Creating capabilities for sustainable smallholder agriculture

A systems perspective on innovation and the adoption of Conservation Agriculture in Kenya and Madagascar

F.J. Van Hulst

Ph.D. Thesis

2016

Creating capabilities for sustainable smallholder agriculture

A systems perspective on innovation and the adoption of Conservation Agriculture in Kenya and Madagascar

Freddy van Hulst

A thesis submitted in fulfilment of the requirements of the University of Greenwich for the Degree of Doctor of Philosophy

The research programme was carried out in collaboration with the ABACO project

July 2016

DECLARATION

I certify that this work has not been accepted in substance for any degree, and is not concurrently being submitted for any degree other than that of Doctor of Philosophy being studied at the University of Greenwich. I also declare that this work is the result of my own investigations except where otherwise identified by references and that I have not plagiarised the work of others.

PhD candidate F.J. van Hulst Date:

Supervisor Prof. dr. J. Morton Date:

Supervisor Dr. K. Wellard Date:

ACKNOWLEDGEMENTS

I would like to thank Helena Posthumus, who initiated this PhD project, supervised me for the greatest part of it, and was there to think through the options at crucial stages of the research process. Our weekly coffee moments during the first months of my stay in England were a source of motivation and inspiration. I would like to thank John Morton and Kate Wellard for their pleasant style of supervising, for guiding me to interesting academic literature, and for their constructive and thorough feedback on the written chapters.

I would like to thank the Vice Chancellor's scholarship of the University of Greenwich for funding me for the first part of the PhD, and I thank the EU-funded ABACO project for facilitating the logistical aspects of the field work.

I had the privilege of working closely with smallholder farmers and was humbled by their hospitality and wisdom. This research was only possible because they gave me some of their valuable time. I also thank the many respondents working at NGOs, GOs and the private sector, with whom I had very interesting and sometimes long discussions about the opportunities and constraints of sustainable smallholder agriculture. Their work is important and I hope this research contributes to it.

The long periods of fieldwork in Kenya and Madagascar were fruitful and enjoyable thanks to the many friends and colleagues. In Kenya I was greatly helped by JJ Gitonga and the local ministry of Agriculture officers, by Saidi Mkomwa, Monica Buyu, Peter Kuria, Barry Pound, my local friends and neighbours, and my translators Anne, Stanley, Dolly and Francis. In Madagascar I am grateful for the help of Pascal Danthu, Lalaina Ranaivoson, Soary Randriamitantsoa, Roland and my translator team of Rivo, Tiavina and Doss.

I thank the interesting, enthusiastic and open-minded people at NRI that contribute to a good work environment, especially my friends of the NRI Postgraduate Society. I will miss the frequent coffee breaks, the cheeky pints we had in the afternoon, the lively discussions, and the friendships that flourished in our 'Tower', overlooking the river Medway.

Finally, I thank my parents(-in-law) for their loving support, and most importantly, I thank Maaike, my partner for life who followed me to the UK, Kenya and Madagascar, and back again; I treasure the good times we had and the homes we made. You supported me morally, academically, spiritually, and in every other way that matters, thank you.

ABSTRACT

In recent years, Conservation Agriculture (CA) has been promoted in sub-Saharan Africa (SSA) as an alternative farming system for smallholder farmers to address declining soil productivity and climate change. CA is a technology package based on 1) minimum soil disturbance; 2) permanent soil cover; and 3) maximum crop diversity through rotation/association. Claims about the potential benefits of CA for smallholder farmers in SSA are contested, and the (non-)adoption by farmers remains difficult to predict and understand. This research combines different conceptual models to better understand the adoption and promotion of CA in Kenya and Madagascar with a wider relevance for similar practices in SSA.

For both countries, the major stakeholders in the innovation systems and their interlinkages are described, with a focus on the position of smallholder farmers. Stakeholders' 'theories of change', narratives and 'framing' of the importance of CA, and their perceived legitimation for their involvement in CA, are described. Results show that the Agricultural Innovation Systems (AIS) approach through Innovation Platforms remains difficult to translate into practice; expert-based development approaches remain the norm. It is argued that this is partly the result of an institutionalisation of purposive-rational policy and practice, while the capabilities approach and Habermas' theory of communicative action explored in this thesis, suggest the need for a counter institutionalisation of more communicative-rational thinking and practice. Communicative action can enable an AIS approach that actually provides sustainable technological and institutional innovation.

This research shows that the social-psychological Reasoned Action Approach is a useful heuristic for understanding farmers' intention to adopt CA practices in terms of attitudes, perceived social norms and perceived behavioural control (PBC), and the respective underlying beliefs. Results show that attitudes and PBC are the main determinants of intentions. It is recommended to promote experimentation and learning, because these influence both PBC and attitudes.

CONTENTS

TABLES AND FIGURES

List of Tables

List of Figures

List of Boxes

List of Appendix Tables

GLOSSARY OF TERMS

Terms and abbreviations

ABC	Actual Behavioural Control
AIS	Agricultural Innovation Systems
CA	Conservation Agriculture
CF	Conservation Farming
CSA	Climate Smart Agriculture
DP	Direct planting
FFD	Farmer Field Day
FFS	Farmer Field School
FGD	Focus Group Discussion
GLB	Greater Lower Bounds
GSD	Groupement de Semis Direct
GO	Government Organisation
HH	Household
IP	Innovation Platform
NGO	Non-Governmental Organisation
PBC	Perceived Behavioural Control
RAA	Reasoned Action Approach
SB	Spearman-Brown
SCPI	Sustainable Crop Production Intensification
SCV	Semis Direct sur Couverture Végétale permanente
SNA	Social Network Analysis
SSA	Sub-Saharan Africa
SWC	Soil and Water Conservation
ToC	Theory of change
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action

Organizations and projects

ABACO	Agro-ecology Based Aggradation-Conservation Agriculture
ACT-Network	African Conservation Tillage Network
AFD	Agence Française pour le Développement (French Development Agency)
AGRA	Alliance for a Green Revolution in Africa
ANAE	L´Association Nationale d´Actions Environnementales (National Agency for Environment)
AU	African Union
BRL	Bas Rhône Languedoc Madagascar
BV-Lac	*Mise en valeur et de protection des Bassin Versants du Lac Alaotra* (Improving the productivity and conservation of the Lake Alaotra watershed)
BVPI/HP	*Bassins Versants Périmètres Irrigués Sud-Est/Hauts-Plateaux* (watershed development of irrigated territories in the south-east highlands
CA-SARD	Conservation Agriculture Project- Sustainable Agriculture and Rural Development
CA2AFRICA	CA in Africa: Analysing and FoReseeing its Impact – Comprehending its Adoption
CA4FS	Conservation Agriculture for Food Security
CAADP	Comprehensive Africa Agriculture Development Programme
CARWG	Conservation Agriculture Regional Working Group
CAWT	Conservation Agriculture With Trees
CETRAD	Centre for Training and Integrated Research in Arid and Semi-arid Lands Development
CIRAD	Centre International de la Recherche Agronomique pour le Développement (International Centre for Agricultural Research for Development)
COMESA	Common Market for Eastern and Southern Africa
CSA	Centre Service Agricole(Agricultural Service Centre)
DFID	(UK) Department For International Development
DRDR	Directorat Régionale pour le Développement Rural (Regional Directorate for Rural Development)
EAFF	East African Farmers Federation
EU	European Union
FACASI	Farm Mechanization & Conservation Agriculture for Sustainable Intensification

FAO	Food and Agriculture Organisation of the United Nations
FIFAMANOR	Fiompiana Fambolena Malagasy Norveziana (Norwegian – Malagasy Centre of Livestock and Agriculture)
FOFIFA	Foibem-pirenena ho an'ny fikarohana ampiharina ho fampandrosoana ny eny Ambanivohitra (National Centre of Applied Research on Rural Development)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GSDM	Group for Direct Planting in Madagascar
ICRAF	World Agroforestry Centre (before: International Centre for Research in Agroforestry)
KALRO	Kenya Agriculture and Livestock Research Institute (at the time of the study still known as KARI)
KARI	Kenya Agricultural Research Institute (now KALRO)
KENDAT	Kenya Network for Draught Animal Technology
KWF	Kreditanstalt für Wiederaufbau (Reconstruction Credit Institute)
LRNP	Legume Research Network Project
MoA	Ministry of Agriculture
NCATF	National Conservation Agriculture Task Force
NEPAD	New Partnership for Africa's Development
PLAE	*Programme de Lutte Anti-Erosive* (Anti-Erosion Programme)
SD-Mad	Semis Direct de Madagascar (Direct Planting Madagascar)
SIDA	Swedish International Development Cooperation Agency
TAFA	*Tany sy Fampandroasoana* (Soil and Development)
TOF	The Organic Farmer
URP-SCRiD	*Unité de recherche en partenariat "Systèmes de culture et riziculture durables"* (Sustainable Farming and Rice Cropping Systems)
USAID	United States Agency for International Development
VIFAM	*Vovonana Iraisan'ny Fikambanana Tantsaha Alaotra Mangoro* (Federation of farmers' organisations of the region of Alaotra-Mangoro)

Words in Swahili (S) or Malagasy (M) languages

Angady	(M) Shovel which is used for most of the work on the land like weeding, planting etc.
Baiboho	(M) Fertile and mostly flat lands with good water drainage, located between *tanety* and *tinam-bary*. Common crops: rice, vegetables and cover crops, also off-season.
Bozoka	(M) Natural grasses that grow on the *tanety,* sometimes used as a source for cut-and-carry mulching.
Dawa	(S) Translates with chemicals, most often used in reference to herbicides.
Dodoka	(M) A sign, usually made with branches and/or a blue plastic bag on top of a stick, placed in a field to indicate that no cattle is allowed to enter the field for grazing.
Fady	(M) Forbidden, taboo. For example, in the area around Amparahitsokatra east of Lake Alaotra, it is considered *fady* to work on the rice paddies on Thursdays.
Fokontany	(M) Local administrative unit, equivalent to commune.
Kilimo hifadhi	(S) Conservation Agriculture.
Lavaka	(M) Literally translates as ´hole´, referring to the huge erosion gullies on the *tanety.*
Makalioka	(M) Traditional rice variety in the Alaotra region with long grains.
Saro-drano	(M) Rice paddy with limited water control
Sihanaka	(M) Literally translates as ‘people of the swamps’, dominant ethnic group in the Lake Alaotra region.
Tanety	(M) Hills with sometimes steep slopes, the least fertile lands in the study area with only rain fed crops. Common crops: Cassava, maize, rain-fed rice, peanuts, etc.
Tinam-bary	(M) Rice paddies, sub-classified as having good water control (irrigated) and bad water control (uncontrolled flooding).
Voly Rakotra	(M) Malagasy word meaning ‘planting with cover’, used to refer to SCV, which is French for conservation agriculture.

1 INTRODUCTION

It is generally acknowledged by a wide range of actors dealing with agricultural development that the productivity of small-scale agriculture must increase in order to meet the second Global Goal for Sustainable Development to “End hunger, achieve food security and improved nutrition and promote sustainable agriculture” (UNDP, 2015; Hounkonnou et al., 2012). At the same time, concerns are widespread about the soil fertility decline and persistent soil degradation in large parts of sub-Saharan Africa (SSA). Moreover, climate change is expected to impact the rainfall variability in SSA, leading to more frequent extreme rain events and droughts (Milder, Scherr and Majanen, 2011; AGRA, 2014; Kurukulasuriya et al., 2006). In this context, Conservation Agriculture (CA) is being promoted as a farming system that can potentially contribute to the sustainable intensification of small-scale agriculture in SSA.

The two main foci of this research are the adoption and promotion of CA in Kenya and Madagascar. With adoption I refer to ‘‘the mental process an individual passes from first hearing about an innovation to final adoption’’ (Rogers, 1983), which despite the focus on the individual psychology has to take into account socio-cultural, economic and political realities. The term ‘promotion’ is loosely applied in this study, and refers to ‘the intentional engagement in activities of individuals and organisations to investigate, fund, support, or up-scale technologies like CA’. As such, promotion is one element of ‘innovation’. The meaning of agricultural innovation, often used to indicate ‘new technology’, is and should be wider to include new processes, social networks and institutional arrangements (FAO, 2014b). The ‘place’ where agricultural innovation is taking place is in the interactions between a diversity of stakeholders and the formal and informal policies and institutions that influence them, a complex referred to as the agricultural innovation system.

Although the main body of data and results in this thesis deals with CA in Kenya and Madagascar, there are several elements that have a wider relevance for sustainable smallholder agriculture in Africa. One such element is the conceptual framework. The conceptual framework in this thesis is based on the capability approach (Sen, 1999; Nussbaum, 2001), a normative framework claiming that the goal of development, including agricultural development, should be to increase capabilities, i.e. the range of options that are realistically open to people. When applied to small-scale agriculture and the two main foci of the thesis, two important questions emerge: To what extent is CA an actual capability for farmers, i.e. a realistic option, and what reasons do they have to make use of that option or not? And: To what extend do technological and institutional innovation processes in the innovation system create capabilities, i.e. expand the range of options open to small-scale farmers that enables them to leading a valuable life? These analytical questions are taken up in the general discussion chapter, based on the empirical findings of this research and the wider literature.

In this chapter I will introduce three important elements that are relevant for understanding CA and its promotion, and relate them to the current research. First, CA can be understood as a farming system that is based on a set of agro-ecological principles. The three defining principles for CA are 1) minimum soil disturbance; 2) permanent soil cover; and 3) crop rotations and associations (FAO, 2014a). The importance of applying agro-ecological principles in small-scale farming in Africa is more and more recognized, partly because small farms in marginal areas have not benefitted much from mainstream agricultural technologies. Instead, agro-ecology builds on location-specific, resource-conserving, participatory management of agro-ecosystems that deliver multiple ecosystem services beyond agricultural productivity (Altieri, 2002).

Second, the adoption of CA by smallholder farmers is a process that is influenced by many factors at different levels. The study of factors influencing adoption of CA starts from the observation that empirical evidence provides contradictory results (Knowler and Bradshaw, 2007), which moreover explain little variance in observed (non-) adoption (Andersson and D'Souza, 2014). Nevertheless, adoption studies are considered important for understanding the impact of promotion projects and policy. Guided by the 'capability' perspective, which emphasizes both the physical possibilities open to a person and an individual choice element, the Reasoned Action Approach is suggested as an alternative avenue for understanding adoption. This behavioural model, building on social-psychology, tries to understand and predict (adoption) behaviour from intentions and attitudinal, social normative and perceived behavioural control constructs (Fishbein and Ajzen, 2010).

Third, the promotion of CA can be seen as an example of Contested Agronomy. For many years the relation between state and agronomy used to be seen as uncontroversial and was centred on the objective of increasing productivity per ha. In recent decades, however, agronomy has become a political arena where different priorities are simultaneously being pursued, including environmental sustainability, farmer participation and (neo-liberal) economic reforms (Sumberg and Thompson, 2012). In this context, this thesis uses a social actor approach to study actors and their interactions in an Innovation Systems perspective. These concepts invite us to approach the processes of knowledge transfer, learning and dissemination in the promotion of CA with an openness for complexity and non-linearity while taking traditionally neglected notions like emergence, interactions and institutions seriously.

1.1 Introduction to CA

1.1.1 CA and agro-ecological principles

For centuries, agronomy was mainly concerned with the search for optimizing farming systems, which traditionally was taken to be the search for achieving higher yields. Agronomy has been an exercise that applied various soil and plant sciences to soil management and crop production (Sumberg and Thompson, 2012). However, in recent decades it has broadened its informational and methodological base (Doré et al., 2011). The contemporary field of agronomy can be more holistically described as *"the scientific and intellectual endeavour that seeks to understand and affect the biological, ecological, physical, socio-cultural and economic bases of crop production and land management"* (Sumberg and Thompson, 2012). Note how this goes beyond soil and plant sciences to include the ecological and socio-economic aspects of farming systems. Contemporary agronomy is increasingly shaped by an ecological perspective on ecosystem functions that support agriculture.

Doré et al. (2011) describe in their review how agronomy is "inspired by natural ecosystems" and how the importance of biological regulation in farming systems is increasing acknowledged. There is increasing consensus on putting *ecological intensification* at the heart of agronomy. Ecological intensification, sometimes referred to as agro-ecology or simply as sustainable intensification, recognizes that farming systems are not only important for the sake of sustaining and improving food production, but should do this in an environmentally sustainable way (Doré et al. 2011). Moreover, agro-ecosystems and their biodiversity have to provide other ecosystem services, including the recycling of nutrients, the regulation of microclimate and local hydrological processes, suppression of undesirable organisms and detoxification of noxious chemicals (Altieri, 1999). Other important ecosystem services are processes of pollination, filtering water and delivering energy such as hydro-energy or bio-fuels (Millennium Ecosystem Assessment, 2005). Sustainable intensification, as it will be called here in a general way, is emerging as a major priority for national and international policymakers.

The special rapporteur of the UN on the right to food, Olivier De Schutter (2010), addresses the importance of agro-ecology for the realisation of the right to food. From this 'right to food' perspective De Schutter sees three general objectives of food systems. First, the global supply must meet the rising global demand; second, agriculture must develop in ways that increase the incomes of especially smallholder farmers, because they are the most deprived of the right to food; and third, agriculture must not compromise its ability to satisfy future needs. De Schutter (2010) identifies several ways in which agro-ecology contributes to these three objectives and thus to the realisation of the right to food. Not only does agro-ecology raise the productivity at field level, but it has potential to reduce rural poverty, to contribute to improving nutrition, and to support small-scale farming in the adaption to climate change. Therefore he identifies the scaling up of the successful experiences with agro-ecology as the main challenge today with respect to the realisation of the right to food.

Sustainable Crop Production Intensification (SCPI) has been accepted in 2010 as FAO's first strategic objective (FAO, 2011). It is a broad agenda that reflects the hope for a win-win situation in which the two challenges of feeding the world's growing population and protecting the environment can be met at once. In order to achieve that objective, FAO promotes an ecosystem approach to agriculture. The ecosystem approach can be seen as one that endorses agro-ecological principles. In its recent publication "Save and Grow" FAO refers to the ecosystem approach as a new paradigm in which the ecosystem underpins the intensification of crop production. *"Essentially, the ecosystem approach uses inputs, such as land, water, seed and fertilizer, to complement the natural processes that support plant growth, including pollination, natural predation for pest control, and the action of soil biota that allows plants to access nutrients"* (FAO, 2011). Crop production based on an ecosystem approach sustains the health of farmland already in use, and can regenerate land left in poor condition by past misuse (Tittonell, 2014).

The ecosystem approach to SCPI identifies three technical objectives for farming systems (FAO, 2011):

- Simultaneous achievement of increased agricultural productivity and enhancement of natural capital and ecosystem services;
- Higher rates of efficiency in the use of key inputs, including water, nutrients, pesticides, energy, land and labour;
- Use of managed and natural biodiversity to build system resilience to abiotic, biotic and economic stresses.

Conservation Agriculture is based on three principles that can theoretically contribute to the three objectives of the SCPI described above. These principles are:

1. **Minimizing soil disturbance** by minimizing mechanical tillage in order to maintain soil organic matter, soil structure and overall soil health;
2. **Enhancing and maintaining a protective organic cover** on the soil surface, using crops, cover crops or crop residues, in order to protect the soil surface, conserve water and nutrients, promote soil biological activity and contribute to integrated weed and pest management;
3. **Cultivating a wider range of plant species**- both annuals and perennials- in associations, sequences and rotations that can include trees, shrubs, pastures and crops, in order to enhance crop nutrition and improve system resilience against pests.

CA can be seen as a technology package that puts these three principles to use. According to the specific contexts where it is applied, CA can take various forms. In SCPI, these principles are ideally further supported by the implementation of other 'good management' practices such as the use of suitable crop varieties and integrated soil fertility-, pest- and water management (FAO, 2011). However, in cases where practising CA requires the use of herbicides, it can be argued that CA is not entirely relying on agro-ecological principles.

Because CA is so broadly defined, it can encompass activities such as zero tillage, ripping, sub-soiling, tractor powered-, animal powered-, or manual direct planting, weed control with herbicides and the digging of Zaï pits or planting basins. In southern Africa, the most widely disseminated CA practice is Conservation Farming (CF), which was developed by Brian Oldreive and combines planting basins and mulching (Andersson and Giller, 2012). CF can sometimes be labour intensive, while a CA system where crops are planted after spraying herbicides, as common in Kenya, generally reduces the work load. Because the actual practices differ per situation, it is important to define what is meant when talking about CA.

1.1.2 How CA ideally works

The idea of CA is that by integrating ecological processes into the farming system, the same (or higher) production can be achieved with much more efficiency (Tittonell, 2014). Whereas ploughed, bare soils are prone to water erosion, evaporation and extreme temperature fluctuations, permanently covering soils enhances moisture conservation, reduces erosion and subdues the soil temperature variations (Hobbs, Sayre and Gupta, 2008). This allows more micro-organisms to survive in the soil, supporting vital biological processes. As the root structures of both crops and cover crops remain intact, soil porosity is increased which, together with a mulch cover, improves both water infiltration and water delivery to the roots (Thierfelder and Wall, 2009).

Instead of using chemical fertilizer, CA primarily taps on biological nitrogen fixation by cover crops, which improves the soil fertility. The smart rotation of various crops can support the control of weeds, pests and diseases (Bunch, 2014). An overview of the main agro-ecological functions of the three CA principles is given in Table 1-1. The FAO summarizes that CA "aims to conserve, improve and make more efficient use of natural resources through integrated management of available soil, water and biological resources combined with external inputs. It contributes to environmental conservation as well as to enhanced and sustained agricultural production. It can also be referred to as resource efficient or resource effective agriculture" (FAO, 2014a).

