The applicability of Conservation Agriculture for the small-scale farmers in Sub-Saharan Africa: A case study from Laikipia, Kenya

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Abstract

Conservation Agriculture (CA) has been promoted as an alternative farming practice for achieving sustainable production intensification in sub-Saharan Africa (SSA) since the 1990s. CA has three principles of 1) minimal soil disturbance; 2) permanent soil cover; and 3) species diversification. While these principles are advocated to generate agronomic, economic and environmental benefits, uptake of CA is very limited in spite of decades of promotion in SSA.

In order to examine the applicability of CA for small-scale farmers in SSA, this study focuses on the dissemination process of CA. The study particularly analyses the 1) promoters and its dissemination approach; 2) adoption process into conventional farming system; and 3) sustainability of the practice. A case study approach was employed which consists of a questionnaire survey and key-informants interview as a mixed method research. The field research was conducted in Laikipia, Kenya, with the involvement of 54 questionnaire survey respondents and 12 key-informants who are the stakeholders of the CA projects implemented in the area.

The results from the survey and interviews, supplemented by literature shows that the CA in Laikipia has been actively promoted by donor-led projects, which are implemented by the local extension services of the county government. One of the main approaches was the on-farm experimentation which also functions as demonstration plots for a farmer field school (FFS). The activities were conducted on the basis of groups, which received input package for the management of demonstration plot as well as training and
backstopping. In addition, there has been increasing attention to Innovation Platform (IP) which tries to integrate different stakeholders into the promotion process with an aim of bringing new innovation and solutions.

The results from the case study have identified the detailed process of adoption and dis-adoption of CA practice in Laikipia. The major constraints for the implementation of CA was mulching material and CA equipment, as they were also pointed out by the literature. There has been ongoing adaptation toward these constraints such as the use of cover crops and introduction of fodder crops. There also has been local fabrication of CA equipment which was developed and promoted though the IP of the projects. This CA equipment is now widely used by adopter farmers as they are locally available and specifically tailored to the smallholders. In terms of sustainability, the dis-adopter farmers had constraints in getting information and training which can be reflected to the project design. Furthermore, the use of input in a package for promoting CA needs to be carefully re-examined for further promotion of CA.

Overall, the case study provides insights into the further dissemination of CA for the small-scale farmers, although care is needed for generalization in a larger context. The study suggests that the local adaptation process is a key in the promotion of CA, which is in line with Agricultural Innovation System (AIS) approach. Thus, there needs to be consideration of the involvement of different stakeholders as well as the degree of farmer’s participation in the project design and implementation.

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<td>Agricultural Innovation Systems</td>
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<td>Conservation Agriculture</td>
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<td>FAO</td>
<td>Food and Agriculture of the United Nations</td>
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<td>FFS</td>
<td>Farmer Field School</td>
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<td>IP</td>
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Chapter 1  Introduction

1.1 Introduction

This chapter brings a series of introductory descriptions to all the chapters of the dissertation, including the background of the study, its justification, research objective, research questions, and the dissertation structure.

1.2 Background and Justification

The world population is estimated to expand from the current 7.6 billion to 9.8 billion in 2050 (UN, 2017). This population growth is especially conspicuous in Africa which is predicted to at least double in 26 countries by 2050 (ibid). Given the rapid population growth, it is expected to increase food production in order to meet the demand. In addition, the food crisis in 2008 heightened the concern and interest in increasing food production (Pingali, 2012). However, it is a challenging situation as most of the farmers in Africa are small-scale, and the agricultural land is limited for further expansion (Netting, 1993). Thus, there is a strong need for agricultural transformation which focuses on production intensification.

On the other hand, there have been a growing concern and an international commitment for sustainable agricultural development. The Sustainable Development Goals (SDGs) explicitly states the promotion of sustainable agriculture under the Goal 2 with a specific target at 2.4 which states that “by 2030 ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters, and that progressively improve land and soil quality” (FAO, 2018a). As climate change has become a high magnitude global concern,
building a resilient production system has become a key issue. Sustainable Intensification (SI) is the similar concept which intends to enhance food production while maintaining other ecosystem services, including resilience to the stock and stresses such as climate change (Vanlauwe et al., 2014).

In Sub-Saharan Africa (SSA), the Conservation Agriculture (CA) has been advocated by international development agencies to promote sustainable agricultural intensification since the mid-1990s. CA seeks to enhance soil fertility through the practice of three principles which work complementary with each other; 1) minimum mechanical soil disturbance; 2) permanent soil organic cover; and 3) species diversification. According to the Food and Agriculture Organization of the United Nations (FAO), CA has multi-dimensional advantages such as Economic Benefit (reduced inputs, costs and labour), Environmental Benefit (reduced soil erosion, increased biodiversity and contribution to carbon sequestration) and Agronomic Benefit (soil moisture and soil structure retention) (FAO, 2018b). Research has shown that CA practice can contribute to the sustainable production intensification and enhancing food securities (Pretty, 2008).

In fact, the global distribution of CA has been increasing from 106 Mha in 2008-2009 to 157 Mha in 2013-2016 (Kassam et al., 2015). However, the adoption rate of CA in SSA is still remaining low. The global share of CA for Africa is currently 2%, accounting for 2.7 Mha in the year 2015-2016 (Kassam et al., 2017), which is in contrast to other continents such as North America for 69.9 Mha, South America for 63.2 Mha, Australia and New Zealand for 22.7 Mha and Asia for 13.2 Mha (ibid). It has been more than two decades since research and development investment for CA in Africa has been promoted, though it is reported that success has been limited (Corbeels et al., 2014; Kassam, 2009).
1.3 Objective and Research Questions

The objective of the research is to examine the applicability of CA for the small-scale farmers in SSA by focusing on its dissemination process. The study will firstly overview general situation in SSA, then later focus on one area in Kenya to draw some implications upon SSA. The ultimate goal of the study is to gain implication for the dissemination of CA practice in achieving sustainable agricultural development. There are three key research questions which attempt to respond to the objective;

1) By whom is CA promoted and what approaches have been used for the dissemination?
2) How has it been integrated into the conventional farming system? What influences the adoption?
3) Is the practice sustainable? What influences the dis-adoption or local adaptation?

1.4 Methodology

The research is composed of a combination of literature review and field research conducted in Kenya. The literature review covers the overview of the CA in SSA presented in Chapter 2, as well as review of relevant theories and concepts presented in Chapter 3. The case study which in chapter 5 is the detailed study of the topic at Laikipia in Kenya. The case study will be conducted by a combination of qualitative and quantitative mixed-method. The methodology for the case study will be further explained at Chapter 4.
1.5 Dissertation Structure

Following Chapter 1, Chapter 2 gives a general overview of the CA in SSA, with present figures on CA area, countries, promoters, approaches and technologies. It also discusses some of the main debates for and against CA practice in SSA, particularly for small-scale farmers. Chapter 3 reviews some of the theoretical and conceptual framework of agricultural research and development, with evolution of the concepts up to date. Those frameworks will be used in the discussion within the final chapter. Chapter 4 will be the description of methodology applied for the field study conducted in Laikipia, Kenya. Then Chapter 5 presents the result of the case study, which includes questionnaire survey and key-informant interviews. Chapter 6, as a final chapter, discusses the result of the case study in relation to the three research questions, and leads to the conclusion of the study.
Chapter 2  An Overview of CA in SSA

2.1 Introduction

This chapter provides a general overview of the current practice of CA in SSA, by summarising the present state, promoters, dissemination approach and technologies. The chapter also contains debates on CA over its applicability for the small-scale farmers in SSA.

2.2 An Overview of CA in SSA

CA is the agricultural production system which is based on three principles: 1) Avoiding or minimizing soil disturbance; 2) Maintaining a permanent mulch cover with organic matter; and 3) Diversification of species through rotation/association. CA is not a single practice, but three principles interlinked and simultaneously functioning with each other (Mkomwa et al., 2017a). There has been renewed attention to CA as it is demonstrated as one of the climate smart agriculture (CSA) options (FAO, 2013; Mkomwa et al., 2017a; Richards et al., 2014; Schaller et al., 2017).

The initial concept of reducing tillage and keeping soil covered was introduced to United States (US) after the dustbowl devastated in the 1930s. It was in the 1960s in US and 1970s in Brazil that no-tillage became farming practice, although it took another 20 years to reach significant adoption level in these countries (Kassam et al., 2015). As Figure 1 shows, the total land area under CA has been increasing worldwide, mainly led by North and South America. CA in Africa accounts for only 2.0%, which is placed second from the last on the basis of the continents. Recent figures, however, shows that there has been more than doubling growth in Africa, from 1.2Mha in 2013/14 to 2.7 Mha in 2015/16 (Kassam et al.,
2017). As Figure 2 represents, the highest share is South Africa (30%), followed by Zimbabwe (27%), Zambia (16%) and Mozambique (12%). The implementing countries are located mostly in East and Southern Africa where the major farming systems are maize-mixed and agropastoral (Dixon et al., 2001) as Figure 3 shows.

![Figure 1 Area of annual cropland under CA by continent](image_url)

Source: Kassam et al. (2017)
**Figure 2** CA area in Africa as a percentage of the total 1.2 Mha in 2013/2014

Source: Kassam *et al.* (2015)

**Figure 3** Major Farming Systems in SSA

Source: Dixon *et al.* (2001) Note: 9=Maize mixed, 11=Agro-pastoral
2.3 Promoters in SSA

The introduction and promotion of CA started in the middle 1990s, with the initiative of the FAO, in partnership with national governments, NGOs, and research and development partners (Mkomwa et al., 2017a). Since then, CA has been actively advocated through various projects and programmes funded by donors such as IFAD\textsuperscript{1}, EU\textsuperscript{2}, NORAD\textsuperscript{3}, DIFID\textsuperscript{4} and GIZ\textsuperscript{5}. There are also numbers of international NGOs implementing CA projects as part of their programme, which include CONCERN Worldwide, Canadian Food Grains Bank and CARE international among others. In addition, there are several national level organizations promoting CA such as Conservation Farming Unit (CFU) in Zambia, Kwa-Zulu Natal No-till Association in South Africa, and Foundation for Development in Zimbabwe (ibid). African Conservation Tillage Network (ACT) is a Pan-African regional body actively promoting CA since 1998, acting as regional coordination of CA promotion.

2.4 Approach

As CA has been promoted by international development organizations, the main approach of CA dissemination has been the implementation of projects, which usually have short-term time boundaries. The main focus of the initiatives can be classified under the following categories; 1) food security and livelihood development; 2) technology development for sustainable production; and 3) advocacy for public and private support (Mkomwa et al., 2017a). At the project level, a participatory approach has been used for smallholder farmers.

\textsuperscript{1} International Fund for Agricultural Development
\textsuperscript{2} European Union
\textsuperscript{3} Norwegian Agency for Development Cooperation
\textsuperscript{4} Department for International Development (UK)
\textsuperscript{5} German Development Cooperation
to adopt and up-scaling CA which includes Farmer Field School (FFS), Lead Farmer Network and No-Till CA Associations. Furthermore, where mechanization is developed, a service provider model or a group ownership approach may be introduced (ibid).

There has been growing attention and the creation of platforms for promoting CA at subnational, national and regional level. The first Africa Congress on Conservation Agriculture was conducted in 2004 with aims to bring together stakeholders across different sectors at all levels to enhance multi-disciplinary and cross-sectoral development of CA. The second congress will be held in 2018 with much focuses on CA for CSA, which is in line with the Malabo Declaration, African Union’s Agenda 2063 and the SDGs (Africa Congress on Conservation Agriculture, 2018) With regard to the policy, the New Partnership for Africa’s Development (NEPAD) programme was established by the African Union (AU) in 2001. Within that, CA has been incorporated into the regional agricultural policies of NEPAD (Mkomwa et al., 2017a).

2.5 Technologies

CA is promoted by three interlinked principles of minimum/no tillage, permanent soil cover, and crop rotation/association. The technology and equipment used in CA are based on these principles. The main operation can be classified as land preparation, planting and weeding stages.

At the land preparation stage, CA avoids inversion tillage, instead uses such techniques as ripping, sub-soiling, planting basins or deep-rooted cover crops to remove problems associated with compacted soil, hard pans, ridges and fallows (IRR and ACT, 2005). At the planting stage, farmers use different tools depending on the farming system and the levels
of mechanization. A study in Kenya shows that, 66% of households used hand hoes for the planting basin, machete for 50%, ox ripper furrows for 20% and Jab planter\(^6\) for 6% (Muriuki \textit{et al.}, 2012). In relations to the planting, cover crops are widely applied in areas with bimodal or higher rainfall in order to cover the open space as much as possible. In areas with monomodal or lower rainfall, they tend to rely on residues from high biomass production (Mkomwa \textit{et al.}, 2017b). One of the common cover crops used are pigeon pea, dolichos lalab, cowpea, desmodium and lucerne among others (ibid). The choice of cover crops depends on their agronomy, combination to the main crops and utilization. The weed management is conducted by no-till, manual shallow weeding, cover crop, and the used of herbicide.

Unlike in North and South America where the majority of the CA farmers are large-scale equipped with mechanization, most of the farmers in Africa is small-scale, and unmechanized (Sims \textit{et al.}, 2017). Thus, CA equipment industry in Africa is still at its initial stage. Given the successful development of smallholder CA equipment in Brazil, some equipment was imported into Africa, and equipment manufacturers were exposed to and trained in Brazil, through donor-funded projects (ibid), while other projects have promoted initiatives to develop locally manufactured equipment for small-scale farmers.

\(^6\) A CA equipment to make planting holes and deposited seeds and fertilizer at one operation (FAO, 2010)
2.6 Current Debate over the CA in SSA

2.6.1 How does CA benefit?

CA has been advocated so as to increase profitability and soil fertility for small-scale farmers in SSA (Corbeels et al., 2014) since the 1990s. In recent years, CA has been gaining more attention in contributing to climate change mitigation (Kassam et al., 2009; Corbeels et al., 2014). Despite the efforts and benefits advocated by the promoters, the adoption rate of CA in SSA still remains low (Kassam et al., 2009). There are many researches debating its benefit and constraints.

