CONSERVATION AGRICULTURAL PRACTICES AND THEIR EFFECTS ON LIVELIHOOD OUTCOMES IN ARID AND SEMI-ARID AREAS IN KENYA

JUSTIN M. KYALO

DOCTOR OF PHILOSOPHY

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Justin M. Kyalo

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university

Signature……..Date……

Justin M. Kyalo

This thesis has been submitted for examination with our approval as the university Supervisors.

Signature……..Date……

Prof. Maurice M. Sakwa

JKUAT, Kenya

Signature……..Date……

Dr. David J. Ndegwah

JOOST, Kenya

DEDICATION

This thesis is dedicated to my late brother Austin who would have been proud of my achievement. May he continue resting in eternal peace.

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ACRONYMS AND ABBREVIATIONS

ASAL	Arid and Semi-Arid Land
CA	Conservation Agriculture
DFID	Department for International Development
EdHH	Education Level of the Household Head
FAO	Food Agricultural Organization
FFV	Fresh Fruits and Vegetables
IFAD	International Fund for Agricultural Development
NACOSTI	National Council of Science Technology and Innovation
PA	Producer Association
SLA	Sustainable Livelihood Approach
SARD	Sustainable Agriculture and Rural Department
UDO	Utooni Development Organization
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WANA	West Asia and North Africa

DEFINITION OF OPERATIONAL TERMS

Conservation Agriculture Conservation agriculture comprises a package of crop production technologies and practices that can achieve sustainable agriculture and improve livelihoods for vulnerable farming populations (Fao, 2018).

Contract farming Contract farming is the agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices (Eaton & Shepherd, 2001).

Crop rotation Crop rotation means that different crops are alternated in the same field, preferably cereals (maize and wheat) followed by legumes (beans) (FAO, 2014).

Farm inputs Farm inputs come in a wide array from the most common which include but not limited to: Manure, Farm chemicals, Machinery, Seeds, Water (Mundlak, 2007).

Institutional arrangements Institutional arrangement refers to a set of rules or agreements governing the activities of a specific group of people pursuing a certain objective (Basu, 2004).

Land productivity Land productivity capacity or land quality is a measure of capability of land to perform specific functions (Devi and Kumar, 2008).

Livelihood Livelihood comprises capabilities, assets and activities required to make a living, cope with and recover from shocks and stresses (Chambers & Conway, 1992).

Participation It concerns the engagement of individuals and communities in decisions about things that affect their lives (Burns and Taylor, 2000).

Producer Association A Producer association can be defined as a member-based organization created by producers to provide services that support the members' farming activities (Bonus, 1986).

Socio-economic characteristics Socio-economic characteristics are primarily concerned with incomes, education levels, employment status and wealth status (Yusuf et al., 2011; Ogunmefun & Achike. 2015; Zoran et al., 2016; PLoS One, 2018; Egyir, 2007; Rahhma et al., 2015).

Transaction costs Transaction costs are the resources used to exchange goods or services (Basu, 2004).

ABSTRACT

There is a need to facilitate the growth and productivity of agriculture to reduce poverty and since most poor people are concentrated in rural areas especially in sub-Saharan Africa. Most economies in sub-Saharan Africa and Kenya are agriculturally based, hence the importance to boost agricultural development for poverty reduction. This can be achieved by promoting conservation agriculture which has been proven to increase productivity while conserving the environment at the same time in other parts of the world. With limited evidence on the effect of conservation agriculture on livelihood outcomes in Kenya, the current study sought to assess the participation in conservation agriculture practices and their effect on livelihood outcomes focusing on Arid and Semi-Arid areas in Kenya. Most studies have mainly focused on economic and environmental aspects to show a change in livelihoods of CA farmers and paid little attention on human development dimensions notably health and education. Specifically, the study investigated the effect of input costs, land productivity, socio-economic characteristics, and marketing institutional arrangements of conservation agriculture on livelihood outcomes of smallholder farmers in ASAL areas. In addition, the moderating effect of participation of conservation agriculture farmer organizations on livelihood outcomes was examined. The study adopted sustainable livelihoods approach, diffusion of innovation theory and the capability approach. The study employed a cross-sectional survey as a research design. The qualitative data was guided by a phenomenology approach. The Cochran formula was used with a 5% level of significance to obtain a sample size of 384 respondents. The study relied on stratified random sampling to achieve a high degree of representation from groups with the desired characteristics. Sample size for each stratum was determined proportionately by dividing the population in each stratum by the sample size. Qualitative data was analyzed with the use of content analysis while quantitative data was analyzed using both descriptive and inferential statistics. The study concluded that Conservation Agriculture reduces input costs, enhances land productivity and marketing of farmers which ultimately increases crop yield and hence, better livelihood outcomes. In addition, Conservation Agriculture increases farmer skills and access to income and thus improving production and livelihood outcomes. Furthermore, the study has concluded that although all CA farmers who were interviewed belonged to farmer groups, the role of these groups on the link between CA farming and livelihood outcomes is not significant. The study recommends that the government at national and county levels should take responsibility in creating awareness on CA practices across the country and provide any necessary support for the farmers to embrace this noble practice. Furthermore, there is a need to relook into the role of CA farmer groups in ASAL areas to make sure that their role is much more pronounced and reflected in production.

Key Words: *Livelihood outcomes, Conservation agriculture, Input costs, Land productivity, marketing institutional arrangement, Farmer groups*

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Poor agricultural practices are among the key factors contributing to decline in agricultural production especially in countries like Kenya, where almost 75% of the population rely on agriculture both directly and indirectly (USAID, 2019). In addition, changes in climate have also affected precipitation and temperature patterns resulting in adverse impact on farming in some areas. In order to enhance the productivity of the farm, the government, and non-governmental organizations have promoted Conservation Agriculture (CA) practices through various initiatives. The United Nations Sustainable Development Goal (SDG) Number 2 envisions a free hunger world and for this to be realized, more emphasis has to be put on best agricultural practices such as CA and use of technology in farming.

According to Food and Agricultural Organization (FAO) conservation agriculture, CA is defined as an approach of resource-saving crop production whose aim is to achieve acceptable profits coupled with high and sustained levels of production while at the same time conserving the environment. From this definition, CA is not an actual technology but a wide array of specific technologies which are based on application of one or more of the key three principles of CA, that is, minimum soil tillage, adequate cover to soil surface completely or continuously and lastly, diversification of crop rotation. What this implies is that, CA systems comprises individual sets of practices which combine in a lucid manner to enable the three principles to be applied simultaneously to realise what is termed as, full conservation agriculture.

It is estimated that 70% of the population in Sub-Saharan Africa (SSA) reside in rural areas where agriculture is the main source of livelihood (Barasa, Araar, Kinyanjui, Maende, & Mariera, 2019). Continuous cropping and application of inappropriate farming methodologies in many counties within the SSA has adversely affected the environment

which has led to decline in soil fertility and erosion, and therefore, low production and food insecurity (IFAD, 2005; FAO, 2007; Guto, Pypers, Vanlauwe, De Ridder, & Giller, 2011). These challenges are particularly prominent in low-income countries such as Kenya where at least 80% of the farmers are small-scale and who rely entirely on simple traditional farming techniques. These problems are further exacerbated by limited farmland due to increasing population, poor agricultural policies and management strategies.

Several researchers have argued that CA attempts to restore soil fertility, and mitigate against the effects of soil degradation and therefore, increase crop yields (Guto et al., 2011; Chikonye et al., 2006; Govaerts et al., 2009). The conservation agriculture principles of minimum tillage, maintenance of soil cover and crop rotation enables farmers to reduce on crop production costs hence higher returns resulting into more spending on various aspects which promote a quality life.

Smallholder farmers in sub-Saharan Africa have practiced conventional farming for several years. This type of farming comprises one or a mixture of activities including harrowing, plowing, and hoeing. These practices are normally associated with soil disturbances leading to erosion and sedimentation of streams and waterways (Mashingaidze and Mudahara, 2006). However, a study by Chiputwa et al., (2011) found that the general perception of farmers in SSA is that conventional farming escalates mineralization of soil organic matter, controls weed growth and creates a favorable soil structure for seed bed preparation. According to Knowler and Bradshaw (2007), conventional farming compacts soil, depletes soil organic matter and soil nutrients leading to major soil losses of up to 150 tons annually in Africa. Giller et al., (2009) conducted a study on conservation agriculture and smallholder farming in Africa. They found out that conventional norms of farming are still evident in many communities despite farmers acknowledging that conventional farming aggravates depletion of resources.

Studies conducted by Thierfelder and Wall (2010); Chiputwa et al., (2011); Kassam et al., (2010) have supported CA technologies to address erosion and other problems intensified

by conventional farming. According to Friedrich and Kassam (2009) CA has the likelihood to maintain or escalate harvests of grains and legumes as it improves soil quality, reduces soil erosion and decreases production costs in the long-term. Studies from various countries show that despite a huge number of small-scale farmers adopting CA practices, the dissemination of these best management practices appears to be relatively slower among small-scale farmers (Friedrich and Kassam, 2009). CA continues to be advocated across various regions over the world, including sub-Saharan Africa where NGOs and international aid agencies spearhead CA adoption.

1.1.1 Conservation Agriculture and Livelihoods

Conservation agriculture evolved as a response to concerns of sustainability of agriculture globally, has steadily increased worldwide to cover about 8% of the world arable land (124.8 M ha) (FAO, 2012). Conservation Agriculture aims to increase crop yields while reducing production costs (for example labour and inputs), improving and maintaining soil fertility (e.g. plant nutrients, organic matter, micro-organisms and structure) and water holding capacities and preventing soil erosion and land degradation. Conservation Agriculture comprises a package of crop production technologies and practices that can achieve sustainable agriculture and improve livelihoods (that is food security, nutrition and income generation) for vulnerable farming populations. Conservation agriculture can be applied to any crop whether cereal, pulse, fruit or vegetable. The practice is based on three core principles which are minimal tillage or soil disturbance, maintenance of soil cover and crop rotation (Fao, 2018).

CA seeks to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources enhancing environmental conservation as well as sustained agricultural production. In addition, CA has been shown to reduce crop vulnerability to extreme climate events. For instance, in drought conditions, it reduces crop water requirements by 30% making better use of soil water and facilitating deeper rooting of crops. In extremely wet conditions, CA facilitates

rainwater infiltration, reduces the risk of soil erosion and downstream flooding (Mrabet, 2011).

Conservation agriculture was started during the United States' dust bowl of the 1930s and is widely practiced in large scale commercial agriculture in North America, Brazil, Australia, Argentina, Morocco, South Africa and Paraguay, and increasingly in Europe, China and India. More research has been directed towards adapting CA to the needs of smallholder farmers in Africa, Asia and South America who lack the resources, particularly mechanization, of large-scale commercial farmers (Wagstaff & Harty, 2010). This advancement progressively attracted consideration from other parts of the world during the 1990s, along with development and international research organizations like FAO, CIRAD and some CGIAR centers. This resulted in increased levels of recognition and implementation in several African countries like Zambia, Tanzania and Kenya and also in Asia. In the year 2011, the total area under CA was predicted to be about 125 million meaning most countries had increased interest in the production system (Friedrich, Derpsch, & Kassam, 2016).

According Ellis (2005), livelihood attempts to "capture not only what people do in order to make a living, but the resources that offer them with the capability to build a satisfactory living, the risk factors that they must consider in managing their resources and the institutional and policy context that either aids or hampers them in their quest for a viable or improved life". Similarly, Chambers and Conway (1992) assert that livelihood comprises "assets, capabilities and activities needed to make a living, cope with as well as recover from shocks and stresses. Higher as well as more stable yields with lower input costs form the commonly discussed impacts of CA on livelihoods implying availability of surplus for sale and subsequently better economic and social wellbeing of the farmers (ACSAD & GTZ, 2008). Livelihoods can be observed from the point of view of locale (for example rural livelihoods); occupations (e.g. farming) and social difference (defined livelihood or gendered) (Scoones, 2009).

Food and agricultural Organization defines food security as a situation where sufficient basic foodstuffs are available at all times to cater for an ever-expanding food consumption and counterbalance fluctuations in both price and production (FAO, 2013). This explains that the concept of food security has various elements such as availability of food and in the right quantity and quality, accessibility and stability. Earlier studies have shown a significant increase in yields with the implementation of CA (Dumanski et al., 2006; Stewart et al., 2008; Mazvimavi et al., 2010).

Participation in conservation agriculture by farmers will lead to improved livelihoods through more income gains and increased yields. Farmers will as a result be able to realize life sustenance which is a key goal of development. They will be in a position to access better education, healthcare, security among others. More food yields attributed to conservation agriculture will ensure that food security is being achieved which is one of the main agendas of the current government. The aim of conservation agriculture is to achieve sustainable and profitable agriculture which will improve farmers' livelihoods. The practice of CA embraces potential for all farm sizes and varied ecological conditions, and it is seen as particularly useful for smallholder farmers, especially those with labour and input shortages in the drier tropic areas.

1.1.1.1 Minimum Tillage and Livelihoods

All CA principles are accompanied by particular functions. FAO (2014) asserts that direct planting involves growing crops with minimum soil disturbance since the harvest of the previous crop. Direct planting can be used with all annual and perennial crops and vegetables. According to Friedrich and Kassam (2009) the minimal soil disturbance principles merits water as well as soil conservation and soil erosion control. Hobbs (2007) adds that the principle of minimum soil disturbance aims at minimum soil aggregation. Soil aggregation involves the binding of soil particles into clumps and defines the overall soil structure and soil health.

Soil conservation and the prevention of soil erosion enables the crops to enjoy the necessary nutrients thus enough food will be produced. Farmers will experience more income because they will market the extra yields harvested from the farms as a result of the water and soil conservation and also control of soil erosion (Nkala et al., 2011). More incomes experienced will go into alternative sources of livelihoods apart from farming. Minimum tillage ensures that a lot of labour is saved which is then invested in non-farm activities resulting in more incomes for the farm households.

1.1.1.2 Maintenance of Soil Cover and Livelihoods

According to Wagstaff and Harty (2010) crop residues left on the ground from previous years form protective mulch that prevents weed growth releasing nutrients back into the soil and building up soil organic matter. The mulch protects the soil from water and wind erosion, reduces evaporation and keeps the soil at a cool, even temperature (Hobbs, 2007). Cover crops aids an increase in soil biological activity, biodiversity and heightened soil carbon sequestrations (Derpsch, 2005). Friedrich and Kassam (2009) also argues that the principle of permanent soil cover leads to water and soil conservation as well as soil erosion control. Hobbs (2007) argues that mulch coming from leftover debris is a vital element of CA that supports soil aggregates that are more stable. This is due to better microbial activity and improved soil surface guard. An arrangement can be categorised as CA if it meets the lower threshold of 30% crop residue prerequisite (Hobbs, 2007).

Mazvimavi and Twomlow (2009) found that dead mulching material (grass, leaves or left-over crop debris) or cover crops are used to achieve the permanent soil cover. Mixed cropping farming systems in southern Africa use creepers such as pumpkins and melons as cover crops. According to Hobbs (2007) CA minimizes the challenge of weeds by 50-60 % and this is because mulch or cover crops prevent weed germination. The reduction in weed will enable the farmers to invest their labour on other non-farm income generating activities such as running business enterprises in the local markets. Income generated from these ventures will enable the farmers to sustain their livelihoods accessing needs not limited to education, quality healthcare, affordable housing and nutrition.

Stable soil aggregates which are provided for by mulching or cover crops provides for retention and exchange of air and water. The effect of this is healthier soils thereby ensuring more yields are produced consequently enabling the achievement of food security (Mashingaidze et al., 2006). More yields produced will enable farmers to sell the extra units and earn better incomes which will be utilized for accessing healthcare, education and other basic needs. More incomes will also enable the farmers to diversify into other forms of economic activities such as engaging in small and medium businesses, investments among others.

1.1.1.3 Crop Rotation and Livelihoods

According to FAO (2014) Crop rotation means that different crops are alternated in the same field, preferably cereals (maize and wheat) followed by legumes (beans). Derpsch, (2005) and Hobbs et al., (2007) argue that crop rotation is linked to the promotion of healthy soils, hence minimizing requirements for pesticide and herbicide, environmental pollution as well as complements natural biodiversity. Dumanski et al., (2006) assert that crop rotations and associations which make up the third principle of CA can be in the form of relay cropping, mixed crops and crop sequences. These practices reduce the need for pesticides and herbicides while at the same time promoting biodiversity. According to Wagstaff and Harty (2010) poor farmers struggling to feed their families are regularly reluctant to rotate their staple crops with non-staple crops. However, with greater crop variety there is often a longer productive season which can continue to provide food or an income hence reducing the hunger gap. Increased variety of crops has the potential to diversify farmers' incomes and spread the risks of harvest failure (Wall, 2009). Thierfelder and Wall (2010) further argue that farmers can also rotate crops with different peak labour requirements spreading the need for farm labour.

Most crops especially in sub-saharan Africa are known to be seasonal mainly due to the erratic weather experienced. The practice of crop rotation enables the smallholder farmers to switch the crops depending on the season at that particular time of the year. The rotation of the crops will ensure that the farmers are able to diversify in terms of the crops they

can grow, therefore tapping into the markets for various commodities. The result of this is that farmers will be in a position to venture into other non-farm activities due to the incomes gained from trading in their commodities. Dumanski et al., (2006) observed that crop rotation is associated with healthy soils thus ensuring that more yields are produced therefore improving access to food.

1.1.2 Conservation Agriculture Adoption Regionally

Global data of CA adoption is not officially reported, nonetheless collecting from local farmers' and interest groups. The data is assembled and published by FAO (FAO, 2011c). Table 1 below shows the spread of CA in 2011 worldwide (about 125 M ha), ranking the countries based on the adopted area. In recent years, CA has become a fast-growing production arrangement. Despite the production arrangement being used only on 2.8 M ha in 1973/74 worldwide, the area grew to 6.2 M ha in 1983/84 and later to 38 M ha in 1996/97. Worldwide adoption in 1999 was 45 M ha and grew to 72ha by 2003 (Friedrich et al., 2016).

Table 1.1: Magnitude of Adoption of Conservation Agriculture Worldwide (Countries with > 100,000 ha)

Country	CA area (ha)
USA	26,500,000
Argentina	25,553,000
Brazil	25,502,000
Australia	17,000,000
Canada	13,481,000
Russia	4,500,000
China	3,100,000
Paraguay	2,400,000
Kazakhstan	1,600,000
Bolivia	706,000
Uruguay	655,100
Spain	650,000
Ukraine	600,000
South Africa	368,000
Venezuela	300,000
France	200,000
Zambia	200,000
Chile	180,000
New Zealand	162,000
Finland	160,000
Mozambique	152,000
United Kingdom	150,000
Zimbabwe	139,300
Colombia	127,000
Others	409,440
Total	**124,794,840**

Source: FAO, 2011c

The expansion of the area covered by CA has been key in South America where the MERCOSUR countries (Argentina, Brazil, Paraguay and Uruguay) are relying on the arrangement on about 70% of the total cultivated area. In MERCOSUR, more than two thirds of no-tillage is permanently under this arrangement signifying that the soil is never tilled again once the process has commenced. As shown in Table 2, 45% of the entire global area under CA is in South America, 32% in the United States of America and Canada, 14% in Australia as well as New Zealand and 9% in the rest of the world

comprising Europe, Asia and Africa. The latter are the developing continents with regards to adoption of CA. The practice has not experienced high degrees of adoption despite satisfactory and long-lasting research in these continents indicating positive results for no-tillage arrangements. As a result of the advantages that arrangements associated with the practice produce with regards to yield, sustainability of land use, incomes, timeliness of cropping practices, farming ease and ecosystem services, the area covered by CA systems has been exponentially increasing, primarily due to the initiative of farmers and their organizations (Friedrich et al., 2016).

Table 1.2: Area under CA by Continents

Continent	Area (ha)	Percent of total
South America	55,464,100	45
North America	39,981,000	32
Australia & New Zealand	17,162,000	14
Asia	4,723,000	4
Russia & Ukraine	5,100,000	3
Europe	1,351,900	1
Africa	1,012,840	1
World total	**124,794,840**	**100**

Source: FAO, 2011c

Agricultural development programs have not yet entrenched CA or supported it by appropriate policies and institutional support in many countries with few of the exempted (USA, Canada, Australia, Brazil, Argentina, Paraguay, and Uruguay). Subsequently, the total arable area covered by this practice worldwide is still approximately small (about 9%) in comparison to areas relying on tillage for farming. However, the degree of global adoption has been exponentially growing, primarily in South and North America, Australia as well as New Zealand. All parts of Asia have seen an increase in the area under the practice. Although much of the CA development has been linked to rainfed arable crops, farmers can administer the same principles to maximize the sustainability of irrigated arrangements, including those in semi-arid areas.

Moreover, CA arrangements have been designed for orchard and vine crops with the direct sowing of field crops, cover crops and pastures underneath or between rows. This gives permanent cover and better water infiltration, soil aeration and biodiversity. Also, since there is less runoff, more water gets into the soil thus bettering efficiency of water use. Functional CA arrangements integrate with current good land husbandry practices rather than substituting the arrangements (Friedrich et al. 2016). This agricultural practice is an alternative approach to ecologically reinforce production arrangements to expand productivity, sustainability and resilience. However, introduction and implementation of the practice must conquer a series of challenges outlined by several stakeholders (e.g., FAO, 2007).

1.1.2.1 Adoption in West Asia and North Africa

In the WANA (West Asia and North Africa) region, a considerable amount of the CA work done in several countries has verified that harvests and productivity can be enriched with no-till arrangements. Table 1.3 shows widespread research and development has been conducted in several countries in the region since the early 1980s for instance in Tunisia, Morocco, Syria, Lebanon, Jordan as well as in Turkey. The adoption has exploded in Syria with Morocco and Tunisia showing a moderate development in CA adoption. The rapid adoption can be attributed to the shortage of fuel and a rise in accessibility of locally produced inexpensive no-till seeders. Promotion and development activities by organizations like ICARDA, GIZ, ACSAD and Aga Khan Foundation have resulted in the no-till seeders being exported to other countries in the region.

Table 1.3: CA Adoption in Selected Countries of North Africa and Middle East

Country	CA Area (ha)
Lebanon	1,200
Morocco	4,000
Syria	18,000
Tunisia	8,000
Total	**31,200**

Source: FAO, 2011c

1.1.2.2 Adoption in Sub-Saharan Africa

In Sub-Saharan Africa, there is development of supply-chains for manufacturing equipment meant for CA intended for small holders through innovative participatory mechanisms. Similarly, there is promotion for participatory learning mechanisms to boost farmers' knowledge of the basic CA principles and how they can be modified to local conditions. Table 7 shows that CA is now beginning to spread to the Sub-Saharan Africa region, predominantly in southern and eastern Africa. Building on indigenous and scientific knowledge and equipment design from Latin America, and with collaboration from China, Bangladesh and Australia more recently, farmers in at least 14 African countries are now applying CA (in Kenya, Uganda, Tanzania, Sudan, Swaziland, Lesotho, Malawi, Madagascar, Mozambique, South Africa, Zambia, Zimbabwe, Ghana and Burkina Faso). In addition, NEPAD (New Partnership for Africa's Development) has incorporated CA into the regional agricultural policies. CA arrangements are appropriate for addressing the barriers of climate change, increased costs of energy, environmental degradation and labour shortages in the African context with resource poor farmers. There is a progressively emerging movement that already includes more than 400,000 small-scale farmers in the region for a total area of nearly 1 M ha (Friedrich et al., 2016).

Table 1.4: CA Adoption in Sub-Saharan Africa

Country	CA area (ha)
Ghana	30,000
Kenya	33,000
Lesotho	2,000
Malawi	16,000
Madagascar	6,000
Mozambique	152,000
Namibia	340
South Africa	368,000
Sudan	10,000
Tanzania	25,000
Zambia	200,000
Zimbabwe	139,300
Total	**981,640**

Source: FAO, 2011c

In Sub-Saharan Africa it is projected that CA will lead to a rise in food production while minimizing negative effects on the energy and environmental expenses and lead to the development of technologies that are locally-adapted which are in line with CA principles. The first CA pilot project in Kenya (2002/03) was supported by the German Government through the German Trust Fund and coordinated by Food Agricultural Organization (FAO). The first phase of the Regional Conservation Agriculture for Sustainable Agriculture and Rural Department (CA-SARD) project was launched which was a 2-year project whose term lasted from June 2004 to August 2006.

1.1.2.3 Conservation Agriculture in Kenya

It is estimated that 70% of the population in Sub-Saharan Africa (SSA) reside in rural areas where agriculture is the main source of livelihood (Barasa, Araar, Kinyanjui, Maende, & Mariera, 2019). However, its contribution to the country's Gross Domestic Product (GDP) has been declining over the years from 40 percent in 1963, 33 percent in the 1980s to 27 percent in 2014, (KNBS, 2015). The sector accounts for about 60 percent of the foreign exchange in Kenya, about 16 percent of the formal sector employment

(KNBS, 2015) and also provides self-employment. There is therefore a high correlation between the growth of the national economy and development in the agricultural sector.

However, the productivity of agricultural production has been on the decline for the last decade. This has partly been informed by drought because most farmers in Kenya are small-scale and their farming depends on rain. For example, failure of the long rain season due to climatic changes in the recent past has been a threat to farming (Wekesa et al., 2018). Because of this, the country with the support of its development partners promotes good agricultural practices especially on water and soil management to enhance production in agriculture. Scaling up of CA, adoption of technology and mechanization has been on the top agenda of the Kenyan government (World Bank, 2015).

In Kenya, conservation agriculture is slowly taking shape as many farmers across the country are embracing the practice. Currently, the total number of CA farmers in Kenya is estimated to stand at 17,170 countrywide (Canadian Food grains Bank, 2018). Food and agricultural Organization (FAO) together with other development partners have initiated several CA practices in Kenya (FAO, 2014). For instance, FAO has established two Farmer Field Schools (FFS) in Laikipia County whose aim was to mitigate against the effect of drought on agricultural production. The goal of the initiative is to improve and maintain the output while at the same time protecting and encouraging biological functioning of the soil. The FFS project comprises integrated management of soil, water and other agricultural resources. Water harvesting, minimum tillage, rotational cropping, and maintenance of the soil cover are some of the practices promoted by the FFS. An evaluation of this project revealed that CA in the county leads to improved food production which in turn enhances food security for the residents (FAO, 2018). More specially, an assessment of the project shows that introduction of crop rotation, better land management practices, and maintenance of soil cover improved the biological functioning of the soil which ultimately led to higher yield and hence, improved farmer livelihoods. However, these observations are based on a project evaluation report, and no scientific study on the impact of CA has been conducted.

A similar initiative under the project, "CA- Sustainable Agriculture for Rural Development (CA-SARD) was also implemented in Bungoma, Siaya, Mbeere and Nakuru. Even though several farmers had embraced the idea, some constraints existed such as insufficient storage facilities, sky-rocketing input costs, lack of irrigation, lack of markets as well as vulnerability of agriculture to natural disasters. However, evidence shows that for those who adopted CA, there was a positive effect on farmers' livelihood since it helps to increase soil fertility, to conserve water and therefore, higher agricultural production leading to food and financial security (Yeray, 2012).

Several CA practices have been adopted in both Machakos and Makueni counties. This includes rotational cropping, water harvesting, soil conservation as well as intercropping. These counties are arid and semi-arid and thus, get insufficient rainfall. Several CA practices have been introduced by non-governmental organizations. The most notable programme in Yatta Machakos County is the one-acre rule quarter system introduced by Christian Impact Mission. Through this initiative, households are supported to build water pans to preserve rain water for irrigating lands during dry season and also training farmers on various CA practices. As a result of the project, small scale farmers have embraced CA practices and can also produce even during dry season. An assessment of the project ten years since its inception has established that most farmers are food secure, they can also afford to pay school fees and medical service and take care of other necessities (Masika, 2020).

Other similar initiatives are promoted in Machakos and Makueni counties by Christian impact mission and Kenya Small Scale Farmers Forum (KSSFF) respectively. Generally, many farmers have embraced CA in Machakos and Makueni counties than other counties in Kenya (Wekesa et al., 2018). Even though evaluation of these projects indicates that participation in CA has improved livelihood outcomes of the people, proper documentation of these findings based on robust scientific analysis is needed.

1.1.3 Challenges of Conservation Agriculture

The first major limiting factor in the adoption of conservation agriculture is farmers' perception. This practice requires additional management skills, farmers might be afraid to register lower crop yields and return from sales, lack of sufficient knowledge, poor weed and crop residue management. Additionally, crop residue retention contributes to pests and diseases and the cost for crop residue clearance is a concern for farmers (Lal, 2007). Furthermore, pest infestation, specifically termites and rodents, under residue retained CA fields are a major farmer concern.

Secondly, there is a lack of suitable farm equipment. Development, standardization, and adoption of farm machinery for seeding amidst crop residues with minimum soil disturbance is required for successful CA. New variants of NT seed-cum-fertilizer drill/planters such as Happy Seeder, Turbo happy Seeder and Rotary-disk drill have been designed for direct drilling of seeds even in the presence of surface residues (loose and anchored up to 10 Mg ha−1) and observed to be very relevant for crop residue management. This results in moisture and nutrients conservation as well as weed control. However, the non-availability or lack of access of such suitable farm equipment for marginal and small farmers are a major barrier to CA adoption (Lal, 2007).

The last limiting factor to CA adoption by farmers is lack of training for farmers and extension workers in the adoption of the CA techniques, which needs new skills and management strategies and also demonstration of best CA technologies on participatory mode involving different stakeholders (Somasundaram et al., 2020).

1.2 Statement of the Problem

Agricultural sector is the engine for growth and development in Kenya. The sustainability of agricultural growth is therefore critical for hunger and poverty reduction. An estimated 80% of Kenyans live in rural areas where farming is their main source of livelihood. However, there are long standing challenges facing smallholder farmers in the country

such as low productivity, production and low profits for commercial farmers. These have been attributed to conventional forms of agriculture which involve a lot of soil inversion and tillage, limited application of soil cover and crop rotation which is associated with poor soil fertility and land degradation that contribute to low crop productivity and eventually food insecurity. This is further compounded by climate change, variability and drought, as well as the depletion and degradation of natural resources (FAO, 2018). Continuous cropping as well as use of inappropriate farming techniques is practiced in many SSA regions resulting in immense negative environmental impacts which are characterized by a decline in erosion and soil fertility. Other effects include degradation of arable land leading to less yields, food insecurity and perennial starvation (Guto et al., 2011). These challenges which are associated with conventional farming prevent small scale farmers from improving their quality of lives since they end up becoming food insecure and unable to produce enough for the markets resulting in less returns.

Studies from other countries reveal that conservation agriculture practices improve the livelihoods of farmers (Nkala et al., 2012; Nkala et al., 2011; Uddin and Dhar, 2016; Fao, 2018). Similar observations have been made in the Kenyan context (FAO, 2008; Yeray, 2012; Masika, 2020). These studies argue that conservation agriculture produces higher net returns in the long run compared to conventional tillage. The higher returns are as a result of decreased costs of fuel, machinery and labor combined with improved strategies for water and soil management. In addition, conservation agriculture leads to increased soil fertility, minimized effects of strong winds, minimized effects of drought, increased crop yields, reduced soil erosion and land degradation, reduced crop production costs. Nevertheless, FAO (2018), Yeray (2012) and Masika (2020) studies have paid little attention on human development dimensions notably health and education in regards to CA farmers.

The studies above have mainly focused on economic and environmental aspects to show a change in livelihoods of CA farmers and paid little attention on human development dimensions notably health and education. In addition, it is not clear from these past studies on the role of producer associations. Furthermore, even though the effect of land

productivity and the cost of inputs on production is known, it is not clear on how these affect livelihood outcomes. There is thus scanty evidence with regard to the effect of participation in CA on farmer's livelihood for which the current study sought to address focusing on ASAL areas.

1.3 The purpose of the Stud

The purpose of this study was to assess conservation agricultural practices and their effects on livelihood outcomes in Arid and Semi-Arid areas in Kenya.

1.4 Objectives of the Study

The objectives of the study were as follows:

i. To analyze the effect of CA input costs on livelihood outcomes in ASAL areas in Kenya.
ii. To evaluate the effect of CA land productivity on livelihood outcomes in ASAL areas in Kenya.
iii. To assess the effect of socio-economic characteristics on livelihood outcomes of conservation agriculture farmers in ASAL areas in Kenya.
iv. To analyze the effect of marketing institutional arrangements of CA on livelihood outcomes of smallholders in ASAL areas in Kenya.
v. To assess the effect of participation in CA producer associations on livelihood outcomes in ASAL areas in Kenya.

1.4 Research Hypotheses

To assess the influence of each of the independent variables on the response variable, this study will be guided by the following null hypothesis:

$H0_1$: There is no significant effect of participation in CA producer associations on livelihood outcomes in ASAL areas in Kenya

$H0_2$: There is no significant effect of CA input costs on livelihood outcomes in ASAL areas in Kenya

$H0_3$: There is no significant effect of CA land productivity on livelihood outcomes in ASAL areas in Kenya

$H0_4$: There is no significant effect of socio-economic characteristics on livelihood outcomes in ASAL areas in Kenya

$H0_5$: There is no significant effect of marketing institutional arrangements on livelihood outcomes in ASAL areas in Kenya

1.5 Significance of the Study

This study makes three key contributions. First, it seeks to fill the literature gap that exists. There are very limited studies on the effect of conservation agriculture on livelihoods of people particularly in Kenya. Thus, the study sheds more light on this. Secondly, findings could be used by policy makers at national, county, intergovernmental and non-governmental organizations to formulate measures to improve rural agricultural practices and enhance yield for poverty alleviation. Third, findings of the study might act as a springboard upon which other studies will be based.