Besides these agronomic advantages at field level, there are economic benefits at the farm level. If ploughing is mechanized, fuel use and thus production costs go down drastically which has been cited to be the most important reason for adoption of CA by Australian farmers (Kirkegaard et al., 2013). If ploughing is done manually or with animal traction, labour and drudgery, and associated costs, are reduced (Hobbs, Sayre and Gupta, 2008; Gowing and Palmer, 2008). In dryland conditions, CA can increase the probability of having good harvests, thus reducing the risks of investing in the farm (Pretty et al., 2006). In the face of climate change, where total rainfall amounts are sometimes increased or decreased, or rainfall is likely to become more erratic, CA is able to deal with both extremely high and extremely low rainfall, because the water is more efficiently captured and stored (Jat, Wani and Sahrawat, 2012).

Table 1-1 Overview of agro-ecological functions of the three CA principles (Source: (adapted from Kassam et al., 2009)**)**

	Contributing CA principle		
Beneficial function of CA	Minimum tillage	Permanent soil cover	Crop diversity
Reducing labour and fuel costs	X		
Minimize temperature fluctuations in soil		X	
Increasing water infiltration/ reducing soil erosion	X	X	
Reducing evaporation from upper soil	X	X	
Increasing soil biology activity	X	X	
Improving water balance	X	X	
Nutrient cycling	X	X	X
Increasing rate of biomass production	X	X	X
Binding C and N into soils	X	X	X
Controlling pests and diseases			X

The abundance of potential benefits does not mean that there are no problems associated with CA. Giller et al. (2009) argue that concerns on initial yield decreases in the first years of adoption are often observed with CA. Also, smallholder farmers in sub-Saharan Africa experience a lack of sufficient biomass for effective mulching because of poor crop productivity and competing uses for crop residues as fodder in crop-livestock systems. Although it seems obvious that stopping ploughing reduces labour time and costs, smallholder farmers sometimes actually face an increase in labour during weeding (Giller et al., 2009). Thus, trade-offs in the farming system are important to consider, rather than focussing on the performance at field level alone. Moreover, because CA is quite counterintuitive and knowledge intensive, it is difficult for smallholder farmers to realize the potential benefits, especially in the short term (Mazvimavi and Twomlow, 2009).

A discussion of the agronomic functioning of CA almost naturally flows into a discussion of advantages and disadvantages of CA for smallholder farmers; it is only a small step to the discussion of their consequences at farm level in terms of labour, opportunity costs and returns. These factors also seem to give clues as to why CA is sometimes adopted or not. However, as section 1.3 will introduce, understanding adoption goes beyond understanding the agronomic performance of a technology, or a calculation of its economic returns to a farmer. It is a complex interaction of benefits and constraints at different levels, and trying to adopt CA often means having to overcome social, biophysical, technical, financial, infrastructural and institutional/political constraints (Friedrich and Kassam, 2009).

1.1.3 Global spread of CA

Estimating areas under CA is difficult for various reasons. Adopting only a part of the technology, e.g. minimum tillage, does not equate to adopting CA. Observations at a single moment in time are not conclusive to establish the adoption of all CA practices (particularly crop rotations) and enquiring adoption through surveys gives the difficulty that although a farmer may practise CA, they might do so only on a small portion of the land. Moreover, adoption studies often operate in an 'artificial' project context where it is nearly impossible to determine instances of sustainable adoption (Andersson and D'Souza, 2014). Therefore, the scientific literature often uses the area under no-till as a proxy for the area under CA (e.g. Derpsch & Friedrich 2010).

The FAO is monitoring the adoption of CA. For this purpose, FAO defines minimum tillage as a practice where "the disturbed area must be less than 15 cm wide or less than 25% of the cropped area (whichever is lower)" (FAO, 2014a). The organic soil cover is considered to comply with CA if the soil is at least 30% covered. The third principle of crop rotations is not considered to classify land under CA, but it is recorded if present. There is evidence of adoption in a wide variety of countries, on all the continents in a variety of agro-ecological conditions. "CA is practiced by farmers from the arctic circle (e.g. Finland) over the tropics (e.g. Kenya, Uganda), to about 50º latitude South (e.g. Malvinas/ Falkland Islands); from sea level in several countries of the world to 3,000 m altitude (e.g. Bolivia, Colombia), from extremely dry conditions with 250 mm a year (e.g. Morocco, Western Australia), to heavy rainfall areas with 2,000 mm a year (e.g. Brazil) or 3,000 mm a year (e.g. Chile). No-tillage is practised on all farm sizes from less than half a hectare (e.g. China, Zambia) to thousands of hectares (e.g. Argentina, Brazil, Kazakhstan). It is practised on soils that vary from 90% sand (e.g. Australia) to 80% clay (e.g. Brazil's Oxisols and Alfisols)" (Friedrich, Derpsch and Kassam, 2012).

An overview of the global adoption of CA based on estimates, however, reveals a clear pattern of where CA is most favoured by farmers. Table 1-2 shows that the area under CA, both as percent of world total area under CA and as percent of arable land, is high in the Americas and Australia and

New Zealand. But in Asia, Europe and Africa the percentage of CA adoption remains low. This thesis will continue to focus on understanding the (limited) adoption of CA in sub-Saharan Africa.

Table 1-2 Area under CA as proportion of arable land by continent (Area under CA: Friedrich, Derpsch and Kassam (2012), total arable land: FAO (2012))

Continent / region	Area under CA (x 1000 ha)	Area under CA (% of world total	Total arable land (x 1000 ha)	Arable land (% of world total)	Area under CA (% arable land)
South America	55464	44.4%	167815	12.0%	33.1%
North America	39981	32.0%	201026	14.4%	19.9%
Australia and New Zealand	17162	13.8%	47693	3.4%	36.0%
Asia	4723	3.8%	466924	33.4%	1.0%
Russia and Ukraine	5100	4.1%	152268	10.9%	3.3%
Europe	1352	1.1%	274749	19.7%	0.5%
Africa	1013	0.8%	237135	17.0%	0.4%
World total	**124795**	**100.0%**	**1395894**	**100.0%**	**8.9%**

1.2 Context of the study

1.2.1 The ABACO project

This research took place within the context of the ABACO project, which stands for 'Agroecology-Based Aggradation-Conservation Agriculture'. This project aimed at targeting innovations to combat soil degradation and food insecurity in semi-arid Africa (Tittonell et al., 2012). The EU-funded project, an initiative of eight institutes from Europe and Africa[1], was implemented in seven sub-Saharan African countries including Madagascar and Kenya. The project built on the results and conclusions of the CA2AFRICA project that was implemented from 2009 to 2012 and aimed at analysing the impact and foreseeing the adoption of CA in Africa (European Commission, 2010).

The overall objective of the ABACO project was "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 of conservation agriculture based on agroecology principles, to combat land degradation and food insecurity in semi-arid regions on Africa" (European Commission, 2010). Four specific objectives were (1) to target CA to smallholder 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

[1] Partners in the ABACO project included ACT-network (Kenya), CIRAD (France), NRI (UK) Wageningen University (The Netherlands), CIRDES (Burkina Faso), FOFIFA (Madagascar), SOFESCA (Zimbabwe), Yellow Window (Belgium) and EMBRAPA (Brazil).

the face of climatic variability; (2) to involve farmers, researchers, extension agents and NGOs in co-Innovation Platforms to promote the adaptation/appropriation of technologies by local communities; (3) to assess the social and economic viability and trade-offs of 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 (Tittonell et al., 2012).

The project worked mainly with organised farmer groups, and invested in their institutional development to ensure sustainable co-Innovation Platforms, their expansion and dissemination; and equal representation and capacity for participation and decision-making for women and men (Tittonell et al., 2012). The approach to focus on location-specific co-Innovation Platforms was considered important because of the complexity and knowledge-intensive nature of CA. It was envisaged to include all the relevant stakeholders in the agricultural innovation system in iterative technology development through action research which facilitates co-learning (Posthumus et al., 2011). The starting points for such platforms were in many cases existing Farmer Field Schools (Kenya) and Learning Centres, and sometimes new groups were created (Madagascar).

The research was carried out independently from the project activities. From the perspective of the researcher, the connection with the ABACO project was limited to working with the FFSs that were part of the project, and to make use of some of the logistical infrastructure. From the perspective of the farmer however, I was often seen as part of the project, and therefore responses to the questions were considered to be influenced by this perception.

1.2.2 CA in the study areas in Kenya and Madagascar

CA has been introduced to Laikipia County in Kenya through several projects starting in 1997, mostly by means of extension, training and the establishment of Farmer Field Schools (FFS) (Kaumbutho and Kienzle, 2007). The FFS members were introduced to CA in 2007-2008 during the CA-SARD[2] research project. The ABACO project established demonstration plots with the FFS members to experiment with, and evaluate, a number of different treatments based on the three CA principles. Some farmers experiment with potatoes under CA, but the majority of farmers apply CA to their maize crop. Mulch is mainly realised from crop residues and sometimes supplemented with tree branches and grasses, while cover crops are realised with dolichos (*Dolichos lablab*), butter beans (*Phaseolus coccineus*), cowpeas (*Vigna unguiculata*) and pigeon peas (*Cajanus cajan*). For conventional land preparation mechanical or manual ploughing is done, while under CA most farmers first slash the weeds manually, then do manual or animal-drawn ripping and direct planting, and spray a Glyphosate-based herbicide (mostly Weedall) (Min. of Agr., 2013).

[2] Conservation Agriculture Project- Sustainable Agriculture and Rural Development. Implemented in two phases from 2004 to 2010, see section 4.4.2.

Conventional weeding is done with a *fork jembe* (which turns the soil) while many CA farmers do 'shallow weeding' with a *panga* or a specially designed *shallow weeder*.

In the Lake Alaotra region in Madagascar, the first field experiments on CA practices took place in the early 1990's, motivated by the performance of CA in tropical conditions in Brazil. From 1992, the design of cropping systems has been led by a Malagasy NGO called TAFA, and assisted by engineers from CIRAD (Naudin, 2012, p. 8). Between 2003 and 2013, there was a large project for the '*Mise en valeur et protection des Bassins Versants du Lac Alaotra*', or BV-Lac. This grew to an initiative to promote sustainable and productive agricultural practices at the watershed level that involved many research and extension institutes. The main technology promoted was CA, by the local stakeholders referred to as *Semis Direct sur Couverture Végétale Permanente* (SCV). Estimates of CA adoption in the Alaotra region range from 2000 ha in 2009, according to a GSDM[3] brochure, to 1400 ha in 2010 (Rakotondramamanana, Husson and Enjalric, 2010), to 419 ha in 2010 (Penot et al. 2011). The latter research found that many farmers did not adopt CA *sensu stricto,* but rather incorporated some improved management elements such as improved seeds, the use of herbicides, or mulching.

The ABACO project activities in Madagascar were limited to two farmer groups of about 30 members each. These groups were trained by the project, and seeds were provided for a shared experimental plot. The nature of the experiments was decided on by the group, while the outcomes of the experiments were jointly monitored by the project and the farmers. Compared to Kenya, the study area in Madagascar has a huge diversity in terms of both crops and cover crops, partly due to the long ongoing research and the intrinsic diversity in types of fields and geomorphology. Common CA rotations on the hillsides, locally called *tanety,* included maize in association with cowpea (*Vigna unguiculata*) or rice bean (*Vigna umbellata*), dolichos (*Dolichos lablab*), crotalaria (*Crotalaria* spp.), velvet beans (*Mucuna pruriens*) pigeon peas (*Cajanus cajan*) or vetch (*Vicia villosa*). For aggradation of degraded hillside land, farmers sometimes planted several years of stylosanthes (*Stylosanthes guianensis*) followed by upland (Asian) rice (*Oryza sativa*), or brachiaria (*Brachiaria brizantha* or *B. ruziziensis*) in association with cassava. On the lower, more fertile alluvial soils, locally called *baiboho,* farmers generally grow rice in season, and due to the shallow water table they can grow an off-season crop, typically vegetables or a cover crop such as vetch (Husson et al., 2013; Naudin, 2012). In CA, these rotations are planted without ploughing, which requires controlling weeds and cover crops with herbicides or manually. Most farmers own and use animal-drawn ploughs in their conventional farm systems; no mechanical implements exist for direct planting for which farmers simply use the *angady kely* (small shovel).

[3] GSDM: Group for Direct Planting in Madagascar, a network organisation of stakeholders involved in CA at the national level.

1.3 Understanding adoption processes

The adoption of CA is a topic that evokes many different arguments and exposes a multitude of perspectives on farming, science and development. Most adoption studies seek to better understand the driving factors for adoption, in order to increase the actual adoption rates of a technology that is assumed to work. Indeed, the 'mysterious non-adoption' of technologies in SSA farming has puzzled not a few researchers, and the adoption of technology in smallholder farming is sometimes called 'disappointing' (e.g. Corbeels et al. 2013). The way adoption is being studied, that is its methods and assumptions, reveals a lot about the researcher's view of humanity, but also about the pathways through which science is thought to make an impact.

As will be discussed in more detail in the literature review, the list of factors that potentially have an influence on a persons' choice to adopt a technology is practically endless. These factors include bio-physical characteristics of the farm (such as agro-ecological zone, steepness of slopes, farming system), characteristics of the technology to be adopted (such as its complexity, associated costs and benefits), demographical characteristics (such as age, education level, wealth, ethnicity), psychological and attitudinal characteristics (such as perception of degradation, innovativeness/ conservativeness, willingness to take risks), cultural characteristics (such as values, power distributions), institutional characteristics (such as land tenure security, effectiveness of farmer groups, functioning of markets), and finally other context-level factors (such as climate, climate change, legislation, policies) (e.g. Prager & Posthumus 2010; Mazvimavi & Twomlow 2009; Knowler & Bradshaw 2007).

Moreover, the adoption process is often depicted as consisting of a cognitive phase in which perceptions play an important role, a normative level in which one makes a decision, and a conative phase in which the effort and continued use are determined (Ervin and Ervin, 1982; De Graaff et al., 2008). Considering that these phases are not necessarily followed in a linear way, and each group of factors influences each phase and each other in unique and different ways, we get a good taste of the bewildering complexity of the adoption literature.

To make sense of this complexity, researchers use simplified decision models which in turn will also determine what kind of results are obtained. Therefore, when selecting a model for the study of adoption, researchers rely on making pre-analytic decisions that will determine part of the outcome. Giampietro (2003), cited by Röling et al. (2004), defines a pre-analytical choice as the "choice of relevant goals, variables, and explanatory dynamics for the selection of an explanatory model". Ervin and Ervin (1982) distinguish three paradigms that approach adoption as a result of certain pre-analytic decision, as being a matter of respectively economic constraints, adopter perception or innovation diffusion. For this thesis, our pre-analytical choices for a model to interpret the reasons for adoption behaviour are guided by the capabilities approach. The capability approach attributes importance to the individual freedom to choose from the options that are open to a person, even though it may be limited by circumstances and influenced by a social environment. This suggests that we approach adoption as a mostly rational choice and have to avoid cultural, economic or psychological determinism.

The adoption of CA by smallholder farmers is studied with the Reasoned Action Approach, which aims at understanding social behaviour from intention. Intention in turn is traced back to three main constructs that have been developed in social psychology: Attitude towards the behaviour; perceived social norms about the behaviour; and perceived behavioural control over the behaviour. Although this behaviour model relies on quantitative data, it is supported by qualitative methods such as observation and informal interviews during the frequent field visits.

1.4 Agricultural innovation: CA as contested agronomy

As discussed earlier (section 1.1), the 'new paradigm' of sustainable intensification can be seen as an emerging consensus within the subject matter of agronomy among an increasing number of actors (Fowler and Rockstrom, 2001). This does not mean, however, that agronomy is a field of consensus where all research gradually makes progress in one direction. Indeed, the apparent consensus on sustainable intensification and the justification of CA principles can often mask the fundamental debates that are going on. There are many different priorities, agenda's and world views that continuously challenge each other at different levels. Giller et al. (2009) questioned the univocal promotion of CA for smallholders in sub-Saharan Africa, using slightly provocative terminology to contrast CA 'believers' and 'heretics'. This opened a discussion that was not only about the agronomy of CA principles, but also about the politics of its promotion. Sumberg and Thompson (2012) observe that CA is indeed an example of what they call 'contested agronomy'. Their analysis highlights that agronomy is not only changing in its subject matter, but also towards a position of *contestation* among the actors concerned with agriculture and rural development.

Sumberg and Thompson (2012) argue that while the relation between agronomy and the state used to be uncontroversial for the most part of the 20th century, the past four decades have seen three important developments that have changed the context within which agronomy takes place. At least until the mid-20th century agronomy operated largely as part of the state. Agronomic research took place in state-led universities, ministries and research institutes, and thus it supported the economic, political and social agendas of the state by generating knowledge and technology that was considered useful. However, the unity of purpose between government policy and agronomic research has been reduced since around 1970.

Sumberg and Thompson (2012) argue that as a response to the growing conviction in society that state-led development was inefficient, environmentally damaging and undemocratic, three important developments have taken place. One is 'the promotion of the neoliberal project' which refers to the wave of economic liberalisation and reform that spread the developing world in the form of structural adjustment programmes. This was driven by the idea that markets are the most efficient way of allocating resources and thus of achieving the greatest public good. Second, the 'environmental agenda' emerged after some parties started realising the ecological damage associated with widespread use of chemicals, and intensive mono-culture farming, such as the loss of biodiversity, problems of salinization, waterlogging and health problems effects. Third, the 'participation agenda' emerged from the conviction that science and state-led research rarely benefited the poor, and thus required the empowerment of the poor, and approaches that put the 'farmer first', also in the design of agricultural research (Sumberg and Thompson, 2012).

These three general developments have changed the nature of agronomy in the past decades and opened up new spaces of contestation over the goals and priorities for agricultural research, which we also need to consider in order to make sense of the confusion and contradictions around the promotion of CA. Andersson & Giller (2012) explore the history of research on CA and try to understand the current drive to promote CA. They argue that there is a disconnection between the agronomic knowledge base and the level of promotion in Zimbabwe, and that the current interest for CA is not following in a logical manner from agronomic experimentation. Instead it is due to the push from a new epistemic community. An epistemic community can be understood as a network of professionals that share a set of norms, principles and a notion of validity of knowledge, and who are responsible for aggregating and articulating knowledge and interests, and disseminating those beliefs e.g. by identifying promising policies (Haas, 2001). In Zimbabwe, the rise of an epistemic community of faith-based organisations, calling CA 'farming God's way', international research institutes, and policy organisations pushed the promotion of CA as a successful, promising option for smallholder farmers (Andersson and Giller, 2012). This particular example shows how religion, policy, development and science have become intertwined, and how agronomy takes place in a particular political arena.

Because of the contested nature of CA, it is important to take into account the different perspectives on the promotion of CA. The innovation and promotion efforts to make CA successful in sub-Saharan Africa are made by social actors with different motivations, rationales and assumptions, actors who belong to certain epistemic groups that frame CA in particular ways. This thesis is cognisant of these political aspects of the promotion and adoption of CA and has therefore adopted an Innovation Systems approach that can broadly be defined as "the interaction of individuals and organisations possessing different types of knowledge within a particular social, political, policy, economic, and institutional context" (Hall et al., 2007). Rather than finding general definitions of CA, and trying to find one best-bet approach of its promotion, the AIS perspective invites to analyse differences in perspectives, knowledge and actions between actors, and how their interactions are shaping the environment in which CA can become an option for farmers.

1.5 Research objectives and - questions

The overall aim of this research is to better understand the composition of the agricultural innovation systems in both countries and to understand what this implies for farmers' capabilities to engage in innovation processes, in particular in relation to the promotion of CA and the reasons for (non-)adoption of CA in smallholder farming systems in Kenya and Madagascar. By combining qualitative and quantitative research methods, this research aims at contributing to the literature on the Agricultural Innovation Systems (AIS) approach by investigating stakeholders' different views on innovation and what this means for the promotion of CA. Furthermore, the study aims at gaining insight in the adoption process by applying a social-psychological decision model, the Reasoned Action Approach, to the adoption of CA. Finally, this study aims at making a contribution to the thinking about priorities for agricultural development in sub-Saharan Africa at the conceptual level, by exploring a capability approach to development that explicitly values freedom of opportunity for farmers. The three research questions are introduced below. The sub-questions are presented in the methodology chapter, in section 4.2.

1. **How does innovation and dissemination of Conservation Agriculture take place in Kenya and Madagascar?**

The goal of this research question, which is addressed in Chapters 5 and 6, is to describe the individuals and organisations involved in the promotion of CA, in terms of their objectives, actions and interactions. The concept of innovation systems is used as a metaphor for this system of interactions that together create capabilities for innovation, or form an obstacle to it. Because CA is considered to be a knowledge-intensive technology, there is an emphasis on tracing back the trajectories of knowledge, including its creation, modification, framing and use.

2. **What influences smallholder farmers' decisions for (non)adoption of CA?**

The goal of this research question, which is addressed in Chapter 7, is to understand the decision making concerning the (non-)adoption of CA in the regions of Laikipia, Kenya and Lake Alaotra, Madagascar. On the basis of a literature review of adoption studies, and of a reflection on the limitations of conventional adoption studies it was decided to use a socio-psychological decision model, specifically the Reasoned Action Approach.

3. **What opportunities for and limits of agricultural innovation emerge from the cases studied in Kenya and Madagascar?**

This sub question is addressed in the general discussion, Chapter 8, and aims at coming to a synthesis of the first two research questions by using the conceptual framework of the Capabilities Approach, and the distinction between purposive and communicative rationality. The identified key elements in the adoption process and the described dynamics in the agricultural innovation system form the basis to understand some of the opportunities and limitations of the promotion of CA and agricultural innovation processes in general.

1.6 Structure and summary of the thesis

The thesis consists of eight chapters: four introductory chapters (Chapters 1-4), three result chapters (Chapter 5-7) and the final chapter (Chapter 8) where the findings of this study are summarized and critically discussed.