One of the key arguments against CA is that it is not suitable for, nor benefiting the resource-poor small-scale farmers who constitute the majority of farmers in SSA. A number of studies have analysed the impact of CA by comparing the contribution of each principle and the combination of those principles. Corbeels et al. (2014) who conducted meta-analysis of CA in SSA concluded that minimum/no tillage without mulch and/or rotation leads to a more depressed yield than conventional tillage practice, while minimum/no tillage with mulch gives a higher yield than the conventional practice. Similarly, global meta-analysis conducted by Pittelko et al. (2015) shows that conservation tillage (minimum tillage) reduces yield compared to conventional tillage, although the negative impact is minimized when the other two principles are combined. Tambo and Mockshell (2018) concluded that adoption of CA practice in combination rather than isolated is more strongly related to the increase of household income. Although many studies similarly claim the importance of three principles practiced simultaneously to maximize the benefit, the implementation of full practice is often challenging for the resource-poor, small-scale farmers, which led to the debate on the impact and sustainability of CA in SSA (ibid).
In addition, it has been argued that the benefit of CA is site specific (Giller et al., 2009), despite it having been advocated that CA fits in different climate and soil environments for a wide variety of crops (Kassam et al., 2014). Numbers of studies report that CA has an advantage in yield in drier climates (Rusinamhodzi et al., 2011; Pittelkow et al., 2015). Furthermore, those benefits of CA tend to be realized in the long-term, thus it may not be acceptable for small-scale farmers who are concerned with immediate cost and return (Giller et al., 2009).

2.6.2 Does CA benefit the small-scale farmers?

While CA is a set of practices under three principles as mentioned earlier, there are discussions addressing the constraints for the farmers to implement full practices. One of the major constraints is the lack of crop residue as mulching materials. Mulching contributes to reducing water runoff and infiltration (Thierfelder and Wall 2009). While this increased moisture retention capability gives benefit especially in semi-arid regions (Kronen, 1994; Bationo et al., 2007), there are trade-offs that farmer face with traditional usage of crop residue such as fodder, fuel or construction materials (Giller et al., 2009; Naudin et al., 2014). Small-scale farmers are particularly in short supply of fodder due limited land size and limited common grazing land (Giller et al., 2009). Given the importance of livestock such as for food, manure, traction, insurance and investment, small-scale farmers give priority for fodder than for mulching (ibid).

Another major discussion for the limitation of full practice is weed control, which is in the principle of minimum/no tillage. In a conventional system, weeds are controlled by tillage practice such as uprooting, dismembering and buring (Chauhan et al., 2012). Therefore, no
tillage commonly results in increased weed pressure (Kayode and Ademiluri, 2004; Giller et al., 2009), and the ineffective weed control is a major deterrent to the adoption of CA (Chauhan et al., 2012). In terms of labour requirement, CA may outweigh the labour needed for weeding compared with labour saved by not ploughing (Giller et al., 2009). In addition, the study shows that it increases the labour demand for females (ibid). As a result, many studies suggest that the use of herbicide is a reasonable solution to this (Hobbs, 2007; Chauhan et al., 2012; Rockstrom et al., 2009).

The use of chemical fertilizer is also considered as another important management factor in promoting CA (Rusinamhodzi et al., 2011; Thiefielder et al., 2013). The meta-analysis conducted in SSA demonstrates the increase in crop yield for CA systems in response to the chemical fertilizer application (Corbeels et al., 2014). However, theis practice which relies on inputs are the subject of debates. Wall (2017) claims that CA is not the low-input system as promoted, but the benefit is in the more efficient use of input. Gowing and Palmer (2008) argues that CA may not spread among smallholders in Africa, but CA is more likely to be adopted by resourceful farmers who have access to herbicides and fertilizers.

2.6.3. Why farmers stop practising CA?

The temporary adoption of CA or dis-adoption has been reported and discussed as part of CA adoption processes. Giller et al. (2009) questions the “adoption” of CA where there are many cases that adoption claimed during the active promotion of programmes, but not sustained after, due to the temporary influence brought by the incentives (food, input). In detailed study, Grabowski et al. (2016) reported 25% of dis-adoption for minimum tillage (MT) practice by cotton farmers in eastern Zambia. He questions that while many studies attribute dis-adoption to the discontinuation of the subsidized or free input incentives, the
largest group of adopters in Zambia have adopted MT without receiving any incentives. The study summarizes that removal of incentives is less important for dis-adopter than challenges related to labour and equipment access. Another study conducted in Zimbabwe on determinants of abandonment of CA, reveals key factors associated with dis-adopter such as human capital, asset endowment, institutional aspects, and agro-ecological variables (Pedzisa et al., 2015). It also indicated that there is a strong, negative relationship between CA abandonment and continued NGO support which suggests the need for continuous institutional support(ibid). These dis-adopter studies give insights for reflecting on more appropriate interventions with regards to CA promotion.
Chapter 3  Review of Relevant Theories and Concepts

3.1 Introduction

This chapter reviews literature on theories of agriculture innovation and how they have evolved over time, in order to reflect on them in examining approaches used for the dissemination of CA in SSA.

3.2 Evolving Theories

The perspectives on agricultural research and development (R&D) has been significantly changing from conventional linear perspective to more complex and innovative one (Spielman, 2006). The new paradigm has emerged as a counterpart to what has been the dominant paradigm, which can be classified as Transfer of Technology (ToT) and which emerged in the 1960s; was particularly influential in the 1960s and 1970s but still informs some policymakers and practitioners today. Other theories have developed since the 1960s, the main ones being Farming System Research (FSR) which emerged in the 1970s, the Agricultural Knowledge and Information System (AKIS) in the 1990s and Agricultural Innovation System (AIS) in the 2000s (Klerkx et al., 2012). The AIS paradigm has different perspectives on what constitutes innovation and where the innovation takes place compared to ToT. Innovation is often regarded as new technology or new procedures. However, following the Leeuwis and Ban de van (2004, p.12), innovation in this study, it is considered in much broader sense as “new or adapted human practices, including the conditions for such practices happen”.
3.3 Adoption and Diffusion Model

3.3.1 Transfer of Technology (ToT)

National Agricultural Research System (NARS) is a system which includes all the entities within a country that are responsible for agricultural research and maintenance of its natural resource (ISNAR, 1992). The NARS framework has been the mainstream of agricultural development planning since the 1960s. The assumption that underlies this approach is that the agricultural research leads to the technology adoption and growth in productivity through the technology transfer (Hall et al., 2007). This ToT model is also called “linear model”, “pipeline model” or “technology supply push” and assumes that the innovation takes place at public agricultural research centres, and the new technology is transferred to and taken up by the farmers. This approach was mainly used for commodity crops with the development of improved varieties (Hall et al., 2007; Darnhofer et al., 2012).

The Green Revolution is such a case, which aimed at improving the yield of staples such as rice, maize and wheat, through the application of high yielding varieties (HYVs) often associated with the use of fertilizer, herbicide and irrigation (Potter et al., 2008). These new HYVs were transferred from international research centres to national government programmes for further adaptation and dissemination (ibid). As a result, the use of modern varieties achieved 82% in Asia by 1998 (Pingali, 2012), contributing to increased productivities and food security in the region. The ToT model has contributed enormously in developing research capacities and transformation of food production (Hall et al., 2007).
On the other hand, ToT has faced criticisms for its linear approach. Green Revolution as an example, with the attempt to generate yield increase in Africa with the same approaches as in Asia, did not succeed despite the initiatives taken during the 1970s to 1980s (AGRA, 2017). The result was low adoption of modern varieties at 27% by 1998 (Pingali, 2012). The technologies delivered to Africa were not appropriately modified for the location-specific context, where the complex cropping patterns under diverse agroecological condition exists (Potter et al., 2008). The limitation of the ToT approach is the research being not effectively connected to the end users and other stakeholders in the sector. This makes farmers not adopt the technology offered because the promoted “solution” did not address the real needs of the farmers (Darnhofer et al., 2012). It is also characterized as commodity-oriented, laboratory and on-station based research, as well as top-down extension schemes (ibid). Although this mode has been widely criticised, it still continues to be the dominant thinking in planning and implementation of research and extension services.

3.3.2 Adoption Process under the Diffusion of Innovation Theory

There have been extensive studies on how and why people adopt or do not adopt new technologies since 1950s (Leeuwis and van den Ban, 2004). The Diffusion of Innovation Theory developed by E.M. Rogers emerged in the 1960s and it is often associated with ToT thinking. Based on the time it takes for individuals to adopt new innovation, he categorised the adopters into five groups; Innovator (2.5%), Early adopters (13.5%), Early majority (34%), Late majority (34%) and Laggards (16%). This adoption process is expressed as an S shape curve, as it shows the pattern for the rate of adoption. The
theory also indicates that there is a sequence of stages thorough which people progress which is listed at Table 1.

Although this perspective is widely used in many sectors, it has been subject to many criticisms. There is a “pro-innovation bias” that the innovation is worthwhile for the farmers to adopt, thus people are taken as “Laggards” if not taking up the innovations. Another criticism is that the model is based on linear and top-down modes of thinking (Leeuwis and van den Ban, 2004). Thus, the role of farmers in the innovation process was taken as not worthwhile and overlooked (Röling, 1994).

**Table 1 Stages in adoption process**

<table>
<thead>
<tr>
<th>Order</th>
<th>Stages</th>
<th>What happens in practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Knowledge</td>
<td>About existence of a new innovation or policy measure</td>
</tr>
<tr>
<td>2</td>
<td>Persuasion</td>
<td>Shaping attitude under the influence of others</td>
</tr>
<tr>
<td>3</td>
<td>Decision</td>
<td>Adoption or rejection of the innovation or policy measure</td>
</tr>
<tr>
<td>4</td>
<td>Implementation</td>
<td>Adapting the innovation and putting it into use</td>
</tr>
<tr>
<td>5</td>
<td>Confirmation</td>
<td>Seeking reinforcement from others for decision made, leading to continuation or discontinuation</td>
</tr>
</tbody>
</table>


**3.4 Farming System Research (FSR)**

Farming System Research (FSR) has emerged after the 1970s, as an alternative approach to overcome the planning capacity of agricultural research and technology transfer (Darnhofer et al., 2012). The FSR broadens scale of farm into a farming system where
there are interactions among natural, social and economic contexts. Thus, this approach focuses on system thinking and interdisciplinarity (ibid), which involves farmers, natural scientists, social scientists, and more recently extension personnel and policy makers to identify constraints and needs of farmers that are particular to their farming system. It aims to increase efficiency through the provision of package of interventions which involves on-farm testing and modification of technologies (Lalani et al., 2017). The criticisms for this approach include the poor focus on resource-poor farmers as well as weak communication between farmers and researchers (ibid).

3.5 Agriculture Knowledge Information System (AKIS)

As a counterpart of previous models, Agriculture Knowledge Information System (AKIS) emerged in the 1990s. This approach addresses the shortcomings of conventional agricultural research and extension system, and tries to overcome it by linking various actors to generate, share and use the technology, knowledge and information (Hall et al., 2007). In this approach, farmers are perceived at the centre of the knowledge system, and information and knowledge are communicated between various actors in rural areas. However, one weakness of this approach is the restriction of actors in the rural environment, such as limited involvement of private sector, or policy framework (ibid).

3.6 Agriculture Innovation System (AIS)

Agricultural Innovation System (AIS) is the latest concept which emerged in the 2000s. Innovation system can be explained as something that “comprises the organizations, enterprises and individuals that demand and supply knowledge and technologies, and the policies, rules and mechanisms which affect the way different agents interact to share,
access, exchange, and use” (Hall et al., 2007, p.5). Hall et al. (2007) characterize the innovation system approach as more systematic, interactive, institutional and evolutional.

The AIS approach has becoming increasingly applied in analysing the transformation of agriculture (Hall et al., 2006; Spielman et al., 2008, Klerkx et al., 2010) In AIS, innovation is seen as the results of the interaction and networking among heterogenous actors such as researchers, farmers, development agencies, private sectors, and other organizations (Klerkx et al., 2010). AIS is also regarded as Complex Adaptive Systems (CAS) (ibid) whose characteristics are summarized at Table 2.

Hall et al. (2006) also summarized the similitudes and differences between ToT approach and AIS in developing countries as presented in Table 3. They emphases that the continuous process of innovation is a key in the present world, to be effectively adapted to the rapid changing situations. In other words, the “collective intelligence” which involves various stakeholders is needed, in order to mobilize knowledge and continuously innovate to cope with the changes. Klerkx et al. (2009, p. 8) points out an importance of intermediary organizations whose role is to “build appropriate linkages in innovation systems, and facilitate multi-stakeholder interaction in innovation”, which they call “innovation brokers”. However, the challenge arises as to who takes those roles, as well as how to stimulate their emergence, which involves policy support (ibid). Spielman (2006, p.46) also argues that there is limitedness in methodology as well as application of the framework for understanding how innovation occurs or how to design mechanisms that strengthen AIS in developing countries. In addition, Sumberg (2005) questions the use of an innovation system framework to create a formal system based on coordinated hierarchies among national and supranational organizations, describing it as an
unresponsive, supply-driven system which does little to encourage technological change in SSA.