1.6 Scope of the Study

The study on the effect of participation in conservation agriculture practices and its effects on livelihoods was restricted to Makueni and Machakos Counties which are ASAL areas where CA is practiced. These two counties receive insufficient amounts of rainfall. The respondents targeted in this study were adopters of conservation agriculture who have embraced the practice at different levels with some having adopted all three principles while others have adopted either one or two principles. The study relied on CA farmer groups that have been formed in the two counties to get respondents who were registered members of the groups.

1.7 Limitations of the Study

This study was limited to Machakos and Makueni counties and not any other counties where CA is practiced since the two are arid and semi-arid thus receive insufficient rainfall. Some farmer groups were not having regular meetings thus making it difficult to meet them for the data collection. This limitation was surmounted through the use of other CA farmer groups within the same localities. In addition, some respondents had difficulties reading and writing on the questionnaires because of low levels of education. This limitation was surmounted through the use of research assistants who assisted such farmers to fill the questionnaires. The group leaders of the various farmer groups also assisted the farmers who were unable to write.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter reviews both theoretical and empirical literature on the influence of participation in conservation agriculture practices and the effects on livelihood outcomes. In this chapter, a theoretical review linking the variables to theories and objectives of the study will be undertaken, the conceptual framework revealed and an empirical review to cover each variable undertaken. The chapter specifically covers the past studies where it discusses literature related to the specific objectives of the study.

2.2 Theoretical Framework

A theory consists of a systematic body of ideas about a particular topic or phenomenon. Theories organize and explain a variety of specific facts or description of behavior (Nelson and Knight, 2010). According to Saunders, Lewis and Thornhill (2016) a theory acknowledges its proponents stating the main arguments emphasized and illustrates the framework using diagrams thus emphasizing the theoretical proposition of the study. A theoretical framework of any study is a structure that holds and supports a theory of the research thus serving as a basis for conducting research (Cooper and Schindler, 2014). This study will be based on the sustainable livelihoods approach and Capability approach theories.

2.2.1 Sustainable Livelihood Approach

The sustainable livelihood approach is associated with a view of development agenda that is people-centered; founded on the premise that people draw from assets owned (financial, natural, human, social and physical) to seek a range of livelihood outcomes such as reduced vulnerability, health, income, food security and a more sustainable use of natural

resources. The framework emphasizes four types of sustainability: economic, institutional, social and environmental sustainability (Carney, 2002).

Sustainable Livelihood Approach is founded upon the notion that intervention must be based upon an appreciation of what underpins livelihoods. This approach/framework evolved in the 1990s and it is based on theoretical work and practical experience of programmes of UNDP, CARE and OXFAM. This framework not only integrates environmental concerns into sustainability of development projects but also tries to include the social and economic concerns into sustainability of development projects. SLA emerged within the international development context approach whereby development practitioners were pursuing the effectiveness of their interventions to assist the underprivileged. In effect, it is a problem-solving tool that offers a structure for analysis resulting in concrete recommendations for intervention (Allison and Horemans, 2006).

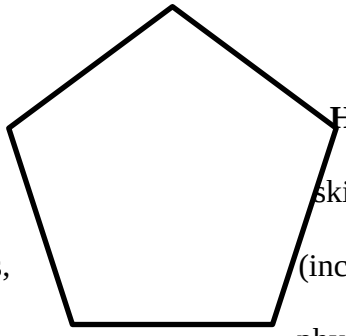
Chambers and Conway (1992) understands a livelihood as involving the capabilities, assets (stores, resources, claims and access) and activities necessary for a means of living. They posit that a livelihood is sustainable if it can cope with and get back from stress and shocks, uphold or heighten its capabilities and assets, and offer sustainable livelihood opportunities for next generations. It is also sustainable if it adds net benefits to other livelihoods both at the global and local levels as well as in the long and short term.

SLA is an example of the "multiple capital" approach where sustainability is treated in terms of available capital (natural, human, social, physical and financial) and an investigation of the context of vulnerability (trends, shocks and stresses) through which these assets exist (Scoones, 1998). There are five capitals of sustainable livelihood as underscored by Scoones (1998).The first one is natural capital which includes natural resource stocks (soil, water, air, genetic resources etc.) and environmental services (hydrological cycle, pollution sinks etc.), secondly, human capital which includes skills, knowledge, labour (includes good health and physical capability).Thirdly is economic or financial capital base (cash, credit/debt, savings, and other economic assets).Fourthly, Social capital social resources (networks, social claims, social relations, affiliations,

associations). Lastly is the Physical capital which are (buildings, roads), production equipment and technologies).

Natural capital

natural resource stocks (soil, water, air, genetic resources etc.) and environmental services (hydrological cycle, pollution sinks etc)



Social capital

social resources (networks, social claims, social relations, affiliations, associations)

Human capital

skills, knowledge, labour (includes good health and physical capability)

Physical capital

Infrastructure (buildings, roads), and other production equipment and technologies)

Economic or financial capital

capital base (cash, credit/debt, savings, economic assets)

Figure 2.1: The Five Capitals of Sustainable Livelihood

Source: (Scoones, 1998)

Farrington (2001) outlines a more informed view of the different aspects of SLA:

1. As a set of principles guiding development interventions (whether community led or otherwise). The vital assumption here is that an intervention has to be evidence-based as opposed to initiated through top-down fashion without satisfactory knowledge of the community. Therefore, SLA can be viewed as a loose checklist of points that require to be deliberated before planning an intervention.
2. As a formal diagnostic framework to aid in understanding what ‘is’ and what can be done. The framework contributes to an appreciation of the capitals which are accessible to households, their vulnerability and the involvement of institutions.

3. As a general developmental objective. Development in this case is viewed as an enhancement of livelihood sustainability, possibly by making capital less vulnerable or by improving the contributions made by some capitals or even by enhancing the institutional context.

The differences between these aspects of SLA may appear to be rather fine, particularly with regard to 1 and 2. SLA has contributed to the establishment of the principles that successful development intervention, if internally led, must begin with a deliberative process of acquiring evidence adequately broad in vision and not limited to what may appear like a good 'technical' fix. This may be a shocking development given that the logic upon which SLA is based appears clear—before development can take place, there needs to be some idea of what should be done as well as with the why and how it should be done. It implies an essential magnitude of humility since it suggests availability of much to be learned and understood before assistance is offered; this has to be built upon a partnership with those meant to benefit as opposed seeing them just as passive recipients.

The framework emanates from the reaction that sustainability of projects is wider and should go beyond the environmental factors. As an approach it is compatible with right based approaches to development which target the participation of the people in projects which leads to better outcomes such as increased wellbeing, improved food security, income levels among others. This approach stresses participation of people in planning of local micro-projects to international projects as key in ensuring sustainability of the outcomes which will go a long way in articulating poverty of the people in the society. This approach has largely been perceived as applicable to rural development projects.

The livelihoods approach places people at the centre of development. The priority concern is people and not resources they use or governments serving them. Complying with this principle may well imply for instance offering support to resource management or good governance. However, it is the primary desire of supporting people's livelihoods that should determine the shape of the support and offer the basis for evaluating its success (DFID, 1997).

SLA has certainly helped establish the principle that successful development intervention, even if led internally, must begin with a reflective process of deriving evidence and this has to be broad in vision and not limited to what may seem like a good "technical" fix. This may be a surprising advance given that the logic upon which SLA is based seems clear. Before development can take place there must be some idea what needs to be done, how and why. Sadly the history of development is replete with top-down projects planned to deliver change to a population without really thinking through feasibility and thus after much spending in terms of resource and time there was little to show for it (Morse and McNamara, 2013).

A further attraction of SLA is that it is people-centered in a direct sense, and depends upon the involvement of those meant to be helped by change. Indeed this is both a principled and practical stance as it is hard to imagine being able to carry out an SLA without the involvement of these people. Thus SLA forces an engagement with those meant to be helped by an intervention or policy. It cannot be done from an office. In line with participatory approaches in general this provides opportunities for community-based learning where people can learn from each other as well as from outsiders (Butler and Mazur, 2007). As a result SLA builds upon the long history of the participatory movement in development.

The SLA was customarily used in poorer countries as part of a planning phase for an intervention through policy, a development project or possibly as the basis for more in-depth research. In that sense the SLA is an analysis of peoples' current livelihood and what is required for an 'improvement', and suitable in avoiding the improper interventions condemned by the post-developmentalists. The SLA could also result in recommendations that people themselves may be able to put into practice rather than be dependent upon the actions of outsiders. It is thus a 'no holds barred' approach to understanding and improving the sustainability of livelihood, although it clearly has to take into account what is feasible in different circumstances (Morse and McNamara, 2013).

The Sustainable Livelihoods Approach is a key theory in this study because it highlights the various tenets that are crucial for sustainability of a project. The theory echoes that human capital is key in sustainability and this human capital is in the form of skills, knowledge and labour. This can only be tapped in projects if there is a greater degree of active involvement of the intended beneficiaries. This is in line with the study's objective on the influence of participation in conservation agriculture on livelihood outcomes. When people are actively involved in projects, their skills and local knowledge can be utilized. This is echoed by Bell (2001) who points out that involvement of people will increase the level of local knowledge and labour which are crucial in realizing sustainable projects. Their contribution also in terms of cash can be realized which is one of the principles of sustainability envisaged by this framework. Mbata (2006) further points out that if local people participate, it would be possible for them to contribute some financial resources for the projects, a component for sustainability. The financial resources will be used in for instance purchase of equipment and seeds recommended for CA practice and leasing of ample land.

SLA is also relevant to the study through farmers applying asset endowments such as land to seek preferred livelihood outcomes relying on conservation agriculture as a means through which those outcomes can be achieved. Niehof and Price (2001) argue that while the accumulation of capital assets enables people to conquer risk and vulnerability, depletion of the assets may lead people into vulnerability. Conventional farming leads to little or no replenishment of nutrients and burning of residues severely depleting the soils and eventually resulting in decreased yields. Therefore, the goal of most development initiatives including CA, achieving the objectives of this study is supporting people to amass capital assets.

2.2.2 Capability Approach

Amartya Sen's original works in social choice, welfare economics, poverty and famine and development economics have greatly inspired the capability approach which is also referred to as the human development approach. The fundamental understanding of

capability approach is that social arrangements should aspire to expand people's capabilities to promote or achieve what they value doing and being. Capability is hence a set of vectors of functioning, reflecting the person's freedom to lead one type of life or another (Sen, 1992).

According to Severin et al., (2009) a crucially imperative phrase in defining functioning is ‘value and have reason to value’. Functioning constitutes things that people value. In other words an activist or situation amounts to a functioning for that person only if that person values it. In this case change is imperative only in so far it leads to outcomes valued by people. Capabilities refer are the freedom to enjoy valuable functioning. In this way, capabilities are portrayed as the real and actual opportunities open to a given person. Development and policy focuses on making people free to enjoy some blend of functioning which allows them to expand their capabilities. Capability building for human beings would involve giving people a sense of self-discipline, education, responsibility, health information and material wealth which is referred to as empowerment (Severin et al., 2009). Development seeks to create an enabling environment for people to enjoy long, healthy and creative lives. All aspects of development including economic growth or international trade; budget deficit; savings, investments or technology are covered by the capability approach. Development aims to widen choices of people and enrich their lives. The capability approach is made up of four essential pillars: equity sustainability, efficiency productivity and empowerment (Haq, 1995).

Equity draws on the concept of justice, impartiality and fairness and integrates a consideration for distributive justice between groups. Efficiency refers to optimal use of existing resources. Empowerment arises from participatory development which entails the processes that people act as agents of their own development. It is about the freedom in making decisions in matters concerning their lives, the freedom to guide development in their communities. Sustainability refers to the durability of development to the face of environmental limitations. It refers to propelling human development in such a way that results in terms of social, political, financial and technological undertakings over time.

Different sets of capabilities exist in the case of an application to an organization. These include managerial technological, investments capabilities, innovation capabilities, linkage capabilities, production capabilities have an effect on the productive efficiency of organizations, innovative capability, substantial growth in productivity and enhancements on organizational resilience and competitiveness. The two most common organizational capabilities in developing countries are managerial and technological. Very few firms have investment capabilities which evidently strain their competitive ability.

2.2.2.1 Capability Approach: Critique

Sen's Capability Approach has been criticized for underplaying the importance of negative freedom vis-à-vis positive freedom: positive freedom is the possession of the power and resources to fulfil one's own potential whereas negative freedom is non-interference by other people (Christopher, 2013). In some respects negative freedom seems to feature more prominently in versions of the Capability Approach that distinguish internal capabilities from the external conditions required to achieve these capabilities. Sen, however, does acknowledge 'the special significance of negative freedom' for the CA (Sen, 1992). He argues that capability failure can stem from the violation of personal rights as well as the absence of positive freedoms (Sen, 1985a). Moreover, in contrast to some capability theorists (who tend to shun personal liberty, e.g. Nussbaum, 2005b), Sen argues that negative freedom has intrinsic as well as fundamental significance (Sen, 1985a).

Gasper (2002) has criticized Sen for failing to modify his terminology in line with these distinctions. He has also argued for a richer conception of human personality, which incorporates the variety of values and motives that influence human action (Gasper, 2002; 2004). These motivations extend well beyond Sen's (1999) classic distinction between acts based on 'sympathy' (feelings for other people) and commitment' (goals beyond personal well-being).

Some commentators have suggested that Sen pays insufficient attention to 'the means of freedom' (Qizilbash, 1996), while others have emphasized the links between human capital and human capability (Streeten, 1994; 2000; Haq, 1995; Sen, 1997; 1999; Bebbington, 1999). While both these approaches 'put humanity at the center of attention, the narrower view of the human capital approach fits into the more inclusive perspective of human capability' which takes note of the direct relevance of human capabilities for well-being and their indirect role through facilitating social change and promoting economic activity (Sen, 1997; 1999).

Sen's capability approach is limited on the basis of arguing for ensuring people are enjoying their freedoms to enable them realize their full potential. Some of the freedoms if not properly checked could infringe on the freedoms of others or could end up being misused. This notwithstanding, the capability approach has great potential for human development since people are allowed to exploit their full abilities and contribute to national development in the long run.

Capability approach enriches this study as it favors the enlargement of people's potentials in regards to what they like doing or being. This argument is supported by Sen (1992) who argues that the increased involvement in projects and activities that benefit them, especially through more income earnings. All these are crucial elements of livelihood outcomes through adoption of conservation agriculture. The fundamental idea of capability approach is that social arrangements seek to expand people's capabilities to advocate or achieve what they value doing and being. People's potentials will be enlarged through participating in conservation agriculture hence they will be able to achieve food security, educate their children, access medical healthcare and venture into alternative sources of income such as off-farm activities.

2.3 Conceptual Framework

Mugenda and Mugenda (2003) defines a conceptual framework as a hypothesized model identifying the concepts under the study and their relationships. It's a diagrammatic

presentation showing the relationship between independent and dependent variables. It aims at explaining the relationship between variables and it synthesizes the idea in a systematic way to provide direction. A dependent variable is what one measures in the experiment and what is affected during the experiment. An independent variable on the other hand is a variable presumed to affect or determine a dependent variable (Dodge, 2003). A moderator variable is related to the direction or strength of the relationship between the independent and dependent variables (Baron & Kenny, 1986).

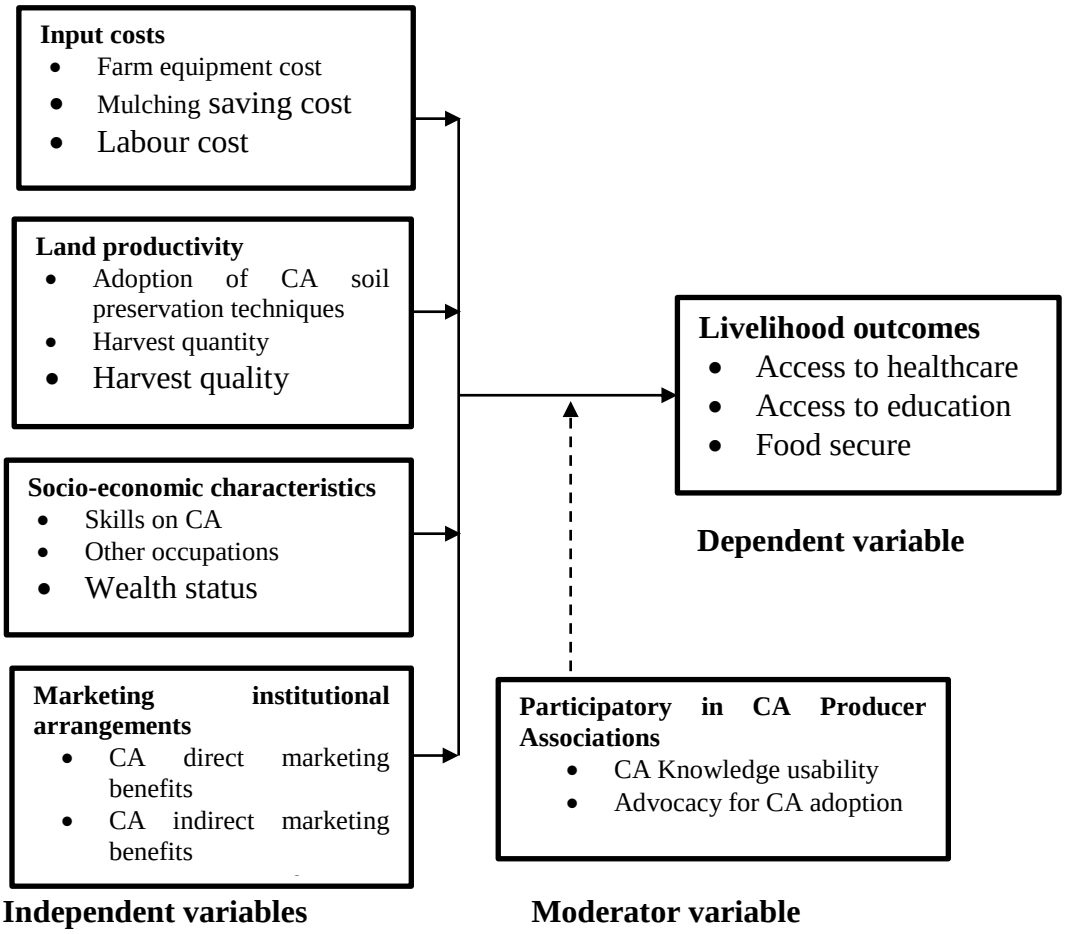


Figure 2.2: Conceptual Framework

2.4 Empirical Literature

The study reviewed empirical evidence from books, journals, periodicals and electronic sources as documented by other scholars both locally and internationally. The review will be done as per the objectives of the study.

2.4.1 Participation in CA Producer Associations

According to Mushtaq (2004) participation is a process by which people from all sects of community both rich, poor, men, women, uneducated, educated can influence or control those decisions, which affect their lives. This involves participation of project beneficiaries, women and men in decision making, design, construction and operation and maintenance of community projects. The supremacy of community participation has become a central idea within contemporary development theory and practice (World Bank 2010; Narayan 1998; and Kumar, 2002). In addition, much of the current development practice analysis has been informed by the idea of participation (Chambers, 2005).

Local participation is seen as one of solutions to the problem of project performance. Since the 1990s, bilateral agencies for example the World Bank placed greater emphasis on stakeholder involvement as a way to ensure development sustainability. It is now considered as a critical component which could promote the probabilities of development initiatives being sustainable through community capacity building and empowerment. This includes giving the marginalized people, vulnerable, and excluded from development, the ability for self-reliance to manage their own resources. Contribution would lead to empowerment through capacity building, skills, and training. Enhancing the ability of people, projects, and or communities to be self-reliant means they are able to contribute towards the performance of development projects which in turn could contribute to broader national development (Mwaura & Ngugi, 2014).

Community participation during project selection, design and installation can contribute to achieving an increased sense of ownership on the part of the community. Communities

that feel ownership of a hand pump installed at a shallow well are more likely to look after it. Institutional arrangement or local community structures for managing the water projects are also important. Community participation and ownership have a valuable role to play in achieving sustainability, but can create other challenges. In particular, how realistic is participatory decision making where community members have very little understanding on various management and technological options and their implications on the long run? This raises the question of whether it is appropriate to try and bridge such a vast and costly knowledge gap for the sake of ownership (Nkongo, 2009).

Mulwa (2008) echoes that community development initiatives fail because of the lack of true participation of the communities in them. The kind of participation often employed involves extractions which seek to extract resources from the people because they are required to do so, handout participation also seeks to foster dependency of communities on external development agents, inhibiting them from making informed decisions about the projects and owning the projects introduced. This basically means the notion of top-down approaches in development. Mulwa (2008) suggests genuine participation practice which will not only seek to involve the beneficiary communities in project design and implementation but more importantly the process which seeks to link people's felt needs with the project goals and objectives. Additionally, participation has to advocate for the best practices ever. This will go in a long way in ensuring local ownership and the sustainability of project benefits long after their implementation. In his view, active participation in community development basically involves components such as needs assessment, prioritization of own needs (making informed choices), action planning, implementation, monitoring, evaluation and sharing of benefits and loss.

Arnstein (1969); Chambers (2005); VeneKlasen and Miller (2002); Kanji and Greenwood (2001) describe various models of participation of communities in development projects and includes the full range and depth of community participation, from simplistic consultation by the elites in the community to the full and active participation of a representative cross-section of a village or set of villages. Other authors have also

described seven models of community participation in development initiatives. These authors include Kumar (2002). The seven models are described below.

The first one is passive participation whereby people participate by being told what is going to happen or has already happened. It is a one-sided announcement by leaders or project management without listening to people's responses or even getting their opinion. Secondly, participation in information giving whereby people participate by answering questions posed by extractive researchers using questionnaire surveys or similar approaches. People do not have the opportunity to influence proceedings, as the findings of the research are neither shared nor checked for accuracy.

Thirdly is participation by consultation. People here participate by being consulted, and external people listen to views. These external professionals define both problems and solutions, and may modify these in light of people's responses. Such a consultative process does not accept any share in decision-making, and professionals are under no obligation to take on board people's views.

Fourth is participation for material incentives whereby people participate by providing resources, for example labour, in return for food, cash or other material incentives. It is very common to see this called participation, yet people have no stake in prolonging activities when the incentives end. The fifth one is functional participation. Here, people participate by forming groups to meet predetermined objectives related to the project, which can involve the development or promotion of externally initiated social organizations. Such involvement does not tend to occur at the early stages of project cycles or planning, but rather after major decisions have been made. These institutions tend to be dependent on external initiators and facilitators, but may become self-dependent.

Interactive participation is the sixth level. Here, people participate in joint analysis, which leads to action plans and the formation of new local institutions or the strengthening of existing ones. It tends to involve interdisciplinary methodologies that seek multiple perspectives and make use of systematic and structured learning processes. These groups

take control over local decisions, and so people have a stake in maintaining structures or practices.

The last level of participation is self-mobilisation. People participate by taking initiatives independent of external institutions to change systems. They develop contacts with external institutions for resources and technical advice they need, but retain control over how resources are used. Such self-initiated mobilisation and collective action may or may challenge existing inequitable distributions of wealth and power.

According to Chambers (2002) the current significance of involving end-users in the assessment, design and implementation phases of development projects was not always the case, with the evolution of participation taking decades. For example, since the early 1960's, development agencies have undertaken to involve communities through using numerous participatory techniques and methods (Chambers, 2002; Chambers, 2005). As Chambers (2002) observes, the modern version of community participation is resultant at least in part from activist participatory research and Paulo Freire's writing in *Pedagogy of the Oppressed* (1968), Gordon Conway and the systems, action-oriented thinking of agro ecosystem analysis (Conway, 1985) the early 1980's applied anthropology movements, particularly Robert Rhoades, *The Art of the Informal Agricultural Survey* (1982), along with the use of Rapid Rural Appraisal (RRA), developed in the late 1970's, as response to the dissatisfaction practitioners were having with traditional surveys and other extractive methods of gathering information (Chambers, 2002).

Kumar (2002) illustrates how the typology of participation has evolved since the concept was first used, reporting that in the 1970's participation basically meant that the people agreed with decisions made for them. In the 1990's participation progressed into the active involvement of people to analyze their situation and organize themselves to take actions for changing it (DFID, 2001). According to Bell and Morse (2004); Garande and Dagg (2005) part of the reason for using participatory processes in development activities is that, there is now a widespread recognition that projects have much greater chance of

accomplishment as well as attaining a much higher level of effectiveness when participatory processes are applied (Bell and Morse, 2004); Garande and Dagg, 2005).

According to Nikkhah and Redzuan (2009) participation in which people get directly involved in the projects ensures that they can take control of decisions that affect their lives. They conclude that participation as an end would lead to empowerment through top-down, bottom-up and partnership. Empowerment and type of participation as an end in bottom up approach of community development will be high, and consequently the particular community will have achieved sustainable development.

Yuerlita, Febriamansyahv and Saptomo (2004) in a study in Indonesia note that there is a need to emphasize on equal participation between men and women in decision-making process, implementation, operation and maintenance and monitoring and evaluation. In the decision-making process, men more actively participate and they attend meetings more frequently than women. Women also participate in the project construction as well as men as unpaid laborers. However, women do not get any knowledge about the schemes during the project construction or training. Women use the facilities more often than men but lack of general knowledge on the schemes make the women unable to do maintenance tasks. The sustainability of a project may be threatened because women are not effectively involved in the project. Therefore, involving both men and women effectively in the project phases need to be emphasized and implemented in the achievement of project sustainability.

Since the 1980's, all the participatory methods and tools share the goal of the involvement of the project beneficiaries in the identification, design, and management of project outcomes (Bentley, 2004). At its most essential, participation entails two similar but distinct principles: efficiency and empowerment (Wright, 1995). Kumar (2002) argues that the empowerment facet of participation seeks to create a condition where the right to define one's destiny is realized and decisions regarding use of resources involve the resource user. Participation as empowerment strives to develop the capacity and ability of

people to enhance their own lives notwithstanding intervention from outside (Freire, 1996; Cleaver, 2001).

2.4.1.1 Producer Associations

A Producer association is an organization created by producers to offer services that support the members' farming activities. A major distinction can be made between cooperatives and producer associations. Although both are membership-based service providers, the cooperative usually is a collectively owned firm with economic activities, assets and strategies, while the association should not be seen as a firm itself but as an economic interest organization (Bonus, 1986).

Evidence suggests that there is immense interest in producer associations by both governments and donors around the world (Bernard & Spielman, 2009). This has been informed by the key role played by these organizations, particularly, that of knowledge dissemination and advocacy for farmers. Fisher and Qaim (2012) argues that PA are institutional vehicles to enhance performance of small-scale agriculture through knowledge generation and lobbying for better policies. These have the potential of increasing agricultural productivity and therefore, food security as well as poverty alleviation. In a similar study, farmers organizations have been proposed to be tools to improve the standards of living of the rural poor in developing countries due to their knowledge- based advice (Mwaura, 2014). This could go a long way in enhancing livelihood outcomes of the farmers.

Olwande and Mathenge (2012) have established that participation in farmer organizations improves livelihood outcomes of small-scale farmers through improved yields. This study attributed this to extension services offered to farmers by these organizations. In addition, the study observed that these associations act as key information sources on the entire value chain such as availability and price of inputs, farming technologies such as use of farm machinery and conservation agriculture, and availability of output markets. Through PA, small scale farmers attempt to find ways through which they can gather resources

through both formal and informal systems to guarantee maximum income and enhanced welfare (Millie et al., 2006). They found that through PA, farmers are able to overcome imperfections in the market through extension services as well as knowledge dissemination. Moreover, PA provides the needed information for farmers to execute their role in the market economy and the associated benefits.

A study by Fisher and Qaim (2012) established that information access and advocacy functions form the primary motivation for farmers to participate in farm/PA. The study notes that failure to prove these services to the farmers threatens their participation in PA. However, this study reports that the role of Pas is faced with myriad challenges such as poor infrastructure, competition with local traders, and insufficient provision of services.

The PA can apply informal mechanisms, in the community and in the organization, to improve information flow among the members and between members and outside trading partners. The transaction costs instigated by uncertainty and difficulties in measurement of performance are reduced by the social capital in the PA which is in the form of identification, commitment and social norms. Therefore, producers as members of a PA tend to exhibit a minor risk of opportunistic behaviour by the marketing firm since it is owned collectively and controlled by themselves. Additionally, the social mechanisms keep members from such behaviour (Borgen, 2001).

Producer associations can be distinguished into formal and informal. A formal legal status provides PAs with the capacity to borrow money and get into contracts. In case there is no legal status for the PA, any contract with a third party must be with individual members or an individual member of the PA. Secondly, lack of a legal framework implies that each cluster of related persons must create the nature of their corporation to each other and their governing framework. Thirdly, formality of a PA ensures that it is safe from misdeeds for instance misappropriation of funds or the abuse of its name. Fourth, a distinct legal status also aids in the partnership of PAs. Fifth, a legal status streamlines the procedures on accountability of the PA and its membership. Formalization may attain significance when

PAs intend to get into contracts with potential buyers regarding the delivery of farm products of specific standards (Eaton et al., 2008).

According to David et al., (2005) the formation of Small Farmer Groups and Associations has the potential to increase the participation of small-scale cattle farmers in formal markets. This proved possible in a vegetable farming project of Fort Hare Farmers Group of Zanyokwe irrigation Scheme. The group of farmers in the farming project penetrated large markets which included Pick 'n Pay and Fresh Produce Market in East London. According to Ntshangase, Muroyiwa, and Sibanda (2018) CA training positively influenced CA adoption in Lesotho and South Africa, respectively. A similar result is also reported by Mulimbi et al., (2019), who claimed that in DRC, a farmer who received CA training was more likely to adopt CA. In Malawi, membership in a farmers' group has been reported as a driver of CA adoption (Chisenga, 2015).

A study of cattle marketing channels used by small scale farmers in South Africa (Musemwa et al., 2008) found that formation of cattle marketing groups' increases information access, lower transaction costs, increases access to information and increases participation into formal markets. In addition, PAs advocates for farmers with regard to agricultural sector policy and market access. The market and bargaining power that a farmer can receive in a small group of between two to five farmers cannot be compared to that from a larger group. By combining to become larger associations, small scale farmers have the potential to achieve even greater economies of scale in accessing services, information, infrastructure and markets. As far as transporting cattle is concerned, costs can be easily reduced if these groups rely on the same transport to the market. By transporting in bulk, they stand a better chance of getting good discounts from transport firms as compared to transporting as individuals and in small quantities.

2.4.2 Input Costs and Livelihood Outcomes

Minimum tillage and permanent soil cover principles of conservation agriculture contribute immensely to livelihood outcomes of farmers. Minimum tillage leads to less

farm inputs being utilized implying that the extra income and labour is then invested in non-farm activities resulting in more incomes for the farm households. Permanent soil cover ensures that not much farming activity goes on in the farm as opposed to conventional agriculture whereby labour and fertilizer will be required for clearing the weeds and enriching the soils for more land productivity.

Friedrich & Kienzle (2007) in a study on the impact of CA on farmers' mechanization and equipment in Italy noted that the equipment for monitoring the surface vegetation is primarily Diammonium phosphate (DAP) and tractor driven comprising chemical (herbicide) control measures as well as mechanical (for example knife rollers). Diminished leveling, especially the traditional labour and power bottleneck during land preparation is normally the power and time conditions for field processes associated with crop establishment and crop farming. Furthermore, the labour necessities for weeding are regularly lessened when herbicides are used.

Doets et al., (2000) assert that the total inputs for conventional ploughing is 40-50% lower. The chief reason for this is decreased input quantities: herbicide, machinery and fuel. Generally, machinery-based inputs are 20-40% lower with conservation which is due to the abolition of the need to plough. There was a reduction of 60% in fuel consumption for the studied systems which is a similar figure for both DAP systems and human-powered. The energy saved is of particular interest to small scale farmers since there is reduced investment of time in agricultural production and more quest for off-farm jobs or the desire to expand their cultivated area. In addition, investment in equipment primarily the size and number of tractors is minimized significantly (Bistayev, 2002).

Long term use of CA shows a drop in the usage of agrochemicals which is due to heightened natural control processes. Over time, the natural control of diseases and pests has been improved and the involvement in weed management using crop rotations supports this long term reduction in agrochemical usage. Less mineral fertilizer is lost through leakage and erosion with the diverse rooting systems salvaging more soil nutrients from a larger soil volume hence the total efficiency of fertilizer usage is enhanced in the

long term. A replication of this is noted in the major decline of the fertilizer needed to preserve the production and levels of soil nutrient over the crop rotation (Saturnino & Landers, 2002). In addition, Bassi, (2000); Saturnino & Landers (2002) argue that the decreased leakage of soil nutrients and farm chemicals combined with the soil erosion results in a significant enhancement of the water quality in watersheds applying CA hence more yields.

A study of the impact of CA on farmers' livelihoods, labour and mechanization in Italy (Friedrich & Kienzle, 2007) found that power and time needs for farm operations associated with crop creation and crop gardening are minimized, leveling mainly the traditional labour and power barrier during land preparation. Furthermore, labour requirements for weeding are decreased especially if herbicides are used. According to Vastola et al., (2017); LaCanne and Lundgren (2018) even when yield reductions are observed in some instances, CA systems can still be more profitable than conventional agricultural systems due to reduced input costs. Additionally, Kumar et al., (2018) and Devkota et al., (2019) observed that where CA leads to similar or greater yields, profitability is generally improved due to reduced costs of land preparation and labor, and reduced water requirements.

The labour input in the CA system can be minimized by 75% since the time saved allows farmers to dedicate more time to other more profitable non-farm occupations for generating income than growing crops. Availability of extra time provides opportunities to farmers for diversification alternatives. Conservation agriculture provides women with opportunities to engage themselves in other income generating and socioeconomic activities while also sparing more time to take care of the family (IFAD, 2005 and FAO, 2007). Uddin & Dhar (2016) reported that farmers adopting conservation agriculture practices could save more time and money to invest in other income generating activities compared to those who are not adopting.