Chapter 2 provides a literature review in two parts. In section 2.1-2.5, the literature about the adoption of Conservation Agriculture is explored, identifying key issues and debates, and highlighting some broader perspectives on adoption studies. In section 2.6-2.11, the literature about the promotion of CA is explored, giving an account of different paradigms of agricultural innovation, extension, with a particular focus on AIS thinking and the difference between *purposive* and *communicative* rationality and action. **Chapter 3** presents a conceptual framework, where both innovation and adoption are put into perspective. Innovation is presented as a process that potentially increases farmers' 'agricultural capabilities', the basket of options open to farmers, and adoption is presented as a choice from these capabilities into an actual practice. Chapter 3 also gives some theoretical perspectives and justifies the choice of the Reasoned Action Approach as a heuristic to conceptualize decision making. **Chapter 4** gives an overview of the study areas in Kenya and Madagascar, the sampling strategy for field work and the research methods used.

Chapter 5 is a the most descriptive of the result chapters, setting out to describe the agricultural innovation systems for CA in both countries in terms of the main stakeholders and their interactions. It also describes the extension methods used in CA projects and how stakeholders view the innovation system. This provides a basis to draw analytical lines between the innovation systems and innovation processes at the field level. **Chapter 6** presents results on how stakeholders see their own role in the innovation system, how they legitimise their involvement in CA and through what narratives they 'frame' the importance of CA. It also gives an impression of the diversity of stakeholders' 'Theories of Change'. **Chapter 7** presents results that give insight into the adoption process, including how many farmers intend and adopt CA practices. Following the Reasoned Action Approach, intentions are further explored by examining attitudes, social norms and perceived behavioural control, and the underlying beliefs.

Finally, **Chapter 8** summarizes the rationale of the study and the main results, and critically discusses the findings. The question is raised to what extent the 'promotion' of CA in the innovation systems addresses the adoption constraints experienced by farmers. Another question is to what extent farmers' capabilities are enhanced by CA projects, drawing on the capabilities approach and the distinction between purposive and communicative rationality. The thesis ends with outlining some implications of the findings for policy and future research.

2 LITERATURE REVIEW

Adoption of Conservation Agriculture

2.1 Introduction to literature review

There is a long and diverse tradition of studying the uptake of technologies that improve production of smallholder farmers and/or reduce negative environmental impacts. This broader field of science is often referred to as 'adoption studies' and it has contributed substantially to understanding the different factors that have an influence on the adoption decision, and the phases a farmer may go through before actually implementing a production or conservation technology. These phases include the acceptance of the practice, the decision to adopt, and the efforts put in the realization and maintenance (De Graaff et al., 2008). Rogers (1983) has defined the adoption process as ''the mental process an individual passes from first hearing about an innovation to final adoption''. The study of adoption as an individual process can be distinguished from, and must not be confused with, the study of how technologies spread in a certain area, i.e. the diffusion of innovations (Rogers, 1983). Another meaning of the word adoption, the way it is often used in practice, is the actual putting in practice of a technology in a measurable context. In Rogers' quote above we recognise it as 'final adoption', and I sometimes refer to it as the 'actual adoption' which also refers to the level or intensity of technology use. So we can distinguish between the 'adoption process' with a focus on the psychology of the farmer (or any other adopter), the diffusion of innovations with a focus on the social processes that influence the spread of a technology at different scales, and the 'actual adoption' with a focus on the technology and its consequences in practice.

Another definition that must be clarified is the object of adoption: is the 'thing' that is adopted an innovation or a technology? In this thesis, Conservation Agriculture is not called an innovation, but a technology, or indeed a technology package. Rogers' research became famous as the diffusion *of innovations* (Rogers, 1983). This suggests that the innovation is a ready-to-go product or technology, and includes a notion of the product or technology being new to an area or application. In that often encountered terminology, agricultural science can be seen as one of the developers of 'innovations' that then can be made ready for 'adoption' through a process of dissemination resulting in 'diffusion'. In this thesis, however, innovation is seen in a broader way, as a process among stakeholders that results not only in new technology, but also in a renewed shared understanding, a shared socially constructed reality (Röling, Kuiper and Janmaat, 1996). The nature of agricultural innovation is discussed from section 2.6 onwards.

A systematic grouping of the different factors influencing adoption is pursued in the next section (**2.2**) to get a grip on the complexity of factors influencing the technology adoption process in smallholder agriculture in general, and to explore whether it makes sense to aim for convergence towards universal understanding of adoption, or rather to target the understanding of adoption to particular cases. This is elaborated in **section 2.3** that describes constraints to CA adoption in sub-Saharan Africa. The limited diffusion of CA in sub-Saharan Africa is not a unique case; very often there have been 'promising' agricultural technologies that were accompanied by 'disappointing' adoption (Erenstein, 1999). Therefore, some broader perspectives on adoption studies are explored in terms of their logic and objectives, and some of their limitations (**section 2.4**). Finally, advances in understanding the adoption process with social psychology are explored with a special attention for the Reasoned Action Approach which features as a research method in this study (**section 2.5**).

2.2 Factors influencing adoption, an overview

The list of factors that potentially have an influence on a persons' choice to adopt a technology is practically endless. In their important review, Knowler and Bradshaw (2007) identified 167 distinct variables used in 31 adoption studies, which they managed to narrow down to 'only' 46 variables for the purpose of their synthesis. Such factors typically focus on field-level bio-physical factors, farm-level socio-economic factors and context-level institutional factors. Based on a review of several articles an overview was made of categories of factors, and specific factors (see Table 2-1). This overview is drawing on literature about the adoption of CA and other soil and/or water conservation practices in smallholder farming. The factors influencing adoption include bio-physical characteristics of the farm, characteristics of the technology to be adopted, demographical characteristics, psychological and attitudinal characteristics, cultural characteristics, institutional characteristics, and finally other context-level factors (Knowler and Bradshaw, 2007; De Graaff et al., 2008; Machado and Silva, 2001; Mazvimavi and Twomlow, 2009; Pretty et al., 2006; Gowing and Palmer, 2008; Fowler and Rockstrom, 2001; Andersson and D'Souza, 2014; Prager and Posthumus, 2010; Ervin and Ervin, 1982; Erenstein, 2003).

De Graaff et al. (2008) argue that adoption of a conservation practice is a process with an important time dimension and different phases. They distinguish between an acceptance phase, an actual adoption phase, and a continued use phase. These phases can be linked to, respectively, the cognitive, the normative and the conative phases of adoption (Prager, 2002). Prager and Posthumus (2010) note that personal, institutional and some environmental factors are more important at the cognitive level; at the normative level the personal, institutional and economic factors are dominant; and at the conative level the institutional and economic factors play the most significant role in determining the intensity and continued use of adoption.

Table 2-1 Overview of factors that influence adoption of conservation practices in smallholder farming (Source: Knowler & Bradshaw 2007; De Graaff et al. 2008; Machado & Silva 2001; Mazvimavi & Twomlow 2009; Pretty et al. 2006; Gowing & Palmer 2008; Fowler & Rockstrom 2001; Andersson & Souza 2013; Prager & Posthumus 2010; Ervin & Ervin 1982; Erenstein 2003)

Factor category	Factors
Bio-physical factors	Agro-ecological zone, drought stress during growing season, steepness of slopes, distance to homestead, total farmland area, degradation status
Economic factors	Labour availability and costs, required investments, increased harvest, reduced costs, complexity of technology, crop/livestock farming system, trade-offs
Demographic farmer characteristics	Age, gender, household size, education level, wealth, ethnicity, off-farm income, presence of head of household, experience
Psychological and experiential factors	Attitude, mind-set, perceptions, innovativeness, willingness to take risks, flexibility, self-identity, past experience,
Psychological factors	Attitude, mind-set, perceptions, innovativeness, willingness to take risks, flexibility, self-identity
Socio-cultural factors	Social capital, values, power distributions, leadership, peer pressure
Institutional factors	Land tenure security, effectiveness of farmer groups, functioning of markets, incentives, access to inputs, extension, project approach
Context factors	Climate (change), legislation, input/output markets, policies, projects, infrastructure

Therefore, it is not sufficient to relate a factor directly with ‘adoption’ because it impacts adoption differently in different stages. Similarly it is recognized that factors influencing adoption will have different importance in the short term and the long term. Short-term economic benefits or long-term soil fertility gains are a classic example of a trade-off in agricultural decision making (Erenstein, 2003). The same differentiation can be made on the basis of different scales: institutional and policy factors will have a dominant impact on adoption at the regional level, while bio-physical factors may be more important at the field level, and at the farm level the economic factors together with household objectives are the most important factors that influence adoption (Corbeels et al., 2013). The implications of the complexity of adoption studies are further discussed in section 2.4, but first a more elaborated overview is given of the constraints to CA adoption specific to sub-Saharan Africa.

2.3 CA adoption in SSA: constraints and opportunities

Why is the adoption of CA limited so far in Africa? One way of approaching the question is by noting that African smallholder farmers generally operate under many constraints, and thereby differ from e.g. typical large-scale farmers in Australia. CA seems to make good sense "in extensive dry land cropping systems on erosion-prone, structurally-unstable soils, where input and labour efficiency is paramount to maintain profits in export-focused, unsubsidized commodity markets" (Kirkegaard et al., 2013). The question arises what the scope can be for CA in achieving the food security and agricultural productivity objectives in the subsistence-oriented, less mechanized systems of smallholder farmers in sub-Saharan Africa. Some authors are in a sense pessimistic about the adoption prospects for CA in SSA. Kassam (2009) summarizes that "with food security among their major objectives, many small-scale farmers are hesitant to invest scarce labour, land, seed and fertilizer in cover crops that do not result in something to eat or to sell. They also suffer from restricted access to relevant knowledge as well as to inputs or credit". Indeed, some argue that CA is not, or not yet, appropriate for farmers in such constraining environments (Gowing and Palmer, 2008; Giller et al., 2009), or that even though it can work for smallholders in some contexts, CA should not necessarily be the first priority (Baudron, Andersson, et al., 2012).

While the promotion of CA as a concept defined in terms of the three principles may be novel, many of its associated techniques as minimum tillage, mulching, green manures and cover crops, intercrops and crop rotations have been practiced, promoted and researched for many decades. Gowing and Palmer (2008) observe that for the adoption of CA, there is a remarkable similarity with the reasons for adoption or non-adoption of soil conservation practices. They conclude that "widespread adoption of the new paradigm amongst millions of small farmers in order to achieve the 'doubly green revolution'[4] in SSA is subject to the familiar constraints of knowledge transfer […]" (Gowing and Palmer, 2008).

[4] References to a new 'green revolution' in Africa, and the suggestion that various complex problems can and should be tackled at the same time through double- or triple-win innovations (i.e. practices that simultaneously contribute to sustainability and development objectives, including improving soil productivity and fertility, climate change mitigation and adaptation, food security and rural development etc.) are also met with criticism, see for example (see for example Naess et al., 2014; Brooks, 2014)

2.3.1 Agronomic factors

Starting with the critical observers of the increasing Conservation Agriculture promotion in Africa, we can see several hindrances to the adoption of CA by smallholder farmers in Africa. In their review about the potential of CA as a sustainable agricultural practice for Africa, Gowing and Palmer (2008) doubt massive future adoption by smallholder farmers. An important reason for them is that although CA is promoted as a low-input system, which is an important precondition if CA is to be adopted by poor smallholders, the evidence shows that it is more likely that CA is adopted by relatively wealthier farmers who have access to fertilizers and herbicides. This is also observed by Tripp (2006), when he concludes that "although many types of low external input technology are able to make significant contributions to improving farm productivity and conserving natural resources, there is no evidence that they are particularly suited to resource-poor farmers", and surprisingly, their patterns of adoption do not differ significantly from Green Revolution technology. Wall (2014) also counters the idea that CA is a way of "growing more with less". Instead of being a low-input system, the benefits of CA lie in using the inputs more efficiently than in conventionally tilled systems (Wall, 2014).

The need for inputs and resources has to do with one of the biggest obstacles to the adoption of CA: the difficult weed control when no longer ploughing. Ploughing affects weeds by burying seeds deep underground, and uprooting and cutting weeds, thus preventing massive infestation. Moreover, in the absence of ploughing, perennial weeds become a big challenge (Chauhan, Singh and Mahajan, 2012). If ploughing is to be replaced with manual weed control, CA is likely to increase the work-load, in many cases particularly so for women (Giller et al., 2009). For the small farmers who rely on manual family labour, CA can require more work, and if they adopt CA, the area that can be cultivated is limited according to the available labour. On the other hand, if herbicides can be used, smallholders can save labour from both the omission of tillage and the fast and effective weed control using herbicides during the growing season (Hobbs, 2007).

Thus, the application of herbicides is likely to be linked to the adoption of CA. In Brazil, a 17% increase in smallholder herbicide use was observed with systems of minimum tillage compared to land that was cultivated in a conventional way (Bolliger et al., 2006). The increase of herbicide use under CA is also noted by Rockstrom et al. (2009) who add that the purchase of herbicides can put an unbearable pressure on resource-poor farm households in SSA who have no access to financial support systems. This financial burden comes on top of the limited availability of affordable quality products in local markets, and often limited knowledge to use them. Moreover, the higher organic matter content and the presence of crop residues in zero-till systems can reduce the (soil-active) herbicide activity (Chauhan, Singh and Mahajan, 2012). Each of these problems with weed control is always 'luring' farmers back to the familiar plough that offers a certain and often cheap solution to the immediate problems arising from the new farming system. On the other hand, overcoming the constraints to buying and using inputs can support the uptake of CA.

A possible alternative for herbicides in weed control is the use of green manure cover crops and mulch for suppressing weeds, corresponding to CA's second principle of permanent soil cover,. Weed response to residue cover is different for each residue type, residue amount and weed species. There are examples in literature where weeds are more abundant under a mulch cover, presumably because they benefit from the improved water retention (e.g. Young & Cousens, 1999). Although the effects of crop residue on the weed population are likely to be dynamic depending on the rainfall and crops (Chauhan et al., 2012), generally the emergence of weeds declines in response to increasing residue amounts (Mohler and Teasdale, 1993). The second and third principle of CA are also promoted as ways of controlling weeds (IIRR and ACT, 2005). However, it is a recognized problem that trials on experimental sites are not necessarily useful for the farmers' fields. Baudron, Andersson et al. (2012) note that most measurements of the effects of mulch are done under controlled conditions. The trial fields are fenced and soils are well covered with mulch, unlike farmers' fields that are subject to a lack of biomass for soil cover, and where free-grazing institutions make it often difficult to maintain the cover throughout the year.

Many authors have explored the trade-offs in the use of crop residues as mulch, fodder, fuel or construction materials for smallholder farmers (e.g. Erenstein 2003; Giller et al. 2009; Naudin et al. 2014). Because of the economic and cultural value of livestock in many areas of SSA it is unlikely that farmers can retain sufficient quantities of residues on their field as soil cover to obtain the beneficial results of this aspect of CA. Three other challenges work together to make it difficult to realize a good mulch cover in many areas of sub-Saharan Africa: First, biomass production is limited on degraded soils with limited rainfall; second, the biomass is quickly decomposed by termites and the high temperatures; and third, it is often not possible to keep the livestock from grazing the fields, thus reducing the available biomass and compacting the soil. Chauhan (2012) therefore concludes that in terms of weed control there is a need to integrate herbicide use with residue retention to achieve season-long weed control in sub-Saharan Africa.

Besides weed control, mulch and cover crops have other important effects on the soil, such as reducing water runoff and increasing infiltration (e.g. Thierfelder & Wall 2009). The resulting increased soil water availability under CA has several benefits for the farming system. Naudin (2010) concluded that the increased water availability due to mulch extended the flowering period and increased the yield of cotton in semi-arid areas. Moreover, Baudron, Tittonell et al. (2012) argue that in sub-humid and semi-arid areas that are characterized by frequent droughts and dry spells, CA enables planting before the first effective rains, thus increasing the use efficiency of limited rains, and thereby stabilizing yields (Haggblade and Tembo, 2003; Erenstein, 2003).

2.3.2 Gender and CA

An underrepresented topic in CA literature is how gender affects the functioning and adoption of CA. Although women play a key role in agriculture worldwide, especially on smallholder farms in SSA, cropping and farming system research and development have paid little attention to gender issues so far (Beuchelt and Badstue, 2013). And despite the promotion of CA in developing countries for more than 20 years, there is a lack in understanding of how returns of CA are different to male and female labour and the land owned or managed by each (Baudron et al., 2007). Giller (2009) noted that the changing labour requirements in CA shift from tasks normally performed by men, such as ox-drawn or hand ploughing, to tasks that are mainly performed by women, such as manual weeding. “Without a reallocation of the gender-division of these roles in agricultural production this may lead to an unacceptable increase in the burden of labour on women” (Giller et al., 2009, p. 27). Baudron et al. (2007) observed the same, but argue that spreading demand for labour could also allow households, especially women and children, to carry out lighter tasks and diversify their activities.

Beuchelt and Badsteu (2013) cite an example of promotion of intercropping in Zambia. Traditionally, maize is controlled by men, especially the high-yielding varieties, whereas beans are considered to be women’s crops. The promotion of intercropping resulted in women being reluctant to adopt, because they feared it would affect their entitlements to the beans. Also, if the men would gain entitlements over the beans, women feared the men would sell it for income instead of for household consumption. They thus resisted adoption of an yield-increasing technology for the sake of food and nutrition security (Beuchelt and Badstue, 2013).

These observations remind us of the limits of the household as unit of research, as intra-household relations are likely to be changed by the introduction of new agricultural technologies due to new patterns of labour, resource and land allocation between men and women. It is not possible to predict these influences in advance, nor is it possible to say who will benefit or lose from adoption (Beuchelt and Badstue, 2013). But it is clear that the two main advantages of CA – yield increases and labour savings are not always equally shared by all farm household members, and adoption is influenced by the intended and unintended impacts of the technology, also at the individual level.

2.3.3 Institutional factors

Institutional factors can be a major constraint to sustainable adoption of CA in Africa. Gowing & Palmer (2008) observed that “it is clear that the key to the widespread adoption of CA in Brazil has been the success of ‘innovation networks’ and in particular the presence of agrochemical companies as agents with sufficient coverage and resources to promote developed technologies.” Despite disagreeing with the previous authors on other points, Mazvimavi and Twomlow (2009) agree that the private sector will need to actively participate in the provision of necessary agricultural inputs to support the uptake of CA in Africa. At the same time, they conclude that active support by both NGOs and government change agents through the supply of seed, fertilizer, and training increased the likelihood of CA adoption (Mazvimavi and Twomlow, 2009).

Although projects and donor-funded programs are significantly influencing adoption in the short term, the projects acknowledge the importance of the private sector for the sake of sustainability. Indeed, if sustainability is to be achieved, the temporary project-based assistance programs should be gradually replaced by properly functioning markets (Andersson and D'Souza, 2014). Many CA systems are based on the use of exogenous varieties of which the seeds are not readily accessible for farmers, just like the fertilizers and herbicides. Market institutions are equally important to 'pull' CA adoption through output markets. The potential economic returns of planting a cover crop, for example, highly depend on the legume markets (Enyong, Debrah and Bationo, 1999).

2.3.4 Profitability of CA

Several studies found that factors such as the profitability of the conservation measures for the farm household are linked to adoption (De Graaff et al., 2008). De Graaff et al (2008) conclude that "if farmers have a prospect of gaining long-term financial benefits (e.g. increased production, reduced labour input, higher off-farm income, etc.) they will be more motivated to actually adopt, maintain and replicate soil and water conservation measures". Gross margin analyses that are done with and by farmers, comparing before and after the adoption of CA, are usually very positive. For example, a livelihoods study with the ABACO project in Kenya found a case where the gross margins for growing maize went from a loss of 11590 KSh in conventional farming to a profit of 2780 KSh with CA. Another farmer went from a Gross Margin of 11000 KSh to 21700 KSh (Pound, 2014). In this calculation labour is assumed to have a value of 200 or 250 KSh per man-day which is used for planting, weeding and harvesting. However, if family labour is used in the labour intensive conventional system, this money need not actually be spent (Baudron, Andersson, et al., 2012). But for the sake of comparing, the message is clear that not only net margins, but also returns to labour are increased. Economic analyses have shown higher returns under (partial) CA adoption in Southern Africa, both in dry and wet years (Mazvimavi and Twomlow, 2009). And: "the significant yield gains realized from adopting Conservation Farming practices also offset the production costs associated with the technology. This improves viability and provides an incentive for CF adoption by smallholder farmers in Zimbabwe and potentially elsewhere in SSA"(Mazvimavi and Twomlow, 2009). The profitability has been reported to come partly from yield increases and from reduced costs (Erenstein, 2003).

Pannel et al. (2013) applied an economic modelling approach to understand the apparent disparity between reported potential income gains with CA and the limited adoption. They conclude that the potential economic gains from switching to CA are not large, and are primarily realised on larger, better resourced farms (i.e. farms more abundant in key resources such as labour and capital). They also conclude that switching to the full CA package sometimes results in economic losses, especially on smaller farms. This is due to the fact that Pannel et al. define the economics of CA broadly, thus not only including profitability but also constraints on resources and risk and uncertainty. Andersson and D'Souza (2013) argue that household economic analyses of CA adoption have some weaknesses. First, the commonly used argument in the CA literature is that higher yields and production can be used to offset higher costs. However, besides the returns, the costs also increase when switching to CA. New tools, such as rippers and sprayers, additional fertilizer and herbicides may be required (Kaumbutho and Kienzle, 2007). Mobilizing cash for farm inputs at the beginning at the season is already a challenge for many smallholder farmers, so increasing them by practicing CA is problematic. Second, in many situations it is more likely that increased crop production will be used to relieve seasonal hunger of food insecure households, rather than being sold and becoming available for higher investments in agriculture (Andersson and D'Souza, 2014).