**Table 2** Comparison of the traditional approach with a recent complexity-aware approach

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Linear approach</th>
<th>Complexity-aware approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>“Transfer of technology” or “pipeline”</td>
<td>“Agricultural innovation systems”</td>
</tr>
<tr>
<td>Era</td>
<td>Central since 1960s to present</td>
<td>From 2000s to present</td>
</tr>
<tr>
<td>Mental model and activities</td>
<td>Supply technology to next user</td>
<td>Co-develop innovation involving multi-actor processes and partnerships</td>
</tr>
<tr>
<td>Knowledge and disciplines</td>
<td>Single discipline driven (mainly plant breeding)</td>
<td>Transdisciplinary, holistic systems perspective</td>
</tr>
<tr>
<td>Drivers</td>
<td>Supply-push from research</td>
<td>Responsiveness to changing contexts, patterns of interaction</td>
</tr>
<tr>
<td>Source of innovation</td>
<td>Scientists</td>
<td>Multiple actors, innovation platforms</td>
</tr>
<tr>
<td>Role of farmers</td>
<td>Adopters or laggards</td>
<td>Partners, entrepreneurs, innovators exerting demands</td>
</tr>
<tr>
<td>Role of scientists</td>
<td>Innovators</td>
<td>Partners, one of many responding to demands</td>
</tr>
<tr>
<td>Key changes sought</td>
<td>Benefits accruing from technology adoption</td>
<td>Institutional change, increase in system capacity to innovate</td>
</tr>
<tr>
<td>Dynamic</td>
<td>Research begins quickly according to a pre-defined agenda</td>
<td>Intervention begins by building relationships and trust through an open research agenda</td>
</tr>
</tbody>
</table>

Source: Douthwaite and Hoffecker (2018)
Table 3 Comparison between agricultural research systems and Agricultural Innovation System (AIS) in developing countries

<table>
<thead>
<tr>
<th>Institutional features</th>
<th>Agricultural research systems</th>
<th>AIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guiding agenda</td>
<td>Scientific</td>
<td>Sustainable and equitable developmental</td>
</tr>
<tr>
<td>Role of actors</td>
<td>As researchers only</td>
<td>Multiple and evolving</td>
</tr>
<tr>
<td>Relationships involved</td>
<td>Narrow, hierarchical</td>
<td>Diverse, interactive</td>
</tr>
<tr>
<td>Partners</td>
<td>Scientists in agricultural research organisations and other public agencies such as universities</td>
<td>Evolving coalitions of interest. Various combinations of scientist, entrepreneurs, farmer and development workers from the public and private sectors</td>
</tr>
<tr>
<td>Policy focus</td>
<td>Narrow related to agricultural research and agriculture and food policy Disconnected from other policy domains</td>
<td>Broad also inclusive of trade, rural development, industry, environment, education. Integration and coordination between many policy domains</td>
</tr>
<tr>
<td>Policy Process</td>
<td>Disconnected from actors and knowledge in research system</td>
<td>Integrated with actors and knowledge and sensitive to agendas in innovation system</td>
</tr>
<tr>
<td>Knowledge produced</td>
<td>Codified Technical/scientific</td>
<td>All forms of codified and tacit knowledge: Scientific, technical, organisational, institutional, marketing and managerial</td>
</tr>
<tr>
<td>Indicators of performance</td>
<td>Short term: scientific publications, technologies and patents Long term: patterns of technology adoption</td>
<td>Short term: institutional development and change / new behaviours, habits and practices/patterns of linkage Long term: social and economic transformation</td>
</tr>
<tr>
<td>Responsibility for achieving impact</td>
<td>Other agencies dedicated to extension and technology promotion</td>
<td>All partners in innovation systems</td>
</tr>
<tr>
<td>Capacity development</td>
<td>Trained scientists and research infrastructure</td>
<td>• Training and infrastructure development related to a range of research and economic activities and people • Policies, practices and institutions that that encourage knowledge flows, learning and innovation among actors in innovation system</td>
</tr>
</tbody>
</table>

Source: Hall et al. (2006)

3.7 Short Conclusion

The chapter explored theories and concepts which are relevant to CA in SSA. It has shown that the paradigm has been shifting from linear to more complex innovation systems. These different paradigms have influenced policy and practice. Thus it gives an analytical framework to an innovation system, the roles of different actors within it and adoption and dis-adoption with regard to CA.
Chapter 4  Methodology for Field Research

4.1 Introduction

Building on the previous chapters, the following Chapter 5 will be focusing on one area in Kenya to draw a detailed explanation of the CA dissemination process. In this Chapter 4, methodology for the field research in Kenya will be explained, covering the method for data collection and data analysis.

4.2 Methodology

The main method applied for the field research is case study. Yin (2014) describes the scope of the case study as “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-world context” (Yin, 2014, p.16). In other words, case study is relevant when “how” and “why” questions are asked on contemporary events, which a researcher does not have control over. In order to investigate the process of CA dissemination for the small-scale farmers in SSA, the application of case study is effective in bringing in-depth information in its contexts. Although, case study is not without its own problems, as much care is needed for the “observer biases” such as the selectivity of the information or generalization of the result (McQueen and Knussen, 2002). Mix method research is the combination of quantitative and qualitative research methods into a single study (Johnson et al., 2007). The benefit of having both quantitative and qualitative methods is to triangulate the result as well as compensate the weakness of each approach (Johnson et al., 2007; small, 2011).
4.3 Selection of the Case
Among the countries practicing CA is Kenya where the research was conducted. CA has been widely adopted in Eastern and Southern Africa (see Figure 3 Chapter 2) where Kenya is located, with strong focuses on cereal production, particularly maize (Mkomwa et al., 2017b, p41). The selection of the case in Kenya was made in consultation with ACT where the author conducted an internship. Laikipia is selected for the case as 1) it has long history of CA project intervention including the one ACT conducted for most recently; and 2) representation of maize based crop-livestock farming system at semi-arid area.

4.4 Selection of the Respondents
4.4.1 Questionnaire
The questionnaire survey was conducted from 18 to 21 June 2018 in Laikipia East sub-county. The respondent farmers were selected from the existing CA4FS group list. A random sampling method was applied for selecting respondents. The 100 farmer groups were categorized into three locations(wards) which they belong to, then six groups were randomly selected from each location (18 groups in total). Furthermore, three farmers were randomly selected from each group, which makes up a total number of 54 farmers. For the purpose of my study, farmers who did not adopt CA (non-adopters), were excluded from the selection process, based on information given from extension officers of the local area. The questionnaires are separately made for adopter and dis-adopters and being listed at the Appendix 1 and Appendix 2.

Conservation Agriculture for Resilient Food Security and Profitability in Machakos and Laikipia Counties of Kenya
4.4.2 Key-Informant Interview

The key-informants were selected from the key stakeholders of CA4FS by consultation with ACT project staff. The 12 key-informants include two project officers, one agriculture extension officer, six CA adopter farmers, two CA dis-adopter farmers and one CA service provider. The farmers were selected with consideration of geographical coverage, gender and representation of local small-scale farmers. The interviews were conducted by semi-structured qualitative interview whose content has relevancy to the questionnaire survey. The key interview questions are listed at the Appendix 3.

4.5 Translation and Enumerators

The questionnaire survey was conducted with the support of three enumerators who were two young CA farmers and a university student. Interviews were conducted partially through translation, with Kiswahili and English, by a local female person who has extensive knowledge of CA. The enumerators and the translator were appointed by agricultural extension officers. The questionnaire and the glossaries of key terms were sent to the enumerators in advance, and a half day of briefing was provided at the beginning of the field research. During the survey, enumerators occasionally received assistance from ACT staff on translation of technical terms.

4.6 Research Procedure

4.6.1 Pilot-test for Questionnaire Survey

The pilot-test for the questionnaire was conducted at one of the selected project sites in Muranga County with arrangement support from a local NGO. The questionnaire was preceded by interviewing two farmers (both genders), currently practising CA, using
prepared survey questions. Based on the results of the pilot-test, the contents and format of the questionnaire were revised.

4.6.2 Field Research

The field research was conducted from 18 June to 22 June for five days at three wards in Laikipia East sub-county. The brief schedule is listed below at Table 4.

**Table 4** Schedule for the field research conducted in Laikipia, Kenya

<table>
<thead>
<tr>
<th>Date</th>
<th>AM</th>
<th>PM</th>
<th>Questionnaire survey by enumerators (total 54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 June</td>
<td>Move to Nanyuki, Laikipia</td>
<td>Briefing to the extension officers and enumerators. Interview for the extension officer (1) and project staff(1) Courtesy visit to the chief officer at the county government</td>
<td></td>
</tr>
<tr>
<td>19 June</td>
<td>Interview for the farmer in Ngobit (1)</td>
<td>Questionnaire survey by enumerators (total 54)</td>
<td>Interview for the farmer in Ngobit (1)</td>
</tr>
<tr>
<td>20 June</td>
<td>Interview for the farmer in Tigithi (1)</td>
<td></td>
<td>Interview for the farmers in Tigithi (2)</td>
</tr>
<tr>
<td>21 June</td>
<td>Interview for the farmers in Umande (2)</td>
<td></td>
<td>Interview for the farmer in Umande(1) Interview for the CA service provider in Umande (1)</td>
</tr>
<tr>
<td>22 June</td>
<td>Move to Nairobi</td>
<td>Collection of Questionnaire</td>
<td>Interview for the project officer at Thika, Kiambu (1)</td>
</tr>
</tbody>
</table>
4.7 Data Analysis

For the questionnaire survey, the data was transformed to SPSS, by classifying into three data files; 1) adopters; 2) dis-adopters; and 3) mixed-data of adopters and dis-adopters. The results were analysed using descriptive statistics, including chi-square, to test the frequency distribution and statistical significance. The interviews were recorded with the permission of the respondents and notes were taken during the field research. Afterwards, the transcriptions were made from the records, then analyses were conducted by identifying the themes as well as with in-depth description. The themes were identified and analysed with integration of descriptive statistic from the questionnaire as well as previous literature review for determining the consistency of findings.

4.8 Limitations

Due to the time and budgetary constraints, the field research was conducted within five days, including travelling days from Nairobi to Laikipia. Therefore, the sampling number for the questionnaire survey is relatively small, considering the total number of farmers benefiting from the project. In addition, the respondents for dis-adopters are limited to 10 which needs care at the representation of the results.
Chapter 5  Case Study of CA project in Laikipia, Kenya

5.1 Introduction
This chapter presents the result of field research conducted at Laikipia in Kenya. The questionnaire survey and key-informant interview, together with overview of the area derived from literature, explains CA dissemination process in detail, including the promotors and its approach, integration into the existing farming system, and dis-adoption and adaptation of CA practices.

5.2 The Study Area
5.2.1 General Characteristics of the Study Area
Laikipia is one of the 47 counties in the Republic of Kenya, located 200 km north of Nairobi (Figure 4). It covers an area of 9,462 km², and is the 15th largest county in the country. According to the Kenya Population and Housing Census (GOK, 2010), the total population of the county was 399,277, of which 198,625 were males and 200,602 were females. The county has large population of youth, with more than half of the population being below 35 years old. The total population is estimated to increase up to 479,072 by 2017 as of 2009 census.
As Figure 5 shows, Laikipia is subdivided into three sub-counties which are Laikipia East, Laikipia North and Laikipia West. Laikipia East and Laikipia West have a denser population than Laikipia North. The county is administratively further divided into 15 wards as Table 5 shows. The field study was conducted at Laikipia East sub-county, targeting three wards of Ngobit, Tihithi and Umande among five. The headquarters of Laikipia East sub-county is Nanyuki.
Figure 5 Location of Three sub-counties in Laikipia

Source: County Government of Laikipia(n.d.)

Table 5 Area, number of wards and population of three sub-counties

<table>
<thead>
<tr>
<th>Sub-county (Constituencies)</th>
<th>Area (km²)</th>
<th>No. of wards</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laikipia East</td>
<td>1448.2</td>
<td>5</td>
<td>142034</td>
</tr>
<tr>
<td>Laikipia West</td>
<td>12579.5</td>
<td>6</td>
<td>224431</td>
</tr>
<tr>
<td>Laikipia North</td>
<td>5434.3</td>
<td>4</td>
<td>32762</td>
</tr>
</tbody>
</table>

Source: Adapted from County Government of Laikipia (2018)

According to the Household Baseline Survey in Laikipia, the annual mean temperature ranges from 16°C to 21°C, experiencing average annual rainfalls between 400mm to 750mm (ASDSP, 2014) (Table 6). The seasonal distribution of rainfall is affected by the Northeast and South trade winds, the Inter-Tropical Convergence Zone (ITCZ) and the
Western wind. The long rainy season normally occurs from March to May while the short rainy season occurs in October to November. Because of being in the rain shadow of the Mt Kenya ranges, the county experiences generally unreliable, inadequate and unevenly distributed rainfall (Apina et al., 2007).

Table 6 Mean annual rainfall in millimetres at Nanyuki, Laikipia

<table>
<thead>
<tr>
<th>Year</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall in Nanyuki (mm)</td>
<td>857.5</td>
<td>727.9</td>
<td>699</td>
<td>732.5</td>
<td>590</td>
<td>719</td>
</tr>
</tbody>
</table>

Source: Adapted from County government of Laikipia (2018)

5.2.2 Agricultural Sector in Laikipia District

Agriculture is the dominant economic activity in the county followed by tourism which mainly relies on wildlife viewing. There has been conflict between wildlife and agriculture, as animals damage crops. According to the 2014 Household Baseline Survey, more than 60% of the population rely on their livelihood on agriculture, contributing 75% of the household incomes in Laikipia.

Influenced by the climatic conditions and ecological zones, there are mainly five distinctive land uses in the county; pastoralism, mixed farming, ranching, agropastoralism and marginal mixed farming. The greater part of the communal ranches have declined with the emergence of new private ranch ownership, especially after the 1990s (Apina, et al., 2007). Immigrants from neighbouring populated area have also settled,
accounting for about 70% of the adult population in the county (Bachman, 1995).

The average land size for a household is two acres for the small-scale holders while it is 20 acres for large-scale holders (ASDSP, 2014). The main crops grown in this area are maize (*Zea mays*), bean (*Phaseolus vulgaris*), potato (*Solanum tuberosum*), and horticultural crops such as cabbage and tomato. Wheat, barley and horticultural crops are mostly grown by large scale farmers, which contributes to the production of the county being higher than neighbouring counties. Most of the small-scale farmers make subsistence living based on cropping and small-scale livestock production (Apina, et al., 2007). The market for agricultural produce is underdeveloped owing to the poor physical infrastructure, except for medium and large-scale farmers who have established a market chain (ibid). The main livestock raised are cattle, chicken, sheep, goat, camel, donkey and pig.

Laikipia is prone to frequent weather changes, including major droughts recurring every four to five years. The latest drought was in 2016 which affected crops severely. The average yield of maize dropped to 0.2 ton/ha compared to the previous year of 1.4 ton/ha (Figure 6) There have been various efforts to mitigate the effect of drought, including promotion of drought resistant crop varieties, CA, water harvesting, introduction of high value small livestock such as rabbits, poultry and bees (Laikipia County Government, n.d.).
Figure 6 Maize yield(ton/ha) from 2012 to 2017

Source: Adapted from County government of Laikipia (2018)

5.3 Project Overview

The section describes the projects conducted in Laikipia in order to analyse the CA dissemination process, with the responding objective of identifying the promoters and their dissemination approaches.