According to a study by Friedrich and Keinzle (2007) in the case of South America, CA was found to reduce the amount of fertilizer application. This has reduced the cost of both

manure and fertilizer for farmers. The money saved can be used to diversify the rural economy by investing in other on-farm and off-farm activities to supplement farmers' income which could go a long way in improving rural livelihood. These substitute income sources include but are not limited to: fruit and vegetable farming, rearing of small animals, bee-keeping, fish farming and the related activities for value addition.

Minimal need for farm machinery and chemicals is one of the most apparent changes for the farmer on introduction of CA. According to Doets et al., (2000), CA reduces total farm requirement for farm equipment for land production by up to 60% when compared to conventional farming. This is because most power intensive activities such as tillage are abolished. Furthermore, conservation agriculture minimizes labour needs for weeding especially if herbicides are used. Nonetheless, in arrangements without the usage of herbicides new labour spikes for weed control can arise during the learning period and mainly in the first two years. During harvest period, new labour spikes can also arise particularly when the introduction of CA leads to substantial increases in yields which eventually can happen during the first years (Friedrich, 2007).

Mariki (2003) asserts that the labour is saved by 54% in the fourth year of implementing no-tillage with cover crops. An IFAD/FAO combined study exploring the prospective of CA as a labour saving exercise revealed that when a jab planter is used compared to hand hoe, labour inputs in conservation agriculture arrangement may be reduced by 75%. Farming without ploughing also alleviates the labour deficiencies that influence smallholder farmers in the sub-Saharan region as a result of rural-urban migration as well as the rapid spread of HIV/AIDS (IFAD/FAO, 2004). Farmer surveys in Pakistan and India reveal that zero-till of wheat after rice reduces costs of production by US$60 per hectare ordinarily due to less fuel (60–80 l haK1) and labour (Hobbs et al., 2007). Mhlanga et al., (2021) conducted a study on the crucial role of mulch to enhance the stability and resilience of cropping systems in southern Africa. They found out that the use of mulch combined with minimum tillage resulted in significantly lower stability variance on maize grain yield and shoot biomass compared with the other cropping systems hence indicating that mulch promoted an increase in the stability of production.

According to Lange (2005) conservation agriculture results in saving time and labour thus the majority of the farms introduce substitutes such as fruit and vegetable farming, rearing of small animals, bee-keeping, fish farming and the related activities for value addition. Waweru et al., (2013) in a study on Farmers' perception of conservation agriculture in Laikipia found that there was labour reduction as a result of CA adoption. Teklewold (2013) reported that in farming, women participate in numerous agricultural tasks including mainly cleaning the field during land preparation, transporting inputs to the field, weeding, harvesting, transporting, threshing and storage of the production. Furthermore, they are also involved in managing home garden crops, poultry raising, feeding, watering and cleaning of livestock and milking. Therefore, women would welcome less work in the field and concentrate on housework and other off-farm activities.

A study on CA, labour and livelihoods in the Arab Region indicated more direct impacts having a potential to improve the daily and periodic calendar and in the long term adjust the daily activities of farmers as a result of minimized labour requirements for tillage expected to occur thus availing more time for diversification options (for e.g on farm sale of produce, poultry farming or other off-farm small enterprise enlargements (Friedrich and Kienzle, 2007).

2.4.3 Socio-Economic Characteristics of Conservation Agriculture

Conservation agriculture practices have essentially targeted vulnerable farmers. Different household characteristics influence technology adoption. Conservation agriculture is a form of technology and its adoption by farmers relies heavily on the socio-economic characteristics of farmers. Some of these characteristics include; level of education, health status, age, land ownership and levels of income. The socio-economic characteristics will also contribute to the different levels of CA adoption by the farmers.

Patrick & Isaac (2010) in a study on CA practices in Zimbabwe found that on average, farmers had 6.4 years of formal education meaning that household heads across the surveyed districts had attained up to primary level of education and are generally literate.

The education level is vital in assessing the ability of farmers to appreciate and grasp new principles or concepts. Bisangwa, (2013) asserts that the level of education of the household head is certainly linked with adoption of CA hence livelihood. Similarly, Wall (2007) argues that CA technologies are relatively knowledge intensive hence household heads with higher educational attainment have a high likelihood of using CA technologies in their fields. Farmers who have received some training in agriculture have a high likelihood of using CA on their fields. Furthermore, farmers trained by NGOs or extension officers tend to receive input subsidies if they practice CA (Bisangwa, 2013). A study by Aryal (2019) reported a positive association between education and the likelihood to adopt CA.

In a study on farmers' perception of CA in Kenya, Waweru et al., (2013) found that the higher the level of education the higher the practicing of CA by the farmers. The reason for this could be that the education exposed the farmers to understanding the benefits of CA such as increased yields and secure livelihoods, lower cost environmental conservation leading to positive perception hence the higher adoption rate. Maphosa et al., (2012) in a study on the impact of CA on food security in Zimbabwe found that on average, farmers had 7 to 10 years of formal education implying that household heads across the surveyed wards had attained up to primary level of education and are generally literate. The literacy levels in the districts are a sign that the knowledge input from the AGRITEX officers on CA practices is well received and applied.

Patrick & Isaac, (2010) in a study on CA practices in Zimbabwe reported that chronic illnesses directly limit conservation agriculture labor availability in the household. This has been found to have adverse effects on livelihoods of the farmers. The study finds that on average, 20% of the households were chronically ill people. The average household size across the survey sample was six, with fewer contributing to full-time labor on the farm. In many sub-Saharan African countries, high rates of HIV and AIDS have had a negative effect on labour requirements for smallholder farmers (Hanlon, 2010). Due to HIV & AIDS by 2010, at least 25% of Mozambican children would be orphaned and this led to worsening vulnerability and low productivity for the smallholder farmers (Arndt,

2003). Maphosa & Ncube, (2012) further argue that HIV\AIDS has grossly affected mainly the sexually active age groups leaving behind the old to practice agriculture.

Waweru, Cornelis, & Okoba (2013) compared the ratio of the sampled population of each gender and the number practicing CA of each gender and found that the rate of practicing CA is higher for the females than the males. This is an indication that the females may have a positive perception of CA because women do the most of the work at home and at the farm and labour reduction is one of the major benefits of CA. Similarly, Odame et al., (2002) add that women get involved in agricultural activities more than men. In farming, women participate in numerous agricultural tasks including mainly cleaning the field during land preparation, transporting inputs to the field, weeding, harvesting, transporting, threshing and storage of the production. Additionally, women are also involved in managing home garden crops, poultry raising, feeding, watering and cleaning of livestock and milking (Teklewold, 2013). Therefore, women would welcome CA as it means less work at the field releasing them to do other household work. On the other hand, women are responsible for other household activities such as cooking, child rearing and cleaning apart from the weeding activities they do in sub-saharan countries. Therefore, CA would have a low likelihood of being practiced on women run fields (Giller et al., 2009).

The CA adoption gravitates towards the wealthier farmers since the enthusiasm to invest in appropriate technology is normally an accomplishment for the rich. There is a likelihood for richer households with more asset endowments to practice CA than their counterparts who are resourced poorly (Giller et al., 2009). According to Nkala et al., (2011) land scarcity and tools to work are negative factors which prevent farmers from practicing conservation agriculture. Waweru et al., (2013) further argue that land ownership has influence on the CA adoption with more adoption by the farmers who own their land compared to the people renting. A similar study by Feder et al., (1985) found that smallholder farmers may fail to adopt new technologies requiring initial capital or input investments due to the lack of loan or credit access. According to Ding, (2018) and Harper et al., (2018), additional assistance may be required for poorer farmers who are

less likely to adopt CA due to the initial investment required with establishment and the risk associated with decreased yields early in the adoption process.

Tambo and Mockshell (2018) argue that significant income gains from full adoption of CA across nine SSA countries. Similarly, Lalani et al. (2017) in a comparison study of net present values for CA vs. conventional agriculture from 197 farmers found CA to be beneficial to both rich and poor farmers in Mozambique. According to Uddin & Dhar (2016), there was an increase in annual income for farmers practicing conservation agriculture in Bangladesh. The results showed that while before practicing conservation agriculture farmers earned Tk. 100 money income, focal, proximal and control farmers earned about Tk. 110, Tk. 107 and Tk. 106 money income, respectively after practicing conservation agriculture.

Young farmers are inclined to be more informed and knowledgeable about new technologies making it easier for them to be more open to adopt current practices compared to older farmers (Adesina and Zinnah, 1993). However, Langyintuo and Mekuria (2000) revealed that older farmers may have amassed more capital over the years and may get more trust from credit agencies thus providing them comparative advantage with regards to accessing loans. Bisangwa (2013) conducted a study on the influence of conservation agriculture Adoption on input demand and maize production in Lesotho. He reported that the percentage of farmers in a household between ages 15 to 55 have a likelihood to be linked with adoption of CA. Maphosa et al., (2012) in a study on the impact of CA on food security in Zimbabwe raised concerns with the average age of practicing farmers. They argued that the district where the study was being conducted geographically bordered Botswana and most of the young people cross the border to Botswana and South Africa soon after completing their secondary education to seek better paying employment opportunities in urban areas as agriculture is not economically attractive and its returns are slow. This leaves out the old people to practice agriculture.

According to Aryal (2019) the likelihood to adopt CA increases with the increase in the share of off-farm income in the total household income. Uddin & Dhar (2016) observed

that farmers adopting conservation agriculture practice could save more time and money to invest in other income generating activities compared to those who are not adopting which ultimately resulted in more money income in case of focal farmers in comparison with proximal and control farmers.

2.4.4 Land Productivity and Livelihood Outcomes

Minimum tillage leads to water conservation ensuring that adequate water is available for the crops, a key factor in determining their growth hence farmers will be in a position to produce more yields. Soil conservation and the prevention of soil erosion enables the crops to enjoy the necessary nutrients thus enough food will be produced. Stable soil aggregates which are provided for by mulching or cover crops provides for retention and exchange of air and water. The effect of this is healthier soils thereby ensuring more yields are produced consequently enabling the achievement of food security.

The conservation agriculture principle of crop rotation enables the smallholder farmers to switch the crops depending on the seasons at that particular time of the year (Hobbs, 2007). The rotation of the crops will ensure that the farmers are able to diversify in terms of the crops they can grow, therefore tapping into the markets for various commodities. The result of this is that farmers will be able to access various foods across the seasons and also incomes accrued from the all year harvesting.

Michler et al., (2019) conducted a study on Conservation agriculture and climate resilience and considered yields during rainfall shocks. The study reported that yields tend to be more resilient under CA cultivation then under traditional cultivation practices. The study also found out that CA can be effective in mitigating yield loss in environments with increased weather-related risks. Climate change threatens to disrupt normal rainfall patterns by reducing the duration and frequency of rainfall (prolonged droughts) and also by increasing the intensity of rainfall. The study revealed that in both cases (abnormally low rainfall and abnormally high rainfall) yields tend to be more resilient under CA then under traditional cultivation.

According to Pittelkow et al., (2015) no-till practices generally resulted in increases of yields, with the greatest benefits reported in rainfed agriculture and regions with low soil fertility. Similarly, Derpsch et al., (2010) conducted a comprehensive overview of the global adoption of minimum tillage, a key principle of conservation agriculture and found out the positive impacts of minimum tillage practices on soil conservation, water management, and crop yields based on empirical evidence from various regions worldwide.

According to Crowder and Reganold (2015) organic system profitability also benefited from longer, more varied crop rotations. They reported that while organic yields were lower than industrial, organic price premiums only had to be 5%–7% for industrial and organic farms to have the same profit, although currently premiums far exceed the break-even-point at 29%–32%. Furthermore, organic agriculture studies have shown improved performance than industrial systems in reducing negative externalities and growing positive ones through improving species richness and abundance, soil fertility, crops uptake of nitrogen, water infiltration, holding capacity and energy use (Lynch et al., 2011; Bengtsson et al., 2005; Tuck et al., 2014; Garbach et al., 2016). Differences in crop rotation between CA and conventional agricultural systems also have the potential to impact soil organic matter (SOC) values. The elimination of monocultures and incorporation of plant species into rotations that return greater amounts of residue to the soil are often associated with greater SOC stock in CA systems (Conceição et al., 2013).

Having a diverse portfolio of agricultural products which is comparable to a diverse portfolio, regularly stimulates resilience since incomes of farmers are less sensitive to variations in any product (Abson, 2013). Additionally, diversification practices frequently encourage stabilization of yields in response to weather events, mostly droughts (Kremen et al., 2012). This is possibly realized through stimulating soil functions such as water infiltration and storage, in turn increasing water uptake efficiency while reducing erosion and runoff (Lotter et al., 2003). Gaudin et al., (2015) conducted a study on how increasing crop diversity mitigates weather variations and improves yield stability. He found out that diversification of corn-soybean rotations and minimized tillage in dry and hot years'

maximized harvest when compared to arrangements without rotations by 7% and 22% for corn and soybean, respectively. According to Lotter et al., (2003) in four out of five drought years, diverse rotations in organic corn-soybean systems combined with manure addition statistically significantly outperformed industrial with less diverse rotations.

According to Devkota et al., (2022a, 2022b) and Kassam et al., (2019) economic incentives, yield stability, and resilience to varying weather are the fundamental driving forces for the wider adoption of CA. Bahri et al., (2019) conducted a simulation study and reported that conservation agriculture is more effective than conventional practices for boosting wheat yield and water use efficiency under semi-arid and sub-humid conditions in Tunisia. Devkota and Kumar (2022) conducted a study on Conservation agriculture, agronomic, economic, and soil fertility indicators for a clay soil in a rainfed Mediterranean climate in Morocco and observed that the average yield was significantly higher for the CA than the conventional practices by 24%, 38%, 48%, and 32% for wheat, barley, chickpea, and lentil, respectively.

In countries such as Zimbabwe (Mashingaidze et al., 2006), Lesotho (Pretty, 1998; 2000), Zambia (Haggblade and Tembo, 2003) some farmers have accepted CA well and this has resulted in substantial changes in agricultural performance by early adopters. Twomlow et al., (2008) in a study on precision conservation agriculture for vulnerable farmers in low-potential zones observed a rise in productivity of up to 3.5t/ha – mostly after the third year which is a positive impact. Nkala et al., (2011) conducted a study in Central Mozambique to examine the impact of CA on livelihoods and analyzed the results by means of propensity score matching which is an econometric inquiry. The results indicated CA is positively associated with crop productivity or higher crop harvests.

The positive impacts of CA comprises rises in productivity through higher crop harvests signifying food security and subsequently improved social and economic wellbeing (Pretty, 1998; 2000). Haggblade et al., (2003) in a study on the early evidence on conservation farming in Zambia reported that initial CA adopters experienced livelihood outcomes which included level of productivity surges of 30 to 70%, improved social

capital through farmers groups, diversification of production, drought resilience and reduced dependency on food relief. A similar study by Fowler et al., (2001) noted an increase of harvests of up to 3.5 t ha-1 for a number of main crops and improved food security in the region. In addition, Twomlow et al., (2006; 2008); Nyagumbo (1999); Mashingaidze et al., (2006) have all reported related results about CA in Zimbabwe.

Previous studies point to a substantial increase in yields after the implementation of CA (Dumanski et al., 2006; Mazvimavi et al., 2010; Stewart et al., 2008). According to Maphosa et al., (2012) the introduction of CA by NGOs in Zimbabwe seems to have brought a big influence on how food security can be improved with most of the interviewed farmers practicing CA confirming that they harvested more grain on CA cultivated land than conventional farming. Their findings were consistent with Mazvimavi (2011) who states that plots on CA tended to produce higher yields than conventional plots as demonstrated by the harvests of the 2008/2009 season where on average maize yielded 1546 kg/ha on CA compared to 970 kg/ha on conventional farming. Mousques and Friedich (2007) similarly noted the positive impact of CA on yields in the Democratic People's Republic of Korea and China.

According to Pittelkow et al., (2015) applying all the three conservation agriculture principles (minimum tillage, cover crop and crop rotation) minimizes yield losses in the first two years of implementation. CA is projected to result in a rise in food production while the negative effects of tillage in Africa reduce (FAO, 2012). According to Silici et al., (2011) the embracing of CA by farmers in many African countries has revealed potential to enhance rural livelihoods through sustainable but strengthened production. A long term study of smallholder farmers embracing CA in Paraguay found significant changes in farmers' livelihoods. Farmers with 7 to 10 years' experience practicing CA were compared with conventional farmers and also with their situation before embracing CA. There was a rise in crop yields after adopting CA and this is due to the rapidly improved soil fertility (Lange, 2005).

Studies conducted in Brazil and Paraguay did a comparison of yields from fields which are CA managed and those tilled conventionally. The findings showed that harvests reduced from 5 to 15% after 10 years under conventional tillage, while fields managed under CA registered an increase from 5 to 15% during the same period (Derpsch, 2008a). Similarly, another study in Brazil revealed that over a period of 17 years, there was increase by 86% of maize yields under a CA system, 56% increase of soybeans yields under a CA system, with fertilizer and herbicides use dropping by 50% and 30% for soybeans and maize, respectively. Additionally, there were reports of significant differences in soil erosion for fields managed using conventional tillage techniques in comparison with fields managed under CA (Derpsch, 2008a).

Conservation agriculture can be seen as a strategy for poor people, improving agricultural productivity for smallholder farmers (Gowing and Palmer, 2008; Marongwe et al., 2011). Mapeshoane et al., (2005) did a study to evaluate the technical performance and agronomic and socioeconomic factors determining the adoption and adaptation of minimum tillage technologies in Lesotho concluding that CA was more effective in yield stability compared with conventional tillage systems. Additionally, Li et al., (2019b) reported that residue retention in CA systems is often observed to have a significant positive impact on soil water storage due to a combination of greater rates of infiltration and decreased soil water evaporation.

CA is projected to result in a rise in food production while the negative effects of tillage in Africa reduce (FAO, 2012). According to Silici et al., (2011) the embracing of CA by farmers in many African countries has revealed potential to enhance rural livelihoods through sustainable but strengthened production. Studies conducted by Twomlow (2008); Nyagumbo (1999); Fowler et al., (2001) and Mashingaidze et al., (2006) found a rise in crop yields for farmers practicing CA in Zimbabwe. Similarly, Nkala (2012) posits that despite the argument that the impacts of CA are felt by farmers in the medium to long term, results have outlined the positive impacts of CA on livelihoods due to a rise in productivity.

A study by Kaumbutho et al., (2007) reported a case of wheat and barley farming in Laikipia County whereby conventional methods led to the farmer running at losses because of the high cost of production. However, when the farmer adopted CA technology some changes were reported. With zero-tillage he started realizing increased yields in the second season as there was significant buildup of soil cover from crop residues. Govaerts et al., (2005) in a rain fed experiment on zero tillage in Mexico City found that zero-tilled plots with residue retention resulted in higher and more stable yields than conventionally tilled plots with residues incorporated. On the other hand, Zero-tilled plots without residue retention had much reduced yields. Additionally, there have been positive impacts of CA adoption on maize/crop yield in Zambia (Ng'ombe et al., 2017; Ngoma, 2018), Tanzania (Arslan et al., 2017) and Ethiopia (Jaleta et al., 2016).

2.4.5 Agricultural Marketing Institutional Arrangements for CA Agricultural Products

According to Basu (2004) institutional arrangement is a set of guidelines meant to regulate the activities of a specific group of individuals pursuing a certain objective. Examples include a contract (such as basically to exchange goods or services, or a sharecropping agreement between landlord and tenant farmer) among others. Therefore, institutional arrangements consist of agreements for exchanging or coordinating services like labour or goods. Enforcement of such agreements involves the expenditure of resources commonly known as transaction costs.

Transaction costs imply the resources used to exchange goods or services (i.e. buyer-seller relations). Transaction costs hence consist of the efforts dedicated to finding a market, negotiating, signing a contract, controlling contract compliance, switching costs in the case of premature termination of the contract, and any opportunities lost (Basu, 2004). Generally, three types of transaction costs related to commercial exchange can be distinguished:

1. Search and information costs: someone considering a certain transaction must search for a suitable party with whom to trade and the search process entails costs. These costs may entail visits to potential traders (e.g. in markets), communication (e.g. telephone calls), looking up prices, testing and quality control etc. Gathering information plays a significant role.

2. Bargaining and decision costs: these costs are attributed to time and (legal) advice put into bargaining and negotiating the agreement between parties. This agreement translates into an informal (verbal) deal or a formal (written) contract.

3. Supervision and enforcement costs: these are costs associated with time put into monitoring the process of agreement implementation. Information here plays a key role as monitoring comprises mainly of obtaining information which may be costly. Parties may have reasons to hide their actions and the fact that they are not complying with the agreement trade.

Normally, a large fragment of transaction costs entails the spending of time on the part of traders and buyers. The time or other resources is dedicated to obtaining information. In most cases, the gathering of such information is intended to decrease the magnitude of uncertainty faced by the buyer or traders. Dorward et al., (2006) argue that the role of institutional arrangements is to reduce transaction risks and not to reduce transaction costs. Parties in an exchange are faced with risks that individual transactions will fail due to the loss of any investments allied with that particular transaction. Therefore, they may need to incur expenses for protection against such transaction deficiency. Dorward et al., (2006) see transaction costs as crucial investments hence focus on minimizing transaction risks and finding the most suitable institutional arrangement to minimize the risks rather than reducing transaction costs.

2.4.6.1 Spot Markets

Spot markets can be viewed as the 'default' marketing option for small rural farmers. According to Fafchamps (2004) markets play a fundamental role in Africa, probably more than in developed countries. There are normally many intermediaries and most transactions are very small with the market participants being either very small firms or individuals. In a pure spot market, the transaction is effected "on the spot" with no personal relationships being developed while the three phases of a transaction: contact, contract and control are immediately implemented. Physical marketplace doesn't have to be there, thus the trader contacts the farmer or vice versa, scrutinizes her/his produce, negotiates a price, agrees on a deal, pays and gathers the produce all within a few hours or even less. Transaction costs tend to be very low for both parties in such a pure structure of market transaction. Collectors purchase produce from farms and in some cases they aid with harvesting the produce in order to meet targeted volumes (e.g. in Uganda (Sonko et al., 2005). Farmers have little influence in setting prices and usually accept the price the rural traders offer.

Studies conducted by Fafchamps (2004); Dorward et al., (2006) found that African markets are essentially characterized by very immense transaction costs. This is supported by Jaffee and Gordon (1992) who argued that markets in Africa are not near the ideal-type spot market. In Africa, input, output and factor markets e.g labour or credit are overwhelmed with contract enforcement problems as well as informational hitches of moral hazard and adverse selection. All these shapes economic exchange and determine how markets are adequate (Bigsten et al., 1999).

The rural traders fulfill various functions with the most important being transporting the collected produce and bringing it to various (local) markets. Nevertheless, they may also be involved in grading, financing, or selling consumer goods. At the market, they either fulfill the function of the wholesaler or sell it to wholesalers. Transporters sometimes come in when rural traders are unable to organize the transport themselves. Rural traders

may be small-scale operators lacking the means to use trucks hence relying on other means (bicycles or motorcycles) or hiring transporters (Eaton et al., 2008).

Eaton et al., (2008) conducted a study on understanding institutional arrangements in East Africa and found that often, fresh fruit and vegetables (FFV) only mature in very explicit agro-climatic surroundings limiting the area where they can be grown and these areas could be located far away from main markets (e.g. in the cities) and consumers. Transaction costs, mainly for traders, entail the time gathering information on the prospective supply with regards to quality and quantity which may involve traveling to the production areas several times. Therefore, establishment of personal relationships may be beneficial to traders since this enables them to contact farmers through their mobile phones to check on progress. Safeguarding supply could be hard in situations where the buyers are men. However, few traders or sellers may wish to secure an agreement in advance to guarantee supply suggesting that within spot markets, all transactions are not characterized by impersonal trade.

Figure 6 below shows that seasonality and uncertainty of production is echoed in prominent quantity and price disparities. As a result of climatic variability the quantity and quality of production cannot be correctly projected thus the buyer requires information to form prospects on the possible supply in order to match it with demand and base price estimates on this. Safeguarding supply becomes more vital when harvests for a certain produce are expected to be bad and this uncertainty is reflected by price fluctuations.

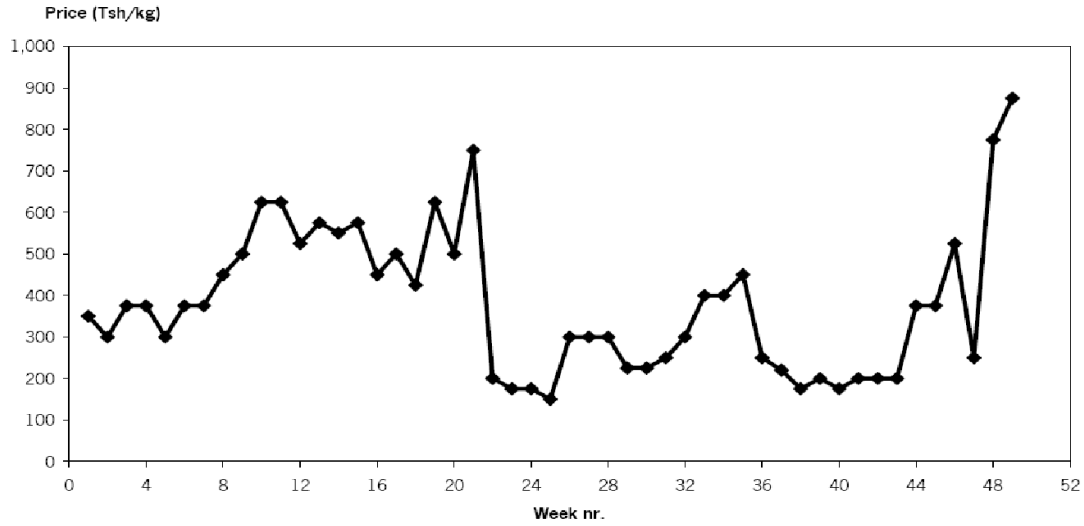


Figure 2.3: Tomato Price at Kilombera Market in Arusha, 2005

Source: (Wiersinga and Jager, 2007)

In FFV spot markets, transactions are also faced by the difficulty in checking performance. Remote farmers might not have access to information about prices on key markets and consumer preferences. Obtaining it may be very costly hence traders having the information can resolve to withhold it from the farmers or misinform them for instance state lower prices than those in key markets or fail to offer information on consumer preferences concerning grades or product features. Due to these problems in monitoring performance, more personal contacts may be developed in spot markets with farmers and sellers getting into agreements which are informal. However, a likelihood of one of the parties not adhering to the agreement as a trader may purchase from another farmer for a lower price or a farmer may sell to a different trader offering a higher price or a quick sale. When perishable products like FFV are involved and markets are small, such breaches end up imposing high costs for instance when a farmer is unable to sell the product to a different trader and the crop has depreciated to the point of becoming unsellable. Minimizing such uncertainties with the use of personal relationships that create trust become imperative (Eaton et al., 2008).

Nyoro et al., (2004) in a study in Kenya found that supermarkets, hotels and hospitals increasingly prefer to buy from brokers instead of from wholesale markets which are often characterized by poor hygiene and sanitation, safety and lack of traceability of commodities. Brokers source their produce from various sources including farmers, wholesale markets and sometimes imports. Brokers are traders who do not have a place on the physical market (i.e. do not own a stall).

2.4.6.2 Contract Farming

According to Eaton and Shepherd (2001) contract farming refers to an agreement between farmers and processing or marketing firms for the production and supply of agricultural produce under onward agreements, normally at fixed prices. The agreement regularly comprises the provision of production assistance by the marketing or processing firm through the supply of inputs or extension services. A contract farming arrangement operates on the foundation of a guarantee on the part of the buyer to assist the farmer's production and buy the produce. On the other hand, the farmer is committed to provide a certain product in quantities and quality standards set by the buyer.

Contract farming has been in existence especially for perishable agricultural commodities meant for the processing industry such as vegetables and fruits. Contract farming became more significant in the food industries of the developed countries in the second half of the 20^{th} century (Royer and Rogers, 1998). Increasingly, agricultural systems are organized into closely allied linkages where the coordination of production, processing and circulation activities is managed closely and this is stimulated by alterations in demands of consumers, international competition and technology.

Trends in the food system affecting developed countries also affect developing countries thus as well experience trade liberalization. As a result, there is a change in preferences for consumers, increased competition, and introduction of harsh quality and safety protocols both private and public. Reardon and Barret (2000) argue that developing countries experience a number of trends that seem to favour the surge of contract farming.

One of these trends is the rapid increase of supermarkets retailing food (Reardon and Berdegue, 2002). Procurement practices in supermarkets regularly comprise a restriction of the number of suppliers (preferring to work only with certain suppliers) and the requirement for private quality standards. Another trend that justifies the dependence on contract farming in developing countries is the minimization of the state's role in supporting activities and provision of services.

Kirsten and Sartorius (2002); Saenz-Segura (2006) assert that contract farming is usually considered as one of the ways of connecting smallholder farmers to local and even foreign markets. Poulton et al., (2005); Dorward et al., (2006) came up with some combination of conditions which forms a basis for incentives to enable buyers to engage in contract farming with smallholder farmers. Contract farming enables smallholder farmers to diversify into new crop varieties, harvest higher yields leading to a rise in incomes (Kirsten and Sartorius, 2002; Singh, 2002). However, a number of challenges also exist such as the restrictions to the inclusivity of contract farming arrangements which are limited to elite smallholder producers, huge risks born by farmers and weakening of terms for farmers.

The growth of supermarkets in domestic food vending as well the rise in international supply chains have key effects on all players in their supply chain. For instance supermarkets prefer particular and committed wholesalers, integrated procurement systems, ideal supplier systems and private protocols for perishable products (Shepherd, 2005). Eventually, these purchasing practices substitute spot market transactions with contracting while excluding smallholder farmers. A study conducted by Donkor et al., (2018) in Nigeria reported that large households in rural areas are mostly constrained with financial burdens hence tend to avoid transaction costs and other marketing risks which are associated with the participation in the direct marketing channels. According to ILO (2017), contract farming models can result in improved access to technical assistance and inputs such as hybrid seeds, as well as a secured market and stable prices.

2.4.6 Livelihood Outcomes on Participants of Conservation Agriculture

In addition to the ability to include small scale farmers, participation conservation agriculture has been found to have a positive impact on the incomes of participants compared to non- participants. According to a study conducted by Nkala et al., (2011) on conservation agriculture and livelihoods of smallholder farmers in central Mozambique, the income of households increased from the sale of surplus products under CA. This income goes into purchasing diverse household assets such as paying school fees, bicycles, building better homesteads, paying for hired labour and purchasing livestock. The implication of this aggregation of assets is improved livelihoods for those farmers who are in a position to produce surplus.

Friedrich and Kienzle (2007) argue that farms experience a rise in crop yields after adopting conservation agriculture and this is due to the rapid improvement in soil fertility. The influence of this is the increased farm incomes which are complemented by a reduction in production costs resulting in significant higher net income. There was an upsurge in economic activities in rural areas of Santa Catarina/Brazil dedicated to animal production and value addition due to the introduction of CA (de Freitas, 2000). Tshuma et al. (2012) in a study on the impact of conservation agriculture on food security and livelihoods found that conservation agriculture practice extended the range of livelihood on a limited scale through improved yields and income.

Uddin and Dhar (2016) conducted a study on CA farmer's livelihood status in Bangladesh and found that adoption of CA led to a decrease in poverty in terms of deprivation of health, education and living standards with the deprived farmers at 21.7% while the privileged farmers were 78.3%. Similarly, Mango et al., (2017) reports that household Food Consumption Scores can be improved indirectly by CA through purchase of other essential food stuffs from income obtained after selling surplus crop outputs.

According to Lange (2005) in a study of Conservation agriculture economics and evolution in Paraguay, 50% of the farmers substituted their original wooden shacks with

stone houses and one of them even bought a house in a nearby town. All the farmers managed to purchase items such as fridges, carts, horses, motorcycles and TV sets. Attendance of school on a regular basis for the school age kids improved as their labour was no longer needed on the farm and the farmers were in a position to fully pay the school fees.

Wagstaff and Harty (2010) in a study of the impact of conservation agriculture on food Security in Zimbabwe found out that improved maize yields contributed to 40% or more of the annual food needs of the poor and very poor CA farmers compared to a contribution of 20-25% of annual food needs among conventional farmers. Chiputwa et al., (2011) noted an inverse relationship between level of disposable income and adoption of CA, implying that households with higher disposable income are less likely to adopt and intensify the use of zero-tillage compared to those with lower income.

According to Maphosa et al., (2012), the introduction of CA by NGOs in Zimbabwe had a positive effect on food security. This was revealed through a qualitative interview with respondents that engage in CA spoke very highly of how the practice has made food available at the household level. The CA farmers also reported that they could sell the surplus and manage to buy kitchen utensils, pay school fees for their children, and buy livestock, among other things. In addition Serrat (2010) asserts that potential livelihood outcomes from activities aimed at enhancing household livelihoods, just like CA, can include ‘more income, increased well-being, reduced vulnerability, improved food security and more sustainable use of the natural resource base.

Nkala (2012) studied the impacts of conservation agriculture on farmers’ livelihood in Central Mozambique and revealed that under the conditions of vulnerable livelihood, lack of institutions supporting smallholder farmers, lack of access to agricultural assets, conservation agriculture did not have a strong influence on livelihood outcomes, normally due to a slight enhancement in crop productivity.

2.5 Summary of the Literature and Research Gaps

The chapter has reviewed various theories and empirical studies related to the topic under investigation "participation in and livelihood outcomes of CA among farmers" across the globe. Literature has been reviewed on the variables under study which are input costs, land productivity, socio-economic characteristics and marketing institutional arrangements. It further highlights the key theoretical frameworks that informed the study which include: Capability approach, Sustainable Livelihoods Framework. Several levels of participation have been discussed as cited by Kumar (2002). Typologies of participation based on the evolution of the concept of participation were reviewed. The literature also provides the ways in which local leadership influences participation in conservation agriculture practices through nurturing the efforts of the rural people and liaising between agencies of development and their communities.