2.4 Broader perspectives on adoption studies

2.4.1 Inconclusive, contradictory evidence of 'factors influencing adoption'

Overviews like Table 2-1 can give a misleading sense of science's capability to understand adoption. Knowler and Bradshaw (2007) concluded that "the aggregated analysis of the 31 distinct analyses of conservation agriculture adoption reveals few if any universally significant independent variables. While some regularly assessed variables such as 'education' and 'farm size' seem to show convergence towards a significant and positive influence, there were incidences of insignificance across all studies […]" (Knowler and Bradshaw, 2007). They note that it appears that "with increasing investigation of individual variables thought to influence adoption, their causal impact only becomes less certain".

Similar conclusions can be found in other research traditions. The behavioural approach, for example, relies largely on attitudes to explain adoption. Wicker (1969, p.75) reviewed all accessible literature in the behavioural approach tradition and was confronted with an abundance of contradictory evidence. He concluded that ''the present review provides little evidence to support the postulated existence of stable, underlying attitudes within the individual which influence both his verbal expressions and his actions'' (Wicker, 1969; Burton, 2004).

The question arises why the abundance of factors that influence adoption, and the insight into the phases of adoption does not go hand in hand with better prediction and understanding of adoption patterns. Why is actual adoption often called *surprisingly* low? Indeed, Knowler and Bradshaw's inference is that “the absence of any clear universally significant factors affecting conservation agriculture adoption, and especially the sometimes contradictory results observed across analyses, makes [… the] task of developing policies to promote globally the adoption of conservation agriculture particularly challenging”. They argue that future research should aim at finding key variables in farmers’ decision to adopt particular conservation agriculture technologies in particular regions that are meaningful for local management rather than for universal understanding (Knowler and Bradshaw, 2007, p. 45).

In their review paper on CA and smallholder farming in Africa, Giller et al. (2009) questioned whether CA should be so widely promoted for smallholder farmers in Sub-Saharan Africa (SSA). The main concluding argument was that CA systems probably do not fit within the majority of current smallholder farming systems in SSA. They argued that CA can offer substantial benefits for certain farmers in certain locations at certain times, recognizing the wide diversity of farmers in terms of resource endowments and farming systems. Therefore, the challenge for research is to identify where and how particular CA practices may best fit, and which farmers in any given community are likely to benefit the most (Giller et al., 2011). This is what I refer to as ‘targeting’, which will be explored as an approach to innovation in section 2.11.

2.4.2 Justification of adoption studies

In many ways, the seminal work of Ervin & Ervin (1982) about factors affecting the use of soil conservation practices contains the blueprint for many adoption studies that followed. The paper starts with noting that *“not since the Dust Bowl era of the 1930s has there been such widespread interest in soil erosion and ways to control it”*(Ervin and Ervin, 1982). The ‘Dust Bowl era’ refers to the huge wind erosion events that occurred in the United States as a result of a persistent and severe drought together with farming practices that lacked proper erosion control. This environmental degradation went hand in hand with significant economic costs. The ‘widespread interest in soil erosion and ways to control it’ refers not least to the political dimension: It became a priority in US Congress to reduce the vulnerability of the agricultural lands to erosion, and the Department of Agriculture started programs to promote soil conservation practices among farmers. Although the adoption of conservation practices happens largely on a voluntary basis, the US government tries to influence it with adequately stimulating policy.

When reviewing the adoption literature, it appears that most adoption studies of conservation practices similarly justify themselves by elaborating on the problems of land degradation, e.g. soil and water conservation measures to stop land degradation (De Graaff et al., 2008). They also position themselves in this policy context by noting that *“*the results [of the research] should prove useful for designing conservation policy and programs” (Ervin and Ervin, 1982). A pattern can be recognized in which there is a known problem, which draws public policy attention, to which a *known* technology is thought to offer the solution. Increased understanding of the adoption process can enhance the programs that lead to higher adoption rates of this technology and thus help to reduce the problem. In that way, adoption studies often deploy an instrumental reasoning, where either implicitly or explicitly a largely linear process is presumed in which the adoption study functions as the feedback channel. Adoption studies, by their nature, seem to be part of an instrumental rationality, in which the found 'determinants' can be included in improved and more effective policy or projects. In section 2.9.2 the distinction between instrumental and communicative rationality in the promotion of agricultural practices like CA in agricultural innovation systems is further explored.

Looking at the justification of CA promotion in projects and proposals, and to a lesser extent research literature, two subtly different approaches can be distinguished. CA is sometimes justified by the 'negative motivation' of apparent degradation and unsustainability, e.g. CA to combat soil degradation and food insecurity (Tittonell et al., 2012). However, an interest in CA is also often justified in terms of their positive opposites like 'aggradation' (e.g. European Commission 2010), sustainability and food security (e.g Hobbs 2007) and climate-resilient agriculture (e.g Milder et al. 2011). Another observation is therefore that the adoption of technology is generally not just valued for its own sake, but is justified as a means to prevent further negative developments or as a means to contribute to positively formulated ends. The justification of adoption studies is closely related to the justification of policy and project interventions, especially in the narratives and 'framing' of a problematic. This is further discussed in section 6.4.

2.4.3 Disappointing adoption

A good part of the recent research literature on Conservation Agriculture have framed their research using a recurring narrative, e.g. "Conservation Agriculture is increasingly seen as a promising farming system to achieve sustainable agricultural intensification. However, adoption by small-holders in Sub Saharan Africa is limited so far" (Corbeels et al., 2013). It has become a well-known chorus that can be heard in offices of the FAO, at Farmer Field Schools and not least in research institutes. This typical introductory sentence does two things. Firstly, it delineates a technical, agronomic problem of how to achieve sustainable agricultural intensification, and suggests that the solution might very well be found in CA. Secondly, it delineates another problem: the situation of mysterious non-adoption of CA. Although it seems to be an unambiguous statement, it can be explained in two different directions that have consequences for the kind of problem we are dealing with.

These two directions present themselves when we ask ourselves who it is that sees CA as such a promising farming system, and the answer will determine the kind of problem that we have at hand. If it is the smallholder farmers that see CA as a promising option, and their adoption is limited, we have to proceed with identifying why smallholder farmers are unable to realize the farming system that they already want. There is no need to convince farmers of a potential benefit of pursuing CA because they already see it as a promising alternative farming system. A big challenge remains, because there are the constraints at field level to deal with, and in SSA these constraints are big. The challenge is how to make the smallholder farmers more 'able' to adopt CA, which includes assisting in specific know-how and knowledge support systems.

However, if it is not the smallholder farmers who consider CA as promising solution, but the policy makers at local, national and regional level, the challenge takes a different turn. In this case the first step will be to convince the smallholder farmers of CA as a beneficial alternative to their current practice. From the policy point of view, the challenge is how to make smallholder farmers more 'willing' to adopt CA, which is an issue of communicating the necessity, convincing of the benefits and educating for a changing perception. If this is the case, and I will argue that it is largely so, it does not mean that the first challenge disappears. The second 'willingness challenge' simply adds to the 'ability challenge'.

A conclusion at this point is that for actors who want to promote CA it is not enough to stand on the scientific basis of the 'promises' of CA on the assumption that farmers share their perspective. Different perspectives exist, and in many cases the first challenge is to overcome a different starting point through a form of interaction in which mutual understanding is increased. If farmers come to share a supportive perspective on the technology, the sustainable actual adoption will depend on their ability, not only in terms of knowledge and know-how, but also from new links with e.g. input and output markets, i.e. institutional factors.

2.4.4 How 'factors' influence adoption

Adoption studies usually hypothesize a number of independent variables that may influence the farmer's decision to adopt a certain technology. This is then examined through econometric analysis. This, however, does not necessarily increase our understanding of *how* these factors are exercising their influence. It can even be argued that a reliance on standard survey instruments using variables such as age, sex, education level, household size, farm implement ownership, causes our understanding of CA adoption by smallholder farmers to be limited (Andersson and D'Souza, 2014). A closer look reveals that the hypothesized influence found through correlation is not one of causation, but its relation with actual adoption is explained with a general narrative that gives some hints as to which underlying mechanism are responsible for this influence. Below, the often used factors 'age' and 'wealth' are discussed.

The 'age' variable is often included in the analysis with the narrative that "the elderly people tend to be conservative about their way of life unlike the young who are dynamic in their worldview"

(Muroki, n.d.). Moreover, it is suggested that younger farmers may have longer planning horizons and therefore may be more likely to invest in conservation (Lapar, 1999). On the other hand, longer farming experience as equated with older farmers is expected to have a positive effect on adoption. This leads Lapar to observe that “the net effect [of age] on adoption, therefore, could not be determined a priori” (Lapar, 1999). But on what basis could it be established a posteriori? Is it a matter of deploying one of the explanatory rationales, depending on whether the found relationship is positive or negative? In all narratives of the influence of age in the examples above, it is not age itself that has an influence on adoption. Instead, age is taken as a proxy for conservativeness, dynamism, length of planning horizon and farming experience respectively.

Another problem which, I would argue, is intrinsically related to standard household survey questions is the imperatives that follow from the results. For example, Somda et al. (2002) found that higher age is negatively related to adoption of composting technology. They conclude that “the negative impact of the farmer’s age raises the problem of which category of farmers should be involved in the development of such a technology” (Somda et al., 2002). With higher adoption of the technology being the implicit objective, promotion of the technology should focus on younger people who are “likely to be prone to innovation”. In this way, the elderly people are subordinated to the success of the technology. This perspective also assumes both elderly people and the technology to be largely static, unchanging, unadaptable entities. If, however, the promotion of the technology in the first place has to do with general livelihoods objectives such as reducing soil degradation and improving food security, it may be more appropriate to search for ways in which the technology can be adapted to the people instead of the other way round.

Similarly, the ‘wealth’ variable is often seen as an important factor to influence adoption of CA or other technologies on smallholder farms. Knowler and Bradshaw (2007) observe that in support of this view, a majority of analyses (not all) that investigated the impact of income, gross income and farm profitability on adoption revealed a positive correlation (e.g. Somda et al., 2002). The source of income is also important, as off-farm income has two contrasting explanatory narratives. One is that having off-farm income increases the possibilities to invest on the farm, thus favouring adoption of technologies. On the other hand, having alternative income sources could diminish the priority of agriculture within the household, thereby reducing interest in especially conservation (Fernandez-Cornejo, 2007). So with increasing off-farm income, a motive to invest in new (conservation) technology may disappear, while the possibility gradually appears.

Andersson and D’Souza (2013) discuss how the influence of cattle, taken to be an indicator of wealth, appears to be contradictory for the adoption of zero-tillage in southern Africa. A significant positive relationship between cattle ownership and adoption and use of zero-tillage was found in northern Zimbabwe. They quote Chiputwa et al. (2011) who postulate that having cattle not only relates to the ability to invest, but also that "the bigger the herd, the more the labour and capital requirements for management purposes and hence the need to explore labour saving technologies (e.g. zero-tillage)". Alternatively, one could argue that given the importance of oxen in some farming systems for animal-drawn ploughing, it would be expected that owning oxen negatively influences adoption of minimum-tillage.

For adoption of CA in Zambia, the relationship with cattle ownership was found to be negative. Arslan et al. (2013) studied adoption of Conservation Farming (CF) in Zambia with several wealth indicators, and found that better-off households are more likely to adopt, but households with more oxen are significantly less likely to adopt CF. This leads Andersson and D'Souza to observe that "while the use of more specific indicators thus produces more clues as to the relevant characteristics of CA adopters, the actual mechanisms (or resource allocation strategies) leading households with more oxen to adopt or not adopt CA remain opaque" (Andersson and D'Souza, 2014).

Other dimensions can be added to explain the influence of wealth and cattle, as wealth also has to do with economic stratum. Previous studies found that people with higher status tend to invest quicker in soil and water conservation (SWC) practices because they can take risks associated with adoption of new practices (e.g. Kessler 2006). Also, in a project context, farmers are rarely asked to pay for the training or seeds of new varieties that come with the introduction of a new technology. On the contrary, farmers sometimes receive allowances to attend meetings. Besides the problem of measuring adoption in such a context, this can serve as an explanatory narrative for finding no significant statistical relationship between income levels and farmers' decisions to adopt new crops (Muroki, n.d.). It can be noted that wealth is therefore a very broad category that is taken as a proxy for ability to invest, status, attachment to the farm, and more. This suggests that the influence of wealth is mediated by more than one factor. There are indeed narratives to explain a positive, negative or no statistical relationship.

This shows that if the underlying mechanisms of found relationships remain opaque, and the 'black box' between the correlating dependent and independent variables is filled with an intuitive narrative, the conclusion is neither very useful for improved policy, nor does it increase the understanding of the complex functioning of diverse smallholder farming households, their resource allocation strategies, and labour relations (Andersson and D'Souza, 2014).

2.4.5 CA adoption: Push or pull?

On the first Africa Congress on Conservation Agriculture held in March 2014 in Lusaka, one of the recurring questions that participants asked themselves was: If CA is such a good and promising practice, why is it not spreading like a wildfire through Africa? Friedrich and Kassam (2009) asked this question, and start by noting that "the simple answer is that the answer is not that simple." In their paper about the constraints and opportunities to adoption of CA, several challenges to farming systems are identified as the so-called 'opportunities to the adoption of CA'. These "actual opportunities which are facilitating change" (Friedrich and Kassam, 2009) are:

1. Crisis and emergencies, such as the soaring food prices, which makes people more receptive to opportunities for change.
2. Increasing environmental concerns and pressures regarding the sustainability of production processes and the natural resource base, which is increasingly putting agriculture under pressure.
3. Rising input and energy costs, calling for improved input use efficiency and productivity.
4. Challenges of climate change for which CA holds promising adaptation and mitigation options.

Friedrich and Kassam (2009) call these opportunities, because they argue that when the risks to the existence of a farming system are bigger than the risks of changing the farming system, farmers will try a new practice like CA. Their reasoning seems to be that before a farmer is convinced to change her practice, there must be problems with the old practices, which 'pushes' her to explore new avenues. This interpretation of 'opportunities', where the constraints of one technology are the opportunities of the other, is true in the sense that there must be a reason for a farmer to change her practices. They interpret the success of CA in Brazil in the same way: "Only in very few occasions, as was the case with the southern parts of Brazil in the 1970s, the problems with conventional tillage-based farming practices become so severe that spontaneous adoption occurs despite these constraints. In that case, it was the uncontrollable water erosion combined with extremely poor profit margins for farmers" (Friedrich and Kassam, 2009, p. 2).

We can contrast this 'constraints push' towards CA adoption with the 'agronomic pull' of field-level and farming system level advantages. With the 'agronomic pull', emphasis is given to beneficial agronomic and economic impacts of CA that can convince farmers towards adoption, such as better yields, saving inputs, timely planting. It is therefore opportunity driven. On the other hand, the 'constraints push' feeds from the awareness that something is wrong, that there is a need to change, such as instances of persistent land degradation and declining fertility or food insecurity. It is therefore driven by necessity. Although they appear to be two sides of the same coin, they represent different influences in the force field of the adoption process. Also, it reminds us again that the adoption of CA is not the final objective, but a means towards objectives such as sustainability and productivity in smallholder farming. If CA adoption were a goal in itself, one could only hope for dramatic climate change, rising energy costs and environmental hazards, as it would push farmers to change their practices.

2.5 Reasoned Action Approach and adoption studies

As further explained and justified in the conceptual framework chapter 3.5, the Reasoned Action Approach (RAA) was selected as a model for understanding adoption of CA. In this section, the main components of the RAA are discussed, as well as critiques that have emerged in the scientific literature. Additionally, some applications of RAA to conservation behaviour and technology adoption are discussed.

2.5.1 About the RAA

The Reasoned Action Approach (Figure 2-1) is the latest version of an attitude-behaviour model in social-psychology that developed from the Theory of Planned Behaviour (TPB) which in turn developed from the Theory of Reasoned Action (TRA) (Ajzen, 2005; Fishbein and Ajzen, 2010). According to the TRA, engaging in an action depends on having the intention to do it, which, in turn, depends on the attitude towards the action and the perceived social norms. An explicit assumption within the TRA was that people have complete volitional control, which is difficult to maintain. This led to the introduction of an additional construct in the TPB with a hypothesized influence on both intention and behaviour: perceived behavioural control (PBC). PBC is seen as a factor that influences intentions alongside attitudes and social norms (Ajzen, 2012), while actual behavioural control (ABC) accounts for the extent to which people are able to act on their intentions. By including the actual control in the model, it has been argued that TPB models link complete volition theories (reasoned action) and constrained volition theories (derived demand) (Lynne et al., 1995). The RAA can be seen as a refined version of the TPB, using the same structure but building on theoretical and methodological advances in social-psychological understanding of the approach's components (Fishbein and Ajzen, 2010).

Attitude has been described as "the primary building stone in the edifice of social psychology" (Allport 1954; in Wicker 1969, p.41) following the assumption that attitudes, being evaluative predispositions, have consequences for the way people act. As such, attitudes have been extensively studied. In the RAA, the attitude towards a behaviour is assumed to follow from behavioural beliefs. These beliefs can be defined as "a person's subjective probability that performing a certain behaviour will produce a particular outcome, and the subjective evaluation of that outcome" (Ajzen, 2012). These two components together, the expected outcome and the value attached to the outcome, are known as the expectancy-value model of attitude. Attitudes towards an object are assumed to be formed automatically and inevitably as new beliefs are formed about the object.

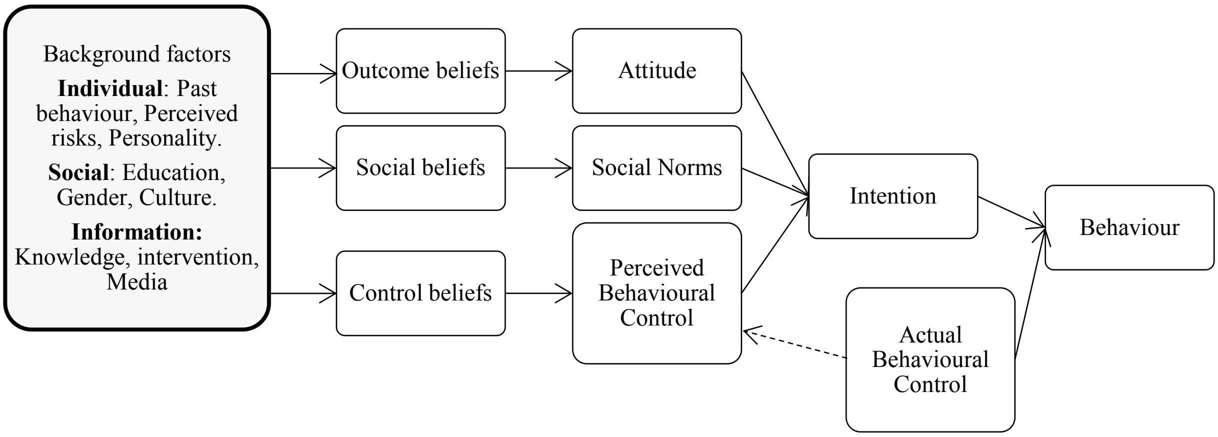


Figure 2-1 Simplified model of the Reasoned Action Approach. (Source: Fishbein and Ajzen, 2010)

So, despite the words 'rational' and 'planned' in the respective approaches, the RAA does not claim that people form attitudes in a rational manner by objectively assessing their set of beliefs towards a specific action, and deliberating at length before engaging in any behaviour. These beliefs may well be biased, inaccurate or even irrational. The meaning of the *reasoned* action lies in the assumption that attitudes reasonably and consistently follow from beliefs, sometimes through careful deliberation but most often in an automatic and spontaneous manner (Fishbein and Ajzen, 2010, p. 24).

Social norms are important, as people are strongly influenced by the opinions and behaviours of others. The hypothesis that peer pressure influences the intention to engage in a particular behaviour features in the TRA and TPB as the construct 'subjective norm', and in the RAA as 'perceived norm' (RAA). Again, the perceived norm is assumed to follow from normative belief, that is, a belief that a particular referent other wants us to perform a given behaviour (Ajzen, 2012). Norms are thus defined in a narrow sense, as being related to a specific behaviour (Fishbein and Ajzen, 2010, p. 130). Fishbein and Ajzen (2010) go beyond the previous definition of 'subjective' norm by distinguishing between 1) the perception of what ought to be done with respect to a specific behaviour, that is the *injunctive* norm; and 2) the perception that others are actually performing the behaviour, that is the *descriptive* norm. Analogous to the expectancy-value model of attitude toward behaviour, the perceived injunctive norm is determined by both the strength of the normative belief and the motivation to comply. The descriptive norms can influence intention directly, as people often copy others' behaviour, but it can also influence the intention indirectly in several ways. It can do so by giving clues to whether the behaviour is rewarded or punished by others, thus informing the injunctive norm. Also, it can affect attitudes by observing positive or negative outcomes from others performing the behaviour. Finally it can influence the perceived behavioural control, as observing others gives clues to the practical barriers that need to be overcome when adopting a behaviour (Fishbein and Ajzen, 2010).