5.3.1 Overview of the CA projects conducted in Laikipia

In Laikipia, CA was initially practised by large scale farmers who mainly grow wheat and barley. Small-scale farmers encountered CA though various donor-funded projects after
the 1990s. The techniques of conservation tillage\(^8\) were introduced by international and national organization such as Kenya Agricultural Research Institute (KALI), the Regional Land Management Unit (RELMA) based at the World Agroforestry Centre (ICRAF), FAO, the Kenyan Network for Draught Animal Technology (KENDAT), the International Livestock Research Institute (ILRI), and the Kenya Rainwater Harvesting Association (KRA). The NGOs together with KENDAT worked with various farmers’ groups for adoption of conservation tillage and draught-animal technology from 1997 to 1998. (Apina, \textit{et al.}, 2007).

The recent interventions include CA-SARD (Conservation agriculture for sustainable agriculture and rural development and food security in Southern and Eastern Africa), which was started in Kenya and Tanzania in 2004, followed by ABACO(Agro-Ecology Based Aggradation- Conservation Agriculture Project) which targeted semi-arid region of six countries in Africa in 2011, CA4CCFS (Up Scaling Conservation Agriculture for Increased Resilience to Climate Change and Improved Food Security in Eastern and Southern Africa) in 2012 and CA4FS (Conservation Agriculture for Resilient Food Security and Profitability in Machakos and Laikipia Counties of Kenya) in 2013. The most recent intervention is the IPP-GAP (Increased Productivity and profitability of small holder farmers through promotion and up-scaling of CA-GAP and Agribusiness in productive semi-arid area of Kenya) implemented by FAO in 2015. Table 7 summarize

\(^{8}\) Conservation tillage is “any tillage and planting system that covers 30 \% or more of the soil surface with crop residue, after planting, to reduce soil erosion by water” (Conservation Tillage Information Center, 2012)
the basic information of those projects. There are also several CA projects conducted by NGOs, such as CARITAS, TIST, CETRAD and Ol Pejeta Conservancy. Due to the limitation in obtaining information, they will not be analysed in this study.

**Table 7 CA projects conducted in Laikipia**

<table>
<thead>
<tr>
<th>Project</th>
<th>Year</th>
<th>Funder</th>
<th>Implementor</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-SARD</td>
<td>2004-2006</td>
<td>German Trust Fund</td>
<td>FAO, MoA, ACT</td>
<td>5 districts in Kenya, 6 districts in Tanzania</td>
</tr>
<tr>
<td>ABACO</td>
<td>2011-2015</td>
<td>EU</td>
<td>MoA, ACT</td>
<td>Semi-arid areas of East (Kenya, Tanzania), West (Mali Burkina Faso) and Southern (Zimbabwe, Mozambique, Madagascar) Africa</td>
</tr>
<tr>
<td>CA4CCFS</td>
<td>2012-2014</td>
<td>Norad</td>
<td>MoA, ACT</td>
<td>Kenya, Tanzania, South Sudan and Zimbabwe</td>
</tr>
<tr>
<td>CA4FS</td>
<td>2013-2016</td>
<td>AGRA</td>
<td>MoA, ACT</td>
<td>2 Counties of Kenya</td>
</tr>
<tr>
<td>IPP-GAP</td>
<td>2015-2018</td>
<td>EU</td>
<td>MoA, FAO</td>
<td>9 Counties in Kenya</td>
</tr>
<tr>
<td>Others (NGOs)</td>
<td>various</td>
<td>various</td>
<td>Ol Pejeta Conservancy, TIST, CARITAS, CETRAD</td>
<td>Laikipia County</td>
</tr>
</tbody>
</table>

Source: Table created by author based on project documents (FAO, 2007; ACT, n.d; ACT, 2014; Mkomwa et al., 2017c; FAO, n.d.)

### 5.3.2 Main Characteristics of the Projects

CA-SARD was a part of a scaling-up project of a previously conducted pioneering project sponsored by RELMA from 1998 to 2002. One of the main characteristics of the CA-
SARD was promotion of CA through FFS (FAO, 2007). The FFS was implemented through at least one acre of “group learning plot” in which farmers exercise various ranges of CA practices. There were 10 groups involved in the project, conducting weekly activities based on their plot. The project has also engaged with various stakeholders, particularly promoting interaction between large-scale and small-scale farmers to share the experience of CA, as the large-scale farmers had been conducting CA for more than three decades. However, the small-scale farmers who have adopted CA were minimal at this point, limited to a few groups and resourceful farmers (Apina, et al., 2007). The project was continued by CA-SARDII from 2007 to 2010.

ABACO targeted seven semi-arid counties in Africa. The project was built on the results of CA2AFRICA project which analysed conditions needed for successful CA adoption in Africa. It has created location specific Co-Innovation Platforms which aimed to create innovation through interaction among various stakeholders. Through the Co-Innovation Platform approach, the project conducted training, workshop, on farm experimentations actively including both genders of farmers, public sectors, private sectors, such as agro-dealers, equipment manufacturers and agro-processors (ACT, n.d). The project employed FFS approach, targeting 250 farmers from 10 groups.

CA4CC focused on development and strengthening of platforms and infrastructure on a larger scale. Some of the outcomes of the projects are the creation of CA centres of excellence (public research and training institute), CA communities of practice (information and knowledge sharing platforms at national and sub-national level, and web-based information sharing system and the first Africa Congress on Conservation
Agriculture which was held in Zambia in 2014 (ACT, 2014).

CA4FS had wider coverage in Laikipia, involving 109 farmers’ groups across the county. The main activity was the on-farm research trials. The trials were conducted at 12 researcher-designed and farmer-managed “mother” demonstration plots, and 100 farmer-researcher designed, farmer-managed “baby” demonstration plots which were set up at farmers’ fields. The mother demonstration plots experimented six different types of treatments while at baby demonstration plots, each group chose three treatments among six. The groups were not obliged to meet on regular basis. Farmers’ trainings were low in intensity compared to previous projects due to the wide coverage of the groups. One of the outputs was the development of small-holder CA equipment which was conducted in collaboration with stakeholders. (Mkomwa et al., 2017c).

IPP-GAP, CA is promoted together with other Good Agricultural Practices (GAP) such as use of appropriate seed varieties, timely planting and correct fertilizer application. It also focused on value chain approach, by developing marketing activities in collaboration with private sectors (FAO, n.d.). The Table 8 shows the main approach used in each project, and Table 9 is the main characteristics of three projects in comparison.

**Table 8** Main approach used for the three selected projects

<table>
<thead>
<tr>
<th>Project</th>
<th>Main approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-SARD</td>
<td>FFS methodology for group learning and knowledge-sharing</td>
</tr>
<tr>
<td>ABACO</td>
<td>Co-Innovation Platforms for multi-directional knowledge transfer</td>
</tr>
<tr>
<td>CA4CCFS</td>
<td>Knowledge and information platform</td>
</tr>
<tr>
<td>CA4FS</td>
<td>Researcher-designed and farmer-managed type of on-farm</td>
</tr>
</tbody>
</table>
experimentation

| IPP-GAP | CA as a basis of Good Agricultural Practices (GAP), Agribusiness approach |

Source: Table created by author based on the project documents (FAO, 2007; ACT, n.d; ACT, 2014; Mkomwa et al., 2017c; FAO, n.d.)

**Table 9** Table Comparison of the characteristics of the projects

<table>
<thead>
<tr>
<th>Main Activities</th>
<th>ABACO</th>
<th>CA4FS</th>
<th>IPP-GAP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inputs provided by the project</strong></td>
<td>To each group; Fertilizer (planting, top dressing), Bean seeds, Dolicos seeds, Pigion peas, Maize seeds, Potatoes seeds, Butter beans seeds, Herbicides, Insecticides</td>
<td>To each group; Fertilizer (planting, top dressing), Bean seeds, Dolicos seeds, Pigion peas, Cow peas, Maize seeds, Sorghum seeds, Mucuna seeds, Butter beans seeds, Herbicides, Insecticides</td>
<td>To each group; DAP fertilizer, CAN fertilizer, Bean seeds (KAT X56), Sorghum seeds, Desmodium seeds, Herbicides, Insecticides, Fungicides, Others; Tractor drawn no-till</td>
</tr>
<tr>
<td><strong>Main Activities</strong></td>
<td>Demonstration plots, On farm experimentations (FFS), Farmer training, Field days, Stakeholders CA Information sharing workshops, National task force meeting, CA communities of Practice, Project Website</td>
<td>Demonstration plots, Forum, On farm experimentations, Farmer group training, Lead farmer Training, Workshops, Field days, Farmer to farmer training, Exhibitions, Training to Extensions officers, Training to service providers</td>
<td>Demonstration plots (FFS), Master trainers training, Trainers of Farmers (ToF) training, Training of farmer, Training of CA service provider, Training of Agribusiness mentors, Extension officers training</td>
</tr>
</tbody>
</table>
To each group; Jab planters, Shallow weeders, Animal drawn planters, Animal drawn ripper

To each group; Jab planters, Shallow weeders, Animal drawn ripper, Hand Ripper

precision planters (2), Animal drawn planters (12), Knapsack sprayers (75), Jab planters (50), Shallow weeders (100), Animal drawn rippers and sub-soilers (30)

<table>
<thead>
<tr>
<th>Characteristics of FFS</th>
<th>Regular basis (once a week)</th>
<th>Not on regular basis (decided by each group)</th>
<th>Regular basis (once a week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of demonstration plot</td>
<td>7 demonstration plots, choice of different cover crops application under no till practice</td>
<td>112 demonstration plots, up to 6 different treatments, comparing till, fertilizer, mulching effects</td>
<td>240 demonstration plots</td>
</tr>
<tr>
<td>Targeted number of groups and farmers</td>
<td>250 farmers from 10 groups</td>
<td>109 groups 8000 farmers reached</td>
<td>240 groups 7200 farmers targeted 120 ToF</td>
</tr>
</tbody>
</table>

Source: Table created by author based on the project documents (FAO, 2007; ACT, n.d; ACT, 2014; Mkomwa et al., 2017c; FAO, n.d.) and information from the interviews

5.4. Results from the Interview and Questionnaire

The overall objective of this section is to find out how CA has been adopted or dis-adopted, by looking at the farmers’ practices and perspectives on CA.

5.4.1 Results from the Questionnaire Survey

The questionnaire survey was conducted in three wards in Laikipia East sub-county,
targeting 54 farmers who were randomly selected from CA4FS participants. The result is described by adopter, dis-adopter and the comparison of both groups.

**(1) General Figure of the Respondent Farmers**

Among the total respondents, 38.9% are male and 61.1% were female. The age varies from 26 to 78, with average of 55 years old. As for the educational level, 44% are at primary level and 35% are at secondary level. The average number per household is 4.34 people, which consist of 2.19 males and 2.15 females. The average number in a household who are constantly working on the farm is 2.07, which is constituted by 0.91 male and 1.17 female.

The most common crops grown are maize, beans and potatoes. 72% of the respondents sell their produce occasionally, while 15% rarely sell their produce. The average land size of farm is 4.33 (median 2.38) acres, of which 2.38 (median 2.0) acres are currently under cultivation. The average ownership of the land is 1.69 acres out of 2.38 acres. All the respondent households keep livestock, with an average number of 3.22 cattle (median 2), 28.23 chicken (median 8), 13.42 sheep (median 6) and 4.38 goat (median 1). 94% of the respondents obtain feed for their livestock from the crop residue, while green hedge is 1.9%, purchased feed is 27.8%. 31.5 % who responded “others” have specified it as grazing.

As Figure 7 shows, 83.3% of the respondents have participated in CA4FS which was implemented from 2013 to 2016. 57.4% who have responded as “others” specified that they have been involved in IPP-GAP by FAO as well as other projects conducted by
NGOs such as Ol Pejeta Conservancy, CALITAS, TIST and CETRAD. 55% of the respondents have experience of participating in more than two projects.

![Participation for different projects by respondents in percentages (N=54)](image)

**Figure 7** Participation for different projects by respondents in percentages (N=54)

### (2) CA practice by Adopters

Among 54 respondents, 44 are currently practicing CA while 10 have stopped the practice at some point. The average land size for the CA adopters is 4.67 (median 2.5) acres, 2.38 (median 2) acres of which is under cultivation. The average area under CA is 1.93 (median 1.88) acres, within which 1.45 (median 1.25) acres are owned by the households itself. The smallest area for CA is 0.25 acre while the largest was 7 acres. The average length of CA practice is 4.87 (median 4) years, since 86.4% of respondents have participated in CA4FS since 2013.

Figure 8 shows CA practice applied by respondent adopters according to each principle. As for minimum/no tillage, ripping is conducted widely (88.6%), followed by hand hoe
Pitting (47.7%). Shallow weeding is commonly practiced (81.8%), while herbicide is also used by more than half (63.6%) of the respondents. As for the permanent soil cover, most of the respondents use both cover crops and crop residue, although cover crops are slightly higher (95.5%) than crop residue (86.4%). As for the third principle, crop rotation is commonly practiced (86.4%), followed by intercropping (70.5%). Mixed cropping and relay cropping are relatively low.

Figure 8 Percentage of respondents adopting each of practice under the three CA principles (N= 44)

Figure 9 shows each equipment used by the respondents in different stages of cultivation under CA. At the land preparation, hand ripper is widely used (88.6%), followed by hand hoe (43.2%). On the other hand, animal traction and machinery are at low level. “Others” (22.7%) are specified as using traditional tools such as “panga”. At the planting stage, hand hoe is the highest used at (45.5%), followed by jab planter (29.5%) and “Others” (25%) which was specified as traditional tools on “jembe”. The use of CA equipment,
such as jab planter and direct seeder is at low adoption. At the weeding stage, a shallow weeder is widely used (88.6%) even though it is a recently promoted CA tool within several projects. The knapsack sprayer for herbicide application is also widely used (68.2%).

**Figure 9** Equipment used at different cultivation stages by respondent adopters in percentages (N=44)

Figure 10 shows benefits which respondents recognized through CA practice. Most recognized the benefit of CA in given multiple aspects. The lowest was the input incentives (75.5%) which may be because the inputs and tools were distributed to the group demonstration plots, but not the individuals. Earlier planting (84.1%) is the second to the last, as some of the area experience frost damage at the early planting season.
In connection with the previous question, Figure 11 shows the time it took for the respondents to recognize the benefit of CA. 36% responded that they have recognized the benefit within one year (two crop seasons), while the rest (64%) found it in more than one year and up to four years. All the respondents have increased the area under CA over time, and answered that they strongly intend to continue CA.
Figure 11 Time taken for recognizing the benefit of CA for respondent adopters in percentages (N=44)

(3) CA Practice by Dis-adopters

Among the total of 54 respondents, 10 (18.5%) have answered that they have tried CA, but stopped. The average land size for dis-adopters is 2.86 (median 2.13) acres, and CA land was 0.63 acre (median 0.25). The average length of the CA practice was 2.4 (median 1.5) years, ranging from 0.5 to 5 years.