The conservation principles of minimum tillage and permanent soil cover ensure that a lot of labour is saved which is then invested in non-farm activities resulting in more incomes for the farm households. These principles also lead to crops enjoying necessary nutrients and provision for retention and exchange of air and water in the soil. The effect of this is healthier soils thereby ensuring more yields are produced consequently enabling the achievement of food security. The CA principle of crop rotation enables the farmers to harvest across the year hence more income gains since different crops are harvested at various periods of the year.

The reviewed literature indicates that it leads to increased crop yields. Equally important also is the contribution of each of the principles of CA to improved yields and the period taken for more productivity to be realized. However, there is limited literature regarding the effect of CA on livelihood and particularly in Kenya. In addition, most of the studies have focused on the impact of agriculture on livelihood, while others have focused on how input utilization affects agricultural yield, and thus, failed to look at the moderating effect CA on the use of input such as fertilizer and agrochemicals on livelihoods. The study thus, seeks to fill these gaps.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the methods and processes that will be followed to conduct the study. It outlines the study's research design, target population, data collection instrumentation, testing for validity and reliability. Other aspects include data collection procedure, methods of data analysis and presentation of results.

3.2 Research Design

According to Kothari (2004) a research design is a strategy of specifying which approach will be used to gather and analyze data. It is the conceptual structure within which research is conducted constituting the collection, measurement and analysis of data. The researcher relied on cross-sectional survey design which consists of both qualitative and quantitative approaches.

According to Penny et al., (2013) cross-sectional survey involves the collection of data at a single point in time from a sample drawn from a specified population. This design is mostly used to document the prevalence of particular characteristics in a population. Cross-sectional surveys provide an opportunity to assess relations between variables and differences between subgroups in a population. This design enabled the study to apply quantitative approaches to provide both numerical evidence and in-depth information about conservation agricultural practices and livelihood outcomes of farmers.

The qualitative data was guided by a phenomenology approach. According to Welman and Kruger (1999) the phenomenologists are concerned with understanding social and psychological phenomena from the perspectives of people involved. A researcher applying phenomenology is concerned with the lived experiences of the people involved, or who were involved, with the issue that is being researched (Holloway, 1997; Maypole

& Davies, 2001; Robinson & Reed, 1998). This design is qualitative in nature and it provided non-numerical data about the participation of farmers in CA practices.

On the one hand, quantitative research is based on the measurement of quantity or amount and is applicable to phenomena that can be expressed in terms of quantity. Qualitative research, on the other hand, is concerned with phenomena relating to or involving quality. It seeks to discover the underlying motives and desires, using in depth interviews for the purpose (Kothari, 2004). The inclusion of qualitative methods in this study demonstrated the immense contribution they make in social research especially in providing in-depth understanding of development issues. The qualitative methods play a key purpose in triangulation since the combination with quantitative methods leads to diverse viewpoints or standpoints casting light upon the topic under study (Olsen, 2004).

3.3 Target Population

The target population refers to the group, or the individual to whom the survey applies, the element of population whom the study seeks response from in relation to the research question. Mugenda and Mugenda (2003) indicate that target population should be explicitly and unequivocally defined, otherwise statements about the target population after the analysis of data will not be trustworthy. The target population refers to the group, or the individual to whom the survey applies, the element of population whom the study seeks response from in relation to the research question.

For this study, the target population was farmers who practice conservation agriculture in ASAL areas drawn from Makueni and Machakos Counties. The study used the population of 5091 CA farmers who are applying CA fully and others partially, hence a comparison was formed. The target population also included 96 group leaders of the various farmer groups.

3.4 Sampling Frame

According to Cargan (2007) a sampling frame is a list of elements from which the sample is actually drawn and is closely related to the population. Similarly, Mugenda & Mugenda (2003) assert that a sampling frame is a list of the items or people forming a population from which a sample is taken. With the help of Utooni Development Organization, a list of CA farmers was generated which constituted the sampling frame. The total number of CA farmers in the sampling frame was 5091 farmers comprising the fully practicing CA and others who are practicing partially.

3.5 Sample Size and Sampling Techniques

According to Nachmias (1996) researchers use a relatively small number of cases (a sample) as the basis for making inferences about all the cases (a population) in question. Kothari (2006) also argues that a sample is a collection unit from the universe to represent it. Generally, the larger the sample, the more representative it is. In quantitative research mathematical procedures are used to determine the sample size.

The researcher adopted the Yamane (1967) formula to calculate the sample size of CA farmers. The sample size of CA farmers at 5% level of significance was obtained as presented below:

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

Whereby n is the sample size
N is the target population (CA farmers) =5091
e is the level of significance = 0.05
n= 384

There exists a variety of methods for obtaining samples varying in cost, efforts and skills required, but their adequacy is assessed by the criterion of representativeness. The quality of the sample for quantitative studies depends on how typical or representative the sample is of the population with respect to the variables of concern in the study. This study relied on stratified random sampling in order to achieve a high degree of representation from groups with the desired characteristics. A stratified sampling technique involves dividing your population into homogeneous subgroups or strata. Key informants were also selected and they included 55 group leaders of farmer groups who were selected through purposive sampling.

Table 3.1: Sample Distribution

Ward	Number of CA farmers	Allocated sample size
Kilili	317	36
Kwa kavisi	272	32
Kavuthu	431	40
Mutyambua	601	32
Kikumbulyu	545	52
Kivani	371	28
Kyuu	404	36
Mumbuni	298	24
Kola	612	40
Masii	946	40
Kitonyoni	294	24
Total	**5091**	**384**

3.5 Data Collection Instruments

Data collection instruments refers to the tools used for data collection that include questionnaires, interviews, observation and reading (Annum, 2017). This study utilized questionnaires and interviews to form the basis for the research findings. The study also applied on-farm observation to observe and verify the information received during filling of the questionnaires.

3.5.1 Questionnaires

The study utilized questionnaires containing closed-ended questions and a few open-ended questions. A questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms (Kothari, 2004). This method of data collection was preferable because of the huge number of respondents. Structured or close ended questions are preferred due to the ability in maintaining uniformity in response categories (Newing, 2011).

Questionnaires were used to collect data from CA farmers in the two counties. The closed ended questions contained a list of possible alternatives from which respondents were required to select the answers that best describes their situation. The open-ended questions provided the farmers with an opportunity to express their opinions on various issues sought in the questions. The questionnaire was divided into sections which provide information on demographic characteristics, input costs, land productivity, socio-economic characteristics and marketing institutional arrangements.

3.5.2 Interviews

In depth interviews were conducted with the aim of collecting information from key informants who included group leaders of farmer groups. In addition, 2 group leaders were selected through purposive sampling from each stratum. The interview method is significant because it enabled the researcher to gather more and in-depth information from the key informants. According to Kothari (2004) the interview method of data collection involves presentation of oral-verbal stimuli and reply in terms of oral-verbal responses. The interview involved a verbal conversation between the researcher and one respondent at a time with the objective of collecting information for the purpose of research. Floyd (2013) asserts that an interview schedule is a guide which is used when conducting a semi -structured interview. According to Kothari (2004) prompting questions can be included in the interview which may include; non-verbal cues, such as facial expressions and gestures can be recorded.

Cohen, Manion and Morrison (2007) points out that face-to-face interview generally yields the highest cooperation and lowest refusal rates, allowing longer, more complex interviews. As (Creswell, 2017) suggests, when an interviewee is relaxed is able to articulate their experience in an unconstrained and comfortable manner and during this time, high response takes center stage allowing the interviewer to gunner valuable data while Rubin and Rubin (2012) suggest that an interview should evolve into a rapport and amicable interaction of guided conversation which will create an enabling environment for both the interviewees and the interviewers.

3.6 Data Collection Procedures

The researcher obtained a research permit from the National commission of Science, Technology and Innovation (NACOSTI) that allowed him to collect data. The researcher sought permission from the local administration of the county to conduct the study in the area. After getting informed consent, the researcher recruited two research assistants to assist in data collection. The research assistants were trained on the research objectives and guided on techniques of administering the questionnaires and the interview guide.

The questionnaire was issued to the respondents during the meetings which are normally held twice a month. The questionnaires sought to collect data on the farmers' experiences about the variables of the study. Once the questionnaires were filled, the researcher collected the questionnaire and arranged with leaders of the farmer groups on when the interview schedule would take place. Data collected from the interviews was used to corroborate the information provided in the questionnaires.

3.7 Pilot Test

A pilot study was conducted before the commencement of actual data collection. The pilot data was not included in the actual study as it allowed for pre-testing of the research instrument. Pre-testing of the questionnaire provides the opportunity to refine the questionnaire by revealing errors in the questions, sequence and design and see how the

questionnaire performs under actual conditions (Churchill and Iacobucci, 2002). Piloting enhances the validity and reliability of the instruments, and ensures familiarity with the administrative procedures in data collection. The results assisted the researcher to correct inconsistencies arising from the instruments to ensure the accuracy of their measurement.

This pilot study was conducted in Mwala and Kalama sub-counties within Machakos county. In Mwala, a sample was drawn from Masii ward while in Kalama, the researcher conducted interviews in Kola ward. A total of 37 questionnaires representing 10 % of the total sample size of the study were filled and returned. A number of questions were revised after the pilot study due to repetitions, lack of clarity and level of understanding of the respondents.

3.7.1 Reliability

Reliability is the degree to which a test is consistent in measurement (Gay, 1987). It is the ability to consistently yield the same results when repeated measurements are taken under the same conditions. The study used ‘split-halves’ and ‘internal consistency’ method to measure reliability. ‘Split-halves’ method will be used by comparing the two halves of the responses to each other and similarities identified. The more similarities between the two halves and each question found the greater the reliability. According to Zikmund (2003) the ‘split-halves’ method is the most suitable and basic method for checking reliability when the study has a large amount of raw data.

Internal consistency method was tested using Cronbach’s Alpha. Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. A "high" value of alpha is often used as evidence that the items measure an underlying (or latent) construct. Reliability with a predetermined threshold of 0.7 is considered acceptable. That is, values above 0.7 indicate presence of reliability while values below signify lack of reliability of the research instrument.

The study conducted a reliability test for the Likert scale items using Cronbach Alpha coefficients. This was to test the internal consistency that is, how closely related a set of items are as a group. A higher coefficient is an indication of internal consistency. Reliability with a predetermined threshold of 0.7 is considered acceptable. Summary statistics are presented in Table 3.2 below.

Table 3.2: Reliability Test

Variables (Likert Scale)	Number of items	Cronbach Alpha	Interpretation
Statement on livelihood outcome;	5	.761	Reliable
Statements on Socio-economic factors;	9	.765	Reliable
Statements on input costs;	9	.801	Reliable
Statement on land productivity;	9	.908	Reliable
Statements on Marketing institutional arrangement;	7	.703	Reliable
Statements on producer associations.	5	.893	Reliable

The reliability test shows that all the Likert scale items have coefficients of at least 0.6. This implies that the instrument is reliable. This means that the Likert scale items are reliable and can produce consistent results if administered in other areas.

3.7.2 Validity

Frankel and Wallen (2008) define validity as the appropriateness, correctness and meaningfulness of the inferences selected on research results. It is the degree to which results obtained from analysis of the data actually represent the phenomenon under study. The question of validity is raised in the context of the form of the test, the purpose of the test and the target population. The researcher concentrated on content validity. Mugenda and Mugenda (2003) define content validity as a measure of the degree to which data collected using a certain instrument represent a specific domain of indicators or content of a particular subject. Validity of the instrument was done using the expert opinion. The questionnaire was given to supervisors who gave their advice on the questions with

reference to the research objectives. This was done to ensure that the questions raised generate the required information for the study.

3.8 Data Analysis

After data collection, the data was edited, handling of blanks responses done, categorized and arranged systematically for coding. Both quantitative and qualitative methods were employed. Quantitative data was entered into the Statistical Package for the Social Sciences (SPSS) version 22 for analysis where both descriptive and inferential statistics were generated. Descriptive statistics included means, standard deviations and percentages of variables under investigation. On the other hand, inferential analysis involves correlation and regression analysis. For qualitative data the study used content analysis. This involved grouping various views from respondents into themes that facilitate drawing of conclusions.

3.8.1 Qualitative Data Analysis

The qualitative data component was subjected to content analysis. The qualitative data had been collected through key informant interviews. Qualitative data collection depends on interpretation of large amounts of qualitative evidence collected. According to Krippendorff (2018) content analysis refers to a research method that allows researchers to both quantify patterns and interpret meanings within the same dataset.

Downe (1992) asserts that the goal of content analysis is to provide knowledge and understanding of the phenomenon under study. In this study, the qualitative data collected was organized into themes corresponding to the study objectives. These themes were complemented by the Kwalitan computer program, whereby codes were created for the data in accordance with study objectives. Kwalitan assisted in identifying all key categories within the created codes, and then a tree structure was made to establish the extent to which the categories are related to the codes and segments.

3.8.2 Quantitative Analysis

Quantitative data was analyzed using descriptive and inferential statistics-with the help of statistical package for social science (SPSS version 22). Quantitative data was derived from the questionnaire. According to Andre (2004) descriptive statistics can be defined as those methods involving the collection, presentation and characterization of a set of data in order to properly describe the various features of that set of data. Gupta and Gupta (1998) argue that a single number describing some feature of a frequency distribution is called a descriptive statistic. The mean informed the researcher on the values of most observations in the population. The standard deviation reflected an accurate impression of how much the sample data varies from the mean. The frequency distribution and percentages informed the researcher on the number of times a score occurs and the extent of occurrence of observation.

This study relied on multi regression analysis to examine the effect of independent variables on the dependent variable. According to Kothari (2004) multiple regression analysis is adopted when the researcher has one dependent variable which is presumed to be a function of two or more independent variables. Saunders et al. (2016) assert that multiple regression analysis as a statistical technique that focuses upon and brings out the structure of simultaneous relationships among three or more phenomena. This analysis made a prediction about the dependent variable based on its covariance with all the concerned independent variables. Livelihood outcomes were regressed against input costs, land productivity, socio-economic characteristics and marketing institutional arrangements.

3.9 Ethical Considerations of Research

To ensure that the study adhered to the ethical standards of research, permission to conduct the research was sought from the relevant authorities mandated to do so. All activities pertaining to the study were fully disclosed to the authorities. A letter of introduction was also obtained from the University providing details about the study. In addition, a research

permit was obtained from NACOSTI. The findings were presented in such a way that they did not reveal identities of the respondents since the data collection instruments did not have a provision for personal details. Respondents were informed about the benefits of the study and assured that it was meant for academic purposes only through contributing to the existing body of knowledge and to inform policy directions on promotion of Conservation Agricultural practices. The respondents had the choice of not participating in the research since they were nor coerced.

3.10 Operationalization of the Variables

In this study, the variables include independent variables: input costs, land productivity, socio-economic characteristics, types and nature of various institutional arrangements. Participation in CA Producer associations is the moderating variable while livelihoods outcomes of CA farmers is the dependent variable. These variables will be operationalized and measured as shown in table below.

Table 3.3: Measurement of Independent Variables and Their Theoretical Effect on Livelihood Outcomes of Farmers

Objective	Variables	Indicators
Objective 1: To analyze the effect of input costs on livelihood outcomes in ASAL areas in Kenya.	● Farm equipment ● Labour requirement ● Mulching	● Amount spend on paying for labour ● Duration for preparation of the land for CA crops ● Time required to prepare the land not under CA ● Duration for using CA farm tools
Objective 2: To examine the effect of land productivity on livelihood outcomes in ASAL areas in Kenya.	● Soil preservation ● Harvest quantity ● Harvest quality	● Number of plots under CA ● Size of the plots under CA ● Number of crops under CA ● Number of seasons for CA crops ● Number of CA crops rotated ● Quantity of yield for CA crops (in kgs) for past harvest
Objective 3: To assess the socio-economic characteristics of Conservation	● Level of education ● Employment status ● Wealth status	● Highest level of education attained ● Other occupations ● Total acreage of land

Objective	Variables	Indicators
agriculture farmers in ASAL areas in Kenya.		● Ownership rights applicable to the farm ● Number of CA principles practiced
Objective 4: To evaluate the moderating effect of participation in CA producer associations on livelihood outcomes in Makueni and Machakos Counties.	● Advocacy ● Knowledge usability	● Membership to farmer associations ● Functions of farmer association ● Training from farmer association ● Credit from farmer association
Objective 5: To examine the types and nature of various institutional arrangements that market CA agricultural products from smallholders in ASAL areas in Kenya.	● Direct marketing ● Indirect marketing	● Price for CA crops in local currency per kg ● Price fluctuation ● Number of marketing arrangements used for selling produce ● Aggregation of crops from different farmers while seeking markets ● Period taken for payment process ● Nature of agreement with the buyer ● Number of advantages of using preferred arrangement ● Number of challenges with preferred arrangement

CHAPTER FOUR

FINDINGS AND DISCUSSION

4.1 Introduction

This chapter focuses on presentation of analyzed results of the study, their discussion and interpretation. The chapter is subdivided into two main sections with several sub-sections under each. The first section comprises farmer demographic characteristics while the second section presents discussion and interpretation of findings based on the study objectives. Both descriptive and inferential analyses are conducted. Prior to the discussion of findings, the response rate of research instruments, reliability and validity of the instruments are highlighted.

4.2 Instruments Response Rate

The study administered three research instruments, that is, farmer questionnaires, in-depth, and key informant interview guides. A total of 384 farmer questionnaires, 55 in-depth interviews and 8 key informant interviews were administered and Table 4.1 below presents the response rate.

Table 4.1: Questionnaire Response Rate

Ward	Questionnaire administered	Filled and returned	Response rate (percentage)
Kikumbulyu	52	34	65.38
Kilili	36	25	69.40
Kithoni	24	17	70.83
Kitonyoni	24	16	66.67
Kivani	28	20	71.43
Kavuthu	40	28	70.00
Kola	40	28	70.00
Kwa Kavisi	32	22	68.75
Kyuu	36	25	69.44
Masii	40	28	70.00
Mutyambua	32	26	81.25
Total	384	269	70.29
Interviews:			
In-depth interviews	55	34	61.80

The questionnaire achieved a response rate of 70.29 percent which was considered more than sufficient for data analysis and making inferences regarding conservation agricultural practices and its effects on livelihood outcomes in ASAL areas in Kenya. Other participants could not be reached for the entire period of the field work. In addition to the questionnaire, 34 out 55 targeted leaders of the groups were interviewed.

4.3 Demographic Characteristics

The study considered various demographic factors including gender, age, marital status, distance to the nearest market, the CA practice adopted and the how long the farmer had been practicing the CA. The study presents the results of the demographic characteristics systematically. To begin with, the study presents part of the demographic characteristics in Table 4.2.

Table 4.2: Gender, Age, Marital Status and Distance to Market

Variable	Frequency	Percentage
Gender of respondent		
Female	218	81.0
Male	51	19.0
Total	269	100.0
Age (years)		
Below 20	0	0.00
21-30	16	5.9
31-40	19	7.1
41-50	105	39.0
Over 50	129	48.0
Total	269	100.00
Marital Status		
Married	137	50.9
Single	93	34.6
Divorced	1	.4
Widowed	38	14.1
Total	**269**	**100.00**

Table 4.2 indicates that the majority of the CA farmers in Machakos and Makueni counties are female at 81 percent. This implies that most farming activities in the counties are done by women. Mostly, farming activities in rural Africa are considered low paying jobs and hence, conducted by women. In addition, its women are often left in the rural areas where agricultural activities take place while men go in search of employment in urban centres. This finding is consistent with other studies. For instance, Waweru, Cornelis, & Okoba (2013) compared the ratio of the sampled population of each gender and the number practicing CA of each gender and found that the rate of those practicing CA is higher for the females than the males. Another study conducted by Njeru (2016) on factors influencing adoption on CA by smallholder farmers in Kenya revealed that majority of the farmers were female respondents at 61.7 % while the male farmers were 38.3 %.

On age, the study has established that most CA farmers in the two counties are aged 50 years and above followed by those aged 41-50. The percentage of young people who practice agriculture or CA is very low. In Kenya, farming is regarded by most young people as a low paying job and this could explain why most of them do not participate in it. Findings show that the majority of the farmers interviewed are married, followed by those who are single and the widowed. Additional demographic characteristics are presented in Table 4.3 below.

Table 4.3: Quality of Roads to Market and CA Principle

Variable	Frequency	Percentage
Quality of the road to market		
Passable only in dry season	68	25.3
Passable throughout the year	201	74.7
Total	**269**	**100.00**
Adoption of CA Principle		
Minimum tillage	4	1.5
Crop rotation	85	31.6
Combined practices (minimum tillage, crop rotation, mulching)	180	66.9
Total	**269**	**100.0**
Years of Practicing CA		
Less than a year	1	.4
1-2 years	6	2.2
More than 2 years	262	97.4
Total	**269**	**100.0**

The study has found that most roads in Machakos and Makueni counties are bad but passable throughout the year. On conservation agriculture, the study has learnt that most farmers in Machakos and Makueni counties practice combined practices (minimum tillage, mulching and crop rotation). On the question of how long the farmers have been practicing CA, statistics show that most respondents had more than 2 years' experience in the practice of CA. This implies that the sampled farmers were more competent to give their views regarding CA practice and its effects on their livelihoods.

4.4 Livelihood Outcomes

The analysis begins by describing the dependent variable which is, the livelihood outcomes. The descriptive statistics are presented first followed by factor analysis. The livelihood outcomes covered include food security, payment of school fees for the households and ability to take care of the household's medical bills. This is explained in this subsection.

4.5.1 Food Security

The researcher sought to understand various livelihood outcomes from the CA farmers using food insecurity experience scale. Firstly, Figure 4.1 below presents summary statistics on food insecurity using FAO scale.

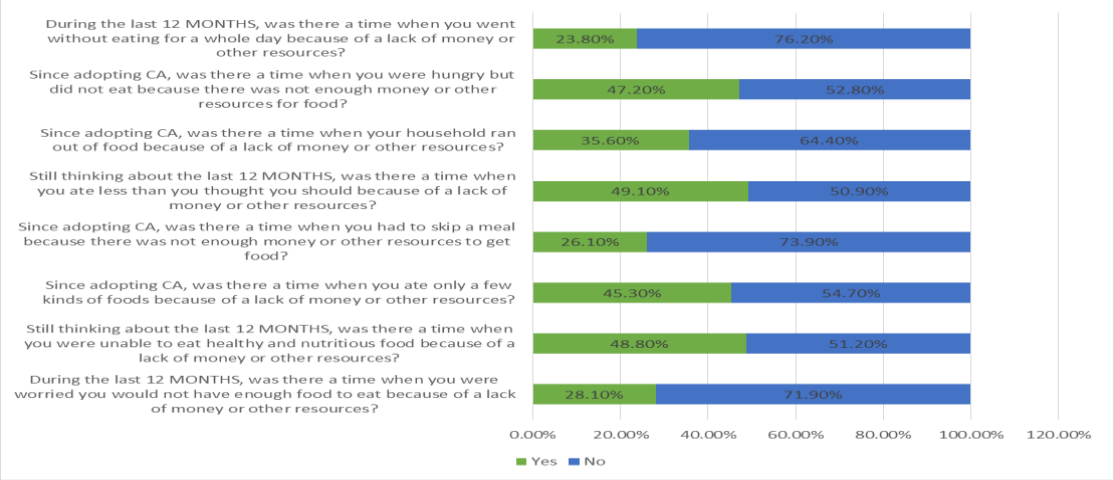


Figure 4.1: Food Insecurity Scale

Findings on food security show that the majority of the households had access to food for the last 12 months. In addition, most farmers argued that since they embraced CA practices, there was no time where the household ran out of food. Additionally, most farmers indicated that since embracing CA practices, there was no time when they went hungry, were worried of not having enough food and were unable to eat healthy and

nutritious food due to lack of money or other resources. From these findings, it can be deduced that generally, practice of CA enhanced food security for the farmers.

4.5.2 Rasch Model Analysis

The study also computed the food severity index using the Rasch model approach. This approach models item severity as the probability of an individual responding to a given item in each way. The model assumes that if a participant responds as "yes" to a question, it implies food severity or food insecurity. Table 4.4 below presents the food insecurity rate based on the respondents' number of affirmative answers from the study. There are four categories: food secure (mildly food insecure, moderately food insecure, and severely food insecure.

Table 4.4: Food Insecurity Scale

Dimensions of food security	**Food insecurity rate**
WORRIED You were worried you would not have enough food to eat	55.1
HEALTHY You were unable to eat healthy and nutritious food	47.7
FEWFOOD You ate only a few kinds of foods	33.6
SKIPPED You had to skip a meal	42.2
ATELESS You ate less than you thought you should	55.1
RUNOUT Your household ran out of food	29.7
HUNGRY You were hungry but did not eat	22.8
WHOLE DAY You went without eating for a whole day	23.8
Overall rate	**38.75**

Key:0-25: Food Secure, 26-50: Mildly food insecure, 51-75: Moderately food insecure and 76-100: Severely food insecure

Findings of the Rasch model analysis indicate that items such as HEALTHY, FEWFOODS, SKIPPED and ATELESS reported food insecurity. The overall Rasch model value of 38.75 shows that 38.75% of the study participants have mild food insecurity. Mango et al., (2017) found that adoption of CA can lead to a direct and positive influence on household Food Consumption Scores.

Furthermore, the farmers were asked to indicate the extent to which they agreed or disagreed with various statements on livelihoods on a scale of 1-5. Descriptive statistics are presented in Table 4.5 below.

Table 4.5: Descriptive Statistics on Livelihood Outcomes (N=269)

Variable	SA	A	N	D	SD	Mean	Std. Deviation
	%	%	%	%	%		
Since adopting CA, I have experienced increased food availability	77.3	22.7	0.00	0.00	0.0	1.23	0.42
Since adopting CA, I have experienced more food varieties	70.4	29.6	0.00	0.00	0.0	1.12	0.43
Since adopting CA, I have been able to cater for school fees for my children	77.3	22.7	0.00	0.00	0.0	1.23	0.42
Since adopting CA, I have been able to cater for medical costs for family members	35.7	64.3	0.00	0.00	0.0	1.64	0.48

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The mean responses ranged between 1.00 to 1.8 which indicate that respondents strongly agreed on all the statements of livelihood outcomes as shown in Table 4.6 above. These findings are quite similar with Tshuma et al. (2012) in a study on the impact of conservation agriculture on food security and livelihoods where the authors found that conservation agriculture practice extended the range of livelihood on a limited scale through improved yields and income. Furthermore, Masika (2020) in a study on the assessment of CA established that most farmers became food secure, they were also able to afford to pay school fees and medical service and take care of other necessities.

4.5.3 Factor Analysis

The study conducted factor analysis of the Likert scale variables with the aim of reducing these variables into a few which retains observed variations from the many variables. In

factor analysis, variables with the same characteristics congregate. The reduced variables are used as inputs in the regression and hypothesis analysis. Table 4.6 below indicates the number of components extracted from a total of four statements. In addition, the table contains eigenvalues, percentage of variance attributable to each component and the total variance of the extracted components.

Table 4.6: Total Variance Explained on Livelihood Outcomes

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.220	69.027	69.027	3.220	69.027	69.027
2	1.032	11.471	85.600	1.032	11.471	85.600
3	.613	.053	99.953			
4	.713	.047	100.000			

Extraction Method: Principal Component Analysis.

The Principal Component Analysis (PCA) extracted only 2 components where the first component explains 69.03% variance while the second component explains 11.47% of the variance. This brings the total variance explained to 85.6%. The remaining percentage (14.4%) is explained by other variables outside the study. Components 3-4 have eigenvalues of less than 1 meaning that insignificant and hence, discarded in the process.

Table 4.7 below presents a component (Factor) Matrix which indicates that all the first two statements associated with food availability are substantially loaded to component 1 while the last two variables related to catering for medical costs and school fees are loaded on the second component.

Table 4.7: Component Matrix on Livelihood Outcomes

Variables	Component	
	Availability of food	**Catering for education and healthcare**
Since adopting CA, I have experienced increased food availability	**.988**	.393
Since adopting CA, I have experienced more food varieties	**.988**	.070
Since adopting CA, I have been able to cater for school fees for my children	.052	**.988**
Since adopting CA, I have been able to cater for medical costs for family members	.123	**.539**

Extraction Method: Principal Component Analysis, Rotation Method: Varimax with Kaiser Normalization.

Table 4.8 below presents the mean of the extracted component on livelihood outcomes. The findings indicate a mean of 1.221 for availability of food with a standard deviation of 0.30 and 1.30 for catering for social services (such as education and healthcare) with a standard deviation of 0.5. In addition, the statistics on Cronbach Alpha shows that the two extracted components meet the reliability threshold since all the coefficients are 0.7 and above.

Table 4.8: Descriptive Statistics on Livelihood Outcomes

Component	Mean	Std. Deviation	Cronbach Alpha
Availability of food	1.22	.30	0.70
Catering for education and healthcare	1.30	0.50	0.90

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The mean responses of the extracted factors show that study participants strongly agreed to the arguments that CA practices enhances availability of food to farmers as well as catering for social services. These imply that farmers who practice conservation agriculture are likely to harvest more from their farms and hence, improve their livelihood

outcomes in terms of availability of food and catering for social services like healthcare and education. This is consistent with several other studies. For instance, Uddin and Dhar (2016) conducted a study on CA farmer's livelihood status in Bangladesh and found that adoption of CA led to a decrease in poverty in terms of deprivation of health, education and living standards. Similarly, Mango et al., (2017) reports that household Food Consumption Scores can be improved indirectly by CA through purchase of other essential food stuffs from income obtained after selling surplus crop outputs.

The findings are also supported by qualitative data as confirmed by an in-depth interview with CA group leaders. Majority of the leaders who were interviewed argued that farmers who embraced conservation agriculture were more food secure than those who have not. For instance, one participant said that;

> *"The practice of conservation agriculture has improved food production for some of us. This has in turn ensured that we have more food for our families and can also have surplus to sell to others." (L07).*

4.5 Input Costs and Livelihood Outcomes

In this subsection, the study analyses various input costs such as labour, mulching and farm equipment. These are then regressed on livelihood outcome variables. Firstly, descriptive statistics of the input costs are presented followed by factor analysis. To begin with, CA farmers were asked to indicate the cost of both casual and full-time labour force. Table 4.9 below displays summary findings.

Table 4.9: Cost of Labour

Type of labour/cost	Median cost per season (Kshs)	Cost per day
Cost of non-family casual labour	6500	72.22
Cost of family casual labour	2100	23.33
Cost of Full-time non-family labour	15000	166.67
Cost of Full-time family labour	3250	36.11

Cost per day=median cost per season/90 (90 days in a season)

In the last 12 months, the median unit cost of non-family casual labourers stood at Kshs. 6500 per season or Kshs. 72.22 per day while that of full-time non-family labourers was Kshs. 15,000 per season or Kshs. 166.67 per day. With regard to unit cost of family labour, the study has established a median value of Kshs. 2100 for casual labour and Kshs. 3250 for full-time family labour per every season. These findings indicate that family labour is much cheaper than non-family labour. This can also be attributed to the fact that most members of the family render their labour on the farm at no cost. In addition, in some cases, family labour is not billed.

The CA farmers were also asked to indicate non-family and family labour force requirements per season. Summary statistics are provided in Table 4.10 below. The median of non-family casual labourers was 3 while that of full-time employees was 1. Indeed, the number of full-time employees is quite low considering that these are small scale farmers and hence, have limited resources to employ many full-time labourers. Statistics show the median value of 2 casual family labour force while the median number for full-time family labour force stood at 4 per season. These imply that there are more full-time family labour force than casual. The findings are similar to a study by (Geddes and Scott, 2011) who found out that numerous farms operate on a dual-labour market system, with a small core of permanent staff, magnified by a fluctuating and temporary workforce.

Table 4.10: Labour Force Requirements

Type of labour	Median labour force per season
No of non-family casual labourers	3
No of family casual labourers	2
No of non-family Full-time labourers	1
No of family full-time labourers (in household/season)	4

When asked about if they had family members providing labour on their farm, all farmers interviewed (269) said yes. On the form of labour provided, the majority of the family members (74.3%) were full-time labourers. Due to the nature of their small-scale operations, most of these farmers make use of the family labour force. When asked about time required to prepare land under CA principle, the majority of the farmers (81.1%) argued that it does not require more time to prepare land for CA practice as compared to planting crops not under CA.

The study also analyzed use of mulches by farmers. First, respondents were asked to indicate whether they applied mulches as a CA principle and secondly, those who applied mulches were required to show where they found them. For those who do not apply mulches, they were asked to indicate reasons why. Table 4.11 below presents summary statistics. Findings show that the majority of the farmers (77.3%) apply mulching as a CA principle. For those who do not apply mulches, they cited that the process of mulching is time consuming (49.18%) followed by ignorance among them on the perceived benefits of mulching.

Table 4.11: Use of Mulches in CA

Variable	Frequency	Percentage
Do you apply mulches?		
Yes	208	77.3
No	61	22.7
Total	269	100.0
Where do you get mulches?		
From my farm	179	86.06
Neighbor	20	9.62
Others	9	4.32
Total	208	100.0
Reasons for not mulching		
Time consuming	30	49.18
Not aware of the benefits	20	32.79
I don't know	11	18.03
Total	61	100.0

When asked about where they get mulches, the majority of the farmers cited their own farms (86.06%) followed by those who get mulches from their neighboring farms. The implication is that mulches are easily available. Still on input costs, farmers were asked to rate the extent to which they agreed to certain statements on a scale of 1-5. Means, standard deviations and percentage responses were computed. These findings are presented in Table 4.12 below.