The perceived behavioural control (PBC) is the third construct that is hypothesized to have an influence on intention to engage in a specific action. PBC stands for the individual's perception of the extent to which the performance of the behaviour is easy or difficult (Ajzen, 1991). It is a measure of Bandura's (1982) concept of self-efficacy (Conner and Armitage, 1998), and can also be found in literature as self-directedness, choice, decision freedom, agency, mastery, autonomy or self-determination (Rodin, 1990). Control can be seen as a continuum ranging from easily executed behaviours to behavioural goals demanding resources, opportunities, and specialized skills. The assumption is that people are more likely to engage in easy behaviours of which they are confident that they can carry them out, and they are prevented from carrying out behaviours over which they have no control. The concept *locus of control* is also relevant as it draws attention to both internal and external factors that play a role in control (Rotter, 1966). Having an internal locus of control means that engaging in the behaviour is thought to be mostly up to the person itself, while having an external locus of control means that a person considers other factors such as fate, powerful others, etc., to determine their control. So in the most general sense, PBC is linked to the perception of the behaviour being 'up to me' and being 'easy' (Fishbein and Ajzen, 2010). The actual behavioural control refers to the personal capacities, skills, knowledge, emotions and other internal factors that enables someone to act upon their intention. It also refers to the extent that they can overcome external obstacles in their environment. If the behavioural control is high, the intention alone should be enough to predict behaviour, while if the behavioural control is low, intention and control jointly affect the behaviour in consideration (Ajzen, 2012).

2.5.2 RAA and adoption

RAA (or TPB) models are generally used to understand a range of *general* human behaviours such as pro-environmental behaviours (as opposed to *specific* practices). Examples are Taylor and Todd (1995) who looked at recycling and composting, and Harland et al. (1999) who looked at reducing energy use. There are many studies that emphasize the importance of 'personal characteristics' without adopting the full TPB model (e.g. Quinn & Burbach 2008). For their study of hillside farmers' environmental behaviours in a context of land degradation in Haiti, Bayard and Jolly (2007) considered personal characteristics in addition to economic and socio-demographic factors. Similarly, Vignola et al. (2010) combine beliefs and knowledge, risk perceptions, and values with a set of socioeconomic factors. Although these studies go beyond economic or demographic variables and result in interesting findings, there is some conceptual arbitrariness in their models.

Actual applications of the RAA (or TPB) to adoption decisions in agriculture are scarce. This is an illustration of the schism between agricultural adoption studies and the social sciences (Burton and

Wilson, 2006a). Lynne et al. (1995) applied the TPB to water-saving technology adoption and technology investment behaviour for Florida strawberry farmers and are often cited as the first to apply the TPB in agricultural decision making, including investments. A study on pro-environmental agricultural practices among dry-land farmers in Australia was able to predict 52% of the variance in behaviour (Price and Leviston, 2014). However, their model was a combination of Value-Belief-Norms and TPB, and the behaviour under consideration 'conservation behaviour' which is a complex, general kind of behaviour. Similarly, a study using the TPB was used to understand farmers' 'conservation-related behaviour' (Beedell and Rehman, 2000). Another study used TPB to understand farmers' willingness to supply ecosystem services for payment (Greiner, 2015). The above studies show that the TPB can be applied to more general conservation behaviours. However, Fishbein and Ajzen (2010) underline the importance of considering specific behaviour for getting more accurate results.

The TPB has also been found effective to explain *specific* agricultural decision making. Intentions to practice riparian zone management in Australia could be explained by the TPB (Fielding et al., 2005). Fielding et al. (2005) found that it is beliefs about the benefits rather than the costs of riparian zone management that are critical for influencing the adoption. The TPB was used for understanding farmers' uptake of organic farming in Ireland (Läpple and Kelley, 2013), as well as intention to adopt improved natural grassland in Mexico (Borges et al., 2014). The adoption of water conservation measures by farmers in Iran was studied with the TPB, complemented with measures for normative inclinations as well as perception of risk (Yazdanpanah et al., 2014). The 'normative inclinations' construct of Yazdanpanah et al. was a conglomerate of attitudes, subjective norms, moral norms and self-identity, and results indicate that especially this factor was explaining intention. They also concluded that the relative contribution of their constructs was different for the various farmer groups they interviewed, a similar conclusion as the one drawn by Läpple and Kelly (2013).

Wauters et al. (2010) applied the TPB without additional constructs to the adoption of soil conservation practices in Belgian agriculture. They found that the attitude towards the behaviour was the main item, while perceived control was not significant in explaining intention or adoption. This means that the Belgian farmers felt they could adopt the practices if they wanted to, but intended not to because of a negative attitude towards these practices (Wauters et al., 2010). Their results, predicting intentions with a validity of 44% - 70%, allowed for policy recommendations towards the agro-environmental schemes that apparently were not successful in fostering positive attitudes.

Besides the present research (Van Hulst and Posthumus, 2014, 2016), only one study is know that applies the TPB to adoption of conservation agriculture (Lalani et al., 2016). Lalani et al. come to the conclusion that farmers' attitude is the strongest predictor of intention followed by PBC and subjective norms. Underlying the positive intention, they found that an improved yield is the strongest driver followed by labour advantages and an improved soil quality (Lalani et al., 2016, p. 88).

This overview, although not pretending to be comprehensive, reveals that applications of the TPB to 'understanding farmers' behaviour' are not many, geographically scattered, often adapted with other variables, and related to very diverse farming practices. However, they share the observation that traditional approaches somehow fall short. The results of applications of the TPB have proven useful by providing deeper understanding of specific actions or general conservation behaviours.

2.5.3 Building on RAA constructs

As the discipline of social-psychology is much wider than is reflected in the Reasoned Action Approach, the sufficiency of these RAA constructs in explaining behaviour has been questioned (e.g. Conner & Armitage 1998). Similar to the development from the TRA to TPB by including the perceived behavioural control construct, many authors have attempted to improve the RAA or TPB models by proposing to add other constructs to it. In this section I will introduce some of the most important proposed additional constructs. As Fishbein and Ajzen are the main authors in the RAA literature, I also consider their view on whether these proposed constructs are likely to improve the RAA model.

Personal moral considerations, or **personal norms**, have been seen as lacking in the TPB (e.g. Kaiser 2006). It is defined as the assessment of whether people themselves think they should engage in a behaviour, as opposed to what others think (which is included in the social norm). Kaiser et al. (2005) acknowledge that "unfortunately", that is despite their theoretical case for personal moral considerations, "the evidence showing a net gain in the explanatory power of a morally extended TPB is ambiguous". Therefore they argue that the Value-Belief-Norm Theory (Stern, 2000) which does lean on personal moral consideration and values is theoretically superior, even though the TPB explains more variance in observed behaviour. Fishbein and Ajzen (1975) argue that people, when answering questions about whether they think they should engage in the behaviour, would most likely be influenced by their beliefs about the behaviour's likely consequences, what they believe important others think they should do or actually do, as well as the potential barriers and facilitating factors. "In other words, the concept of personal norm is very similar to the concept of intention and it is likely influenced by the same kinds of factors" (Fishbein and Ajzen, 2010, p. 285).

Past behaviour is an indicator that has (not surprisingly) been found to influence future action (Conner and Armitage, 1998). Ajzen (1991) argued that the influence of past behaviour is largely mediated by the attitude, perceived norm and PBC. Past experiences of a specific behaviour inform outcome beliefs and valuations and expectations of important others' opinions. The effects of past behaviour should be mediated in particular by PBC, as repetition of behaviour should lead to enhanced perceptions of control. However, it has been shown repeatedly that there is a residual effect in explained variance of intention that is not mediated by the three RAA components (Conner and Armitage, 1998). Fishbein and Ajzen (2010) have to admit that including past behaviour as an additional predictor in the RAA has consistently found to produce a substantial increase (around 10%) in the amount of explained variance. Moreover, often repeated performance of an action leads to habituation, and habitual behaviours may not be amenable to prediction by models such as the TPB (Aarts, Verplanken and Van Knippenberg, 1998). Even well before we can speak of habituation, "there appears to be an empirical case to support past behavior as a predictor of unique variance in intentions and behavior in the TPB" (Conner and Armitage, 1998). The reason why it is not included in the RAA is because it does not meet the 'criterion of causality'. "Unlike attitude, perceived norm, perceived behavioural control, and intention, frequency of past behaviour cannot readily be used to explain performance of later action" (Fishbein and Ajzen, 2010, p. 286). Although it appears to add to the predictive quality of RAA, the mechanisms underlying the residual effect of past behaviour on intentions remain an unsolved puzzle (Fishbein and Ajzen, 2010).

Self-identity has proven to be a popular candidate to complement the RAA. Being generally defined as "the salient part of an actor's self which relates to a particular behaviour" (Conner and Armitage, 1998), it reflects the extent to which an actor sees him- or herself as fulfilling a particular social role. It is assuming that people's self-concepts can influence their intentions and actions. Again, empirical data shows that self-identity can be a moderator between RAA constructs and intention, but also independently accounts for extra explained variance of intentions. Terry and Hogg (1996), for example, show that the degree of identification with a group can influence the relative importance of perceived norms, thus fulfilling a moderator function with intention. Fishbein and Ajzen (2010) argue that although inclusion of self-identity may add to the predictive quality of the model, conceptually and methodologically there is considerable overlap with other constructs and there is little value in adding self-identity as an independent determinant of intention.

Similarly, **anticipated affect** is often considered as a potential factor that influences intention or behaviour by arguing that the RAA does not take sufficient account of affective or emotional reactions (Fishbein and Ajzen, 2010, p. 294). It is assumed that anticipated affective reactions to a behaviour may be important determinants of attitudes and intentions, especially in cases of 'anticipated regret' where the consequences of the behaviour are negatively affectively laden (Conner and Armitage, 1998). An important difference with how the RAA is usually operationalized, is that also alternative courses of action are considered, that is the anticipated affect of *not* performing a behaviour. Moreover, factor analysis shows that in the attitude construct of the RAA, where specific action-related anticipated emotions are often included, there is indeed room for distinguishing cognitive and affective elements, or, as preferred by Fishbein and Ajzen: instrumental and experiential factors. While some argue that anticipated affect deserves an independent role in the understanding of intention (e.g. Richard et al. 1998), Fishbein and Ajzen hold the position that general moods and emotions are sufficiently considered as background factors that influence beliefs, while specific anticipated affect can be accommodated for within the attitudes construct (Fishbein and Ajzen, 2010, p. 249).

Overall, there seems to be room for improving the model in a way that increases its predictive accuracy of intentions in a similar way as the TPB proves to be an improvement of the TRA. While the argument for not including personal norms and anticipated affect as independent factors influencing intention is convincing, the role of past behaviour and self-identity in explaining intentions are clearly not optimally accommodated for in the RAA model. There remains a need for conceptual and methodological development in order to understand the underlying mechanisms, because clearly past behaviour is not *causing* future behaviour (Conner and Armitage, 1998), neither is self-identity a causal mechanism that can reasonably be thought to influence intention in a *direct* way like the other RAA predictors can (Fishbein and Ajzen, 2010).

In the present context where there is not much reference literature for the relative importance of including other RAA constructs for understanding smallholder farming in SSA, the application of RAA in the present study is limited to the standard RAA constructs, which should already explain a reasonable percentage of the variance in intentions.

Promotion of Conservation Agriculture

2.6 Introduction to literature review

This section discusses literature about the promotion of CA, with which I refer to the efforts of dissemination, extension, scaling-up and scaling out of CA through research, policy and projects. In current CA adoption literature, two important approaches are being proposed to increase the adoption of CA in sub-Saharan Africa: Innovation Platforms and tailoring specific technology to socio-cultural niches (Tittonell et al., 2012; Giller et al., 2009). In order to be able to position and understand these approaches, the dominant paradigms of agricultural innovation are described. To understand how promotion of CA is related to innovation at farm level, the chapter builds on Röling's work on how different paradigms of agricultural innovation and approaches in learning and extension have developed over time, and how the approaches reflect different ideas about society. He argues that the 'extension education' in general can either focus on behavioural change, knowledge transfer, advising, facilitating or organisational development.

First, it is appropriate to clarify what exactly is meant with innovation. In section 2.1, CA was approached as a technology, not an innovation. Sometimes, the fact that a technology is new to a certain area is thought to qualify it to be called an innovation. However, Hall (2006) argues that "the notion of novelty is fundamental to invention, but the notion of the process of creating local change, new to the user, is fundamental to innovation". In my thesis innovation is used to refer to a process among stakeholders that results in a renewed shared understanding, a shared socially constructed reality (Röling, Kuiper and Janmaat, 1996). A possible result of this process can be new technology, but innovation is much wider and is often seen as encompassing three elements: technological, institutional and organisational change (Leeuwis and Van den Ban, 2004) which is sometimes referred to as 'hardware' (technology, infrastructure etc.), 'software' (knowledge, skills etc.) and 'orgware' (organisation and capacity building etc.) (World Bank, 2012).

In a discussion of the paradigms of agricultural innovation, it will become clear that a science-based technology-push is not sufficient for realizing the sustainability, livelihood and productivity objectives in sub-Saharan Africa (Altieri, 1999). If technology cannot simply be transferred from an expert's drawing table to the end-users, how *do* we get agricultural innovations to work in practice? Roughly since 2005, the Agricultural Innovation Systems (AIS) model has gained popularity because it is sensitive to "the interaction of individuals and organisations possessing different types of knowledge within a particular social, political, policy, economic, and institutional context" (Hall 2006). In a way, the AIS perspective goes beyond traditional dichotomies of scientific versus indigenous knowledge, or endogenous versus exogenous innovation. It does not picture promotion of new technologies or practices as a communication issue from an expert to a farmer. Instead, there is a notion that technological and institutional innovation are processes, emergent in hands-on action that involves a variety of actors.

The Innovation Platforms and targeting of CA practices, two popular approaches to promote CA, are positioned in the various paradigms. These paradigms can be seen in a continuum of increasing farmer participation in projects and policy, but also as having different underlying rationalities that inform specific dissemination strategies. For the latter, a distinction is made between instrumental, strategic and communicative rationalities (Habermas, 1984). Such distinctions are useful to see the general differences, but for understanding the promotion of CA within an innovation system it needs to be realized that agricultural research and development projects are a mix of linear transfer of technology thinking, attempts at AIS thinking, and everything in between. Understanding the promotion of CA will thus require good understanding of how and why this development towards an AIS perspective has taken place.

2.7 Chronology of paradigms of agricultural innovation

In recent years, research efforts have been put into understanding the processes and mechanisms through which agricultural research is actually put to use, largely as a response to the sub-optimal impact of science on the livelihoods of resource-poor farmers in SSA. One example is the Convergence of Sciences programme which aimed at developing insights into the pathways through which investment in science and technology can improve rural lives. The programme explored how innovation comes to be the emergent property of the interaction among different stakeholders in agricultural development, in a number of case studies in West-Africa (Hounkonnou et al., 2005). Another example is the Research Into Use programme funded by DFID that lasted from 2006 to 2012, and was commissioned to address ways to scale up successful innovations from agricultural research. This project meant a change in direction for DFID to funding agricultural research on uptake rather than on the generation of new technologies (Frost, 2014).

If the challenge is to enhance innovation in agriculture, it is important to study the assumptions that underlie ideas of how agricultural knowledge and science are considered to have an impact. In Table 2-2, a chronological overview is given of four important paradigms of agricultural innovation that have emerged in the last decades. Hall (2007) distinguishes between ‘transfer of technology’, ‘farming systems research’, ‘participatory research’ and ‘agricultural innovation systems’. It can be seen that almost every decade has seen the rise of a new paradigm of innovation, often emerging as a critique on the previous dominant paradigm. The ‘organisation focus’ has kept expanding to include nearly all actors in an AIS approach, while for ‘transfer of technology’ there is only a limited number of actors involved. Röling (2009) argues that there are several conceptually distinct pathways of agricultural innovation. These pathways, briefly described below, also range from the ‘transfer of technology’ to the ‘agricultural innovation system’.

Table 2-2 Overview of paradigms of agricultural innovation (Adapted from Hall et al., 2007; Hall, 2007)

Paradigm	Transfer of Technology	Farming Systems Research	Farmer First / Participatory Research	Agricultural Innovation Systems
Era	Widespread since the 1960s, but building on a very long history of science	Starting in the 1970s and 1980s	Starting in the late 1980s / early 1990s	Since 2005
Purpose	Top-down planning of agricultural research, technology development, and technology transfer	Planning capacity for agricultural research, technology development, and technology transfer	Strengthening communication and knowledge delivery services to people in the rural sector	Strengthening the capacity to innovate throughout the agricultural production and marketing system
Framework	Agricultural research arranged in National Agricultural Research Organisations (NARO)	NARO as part of a National Agricultural Research Systems (NARS)	NARS as part of Agricultural Knowledge Innovation System (AKIS) including education and capacity building	AKIS as part of Agricultural Innovation Systems (AIS) including private sector and other actors
Mental model of activities	Technology supply, through pipeline model	Learn through surveys and modelling	Collaborate in research	Interact and learn for innovation
Farmers seen by scientists as	Progressive adopters, laggards	Important sources of information	Research partners	Important actor among other actors
Farmers' roles	Learn, adopt, conform	Provide information for scientists, learn, adopt	Diagnose, experiment, test, adapt	Co-generate knowledge, institutions and innovation
Core element	Technology packages	Modified packages to overcome constraints	Joint production of knowledge	Facilitated interactional learning and change
Driver	Supply push from research	Scientists' need to learn about farmers' conditions and needs	Demand pull from farmers	Responsiveness to changing contexts
Key changes sought	Farmer behaviour	Scientists' knowledge	Scientist-farmer relationships	Institutional, professional and personal
Intended outcome	Technology transfer and uptake	Technology produced with better fit to farming systems	Co-evolved technology with better fit to livelihood systems	Enhanced capacities to innovate
Innovators	Scientists	Scientists, based on understanding farmers	Farmers and scientists together	Potentially all actors
Role of policy	Set priorities and allocate resources for research	Set priorities and allocate resources for research	Set priorities and allocate resources for research in consultation with different stakeholders	Strengthening enabling environment and support systems coordination

2.7.1 Transfer of technology

The transfer of technology model, also called 'the linear model', 'the pipe-line model' or the 'technology supply push', assumes that innovation mainly originates from formal agricultural research. The technologies are then to be transferred through dissemination to the ultimate users, also called 'end users' or 'ultimate beneficiaries'. In this perspective, cases of observed limited adoption are often considered to be a communication problem, because there is scientific support for the effectiveness of a technology and this needs to be communicated for the users to be convinced.

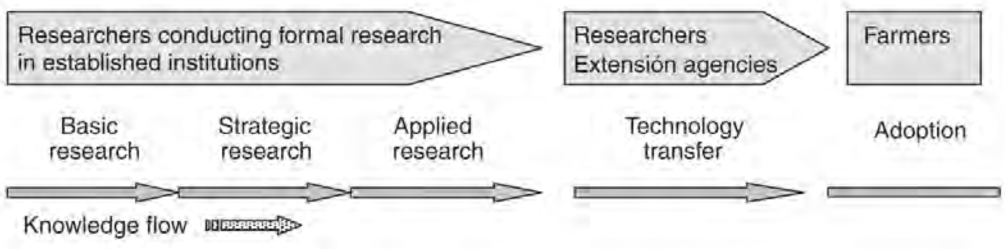


Figure 2-2 A representation of the linear model of technology and knowledge development in agriculture (Source: Wall, 2007; based on: Ekboir, 2002)**.**

There is increasing recognition that, from a perspective of reaching smallholder farmers, the technology supply push model has not been very effective (Röling, 2009a, p. 85). Altieri (1999) notes that "perhaps the most significant realization at the beginning of the 21st century is the fact that the areas in the developing world, characterized by traditional / subsistence agriculture, remain poorly served by the top-down transfer-of-technology approach, due to its bias in favour of modern scientific knowledge and its neglect of local participation and traditional knowledge" (Altieri, 1999). The technology supply push model and its assumption that exogenous technological change can drive social and economic development, have been criticised widely. Chambers and Jiggins (1987) argue that 'transfer of technology' does not fit the diverse and complex conditions and needs of resource-poor farmers. A single-minded focus on technology as the pathway to agricultural development is a *pars-pro-toto* reasoning, in which a necessary condition is taken to be sufficient (Pant, 2014). Röling (2009) argues for example that this approach is blind to institutions.

2.7.2 Participatory development

The participatory – technology – development trajectory is one that acknowledges the value of indigenous knowledge of farmers and actively includes them in the agricultural research process. In participatory technology development it is recognized that if scientific results are to be utilized by farmers it is necessary to know what their conditions are in terms of labour, land resources, access to inputs and markets, etc. The active involvement of the farmer should ensure effectiveness, goodness-of-fit, desirability and feasibility of the developed technologies (Röling, 2009a, p. 86). The strength of this approach is that it allows the development of new configurations of resources that may lead to technological innovation. However, the focus is still on technology while in the very constraining situation of smallholder farmers in Africa, it is also necessary to address the institutional conditions that determine the opportunities (Hounkonnou et al., 2005, p. 364).

2.7.3 Agricultural treadmill

The agricultural treadmill assumes that farms are small firms in a free market who all produce the same commodities. The introduction of an 'innovation' allows its early adopters to capture a comparative advantage, but after diffusion it will lead to overproduction. The farmers who cannot keep up with the change eventually drop out, and their resources are absorbed by those who could adapt. In this way, diffusion leads to fewer farmers but increasing farm sizes and scale enlargement (Röling, 2009a, p. 88). As a pathway for innovation it has led to increased efficiencies in the entire farm sector, mainly in industrial countries. Due to the specific institutional context in most African countries, this pathway is unlikely to bring innovation to smallholder farming (Röling, 2009a).

2.7.4 Agricultural Innovation Systems

The Agricultural Innovation Systems (AIS) approach assumes that agricultural innovation follows from interactions in networks, partnerships and collaborations. The AIS perspective extends the understanding of how actors generate, exchange, and use knowledge from several key actors in agricultural knowledge systems to potentially all actors, both public and private. It focuses on complex relationships among diverse actors, social and economic institutions, and opportunities for technological and institutional change (Spielman, 2006). The AIS approach engages in processes with a heterogeneous set of actors and therefore principles, in a way that evolves over time. Agricultural innovation is seen as the emergent property not of science, or of markets, but of interaction among stakeholders in opportunities for development. "It is their negotiations, conflicts, agreements and ability to undertake concerted synergistic action that determines whether we shall be able to move forward" (Röling, 2009a).