Figure 12 shows the main reasons for stopping CA. The highest was lack of CA equipment (60%), while weed was not recognized as problem associated with dis-adoptation of CA. This may be due to the fact that 80% of respondent dis-adopters used herbicide under CA practice (Figure19).
Figure 12 Main reasons for stopping CA for respondents dis-adopter in percentage (N=10)

Most of the respondents have answered that they have recognized the positive impacts of CA while they were practicing it. As Figure 13 and Figure 14 show, 89% respondents observed increased yield and 90% respondents observed improved soil quality under CA practice. As a consequence, 70% observed negative changes after stopping CA as Figure 15 shows. The negative impacts were specified as a decrease in crop yield, tiresome with normal cultivation, wilting of crops, increased farming cost and decreasing in soil quality.
**Figure 13** Changes in yield under CA practice observed by dis-adopter respondents in percentages (N=10)

- Increased yield: 89%
- Decreased yield: 11%
- No change: 0%

**Figure 14** Changes in soil under CA practice observed by dis-adopter respondents in percentage (N=10)

- Improved soil quality: 90%
- No change: 10%
- Reduced soil quality: 0%
Figure 15 Changes observed after stopping CA by respondents dis-adopters in percentages (N=10)

The Figure 16 shows factors which would have helped respondents dis-adopters to continue CA. The highest need was on the training (80%) followed by CA equipment, input incentives, technical support, and information (all 50%). The majority of these needs corresponded to the reasons for stopping CA shown in Figure 12.

Figure 16 Factors which would have helped to continue CA in percentages of dis-
(4) Comparison between Adopters and Dis-adopters

1) Initial Reason

Figure 17 shows initial reasons of starting CA for adopters and dis-adopters. The biggest difference among the two groups was on gained confidence from the trial, which shows a statistically high significant difference ($X^2 = 7.420$, $p = 0.006$). The other statistically significant difference among two groups was the reduced soil erosion ($X^2 = 4.531$, $p = 0.034$). On the other hand, there was no statistically significant difference between two groups on input incentive as well as to be in the project. This may be explained by the fact that input was provided only to group demonstration plots but not to the individuals.

**Figure 17** Comparison of initial reasons of starting CA between respondent adopters and dis-adopters by percentages (Adopters N=44, Dis-adopters N=10)
2) **Decision Making**

The initial decision for starting CA in a household was made by a female adult by 63% and a male adult for 37% among all the respondents which respond to the participation rate of the project. Figure 18 shows the support respondents received from when starting CA. The extension officers were the highest among others for both adopters and dis-adopters. Dis-adopters had higher percentage for choosing members of the CA group than adopters, while adopters had higher percentage for choosing other farmer outside the group compared to the dis-adopters. The only statistically significant difference was on the support from project staff ($X^2=5.479$, $p=0.019$). Because the CA4FS covered relatively wider areas of county with limited project human resources, the interaction between farmers and the project side had limitations, which also implies that the support and interaction with the project staff has effects on the continuity of practice for the farmers.

![Bar chart showing support received in decision making]  
**Figure 18** Comparison of support received in making decision to start CA between adopters and dis-adopters.
respondent adopters and dis-adopters by percentage (Adopters N=44, Dis-adopters N=10)

3) Inputs

Figure 19 shows input used before CA (under conventional), and after starting CA (under CA), for adopters and dis-adopters. Looking at the comparisons of inputs between the two groups under conventional practice, the only significance difference was the use of manure ($X^2=6.168$, $p=0.013$); adopters used more manure than dis-adopters. When it comes to the CA practice, the use of CA equipment was the only statistically significant difference ($X^2=10.370$, $p=0.001$); adopters use CA equipment more than dis-adopters. Another tendency found for both groups is that the percentage for the use of inputs tends to increase with association with CA. For the adopters, herbicide has increased by 43.2%, pesticides by 29.5%, improved seeds by 15.9% and chemical fertilizer by 15.9%. For the dis-adopters, herbicide has increased by 20%, pesticides by 20%, and improved seeds by 30%.
Figure 19 Comparison of input used under conventional practice and CA practice between respondent adopters and dis-adopters by percentages (Adopters N=44, Dis-adopters N=10)

4) Difficulties

Figure 20 shows the difficulties respondents faced with CA practice. The highest figure was an access to the CA equipment, followed by mulching materials, both for adopters and dis-adopters. Marketing of produce ($X^2=6.284$, $p=0.012$) where adopters faced more difficulties, and understanding from the family ($X^2=4.880$, $p=0.027$) where dis-adopters faced more difficulties, were the statistically significant differences found between the
two groups.

In connection with the difficulties, Figure 21 shows how those difficulties were dealt with the respondents. For the adopters, the most common way was to consult with extension officers (79.5%) followed by consultation with other farmers (68.2%). For the dis-adopters, consultation with other farmers was the most common practice (80%); whereas consultation with extension offices was not widely practiced (50%) compared to the adopters. The statistically significant difference among two groups was the consultation with CA service provider ($X^2=3.895, p=0.048$) which may due to the difference between two groups with regards to the length of practice and CA land size which gives favour to the adopters for having CA service provision.

![Figure 20](image_url)

**Figure 20** Comparison of difficulties faced with CA practice between respondent adopters and dis-adopters by percentages (Adopters N=44, Dis-adopters N=10)
Comparison of ways of coping with difficulties between respondent adopters and dis-adopters by percentages (Adopters N=44, Dis-adopters N=10)

5) Information and Support

Figure 22 shows the comparison of support received during and after the project, for adopters and dis-adopters. During the project implementation, more adopters responded that they have received necessary information and support than dis-adopters, although there is not a statistically significant difference. On the other hand, there is a clear statistical difference between two groups after the completion of the project ($X^2=10.568$, $p=0.014$). 60% of dis-adopters responded that they did not receive necessary information and support, whereas it was 13.6% for the adopters for after the project completion.
Figure 22 Comparison of information and support received during the project implementation and after the completion of the project between respondent adopters and dis-adopters by percentages (Adopters N=44, Dis-adopters N=10)

5.4.2 Results from the Key-Informant Interview

In this section, five key-informant interviews are presented by description of adopter, dis-adopter, service provider and project staff. The purpose of this section is to provide detailed information on the process of dissemination from different perspectives of stakeholders, in order to further analyse how CA practice has been integrated into or dis-adopted in the existing farming system.
(1) Female Adopter’s Perspective

The informant female farmer is currently cultivating five acres of land under CA with her husband who joined her after retirement from employed work. The initial contact to CA was in 2009, when the agricultural group she belonged to, was involved in a CA project. The project encouraged interaction with large-scale CA farmers in the area. The group received a chance for CA service provision at low cost from the large-scale CA farmer who possessed planting and spraying machinery. The cost for planting was 300Ksh\(^9\)/acre, spraying herbicide for 150Ksh/acre, which was only needed to cover the cost for the operators but not for fuel and machinery. She took the opportunity and started CA on three acres of the land they owned. However, that result was far from a success, as they received little harvest under CA for two seasons. She recalls the experience as;

You know people got discouraged. You know the area, it was really big. If the tractor goes to sit for water, it is still there maybe for a month. When it comes to this area, the rain has gone. So you didn’t get anything. That is how thing corrupted. I got discouraged. When you needed a tractor, you cannot get it, at the right time. Here, you know we do timing. We do plant dry planting, wait for the rain to come when the seeds and whatever you have done with everything. But If the rain comes, and it goes, and then you plant, that is when the crops fail.

Through not being able to make timely planting, the harvest was poor for two seasons. Then she decided to go back to the “normal tractors” as most of the group members did. Then in 2012, the Ministry of Agriculture started a new CA project as a part of National Agriculture Livestock Extension Programme (NALEP). Because “agricultural extension

\(^9\) Kenyan shiling
"officer was available, and information was near” at this time, she started CA again with a member of a different group. She began this time with a small plot of 10m x 10m, as a trial for two seasons based on past failure experience. The plot was “easy to manage”, and she could compare CA area with other parts of conventional area, finding that the CA plot had results better than the conventional. In terms of equipment, she used traditional tools such as slasher and panga for the land preparation, jembe for preparing hole, and panga for weeding (Figure 23, 24, 25).

In 2013, CA4FS project was started, and she joined the project through a group. She offered a part of her farm land for a demonstration plot for the group members. The group received inputs for the demonstration plot from the project such as maize seed, dolicos seeds for cover crop, fertilizer, herbicides and pesticides. The group members received demonstration training on how to use a hand ripper and a shallow weeder (scraper) which were newly developed CA equipment by the project. She compares CA4FS with previous ones as;

Like now, after 2013, we come up with a ripper, we come up with a scraper. That’s the time the smaller farmer benefitted. Because you can do your work. You don’t need a tractor. If it is strain, it is you who is going to be the work.

Within her group, all the 13 members started CA, and five are still continuing while eight members have stopped after two seasons. She observes that women in her group were prone be out, because of difficulties in convincing their husbands. It was not the case for her as her husband was an employed worker, thus she was “the manager of the farm”. Now her husband has joined CA after his retirement and is contributing the fabrication of
hand rippers with expertise from his previous job.

**Figure 23** Traditional tools of panga (left) and jembe (right)

**Figure 24** Locally fabricated hand ripper
(2) Male Adopter’s Perspective

The informant male adopter farmer started CA in 2013 with CA4FS. He is currently conducting CA on 3/4 acre, out of two acres of the land. He is partially practicing CA, because the rest of the land is cultivated by his son, who practices conventional agriculture.

CA was introduced to him by an extension officer through the group he belonged to. The group was established in 2011 before the project started, for the purpose of supporting community welfare services. Among the 30 members, five people have started CA in 2013 and two have stopped by the end of the project in 2016. He observes the other member’s dis-adoptions as follows;

*The transition was so hard for them. They could not follow instructions, like, doing a crop cover, mulching, and proper tools. Because you see, many people who are doing farming is above 50, not young people. So unless it make works easier, it is so hard for them to accept.*
In 2015, another project by FAO has launched. He again participated in the project, with members of a newly established group particular to this project. At this time, two out of 10 members have stopped CA after a while. He describes the reason of dis-adoption as;

They don’t follow instructions. If you are told not to mix crops at their shamba, they don’t want. They’re just mixed with other crops. But CA needs this one, you plant maize and the crop cover. But we Africans, we just plant about five plants at the same time, in one shamba.

For his case, production at the beginning under CA was not so high as he expected. He produced two bags/acre (90 kg/bag) with conventional practice, and increased by one more bag under CA for the initial year in 2013. The production has now increased up to 12 bags/acre in 2017, by using certified seeds for maize and beans, manure, fertilizer, ash and herbicide. For the land preparation, he mainly uses a hand ripper, and sub-soiler every three years. When at planting stage for maize, he uses jembe to make pits, then places one maize seed in each pit, covering soil with a panga. After planting maize, selective herbicides are applied when weeds start to germinate. After a few weeks later, beans or sometimes sweet potatoes are planted in between the maize for intercropping. He uses a shallow weeder for the second weeding. He now expands his knowledge on CA to other crops as well;

If you are taught everything, by the time you are practising, even yourself you can fit according to how you see. Because like me, I was taught how to plant maize, and after sometime, I just plant even potato. I was using just CA by the time. So

10 Farm land
whenever you are doing anything, you must, even yourself, use your brain. So you can introduce anything, even if you are not taught.

He has also experimented on the germination percentage of maize in his farm plot, to confirm what he was taught by the project was right or not at the end. He found that the germination rate was 16% higher when he planted maize seeds two to three days after the rain, rather than planting before the rain comes. He has also modified the shallow weeder, by putting extra weight on the steel part so that the operation becomes easier.

(3) Female Dis-Adopter’s Perspective

The informant farmer has 3/4 acre of land, cultivating together with her son who joined her in agriculture in 2015. She keeps one cattle and 27 chickens, and the manure is applied to the farm at the land preparation stage. She was practicing CA between 2014 to 2015 for two years, taking part in CA4FS.

In 2014, at the first year of the project, she immediately started CA on a small part of her land, beside the demonstration plot. She had tried three different applications using 10m x10m plot for each. The applications were; 1) conventional tillage plus fertilizer; 2) minimum tillage plus fertilizer; and 3) minimum tillage plus manure. She recognized that the CA with fertilizer produced the highest yield, which was so high that other farmers came to see her plot as part of field visit activities.

The following year in 2015, she increased the CA plot to 1/4 of her land. She experimented four different applications, by adding minimum tillage without manure/fertilizer, in addition to the previous year’s three applications. The region experienced
severe drought in this year, but she recognized that CA with fertilizer still performed the
best among others.

It was in 2016, that she stopped CA as she had to return the CA plot back to his son who
started farming himself. She did not apply CA at other parts of the land, as they were
already farmed in a conventional way. She thought that it is difficult to practice CA where
she had mixed cropping. What she has been taught and practised with CA was maize
intercropped with dolicos, which does not need much effort for weeding because dolicos
spread widely on the ground. But when it comes to beans for example, the weeding
becomes much more of a problem with less soil coverage. In addition, she understood
that the beans can be planted after six months if the selective herbicides are applied to the
maize. Because of these limitations she assumed, she preferred conventional practice
which does not give limitations for practising mix-cropping.

She is currently practising mixed cropping of maize, beans, peas and potatoes. She
conducts oxen tillage for the land preparation, pitting holes for planting, and hand pulling
for the weeding. She still continues crop residue retention and crop association/rotation,
but she feels she is out of CA as long as she tills. She thinks that more training on the use
of herbicides as well as how to conduct farming without chemicals would help her to
return to CA.

