environment Protection, 10(3)

Wezel, A., M. Casagrande, F. Celette, J., Vian, F., Ferrer, A. & Peigné, J. (2014). Agroecological practices for sustainable agriculture. A review. Agron. Sustain. Dev. 34(1), 1-20. https://doi.org/10.1007/313593-013-0180-7.

Zulu-Mbata, O., Chapoto, A. & Hichaambwa, M. (2016). Determinants of Conservation Agriculture Adoption Among Zambian Smallholder Farmers' Indaba Agricultural Policy Research Institute (IAPRI), Working Paper No. 11.