Table 4.12: Descriptive Statistics on Input Cost (N=269)

Variable	SA	A	N	D	SD	Mean	Std. Deviation
	%	%	%	%	%		
There is less labour cost for CA crops	71.7	22.7	0.00	5.6	0.00	1.39	0.76
There is ease of access to labour for CA crops	71.7	28.3	0.00	0.00	0.00	1.29	0.45
The time saved through use of CA is dedicated to non-farm occupations	70.02	29.98	0.00	0.00	0.00	1.29	0.45
The use of mulches saves the amount of water used for watering crops	87.7	12.3	0.00	0.00	0.00	1.13	3.33
The use of mulches saves the time used on the CA farm	86.6	13.4	0.00	0.00	0.00	1.13	3.34
The use of mulches minimizes the cost incurred in hiring extra labour to work on the CA farm	81.1	11.9	0.00	0.00	0.00	1.12	3.32
The use of CA farm equipment minimizes the number of times land is prepared;	66.9	33.1	0.00	0.00	0.00	1.33	0.47
The use of CA farm equipment minimizes the time spent preparing land;	63.6	36.4	0.00	0.00	0.00	1.36	0.48
The use of CA farm equipment saves on the number of labourers required to prepare land.	72.1	27.9	0.00	0.00	0.00	1.28	0.45

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The study participants strongly agreed to all the arguments on the input costs such as labour requirement, use of mulches and farm equipment. These findings imply that adoption of CA practices reduces farm input costs which makes farming less costly. For instance, the use of mulches could reduce the number of labourers on the farm, availability of relevant farm equipment for CA practices is critical towards increasing productivity of the farm. These results tend to be consistent with other studies conducted by Hobbs, (2007); Hobbs et al., (2008) and Wall, (2009) where the authors found that when the three

principles of minimum tillage, mulching and crop rotation are adhered to, CA is reported to improve soil quality, optimize crop yields and reduce input costs. Even when yield reductions are observed in some instances, CA systems can still be more profitable than conventional agricultural systems due to reduced input costs (Vastola et al., 2017; LaCanne and Lundgren, 2018).

4.5.1 Factor Analysis on Input Costs

The study conducted factor analysis for input cost. Table 4.13 below presents results for variance explained which shows that three components were extracted from the process which had a total of 9 statements. The first component accounts for 19.67% of the total variance while the second component accounts for 16.7% of the variance. The third component accounted for 26.9%. Thus, the three extracted components explain 63.261 % of the variance in the observed variables. The 6-9 components were found not significant and hence, discarded.

Table 4.13: Explained Variance on Input Costs

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.973	27.031	27.031	2.973	27.031	27.031	2.164	19.673	19.673
2	1.548	14.074	41.105	1.548	14.074	41.105	1.836	16.689	36.363
3	1.434	13.036	54.141	1.434	13.036	54.141	1.769	26.899	63.261
4	.915	8.319	71.580						
5	.765	6.958	78.538						
6	.634	5.766	84.304						
7	.530	4.814	89.119						
8	.451	4.104	93.222						
9	.333	3.024	100.000						

Extraction Method: Principal Component Analysis.

Table 4.14 below presents rotated component matrix which shows that the first three statements are substantially loaded on the second component associated with access to labour, the next three variables are loaded on the first component related to use of mulches

and the last three variables associated with access to farm equipment are adequately loaded on the third component.

Table 4.14: Rotated Component Matrix on Input Costs

Variables	Cost of use of mulches	Access to labour	Access to farm equipment
There is less labour cost for CA crops;	0.245	**.758**	0.245
There is ease of access to labour for CA crops;	0.001	**.660**	0.109
The time saved through use of CA is dedicated to non-farm occupations;	0.124	**.799**	0.230
The use of mulches saves the amount of water used for watering crops;	**.671**	0.26	0.120
The use of mulches saves the time used on the CA farm;	**.528**	0.330	0.240
The use of mulches minimizes the cost incurred in hiring extra labour to work on the CA farm;	**.501**	0.102	0.210
The use of CA farm equipment minimizes the number of times land is prepared;	0.102	0.210	**.784**
The use of CA farm equipment minimizes the time spent preparing land;	0.132	0.230	**.800**
The use of CA farm equipment saves on the number of labourers required to prepare land.	0.232	0.120	**.543**

Table 4.15 below presents descriptive statistics on input costs consisting of the mean and Cronbach Alpha coefficients. The mean statistics indicates that participants strongly agreed on the arguments concerning the cost of labour with a mean of 1.301 with a standard deviation of 0.40. In addition, there was a strong agreement among the farmers on the arguments related to the use of mulches with a mean of 1.312 and standard deviation of 0.46.

Table 4.15: Descriptive Statistics on Input Costs Components

Component	Mean	Std. Deviation	Cronbach Alpha
Reduced cost of labour	1.301	0.40	0.87
Reduced cost of use of mulches	1.312	0.46	0.98
Access to farm equipment	1.22	0.20	0.71

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The results also reveal that farmers had a strong agreement on the issue of access to farm equipment with a mean of 1.22. Furthermore, all the coefficients of Cronbach Alpha meets the reliability threshold. These findings imply that application of CA practices reduces labour requirements and also minimizes farm equipment needed for farming. Additionally, the results show that access to mulches saves cost spent on the farm.

From these results, it can be said that mulching reduces the cost of farming which could ultimately lead to higher incomes of the farm. As a result, farmers would be able to access better healthcare and education more easily. These findings are consistent with several other studies. For instance, Farmer surveys in Pakistan and India reveal that zero-till of wheat after rice reduces costs of production by US$60 per hectare ordinarily due to less fuel (60–80 l haK1) and labour (Hobbs et al., 2007). Mhlanga et al., (2021) conducted a study on the crucial role of mulch to enhance the stability and resilience of cropping systems in southern Africa. They found out that the use of mulch combined with minimum tillage resulted in significantly lower stability variance on maize grain yield and shoot biomass compared with the other cropping systems hence indicating that mulch promoted an increase in the stability of production.

During in-depth interviews, the majority of the group leaders noted that use of mulches is very critical in production. For instance, one group leader in an interview argued that;

> *"..Application of mulches preserves water in the soil and therefore, farmers spend little or no time in watering the crops.*" *(L04).*

In addition, a large number of group leaders interviewed were of the view that application of most CA principles reduces the amount of time required to work on the farm. This implies that less labour force is needed to work on CA farms. For example, one leader stated that;

> *"Application of CA practices such mulching minimizes growth of weeds in the farm and as a result, there is less labour force needed during weeding." (L02).*

4.5.1.1 Regression on the Effect of Input costs on Livelihood Outcomes

The study conducted a regression analysis between livelihood outcome variables and the input cost variables. Livelihood outcome variables obtained in the PCA process were regressed on the three independent variables and the results are presented in Table 4.16 below.

Table 4.16: Regression Results on the Effect of Input Costs on Livelihood Outcome Variables

	Model 1					Model 2				
	B	**Std. Error**	**Beta**	**T**	**Sig.**	**B**	**Std. Error**	**Beta**	**T**	**Sig.**
Independent										
(Constant)	-.784	.239		-3.28	.001	3.481	.124		28.038	.000
Cost of Labour	1.081	.113	.573	9.554	.000	.190	.067	.137	2.836	.009
Cost of use of Mulches	1.183	.217	.250	5.440	.000	1.181	.200	.297	5.903	.000
Access to Farm equipment	.992	.174	.323	5.707	.000	0.24	.079	.205	3.038	.000
Dependent	**Availability of food**					**Catering for education and healthcare**				
R – squared	0.036					0.626				
Adj. R squared	0.029					0.6151				
Std. Error	1.055					.761				
F – ratio (2, 263)	4.946					0.000				
Prob. > F	0.008					0001				

The results indicate that the model is statistically significant given the ANOVA (F-statistic) p-value of 0.000. This implies that findings are statistically significant. The R squared value of 0.626 shows that the input cost accounts for 0.626 variation in the

farmer's livelihood outcomes (catering for education and healthcare, and availability of food), and 0.036 variation in the availability of food.

Turning to the estimated coefficients, the study has established a positive and statistically significant influence of input costs on the availability of food. This implies that the cost of labour, mulches and access to farm equipment by CA farmers has a positive impact on their farming activities which generate more income that enables the farmers to have an access to food. The increased income could be attributed to reduced amount of time or labour hours spent on the farm/inputs as well as higher farm productivity. Mulches limit the amount of water that evaporates and thus, reducing the crop water requirements. These imply that the plants can flourish even with the little rainfall. This enhances the productivity of the farm which leads to more income to the farmer and hence, better living conditions. Mulching also allows better water and air movement through the soil, some mulches provide nutrients to the soil which ultimately improves production.

The study has also established a positive and statistically significant influence between input costs and catering for education and healthcare. This implies that cost of use of mulches, access to farm equipment and cost of labour by CA farmers is favorable and hence, promotes access to better healthcare and education among CA farmers. In addition, the results indicate that access to farm equipment increases production of agricultural activities conducted by the CA farmers. Access to relevant farming equipment makes farming easier and more efficient which in turn leads to more production, more income and hence, better livelihood outcomes by the CA farmers. The findings are in line with other studies conducted previously. For example, according to Doets et al., (2000), access to modern farm equipment increases production by about 60% as compared to use of traditional farm equipment. Additionally, Kumar et al., (2018) and Devkota et al., (2019) observed that where CA leads to similar or greater yields, profitability is generally improved due to reduced costs of land preparation and labour, and reduced water requirements.

These findings were also supported by in-depth interviews with farmer group leaders. For instance, during the interviews with farmer group leaders, a vast majority of them argued that labour in the rural areas is cheap and readily available. As such, CA farmers pay less for both hired and family labour and this increases output, incomes and ultimately, enhanced livelihood outcomes through availability of food and ability to cater for the necessities of life. A leader argued that;

> *".....there is surplus labour in the rural areas which makes it readily accessible and cheap in that matter." (L021)*

Another leader stated that;

> *"Most of us farmers have more labour force within our households which we utilise free of charge." (L016)*

4.6 Land Productivity and Livelihood Outcomes

The second objective sought to examine the effect of land productivity on livelihood outcomes in ASAL areas. Various aspects of land productivity were investigated. These included CA principles being practiced by farmers, the number of seasons cultivated under a CA principle and the crops cultivated. The study started by asking the respondents the number of seasons they had so far planted crops under CA practices and the crops they had planted. Summary statistics are presented in Table 4.17 below.

Table 4.17: CA Principles and Crops Cultivated

Variable	Median
Seasons per CA principle	
Minimum tillage	3
Mulching	3
Crop rotation	3
Main crops cultivated under CA	Frequency
Maize	72
Beans	195
Cowpeas	2
Total	**269**
Was the CA crop rotated with another one?	
Yes	173
No	96
Total	**269**
Which crops were rotated with the CA crop?	
Maize	230
Beans	39
Total	**269**

Statistics indicate a median number of three (3) seasons under minimum tillage practice, mulching as well as crop rotation. This implies that on average, farmers in Machakos and Makueni counties have three seasons under CA principles per year. With regard to the main crops cultivated under CA practices, the study reports beans at 72.5%, followed by maize and cowpeas at 26.8% and 0.7% respectively. The study results also indicate that most CA farmers' practice rotational farming with CA crops and that maize is the most widely rotated crop. In addition, farmers were asked to indicate the extent to which they agreed or disagreed with arguments related to land productivity on a scale of 1-5. Descriptive results are presented in Table 4.18 below.

Table 4.18: Descriptive Statistics on Land Productivity (N=269)

Variable	SA	A	N	D	SD	Mean	Std. Deviation
	%	%	%	%	%		
Crop rotation/intercropping has led to application of fewer fertilizers;	63.6	36.4	0.00	0.00	0.00	1.36	0.48
Crop rotation/intercropping has led to improved water retention of the soil;	58.4	41.6	0.00	0.00	0.00	1.42	0.49
Crop rotation/intercropping has led to reduced soil erosion.	60.6	39.4	0.00	0.00	0.00	1.39	0.49
The output levels have remained the same since adopting CA	0.00	0.00	0.00	91.4	8.6	4.09	0.28
The output levels have improved since adopting CA	71.7	28.3	0.00	0.00	0.00	1.28	0.45
I am always assured of output every season since adopting CA	94.4	5.6	0.00	0.00	0.00	1.06	0.23
The output from my farm has been affected by pests since adopting CA	25.7	74.3	0.00	0.00	0.00	1.74	0.44
The output from my farm has been affected by diseases since adopting CA	25.7	74.3	0.00	0.00	0.00	1.74	0.44
The output from my farm has been mature since adopting CA	61.7	38.3	0.00	0.00	0.00	1.38	0.49

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The mean response indicates that farmers strongly agreed on the arguments regarding land productivity which included intercropping, improved output level and quality. These results mean that the practice of CA enhances soil fertility which ultimately improves the productivity of the farms in terms of output quantity and quality. Evidence shows that the adoption of CA practices including crop rotation, crop diversification and residue retention improves infiltration and soil moisture conservation (Thierfelder et al., 2017). Differences in crop rotation between CA and conventional agricultural systems also have the potential to impact soil organic carbon (SOC) values. The elimination of monocultures and incorporation of plant species into rotations that return greater amounts of residue to the soil are often associated with greater SOC stock in CA systems (Conceição et al., 2013).

4.7.1 Factor Analysis

The study conducted factor analysis for land productivity. Table 4.19 below presents results for variance explained which shows that three components were extracted from the process which had a total of 9 statements. The first component accounts for 28. 23 % of the total variance while the second component accounts for 13.24 % of the variance. The third component accounted for 24.56%. Thus, the three extracted components explain 65.67 % of the variance in the observed variables. The remaining variance (34.33) can be explained by omitted or unobserved factors. The 6-9 components were found not significant and hence, discarded in the process.

Table 4.19: Variance Explained for Land Productivity

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.604	28.933	28.933	2.604	28.933	28.933	2.544	28.267	28.267
2	1.206	13.403	42.336	1.206	13.403	42.336	1.191	13.238	41.506
3	1.072	11.908	65.665	1.072	11.608	65.665	1.130	24.551	65.665
4	.028	11.422	65.665						
5	.995	11.061	76.726						
6	.887	9.857	86.583						
7	.551	6.119	92.702						
8	.499	5.549	98.251						
9	.157	1.749	100.000						

Extraction Method: Principal Component Analysis.

Table 4.20 below indicated that the first three variables were loaded on the first component associated with intercropping while the next three variables were loaded on the third component which is related to output level. The last three variables were adequately loaded on the second component which is related to quality of the output.

Table 4.20: Rotated Component Matrix on Land Productivity

Variable	Component		
	Intercropping	**Quality of output**	**Output level**
Crop rotation/intercropping has led to application of fewer fertilizers	**.804**	.051	-.010
Crop rotation/intercropping has led to improved water retention of the soil	**.751**	.003	.109
Crop rotation/intercropping has led to reduced soil erosion	**.949**	.017	.039
The output levels have remained the same since adopting CA	.014	.208	**.561**
The output levels have improved since adopting CA	.142	.230	**.861**
I am always assured of output every season since adopting CA	.008	.063	**.562**
The output from my farm has been affected by pests since adopting CA	.013	**.782**	.028
The output from my farm has been affected by diseases since adopting CA	.111	**842**	.091
The output from my farm has been good since adopting CA	.182	**.963**	.170

Extraction Method: Principal Component Analysis.

Descriptive statistics for extracted components are presented in Table 4.21 below.

Table 4.21: Descriptive Statistics on Land Productivity Components

Component	Mean	Std. Deviation	Cronbach Alpha
Intercropping	1.40	.401	0.77
Output level	1.12	0.30	0.80
Quality of output	1.5	0.67	0.90

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The mean responses show that the study participants strongly agreed on the argument that intercropping enhances productivity which is demonstrated by more output. Similarly,

study participants strongly agreed to the arguments that CA practices improve both the output levels and quality of the produce. Several studies support these arguments. For instance, Thierfelder et al., (2017) argue that the adoption of CA practices including crop rotation, crop diversification and residue retention improves infiltration and soil moisture conservation. Similarly, Bassi, (2000), Saturnino & Landers (2002) argue that crop rotation or intercropping adds nutrients to the soil which enhances the quality of output harvested.

The same arguments were advanced by farmer group leaders during in-depth interviews. For example, a large majority of the leaders who were interviewed said that the practice of intercropping regenerates nutrients into the soil which improves the fertility of the soil. This in turn leads to more production which could potentially enhance livelihood outcomes. For instance, a leader argued that.

> *"The act of intercropping is very beneficial in the sense that it reduces the amount of fertilizer."* (L004).

4.6.1 Regression on Land Productivity and Livelihood Outcomes

The study regressed livelihood variables on the land productivity variables (intercropping, output level and quality of output) which were constructed from the Likert scales. The estimated results are presented in Table 4.22 below.

Table 4.22: Regression Results on the Effect of Land Productivity on Livelihood Outcomes

	Model 1					Model 2				
	B	**Std. Error**	**Beta**	**T**	**Sig.**	**B**	**Std. Error**	**Beta**	**T**	**Sig.**
Independent										
(Constant)	-6.28	.451		-13.92	.000	-6.903	.563		-12.260	.000
Intercropping	1.628	.150	.499	10.86	.000	2.140	.238	.452	8.994	.000
Output level	1.183	.217	.250	5.440	.000	1.181	.200	.297	5.903	.000
Quality of output	.913	.170	.229	5.364	.000	.280	.115	.118	2.425	.016
Dependent	Availability of food					Catering for education and healthcare				
R – squared	0.555					0.326				
Adj. R squared	0.490					0.3101				
Std. Error	.938					.761				
F – ratio (2, 263)	5.031					4.312				
Prob. > F	0.000					0.026				

The probability of the ANOVA test shows that findings are statistically significant given the probability value of less 0.05 in both the models. The R squared statistics indicates that the explanatory variable (land productivity) accounts for 55.5% variation in the CA farmer's availability of food and 32.6% variations in catering for education and healthcare.

Findings show that land productivity has a positive and statistically significant relationship with availability of food among the CA farmers. This means that conservation agricultural practices like mulching, crop rotation and minimum tillage enhances the fertility of the soil which in turn leads to more production and hence, availability of food and better livelihood outcomes of the farmer's households in general.

Similarly, the study established a positive and statistically significant relationship between land productivity variables such as intercropping, output level, quality of output and catering for education and healthcare. This means that CA practices lead to increased land production. Higher production means more income for the farmers to take care of health care and education needs of the family. The practice of conservation agriculture enhances the quality of the farm produce and ultimately, the quality of livelihood outcomes.

These findings are supported by other previous studies. For instance, Lange (2005) study in Paraguay reported that the majority of farmers came up with new crops and diversified their crop through rotation which resulted in increased farm productivity which once

combined with the minimized production costs led to significantly more net income and hence, enhanced livelihood outcome of the farmers. Similarly, previous studies have linked practice of CA with higher output (Dumanski et al., 2006; Mazvimavi et al., 2010; Stewart et al., 2008). There have been positive impacts of CA adoption on maize/crop yield in Zambia (Ng'ombe et al., 2017; Ngoma, 2018), Tanzania (Arslan et al., 2017) and Ethiopia (Jaleta et al., 2016).

An in-depth interview with CA farmer group leaders has revealed that practice of conservation agriculture leads to increase in output levels. This was argued by a vast majority of leaders who were interviewed. In addition, the leaders also argued that CA practices such as mulching and minimum tillage reduces input costs which in turn enhances revenues. In addition, the majority of the leaders argued that crop rotation improves output, then revenues and hence, better livelihood outcomes. For example, one leader stated that;

> *"That rotating crops like legumes for maize increases soil fertility for the next maize planting season. This in turn provides more revenue to the farmer." (L012).*

4.7 Socio-Economic Characteristics and Livelihood Outcomes

In this sub-subsection, the study analyzes both descriptive and inferential statistics related to socioeconomic characteristics and farmer's livelihoods. To begin with, the study sought to find out the highest level of education of the farmers. Table 4.23 below presents summary results. Majority of the farmers possess a primary school certificate as their highest level of education followed by those with secondary level of education.

Table 4.23: Highest level of Farmer's Education

Education	Frequency	Percent
Informal	41	15.2
Primary	103	38.3
Secondary	90	33.5
Diploma	32	11.9
Degree	1	0.4
Masters	2	0.7
Total	**269**	**100.0**

The respondents were asked if they had other occupations apart from farming. Table 4.24 below presents findings of the study. The results show that most of the farmers, 39.8% are not engaged in any other occupations apart from farming. This was followed closely by those offering their labour for casual jobs. The findings imply that farming is the main source of livelihood for the majority of the Machakos and Makueni residents.

Table 4.24: Other Occupations

Variable	Frequency	Percent
Casual labour	90	33.5
Teaching	16	5.9
Business venture	56	20.8
None	107	39.8
Others	0.0	0.00
Total	269	100.0

Still on socioeconomic characteristics, the farmers were asked to indicate the total acreage of land they owned and the type of ownership. Summary statistics are presented in Table 4.25 below. Most of the surveyed households have less than five (5) acres of land followed closely with those with 5-10 acres.

Table 4.25: Land Size and Ownership type

Variable	Frequency	Percent
Land size in acres		
Below 5 acres	137	50.9
5-10 acres	57	21.2
11-15 acres	19	7.1
16-20 acres	30	11.2
Above 20 acres	26	9.7
Total	**269**	**100.0**
Ownership type		
Title deed	60	22.3
Allotment letter	112	41.6
Leasehold	97	36.1
Total	**269**	**100.0**

These results imply that the majority of the residents of Machakos and Makueni have smaller pieces of land. This implies that most farmers in Makueni and Machakos counties practice small scale farming. This could be attributed to sub-division of land into smaller units and limited CA skills and resources. This argument is supported by Nkala et al., (2011) who found CA farming in central Mozambique was on a small scale. When it comes to land ownership, the study has established that only 22.3 percent of the interviewed farmers have title deeds for their land. The rest have an allotment letter or are on a leasehold.

Furthermore, research participants were asked to rate the extent to which they agreed or disagreed on the arguments related to socioeconomic characteristics and CA practices on a scale of 1-5. Descriptive statistics are shown in Table 4.26 below.

Table 4.26: Descriptive Statistics on Level on Socio-economic Characteristics (269)

Variable	SA	A	N	D	SD	Mean	Std. Deviation
	%	%	%	%	%		
I have been able to understand the principles of conservation agriculture;	59.5	40.5	0.00	0.00	0.00	1.41	0.49
I have been able to apply CA technologies	49.1	43.9	0.7	2.6	3.7	1.68	0.92
I have been able to comprehend the various CA benefits	75.5	23.0	1.50	0.00	0.00	1.26	0.47
The income gained from the other occupation, enables me to purchase farm equipment for CA;	61.0	39.0	0.00	0.00	0.00	1.39	0.49
The income gained from the other occupation, enables me to hire extra farm labour;	26.4	61.3	0.00	1.5	10.8	2.09	1.14
The other occupation supplements CA farming.	59.5	40.5	1.50	0.00	0.00	1.41	0.49
Since embracing CA, my poverty status has gone down;	55.4	32.3	12.3	0.00	0.00	1.59	0.70
Since embracing CA, I have been able to afford basic commodities with ease;	59.9	38.7	1.5	0.00	0.00	1.42	0.52
Since embracing CA, I have been able to increase my income streams.	64.3	35.7	1.50	0.00	0.00	1.35	0.49

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The mean responses show that farmers either strongly agreed or agreed to the arguments of socioeconomic characteristics of the study participants. This means that socioeconomic characteristics have implications on the relationship between CA practices and livelihood outcomes. In particular, the results mean that non-farming activities enhanced their CA by providing money for buying inputs.

4.7.1 Factor Analysis

The study conducted factor analysis for socioeconomic characteristics. Table 4.27 below presents results for variance explained which shows that three components were extracted from the process which had a total of 9 statements. The first component accounts for 18.96 % of the total variance while the second component accounts for 17.20 % of the variance. The third component accounted for 25.05%. Thus, the three extracted components explain

61.87 % of the variance in the observed variables. The remaining components were found not significant and hence, discarded in the process. This is because their total eigenvalues is less than 1.

Table 4.27: Total Variance Explained for Socioeconomic Characteristics

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	1.725	19.163	19.163	1.725	19.163	19.163	1.707	18.964	18.964
2	1.662	18.462	37.625	1.662	18.462	37.625	1.548	17.198	36.161
3	1.152	12.804	61.870	1.152	12.804	61.870	1.264	25.048	61.870
4	.030	11.440	61.870						
5	.971	10.783	72.653						
6	.881	9.789	82.442						
7	.641	7.121	89.563						
8	.554	6.151	95.714						
9	.386	4.286	100.000						

Extraction Method: Principal Component Analysis.

Table 4.28 below presents a rotated component matrix where the first three variables associated with the skills on CA are loaded on the first component, the next three variables related to non-farm activities are loaded on the third component while the last three variables associated with access to income are substantially loaded to the second component.

Table 4.28: Rotated Component Matrix for Socioeconomic Characteristics

Variables	Component		
	Skills on CA	**Access to income**	**Non-farm activities**
I have been able to understand the principles of conservation agriculture;	**.777**	.141	.286
I have been able to apply CA technologies;	**.624**	.088	.077
I have been able to comprehend the various CA benefits;	**.827**	.144	.048
The income gained from the other occupation, enables me to purchase farm equipment for CA;	.079	.251	**.823**
The income gained from the other occupation, enables me to hire extra farm labour;	.167	.175	**.701**
The other occupation supplements CA farming;	.193	.281	**.666**
Since embracing CA, my poverty status has gone down due to more earnings;	.040	**.779**	.154
Since embracing CA, I have been able to afford basic commodities with ease due to increased income;	.060	**.818**	.035
Since embracing CA, I have been able to increase my income streams.	.043	**.613**	.129

Table 4.29 below presents descriptive statistics for socioeconomic characteristics components. The mean response rate shows that study participants strongly agreed that farmers have well-grounded CA skills given a value of 1.12. In addition, the statistics show that farmers strongly agreed on the arguments of non-farm activities and access to income with reference to the implementation of CA practice.

Table 4.29: Descriptive Statistics for Socioeconomic Characteristics Components

Component	Mean	Std. Deviation	Cronbach Alpha
Skills on CA	1.12	0.11	0.87
Non-farm activities	1.34	0.20	0.78
Access to income	1.61	0.43	0.70

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

Indeed, to practice conservation agriculture, skills and access to resources are very critical. These findings are affirmed by Tambo and Mockshell (2018) who argue that significant income gains from full adoption of CA across nine SSA countries. Similarly, Uddin & Dhar (2016) argued that there was an increase in annual income for farmers practicing conservation agriculture in Bangladesh. The results showed that while before practicing conservation agriculture farmers earned Tk. 100 money income, focal, proximal and control farmers earned about Tk. 110, Tk. 107 and Tk. 106 money income, respectively after practicing conservation agriculture. According to Aryal et al., (2019), the likelihood to adopt CA increases with the increase in the share of off-farm income in the total household income.

An in-depth interview with CA farmer's leaders reveals that income generated from other occupations enhance their farming. This argument was advanced with 25 out of 34 group leaders who were interviewed. Most participants argued that income from off-farm activities is used for purchasing farm inputs and hiring of the labour force. In general, the findings indicate that the practice of CA has the potential of economic empowerment and hence, poverty alleviation. For instance, one leader argued that;

> *"...other economic activities apart from farming helps farmers acquire inputs such as hiring of labour and purchase of fertilizer. This also supplements farmers' income." (L014).*

4.7.2 Regression on Socio-economic Characteristics and Livelihood Outcomes

The study conducted a regression analysis between socioeconomic characteristics (Skills on CA, non-farm activities and access to income) and livelihood outcomes. Summary findings are presented in Table 4.30 below.

Table 4.30: Regression Results on the Effect of Socioeconomic Characteristics on Livelihoods

	Model 1					Model 2				
	B	**Std. Error**	**Beta**	**T**	**Sig.**	**B**	**Std. Error**	**Beta**	**T**	**Sig.**
Independent										
(Constant)	-.815	.318		-2.566	.011	-2.265	.265		-8.541	.000
Skills on CA	.183	.116	.078	1.582	.115	.291	.128	.123	2.279	.023
Non-farm activities	-.691	.104	-.327	-6.616	.000	-1.274	.134	-.497	-9.507	.000
Access to income	1.157	.127	.451	9.111	.000	.138	.054	.138	2.560	.011
Dependent	**Availability of food**					**Catering for education and healthcare**				
R – squared	0.366					0.279				
Adj. R squared	0.340					0.271				
Std. Error	1.986					.8538				
F – ratio (2, 263)	6.231					4.512				
Prob. > F	0.000					0.000				

The probability of the ANOVA test shows that the findings are statistically significant. The R squared statistic of 0.366 and 0.279 indicates that the explanatory variable (socioeconomic characteristics) accounts for 36.6% and 27.9% variation in the CA farmer's availability of food and catering for education and healthcare respectively. This implies that socioeconomic characteristics have relatively lower impact on the CA farmer's livelihood outcomes as compared to both input cost and land productivity.

With regard to the estimated coefficients, the study has revealed that the farmer's skills on CA has a positive effect on both availability of food and catering for education and healthcare. Nevertheless, only the coefficient of catering for education and healthcare was statistically significant. This implies that skills in CA have a positive impact on catering for education and healthcare. Improved skills on CA helps farmers to implement the

farming practices well which eventually improves livelihood outcomes through increased output and income.

There is a negative and statistically significant relationship between non-farm activities and availability of food and catering for education and healthcare livelihood outcome variables given negative coefficients. This means that having another occupation apart from CA discourages production and hence, livelihood outcomes of the farmers. This also means that wages from non-farming activities are not used to promote CA practices through purchase of farm inputs and equipment. In addition, having another occupation is likely to reduce the number of hours a farmer spends on farming which eventually reduces the quantity of harvest.

The results indicate a positive and statistically significant relationship between the access to income and livelihood outcomes given positive and statistically significant coefficients. This means that farmers with more access to income are likely to produce more with CA practices. More income could imply more ability to purchase farm tools and inputs, attend relevant training, seek for extension services and hence, more production. Indeed, Maphosa et al. (2012) argues that good harvest years provide opportunities for increased incomes arising from more sales. The increased incomes boost the access dimension of food security since the farmers have the ability to purchase food items that they would not have grown in their fields. According to Ding, (2018) and Harper et al., (2018), additional assistance may be required for poorer farmers who are less likely to adopt CA due to the initial investment required with establishment and the risk associated with decreased yields early in the adoption process. Bisangwa (2013) argues that farmers who have received some training in agriculture have a high likelihood of using CA on their fields which could enhance farm produce, income and better livelihood outcomes by extension.

During an in-depth interview, most group leaders argued that access to income was very critical for the CA farming since acquisition of farming technology, training and hiring of labour dependent on money. All the leaders also argued that farmers who possessed

relevant skills in CA stood a better chance of uplifting their farming and therefore, livelihood outcomes. For instance, a leader argued that:

> *"....Having relevant knowledge and skills in conservation agriculture is very important and could influence the outcome of farming.*" *(L24).*

4.8 Marketing Institutional Arrangement and Livelihood Outcomes

The fourth objective sought to determine the effect of marketing institutional arrangement on the livelihood of CA farmers. First, farmers were asked to indicate whether they had sold their produce in the last harvest season of which the majority, 68% said that they sold while the remaining 31.2% indicated to have never sold their produce in the previous harvest season. Secondly, for those who sold, the study sought to find out the price per kilogram at which they sold the main crop under CA produce. Summary findings are presented in Table 4.31 below.

Table 4.31: Descriptive Statistics on the Price of Produce (N=269)

Produce	Price in Kshs. /kg			
	Min	Max	Mean	Std. Deviation
Maize	40	80	55.50	0.450
Beans	95	130	92.5	12.213
Cowpeas	135	156	140.50	20.178

The price of maize produce ranged between a minimum of Kshs 40 to Kshs. 80 per kilogram while that of beans ranged between a minimum of Kshs. 95 to Kshs. 130 with a mean of Kshs. 92.50. For cowpeas, farmers sold at mean price Kshs. 140.50 per kg with a standard deviation of Kshs. 20.178.

Next, farmers who had sold the previous season were asked several questions on marketing arrangement. Table 3.32 below presents summary statistics on various marketing arrangements.

Concerning the question of whether the price was better in the last harvest season, the majority of the farmers indicated no at 74.47%. With respect to marketing arrangements used to sell produce, the majority of the CA farmers adopted direct marketing (selling in the local village) while only a few farmers sold their produce through brokers. On payment, statistics show that farmers get paid immediately when they submit their produce to the buyers (within a week). This is attributed to direct marketing preferred by most of them in the previous harvest season. These findings imply that farmers get their dues faster and hence, the marketing arrangement is perceived to be very efficient.

Table 4.32: Descriptive Statistics on Marketing Arrangement

Variable	Frequency	Percent
Was the price better in the last season?		
Yes	20	23.53
No	65	74.47
Total	85	100.00
Market arrangement used for selling		
Sale in local village	62	73.2
Sale to schools	9	10.8
Sale to contract farmers	3	3.3
Sale to brokers	11	12.6
Total	**85**	**100.0**
How long do you take to receive payment?		
Within a week (immediately)	75	88.1
1 Week	4	5.2
After a month	6	6.7
Total	**85**	**100.0**

In addition, farmers who had sold before (in the previous seasons) were asked to indicate their preferred marketing arrangement and the kind of agreement they had with their buyers. Table 4.33 below presents descriptive statistics.

Table 4.33: Descriptive Statistics on Preferred Marketing Arrangement

Variable	Frequency	Percent
Preferred Marketing arrangement		
Direct marketing-spot markets	112	41.6
Indirect marketing-contract farming (brokerage)	157	58.4
Total	**269**	**100.0**
What kind of agreement did you have with the buyer?		
Individual written contracts	31	11.5
Group written contracts	3	1.1
Individual verbal agreement	185	68.8
Group verbal agreement	50	18.6
Total	**269**	**100.0**

According to statistics, most CA farmers prefer indirect marketing-contract farming. This can be attributed to less complexities and exploitation associated with indirect marketing arrangements such as selling through brokers and contract farming. On the question of the kind of agreement the farmers had with the buyers, the study reveals that most farmers had individual verbal agreements. This supports the argument that most farmers sold their produce through direct marketing. Furthermore, farmers were asked to state the extent to which they agreed to statements related to marketing institutional arrangement on a scale of 1-5. Descriptive results are presented in Table 4.34 below.