(4) Service Provider’s Perspective
The informant CA service provider is an experienced farmer. He has won a competition
on oxen tillage held in Laikipia, and has been involved in various CA projects since its
initial stage in 1998. After receiving much training on CA, including farm mechanization, through the projects, he started providing CA service to other farmers in 2005. He recalls of facing many constraints until recent years when the business atmosphere improved. As a pioneer, he perceives current business situation which has an increasing number of CA service providers as follows;

Because like me, when I was doing training, I lost a lot of time. But because of the passion, I was consistent to do the training. But you know who came after me with the equipment like I have, and a very good opportunity to penetrate without a lot of constraints.

He thinks that until recent years, there was a resistance from county government. The main services he offers now are planting legumes and grains, spraying for pest and weed control, as well as consultancy to the farmers. He covers five villages in Laikipia East sub-county, having a total number of about 350 farmers who are constantly using his service. He has numbers of youth clients with whom he operates through mobile phones and computers. He established his biasness in this way;

Normally what I do is I consolidate the business. I have my contact people there on the ground, contact people to the farmers who will work for me under commission. Now the group leaders can organize a job for me. Then I can go and do the job survey. Then consolidate that survey. I know this week I will be area A, next week area B, to minimize the running cost. Because if you are running one acre, two acres, the end of the day, you get very little. Operation corridor is a bit narrow. That is where we involve the organization. You must be organized.

He has seven contact persons across five villages, who will gather the orders from farmers
for him. Usually, the commission is 50Ksh/acre, depending on the type of services. Other than the contact person, he sometimes asks chiefs and church pastors for the advertisement for his services. He originally started the CA service with oxen, but now uses two-wheel tractor. His next step is to shift to four-wheel tractors;

*Now issue is the coverage. The customers are increasing but I am unable to serve all of them. So I am now forced to give other service providers by opportunity, which is not very good. Because now the small tractor I have, can do only five acres in a day, planting, two-wheels. Spraying, I can do that 10 to 15 acres per day.*

The number of service providers in Laikipia is increasing. There are more than 50 service providers he recognizes. Some start the business and others are shifting from conventional service to CA service providers.

(5) **Project Staff’s Perspective**

The informant project officer joined the CA4FS in 2013, soon after the project was started. One of the main activities of the project was the demonstration plot which experimented with different types of CA and non-CA treatments. There were 112 demonstration plot which is consisted of 12 “mother-demo” managed by KALO with full treatment, and 100 “baby-demo” managed by farmers’ groups where farmers could choose three treatments out of six. A total of 109 farmers’ groups were involved in this activity, through hosting the demonstration plot, choosing the treatments and collecting data. The result of the demonstration plots came to be; 1) minimum tillage with residue plus fertilizer had the highest yield; and 2) minimum tillage with residue plus manure resulted the best in terms of cost-benefit analysis. The project also developed CA equipment, such as hand rippers
and shallow weeders in order to accelerate small-scale farmers’ adoption of CA though creating a platform;

As part of project, you are supposed to be innovations into the CA, especially in the area of mechanization. So we brought in these small-holder equipment, which are cheap and affordable to most of the farmers. Remember we normally have forum for service providers, we sit down with them, those forums, and the technicians were invited into meetings, then we come up with the ideas. Then we come up with the product eventually, which is now convenient for the smallholder farmer.

The project tried to involve various stakeholders, both public and private sectors. One of the important stakeholders was the CA service provider. He emphasizes that;

That is the biggest voice. In fact, if you want to promote Conservation Agriculture, the service provider is the key person in promotion. Because he is the person who decides the better practice they are going to use, especially when it comes to tillage. If a service provider comes with a plough, he will convince you that this is the best equipment, but if he comes with a ripper, this is the person who can be able to convince the farmer more. So the service providers are very capable as far as the promotion of new technologies.

The extension officers were other key stakeholders. During the project implementation, 10 extension officers were assigned to six wards, for supporting the management of demonstration plots, collecting data and providing training;

Before we started the project, we trained all the extension officers. Because if you want the technology to be adopted, it might be adopted by those who are living in
the villages and who are extension officers. If they are not adopted the technologies, which they are telling the farmers to adopt, then to have a negative effect for adoption. So we started training them, and we actually ensure that the number all of them, especially those who are in the project. We monitored whether they are practising and telling farmers to do.

The project had a close relationship with the county government because of the interactions made by previous projects. The county leader had also encouraged the extension officers to participate in the project. He thinks that the CA service provider and the extension officers are the key for the sustainability of the project. In addition, he thinks that it is important to have a policy on CA in extension programmes so that the officers do not bring conflicting messages to the farmers regarding tillage and no-tillage.

5. 5 Summary of the Results

The purpose of this section was to integrate results from literature, questionnaire survey and key-informant interviews. The county has been continuously exposed to CA project intervention since 2004 by the donor-funded projects. The main approach used was on-farm experimentation, demonstration plots, FFS and backstopping on the basis of group activities. From the questionnaire survey, it is found that the majority (81.5%), of the farmers are still continuing CA, although 18.5% have dis-adopted at some point. The practice of CA, including initial reasons, benefits, challenges were summarized and compared for adopters and dis-adopters in section 5.4.1. The key-informant interview in section 5.4.2 provides further details in explaining the process of adoption and dis-adoption, by adding more context. Furthermore, it provides different perspectives on CA by different stakeholders so as to understand the dissemination process in the area with
much broader perspectives. In the following final chapter, the result of the case study will be discussed under the key themes which lead to the conclusion of the study.
Chapter 6 Discussion and Conclusion

6.1 Introduction
This final chapter discusses key findings from the case study, which will lead to conclusions and the implications regarding the applicability of CA for small-scale farmers in SSA. The chapter finishes with addressing limitation of the study and implications for future research.

6.2 Discussion of Key Findings

6.2.1 CA Promotion and Dissemination Approach

(1) CA Promotion in Laikipia
CA in Laikipia has been promoted mainly through donor-funded projects since 2004. The main implementors includes MoA (national research centre, county extension service) in collaboration with ACT and/or FAO. The projects were implemented by the extension officers to the farmers’ groups, in which they were already involved for other purposes. The main activities for disseminating CA are demonstration plots, FFS, training, field visits and technical backstopping, that are carried out on the basis of the groups. The number of groups involved in each project are increasing (Table 9 in Chapter 5), although some groups have been involved in various projects. As presented in Chapter 5, CA group members play an important role from the initial stage of supporting decision making on starting CA for others (Figure 18), to the implementation stage of consultation on the difficulties with CA(Figure 21).

The latest GAP-IPP conducted by FAO applies ToF as one of dissemination approach
which enables it to cover larger numbers of groups with limited project resources. As listed in Table 9 in Chapter 5, demonstration plot and FFS has been the main activities. Although the treatment measures applied vary among projects, the purpose of demonstration was common. The CA4FS reports it as “the project disseminated and imparted CA options through the use of scientifically validated trials and demonstrations (farmer learning-by-doing activities) which were instrumental in facilitating and accelerating the adoption.” (Mkomwa et al., 2017c, p3).

These on-farm research approach can be characterized into 4 elements: the farmer, the farmer’s land, the farmer’s involvement, and the farmer’s environment (FAO, 2018c; Atta-Krah and Francis, 1987). Through the on-farm research, it is expected to:
1) Test and validate technologies under local farmer’s conditions;
2) Develop and adapt the technologies for local farmer’s condition; and
3) Demonstrate and extension of technologies in local farming communities (FAO, 2018)
The on-farm research combined with the demonstration plot and FFS is an effective approach to realize the above mentioned purpose when it is appropriately designed. However, one of the concerns is that each farmer’s environment is much more complex than what is being tested at the plot. For example, the project promoted CA through demonstrating maize and a cover crop intercropped, while it is common for the farmers to practise mix cropping which leads to some farmers not being able to follow the optimum practices (section 5.4.2 in Chapter 5). In addition, there is also a gap in this process that while all the necessary inputs and tools are provided at the demonstration plot (Table 9 in Chapter 5), farmers find it difficult to replicate the same conditions on their own farms unless they are resourceful farmers. The fact that the highest reason for
dis-adoptation being access to the CA equipment (Figure 12 Chapter 5), illustrate this issue. Therefore, depending on the design of the on-farm experimentation, the demonstration plot can be the representation of the ToT approach discussed in Chapter 3.

In this regard, there has been increasing attention to AIS and Innovation Platform (IP) type of approach in promotion of CA (Tittonell et al., 2012). The ABACO project actively promoted the IP approach as “The project used Co-Innovation Platforms to allow multi-directional knowledge transfer and iteration between the various stakeholders, male and female, involved in local agriculture to help arriving at better targeted, site-specific definitions of what CA means and how it should work” (ACT, n.d, p11). The AIS as explained in Chapter 3, reconceptualized the linear approach by inclusion of “multiple sources of innovation” (Biggs, 1990). Therefore, the increasing number of CA service providers are seen as key stakeholders in the promotion of CA (Section 5.2.4 in Chapter 5).

6.2.2 Integration of CA into the Conventional Farming System

(1) Livestock and Mulching Material

Since Laikipia is located in a semi-arid region, the role of livestock has been a vital part of livelihood and agriculture (Ulrich et al., 2012; Awa et al., 2002). Under this condition, the integration of CA into a livestock-crop mixed farming system is one of the biggest challenges in terms of managing crop residues (Valbuena et al., 2012; Giller et al., 2009). Mulching contributes greatly to the benefits of CA (section 2.6.2 in Chapter 2), but the farmers face trade-offs with the conventional use of crop residues under the CA practice. As Figure 20 in Chapter 5 shows, mulching material was identified as the second highest
constraint after CA equipment by both adopter and dis-adopter respondents. The corresponding result is the use of cover crops for intercropping with maize, together with the residue retention. The intercropping of maize and beans has been traditionally practised in the area, but farmers are taking up new types of beans that covers the soil better, such as butter beans and dolichos which have been promoted by several projects. In addition to the cover crops, the CA related projects and the MoA have been trying to accommodate the issue, by introducing hay grasses (Rhodes grass, Napier grass) as fodder, as well as instructing farmers to retain a certain percentage of the residue on the farm as a mitigation.

(2) Equipment and Inputs
Minimal soil disturbance is arguably at the heart of CA, which involves direct planting without inversion of the soil. This has been practised mostly by planting on the rip line, or making a pit with a hand hoe. As Figure 9 in Chapter 5 shows, most of the farmers (88.6%) use hand rippers in land preparation to make a rip line, and use several different tools at planting, depending on the type of crops and availability of the tools. The jab planter\textsuperscript{11}, has been promoted through the projects, and it has been used by 29.5% of adopters. Although the figure is higher than other studies with 6% adoption in Kenya (Muriuki et al., 2012), it still remains low because of inaccessibility at local area.

Another key practice under CA is weed control, which involves minimum soil disturbance. The Figure 9 in Chapter 5 shows that the shallow weeder is widely (88.6%) used by the
adopters. It is notable to emphasize that those tools, such as hand rippers and shallow weeders, have developed in Laikipia through the IP (Section 5.4.2 in Chapter 5). As a key-informant CA adopter stressed, this small-holder CA equipment has benefitted farmers, much more than mechanized and locally unavailable equipment. Therefore, there needs to be a caution with the promotion of CA equipment in terms of its suitability, accessibility, affordability (Sims et al., 2017).

As for other inputs, the Figure 19 shows that 84.1% of adopter respondents use herbicide under CA practice, which is double compared to the conventional practice. CA has been criticised for increasing labour demand for weeding (Giller et al., 2009). Nyamangara et al. (2014) reports that CA requires increasing more weeding operation than with conventional tillage farming up to six times in a season. Many studies therefore suggest the need for an integration of herbicide into CA systems (Gowing and Palmer, 2007; Chauhan et al, 2012; Muoni et al. 2013).

In addition to the herbicide, the projects also incorporate other inputs such as improved seed, fertiliser and pesticide. Together with the provision of those inputs into the demonstration plot, the project conducted training on good agricultural practice such as appropriate use of chemical inputs. As discussed in Chapter 2, this input package promotion brings a question of whether CA benefits the majority of the farmers who are resource-poor small-scale farmers. Tripp (2006) discuss about the low external input technology (LEIT), and observes that the pattern for adoption of CA is not so different from that of the Green Revolution, which implies limitation in wide adoption of CA in SSA.
6.2.3 Sustainability of the CA Practice

(1) Dis-adoption

The survey indicated that 18.5% of respondents have dis-adopted CA after 2.4 years (1.5 median). One of the main constraints for the dis-adopters was the lack of further information and training, which was mentioned as; 1) reason for stopping CA (40%); and 2) things which would have helped to continue CA (80%). Since CA4FS was implemented on a larger scale compared to the previous projects, the interaction and facilitation from the project (extension officers, project officers) would have been limited. In addition, the FFS at CA4FS was not carried on a regular (weekly) basis compared to other projects (Table 9 in Chapter 5). Thus, these circumstances may have created the need for more training, especially for dis-adopters. Furthermore, the dis-adopters’ perception of receiving necessary information and support, particularly after the project, is lower than adopters’ perception (Figure 22 in Chapter 5). As CA is characterized as knowledge intensive (Wall, 2007), and needs a longer time of facilitation (Amelia et al., 2014), the dis-adopters responses give lesson for creating much intensive interaction as well as follow-up systems for effective intervention. This also suggests the institutionalization of CA support systems, such as into county government policy or to extension programmes.

In terms of the incentives, the results from the questionnaire shows that there was not statistically significant difference between adopters and dis-adopters as to input incentives being a motivation for starting CA. Similarly, the lack of input incentives was not a major reason for stopping CA (Figure 12 in Chapter 5). This can be explained as the projects did not provide input incentives to individual farmers, but to each group’s
demonstration plot. In fact, input incentives are an effective way for facilitating adoption in a short-period of time. However, as numbers of studies point out, it creates dependency of farmers to the project, and dis-adoption when the incentives are withdrawn (Giller et al., 2009). Minimizing the dis-adoption is an important factor to consider at the design of a project. In addition, as it has been discussed in previous sections, the use of input including equipment as a part of the promotion package, needs to be reconsidered under the feasibility of application to the majority of farmers. Furthermore, as several key-informants mentioned, the demonstration of CA was based on intercropping of maize and a cover crop, thus some of the farmers who practise mixed cropping faced difficulties in following the instructions. As herbicide and fertilizers are more easily handled in a mono-cropping field, the input package approach may not be easily matched with complex mix-cropping farming which is commonly practiced in SSA.