Hall (2006) notes three important advantages of adapting an AIS perspective to the agricultural sector in developing countries: 1) it draws attention to the totality of actors needed for innovation and growth, 2) it consolidates the role of the private sector and stresses the importance of interactions within a sector, and 3) it emphasizes the outcomes of technology and knowledge generation and adoption rather than the strengthening of research systems and their outputs. The key to support change in the agricultural sector is perhaps no longer more knowledge and a strengthened agricultural research system, but rather the facilitation of interactions between a broad set of actors that can take innovation forward.

This approach implies that to stimulate innovation, it is a priority to find ways of developing and adapting habits and practices that foster a capacity to innovate. This implies a shift in interventions away from supporting agricultural research, with a new focus on strengthening patterns of interaction across a whole range of actors involved in innovation (Hall, 2007). An AIS approach requires the facilitation of learning processes and the managing of change, building on the 'soft' capacities of human communication, trust building, diplomacy networking, making sense of messy social situations, political advocacy and leadership (Woodhill, 2010).

2.8 Extension approaches

In analogy with the development of paradigms of agricultural innovation, ideas have developed about the role of extension. When speaking about extension interventions, a broad definition is maintained to include actions of information provision, advisory work, and intentional learning processes, with the objective to bring about change in attitudes and behaviour of people. Table 2-3 gives an overview of different models which can be applied to different sectors, including agricultural development.

Table 2-3 Overview of models of extension interventions (Source: Röling et al. 1996, p. 55)

	Behavioural change	Knowledge transfer	Advising	Facilitating	Organizational development
Person who is informed	unsuspecting target group	passive adopter	active client	people with a problem	participant
Role of the informer	strategist	expert	consultant	trainer	organizer
Metaphor	'(social) engineer'	'product'	'marketing'	'learning'	'housekeeping'
Point of action	determinants of behaviour	acceptance process	problem solving process	organisation, awareness	group processes
Goals of	intervening party	intervening party	both (overlap)	client	collective
Nature of planning	blueprint	linearly phased	strategic anticipation	planning of learning process	planning of group process
Objective	increase the frequency of wanted behaviour	adoption of technology	remove obstacles	Improve decision capacity	Platform at higher aggregation level
Rationality	instrumental	instrumental	strategic	strategic/ communicative	strategic/ communicative
Legitimation	politically accepted decision	scientific basis	active demand	there is a hidden need	ideology, hidden social problem

According to Röling (1996), extension interventions can be seen as aiming at 'behavioural change', 'knowledge transfer', 'advising', 'facilitating' or 'organisational development'. An insightful distinction between them can be made in the underlying rationality, being instrumental, strategic and/or communicative which is further elaborated in section 2.9.2. The legitimation of the different promotion approaches is also different: advising is based on having an active demand, while knowledge transfer is legitimized by a solid scientific basis. The behavioural change model is legitimized by a politically accepted decision, and is therefore also a largely supply driven approach. The last two approaches, facilitating and organizational development, are neither demand nor supply based, but emerge from a hidden need or problem which is not strictly defined by one actor. Instead, they are agreed upon in a process, which is why the underlying rationality is no longer instrumental but strategic/ communicative.

2.9 Unpacking the AIS approach

The paradigms or pathways of agricultural innovation can be understood as differing in their degree of participation, and in the underlying rationality. Both are discussed below as crosscutting issues that delineate a continuum in which extension approaches can be placed. The AIS pays particular attention to networks and social interaction, so some basic notions from the concept of social capital are described.

2.9.1 Degrees of participation

The pursuit of farmer participation is one way to understand the current interest in AIS both as an approach and as a descriptive framework. Farmer participation is sought and included into environmental decision-making processes, including projects that research and promote CA. As Table 2-2 showed, the role of the farmer in agricultural innovation has increasingly been recognized, from being an adopter in the 'transfer of technology' model, to being a research partner in the 'farmer first/participatory research' model. The relative importance of agricultural researchers, on the other hand, has reduced over the decades according to these paradigms of agricultural innovation. During the history of its development and in the many different contexts where it has been applied, participation has become synonymous with a variety of ideological, social, political and methodological meanings (Lawrence, 2006).

The benefits of participation are defended along two lines. One follows normative argumentation, mostly focusing on benefits for democratic society, citizenship and equity. The other follows more pragmatic reasoning, focusing on the quality and durability of environmental decisions that are made through engagement with stakeholders. Whether participation is judged to be important for its own sake or is valued for contributing to achieving more efficient and sustainable results, it is now part of the development agenda.

The first typologies distinguished between the degree to which stakeholders were engaged. Arnstein's (1969) 'ladder of participation' described a continuum of increasing stakeholder involvement, from passive dissemination of information (which she called 'manipulation'), to active engagement ('citizen control'). Similarly, DFID (1995) identifies degrees of participation in a continuum:

- Being in **control** and only consulting, informing or manipulating other stakeholders
- Being in **partnership** with one or more of the other stakeholders, with equal powers of decision-making
- Being **consulted** by other stakeholders who have more control
- Being **informed** by other stakeholders who have more control
- Being **manipulated** by other stakeholders (DFID, 1995)

The often cited typology of Biggs (1987), (e.g. Martin and Sherington, 1997) is based on degrees of participation in terms of researchers' and farmers' relative degree of control over the research agenda:

- **Contract**: in which the researcher sets the research agenda, and the farmer's land and/or services are used. This helps the researcher to locally validate technologies that are developed on a research station. Although there is an agreement and a useful link between the researcher and the farmer, this would not constitute participation by most definitions.
- **Consultative**: in which the researcher consults farmers to make the best possible diagnosis of problems, design and modify research plans, pretty much in a doctor-patient relationship. Farmers are consulted through surveys, or are called to participate in evaluations, but decisions are primarily made by the researcher.
- **Collaborative**: in which researchers and farmers work as equal partners, which involves continuous interaction. The important decisions over the priorities and practical execution of the project are made jointly.
- **Collegiate**: in which the research system is farmer-driven, and actively strengthens the local capacity to conduct informal research and development at farmer and community levels. Farmers have the final say in all decisions.

The cultural aspect of participation is highlighted by Roncoli et al. (2011). They argue that the more Western style of participation is "based on values of equity, fairness, and legitimacy, and understood largely in terms of individual expression and affirmation, […] grounded in Western ideas of the democratic process and epitomized by the ability to express one's opinions and to affect decisions by voting on propositions" while the Kiganda[5] style of participation as "informed by cultural norms of social interaction, which stress courtesy, modesty, reserve, and respect. In this perspective, the purpose of participation is to demonstrate unity and to reach decisions by consensus" (Roncoli et al., 2011). The link between such cultural understanding of participation and democracy, and its importance for 'creating capabilities' through communicative action is further explored in section 3.3.3.

2.9.2 Instrumental, strategic and communicative rationalities

The overview of approaches to agricultural development summarized Table 2-2, shows that where the earlier approaches are explicitly research driven, the innovation system is not necessarily driven by research. Instead it is driven by the facilitation of change processes, which may not be the key capacity of agricultural researchers, and for this reason it may seem a categorically different paradigm. Besides a changing level and style of farmer participation, the approaches can be seen as differing a more fundamental way, the underlying rationality. As further explained in section 3.2.2, the idea of different rationalities emerged in Habermas' critical theory and his critique on instrumental reason.

The three types of rationalities distinguished by Habermas and others (Habermas, 1984; Röling, Kuiper and Janmaat, 1996) form a continuum with purposive rationality on the one hand (which includes instrumental and strategic rationality) and communicative rationality on the other. The relative importance of each type of rationality can be recognized in the paradigms of agricultural innovation and the largely corresponding styles of promotion discussed later. The following description of the three rationalities draws on chapters 1 and 2 of Röling et al. (1996) to get

The *instrumental* rationality is one of a subject relative to an object. A 'social engineer' tries to solve a social problem with an instrumental approach. When reasoning in an instrumental way, an (extension) intervention is seen as a deliberate attempt to influence determinants of behaviour, using instruments (such as laws, enforcement, awareness campaigns, etc.) in a direction that is considered valuable. The changed behaviour remains voluntary in the sense that actors can generally reject the proposed options and say 'no'. Effective intervention based on instrumental reasoning thus requires understanding of the determinants of the voluntary behaviour and aims to influence them.

Reasoning in a *strategic* way assumes that extension is an interactive intervention process, which is adapted according to the actions of the other. It is a more iterative process in which monitoring is important and project or intervention design is adapted accordingly. An intervention in a strategic

[5] Kiganda is a term in the Luganda language, spoken in Uganda, to refer to the Baganda i.e. people in Buganda. In fact, Uganda is the Swahili word to refer to Buganda, which is now a large kingdom within Uganda.

way is aware of the strategies of the other actors, and their interaction is therefore like a game of chess in which both players anticipate on the other player's next move, but are guided by self-oriented objectives. Where the key-word for instrumental interventions is 'predicting', in the subject-subject relation of strategic reasoning, the key-word is 'anticipation'. The goal is not 'controlling' but rather improving your position relative to other equally strategic social actors.

Finally, reasoning *communicatively* does not assume a problem in advance which is then addressed by an intervention, but it starts from several actors that are aware of a shared problem, and accept that they need to take joint action and agree upon the necessary course of action. It is also a subject-subject relationship, but one that gives more importance to reaching a shared understanding on a problem and on ways to improve the situation. It is the basis for organisation, and an important form of human rationality. Communicative reasoning requires 'platforms' where the interaction can take place, and an intervention from this perspective aims at facilitating this communicative process among actors.

Although making this distinction implies a criticism on instrumental reasoning, it is good to recognize that instrumental reasoning has a legitimate place. This is especially true when the objectives of an intervention are uncontroversial and broadly shared in society. The critique of instrumental reason must therefore be understood as a critique of its ubiquitous manifestations during and after the enlightenment period (Horkheimer, 1986), and a corresponding lack of communicative rationality and action (Habermas, 1997, 1984).

2.9.3 Agricultural innovation and social capital

Social capital is a broad concept, and not a primary focus of this thesis. Nevertheless, its importance is implied in the Agricultural Innovation Systems (AIS) approach, so some basic notions from the social capital literature are described in this section. Relative to the previous theories on agricultural innovation, the AIS approach draws more attention to the interaction between social capital and agricultural innovation (Silici, 2009). Where Rogers (1983) reviewed the empirical research on the diffusion of innovations, he found that 'social participation', 'interconnectedness with the social system', 'exposure to interpersonal communication channels', and 'belonging to highly interconnected systems' are associated with the early adoption of innovations (Narayan and Pritchett, 1996). The importance of social capital for CA adoption in particular is increasingly recognized, although research to the role of social capital in the adoption and diffusion of CA is limited so far (Knowler and Bradshaw, 2007).

Although no consensus definition of social capital exists, indeed some scholars are sceptical of the usefulness of the concept altogether (e.g. Solow, 2000), it can be said to refer to "the norms and networks that enable people to act collectively" (Woolcock and Narayan, 2000). The 'norms' element consists of institutional factors, such as laws and community rules, norms and ideas, while the networks element refers to complex patchwork of social connectedness. Generally, three types of 'social connectedness' have been identified as important for social networks within (bonding), between (bridging) and beyond (linking) groups or communities (Woolcock and Narayan, 2000). The same authors argue that some close-knit poor communities may have plenty of bonding social capital 'to get by', but may lack the bridging social capital that non-poor deploy to 'get ahead'. In agricultural innovation, an important element of social capital is social learning, defined as "a process that fosters innovation and adaptation of technologies embedded in individual and social transformation. It is associated, when it works well, with participation, rapid exchange and transfer of information when trust is good, better understanding of key ecological relationships, and rural people working in groups" (Pretty, 2003).

The nature of innovation and farmers' ability to share its potential benefits are critically influenced by 'norms and networks'; At this general level, there is little disagreement about the importance of social capital for development processes – manifest by a wealth of literature on social networks, collective action and formal/informal institutions. But how social capital impacts innovation in concrete cases and how it can be measured and stimulated remains an open debate (Solow, 2000). It is clear, however, that social capital is central to innovation, and as such it is incorporated in the conceptual framework of this study as a 'means to achieve' that contributes to farmers' capabilities (Section 3.4, 'Conceptual framework'). Social capital allows farmers to participate in processes of innovation and helps creating agricultural capabilities, e.g. through processes of sharing resources and knowledge.

Silici (2009) argues, following Berdegué and Escobar (2002), that because rural households operate in unfavourable environments, innovation is more driven by social capital relative to e.g. human or natural capital, and is often aimed at managing risks and reducing vulnerability. Moreover, in in the face of economic and climatic uncertainty in SSA, the capacity of people both to innovate and to adapt technologies and practices to suit new conditions becomes vital (Pretty, 2003). An important question is whether forms of social capital can be stimulated in order to enhance innovation. Some authors indeed infer that it is necessary to intentionally invest in social capital (e.g. Woodhill, 2010; Pretty, 2003), while others are less confident that social capital can be easily generated (e.g. Röling, 2009a).

2.10 CA Innovation Platforms in practice

In order to address the bottlenecks in CA adoption, Innovation Platforms (IPs) are increasingly being proposed as a way to promote CA through a mechanism that operationalises the AIS approach. The idea is that the platforms provide a space where different stakeholders can come together around a shared problem or objective, for information exchange, negotiation, planning and action (Hall et al., 2007). The literature is not always in agreement about the specific characteristics of IPs, and this is understandable as they can operate at different scales (local, national), and in different sectors (dairy, horticulture, crops, etc.) and as such will have different objectives (Nederlof, Wongtschowski and Van der Lee, 2011).

Nederlof et al. (2011, p.68) distinguish between different types of platforms. One distinction was made on the basis of the common purpose that binds stakeholders together in an IP, such as the adoption of CA or improved maize-legume production systems in Ghana. The other distinction was made on the basis of the role of research. They found there to be three main types which they called 'learning and research oriented', 'development and research oriented', and 'development and non-research oriented'. In the IPs of the first kind, researchers played a dominant role both in the preparatory stage and in the functioning of the Innovation Platform. They also had "deliberate strategies to institutionalise the principles behind an Innovation Platform in the organisations involved" (Nederlof, Wongtschowski and Van der Lee, 2011, p. 73). In IPs of the second kind, the platform generally started with proposals from organisations in the field. In that sense they are more 'grounded', but in the functioning of the platform researchers would play a dominant role. The third type of IP started and functioned on the basis of effort and initiative of the members themselves, with usually the private sector playing a more prominent role. Platforms of this kind usually functioned only at one level (e.g. local or national) and were in that sense limited in their capacity to connect with other levels and achieve some of their objectives (Nederlof, Wongtschowski and Van der Lee, 2011).

2.10.1 A CA Innovation Platform in Zambia

In this section, a well-documented case study of the promotion of CA in Zambia is explored as an example of how an IP can work in practice (Van der Lee et al., 2011). The Monze Innovation Platform was initiated in 2009 as a response to disappointing adoption levels of CA among the local farmer population despite investments of government and projects. The Monze platform, functioning at the district level and thus linking the local and national level, comprises different stakeholders which include (a representation of) local farmers, the ministry of agriculture and co-operation, the private sector in the form of a local input supplier and a business association, a local NGO and local media. The chairperson has the responsibility to facilitate general forms of interaction, sharing of knowledge and co-ordination of joint activities on CA.

The incentives vary for the different stakeholders. The public sector is driven by the government's mandate to promote CA, the private sector is motivated by possible enhanced sales of inputs such as herbicides and rippers. The NGOs see CA as a means to improve yields and improving livelihoods, while research institutes see the IP as a way to increase the use of their research outputs. For farmers the IP can help them to improve their production and incomes while lowering farming risks through CA. All stakeholders see sharing of information as an important motivation for joining the platform meetings and activities (Van der Lee et al., 2011).

The main achievement of this IP after 3 years is the improved coordination of CA activities at district level. The platform has also led to improved interaction between the public and private sectors, and the media activities have encouraged engagement with stakeholders around the issue of CA and harmonised some of the lessons learned. However, challenges were also identified, particularly around the sustainability of the platform after the project would withdraw. Some of the activities are refunded by the project and especially at the national level there is limited commitment of the public members of the platform. Also at the regional level where the responsibilities are partly shared with local actors, the authors question whether it will continue 'on its own' (Van der Lee et al., 2011).

2.10.2 Lessons learned on Innovation Platforms

On the basis of the case of CA in Zambia summarized above, and other cases in smallholder agriculture in sub-Saharan Africa where experiments have been done with Innovation Platforms (IPs), several general lessons can be drawn. Innovation is understood to be a mix of technological, organisational and institutional change, and the premise of innovation is that such change results from interaction. Interaction is stimulated on IPs and can provide a space for negotiation, joint planning, working and learning, within clear but flexible boundaries and purposes. Members of an IP must have a common purpose and realize that it is necessary for stakeholders to cooperate to achieve the purpose. The problem definitions and agreed courses of action can always be changed as new members join in or leave. Therefore, there is a sense of flexibility and evolvement in IPs.

Brokering, facilitating, co-ordinating or representing IPs are some of the roles and responsibilities that the members have to take up. Each of these tasks requires skills and capacities that can be developed by doing, or through training. Particularly the brokering role has received a lot of attention in literature, and the broker is important because it is the IP member who acts as a 'catalyst of interaction'. It is the brokers task to be a mediator, to make new collaborations and thus to contribute to the effectiveness of the platform and stimulating innovation (Röling et al., 2012).

2.10.3 Innovation Platform as instrument?

Combining the spheres of innovation and the promotion of CA is bound to bring a paradox. Promotion of CA is a goal-oriented, intentional provision of information towards a pre-determined objective, whereas an innovation system is characterized by largely unpredictable, iterative processes, influenced by many stakeholders, with uncertain outcomes. It can be questioned if one can achieve predefined objective through spontaneous, emergent processes of interaction in which objectives are also subject to discourse. Posthumus et al. (2014) asked themselves if Innovation

Platforms for conservation agriculture are a contradiction in terms. They recognize the risk that, in practice, facilitators of Innovation Platforms can make presumptions about the problems that need addressing, and overemphasize the importance of CA among other possible solutions. However, if the notion of an Innovation Platform is being taken seriously, it cannot be harnessed and incorporated in some kind of instrumental thinking, and there can be no set objectives except the ones agreed upon by the stakeholders. This may very well be 'increasing the adoption of CA' but not necessarily so. From the perspective of promotion of CA, it is clear that adopting an AIS approach in the form of IPs not only serves the understanding or supporting of the innovation processes, but also to steer and manoeuvre it into a direction that the 'promoters' have reason to value.

2.11 Targeting and tailoring CA

The linear 'transfer of technology' model is too simplistic for complex problems, and the necessity to consider a broad set of actors and their interactions is generally accepted. The academic literature on the agronomic functioning and adoption of CA in SSA emphasizes that universal 'silver bullets' or 'one-size-fits-all solutions' do not exist. This implies that opportunities for smallholder farming are locally defined, and the success of technology depends not on how ingenious it is in theory, but how well it fits within local, practical circumstances. The word 'targeting' or 'tailoring' is often used to label this approach. Another way to express the concern for a goodness-of-fit between technology and a context is to talk of a 'niche'. Although it seems a simple and logical conclusion, it is worth investigating the reasoning behind this approach and trying to find out how it relates to the paradigms of agricultural innovation and the models of promotion discussed earlier.

2.11.1 Tailoring CA research and promotion to the socio-ecological niche

As discussed earlier, Knowler and Bradshaw (2007) concluded that there are no universal factors that influence adoption of CA, and therefore recommended that research and promotion of CA should be geared to the particulars of a locale or, preferably, to individual farmers: a targeted approach, which is in line with the 'targeted policy approach' (Stonehouse, 1996). The need to tailor CA technologies follows also from the recognition that there exists spatial heterogeneity in the areas where smallholder farmers operate. The possibility to grow a good cover crop in a CA farming system is often limited by low soil fertility (Tittonell, 2014). Soil fertility varies at a regional scale between areas and is determined by the underlying parent material and geomorphology, but also by population density. Variations in household wealth and farm size can be associated with differences in soil fertility management (Tittonell, Vanlauwe, Leffelaar, Rowe, et al., 2005). Similar heterogeneity exists between different fields within a single farm in terms of agricultural productivity and nutrient depletion, and the allocation of resources and production activities often varies accordingly (Tittonell, Vanlauwe, Leffelaar, Shepherd, et al., 2005). These last authors argue that targeting soil fertility management strategies and fine-tuning decision aids for resource allocation in smallholder farms can benefit from such an approach.

Ojiem (2006) developed the concept of the socio-ecological niche "for facilitating the identification and integrated assessment of biophysical and socioeconomic factors with potential influence on the choice of sustainable legume technologies for smallholder farmers" (Ojiem, 2006). Not only does he recognize the spatial biophysical and socio-economic variability as described above, but it is factored in an integrated manner in the technology development. For example, Guto et al. (2011) worked with the hypothesis that properly targeted tillage and crop residue practices can improve soil productivity but are feasible only in some socio-ecological niches within heterogeneous smallholder farms. They concluded that niches could be identified due to variability across cropping seasons and soil fertility classes: Minimum tillage and crop residue retention could only be implemented in the poor soil fertility fields after investment in rehabilitation of these soils for better crop performances (Guto et al., 2011).

Giller et al. (2009) argued that "under present circumstances CA is inappropriate for the vast majority of resource-constrained smallholder farmers and farming systems. We do not doubt that CA is one approach that can offer substantial benefits for certain (types of) farmers in certain locations at certain times". The challenge, in their view, is therefore to define if, when and where CA can work for farmers: to target technological options that can work in specific contexts. They first proposed the concept of the socio-ecological niche as a framework to explore where CA can potentially work.