Table 4.34: Descriptive Statistics on Marketing Institutional Arrangement (N=269)

Variable	SA	A	N	D	SD	Mean	Std. Deviation
	%	%	%	%	%		
The buyer normally collects farm produce from my farm;	69.5	20.1	0.00	10.0	0.40	1.52	0.95
The buyer caters for transportation cost of farm produce to the market;	54.3	10.4	0.00	33.5	1.90	2.18	1.42
There is a guaranteed market for farm produce;	4.8	0.00	0.00	94.8	0.40	3.91	0.43
The market prices for farm produce are adequate;	0.00	0.00	0.00	9.70	90.3	4.90	0.29
The buyer offers farm inputs;	0.00	0.00	0.00	8.90	91.1	4.91	0.29
The buyer offers extension services;	0.00	0.00	0.00	8.90	91.1	4.91	0.29
The buyer normally provides specifications with regard to quantity and quality of farm produce to be supplied.	21.2	29.0	39.4	8.90	1.5	2.41	0.97

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The mean responses on marketing institutional arrangement range from strongly agree to strongly disagree. For instance, while farmers strongly disagree with the arguments that the market prices for farm produce are adequate, the buyer offers farm inputs and that buyers offer extension services, they on the other hand strongly agreed that the buyer normally collects farm produce from their farms, the buyer caters for transportation cost of farm produce to the market and that the buyer normally provides specifications with regard to quantity and quality of farm produce to be supplied. This imply that the participants had mixed reactions on the marketing arrangements. The findings are consistent with a study conducted by Donkor et al., (2018) in Nigeria where it was reported that large households in rural areas are mostly constrained with financial burdens hence tend to avoid transaction costs and other marketing risks which are associated with the participation in the direct marketing channels. Another study conducted by Oyekale and Matsane (2014) in South Africa revealed that the return for the majority of the farmers for sale of vegetables was low.

4.8.1 Factor Analysis

The study conducted a factors analysis to extract components of marketing institutional arrangement. Table 4.35 below indicates that two factors were extracted from this process which adopted PCA. The extracted components account for 78.304 of variance in the whole dataset of marketing institutional arrangement.

Table 4.35: Total Variance Explained on Marketing Institutional Arrangement

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.323	61.752	61.752	4.323	61.752	61.752	4.177	59.670	59.670
2	1.159	16.553	78.304	1.159	16.553	78.304	1.304	18.634	78.304
3	.784	11.193	89.498						
4	.495	7.066	96.564						
5	.193	2.757	99.321						
6	.048	.679	100.000						
7	-.002E-013	-1.028E-013	100.000						

Extraction Method: Principal Component Analysis.

Next, the rotated component matrix shows that the first two variables associated with access to direct marketing are substantially loaded on the first component while the last five variables related to access to indirect marketing are adequately loaded on the second component (see Table 4.36 below).

Table 4.36: Rotated Component Matrix

Variables	Component	
	Access to direct marketing	**Access to indirect marketing**
The buyer normally collects farm produce from my farm;	.919	.007
There is a guaranteed market for farm produce;	.557	.029
The buyer caters for transportation cost of farm produce to the market	.029	929
The market prices for farm produce are adequate;	.165	.959
The buyer offers farm inputs;	.149	.959
The buyer offers extension services;	.149	.959
The buyer normally provides specifications with regard to quantity and quality of farm produce to be supplied;	,103	.528

Table 4.37 below presents descriptive statistics of the extracted component on marketing institutional arrangement. According to the findings, farmers had a strong agreement on the statements associated with access to direct marketing with a mean of 1.32 and standard deviation of 0.20. In addition, there was a strong agreement among the CA farmers on the arguments associated with access to indirect marketing (contract).

Table 4.37: Descriptive Statistics on Marketing Institutional Arrangement

Component	Mean	Std. Deviation	Cronbach Alpha
Access to direct marketing	1.32	.20	0.90
Access to indirect marketing	1.20	.10	0.88

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The means of the two components indicates that farmers strongly agreed on the arguments related to marketing institutional arrangement. For instance, the mean results indicate that farmers strongly agreed to accessibility to the direct market. In addition, they strongly agreed with statements concerning accessibility to indirect marketing. The findings, therefore, imply that farmers have access to both direct and contract marketing channels. These results tend to be inconsistent with a study by Umberger et al., (2015) where the authors found that in many SSA countries, the marketing of agricultural commodities remains a challenge for most smallholder producers.

During a qualitative interview with group leaders, the majority of them argued that both direct and indirect markets exist in Machakos and Makueni counties. In fact, a leader stated that;

> "*There are various marketing channels where one can either sell directly to the market or through brokers.*" *(L).*

4.9.1 Regression Analysis on Marketing Institutional Arrangement and Livelihood Outcome

To investigate the effect of marketing institutional arrangement on livelihood outcomes, the study regressed livelihood outcome variables on the access to direct and access to contract marketing institutional arrangement variables with the aid of OLS estimator. Summary findings are presented in Table 4.38 below.

Table 4.38: Regression Results on the Effect of Marketing Institutional Arrangement on Livelihoods

	Model 1					Model 2				
	B	**Std. Error**	**Beta**	**T**	**Sig.**	**B**	**Std. Error**	**Beta**	**T**	**Sig.**
Independent										
(Constant)	-.815	.061		13.36	.000	.418	.071		5.8871	.000
Access to Direct Marketing	.107	.061	.107	1.749	.082	.119	.051	.312	2.333	.042
Access to indirect marketing	-.022	.081	-.022	-.272	.723	-.032	.041	-.02	-.780	.423
Dependent	**Availability of food**					**Catering for education and healthcare**				
R – squared	0.366					0.012				
Adj. R squared	0.327					0.004				
Std. Error	0.9978					.997				
F – ratio (2, 263)	4.592					3.753				
Prob. > F	0.040					0.000				

The probability of the ANOVA test shows that the findings are statistically significant. The R squared statistic of 0.012 indicates that marketing institutional arrangement accounts for 1.2 % variation in the CA farmer's catering for education and healthcare while the R squared 0.366 shows that marketing institutional arrangement accounts for 36.6% changes in availability of food. This means that marketing institutional arrangement has a very low impact on catering for social services of the CA farmers.

According to the findings, there is a positive and statistically significant relationship between access to direct marketing and catering for education and healthcare. Though the coefficient for availability of food is also positive, its p-value shows that the coefficient is not statistically significant. Concerning access to indirect marketing, the study has found a negative relationship with both availability of food and catering for education and healthcare. Nevertheless, these coefficients are not statistically significant. This could imply that access to indirect marketing among the CA farmers in Machakos and Makueni is not statistically significant when it comes to availability of food and catering for education and healthcare which are the variables for livelihood outcomes.

4.9 Participation in CA Producer Associations and Livelihood Outcomes

The fifth objective sought to evaluate the moderating effect of participating in CA producer associations on livelihood outcomes in ASAL areas in Kenya. This objective was examined through various questions. Firstly, the study has learned that all the farmers who were interviewed belonged to a farmer group. In addition, farmers indicated that all farmer groups to which they belonged promoted conservation agriculture. Majority of the farmers (83.3%) indicated that joining the farmer groups was open to any individual who wishes to do so. An interview with farm group leaders revealed that the groups were open to any farmer who wished to join. Leaders further stressed that conditions for joining the groups were very favorable and as such, no farmer who is willing can be left out.

The farmers were asked whether they had received any training organized by farmer groups on CA practices of which nearly all of them 98.02% indicated to have been trained. This implies that the groups play a critical role of empowering their members on CA. Next, the farmers were required to indicate the extent to which they agreed with various arguments of the training they received and advocacy on a scale of 1-5. Descriptive findings are presented in table 4.39 below.

Table 4.39: Descriptive Statistics of Participation in CA Producer Associations (N=269)

Variable	SA	A	N	D	SD	Mean	Std. Deviation
	%	%	%	%	%		
The training received through the farmer group has enabled me to apply the CA principle on minimum tillage	82.2	17.8	0.00	10.0	0.00	1.18	0.38
The training received through the farmer group has enabled me to apply the CA principle on mulches	50.6	8.6	0.4	26.4	14.1	2.45	1.63
The training received through the farmer group has enabled me to apply the CA principle on crop rotation	49.4	10.4	0.4	13.0	26.8	2.57	1.76
The training received through the farmer group has enabled me to use CA farm equipment	53.2	11.5	0.00	7.1	28.3	2.46	1.78
The training received through the farmer group has enabled me to keep farm records	47.6	0.00	1.5	30.9	20.1	3.23	1.24
The farmer group has demonstration plots which have encouraged me to embrace CA	74.0	26.0	0.00	10.0	0.00	1.26	0.44
The farmer group normally organizes for farm visits which have encouraged me to embrace CA	74.3	25.7	0.0	0.0	0.0	1.26	0.44
The farmer group normally networks with other producer associations, and this has encouraged me to embrace CA	63.6	36.4	0.00	0.00	0.00	1.36	0.48
The farmer group normally invites agricultural experts to advice members and conduct trainings and this has encouraged me to embrace CA	67.7	32.3	0.00	0.00	0.00	1.32	0.47

The mean results show that farmers strongly agreed to the argument that training received through the farmer group has enabled them to apply the CA principle on minimum tillage. Statistics indicate that farmers agreed to the arguments that the training received through the farmer group has enabled them to apply the CA principle on mulches and to use farm equipment. Nevertheless, farmers neither agree nor disagree on

the argument that the training received through enabled them to keep farm records and practice crop rotation.

These findings could imply that the study participants had mixed feelings about the CA training offered to them. This has been demonstrated by lack of coherence in their responses regarding various aspects of the training. It could be attributed to limitations to certain aspects such as probably differential training curriculum and methodologies as well as differences in their level of understanding. Concerning advocacy, farmers strongly agreed with the arguments that farmer groups ably advocate for the CA farmers. This implies that the farmer group normally networks with other producer associations and also that farmer groups invite agricultural experts to advise members and conduct training which have encouraged them to embrace.

4.9.1 Factor Analysis

The study conducted factor analysis on the variables of participatory in the CA producer associations. The explained variance findings are presented in table 4.40 below. These findings indicate that two factors were extracted and these account for 74.704% variation in the dataset for participants in the CA producer associations. The remaining percentage variance is explained by factors outside this study.

Table 4.40: Total Variance Explained on Participation in CA Producer Associations

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	**% of Variance**	**Cumulative %**	**Total**	**% of Variance**	Cumulative %	Total	% of Variance	Cumulative %
1	5.323	61.752	61.752	4.323	61.752	61.752	4.177	59.670	59.670
2	1.358	15.094	38.545	1.358	15.094	38.545	1.353	15.034	74.704
3	.784	11.193	89.498						
4	.998	.998	.998						
5	.937	.937	.937						
6	.790	.790	.790						
7	.750	.750	.750						
8	.481	.481	.481						
9	.444	.444	.444						

Extraction Method: Principal Component Analysis.

Next, the rotated component matrix shows that the first four variables associated with knowledge usability (Access to CA training) are substantially loaded on the first component while the last four variables related to producer association are sufficiently loaded on the second component (see Table 4.41 below).

Table 4.41: Rotated Component Matrix

Variables	Component	
	Access to CA training	Belonging to farmer group
The training received through the farmer group has enabled me to apply the CA principle on minimum tillage	**.759**	.007
The training received through the farmer group has enabled me to apply the CA principle on mulches	**.711**	-.029
The training received through the farmer group has enabled me to apply the CA principle on crop rotation	**.512**	.029
The training received through the farmer group has enabled me to use CA farm equipment	**.702**	-.165
The training received through the farmer group has enabled me to keep farm records	.052	**.749**
The farmer group has demonstration plots which have encouraged me to embrace CA	.101	**.712**
The farmer group normally organizes for farm visits which have encouraged me to embrace CA	.127	**.752**
The farmer group normally networks with other producer associations and this has encouraged me to embrace CA	-.037	**.623**
The farmer group normally invites agricultural experts to advice members and conduct trainings and this has encouraged me to embrace CA	-.117	**.712**

Extraction Method: Principal Component Analysis.

Table 4.42 below presents descriptive statistics of the extracted component on participation in producer associations.

Table 4.42: Descriptive Statistics on Participation in CA producer Associations

Component	Mean	Std. Deviation	Cronbach Alpha
Access to CA training	1.32	.20	0.76
Belonging to farmer group	1.20	.10	0.80

Mean: Strongly Agreed=1.00-1.80, Agreed=1.81-2.60, Neither Agree nor Disagree=2.61-3.40, Disagree=3.41.4-20, Strongly Disagree=4.21-5.00

The means of the two components indicates strong agreement among the farmers on the argument on participation in CA producer associations. This implies that participation in

CA producer association enables farmers to access necessary skill sets through training and access to expansive markets. The producer associations also provide extension services to the farmers which enhances productivity. These findings are consistent with Ntshangase, Muroyiwa, and Sibanda (2018), who demonstrated that CA training positively influenced CA adoption in Lesotho and South Africa, respectively. A similar result is also reported by Mulimbi et al., (2019), who claimed that in DRC, a farmer who received CA training was more likely to adopt CA. In an in-depth interview, all leaders interviewed underscored the importance of belonging to producer associations. The leaders argued producer associations sensitised farmers especially on the output quality acceptable to the market besides helping farmers to access the market. A leader argued that;

> *"Producer associations help farmers access markets in addition to providing training and exposure." (L024).*

4.9.2 Investigating the Moderating Effect of Producer Associations of the link between Conservation Agricultural Practices and Livelihood Outcomes

To test the moderating effect of producer associations, the study conducted a two-step regression equation analysis whose findings are presented in Tables 4.44 and 4.45 below. The first regression equation excluded the moderating variables (composite variable constructed between access to CA training and belonging to the farmer group). In the second regression equation, the moderating variable was interacted with all the independent variables. A comparative analysis is given to show how participation in CA producer associations affected the relationship between CA practices and livelihood outcomes (availability of food and catering for healthcare and education).

The ANOVA tests in Tables 4.43 shows that the findings are statistically significant given the p-value of F-statistic of 0.000. The R squared statistic of 0.859 (without moderating variable) indicates that the explanatory variables account for 85.9 % variation in the CA farmer's availability of food. Nevertheless, the introduction of moderating variables (CA

producer associations) reduces this impact to about 35%. This could be attributed to probably limited capacity of the CA producer associations in empowering the farmers.

Concerning input costs, the estimated coefficients for cost of labour, cost of use of mulches and access to farm equipment have a positive influence on availability of food of CA farmers in the two regressions (with or without the moderating variables. However, these findings are statistically significant for the case of regression without moderating variables. The only variable with statistically significant results in both regressions is the cost of labour. The implication here is that there is less labour cost for CA farmers who belong to CA farmer groups. In addition, farmers groups appear to have insignificant contributions to their members when it comes to access to farm equipment and the use of mulches. Belonging to CA farmer groups can enhance the CA skills for which upon their application leads to reduced labour force requirement. Farmers who belong to an association are more likely to be trained and have access to farm input including the latest technology which is likely to enhance their production. The findings are similar to a recent study by (Goedde et al., 2019) where it was reported that Kenya has worked hard towards merging some of the smallholder farmers‟ activity in order to increase productivity, provide market access, and reduce risk.

With respect to land productivity variables, the study has not found any significant influence of intercropping, quantity level and quality of output on the availability of food with introduction of the moderating variable (belonging to producer associations). This means that farmer groups have not yet registered any significant influence on intercropping, quantity, and quality levels of output of CA farmers. A similar situation was reported by the findings of socioeconomic characteristics which includes skills on CA, non-farm activities and access to income.

Concerning marketing institutions, findings show a positive influence of both direct and indirect marketing on the availability of food. Nevertheless, with the introduction of the moderating variable, only the results of indirect marketing are statistically significant. This means that belonging to producer associations helps CA farmers gain access to

indirect marketing channels such as brokerage and contract besides spot on marketing. According to ILO (2017), contract farming models can result in improved access to technical assistance and inputs such as hybrid seeds, as well as a secured market and stable prices.

Table 4.43: Multivariate Regression on Producer Associations, Practice of CA and Availability of Food

	Without moderation					With moderating variable				
	B	**Std. Error**	**Beta**	**T**	**Sig.**	**B**	**Std. Error**	**Beta**	**T**	**Sig.**
Independent										
(Constant)	-2.01	.552		-3.64	.000	-.143	.055		-2.615	.009
Input costs										
Cost of labour	1.75	.142	.929	12.31	.000	1.145	.255	1.669	4.492	.000
Cost of use mulches	.667	.127	.152	5.27	.000	.164	.237	.196	.693	.489
Access to farm equipment	.488	.113	.159	4.308	.000	.492	.268	.669	1.837	.067
Land productivity										
Intercropping	.558	.099	.171	5.662	.000	.060	.229	.087	.264	.792
Output level	.604	.254	.128	2.37	.018	-.454	.311	-.983	-1.459	.146
Quality of output	.324	.103	.081	3.147	.002	-.269	.240	-.453	-1.119	.264
Socioeconomic characteristics										
Skills on CA	-.056	.060	-.024	-.940	.348	-.147	.123	-.224	-1.192	.234
Non-farm activities	-.100	.056	-.047	-1.77	.077	.024	.116	.041	.206	.837
Access to income	.024	.084	.010	.291	.772	-.061	.173	-.092	-.352	.725
Marketing institutional arrangement										
Direct marketing	.114	.027	.114	4.138	.000	.128	.066	.105	1.939	.054
Contract marketing	.516	.043	.516	12.07	.000	.350	.095	.387	3.698	.000
Dependent						**Availability of food**				
R – squared		0.8610				0.350				
Adj. R squared		0.859				0.322				
Std. Error		0.3851				0.8232				
F – ratio (2, 263)		11.375				12.592				
Prob. > F		0.000				0.000				

The ANOVA tests in Tables 4.44 below shows that the findings are statistically significant given the p-value of F-statistic of 0.000. The R squared statistic of 0.759 (without moderating variable) indicates that the explanatory variables account for 75.9 % variation in the CA farmer's catering for healthcare and education. However, the introduction of moderating variable reduces this impact to about 27%. This implies that participation in

CA producer associations does not have a strong influence on catering for education and healthcare for the farmers.

Regarding input costs, coefficients for cost of labour, cost of use of mulches and access to farm equipment have a positive influence on catering for education and healthcare of CA farmers in the two regressions. Nevertheless, these findings are statistically significant for the case of regression without moderating variable except for the case of cost of labour variable which is found statistically significant in both regressions. This was the same case with the regression on availability of food.

With respect to land productivity variables, the study has not found any significant influence of intercropping, quantity level and quality of output on catering for education and healthcare with introduction of the moderating variable. This means that farmer groups are yet to influence land productivity among CA farmers in Makueni and Machakos counties. A similar situation was reported by the findings of socioeconomic characteristics which includes skills on CA, non-farm activities and access to income.

Finally, the results with respect to marketing institutional arrangement show a positive influence of both direct and indirect marketing on catering for healthcare and education. Nevertheless, with the introduction of the moderating variable, only the results of indirect marketing are statistically significant. This means that belonging to producer associations helps CA farmers gain access to indirect marketing channels such as brokerage and contract besides spot on marketing. According to ILO (2017), contract farming models can result in improved access to technical assistance and inputs such as hybrid seeds, as well as a secured market and stable prices.

Table 4.44: Multivariate Regression on Producer associations, Practice of CA and Catering for Education and Healthcare

	Without moderation					with moderating variable				
	B	**Std. Error**	**Beta**	**T**	**Sig.**	**B**	**Std. Error**	**Beta**	**T**	**Sig.**
Independent										
(Constant)	-1.14	.408		-2.81	.005	-.134	.058		-2.31	.021
Input costs										
Cost of labour	1.438	.208	.361	6.902	.000	.980	.270	1.430	3.628	.000
Cost of use mulches	.096	.036	.09	2.64	.009	.091	.251	.109	.363	.717
Access to farm equipment	.575	.131	.144	4.396	.000	.221	.284	.300	.778	.437
Land productivity										
Intercropping	-.134	.073	-.06	-1.83	.068	.078	.243	.112	.320	.749
Output level	1.037	.135	.337	7.696	.000	-.539	.330	-1.16	-1.63	.103
Quality of output	.992	.121	.304	8.177	.000	.211	.255	.356	.828	.408
Socioeconomic characteristics										
Skills on CA	1.306	.257	.276	5.081	.000	-.208	.130	-.318	-1.59	.111
Non-farm activities	.070	.077	.030	.901	.368	-.036	.123	-.061	-.292	.771
Access to income	.461	.101	.180	4.571	.000	-.066	.184	-.098	-.357	.721
Marketing institutional arrangement										
Direct marketing	.114	.037	.114	3.099	.002	.122	.070	.100	1.749	.081
Indirect marketing	.370	.048	.370	7.734	.000	.297	.100	.329	2.961	.003
Dependent	Catering for healthcare and education									
R – squared	0.759					0.270				
Adj. R squared	0.748					0.239				
Std. Error	.1786					0.8726				
F – ratio (2, 263)	20.458					8.633				
Prob. > F	0.000					0.000				

4.10 Overall Regression

The overall regression analysis is presented in Table 4.46 below.

Table 4.45: Overall Regression Results

	Model 1					Model 2				
	B	**Std. Error**	**Beta**	**T**	**Sig.**	**B**	**Std. Error**	**Beta**	**T**	**Sig.**
Independent										
(Constant)	-1.14	.408		-2.81	.005	-2.0	.552		-3.64	.000
Cost of labour	1.438	.208	.361	6.902	.000	1.75	.142	.929	12.31	.000
Cost of use mulches	.096	.036	.09	2.64	.009	.667	.127	.152	5.27	.000
Access to farm equipment	.575	.131	.144	4.396	.000	.488	.113	.159	4.308	.000
Intercropping	-.134	.073	-.06	-1.83	.068	.558	.099	.171	5.662	.000
Output level	1.037	.135	.337	7.696	.000	.604	.254	.128	2.37	.018
Quality of output	.992	.121	.304	8.177	.000	.324	.103	.081	3.147	.002
Skills on CA	1.306	.257	.276	5.081	.000	-.056	.060	-.024	-.940	.348
Non-farm activities	.070	.077	.030	.901	.368	-.100	.056	-.047	-1.77	.077
Access to income	.461	.101	.180	4.571	.000	.024	.084	.010	.291	.772
Direct marketing	.114	.037	.114	3.099	.002	.114	.027	.114	4.138	.000
Indirect marketing	.370	.048	.370	7.734	.000	.516	.043	.516	12.07	.000
Dependent	**Catering for healthcare and education**					**Availability of food**				
R – squared	0.759					0.350				
Adj. R squared	0.748					0.322				
Std. Error	.1786					0.8232				
F – ratio (2, 263)	20.458					12.592				
Prob. > F	0.000					0.000				

The results show that input costs have a positive influence on both the availability of food, catering for healthcare and education of the CA farmers in ASAL areas in kenya. This is demonstrated by positive and statistically significant coefficients of all indicators of input costs (costs of labour, mulches and access to farm equipment). The results therefore, imply that the application CA practices enhances livelihood outcomes of the farmers. These findings are consistent with simple regression (see Table 4.16) results and several other studies. For instance, Hobbs, (2007); Hobbs et al., (2008) and Wall, (2009) found that application of CA practices such as minimum tillage, mulching and crop rotation reduce input costs and optimize crop yields. Yet in other studies, it has been established that CA practices are more profitable than conventional agricultural systems due to reduced input costs (Vastola et al., 2017; LaCanne and Lundgren, 2018).

The study has established that the indicators of land productivity (intercropping, output level and quality) have a positive influence on the availability of food among the CA farmers. Similar results were reported with respect to catering for healthcare and education

except for the intercropping variable which was not statistically significant. Generally, these results indicate that CA practices improve the productivity of land by enhancing out levels and quality which ultimately boosts the livelihoods of farmers. Previous studies have established that adoption of CA practices improves infiltration and soil moisture conservation which eventually leads to increased quantity and quality of the yields (Thierfelder et al., 2017). Another study has established that the elimination of monocultures and incorporation of plant species into rotations that return greater amounts of residue to the soil are often associated with greater soil organic carbon stock in CA systems (Conceição et al., 2013).

Concerning socioeconomic characteristics, results show that skills on CA and access to income has a positive influence on catering for healthcare and education of the farmers. Findings with respect to availability of food were not statistically significant. The findings imply that CA skills and access to income is very crucial. Indeed, Tambo and Mockshell (2018) opine that there are significant income gains from full adoption of CA across nine SSA countries. In addition, a study by Uddin & Dhar (2016) found an increase in annual income for farmers practicing conservation agriculture in Bangladesh. According to Aryal et al., (2019), the likelihood to adopt CA increases with the increase in the share of off-farm income in the total household income.

Access to both direct and indirect markets has been found to influence livelihood outcomes of CA farmers positively. This has been demonstrated by positive and statistically significant results with respect to the market variables. Access to the market means an ability to sell one's produce, and an encouragement to produce more, and enhance livelihoods.

4.11 Hypothesis Testing

The study conducted Hypothesis testing based on regression analysis output. Rejection or acceptance of a hypothesis depends on the p-values. In this study, the null hypothesis was rejected when $p < 0.05$, otherwise accepted. Table 4.46 shows that all the null hypotheses

were rejected given the p-values of less than 0.05. This means that there is a significant influence of input costs, land productivity, marketing arrangement and socioeconomic characteristics. In addition, the study rejected the hypothesis that there is no significant effect of participation in producer associations on livelihood outcomes in ASAL areas in Kenya. This means that farmer groups/producer associations have an impact on the CA farmers output and hence livelihood outcomes.

Table 4.46: Summary of Hypothesis Testing

No	Hypothesis	P value	Verdict
$H0_1$	There is no significant effect of participation in CA producer associations on livelihood outcomes in ASAL areas in Kenya.	0.0412<0.05	Reject
$H0_{2:}$	There is no significant effect of input costs on livelihoods outcomes in ASAL areas in Kenya.	0.000<0.05	Reject
$H0_3$	There is no significant effect of land productivity on livelihood outcomes in ASAL areas in Kenya.	0.000<0.05	Reject
$H0_4$	There is no significant effect of socio-economic characteristics on livelihood outcomes in ASAL areas in Kenya.	0.000<0.05	Reject
$H0_5$	There is no significant effect of marketing institutional arrangements on livelihood outcomes in ASAL areas in Kenya.	0.000<0.05	Reject

4.12 Discussion of Key Findings

4.12.1 Input Costs and Livelihood Outcomes

The overall regression results have established that the cost of inputs has a positive influence on availability of food and catering for education and healthcare among the CA farmers in ASAL areas in Kenya. This means that the practice of conservation agriculture such as mulching, crop rotation, minimum land tillage and intercropping reduces the cost of farm inputs which in turn leads to production of more food. For example, the use of mulches reduces evaporation of water in the soil, and this ultimately limits the amount of water intake by crops. These results are supported by LaCanne and Lundgren, (2018) who

found that CA systems can still be more profitable than conventional agricultural systems even when yield reductions are observed in some instances and this mainly due to reduced input costs.

Input costs were found to influence positively catering for education and healthcare. This indicates that lower cost of farm inputs such as labour and equipment attributable to CA farming practices increases farm production and then, income of the farmers. With increased household income, farmers can pay for rent, school fees for their children as well as medical care services. This ultimately enhances their total welfare. For example, the results have shown that CA farming facilitates access to farm equipment which increases productivity. Similar results were reported in the simple regression model and hypothesis test whether the null hypothesis that there is no statistically significant effect of input costs on livelihood outcomes was rejected.

4.12.2 Land Productivity and Livelihood Outcomes

Concerning land productivity, the study has established that all the variables have a positive influence on livelihood outcomes which includes availability of food and catering for education and healthcare. For instance, there is a positive and statistically significant relationship between output level and availability of food, catering for education and healthcare. Similar findings are reported with respect to output quality. Nevertheless, the coefficient on intercropping was only statistically significant with respect to availability of food. Generally, these findings imply that practices such as minimum land tillage, mulching, crop rotation as well as intercropping improves fertility of the farms. These findings are consistent with Li et al., (2019b) who reported that residue retention in CA systems is often observed to have a significant positive impact on soil water storage due to a combination of greater rates of infiltration and decreased soil water evaporation. With fertile farms, there is more produce and then higher level of income, better livelihood outcomes like food security, good health, and ability to educate family members. Indeed, the practice of conservation agriculture enhances the quality of the farm produces and ultimately, the quality of livelihood outcomes. Consistent with these are the simple

regression model estimates. In addition, the study rejected a null hypothesis that land productivity has no effect on livelihood outcomes in ASAL areas in Kenya.

4.12.3 Socioeconomic Characteristics and Livelihood Outcomes

Findings regarding socioeconomic characteristics indicate that farmers skills of CA have a positive influence on catering for education and healthcare. Similar results are reported with reference to access to income variables (in the simple regression). This implies that with enhanced skills in CA, farmers can generate more income through increased production and hence, better livelihood outcomes. These results agree with Lalani et al., (2017) in a comparison study of net present values for CA vs. conventional agriculture from 197 farmers found CA to be beneficial to both rich and poor farmers in Mozambique.

Nevertheless, the study established mixed findings with respect to the relationship between non-farm activities and livelihood outcomes. On one hand, there is a negative coefficient between food availability and non-farm activities while on the other hand, the coefficient of non-farm activities is positive with reference to catering for education and healthcare. However, the multivariate results are not statistically significant given a p-value of more than 0.05 in both cases. But for the case of simple regression, the coefficient of non-farm was negative and statistically significant. Non-farm activities can either have a positive or negative influence on agricultural production. For instance, on one hand, engaging in other occupations besides farming can reduce crop yields and hence, incomes. This could be due to less hours spent on the farm or investment of capital meant for farm inputs into non-farming activities. On the other hand, farmers can use income from non-farm activities to boost their agricultural produce through purchase of farm inputs and equipment. These results are similar to a claim made by Aryal (2019) that likelihood to adopt CA increases with the increase in the share of off-farm income in the total household income. Regarding hypothesis, the null hypothesis that there is no statistically significant effect of socioeconomic characteristics on livelihood outcomes was rejected. This means that both the regression findings and hypothesis test had a convergence.

4.12.4 Marketing Institutional Arrangement and Livelihood Outcomes

The results on marketing arrangement shows that direct marketing has a positive influence on catering for education and healthcare. In addition, the study has reported that direct marketing has a positive influence on availability of food. All the coefficients were statistically significant. Similarly, the overall result of the study shows that indirect marketing platforms such as brokerage and contract marketing have a positive and statistically significant influence on both catering for education and healthcare and availability of food. This means that belonging CA farmers have access to both direct and indirect marketing channels. These results are supported by a study conducted by ILO (2017) where it was observed that contract farming models can result in improved access to technical assistance and inputs such as hybrid seeds, as well as a secured market and stable prices. Concerning simple regression, only the coefficient of direct marketing was statistically significant. In addition, the null hypothesis that there is no significant effect of marketing institutional arrangement on livelihood outcomes was rejected.

4.12.5 Participation in CA Producer Association and Livelihood Outcomes

The study also evaluated the moderating effect of participating in CA producer associations on livelihood outcomes. Empirical results report a positive and statistically significant relationship between cost of labour and availability of food. This means that CA farmers who participate in the groups experience less labour costs which enhances food production. Belonging to CA farmer groups can enhance the CA skills for which upon their application leads to reduced labour force requirement. In addition, the study has shown that farmers who belong to an association are more likely to be trained and have access to farm input including the latest technology which is likely to enhance their production. These findings have been affirmed by Goedde et al., (2019) who reported that Kenya has worked hard towards merging some of the smallholder farmers‟ activity in order to increase productivity, provide market access, and reduce risk. However, the study has established that belonging to a CA farmer group does not have any statistical significance when it comes to the influence of land productivity and marketing

institutional arrangement (apart from indirect marketing) on livelihood outcomes. The null hypothesis that there is no significant effect of participation in CA producer associations on livelihood outcomes in ASAL areas in Kenya was rejected. This means that CA producer associations have played a significant role regarding food availability and catering for education and healthcare.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The practice of conservation agriculture has been viewed as a sustainable way of improving agricultural production. The aim of adopting this practice is to protect the soil not just from erosion but degradation as well which in turn enhances crop yields. Practices like crop rotation, intercropping, minimum soil tillage, mulching are among the key principles of CA practices. This study investigated how the practice of CA affected livelihood outcomes of farmers in ASAL areas in Kenya with a particular focus on Makueni and Machakos counties. Having presented both descriptive and inferential findings in chapter four, this chapter summaries and gives conclusions based on study objectives. The chapter ends with policy recommendations and suggestions for further studies.

5.2 Summary

This study sought to assess conservation agricultural practices and its effects on livelihood outcomes of farmers in ASAL areas in Kenya. This was achieved by answering five specific objectives which were: to analyze the effect of input costs on livelihood outcomes, to evaluate the effect of land productivity on livelihood outcomes, to assess the effect of socio-economic characteristics on livelihood outcomes, to analyze the effect of marketing institutional arrangements on livelihood outcomes and to assess the effect of participation in CA producer associations on livelihood outcomes of CA farmers in ASAL areas in Kenya.

The study relied on cross-sectional survey design which incorporated both qualitative and quantitative data collection methods from a target population of 384 CA farmers in Makueni and Machakos counties. Quantitative data from the farmers was gathered using questionnaires while interview guides were deployed by the researcher to collect

qualitative data from CA producer association group leaders. Both descriptive and inferential data analysis techniques were employed.