(2) Adaptation

Under the continuous exposure to CA projects, there are ongoing adaptation by farmers in Laikipia. Several key-informant farmers as well questionnaire survey respondents provided examples such as applying the concept of CA for other crops, using local available new type of cover crops, as well as fabricating and modifying CA equipment. In addition, the concept of innovation and IP has recently been incorporated into the project components (see Appendix 4) as example was given by the development of smallholder CA equipment (section 5.4.2 in Chapter 5). However, there are possible constraints with AIS approach as it may contradict with the donor-funded project approach where there are pre-determined activities and expected outcomes. Furthermore, the role of “innovation broker” (Klerks et al, 2009) which played by the project personnel,
may be the missing part after completion of the project.

6.3 Conclusion

The study has looked at the dissemination process and applicability of CA in SSA, focusing on the case in Laikipia, Kenya. Through the study conducted, three research questions were explored and answered, which are; 1) CA promoters and its approach; 2) integration of CA into a conventional farming system; and 3) sustainability of the practice.

For the first question, CA has been promoted to SSA by strong initiatives of international organizations and donor countries through project-based activities. This intervention can be merely linear approach as CA is characterized as goal-oriented. However, there has been an increasing attention to IP which involves multi-actor interactions as advocated in ABACO projects. Some of the farmer participatory approach, such as FFS and demonstration plots, have also been commonly used in the project, yet the degree of farmers’ participation depends on the design of the project. These alternative approaches give insights into further CA promotion that it needs to go beyond the technology delivery itself, and toward enhancing the process of learning and changes with interaction among wide range of stakeholders.

As for the second question, the integration into maize based, crop-livestock mixed farming systems was explored. Through the case study, some of the practices to mitigate the lack of mulching material were identified. In addition, the wide adoption of smallholder CA equipment which was promoted through the IP of the project were addressed. In addition, there was wide adoption of external inputs use under the CA
practice. This implies that CA may not be suitable for resource-constrained small-scale farmers if the use of herbicide being the precondition to gain benefit from CA. The promotion of input package needs to reflect on this point and well thought at the project intervention.

With regards to the sustainability of the CA practice, the constraints and reasons for dis-adoption such as a need for more training and information were identified at the case study site. The reason why farmers dis-adopt CA needs to be well considered for further dissemination, especially at project design and implementation. Moreover, since the resource endorsement of farmers differs for individuals and localities, there needs to be a tailoring, and adapting process, which needs flexible and inclusive intervention design.

Overall, this study provides insight into the dissemination of CA for the small-scale farmers in SSA, although the extent is limited. The sustained adoption would not be achieved without local adaptation processes in which technology is tailored to farmers’ needs, constrains and various local conditions. Furthermore, the integration of AIS perspectives enables the intervention to be more adaptive and innovative in the local context.

6.4 Limitation of the Study

The research employed case study as a methodology, focusing on one location in Kenya. Thus, care is needed for generalization of the results. In addition, the field research conducted in Laikipia was for a relatively short period which hinders further communication with the respondent farmers for confirmation of collected information.
There is also limitation for the small number of respondents, especially for the dis-adopters. If one needs to study further, focusing on the dis-adopters, the sampling method needs to be reconsidered.

6.5 Implication for Further Studies

This research has looked into the maize based, livestock-crop mixed farming system in Kenya. The research outcome can be compared and computed with other studies within the farming system. It would also gain deeper perspectives if the study could include wider stakeholders such as NGOs. In addition, the study on CA system in other farming systems, which have had less studies, would be useful in practical discussions on the applicability of CA in SSA.
References


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Appendices

Appendix 1 Questionnaire Survey Sheet for Adopters

Questionnaire Survey
on Practices of Conservation Agriculture
in Laikipia County

❖ Purpose of the Survey
This dissertation research focuses on experience of Conservation Agriculture (CA) for small-scale farmers in Laikipia County, Laikipia East Sub-County/District. The student conducting the research is interested in exploring the factors affecting the adoption, adaption and dis-adoption of CA in order to gain implication for further dissemination of CA in other regions.

❖ Questionnaire
Code Number……………………
Starting time:………………… Ending time: …………………

❖ Bio information of the farmer
Name of respondent:………………………………………………
Position in household: …………………………………………………
Gender: ☐ Male ☐ Female
Age: …………………
Contact address (phone number): ……………………………
Name of household head (if different from respondent):…………………………
Gender: ☐ male ☐ female
Education Level: ☐ Primary ☐ Secondary ☐ Tertiary ☐ None ☐ Others

❖ Enumerator’s Detail
 Enumerator’s Name:………………………………………………
Tel:…………………………… Date:………………… Signature:…………………
Questionnaire Survey for Adopters/Adapters

Code Number: ……………………

(1) Do you practice Conservation Agriculture (CA)?
   (□ Yes/currently practicing, □ No/Tried before but stopped, □ No/Never tried)

*If the answer is No/Tried before but stopped, please use the other sheet.

(2) How many members are there in your household?
   ( males  females)

(3) How many members of the household are constantly working on the farm?
   ( males  females)

(4) What crops do you grow on your farm (including non-CA farm land)? Please specify.
   ( )

(5) Do you sell your produce to the market?
   (□ Yes constantly, □ Yes sometimes, □ Rarely, □ No)

(6) What is the land size of your farm land (excluding homestead)?
   ( Acres )

(7) How much area of your land is currently under cultivation?
   ( Acres owned, Acres rented, Acres other/Specify )

(8) How much area of your land is currently under CA?
   ( Acres owned, Acres rented, Acres other/Specify )

8a) How has the area under CA changed over time?
   □ Increased  □ Decreased  □ No change  □ Others/Specify
(9) If you are partially applying CA, what are the reasons for NOT applying CA to all the land?

☐ Land size, ☐ Land tenure, ☐ Shortage of soil cover, ☐ Availability of CA equipment and services, ☐ Cost for inputs ☐ Constraints in labour and time, ☐ Difficulties in marketing of the produce, ☐ Inappropriate soil type, ☐ Distance to the land, ☐ Others/please specify

(10) Do you keep any livestock?

☐ Yes, ☐ No

(11) If yes, please specify the kinds and the numbers of each livestock,

☐ Cattle, ☐ Chicken, ☐ Sheep, ☐ Goat, ☐ Pig, ☐ Donkey, ☐ Others/Specify

(12) Where do you mainly get the feed for the livestock from?

☐ Crop residue, ☐ Green hedges, ☐ Purchased feed, ☐ Others/Please specify

(13) How long have you been practicing CA? Please specify the duration.

☐ years ☐ months

(14) Which CA project did you participate in?

☐ CASARD (Conservation agriculture for sustainable agriculture and rural development and food security in Southern and Eastern Africa), 2004-2006, by FAO, ACT and Ministry of Agriculture (MoA)

☐ ABACO (Agro-Ecology Based Aggradation- Conservation Agriculture Project), 2011-2015, by ACT and MoA

☐ CA4CC2 (Up Scaling Conservation Agriculture for Increased Resilience to Climate Change
and Improved Food Security in Eastern and Southern Africa), 2012-2014, (Model Farmers) by ACT and MoA

□ CA4FS (Conservation Agriculture for Resilient Food Security and Profitability in Machakos and Laikipia Counties of Kenya), 2013-2016, by ACT

□ Others / please specify the name of the project, year and implementing agency(s)

(15) Which crops do you grow under CA? Please specify the type of crops.
( )

(16) Have you introduced new crop(s) after starting CA on your farm?
(□ Yes, □ No)

(17) Which practices of CA do you apply on your farm? Multiple answer is allowed.
A: Minimum/No Tillage
□ Hand hoe pitting, □ Ripping, □ Sub-soiling, □ Shallow weeding, □ Herbicides
B: Permanent Soil Cover
□ Mulching with crop residue, □ Cover crops
C: Crop Rotation/Association
□ Intercropping, □ Mixed cropping, □ Crop rotation, □ Relay cropping rotation

(18) Who made the decision of starting CA for your family?
( □ Myself, □ Spouse (husband or wife), □ Children, □ Elderlies □ Others / please specify)

(19) Who supported the decision to start CA? Multiple answer is allowed.
( □ Family member, □ Member of the CA group □ Other experienced CA farmer (outside the group), □ Project staff, □ Extension officer, □ Others / please specify)
(20) What were the initial reasons of starting CA? Multiple answer is allowed.

☐ To be in the project, ☐ Input incentives from the project, ☐ Earlier planting, ☐ Yield increase, ☐ Reduced input cost, ☐ Soil fertility improvement, ☐ Soil moisture retention, ☐ Reduced soil erosion, ☐ Reduced labour for tillage, ☐ Reduced labour for weeding, ☐ Gained confidence from initial trails, ☐ Others/please specify

(21) What equipment do you use for CA practice?

A: At Land Preparation

☐ Hand hoe, ☐ Hand Ripper, ☐ Animal drawn ripper, ☐ Tractor ripper, ☐ Animal drawn sub-soiler, ☐ Tractor drawn sub-soiler, ☐ Others/please specify

B: At Planting

☐ Hand hoe, ☐ Dibble stick, ☐ Jab Plater, ☐ Animal drawn direct seeder, ☐ Tractor drawn direct seeder, ☐ Others/please specify

C: At Weeding

☐ Hand (pulling or uprooting), ☐ Hand-hoe, ☐ Shallow-weeder, ☐ Slashers, ☐ Animal drawn weed roller, ☐ Tractor drawn weed roller, ☐ Knapsack sprayer, ☐ Boom sprayer, ☐ Others/please specify

(22) What kind of inputs do you currently use under CA?

☐ CA equipment, ☐ Improved seeds, ☐ Organic compost, ☐ Livestock Manure, ☐ Ash, ☐ Chemical fertilizer, ☐ Herbicide, ☐ Pesticide, ☐ Irrigation, ☐ Machinery, ☐ Others/please specify
(23) What kind of inputs have you been using BEFORE starting CA?

( □ Improved seeds □ Organic compost □ Livestock Manure, □ Ash, □ Chemical fertilizer, □ Herbicide, □ Pesticide, □ Irrigation, □ Machinery, □ Others/ please specify )

(24) What crop combination do you intercrop on your farm? (eg: Maize and Groundnut)

(                                                                       )

(25) What type of crop rotation do you practice?

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<th>Year/Season</th>
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(26) What do you use for covering the soil?

( □ Crop residue, □ Cover crop/please specify , □ Others/please specify )

(27) What difficulties/challenges do you face while practicing CA? Multiple answer is allowed.

( □ Access for the CA equipment, □ Techniques for minimum/no tillage, □ Increased labour, □ Increased cost, □ Management of time, □ Mulching material, □ Techniques for rotation and intercropping, □ Soil condition, □ Marketing of produce, □ Understanding from the family, □ Others/please specify ……………………………….)
(28) How do you cope with those difficulties?

☐ Try own innovative idea, ☐ Discussion with family, ☐ Consultation with other farmers, ☐ Consultation with extension officers, ☐ Consultation with CA service providers, ☐ Collecting information through media, ☐ No action ☐ Others/please specify

(29) Were you able to get necessary information and support for CA practice DURING the project participation?

☐ Strongly yes, ☐ Yes, ☐ Weakly yes, ☐ No

(30) If your answer is Yes, what was(were) the most useful way(s) of getting the information and techniques?

☐ Technical backstopping visits, ☐ Farmer to farmer interaction, ☐ Training, ☐ Field days, ☐ Farmer exchange visits, ☐ Exhibitions and shows, ☐ Media, ☐ Others/please specify

(31) Are you now able to get necessary information and support AFTER the completion of the project?

☐ Strongly yes, ☐ Yes, ☐ Weakly yes, ☐ No

(32) If the answer is Yes, where do you usually get actual consultation, when you get difficulties in implementing CA?

☐ Other farmers practicing CA, ☐ Extension Officer, ☐ Media, ☐ Others/please specify
(33) What are the benefits of CA that you recognize through the practice? Multiple answer is allowed.

☐ Earlier planting, ☐ Increased yield, ☐ Increased income, ☐ Increased food for family, ☐ Reduced input cost, ☐ Improved soil fertility, ☐ Increased soil moisture, ☐ Reduced erosion, ☐ Reduced labour for tillage, ☐ Reduced labour for weeding, ☐ Increased resistance to the weather variabilities, ☐ Input incentives from the project, ☐ Interaction with other farmers, ☐ Others/please specify

(34) When did you start to recognize the benefits?

☐ Within 1 year, ☐ More than 1 year, ☐ More than 2 years, ☐ More than 3 years, ☐ More than 4 years, ☐ Others/please specify the time

(35) Have you tried new techniques or further developed techniques from what you are taught by the project?

☐ Yes, ☐ No

(36) If yes, what are those techniques? Please explain.

( )

(37) Do you intend to continue CA?

☐ Strongly yes, ☐ Weakly yes, ☐ No, ☐ Undecided

(38) What trainings and incentives were you given? Please specify.
(39) If there are any other comments, please freely express.

Thank you for your cooperation! This is the end of the question.
**Appendix 2 Questionnaire Survey Sheet for Dis-adopters**

## Questionnaire Survey on Practices of Conservation Agriculture in Laikipia County

<table>
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<th>✷ Purpose of the Survey</th>
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<tr>
<td>This dissertation research focuses on experience of Conservation Agriculture (CA) for small-scale farmers in Laikipia County, Laikipia East Sub-County/District. The student conducting the research is interested in exploring the factors affecting the adoption, adaption and dis-adoption of CA in order to gain implication for further dissemination of CA in other regions.</td>
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<td>Name of respondent: …………………………………………………..</td>
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<td>Position in household: …………………………………………………</td>
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<td>Gender: □ Male □ Female</td>
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<td>Contact address (phone number): ……………………………………………..</td>
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<td>Name of household head (if different from respondent): ………………………..</td>
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<td>Gender: □ male □ female</td>
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<td>Education Level: □ Primary □ Secondary □ Tertiary □ None □ Others</td>
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<th>✷ Enumerator’s Detail</th>
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<td>Enumerator’s Name: ……………………………………………..</td>
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</table>
Code Number: ……………………

(1) Do you practice Conservation Agriculture (CA)?
( □ Yes/currently practicing, □ No/Tried before but stopped, □ No/Never tried)

*If the answer is yes, please use the other questionnaire sheet for CA adopters

(2) How many members are there in your household?
(   males   females)

(3) How many members of the household are constantly working on the farm?
(   males   females)

(4) What crops do you grow in your farm? Please specify.
(   )

(5) Do you sell your produce to the market?
( □ Yes constantly, □ Yes sometimes, □ Rarely, □ No)

(6) What is the land size of your farm (excluding homestead)?
(   Acres)

(7) Do you keep any livestock?
( □ Yes, □ No)

(8) If yes, please specify the kinds and the numbers of each livestock
( □ Cattle , □ Chicken , □ Sheep , □ Goat , □ Pig ,
 □ Donkey , □ Others/Specify )

(9) Where do you mainly get the feed for the livestock from?
( □ Crop residue, □ Green hedges, □ Purchased feed, □ Others/Please specify )

(10) How long did you practice CA before you stopped?
(   years   months)

1 0 0
(11) Which CA project did you participate in?