This concept has been recognized and taken up in recent years in some variations. For the case of crop residue retention in CA and the competing use for livestock, Baudron et al. (2013) argue that "the question should not be 'if', but 'how' crop residues can fulfil the need of both the soil and the livestock. In each site, the adoption of the technologies that best fit local circumstances may be stimulated by putting in place the right incentives". Their objective is even bigger, as they argue that although crop residue trade-offs in mixed crop-livestock systems have been quantified and explained, "few have explored alternatives to feed both the livestock and the soil, and thus expand the niche in which CA would fit" (Baudron et al., 2013). The task of research is thus not only to fit research to the socio-ecological niche, but also to expand the niche through technological innovation. In a similar vein, Giller et al. (2011) argue to shift the focus from 'best-bet' technologies, which are "a selection of approaches to improving productivity that show promise for a given agro-ecological environment", to 'best-fit' technologies which are "targeted to different types of farms and to specific socio-ecological niches within farms". By distinguishing types of farms that differ in resource endowment and production objectives, they argue, appropriate technologies can be targeted to farmers. So targeting requires niche-mapping which includes the use of farm typologies.

Attention for targeting with respect to variability in soil fertility can be found in a study by Lahmar et al. (2011). They propose a 'targeted' CA package for semi-arid West Africa that aims at first rehabilitating the biomass production capacity of the soil through SWC practices. The growth of native woody shrubs is the second phase, followed by the less labour intensive CA practices. It builds on traditional local practices and native, useful shrub varieties, and is in that sense socio-culturally sensitive. But the targeting in this case seems to be technology oriented as the proposed technological pathway is very demanding in terms of labour, time, and knowledge.

The powerful imagery of the words tailoring and targeting is utilized by (technology-oriented) agronomists and sociologists alike. A sociologist studying farmers' perception and acceptance of water and soil conservation (SWC) techniques in the semi-arid Laikipia County in Kenya, elaborated a bit on the metaphor of the 'tailor' and put it like this: "Research should […] look into the situation of the small holders and tailor techniques appropriate to their circumstances. […] appropriate adjustments in the "suits" may be necessary in order to enable the farmer to tolerate the discomfort caused by recommended techniques" (Keter, 1989, p. 76). The study of perceptions and the acceptance of SWC techniques is therefore seen as a way to inform scientists who can then fit farmers with a better suit. The farmer, however, remains largely passive and is undergoing a treatment, standing still while being fitted a suit by the tailor.

2.11.2 Targeting and promotion of CA

From the discussion above, several perspectives on tailoring emerge that are often combined in various ways. The most common idea is that CA technology should be tailored to fit the agro-ecological, biophysical circumstances of the smallholder's farm. This is often extended to include the tailoring CA technology to fit farmers' socio-economic and cultural circumstances. The combination of these is found in the socio-ecological niche (Ojiem, 2006). Technological innovation is seen as a way to expand the niche of where CA can be feasible (Baudron et al., 2013). Tailoring refers not just to the technology development process, but also to the promotion through extension that should connect with the farmers' socio-economic and cultural situation. In its ultimate form, CA promotion and extension is tailored to the farmers' personal learning style and the individual needs and constraints.

The tailoring of CA can take different shapes, and can therefore be linked with various paradigms of agricultural innovation. The most clearly related paradigm, however, is 'farming systems research' in which the farmers are mainly seen as the objects of study and a source of information. The 'core elements' of this approach, as defined by Hall (2007) are the modified (tailored) packages to overcome constraints. Scientists need to learn about farmers' conditions and needs, and the intended outcome is to produce a technology with a better fit to the farming system. The effective targeting and tailoring within the farming systems research paradigm of agricultural innovation requires holistic consideration of biophysical and socio-cultural aspects of farming to propose appropriate technology. This kind of targeting CA to a specific niche remains a science-based technology-oriented approach. In some of the discussed literature farmers are more seen as partners and the intended outcome is seen as co-evolved technology with a better fit to livelihood systems, which fits more with the participatory research paradigm.

Relating the targeting approach with the models of extension intervention discussed in section 2.8 is more difficult. The dominant underlying rationality in a targeting approach is 'instrumental' if it focuses on the agro-ecology of the farm (subject-object relation), and becomes more 'strategic' if it comes to include the farmers' decision making and priorities (subject-subject relation). On the basis of the literature discussed above, two extension intervention models (see Table 2-3) seem to fit best with the targeting approaches of CA in SSA. Elements of the 'behavioural change' model can be recognized, such as the politically accepted decision which drives the promotion of CA towards sometimes unsuspecting target groups who may have other pressing priorities than CA. Also the metaphor of the '(social) engineer' remains applicable to some CA promotion interventions in which a blueprint is applied to achieve (social) change. The 'knowledge transfer' model is perhaps the most common way to target a CA intervention, as the target group participates a bit more, and there is attention for the acceptance process that a farmer must go through. The adopter remains a largely passive receiver of a (knowledge) product, and the legitimation comes from the scientific evidence of proven 'best-fit' solutions.

3 CONCEPTUAL FRAMEWORK

3.1 Introduction

This study pulls together different conceptual models from diverse academic traditions with the common objective to better understand the promotion and adoption of sustainable agricultural practices. The concepts range from the high-level social theory from the German tradition (Habermas' idea of Communicative Action), to the more rigid procedural behaviour approach from American social-psychology (Ajzen and Fischbein's Reasoned Action Approach), to a moral framework of wellbeing and agency rooted in political philosophy (Sen and Nussbaum's Capabilities Approach).

In **section 3.2** some theoretical perspectives are introduced that informed the thesis throughout. These include a social actor perspective and the implied constructivist epistemology, and some input from critical social theory, in particular the critique on instrumental rationality and Habermas' theory of communicative action. **Section 3.3** gives a background of the political philosophical debates that inspired the capabilities approach and zooms in on the *agency* and *opportunity* aspects of freedom which are both relevant to understanding agricultural innovation and adoption of new agricultural practices.

In **section 3.4**, the conceptual framework based on the capabilities approach is introduced. It is used in this thesis both in a normative and a descriptive/evaluative sense as it articulates what should be the means and ends in agricultural development, and also offers a perspective from which to structure the analysis in the thesis. This approach has the potential to connect the two principal foci of this research. Stakeholders in the agricultural innovation system, acting strategically as social actors and communicatively in processes of social learning and collective agency, can advance or limit the opportunities of smallholder farmers in SSA. The adoption of CA is understood as a choice from the opportunities open to farmers, the capabilities, to actual achievements. **Section 3.5** explains and justifies why the Reasoned Action Approach was selected and how it fits in the conceptual framework as a heuristic to conceptualise decision making.

3.2 Theoretical perspectives

3.2.1 Social actor perspective

In this thesis, people are at the centre of research. Farmers adopt, dis-adopt, experiment, adapt, innovate, and other stakeholders promote, facilitate, teach, learn, emphasise, investigate etc. Understanding smallholder farmers and other social actors who are involved in the promotion of CA is the key to understanding CA and its functioning in practice. Social actors are at the centre of change, including technological change (Richards, 2010). Horkheimer sees the task of social theory as to penetrate the world of things to show the underlying relations between persons, to see "the human side of nun-human things" (Horkheimer, 1986). This perspective can be applied to CA by shifting the focus from *determining factors* influencing CA adoption, to *understanding actors* influencing CA adoption. Without neglecting the importance of factors as such, this perspective challenges us to see the human, or social, aspects of them, which forms the basis of the research approach in this thesis.

When discussing the role of (agro-)technology for poverty alleviation and achieving food security, Paul Richards argues that "users contribute as much to effective technology design as engineers. […] Our aim in looking both ways – at agrarian engineers and users of agrarian engineering – is the hope of closing a gap. This gap […] is more than a problem of communication. It is a gap in science itself" (Richards, 2010). Studying farmer behaviour and decision making is clearly not enough to close the 'adoption gap', nor is the solution to improve the communication between the engineers and users of agricultural technologies. The reconciliation of design and use requires a deeper understanding of both groups and their interactions, which is partly found in a social actor perspective on development intervention.

Long and Van der Ploeg (1989) deconstructed the planned social intervention in agricultural development, demonstrating the insufficiency of purely instrumental approaches used by 'naïve social engineers'. Instead, they portray intervention "as a 'multiple reality' made up of differing cultural perceptions and social interests, and constituted by the ongoing social and political struggles that take place between the social actors involved" (Long and Van der Ploeg, 1989, p. 226). In this thesis, people are regarded as *social actors,* to concretize the notion that people make plans, set goals and strategically mobilize the resources at their command. This is true for individuals and groups, for wealthy people and those who are very limited by their circumstances. They have intentions and develop their own symbolic life worlds on the basis of experience and interactions with other social actors (Röling, Kuiper and Janmaat, 1996). Social actors have the capacity to exercise influence on their environment on the basis of their intentions and are capable to change this environment to a greater or lesser extent. An actor-oriented approach as set out by Long and Long (1992), includes the realization that researchers are themselves active social agents who “struggle to understand social processes by entering the life-worlds of local actors who, in turn, actively shape the researcher’s own fieldwork strategies, thus moulding the contours and outcomes of the research process itself” (Long and Long, 1992).

Long and Long (1992) argue how an actor-oriented approach contrasts with two types of structural schools in development theory: modernization theory and neo-Marxist theory. Although these theories represent ideological opposites, they are similar in that they see development and social change primarily as being determined by intervention of the state or by international interests and forces, and where development is following a broadly determined path. An actor oriented approach accentuates a third, alternative stance. It is important to note that the *social* actor signifies more than just ‘a person’ or ‘actor with individual agency’. It is a person with individual agency, but one that remains socially shaped and influenced to a great extent.

An important advantage of an actor oriented approach for the study of CA in sub-Saharan Africa is that it helps explain differential responses to similar structural circumstances, even if the conditions appear relatively homogeneous. It has the potential to shed light on the intriguing question why a certain smallholder farmer is adopting CA successfully while her neighbour is not, in a way that structuralist approaches cannot. The assumption is that the differential patterns that arise are in part the creation of the actors themselves, instead of the outcome of external forces (Long and Long, 1992, p. 21). Instead of being passive recipients of knowledge, farmers are active participants who process information and strategize their interaction, including CA research and promotion projects. Besides turning our attention to this continuous ‘strategizing’ in the ‘battlefields of knowledge’, the social actor perspectives fits well with a descriptive use of the Agricultural Innovation Systems (AIS) concept. By its emphasis on examining instead of assuming objectives, it pays up-front attention to the diversity of conflicting goals, attitudes, values, aspirations and standards that we may encounter in the AIS (Röling, Kuiper and Janmaat, 1996).

3.2.2 Critical theory and communicative action

Another guiding concern in this thesis is the social theory of Habermas, in particular the conceptual aspect of the theory of communicative action, in which he distinguished between instrumental and communicative rationality and action (Habermas, 1984). Habermas is often grouped under the ‘Frankfurt school of critical theory’, or simply ‘critical theory’, an influential group of philosophical thought initiated by Max Horkheimer and Theodor Adorno in the early 20th century. Building on the dialectic philosophy of Hegel and Marx, critical theory refers to a social theory that is reflective, based on interdisciplinary and emancipatory philosophy, and aimed at radically transforming and liberating society (Joll, 2010). The central thesis of the early critical theorists was that instrumental rationality, that is a means-ends understanding of relations, has become the dominant form of knowledge in the industrialized and bureaucratized modern world. Instead of liberating man from nature, as was generally claimed by 18th century Enlightenment thinkers, Adorno and Horkheimer saw that the domination, or success, of instrumental thinking inevitably bears the seeds of new forms of unfreedom and oppression in society (Finlayson, 2005).

Habermas criticized, or built on, the school of critical theory by rejecting this pessimistic view on rationality. Whereas most intellectuals in the late 20th century time tended to interpret structures of unfreedom that emerged in modernity as being caused by ‘too much’ rationality, Habermas posed the idea that the rationality was incomplete, indeed, that there was not enough rationality (Habermas, 1997). What is relevant for this thesis, is the distinction between instrumental and strategic action on the one hand, and communicative action on the other. Instrumental action occurs mostly in a subject-object relation, when an actor does something as a means to achieve an objective, while strategic action aims at getting other people to do things as a means to achieve the actor’s objective, which occurs in a subject-subject relation. Communicative action emerges from the interactions between people. This action is shaped by communication, which Habermas explicitly connects to speech acts and language. The objective of communicative action is reaching a shared understanding as a newly constructed reality: “The concept of communicative action refers to the interaction of at least two subjects capable of speech and action who establish interpersonal relations (whether by verbal or extra-verbal means). The actors seek to reach an understanding about the action situation and their plans of action in order to coordinate their actions by way of agreement” (Habermas, 1984, p. 86).

Finlayson (2005) formulates the distinction between the instrumental and communicative reasoning as follows: “Instrumental action is the practical result of instrumental reasoning, the calculation of the best means to a given end. Habermas argues that there are two criteria of instrumental action: that the end of the action is determined antecedently and independently of the means of its realization, and that it is realized by a causal intervention in the objective world. Communicative action does not meet these criteria, for its inherent goal – the recognition and acceptance of a validity claim – cannot be determined independently of the vehicle of its realization, speech, and is not something that could be brought about causally” (Finlayson, 2005, p. 48).

This shows how the concept of communicative action goes beyond the social actor perspective. Where the social actor perspective can be seen as an acknowledgment of people’s strategic and thus instrumental action, it depicts society as an aggregate of individuals who are each calculating the best way of pursuing their own ends. Although Long and Long (1992) explicitly include the social nature and social construction of objectives in their theory of social action, their perspective remains largely in the realm of strategic action which implies instrumental reasoning (Röling, Kuiper and Janmaat, 1996).

3.3 Capabilities approach

3.3.1 Ethical aspects of CA

In a keynote address discussing the priorities of agricultural development, Richard Bawden (1991) argued that reductionism and positivism are no longer sufficient to articulate broad agricultural objectives, including sustainable practices, in increasingly complex and dynamic rural contexts. This led him to argue that “our focus must extend beyond what is effective and efficient to embrace the ethical”, and “as agricultural scientists, we must be prepared to question critically our beliefs about what we really think constitutes improvements to agriculture” (Bawden, 1991).

When Conservation Agriculture is proposed as a promising farming technology in a specific context, an appeal is made to several, often implied, ethical concerns. It is claimed that CA can bring improved livelihoods and food security for smallholder families in marginal areas (Govaerts, Sayre and Deckers, 2005), that it can decrease land degradation and reverse soil fertility loss (Hobbs, 2007; Tittonell et al., 2012), and that it can increase the productivity of the agricultural sector. The environmental aspect is highlighted by the word ‘conservation’, which gives CA a sustainable feel, even though this may not always be warranted by actual CA practices that depend on increased use of herbicides. CA is promoted to increase adaptation to climate change and to create a ‘resilient’ agricultural sector (ACT-Network, 2014). Moreover, CA interventions for smallholder agriculture are often specifically targeted to benefit ‘the poor’ (European Commission, 2010), and when introducing CA one should carefully consider the consequences in terms of gender equality (Beuchelt and Badstue, 2013). It is argued, and hoped, that “with adequate policies to promote Conservation Agriculture/No-till, it is possible to obtain what is called the triple bottom line, economic, social and environmental sustainability” (Derpsch, Friedrich and Sol, 2009). But how do we weigh the importance of these objectives?

In a similar vein, the increasingly popular word ‘innovation’ implies a claim that it is very important for human development and wellbeing. This may very well be the case, however, by using the term innovation without clearly defining the concept, it risks becoming ambiguous and thus meaningless. Rather than assuming that innovation is good in itself, the challenge must be faced to articulate under what circumstances innovation is good, and if and why it should be valued in the case of smallholder farming. What ‘types’ of innovation support development that we can call meaningful? Similarly, technological advancement is often pursued as an end in itself, without specifying the important concerns that may rise from its pursuit. To evaluate the objectives of CA promotion and innovation, we need to enter ethical debates about the nature and objectives of rural development that can inform a holistic evaluative framework.

3.3.2 Defining development

This objective leads us back to 1979, when Amartya Sen gave his famous Tanner Lecture on human values under the title "Equality of what?" (Sen, 1979). He took a position on the question of whether equal political distribution should be primarily understood as either equality of well-being as an experiential metric, or equality of resources as a material metric. He argued for a third 'space': equality of capability, thus inspiring something that became known as the capability approach. Together with Mahbub ul Haq he started building on the human development movement that contrasted with the economic development paradigm. The philosopher Martha Nussbaum has also contributed to the capability approach, adding important notions from Aristotelian and Kantian political philosophy. Sen and Nussbaum jointly wrote 'The Quality of life' (1993) in which they started to argue the case for capabilities as the objective of development.

The concept of capabilities can be placed between the traditional movements in political philosophy that focus either on well-being and desire fulfilment on the one hand, or on resources, income and consumption on the other hand (Robeyns, 2005). Representing the first movements are the welfare economists, who take subjective well-being of people as a guide for policy, and utilitarianism that take well-being as being represented by individual utility (Sen, 2009, p. 277). Instead of looking at resources or income, they focus on the 'happiness effects'. Besides the difficulty of measuring and comparing the subjective notion of individual utility, there are several reasons why a utilitarian approach is quite powerless in dealing with objective inequalities. One reason is that people who are structurally deprived of certain endowments tend to adjust their desires as a coping mechanism, thus distorting the scale of utilities in the perspective of comparative justice. Another reason is that although utility may be an important metric, ignoring the intrinsic importance of everything else can cause violations of very basic human freedoms and rights (Sen, 1999). Sen takes the notions of well-being, happiness and utility very seriously, but judges them to be insufficient to serve as comprehensive ethical categories. Justice demands more than just that (Sen 2009).

The second movement can easily be recognized in development economics by the primary focus on income and gross domestic product as indicators of development. In political philosophy this movement is represented by the influential justice theorist John Rawls, who argued that for interpersonal comparisons one should focus on resources distribution. Rawls' concept of resources, understood as primary (including social) goods, goes beyond income and wealth alone, but it remains the important 'all-purpose' means for leading a valuable life away from poverty. Sen's most fundamental critique of primary goods as Rawls proposes is that it would suffice to indicate freedom only if all human beings were the same. But they are clearly not; people are not only diverse in their hopes and priorities, but also in their capacity to benefit from opportunities.

Opportunities and freedoms vary partly due to personal heterogeneities, diversities in the physical environment, and variations in social climate. For example, a severely physically or mentally disabled person will have a lower income generating ability due to his disability, but at the same time will have more difficulty in converting incomes and resources into good living (Sen, 2009, p. 255–258). Similarly, a literate and educated farmer will generally derive more advantage from trainings or farming incentives than an uneducated and illiterate farmer would. This implies that there is a case to give 'unequal' support to these farmers in order to achieve equal opportunity. In their critique of resource based ethical positions such as that of John Rawls, Sen and Nussbaum reshape an important notion from Aristotle who argues that "wealth is evidently not the good we are seeking; for it is merely useful and for the sake of something else". In his book 'Development as Freedom' (1999) Sen states that "without ignoring the importance of economic growth, we must look well beyond it." Indeed, economic growth of nations "is only a means – and not a very efficient means – for the goals of development" (Crocker, 2008).

A comprehensive analysis of how Sen and Nussbaum criticize alternative ethical perspectives briefly discussed above, can be found in Crockers "Ethics of Global Development" (Crocker, 2008, p. 109–149). The capabilities approach, the proposed alternative for the important but one-sided foci on either well-being or resources, focuses on what people are effectively able to do and be. It is the combination of 'doings' and 'beings' that constitute functionings, and the whole of the achieved functionings is what makes a life valuable. From this perspective, policies should focus on removing obstacles in humans' freedom to choose the kind of life that they have reason to value. The ultimate concern of development should be about "what people can or cannot do, e.g., whether they can live long, escape avoidable morbidity, be well nourished, be able to read and write and communicate, take part in literary and scientific pursuits, and so forth" (Sen, 1999). Thus, development has to do with what Karl Marx phrased as 'replacing the domination of circumstances and chance over individuals by the domination of individuals over chance and circumstances" (McLellan, 2000, p. 207).

3.3.3 Exploring capabilities

The basic elements of a capabilities based approach can be summarized and schematically represented as shown in Figure 3-1. Certain capability inputs, or means to achieve, constitute a capability set, or freedom to achieve. According to an individual's preferences and choice, these freedoms may or may not become realized in functionings, or achievements. There is an important difference between the achieved functionings on the one hand, and the capabilities on the other. It is the difference between what is actually realized and what could potentially be realized, between functionings and freedoms. This distinction builds on Aristotle's notions of human capability

(Greek *dunamis*) and functioning (Greek *energeia*) in order to articulate some of the goals of good political organisation (Nussbaum, 1988).

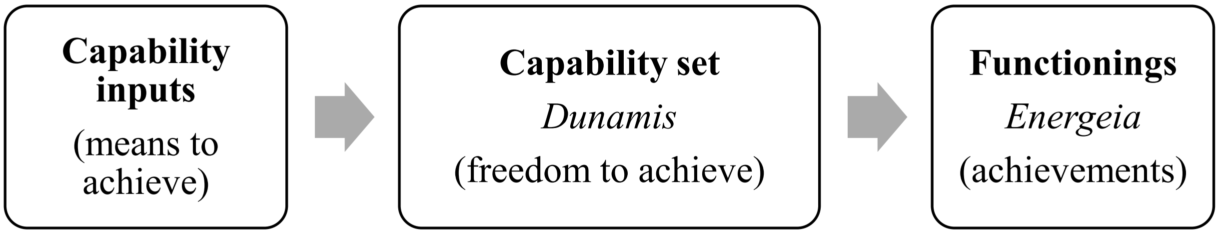


Figure 3-1 Schematic representation of the main elements within a capability approach (adapted from Robeyns 2005)

The importance of distinguishing capability from functioning can be illustrated with the case of calorie intake in India. Data from the past decades suggests that while Indians have become richer, the calorie intake has decreased for every income class. The reason was not a decreased income or increased food prices, but rather that the money is spent more and more on luxury food (Banerjee and Duflo, 2011). In this case it is a personal choice that leads to the realization of some functionings, even at the expense of something crucial like calorie intake. While it is tempting to use the achieved functionings as evaluative criteria, Sen argues that we should evaluate people's freedom. This principle position of evaluating capabilities rather than functionings fits in a liberal perspective that respects people's different ideas of the good life.