Descriptive statistics show that most CA farmers in Makueni and Machakos counties are women. This means that farming activities in the rural areas of Kenya are dominated by women. Men view small scale farming in rural Kenya as a low paying job. In addition, the study has discovered that most farmers are aged 50 years and above. In Kenya and sub-Saharan regions in general, most young people migrate to urban areas to look for white colour jobs and it is their old folks who remain in the rural areas where agriculture is the main economic activity. Concerning CA, findings show that most farmers practice combined CA principles such as crop rotation and intercropping or mulching and minimum tillage among others. On food insecurity, Rasch model analysis indicates that items such as HEALTHY, FEWFOODS, SKIPPED and ATELESS reported severe food insecurity though on average, the study participants have moderate food insecurity. The following subsections present summarised findings based on the study objectives:

5.2.1 Input Costs and Livelihood Outcomes of CA farmers

Most farmers relied on family labour in their farms as opposed to hired labour which would ideally be expensive. Majority of the farmers argued that adoption of CA led to reduced labour requirements and also minimizes farm equipment needed for farming, and saves on time required to work on the farm. Furthermore, the results show that access to mulches saves both cost and time spent on the farm. Leaders during the in-depth interviews argued that application of most CA principles reduces the amount of time required to work on the farm which means less labour force is needed to work on CA farms.

The regression analysis indicates that the cost of inputs has a positive influence on catering for education and healthcare of CA farmers in ASAL areas in Kenya. This was the case for all the cost of input indicators which included labour, use of mulches and farm equipment. Thus, practices such as mulching, crop rotation, minimum land tillage and

intercropping minimizes farm production costs which ultimately leads to more food, income. Increase in the household income arising from more agricultural production enables farmers to take care of their bills such as school fees, electricity, house rent and healthcare. These findings were further complemented by a hypothesis test which established a statistically significant effect of input costs on CA farmers livelihood outcomes.

5.2.2 Land Productivity and Livelihood Outcomes of CA farmers

The productivity of the soil has a direct relationship with crop production. Findings of the study show that CA practices enhance soil fertility which enhances farm production. It has been found that on average, there are three seasons of crop production in the two counties (Makueni and Machakos). In addition, Maize, Beans and Cowpeas are the commonly grown crops under CA practices. The study has also established that most farmers practice rotational farming and maize as the most widely rotated crop. Furthermore, descriptive results have demonstrated that CA practices enhance both quantity and quality of farm produce.

Regression results indicate that all land productivity indicators (intercropping, output level & quality) have a positive influence on the livelihood outcome indicators (catering for education and healthcare). This was demonstrated by positive and statistically significant coefficients for all the variables. This means that practices such as minimum land tillage, mulching, crop rotation as well as intercropping improves soil fertility which in turn leads to more farm produce, income and hence, better livelihood outcomes. Furthermore, the study rejected a null hypothesis that land productivity has no effect on livelihood outcomes in Makueni and Machakos counties. This implies consistency with regression findings.

5.2.3 Socioeconomic Characteristics and Livelihood Outcomes of CA farmers

Concerning socioeconomic characteristics, descriptive results indicate that most CA farmers are not engaged in any other occupation apart from farming. This means that farming is the main economic activity practiced in rural Makueni and Machakos counties. In addition, the study has demonstrated that the majority of the CA farmers in the two counties are small-scale.

Regression findings show that skills on CA and access to income have a positive influence on livelihood outcomes (catering for education & healthcare). This shows that with more skills in CA practices, more income is generated through increased production and hence, better education and healthcare. On the existence of non-farm activities, mixed results are reported. On one hand, the study established a negative coefficient between food availability and non-farm activities and on the other hand, catering for healthcare reported a positive coefficient. This is consistent with the theory that non-farm activities can either have a positive or negative influence on agricultural production. Spending more hours in non-farm activities for instance can reduce the time spent on the farm and this could reduce crop production. Conversely, farmers can use income from non-farm activities to boost their agricultural produce through purchase of farm inputs and equipment. The null hypothesis that there is no statistically significant effect of socioeconomic characteristics on livelihood outcomes was rejected. This means that both the regression findings and hypothesis test had a convergence.

5.2.4 Marketing institutional Arrangement and Livelihood Outcomes of CA Farmers

Descriptive statistics show that the majority of the CA farmers did not sell their farm produce for the previous season. This means that most farmers practiced peasant farming. Concerning the marketing arrangement used by those who had sold their produce, the majority indicated to have used direct marketing as opposed to indirect marketing. Direct

marketing is more straightforward and farmers get cash on the spot. Furthermore, most farmers demonstrated that they preferred direct marketing.

According to regression results, the study reports that direct marketing has a positive influence on catering for education and healthcare. Similarly, direct marketing has a positive influence on the availability of food. These findings imply that direct markets have a positive impact on the farmers' livelihoods. In addition, the null hypothesis that there is no significant effect of marketing institutional arrangement on livelihood outcomes was rejected.

5.2.5 Participation in CA Producer Associations and Livelihood Outcomes

The fifth objective of the study sought to evaluate the moderating effect of participation in CA producer associations. Descriptive statistics show that all the CA farmers who participated in the study belonged to a producer group and that they were all trained on CA practices. In addition, the study has established that participation in CA producer association enables farmers to access necessary skill sets through training and access to expansive markets. Furthermore, the study has demonstrated that CA farmer groups provide extension services to the farmers which enhances productivity.

Regression findings show that CA farmers who participate in the groups experience less labour costs which enhances food production. This demonstrates that farmer groups can improve farmer skills in CA and hence, the application of these skills could lead to reduced labour force requirements. The results further indicate that CA farmer groups in ASAL areas in Kenya have significant influence on the link between marketing institutional arrangement (apart from direct marketing) and livelihood outcomes.

5.3 Conclusion

From the findings on input costs, it can be inferred that the practice of CA reduces labour and other input requirements of farming. A practice like crop rotation for instance

improves soil fertility and hence, less fertilizer requirement while mulching minimizes farm labour requirement. Therefore, it can be concluded that CA practices enhance crop yields, quality, and hence income as well as livelihood outcomes.

The study concludes that most CA farmers are not engaged in any other economic activity. This means that farming is the main economic activity of rural residents. In addition, from findings on socioeconomic activities, it can be concluded that skills on CA and access to income have a positive influence on catering for education and healthcare among CA farmers in the two counties. Indeed, better farming skills leads to more farm produce, enhanced income and ultimately, better living conditions.

From the findings on marketing of farm produce, the study concludes that the majority of the CA farmers sell their farm produce directly to their customers. Only a few market their produce through contract marketing channels and brokerage. In addition, it can be inferred that both direct and indirect marketing has a positive influence on the livelihood outcomes of the CA farmers.

Furthermore, the study has concluded that CA farmers who belonged to farmer groups were more likely to have improved livelihood outcomes. This implies that belonging to farmer groups has influence on the livelihood outcomes of CA farmers.

5.4 Recommendations

Food security in Kenya has remained a challenge even though the majority of the population, especially those residing in rural areas, depend on the agricultural sector both in terms of food and jobs. This study demonstrated that CA can help to solve some of the challenges experienced by farmers and address food insecurity issues, increase farmers income and ultimately enhance household livelihoods. Thus, the government at national and county levels should take responsibility in creating awareness on CA practices across the country and provide any necessary support for the farmers to embrace this noble practice.

In addition, Kenyans of all walks of life, that is, men and women, the young and the elderly should be educated on the inherent potential in modern farming. For a long time, agriculture in the country has been associated with poverty, a myth which should be demystified as a matter of agency to attract these youthful people to this lucrative enterprise. This could also resolve the perennial youth unemployment problems. Measures such as provision of cheap credit for farming and equipping the youths with modern farming techniques will be very instrumental in attracting this critical mass into the agricultural sector.

The national government, county governments and various development partners such as NGOs and CBOs need to support farmers to market their produce especially through contract farming. This would encourage most of them to venture into commercial farming as opposed to practicing subsistence farming. Such initiatives could go a long way in improving their livelihood outcomes since they would be in a position to cater for education needs for their children and also healthcare. The extra income earned from sale of produce would enable them to purchase food varieties that they do not grow.

Furthermore, there is a need to relook into the functionality of CA farmer groups in Makueni and Machakos to make sure that their role is much more pronounced and reflected in production. For instance, an evaluation should be undertaken to establish their farmer training methodologies and relevance and their empowerment programs in general to enhance their efficacy.

Lastly, there is a need for the government and other development partners working in the agriculture space to support farmers to develop modern farming tools. This will go a long way in encouraging the youth in participating in agricultural activities since the study has shown that the sector is dominated by mainly the elderly. The ability to make farm tools will also reduce the cost of farming and eventually the prices of final products will also come down.

5.5 Suggestions for Further Studies

Even though this study largely achieved its objectives, there are some glaring gaps which require further investigations. For instance, future researchers need to document reasons why men and young people in general are not attracted towards CA farming in our rural areas despite the high levels of unemployment across the country.

Although farmer groups play a very significant role in enhancing farming and marketing of produce, very little can be said of CA farmer groups in Makueni and Machakos. Therefore, future studies should investigate and explain why these groups are underperforming in the two counties. Similar studies could also be conducted looking at the determinants of performance of farmer groups.

Non-farm activities are known to influence agricultural production either negatively or positively. This aspect did not come out clearly in the study. In this regard, it is important that future studies investigating the influence of non-farm activities on agricultural production are considered and conclusive findings provided.

REFERENCES

Abson, D.J.; Fraser, E.D.; & Benton, T.G. (2013). Landscape diversity and the resilience of agricultural returns: A portfolio analysis of land-use patterns and economic returns from lowland agriculture. Agric. *Food Security*.10.1186/2048-7010-2-2.

ACSAD & GTZ. (2008). Desertification Monitoring and Assessment in the Arab World. *ACSAD Desertification Bulletin*.

Adesina, A. A & Zinnah, M.M. (1993). Technology characteristics, farmers' perceptions and adoption decisions: A Tobit model application in Sierra Leone. *Agricultural Economics, 9*(4), 297-311.

Alila, P.O , & Atieno, R. (2006). Agricultural Policy in Kenya: Issues and Processes. A paper for the Future Agricultures Consortium workshop, Institute of Development Studies.

Allison, E.H. & Horemans, B. (2006). Putting the principles of the Sustainable Livelihoods Approach into fisheries policy and practice. *Marine Policy, 30*, 757-766.

Andre, F. (2004). *Business maths and statistics*, (6^{th} ed).

Annum, G. (2017). *Research Instruments for Data Collection*.

Arnstein, S.R. (1969). A Ladder of Citizen Participation. *Journal of the American Institute of Planners.*

Arslan, A., Belotti, F., & Lipper, L. (2017). Smallholder productivity and weather shocks: adoption and impact of widely promoted agricultural practices in Tanzania. *Food Policy 69*, 68–81. doi: 10.1016/j.foodpol.2017.03.005.

Aryal, J.P., Ghimire, S. & Sadashivappa, P. (2019). Determinants of Conservation Agriculture in the Indo-Gangetic Plains.

Bahri, H., Annabi, M., M'Hamed, H.C., & Frija, A. (2019). Assessing the long-term impact of conservation agriculture on wheat-based systems in Tunisia using APSIM simulations under a climate change context. *Sci. Total Environ. 692*, 1223–1233.

Barasa, L.L., Araar, A., Kinyanjui, B.K., Maende, S. O., & Mariera, F. (2019). Off-farm Participation, Agricultural Production and Farmers Welfare in Tanzania and Uganda. Working Paper of the Partnership for Economic Policy (PEP) No. 2019-01: https://portal.pepnet. Org/document/download/32757

Bastian, S. & Bastian, N. (1996). *Assessing participation*. Konark Publishers PVT Ltd.

Baron, R.M. & Kenny, D.A. (1986). The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations. *Journal of Personality and Social Psychology.*

Bassi, L. (2000). Impactos sociais, econômicos e ambientais na Microbacia Hidrográfica do Lajeado São José, Chapecó, SC; EPAGRI, Documentos No 203, 50p.

Basu, K. (2004). *India's Emerging Economy: Performance and Prospects in the 1990s and Beyond.* Cambridge, Massa:The MIT Press.

BBijman, J. (2002). Essays on Agricultural Co=Operatives: Governance Structure in Fruit and Vegetable Chains. Erasmus Research Institute of Management. Rotterdam, the Netherlands., Erasmus University Rotterdam. PhD.

Bebbington, A. (1999). Capitals and Capabilities: A Framework for Analyzing Peasant Viability, Rural Livelihoods and Poverty. *World Development*, *27*(12), 2021-44.

Bell, S., & Morse, S. (2004). *Experiences with sustainability indicators and stakeholder participation: a case study relating to a 'Blue Plan' project in Malta*.

Bernard, T., & Spielman, D. (2009). Reaching the Rural poor through Rural Producer Organizations. A study of Agricultural Marketing Cooperatives in Ethiopia. *Food Policy, 34*(1), 60-69.

Bengtsson, J.; Ahnström, J.; & Weibull, A.C. (2005). The effects of organic agriculture on biodiversity and abundance: A meta-analysis. *J. Appl. Ecol. 42*, 261–269.

Bigsten, A., Collier, P., Dercon, S., Fafchamps, M., Gauthier, B., Gunning J. W., ‘’'A. Zeufack. (1999). *Contract Flexibility and Dispute Resolution in African Manufacturing*. Oxford, Oxford University: 45.

Bisangwa, E. (2013). The Influence of Conservation Agriculture Adoption On Input Demand and Maize Production in Butha Buthe , Lesotho.

Bistayev, K.S. (2002). Farmer experience with Conservation Agriculture technology in northern Kazakhstan, paper presented at the inception workshop of the FAO project on Conservation Agriculture for sustainable crop production in northern Kazakhstan, Ministry of Agriculture, Astana, Kazakhstan.

Black, K. (2004). *Business Statistics for Contemporary Decision Making* (4th ed.). Wiley-India. ISBN 978-81-265-0809-9.

Bonus, H. (1986). The cooperative association as a business enterprise: a study in the economics of transactions. *Journal of Institutional and Theoretical Economics 142*(2), 310=339.

Borgen, S. O. (2001). Identification as trust generating mechanism in cooperatives. *Annals of Public and Cooperative Economics 72*(2): 209=228.

Burns, D. L., & Taylor, M. (2000). *Auditing community participation*. Policy Press.

Butler, L.M. & Mazur, R.E. (2007). Principles and processes for enhancing sustainable rural livelihoods: Collaborative learning in Uganda. *International Journal of Sustainable Development and World Ecology, 14*(6), 604-617.

Canadian Foodgrains Bank. (2018). Midterm Reflection of the Scaling-Up of Conservation Agriculture Program in East Africa.

Cargan, L. (2007). *Doing Social Research*. Rowman & Littlefield.

Carney, D. (2002). *Sustainable Livelihoods approaches: Progress and Possibilities for change.* Department for International Development. London.

Chambers, R. & Conway, G.. (1992). *Sustainable rural livelihoods: Practical concepts for the 21stcentury*. IDS Discussion Paper 296. IDS, Brighton.

Chambers, R. (2005). *Ideas for development.* Earthscan, London.

Chamber, R. (2002). *Relaxed and participatory appraisal: notes on practical approaches and methods for participants in PRA/PLA related familiarisation workshops*. Institute of Development Studies, Brighton.

Cleaver, F. (2001). Institutions, Agency and the Limitations of Participatory Approaches to Development", In Cooke, B. & U. Kothari (eds.) *Participation: The New Tyranny?*, Zed Books Ltd., London-New York, 207p.

Chiputwa, B., Langyintuo, A.S. & Wall, P. (2011). *Adoption of conservation agriculture technologies by smallholder farmers in the Shamva district of Zimbabwe*: A Tobit application."

Chisenga, C.M. (2015). *Socio-economic Factors Associated with the Adoption of Conservation Agriculture among Women Farmers in Balaka District, Malawi*. Purdue University: West Lafayette, IN.

Christopher, R.A. (2013). *Disability and justice: The capabilities approach in practice*. Lexington: Lexington Books / Rowman & Littlefield.

Churchill, G. & Iacobucci, D. (2002). Marketing Research, Methodological Foundations, 8th Edition, Harcourt Publishing, London.

Cohen, L., Manion, L., & Morison, K. (2007). *Research Methods in Education* (6th ed). London: Routledge.

Conceição, P. C., Dieckow, J., & Bayer, C. (2013). Combined role of no-tillage and cropping systems in soil carbon stocks and stabilization. *Soil Till. Res. 129*, 40–47. doi: 10.1016/j.still.2013.01.006.

Cooper, D., & Schindler, P. (2014). *Business research methods* (12th ed.). New York: McGraw Hill.

Creswell, J., & Poth, C. (2017). *Qualitative inquiry and research design: Choosing among five approaches.* (4th ed). Thousand Oaks, CA: Sage.

Crowder, D.W., & Reganold, J.P. (2015). Financial competitiveness of organic agriculture on a global scale. Proc. Natl. Acad. Sci. USA.

David, N., Reardon, T. & Hopkins, R. (1995). Case studies of farmer organizations linking to dynamic markets in Southern Africa: The Fort Hare Farmers Group, South Africa. Retrieved from http://www.pfid.msu.edu/FormerOrgan LinktoDynMrktsForeHare.pdf.

de Freitas, V H. (2000). Soil management and conservation for small farms. Strategies and methods of introduction, technologies and equipment. Rome. Food and Agriculture Organization of the United Nations. *FAO Soils Bulletin 77*. 66 p.

Department for International Development (DFID), (1997). Eliminating World Poverty: A Challenge for the 21st Century. In *White Paper on International Development. HMSO*, London.

Derpsch, R. (2005). The extent of Conservation agriculture adoption worldwide – Implications and impacts. In *Third World Congress on Conservation Agriculture: Linking livelihoods and Conservation*", Nairobi.

Derpsch, R. (2008a). No-tillage and Conservation Agriculture: a progress report. In: T. Goddard, M.A. Zoebisch, Y.T. Gan, W. Ellis, A. Watson and S. Sombatpanit (eds) No-Till Farming Systems. *Special Publication* No. 3 (pp. 7–39). Bangkok: World Association of Soil and Water Conservation (WASWC).

Derpsch, R., Friedrich, T., Kassam, A., & Li, H. (2010). Current status of adoption of no-till farming in the world and some of its main benefits. *International Journal of Agricultural and Biological Engineering*, *3*(1), 1-25.

Devkota, M., Devkota, K. P., Acharya, S., & McDonald, A. J. (2019). Increasing profitability, yields and yield stability through sustainable crop establishment practices in the rice-wheat systems of Nepal. *Agric. Syst. 173*, 414–423. doi: 10.1016/j.agsy.2019.03.022.

Devkota, K., Devkota, M., Rezaei, M., & Oosterbaan, R., (2022a). Managing salinity for sustainable agricultural production in salt-affected soils of irrigated drylands. *Agric. Syst. 198*, 103390.

Devkota, M., Singh, Y., Yigezu, Y.A., Bashour, I., Mussadek, R., & Mrabet, R. (2022b). Conservation agriculture in the drylands of the Middle East and North Africa (MENA) Region: past trend, current opportunities, challenges and future outlook.

Devkota, K., Devkota, M., & Kumar, S. (2022). Conservation agriculture improves agronomic, economic, and soil fertility indicators for a clay soil in a rainfed Mediterranean climate in Morocco.

Ding, Y. (2018). The role of government policies in the adoption of conservation tillage in China: a theoretical model. IOP Conf. Ser. *Earth Environ. Sci. 108*, 1–8.doi: 10.1088/1755-1315/108/4/042012.

Doets, C E M, Best, G, & Friedrich, T. (2000). *Energy and conservation agriculture*. Rome. FAO, sustainable Development and Natural Resources Division Energy Program. Draft unpublished report. 28 p.

Dodge, Y. (2003). *The Oxford Dictionary of Statistical Terms*, OUP.

Donkor, E., Stephen, O., Joe, B. & Ignacio, L.R. (2018). Determinants of farmer participation in direct marketing channels: A case study for cassava in the Oyo State of Nigeria. *Spanish Journal of Agricultural Research*.

Dorward, A., Kydd, J. & Poulton, C. (2006). *Traditional Domestic Markets and Marketing Systems for Agricultural Products.* Background Papers World Development Report: Agriculture for Development Washington, World Bank.

Downe-Wamboldt, B. (1992). Content analysis: Method, applications, and issues. *Health Care for Women International*, *13*, 313-321.

Dumanski, J., Peiretti, R., Benetis, J. McGarry, D. & Pieri, C. (2006). The paradigm of conservation tillage. In *Proceedings World Association of. Soil and Water Conservation, 58-64.* Retrieved from http://www.unapcaem.org/admin/exb/ ADImage/ConservationAgri/ParaOfCA.pdf.

Eaton, C. and Shepherd, A.W. (2001). *Contract farming; partnerships for growth*. FAO Agricultural Services Bulletin. Rome, FAO. (p. 182).

Eaton, D., Meijerink, G. and Bijman, J. (2008). Understanding institutional arrangements: Fresh Fruit and Vegetable value chains in East Africa.

Ellis, F. (2005). Conceptual Framework and Overview of Themes, in F, Ellis and H.A Freeman (eds) Rural Livelihoods and Poverty Reduction Policies, pp. 3 – 15. London and New York: Routledge.

Fafchamps, M. (2004). *Market institutions in Sub=Saharan Africa.* Cambridge, Massachusetts, The MIT Press.

FAO. (2012). Evaluation of FAO's Contribution to the Conservation Agriculture Thematic Cluster.

FAO, (2014). *Conservation agriculture: The 3 principles.* Food and Agriculture Organization of the United Nations.

FAO. (2013). *Food Security and Sovereignty*. Access on 27th October, 2019 from: http://www.fao.org/3/a-ax736e.pdf

FAO, (2014). *Science to Support Climate Smart Agricultural Development: Concepts and Results from the MICCA Pilot Projects in East Africa. Mitigation of Climate Change in Agriculture.* Series 10, Rome.

FAO. (2018). *Evaluation of FAO's Contribution to the Conservation Agriculture Thematic Cluster.* Food and Agriculture Organization of the United Nations.

Farrington, J. (2001). *Sustainable livelihoods, rights and the new architecture of aid.* Natural Resource Perspectives. Overseas Development Institute, London.

Fischer, E., & Quaim, M. (2012a). Linking smallholders to markets: Determinants and impacts of farmer collective action in Kenya. *World Development Journal, 40*(6), 1255-1268.

Floyd, J. (2013). *Survey Research Methods. Applied Social Research Methods Series*. V1. 5th ed. London: SAGE.

Fowler, R. & Rockström, J. (2001). Conservation tillage for sustainable agriculture. An agrarian revolution gathers momentum in Africa. *Soil & Tillage Research, 61*, 93-107.

Feder, G., Just, R.E. & Zilberman, D. (1985). Adoption of agricultural Innovations in Developing Countries: A Survey. Economic Development and Cultural change, vol. 33, 255-298.

Figuere, C. (2003). *Rethinking Water Management*. Earthscan Publication Ltd, USA. Holland.

Fraenkel, J.R. & Wallen, N.E. (2008). How to Design and Evaluate Research in Education. McGraw-Hill Higher Education.

Freire, P. (1970). Pedagogy of the Oppressed. Penguin: London.

Friedrich, T. & Kienzle, J. (2007*). Agriculture: Impact on Farmers' Livelihoods, Labour, Mechanization and Equipment.* Paper presented at the Conservation International Workshop on Conservation Agriculture for Sustainable Land Management.

Friedrich, T., Derpsch, R., & Kassam, A. (2016). Overview of the Global Spread of Conservation Agriculture. *Institut Veolia Environnement Electronic*.

Friedrich, F. & Kassam, A.H. (2009). *Adoption of Conservation Agriculture Technologies: Constraints and Opportunities.* In *Invited paper, IV World Congress on Conservation Agriculture*, 4 – 7 February, New Delhi.

Garande, T. & Dagg, S. (2005). *Public participation and effective water governance at the local level: A case study from a small under-developed area in Chile*. *Environment Development and Sustainability, 7*(4), 417–431.

Garbach, K., Milder, J.C., DeClerck, F.A., de Wit, M.M., Driscoll, L., & Gemmill-Herren, B. (2016). Examining multi-functionality for crop yield and ecosystem services in five systems of agroecological intensification. *Int. J. Agric*.

Gasper, D. (2002). Is Sen's Capability Approach an Adequate Basis for Considering Human Development? *Review of Political Economy*, 14(4), 435-461.

Gasper, D. (2004). *The Ethics of Development*, Edinburgh: Edinburgh University Press.

Gaudin, A.C., Tolhurst, T.N., Ker, A.P., Janovicek, K., Tortora, C.; Martin, R.C., & Deen, W. (2015). Increasing crop diversity mitigates weather variations and improves yield stability.

Gay, L. R. (1987). Educational Research: Competencies for Analysis and Application. 3rd.edn. London: Merrill Publishing.

Geddes, A, & Scott, S. (2011). UK Food Businesses' reliance on low-wage migrant labour: a case of choice or constraint? In: Ruhs M, Anderson B, eds. *Who needs*

migrant workers?: Labour shortages, immigration and public policy. Oxford: Oxford Scholarship Online.

Giller, K.E., Witter, E., Corbeels, M. & Tittonell, P. (2009). Conservation agriculture and smallholder farming in Africa: the heretics' view. *Field Crops Research 114*, (1), 23–34. doi: 10.1016/j.fcr.2009.06.017.

Giesler, M. (2012). How Doppelgänger Brand Images Influence the Market Creation Process: Longitudinal Insights from the Rise of Botox Cosmetic. *Journal of Marketing.*

Govaerts, B., Sayre, K. D. & Deckers, J. (2005). Stable high yields and zero tillage and permanent bed planting? *Field Crops Res*. *94*, 33–42. (doi: 10.1016/ j.fcr.2004.11.003).

Gowing, J. W., & Palmer, M. (2008). Sustainable agricultural development in sub-Saharan Africa: the case for a paradigm shift in land husbandry. *Soil Use and Management, 24(*1), 92-99.

Gupta, C.B. & Gupta, V. (1998). *An Introduction to Statistical Methods* (21st ed). New Delhi: Vikas Publishing House PVT Ltd.

Guto, S. N., Pypers, P., Vanlauwe, B. de Ridder, N. & Giller, K.E. (2011). Socioecological niches for minimum tillage and crop-residue retention in continuous maize cropping systems in smallholder farms of central Kenya, soil tillage conservation. *Agronomy Journa,l 103*(3), 644–654.

Haggblade, S. & Tembo, G. (2003). Early evidence on conservation farming in Zambia. In *A paper prepared for the International Workshop on 'Reconciling Rural Poverty and Resource Conservation: Identifying Relationship and Remedies'*. Cornell University Ithaca. New York.

Harper, J. K., Roth, G. W., Garalejic, B., & Skrbic, N. (2018). Programs to promote adoption of conservation tillage: a Serbian case study. Land Use Pol.

Haq, M. (1995). *Reflections on Human Development*, Oxford: Oxford publishers.

Hobbs, P. R., Sayre, K. & Gupta. R. (2007). The role of conservation agriculture in sustainable agriculture. *Phil. Trans. R. Soc. B, 363,* 543 – 555.

Hobbs, P.R. (2007). Conservation agriculture: what is it and why is it important for future sustainable food production? *Journal of Agricultural Science, 145*, 127-38.

Hobbs, P.R., Sayre, K. & Gupta, R. (2008). The Role of Conservation Agriculture in Sustainable Agriculture. *Philosophical Transactions of the Royal Society B, 363*, 543-555.

IFAD/FAO (2004). *Conservation Agriculture as a labour saving practice for vulnerable households*, FAO Rome, 73p.

ILO (2017). Improving market access for smallholder farmers: What works in out-grower schemes – evidence from Timor-Leste.

Jaffee, S. M. & P. Gordon (1992). *Exporting High=Value Food Commodities: Success Stories from Developing Countries.* World Bank Discussion Papers. Washington, The World Bank: 124.

Teklewold, T., Jaleta, M., Kassie, M., Tesfaye, K., Jena, P. R., Marenya, P., et al. (2016). Resource saving and productivity enhancing impacts of crop management innovation packages in Ethiopia. *Agric. Econ.* 47, 513–522. doi: 10.1111/agec.12251.

Kasiaka, K. (2004). *Participatory Planning and Sustainability of Water*. TASAF Water Project UDSM Press, Tanzania.

Kassam A., Friedrich, T. & Derpsch, R. (2010). CA in the 21st Century: A Paradigm of Sustainable Agriculture. In *European Congress on CA, Madrid*, October. Retreived from http://www.marm.es/es/ministerio/serviciosgenerales/ publicaciones/Opening_plenary_sessions_tcm7-158496.pdf.

Kassam, A. H, Friedrich, T., Shaxson, F. & Jules, P. (2009). The spread of Conservation Agriculture: Justification, sustainability and uptake. *International Journal of Agriculture Sustainability* 7(4): 292-320.

Kassam, A., Friedrich, T., & Derpsch, R. (2019). Global spread of conservation agriculture. *Int. J. Environ. Stud. 76*, 29–51.

Kanji, N & Greenwood, L. (2001). Participatory approaches to research and development in IIED: Learning from experience.

Kaumbutho, P. &Kienzle J. (2007). Conservation agriculture as practised in Kenya: two casestudies. Nairobi: African Conservation Tillage Network, Food and Agriculture Organization of the United Nations.

KNBS. (2015). *Economic Survey*. Nairobi: Kenya National Bureau of Statistics.

Kydd, J. & Dorward, A. (2004). Implications of market and coordination failures for rural development in least developed countries. *Journal of International Development 16*(7), 951=970.

Kirsten, J. & K. Sartorius (2002). Linking agribusiness ans small=scale farmers in developing countries: is there a new role for contract farming? *Development Southern Africa 19*(4), 503=529.

Kothari, C. (2004). *Research methodology: Methods and techniques.* (2nd ed.). New Delhi: New Age international ltd.

Knowler, D. & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy, Elsevier, 32*(1), 25-48.

Krippendorff, K. (2018). *Content analysis: An introduction to its methodology*. (4th ed.). Sage.

Kothari, C. (2004). *Research Methodology: Methods and Techniques* (2nd Rev ed.). New Delhi: New Age International (P) Ltd.

Kremen, C., Iles, A., & Bacon, C., (2012). Diversified farming systems: an agroecological, systems-based alternative to modern industrial agriculture. *Ecol. Soc*., 17, 44.

Kumar, S. (2002). *Methods for community participation*. *A complete guide for practitioners.* London: ITDG Publishing.

Kumar, V., Jat, H. S. Sharma, C., Balwinder, S., Gathala, M. K. & Malik, R. K., (2018). Can productivity and profitability be enhanced in intensively managed cereal systems while reducing the environmental footprint of production? Assessing sustainable intensification options in the breadbasket of India. *Agric. Ecosyst. Environ. 252*, 132–147. doi: 10.1016/j.agee.2017.10.006.

LaCanne, C. E., & Lundgren, J. G. (2018). Regenerative agriculture: merging farming and natural resource conservation profitably. *Peerj 6*, e4428. doi: 10.77 17/peerj.4428.

Lal, R. (2007). Constraints to adopting no-till farming in developing countries. *Soil Tillage Res*. *94*, 1–3. doi: 10.1016/j.still.2006.11.004.

Lalani, B., Dorward, P., & Holloway, G. (2017). Farm-level economic analysis - is conservation agriculture helping the poor? *Ecol. Econ. 141*, 144–153. doi: 10.1016/j.ecolecon.2017.05.033.

Lange, D. (2005). *Economics and Evolution of Smallholdings Conservation Agriculture in Paraguay*. mid-term experiencfes; FAO-GTZ, Asunción/Paraguay, 91 pp.

Langyintuo, A.S. & M. Mekuria. (2000). F*armers Strategy for Sustainable Food Security Determinants of the adoption of improved rice varieties in the inland valleys of northern Ghana*". A Tobit model application.

Li, Y., Li, Z., Cui, S., Jagadamma, S., & Zhang, Q. P. (2019b). *Residue retention and minimum tillage improve physical environment of the soil in croplands: a global meta-analysis*. *Soil Tillage Res. 194*, 104292. doi: 10.1016/j.still.2019.06.009.

Lotter, D.; Seidel, R. & Liebhardt, W. (2003). The performance of organic and conventional cropping systems in an extreme climate year. *Am. J. Altern. Agric.18*, 146–154.

Lynch, D.H., MacRae, R. & Martin, R.C. (2011). The carbon and global warming potential impacts of organic farming: Does it have a significant role in an energy constrained world? *Sustainability, 3*, 322–362.

Mango, N., Siziba, S. & Makate, C. (2017). The impact of adoption of conservation agriculture on smallholder farmers' food security in semi-arid zones of southern Africa. *Agriculture & Food Security.*

Mapeshoane, B., Marake, M.V., Khoeli, M. & Obuh, J. (2005). Evaluation of Conservation Agriculture Strategies Employed in Lesotho: a Farmers' Perspective. Report prepared for FAO Representation Lesotho.

Maphosa, M., Tshuma, N., Ncube, G., Dube, T. & Dube, Z. L. (2012). The Impact of conservation agriculture on food security and livelihoods in Mangwe district. *Journal of Sustainable Development in Africa*, *14*(5), 107-125.

Michler, J.D., Arends-Kuenning, M., & Mazvimavi, K. (2019). Conservation agriculture and climate resilience. *Journal of Environmental Economics and Management.*

Mariki, W.L., (2003). The Impact of Conservation Tillage and Cover Crops on Soil Fertility and Crop Production in Karatu and Hanang Districts of Northern Tanzania (1999-2003) TFSC/GTZ Technical Report; Selian Agricultural Research Institute (SARI).

Marongwe. L. S, K. Kwazira, M. Jenrich, C. Thierfelder, A. Kassam & T. Friedrich. (2011). An African success: the case of conservation agriculture in Zimbabwe. *International Journal of Agricultural Sustainability*, *9*(1), 153-161.