☐ CASARD (Conservation agriculture for sustainable agriculture and rural development and food security in Southern and Eastern Africa), 2004-2006, by FAO, ACT and Ministry of Agriculture (MoA)

☐ ABACO (Agro-Ecology Based Aggradation- Conservation Agriculture Project), 2011-2015, by ACT and MoA

☐ CA4CC2 (Up Scaling Conservation Agriculture for Increased Resilience to Climate Change and Improved Food Security in Eastern and Southern Africa), 2012-2014, (Model Farmers) by ACT and MoA

☐ CA4FS (Conservation Agriculture for Resilient Food Security and Profitability in Machakos and Laikipia Counties of Kenya), 2013-2016, by ACT and MoA

☐ Others/please specify the name of the project, year and implementing agency(s)

(12) Who made the decision of starting CA for your family?

( ☐ Myself, ☐ Spouse (husband or wife), ☐ Children, ☐ Elderlies ☐ Others/please specify)

(13) Who supported the decision to start CA? Multiple answer is allowed.

( ☐ Family member, ☐ Member of the CA group ☐ Other farmer practicing CA (outside the group), ☐ Project staff, ☐ Extension officer, ☐ Others/please specify)

(14) Which crops did you grow under CA? Please specify the type of crops.

( ☐

(15) How much area of your land was under CA while you were practicing?

( ☐ Acres owned, ☐ Acres rented, ☐ Acres others/specify)

1 0 1
(16) What kind of inputs did you use DURING practicing CA?

☐ CA equipment, ☐ Improved seeds, ☐ Organic compost, ☐ Livestock Manure, ☐ Ash, ☐ Chemical fertilizer, ☐ Herbicide, ☐ Pesticide, ☐ Irrigation, ☐ Machinery ☐ Others/ please specify

(17) What kind of inputs have you been using BEFORE implementing CA?

☐ Improved seeds ☐ Organic compost ☐ Livestock Manure, ☐ Ash, ☐ Chemical fertilizer, ☐ Herbicide, ☐ Pesticide, ☐ Irrigation, ☐ Machinery, ☐ Others/ please specify

(18) Which practices of CA did you apply on your farm? Multiple answer is allowed.

A: Minimum/No Tillage

☐ Hand hoe pitting, ☐ Ripping, ☐ Sub-soiling, ☐ Shallow weeding, ☐ Herbicides

B: Permanent Soil Cover

☐ Mulching with crop residue, ☐ Cover crops

C: Crop Rotation/Association

☐ Intercropping, ☐ Mixed cropping, ☐ Crop rotation, ☐ Relay cropping rotation

(19) What were the initial reasons/intention of starting CA? Multiple answer is allowed.

☐ To be in the project, ☐ Input incentives from the project, ☐ Earlier planting, ☐ Yield increase, ☐ Reduced input cost, ☐ Soil fertility improvement, ☐ Soil moisture retention, ☐ Reduced soil erosion, ☐ Reduced labour for tillage, ☐ Reduced labour for weeding, ☐ Gained confidence from initial trial, ☐ Others/please specify

(20) Did you find any benefits when practicing CA?

1 0 2
(☐ Yes, ☐ No )

(21) If your answer is yes, what were the benefits of CA that you recognized? Multiple answer is allowed.
☐ Earlier planting, ☐ Increased yield, ☐ Increased income, ☐ Increased food for family,
☐ Reduced input cost, ☐ Improved soil fertility, ☐ Increased soil moisture, ☐ Reduced erosion,
☐ Reduced labour for tillage, ☐ Reduced labour for weeding, ☐ Increased resistance to the weather variabilities,
☐ Input incentives from the project, ☐ Interaction with other farmers, ☐ Others/please specify

(22) What difficulties/challenges did you face while practicing CA? Multiple answer is allowed.
☐ Access for the CA equipment, ☐ Techniques for minimum/no tillage, ☐ Increased labour,
☐ Increased cost, ☐ Management of time, ☐ Mulching material, ☐ Techniques for rotation and intercropping,
☐ Soil condition, ☐ Marketing of produce, ☐ Understanding from the family, ☐ Others/please specify)

(23) How did you cope with those difficulties?
☐ Try own innovative idea, ☐ Discussion with family, ☐ Consultation with other farmers,
☐ Consultation with extension officers, ☐ Consultation with CA service providers, ☐ Collecting information through media, ☐ No action ☐ Others/please specify)

(24) Were you able to get necessary information and support for CA practice WHILE
participating the project activities?

(□ Strongly yes, □ Yes, □ Weakly yes, □ No)

(25) If your answer is Yes, what was(were) the most useful way(s) of getting the information and techniques?

(□ Technical backstopping visits, □ Farmer to farmer interaction, □ Training, □ Field days, □ Farmer exchange visits, □ Exhibitions and shows, □ Media, □ Others/please specify)

25a) If the answer is no, what information and support did you require? Please specify.

(26) Were you able to get necessary information and support AFTER the termination of the project?

(□ Strongly yes, □ Yes, □ Weakly yes, □ No)

(27) Are you actively in touch with other members of the CA group at the moment?

(□ Strongly yes, □ Yes, □ Weakly yes, □ No)

(28) When did you stop CA?

(□ During the project participation period, □ Within one year after termination of the project, □ Within 2 years after termination of the project, □ Others/please specify)
(29) What were the main reasons of stopping CA? Multiple answers allowed.

☐ Difficulties in techniques, ☐ Lack of further information, ☐ Lack of further technical support, ☐ Lack of input incentives, ☐ Difficulties in access to inputs, ☐ Lack of CA equipment, ☐ Constraints in money, ☐ Constraints in time, ☐ Problems with pest and diseases, ☐ Problem with weeds, ☐ Inappropriate soil type, ☐ Difficulties of getting an understanding from family, ☐ Discouragement from other farmers, ☐ Others/please specify

(30) Did you observe any changes on crops and soil DURING the implementation of CA?
A: Soil
☐ Improved soil quality, ☐ Reduced soil quality, ☐ No change in soil quality
B: Crop
☐ Increased yield, ☐ Decreased yield, ☐ No change in yield

(31) What changes did you see AFTER stopping CA?

☐ No changes, ☐ Positive changes/please specify
☐ Negative changes/please specify

(32) What would have helped you to continue with CA?

☐ More information, ☐ More trainings ☐ Further technical support, ☐ Continued input incentives, ☐ Availability and access for the CA equipment, ☐ Getting an understanding from family, ☐ Understanding from neighbouring farmers, ☐ Others/please
(33) What trainings and incentives were you given? Please specify.

(34) If there are any other comments, please freely express.

Thank you for your cooperation! This is the end of the question.
Appendix 3 Field Questions

Interviews:
Name of the respondent: ........................................................................................................
Position: .........................................................................................................................
Gender: □ Male □ Female
Age: .........................
Contact address (phone number): .................................................................
Starting time:......................... Ending time: .........................

The interviews were conducted based on questions below;
1. Interview
1-1. Interview for the Extension Officer
When did you become extension officer?
What is your position in the organization?
When were you involved in the project? How did you get involved in the project? What was your role?
Did you know about the conservation agriculture before the project? What did you think about the CA at first?
How the project activities were planned? Were you involved in the planning stage?
How were the groups formed, selected?
How were the reaction of farmers for CA at the beginning of the project?
How often have you visited farmers on the field?
What do you think is the success of project?
Do you think that the project has been successful? Or challenging?
What were the activities that you think most successful in terms of disseminating the technology?
What difficulties did you face while implementing the project activities?
Which practices of CA do you think is most challenging for the farmers in this area?
Which benefit of CA is most desirable for the farmers in this area?
What types of farmers are keen in accepting CA? IS there any tendency?
Do you still get consultation from the farmers on CA? If so, are the major issues?
Do you think that farmers need incentives to participate in the project? If yes, what kind?
Do you think that farmers need continuous inventive after the project for the further continuation?
What do you think is the reason for dis-adoption?
What do you think is important in continuity of the project activities/CA practices?
Are there any particular difficulties for CA in continuing practise?
What do you think makes difference that one farmer being successful in CA and others are not?
Do you see farmers developing their own ideas regarding CA?

1-2. Project staff
What was your role in the project?
How the project area was decided? How did you select the target farmers?
Who were involved in the project? Who were the main actors, and what role are they playing in project? Were there any platform for those people?
What approach did you use to disseminate the project activities?
What do you think is the effective ways of extension, dissemination?
How are the responses of the farmers to CA at the beginning of the project? Did you find any differences during the implementation of the project?
Did project provide inputs/incentives to the farmers? What do you think of the use of incentives for the farmers to participate in the project?
What as the major constraints during the implementation of the project? Dis project take any measures to address the constraints?
What do you think of the sustainability of the project? Do you take any measures to encourage the continuity of the activities after the completion of the project?
Did you observe any changes to the farmers, extensions offices, other main stake holders?
Does the existence of donors affect you or the project in some way? How exactly?

1-3. Interview for the key stakeholders (service provider)
When did you start participating in CA project?
What was your motivation in joining the project/starting the CA services?
What are your main activities for your business?
What equipment do you use? How do you conduct the operations?
How do you evaluate your business?
What are the major advantages as a CA service provider?
What are the major constraints as a CA service provider?

1-4. Interview for the adopter farmers
When did you start CA? How long have you been doing CA?
What made you to start CA? (What are the reasons? Who decide to start CA in your family? Is there anyone who supported your decision? Was there any incentive given by the project?)
What are the crops you are growing under CA?
How much areas are under CA? The area under CA is increased over time?
What kind of tools do you use under CA?
What kind of inputs do you use under CA? Access to CA equipment?
How do you control weed?
How do you manage mulching material?
How do you get information, techniques, support on CA? Who do you consult if you face any problems regarding CA?
What are the main benefits of CA? What changes do you see after implementing CA?
When did you start to see the change? In what stage or process of production did you notice this?
What kind of difficulties do you face in implementing CA? Which practice of CA is difficult to implement?
Are you intending to continue CA?

1-5. Interview for the dis-adopter farmers
How long have you practiced CA? When started/stopped
What was your main expectation for CA when you started?
What kind of inputs are used? (Before and after CA)
What kind of tools did you use under CA?
What were the benefits of CA?
What were the difficulties with CA?
What are the main reasons for stopping CA? What were the constraints?
Did you see any changes during the implementation of your CA practice?
What would have helped you in continuation of CA?
### Appendix 4 Objectives and expected outputs for the project

<table>
<thead>
<tr>
<th>Project</th>
<th>Goal/Overall Objectives</th>
<th>Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA-SARD</td>
<td>to improve food security and rural livelihoods and build a foundation for the expansion of conservation agriculture to contribute to sustainable agriculture and rural development.</td>
<td>1. CA practices applied by farmers; 2. owners of draught animal power and tractors enabled to offer hire services in CA practices to others; 3. extension staff trained to organize, facilitate and provide ongoing support to CA farmer field schools (FFS); 4. capacity within the local manufacturing and retail sector for the supply of equipment and tools suitable for CA inputs improved; 5. knowledge networks for exchanging experiences established at local, national and regional levels</td>
</tr>
<tr>
<td>ABACO</td>
<td>to reduce the vulnerability of smallholder farmers to climatic variability by building capacity through co-innovation platforms to design, evaluate and implement targeted technological options for and mechanisms to promote adoption CA based on agroecology principles to combat land degradation and food insecurity in semi-arid regions of Africa.</td>
<td>1. To adapt CA systems to different kinds of smallholder African farmers by studying which principles of CA, and under which conditions contribute to the effects sought in terms of food production and land rehabilitation in the face of climatic variability; 2. To involve farmers and research in co-innovation platforms to promote the adaptation/appropriation of technologies by local communities; 3. To assess the social and economic viability and tradeoffs of</td>
</tr>
<tr>
<td>CA4CCFS</td>
<td>to strengthen resilience to climate change among rural communities and smallholder farmers thus contributing to their increased food security</td>
<td></td>
</tr>
<tr>
<td>CA4FS</td>
<td>to improve food and income security and build the resilience of smallholder farmers by enhancing the adoption of Conservation Agriculture practices.</td>
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| | implementing CA at farm and village scales, and across scenarios, to inform policies; |
| | 4. To promote dissemination of targeted CA alternatives and approaches through divulgation, training and capacity development; |

1. CA – climate change (CA4CC) knowledge support networks functioning at national and regional levels and enriching available local knowledge and information on CA4CC
2. Smallholder agriculture producers and practitioners empowered to participate in national and regional CA4CC related policy processes and development planning.
3. Smallholder farmers including vulnerable groups such as women and youth farmers and other agriculture practitioners adopting/ supporting adoption of CA4CC

1. To evaluate and identify cover crop options for Conservation Agriculture
2. To increase awareness of Conservation Agriculture among smallholder farmers and extension staff in Machakos and Laikipia Counties for sustainable agricultural production
3. To improve access to information and communication products on
<table>
<thead>
<tr>
<th>Source</th>
<th>Table created by author based on project document (FAO, 2007; ACT, n.d; ACT, 2014; Mkomwa et al., 2017c; FAO, n.d.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPP-GAP</td>
<td>Contribute to improving the livelihoods of rural farming population in semi-arid Kenya by increasing their incomes, making them more resilient to climate shocks and reducing their vulnerability to poverty and food deficits.</td>
</tr>
</tbody>
</table>
| Conservation Agriculture for practitioners including policy makers  | 1. Improving farmers productivity through CA as the basis of Good Agricultural Practice.  
2. Increasing farmers’ profitability by infusing an agribusiness approach to the way they farm. |
| 4. To improve smallholder farmers’ access to input and output markets|                                                                                                                                |