Mashingaidze, A. B., Govere, I., Rohrbach, D., Hove, L. & Twomlow, S. (2006). Conservation agriculture in Southern Africa. In *Harrison's Conference, Johannesburg.*

Mashingaidze, A.B. & Mudhara, M. (2006). Non-Governmental Organizations (NGO) efforts to Mexico, and Southern Africa. *Journal of Sustainable Agriculture*, 36, 180 -206.

Masika, T. (2020). Impact of One Quarter Rule System on Households Welfare: A case of Yatta, Machakos. In *A presentation at First Agricultural Industry Forum held at Nairobi Hospital Convention Centre on 4th March 2020.*

Maypole, J., & Davies, T. G. (2001). Students' perceptions of constructivist learning in a community college American History II. *Community College Review*, 29(2), 54–80.

Mazvimavi, K. & Twomlow,S. (2009). Socioeconomic and institutional factors influencing adoption of conservation agriculture by vulnerable households in Zimbabwe. *Agricultural Systems 101*, 20-29.

Mazvimavi, K., (2011). *Socio-economic analysis of conservation agriculture in Southern Africa*. Technical Report. FAO Regional Emergency Office for Southern Africa (REOSA).

Mazvimavi, K.., Nyathi, P., Ndlovu & Minde, J. (2010). *Conservation Agriculture Practices and Adoption by Smallholder Farmers in Zimbabwe.* Poster presented at 3rd AAAE Conference, 19–23 September 2010, Cape Town, South Africa.

Mbata, J. (2006). Estimating Household Willingness for Water Services in Rural economy: the Case of Kanye in Southern Botswana. *Development of Southern Africa*.

McCommon, C. (1990). *Community Management of Rural Water Supply and Sanitation Services*. Washington DC, USA.

McCullen, N. J. (2013). Multiparameter Models of Innovation Diffusion on Complex Networks. SIAM *Journal on Applied Dynamical Systems*, *12*(1), 515–532.

Mhlanga, B., Ercoli, L., Pellegrino, E., Onofri, A., & Thierfelder, C. (2021). The crucial role of mulch to enhance the stability and resilience of cropping systems in southern Africa. *Agronomy for Sustainable Development*.

Millie, B. A., Nyakuni, A., & Gideon, S. (2006). Strengthening Farmer's Organizations: RELMA's experience in Eastern and Southern Africa. In *ICRAF Working Paper No. 23*.

Morris, M., & Ogan, C. (1996). The Internet as a Mass Medium. *Journal of Communication*, *46*, 39-50.

Morse, S & McNamara, N. (2013). *Sustainable Livelihood Approach*. Springer Science.

Mousques, C., & Friedrich, T., (2007). *Conservation agriculture in China and the Democratic People's Republic* of Korea'. http://www.fao.org/ag/ca/7.html.

Mrabet, R. (2011). Conservation Agriculture as a Strategy for Responding to Climate change in the Dry Mediterranean-type Environments.

Mulwa, F.W. (2008). *Participatory Monitoring and evaluation of community projects*. Paulines publications Africa, Nairobi Kenya.

Mugenda, O.M & Mugenda, A.G. (2003). *Research Methods Qualitative and Quantitative approaches.* Africa Center for Technology Studies (Acts) Press. Nairobi Kenya.

Musemwa, L., Chagwiza, C., Sikuka*, W., Fraser, G. Chimonyo, M. & Mzileni, N. (2007). Analysis of cattle marketing channels used by small scale farmers in the Eastern Cape Province, South Africa.

Mushtaq, A.M. (2004). *Community participation in water supply and sanitation schemes.*

Mwaura, M., & Ngugi, K. (2014). Factors affecting performance of community-based organizations projects in Kisii County Kenya. *International Journal of Social Sciences Management and Entrepreneurship, 1*(2), 51- 67.

Nachmias, D. & Nachmias, F. (1996). *Social Statistics for a Diverse Society*. Milwaukee: Sage Publications.

Narayan, D. (1995). *Participatory evaluation: tools for managing change in water and* Natural *Resource Perspectives 69*. Overseas Development Institute, London.

Nelson, D.W. & Knight, A.E. (2010). The power of positive recollections: Reducing test anxiety and enhancing college student efficacy and performance. J*ournal of Applied Social Psychology*, *40*(3), 732-745.

Newing, H. (2011). *Conducting Research in Conservation Social Science Method and Prentice*. New York, USA: Routledge.

Ngoma, H. (2018). Does minimum tillage improve the livelihood outcomes of smallholder farmers in Zambia?. *Food Secur. 10*, 381–396. doi: 10.1007/s12571-018-0777-4.

Ng'ombe, J. N., Kalinda, T. H., & Tembo, G. (2017). Does adoption of conservation farming practices result in increased crop revenue? *Evid. Zambia Agrekon, 56*, 205–221. doi: 10.1080/03031853.2017.1312467.

Niehof, A. & Price, L.L. (2001). Rural livelihood systems: A conceptual framework. *Wageningen-UPWARD Series on Rural Livelihoods No.*

Nikkhah, H. A. & Redzuan, M. (2009). Participation as a Medium of Empowerment in Community Development. *European Journal of Social Sciences*, *11*(1)

Njeru, E. K. (2016). *Factors influencing adoption of Conservation Agriculture by Small Holder Farmers in Kenya: A Case of Laikipia East Sub-County, Kenya.* (Unpublished Thesis): University of Nairobi.

Nkala, P., Mango, N., & Zikhali, P. (2011). Conservation Agriculture and Livelihoods of Smallholder Farmers in Central Mozambique, pp. 757–779. https://doi.org/10.1080/10440046.2011.606492.

Nkala, P. (2012). *Assessing the impacts of conservation agriculture on farmer livelihoods in three selected communities in Central Mozambique.* Ph.D. Thesis, University of Natural Resources and Life Sciences, Vienna, Austria.

Nkongo, D. (2009). *Management and regulation for sustainable water supply scheme in rural communities in Tanzania*.

Ntshangase, N.L., Muroyiwa, B., & Sibanda, M. (2018). "Farmers' Perceptions and Factors Influencing Adoption of No-Till Conservation Agriculture by Small-Scale Farmers in Zashuke, Kwazulu-Natal Province. Google Scholar

Nyagumbo, I. (1999). Conservation Tillage for sustainable crop production systems: experiences from on-station and on-farm research in Zimbabwe (1997-1998)." In Kaumbutho P.G and T. E. Simalenga. (Editors). Conservation Tillage with Animal Traction. *ATNESA. Harare. Zimbabwe*.107-114.

Nyoro, J., Ariga, J. & Komo, I. (2004). Kenyan Case Study on Fresh Fruits, Vegetables and Dairy products. Regoverning Markets Phase 1. Nairobi Kenya, *Tegemeo Institute of Agricultural Policy and Development, 58.*

Qizilbash, M. (1996). Capabilities, Well-being and Human Development: A Survey. *Journal of Development Studies, 33*(2), 143.62.

Pittelkow, C.M., Liang, X., Linquist, B.A., van Groenigen, K.J., Lee, J.; Lundy, M.E.; …& van Kessel, C. (2015). Productivity limits and potentials of the principles of conservation agriculture.

Odame, H., Mbote, P.K. & Wafula, D. (2002). The Role of Innovation in Policy and Institutional Change: Influence of modern biotechnology on institutional and policy change in Kenya. IELRC. Environment Team, IDS, Sussex, 2002, Kenya.

Odhiambo, M. & Taifa, A. (2009). *Devolved Funds Development: A Handbook on Participation.* Nairobi: Claripress.

Okello, M., Oenga, I. & Chege, P. (2008). *Participatory Urban Planning Toolkit Based on the Kitale Experience: A guide to Community Based Action Planning for Effective Infrastructure and Services Delivery.* Nairobi: Practical Action.

Olwande, J., & Mathenge, M. (2012). *Market participation among Poor Rural Households in Kenya*. Contributed paper, International Association of Agricultural Economists (IAAE) Triennial Conference, Foz do Iguaçu, Brazil. August 18-24, 2012.

Olsen, W.K. & Jamie, M. (2004). A critical Epistemology of Analytical Statistics. New York: *The British Sociological Association.*

Orodho, J. (2004). *Techniques of writing research proposals and reports in education and social sciences.* Nairobi: Masola Publishers.

Oyekale, A. & Matsane, S.H. (2014). Factors Affecting Marketing of Vegetables among Small-Scale Farmers in Mahikeng Local Municipality, North West Province, South Africa. Mediterranean Journal of Social Sciences.

Patrick, V., & Isaac, J. (2010). Conservation Agriculture Practices and Adoption by Smallholder Farmers in Zimbabwe. Poster presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa.

Poulton, C., Dorward, A.& Kydd, J. (2005). *The Future of Small Farms: New Directions for Services, Institutions and Intermediation.* The Future of Small Farms, Proceedings of a Research Workshop; Wye, UK, June 26=29, 2005. Wye, UK, IFPRI.

Pretty, J. (1998). The Living Land: agriculture, food systems and community regeneration in rural Europe. Earthscan Publications, London.

Pretty, J. (2000). *Can sustainable agriculture feed Africa? New evidence on progress, processes and impacts.* Centre for Environment and Society. University of Essex. Colchester.

Reardon, T. & Barrett, C.B. (2000). Agro industrialization, globalization, and international development. An overview of issues, patterns, and determinants. *Agricultural Economics, 23*, 195=205.

Reardon, T. & Berdegué, J.A. (2002). The rapid rise of supermarkets in Latin America: challenges and opportunities for development. *Development Policy Review, 20*(4): 371=388.

Robinson, D., & Reed, V. (Eds.). (1998). The A Z of social research jargon. Aldershot, UK: Ashgate.

Rogers, E. (2003). Diffusion of Innovations, 5th Edition. Simon and Schuster.

Royer, J. S. & Rogers, R.T. Eds. (1998). T*he industrialization of agriculture*. Vertical coordination in the U.S. food system. Aldershot, Ashgate.

Rubin, H.,Rubin, I.,(2012). *Qualitative interviewing: The art of hearing data* (3rd ed.). Thousand Oaks, CA: Sage

Sáenz-Segura, F. (2006). Contract Farming in Costa Rica. Opportunities for smallholders? Development Economics. Wageningen, Wageningen University. PhD.

Saturnino, H M, & Landers, J.N. (2002). The Environment and Zero Tillage; APDC-FAO, Brasilia, Brazil UDC 504:631/635, CDD 631.521, 144 p.

Saunders, M., Lewis, P., & Thornhill, A. (2016). *Research methods for Business students* (7th ed.). Edinburg Gate: Pearson Education Limited.

Schouten, T. & Moriarty, P. (2003). *Community Water, Community Management*. London, UK.

Scoones, I. (2009). Livelihoods Perspectives and Rural development. *Journal of Peasant Studies, 36*(1), 171-196.

Scoones, I. (1998). Sustainable Rural Livelihoods: A Framework for Analysis", Working Paper 72, Brighton, UK: Institute for Development Studies.

Sedgwick, P. (2012). Pearson's Correlation Coefficient. London: BMJ Publishing Group.

Sen, A.K. (1992). *Inequality Re-examined*. Oxford: Clarendon Press.

Sen, A. K. (1985). *Commodities and Capabilities*. Oxford: Elsevier Science.

Serrat, O. (2010). *The Sustainable Livelihoods Approach*. Washington DC. Asian Development Bank.

Shepherd, A. W. (2005). The implications of supermarket development for horticultural farmers and traditional marketing systems in Asia (revised paper). FAO/AFMA/FAMA Regional Workshop on the Growth of Supermarkets as Retailers of Fresh Produce. Kuala Lumpur.

Silici, L., Ndabe, P., Friedrich, T. & Kassam, A. (2011). Harnessing sustainability, resilience and productivity through CA: the case of *likoti* in Lesotho. *International Journal of Agricultural Sustainability*, *9*(1), 137-144.

Singh, S. (2002). Contracting Out Solutions: Political Economy of Contract Farming in the Indian Punjab. *World Development, 30*(9), 1621=1638.

Sonko, R., Njue, E., Ssebuliba, J.M. & Jager, A.D. (2005). The Horticultural Sector in Uganda", *Scripta Horticulturae*, *1*, 1-78.

Somasundaram, J., Sinhaa, N. K, Ram, C.D., Mohanty, M., Naorem, A.K., Hati, K.M., …& Chaudhari, S.K. (2020). No-Till Farming and Conservation Agriculture in South Asia – Issues, Challenges, Prospects and Benefits. Taylor & Francis Online.

Streeten, P. (1994). Human Development: Means and Ends. *American Economic Review*, 84(2),

Stewart, B.I., Asfary A.F., Belloum, A. Steiner,K. & Friedrich, T. (2008). *Conservation Agriculture for Sustainable Land Management to Improve the Livelihood of People in Dry Areas.* Arab Center for the Studies of Arid Zones and Dry Lands and the German Agency for Technical Cooperation, Damascus, Syria and Eschborn, Germany.

Tambo, J.A. & Mockshell, J. (2018). Differential Impacts of Conservation Agriculture Technology Options on Household Income in Sub-Saharan Africa. Ecological Economics.

Teklewold, H. (2013). Gender plays a key role for sustainable farming in Africa. EU news & policy debatesacross languages. Retrieved from http://www.euractiv.com /development-policy/researcher-eu-aideducation- afri-interview-517158

Thierfelder, C, & Wall, P.C. (2010). Investigating CA (CA) Systems in Zambia and Zimbabwe to Mitigate Future Effects of Climate Change. *Journal of Crop Improvement*, *24*, 113-121.

Thierfelder, C. & Wall, P. (2010). *Rotation in conservation agriculture systems of Zambia: effects on soil quality and water relations*. Experimental Agriculture, *46*(3), 309-26.

Thierfelder, C., Chivenge, P. & Mupangwa, W. (2017). How climate-smart is conservation agriculture (CA)? – its potential to deliver on adaptation, mitigation and productivity on smallholder farms in southern Africa. *The International Society for Plant Pathology.*

Tshuma, N., Maphosa, M., Ncube, G., Dube, T. & Zenzo L.D. (2012). The impact of conservation agriculture on food security and livelihoods in Mangwe district. *Journal of Sustainable Development in Africa.*

Tuck, S.L., Winqvist, C, Mota, F.;, Ahnström, J., Turnbull, L.A. & Bengtsson, J. (2014).

Land-use intensity and the effects of organic farming on biodiversity: A hierarchical meta-analysis. J. Appl. Ecol. 51, 746–755.

Twomlow, S.J., Hove, L., Mupangwa, W., & Masikati, P. (2008). *Precision conservation agriculture for vulnerable farmers in low-potential zones*. Paper presented at the CPWF meeting. Ghana.

Twomlow, S., Urolov, J.C., Jenrich, M. & Oldrieve B. (2008). Lessons from the field Zimbabwe's Conservation Agriculture Task Force. *Journal of SAT Agricultural Research* 6 (11pages).

Singhal, A. & Dearing, J.W. (2006). Communication of innovations: A journey with Ev Rogers. New Delhi: Sage Publications.

Uddin, M. T., & Dhar, A. R. (2016). Conservation agriculture practice and its impact on farmer's livelihood status in, *14*(1), 119–140.

Umberger, W.J., Reardon, T., Stringer, R., & Loose, S.M. (2015). Market-channel choices of Indonesian potato farmers: A best-worst scaling experiment. Bull Indones Econ Stud, *51*(3), 461- 477.

USAID (1992). USAID Policy Determination: Definition of food security. http://www.usaid.gov/pubs/ads/pd19.pdf.

USAID. (2019). *Agriculture and Food Security*. Retrieved from http://www.usaid.gov /kenya/agriculture-and-food-security.

Vastola, A., Zdruli, P., D'Amico, M., Pappalardo, G., Viccaro, M., & Di Napoli, F. (2017). A comparative multidimensional evaluation of conservation agriculture systems: a case study from a Mediterranean area of Southern Italy.

VeneKlasen, L., & Miller, V. (2002). Power and empowerment. *PLA Notes, 43*, 39-41.

Wagstaff, P., & Harty, M. (2010). The Impact of Conservation Agriculture on Food Security in three low veldt districts of Zimbabwe, 67–84.

Wall, P. C. (2007). Tailoring conservation agriculture to the needs of small farmers in developing countries: An analysis of issues. *Journal of Crop Improvement 19*, 137–155.

Wall, P. (2009). Fourth World Congress on Conservation Agriculture, "Strategies to overcome the competition for crop residues in Southern Africa: some light at the end of the tunnel, New Delhi

Waweru, G., Cornelis, W., & Okoba, B. (2013). Farmers' percept ion of conservation agriculture in Laikipia East District in Kenya, (October), 1–8.

Welman, J. C., Kruger, S. J. (1999). *Research methodology for the business and administrative sciences.* Johannesburg, South Africa: International Thompson.

Welman, J. C., Kruger, S. J. (1999). R*esearch methodology for the business and administrative sciences.* Johannesburg, South Africa: International Thompson.

Wejnert, B. (2002*). Integrating models of Diffusion of Innovations:* A Conceptual Framework. Annual Review of Sociology (Annual Reviews) 28, 297–306. Retrieved from http://www.jstor.org/stable/3069244.

Wiersinga, R. & Jager, A.D. (2007). *Development of commercial field vegetable production, distribution and marketing for the East African market*. A literature review. The Hague, LEI.

Wekesa, B, Oscar, A. & Job, L. (2018). Effect of climate smart agricultureal practices on household food security in smallholder production system: micro-level evidence from Kenya. *Agriculture and Food Security, Open Access; 7:80.*

World Bank, (2015). Climate Smart Agriculture in Kenya. *Climate Smart Agriculture Country Profiles for Africa, Asia, Latin America and Caribbean Series*, Washington D. C.: The World Bank Group.

World Bank. (1986). *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*. Washington DC. World Bank.

World Bank, (2010). *World Development Indicators* (Washington, DC: The World Bank); as posted on the World Bank website .

Wright, A.M. (1997). *Towards a Strategic Sanitation Approach: Improving the Sustainability of Urban Sanitation in Developing Countries*. Washington DC: UNDP/World Bank Water and Sanitation for Health Programme.

Yamane, Taro. (1967). *Statistics, An Introductory Analysis*. (2nd Ed.). New York: Harper and Row.

Yeray, R.S.G. (2012). *Assessment of conservation agriculture (ca) Practices in Bungoma, western Kenya: towards an insight in ca adoption and its constraints.* (Unpublished Thesis): Wageningen University.

Yuerlia, F.R. & Saptomo, A. (2004). *Peoples' Participation in Rural Water Supply and Sanitation Project:* A case study in Jorong Kampung Baru, West Sumatra, Indonesia.

Zikmund, W.G. (2003) Business Research Methods. 7th Edition, Thomson/ South-Western.

APPENDICES

Appendix I: Self Introduction

Dear Respondent,

REF: REQUEST TO BE INTERVIEWED

The researcher is a Doctor of Philosophy in Development Studies candidate at Jomo Kenyatta University of Agriculture and Technology currently conducting research study. The questionnaire attached is designed to gather information "On conservation agriculture practices and its effects on livelihood outcomes in ASAL areas in Kenya". The information you will give is entirely for academic and learning purposes and will be treated with strict confidence.

Your co-operation will be highly appreciated. Thanking you in advance.

Yours sincerely

JUSTIN KYALO

Reg. No: HD424-8177/2015

Appendix II: Questionnaire

SECTION A: Farmer site identification and farm characteristics

1.	Sub-county	
2.	Please indicate your gender	Male [ ] Female [ ]
3.	Please indicate your age group	Below 20 years [ ] 21-30 years [ ] 31-40 years [ ] 41-50 year [ ] Over 50 years [ ]
4.	What is your marital status?	Married [ ] Unmarried [ ] Divorced [ ] Widowed [ ]
5.	Name of nearest market	
6.	Distance to the nearest market (km)	
7.	Type of road access to market	1. Earthen roads 2. Murram road (gravel roads) 3. Tarmac (paved roads)
8.	Quality of access road	1. Bad and passable only during dry seasons 2. Bad but passable all year round 3. Good (all weather road)
9.	Do you practice any CA on your farm	Yes [ ] No [ ]
10.	If yes, which CA principles do you practice?	1. Minimum tillage 2. Mulching 3. Crop rotation/ Intercropping 4. Combined practices (specify)
11.	For how long have you been practicing CA	<1 year [ ] 1-2yrs [ ] >2yrs [ ]

12. Indicate items you own as a household. (Put a tick (✓) where appropriate)

Item	**Yes**	**No**
Tv set		
Internet access		
Computer		
Car or Van		
Motorcycle		

SECTION B: Socio-economic characteristics

Level of education

13. Please indicate the highest level of education attained.

Never attended school [ ] Primary level [ ] Secondary level [ ]

Diploma [ ] Degree [ ] Masters [ ] Doctorate [ ]

14. Please indicate the extent to which you agree or disagree with the following statement. Tick appropriately.

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	**1**	**2**	**3**	**4**	**5**
I have been able to understand the principles of conservation agriculture					
I have been able to apply CA technologies					
I have been able to comprehend the various CA benefits					

Employment status

15. Do you have any other occupation apart from farming? Yes [ ] No [ ]

(If no, proceed to question 18)

16. If yes, choose among these: Casual labourer [ ] Teaching [ ] Business venture [ ] Any other? Specify……
….

17. Please indicate the extent to which you agree or disagree with the following statements.

(Put a tick (✓) where appropriate)

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	1	2	3	4	5
The income gained from the other occupation, enables me to purchase farm equipment for CA					
The income gained from the other occupation, enables me to hire extra farm labour					
The other occupation supplements CA farming					

Wealth status

18. Indicate the total acreage of land? Below 5 acres [ ] 5-10 acres [ ]

10-15 acres [ ] 15-20 acres [ ] Over 20 acres [ ]

19. Indicate the kind of ownership rights applicable to the farm?

Own title deed [ ] Have allotment letter [ ] Leased land [ ] Community land [ ]

20. Please indicate the extent to which you agree or disagree with the following statements. (Put a tick (✓) where appropriate)

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	1	2	3	4	5
Since embracing CA, my poverty status has gone down					
Since embracing CA, I have been able to afford basic commodities with ease					
Since embracing CA, I have been able to increase my income streams					

SECTION C: Input costs

Labour requirements

21. How much did you spend in paying for the labour of your various farm enterprises in 2020? Use the table below.

Type of cost	Unit	Cost
Manpower* (only those who are not part of the family) (provide the no. of those who provide labour and how much they are paid)		
Casual labourers		
Full-time labourers		

22. Do you have family members who are providing labour in the farm?

Yes [ ] No [ ]

(*If no, proceed to question 25)*

23. Indicate the form of labour they offer.

a. Casual [ ]

b. Full-time [ ]

c. Both [ ]

24. Please indicate how many they are and their total wages.

	Unit	Cost
Casual labourers		
Full-time labourers		

25. Is more time required to prepare land for CA crops than time required to prepare same crop not under CA?

Yes [ ] No [ ]

26. Please indicate the extent to which you agree or disagree with the following statements. (Put a tick (✓) where appropriate).

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	**1**	**2**	**3**	**4**	**5**
There is less labour cost for CA crops					
There is ease of access to labour for CA crops					
The time saved through use of CA is dedicated to non-farm occupations					

Mulching

27. Do you apply mulches on your CA farm?

Yes [ ] No [ ]

(If no, proceed to question 29)

28. Where do you normally get the mulches from?

From my farm [ ]

Neighbours [ ]

Other (Specify)……..

29. Indicate the reasons why you do not apply mulches on your CA farm.

The process is time consuming [ ]

Mulch not available [ ]

Not aware of the benefits [ ]

Other (Specify)……..

30. Please indicate the extent to which you agree or disagree with the following statements. (Put a tick (✓) where appropriate).

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	1	2	3	4	5
The use of mulches saves the amount of water used for watering crops					
The use of mulches saves the time used on the CA farm					
The use of mulches minimizes the cost incurred in hiring extra labour to work on the CA farm					

Farm equipment

31. Do you have access to CA farm tools?

Yes [ ] No [ ]

(If no, proceed to question 34)

32. Indicate the farm tools you have access to and the form of ownership? ((Put a tick (✓) where appropriate)

Farm Tools	Yes	No	Form of ownership	
			Hired	Bought
Rippers				
Jab planter				
Chisel plough				

33. Do you use any other farm tools for CA farming?

Farm Tools	Yes	No	Form of ownership	
			Hired	Bought
Oxen plough				
Modified plough				
Hand hoe				
Other (Specify)				

34. Why don't you have access to CA farming equipment?

a. Too costly to purchase [ ]
b. Too costly to hire [ ]

c. Not locally available [ ]
d. Other (Specify) [ ]

35. Please indicate the extent to which you agree or disagree with the following statements. (Put a tick (✓) where appropriate).

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	**1**	**2**	**3**	**4**	**5**
The use of CA farm equipment minimizes the number of times land is prepared					
The use of CA farm equipment minimizes the time spent preparing land					
The use of CA farm equipment saves on the number of labourers required to prepare land					

SECTION D: Land Productivity

Soil preservation

36. Indicate the number of seasons and for which main crops you have practiced each of the CA principles?

Category of CA principle	**No. of seasons**	**Main crop under each principle**
Minimum tillage		
Mulching		
Crop rotation		

37. For the just ended growing season, please answer the following questions for one of your CA plots only.

Last Season	**CA Crop 1**	**CA Crop 2**	**CA Crop 3**	**CA Crop 4**
a. Indicate the crops grown using CA principles				

during this last season? (list your most important crops, up to 4).				
b. Was another crop intercropped with the CA crop? If yes, with which one(s)?	___ Yes ___ No If yes, Crop 1 was intercropped with:	___ Yes ___ No If yes, Crop 2 was intercropped with:	___ Yes ___ No If yes, Crop 3 was intercropped with:	___ Yes ___ No If yes, Crop 4 was intercropped with:
c. Was another crop rotated with the CA crop? If yes, with which one(s)?	___ Yes ___ No If yes, Crop 1 was rotated with:	___ Yes ___ No If yes, Crop 2 was rotated with:	___ Yes ___ No If yes, Crop 3 was rotated with:	___ Yes ___ No If yes, Crop 4 was rotated with:

38. Please indicate the extent to which you agree or disagree with these statements. (Put a tick where appropriate).

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	**1**	**2**	**3**	**4**	**5**
Crop rotation/intercropping has led to application of fewer fertilizers					
Crop rotation/intercropping has led to improved water retention of the soil					
Crop rotation/intercropping has led to reduced soil erosion					

Harvest quantity

39. Indicate the yield of your CA crop (in kgs) for the last 4 seasons beginning with the most recent?

Seasons	**CA Crop 1**	**CA Crop 2**	**CA Crop 3**	**CA Crop 4**
Season 1				
Season 2				
Season 3				
Season 4				

Season 5				

40. Please indicate the extent to which you agree or disagree with these statements.

Tick appropriately.

Last Season	**CA Crop 1**	**CA Crop 2**	**CA Crop 3**	**CA Crop 4**
Name of the crop				
What price did you sell the CA crop for? (in local currency per Kg)				
Is this a better price compared to previous season?	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No
How is the price of produce fixed?	Fixed pre-agreed price Negotiated at farm gate Open market price Other (specify)……	Fixed pre-agreed price Negotiated at farm gate Open market price Other (specify)……	Fixed pre-agreed price Negotiated at farm gate Open market price Other (specify)……	Fixed pre-agreed price Negotiated at farm gate Open market price Other (specify)……
What marketing arrangements did you use to sell your CA produce?	Direct marketing Indirect marketing (use of brokers) Contract farming	Direct marketing Indirect marketing (use of brokers) Contract farming	Direct marketing Indirect marketing (use of brokers) Contract farming	Direct marketing Indirect marketing (use of brokers) Contract farming
Did you combine your CA crop with other farmers' harvest for a higher price?	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No	___ Yes ___ No
How soon after delivery of produce did you receive your payment?	Immediately Within one week After 1 weeks After 2 weeks After 1 month After 3 months Other (Specify)	Immediately Within one week After 1 weeks After 2 weeks After 1 month After 3 months Other (Specify)	Immediately Within one week After 1 weeks After 2 weeks After 1 month After 3 months Other (Specify)	Immediately Within one week After 1 weeks After 2 weeks After 1 month After 3 months Other (Specify)

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	1	2	3	4	5
The output levels have remained the same since adopting CA					
The output levels have improved since adopting CA					
I am always assured of output every season since adopting CA					

Harvest quality

41. Please indicate the extent to which you agree or disagree with these statements. Tick appropriately.

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	1	2	3	4	5
Output from my farm has been affected by pests since adopting CA					
Output from my farm has been affected by diseases since adopting CA					
Output from my farm has been mature since adopting CA					

SECTION E: Marketing institutional arrangements

42. Did you sell your produce in the last harvest season?

    Yes [ ] No [ ]

    (If no, proceed to question 44)

43. If yes, please answer the following questions for the main CA crops grown.
44. If you have ever sold produce before, indicate your preferred marketing arrangement?

a. Direct marketing
b. Indirect marketing (use of brokers)
c. Contract farming

(If you have never sold, proceed to section F)

45. Explain the nature of the marketing arrangement?

.....

46. What type of agreement did you have with the buyer?

a. Individual written contract [ ]
b. Group written contract [ ]
c. Individual verbal agreement [ ]
d. Group verbal agreement [ ]
e. No agreement [ ]

a. Other, please specify.....

47. Please indicate the extent to which you agree or disagree with these statements. Tick appropriately.

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	**1**	**2**	**3**	**4**	**5**
The buyer normally collects farm produce from my farm					
The buyer caters for transportation cost of farm produce to the market					
There is a guaranteed market for farm produce					
The market prices for farm produce are adequate					
The buyer offers farm inputs					
The buyer offers extension services					
The buyer normally provides specifications with regard to quantity and quality of farm produce to be supplied					

SECTION F: Producer associations

Knowledge usability

1. Are you a member of a farmer group?	1. Yes [ ] No [ ]
2. Which year did you join the farmer group?	
3. If yes, what is the name of the farmer group?	
4. Is the membership open to any willing farmer?	Yes [ ] No [ ]

5. Does your farmer group support CA farming?	Yes [ ] No [ ]

Please indicate the extent to which you agree or disagree with these statements. Tick appropriately.

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	**1**	**2**	**3**	**4**	**5**
The training received through the farmer group has enabled me to apply the CA principle on minimum tillage					
The training received through the farmer group has enabled me to apply the CA principle on mulches					
The training received through the farmer group has enabled me to apply the CA principle on crop rotation					
The training received through the farmer group has enabled me to use CA farm equipment					
The training received through the farmer group has enabled me to keep farm records					

Advocacy

48. Do you receive training on CA farming through the producer association?

Yes [ ] No [ ]

49. Which training sessions have you attended over the past four years?

Topic	**Mark (Tick)**	**Relevance/Usefulness (1-5) where 1 is lowest, 5 is highest**	**If didn't attend Why not?**
Group dynamics			
Importance of CA			
Minimum tillage			

Importance of mulching			
Record keeping			
Crop rotation			
Weed Management			
Crop residue Management			
Post-harvest Management			
Village Savings and Loans (VSLA)			

50. Please indicate the extent to which you agree or disagree with these statements. (Put a tick (✓) where appropriate).

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	**1**	**2**	**3**	**4**	**5**
The farmer group owns demonstration plots which have encouraged me to embrace CA					
The farmer group normally organizes for farm visits which have encouraged me to embrace CA					
The farmer group normally networks with other producer associations and this has encouraged me to embrace CA					
The farmer group normally invites agricultural experts to advice members and conduct trainings and this has encouraged me to embrace CA					

SECTION G: Livelihood outcomes

51. Food insecurity experience scale.

Short reference	Question wording
WORRIED	During the last 12 MONTHS, was there a time when you were worried you would not have enough food to eat because of a lack of money or other resources?
HEALTHY	Still thinking about the last 12 MONTHS, was there a time when you were unable to eat healthy and nutritious food because of a lack of money or other resources?
FEWFOODS	Since adopting CA, was there a time when you ate only a few kinds of foods because of a lack of money or other resources?

SKIPPED	Since adopting CA, was there a time when you had to skip a meal because there was not enough money or other resources to get food?
ATE LESS	Still thinking about the last 12 MONTHS, was there a time when you ate less than you thought you should because of a lack of money or other resources?
RANOUT	Since adopting CA, was there a time when your household ran out of food because of a lack of money or other resources?
HUNGRY	Since adopting CA, was there a time when you were hungry but did not eat because there was not enough money or other resources for food?
WHOLE DAY	During the last 12 MONTHS, was there a time when you went without eating for a whole day because of a lack of money or other resources?

52. Please indicate the extent to which you agree or disagree with these statements.

(Put a tick (✓) where appropriate).

1= strongly agree, 2=agree, 3=neither agree or disagree, 4= disagree, 5= strongly disagree

Statement	**1**	**2**	**3**	**4**	**5**
Since adopting CA, I have experienced increased food availability					
Since adopting CA, I have experienced more food varieties					
Since adopting CA, I have been able to cater for school fees for my children					
Since adopting CA, I have been able to cater for medical costs for family members					

Thank you for your time.

Appendix III: Interview Schedule For Leaders of Farmer Groups

1. How long have you been practicing CA?
2. How long have you been a leader of this group?
3. How frequent do you meet as a group?
4. Do you think that your members have been able to understand all the principles of CA?
5. How do the other occupations the members engage in benefit the CA farming?
6. Do you think that the poverty levels of your members have reduced since they embraced CA?
7. Do you think that your members incur less labour cost on their CA farms?
8. Do you think that the members using mulch save on the amount of water used for watering crops?
9. Do you think that the use of CA farm equipment has minimized the time members spent preparing their land?
10. Do you think that crop rotation has led to application of fewer fertilizers for your members?
11. Do you think that the output levels for your members have improved since they adopted CA?
12. Has the output from members been affected by pests since they adopted CA?
13. Which marketing arrangements have your members adopted?
14. To what extent do you think the training offered to your members has enabled them to embrace CA principles?
15. To what extent do you think farm visits have encouraged your members to embrace CA?
16. Do you think food supply for your members has increased since they adopted CA?

Thank you for your time.