Capabilities are freedoms that are constituted by a social context of goods and services. Nussbaum (2000) introduces the term internal capabilities to describe the physical and mental states of a person that enables him or her to exercise a specific capability. This represents the efficiency with which a person can make use of an opportunity. Obviously, a person with severe disabilities will need much more to realize the same achievement than a healthy person, and the same applies for somebody who received little or poor education. Nussbaum also introduces the term combined capabilities which include internal capabilities and external means. Hereby she recognizes the importance of material means and external provision that enable a person to have the freedom to choose. The functionings that are actually achieved are a combination of these combined capabilities and valuable choices.

As described above, the work of Sen and Nussbaum reveals a concern for the distinction between well-being freedom and achievement. The role of agency is also relevant to fully appreciate their capability approach. That agency is important from an ethical point of view is demonstrated by the observation that development ethicists all reject a model of authoritarian egalitarianism in which physical needs may be satisfied, but at the expense of political liberties. This means that agency freedom is as seriously and intrinsically important as well-being freedom, as they are both part of either realizing or inhibiting a valuable life. Following Crocker (2008) we can combine the two dimensions of ethical concerns in a matrix as in Figure 3-2.

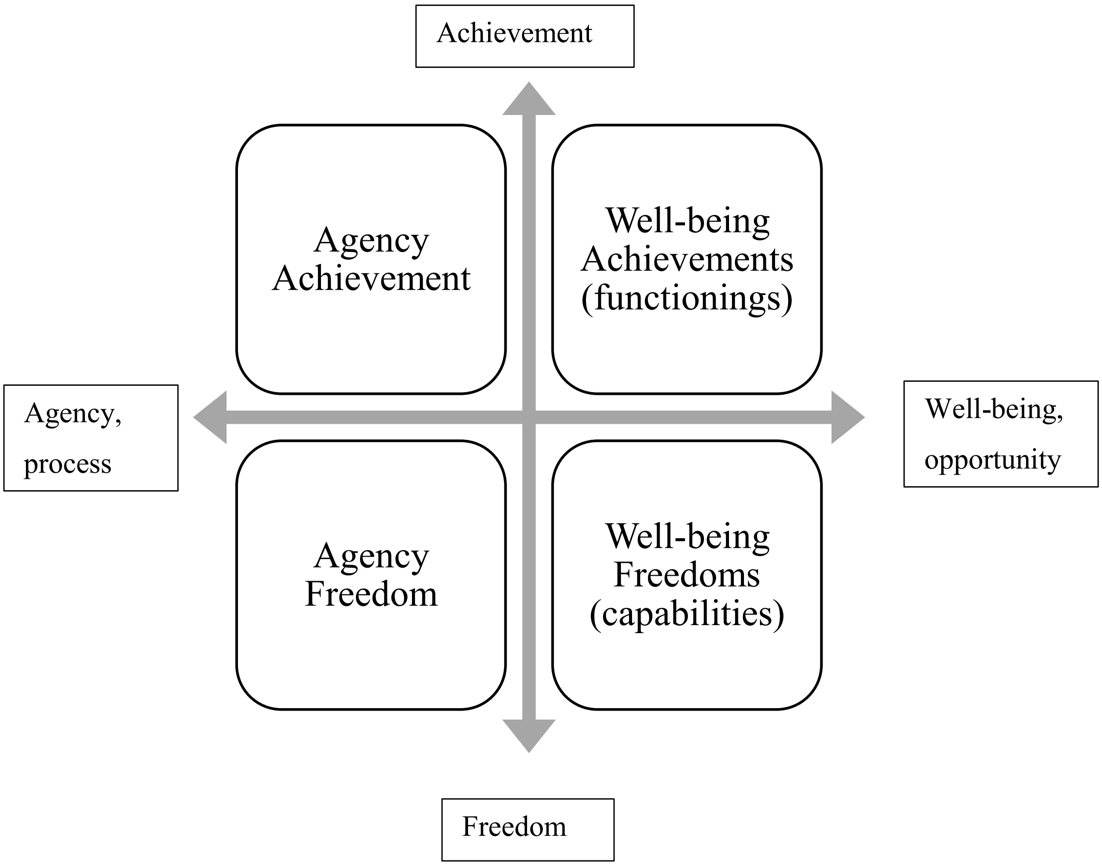


Figure 3-2 Agency and well-being; achievement and freedom (Source: Crocker 2008)

This distinction is important for Sen to move the idea of capabilities beyond a mere passive enjoyment of some material goods to a concept that involves peoples' active involvement and shaping of their lives. In Nussbaum's list of ten central capabilities, she included 'control over one's political and material environment' (Nussbaum, 2001). However, Crocker (2008, p. 160) notes that Nussbaum rejects Sen's distinction between agency and opportunity. She holds that this distinction can be captured as aspects of the capability/functioning distinction and by defining capabilities as *being* and *doing* that a person finds valuable. An implication of Sen's concern for agency freedom, apparent in his later writing, is the importance of deliberation and (local) democratic processes through which people are able to exercise their agency and enjoy and expand their capabilities. Interestingly, this intimate relation between democracy and freedom is supported by the cultural interpretation of 'democracy' in Buganda (in Uganda). Karlstrom (1996) argues that the Lugandan term for democracy (*eddembe ery'obuntu*) is best translated with 'freedom and choice of people', in which freedom from oppression, freedom of speech, and some notions of justice and equity are implied (Karlström, 1996).

At this point, a link can be made with Habermas, whose attention for discourse and communicative action has the same emancipatory objective as Sen's agency freedom. Habermas speaks of discourse as a case of communicative action. It is a technical term for a reflective speech act through which participants of discourse strive for a rationally motivated consensus (Finlayson, 2005, p. 41). Habermas further argues that participants in the 'discursive arena' must adhere to some rules to create 'the ideal speech situation' (Habermas, 1990). These are not formal rules, but function as 'pragmatic presuppositions' that are implicit in discourse (Finlayson, 2005). The ideal speech situation is met if:

1. Every subject with the competence to speak and act is allowed to take part in a discourse.
2. a) Everyone is allowed to question any assertion whatever.
   b) Everyone is allowed to introduce any assertion whatever into the discourse.
   c) Everyone is allowed to express his attitudes, desires and needs.
3. No speaker may be prevented, by internal or external coercion, from exercising his rights as laid down in (1) and (2) (Habermas, 1990).

In the Agricultural Innovation Systems (AIS) thinking about agricultural innovation, these concepts are all important. The AIS focuses on farmer participation, social learning and multi-stakeholder interactions as a way to move towards innovation. The question must be answered whether this rather abstract concept of capabilities makes sense when it meets the empiric reality of smallholder farmers, men and women, in sub-Saharan Africa. In the next section I will argue that this is the case, and a conceptual framework will be introduced that combines the notion of innovation, capabilities and technology adoption.

3.4 Conceptual framework

As shown in Figure 3-3, the main elements in the conceptual framework are structured according to the capabilities approach, including the means to achieve (resources), the freedom to achieve (opportunity and agency freedom) and the achievements (opportunity and agency achievements). The means to achieve consist of several types of resources, simplified to include personal resources (such as knowledge and skills), farm resources (such as land and farming tools) and social resources (such as links with farmer organisations and extension services). These resources have a clear connection with the capital assets in the livelihoods framework consisting of financial, natural, physical, human and social capital (Scoones, 1998).

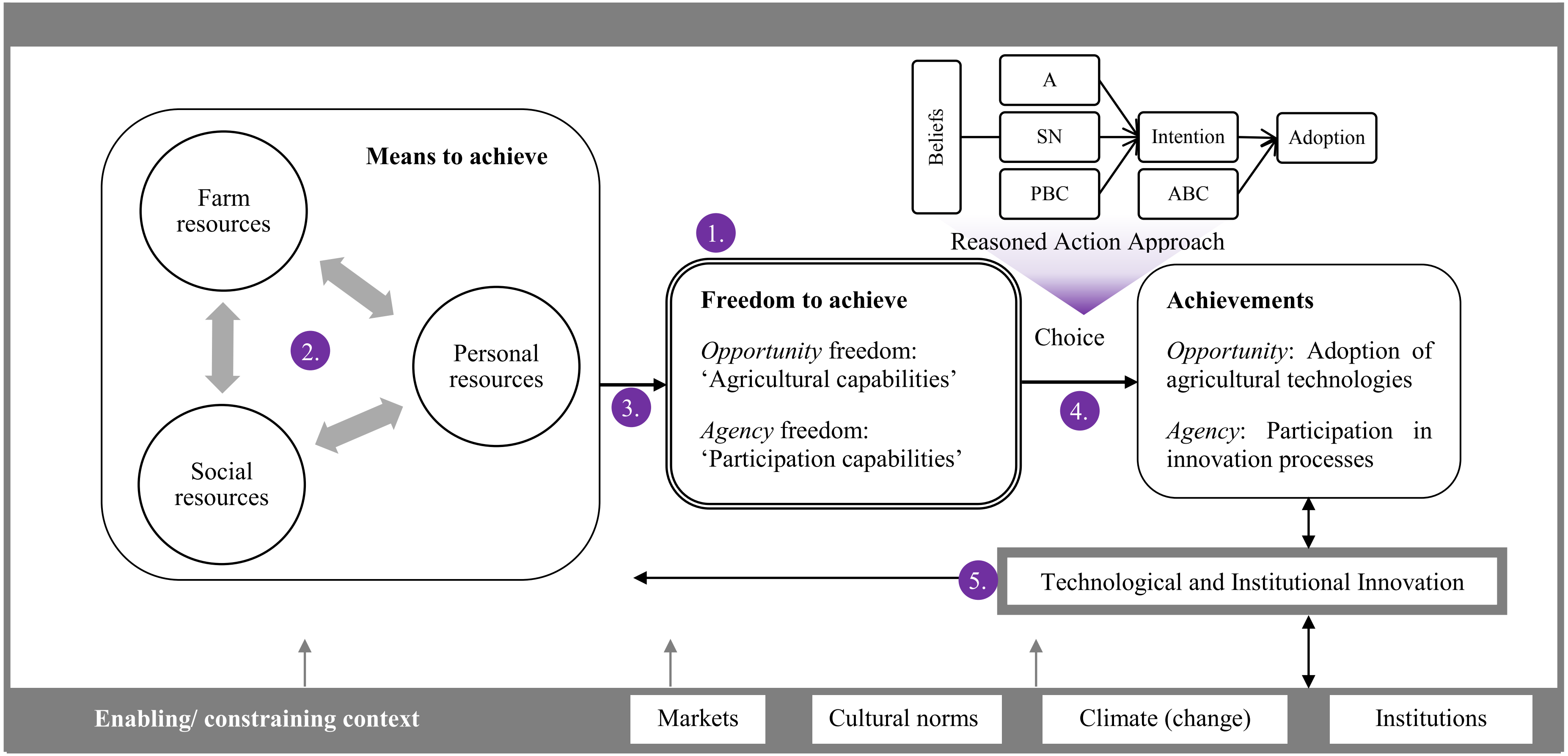


Figure 3-3 A conceptual framework based on the capability approach for understanding the domain in which the adoption and promotion of Conservation Agriculture and innovation take place.

1. The basic structure of means, freedom and achievements, in which opportunity and agency freedom are central, is derived from the capability approach (Sen, 1999).
2. The various resources, similar to the five 'capitals' in the livelihoods framework (Scoones, 1998)
3. The 'efficiency' of making use of resources differs per person (e.g. education and gender) and also depends on the enabling/ constraining context (e.g. labour markets, land tenure security) (Robeyns, 2005).
4. In this thesis, choice is conceptualized with the Reasoned Action Approach (Fishbein and Ajzen, 2010).
5. Innovation processes taking place in dynamic innovation systems (Hall et al., 2007) at the interface between markets, institutions etc. and a farmer's resources and achievements. Technological innovation allows more efficient use of resources within a given context, while institutional innovation actively influences the enabling/constraining context.

Given a certain enabling/ constraining context (e.g. climate, access to markets), these factors determine the freedom to achieve, or capabilities. The capabilities refer to the range of possibilities or options that a farmer has. More knowledge, more land or more social links, 'more' being quantitative or qualitative, implies having more capabilities. The theoretical (and practical) possibility does not mean that it is actually done. What is actually done are the achievements, such as the adoption of CA or perhaps agro-forestry or conventional farming.

Technological innovation, when seen in this framework, can be defined as a new configuration of resources and the enabling/constraining context, which inclines to removing capability deprivations and increasing agency and opportunity freedom. Innovation can be situated within the various non-social resources (e.g. when a farmer experiments on his/her own land and thus learning to increase the production) or within the resources including the social capital (e.g. when a farmer gains knowledge through training). Technological innovation can both bring direct benefits, in terms of income, food security or labour requirements, and indirect benefits through effects on food prices, employment and linkages with other parts of the economy (Berdegué and Escobar, 2002).

Institutional innovation can come from action and processes that challenge the structures in the enabling/constraining context that will lead to new institutions or policies (e.g. a producer organisation negotiating better market prices). In this way, innovation can increase capabilities and create conditions that allow the feasibility of e.g. CA as a farming system. Once CA is a feasible option, a farmer can choose to adopt it, in any form. This choice depends on a combination of influencing factors such as personal psychology, history, needs, values, dreams, group decisions/pressure, habits or incentives, among others (Robeyns, 2005). At the level of achievements, these processes become tangible and measurable again: what has actually been done? Using the words of the capability approach, the achievements consist of the doing and being that is valued by the farmer.

The 'achievements' have an impact on the means to achieve and capabilities (e.g. changing intra-livelihood roles and responsibilities) and potentially on the enabling/ constraining context (e.g. after regional adoption of cover crops, the market prices for produce and seeds will have changed). This is indicated by the feedback arrows that highlight how the enabling/ constraining context is a dynamic, rather than a fixed and static environment.

3.4.1 Capabilities and smallholder farming

The capabilities approach was one of the primary inspirations for the livelihoods framework 'as both end and means of development' (Chambers and Conway, 1992; Scoones, 1998), and is more generally emerging as central theme in international development (Johnson and Lundvall, 2003).

This section explores whether the capabilities framework makes sense in the sub-Saharan African context of the promotion and adoption of CA.

The adoption of Conservation Agriculture by smallholder farmers is not an end in itself. Rather, new technologies should be evaluated for their contribution to broader goals including farmers' capabilities and environmental sustainability (Knox Mcculloch, Meinzen-dick and Hazell, 1998). The adoption of CA can be one of the ways to ensure sustainable agriculture and contribute to sustainable livelihoods in rural environments.

Having a variety of management options is something worth pursuing in smallholder agriculture. Giller et al. (2006) write "For a given combination of agro-ecological and socio-economic conditions, a multitude of different combinations and trajectories of response by farmers may be equally productive. Increased attention to the multiple goals and constraints of farmers when developing new varieties and/or designing new technologies is required, recognising the potential benefits of reliable production and contributions to fodder supply and soil fertility improvement, in addition to direct yields". They reject one predetermined outcome of agricultural development, and embrace the freedom of individual farmers in their specific context. This can be identified as an agronomic expression of concern for the opportunity freedom (or well-being freedom) of smallholder farmers with respect to their farm management. It carefully rejects a vision of a predetermined, expert-identified configuration of agronomic achievements. In the case of CA's first principle of minimum soil disturbance, Baudron, Tittonell et al. (2012, p. 127) argue that "CA and ploughing should not be seen as competing technologies, but rather as alternative technical options available to farmers, that may be deployed depending on their local circumstances". By doing so, they argue against the apologetic pursuit of an actually *achieved* zero-tillage regime throughout landscapes and in favour of developing management options as opportunity-*freedom*. They implicitly argue that the task of agronomists and policy makers is creating the capability for CA.

Without assuming a specific conceptual framework, Erenstein (2003) concludes in his study about the potential of mulching that "although mulching practices are no panacea, they represent a *valuable addition to the basket of technological options* that integrate conservation and productivity considerations" (Erenstein, 2003, emphasis added). Again, the language is one of agricultural options and the assumed role of science is one of creating capabilities. He recognizes that capabilities are created not only through the development of new technology, but also in the interaction of diverse factors. Erenstein (2003): "In the end, it is the combination of these biophysical, technological, farm level and institutional factors that determine the socio-economic viability of mulching practices. […]. Farmers typically have the final say in the decision whether to apply mulching". There is the recognition of the choice of farmers, clearly distinguished from the pursuit of technology or sustainability objectives of policy or researcher.

These are just a few examples of how the language of the opportunity freedom aspect of capabilities is already used in studies about smallholder farming. Similarly, process freedom can be identified behind the concern for participation. This is exemplified elsewhere in this thesis. This section has introduced a conceptual framework on the basis of the capability approach, but adapted to fit the adoption and promotion of CA for smallholder farming. As implicitly done in the above mentioned articles, I explicitly put *capabilities* at the centre of development and evaluation. Seen in this perspective, innovation processes are valued by their direct and indirect contribution to creating capabilities for small scale farming. Adoption is approached as the strategic materialization of capabilities into actual functionings.

3.4.2 Some implications of the capabilities framework

There are several implications of using this capability approach for the study of promotion and adoption of CA, but also more generally for research in agriculture and development. First, it allows two types of innovation in farming systems to be distinguish. One is the more efficient use of available resources, no matter how limited they are. This is what I refer to as technological innovation. Technological innovation is only relevant if it creates new capabilities that have meaning for farmers. The other is the change of the institutional and social structures within which farmers are living, which I refer to as institutional innovation. The AIS approach contains both elements. The importance of farmer participation in the agricultural innovation system implies *agency freedom* to participate in discourse and communicative action. This agency can be oriented towards challenging the structural constraints that both enable and constraint it. Capabilities can be evaluated at different levels of social aggregation, as sometimes the opportunities for one person or group limit those of others. Similarly, communicative action and inter-stakeholder understanding and agreement have to operate at various levels. This is also an important feature of the AIS approach.

Another element that becomes evident from this framework is the position of choice, which draws attention to substantive and experiential aspects of what people value, including the aesthetic, economic and cultural dimension of agriculture (Burger and Christen, 2011). In the capabilities framework, choice is the transformation of the hypothetical, the potential, into the real, the actual. Choice is a way of materializing capabilities, which is related to *opportunity freedom.* Applied to agriculture it is the decision to adopt agricultural practices that contribute to the farming households' values and objectives. Given the diversity of individual and household objectives, this framework suggests that policies should aim at creating capabilities, rather than aiming at achievements. This is a fundamental implication of identifying capabilities as the goal of development. Applied to CA, the capabilities framework suggests that the success of a CA project should be evaluated not by how many farmers adopt CA or how many hectares are under CA, but by how many farmers have the actual opportunity to adopt CA if they wanted to. This counterfactual nature of capabilities poses challenges for measurement and evaluation, and in practice achievements will be considered to indicate capability, but this distinction remains critical.

3.5 Reasoned Action Approach

3.5.1 Limits of conventional 'factors influencing adoption' approaches

As discussed in section 2.4, conventional approaches to studying adoption of technologies in smallholder farming have limitations that are increasingly recognized (Andersson and D'Souza, 2014). Although farmers have an interest in profit maximisation, cost-benefit models cannot fully capture the complexity of farmers' behaviour and attitudes (Lynne et al., 1995). Also, econometric approaches are often deployed without a suitable theoretical framework for understanding farmers' behaviour (Andersson and D'Souza, 2014; Burton, 2014; Bayard and Jolly, 2007). More generally speaking there has been little integration of non-economic social sciences in the agricultural adoption literature (Price and Leviston, 2014; Burton and Wilson, 2006b).

Therefore, some studies about the limitation of adoption studies suggest to explore socio-psychological elements for improving their approaches. For example, Van de Bergh et al. (2000) suggest that, especially in developing countries, changed behavioural economics should include psycho-social dimensions of agriculture. Burton (2004) argues that while the behavioural approach relies too much on attitudes alone, it can be enriched with advancements in social-psychology, in particular by including subjective norms and measures of self-identity.

Another shortcoming of adoption studies is that the methodologies are often unsound and built on different approaches, making different studies difficult to compare and to understand the validity and reach of their conclusions (Knowler and Bradshaw, 2007; Andersson and D'Souza, 2014). If policy makers are to use research results for their policy development, they would expect methodologies to be theoretically sound, and to some extent standardized and repeatable (Wauters et al., 2010).

3.5.2 RAA and capabilities

The pre-analytical decision for an adoption model is guided by the capabilities approach. The capability approach attributes importance to the individual freedom to choose from the options that are open to people, thus respecting different ideas of what is considered valuable. This suggests that adoption is approached as a mostly rational choice and cultural, economic or psychological determinism needs to be avoided. Sen's version of the capability approach in particular gives an important role to agency to explain action as intentional behaviour. This suggests that to understand the performance of actions we must understand the intentions as way of expressing this agency (Crocker, 2008). We should be looking for reasons, not for determinants. Obviously, not everything that a person wants to do can be done, thus the choice is limited by the actual possibilities, or indeed the *capabilities*. In the language of the capability approach, this means that to understand the adoption process one should consider the window of opportunities for a person, and the motivation to make use of them. The inclusion of social norms in the RAA fits well with the importance that some writers on the capability approach attribute to group processes and social norms (e.g. Alkire, 2002).

The Reasoned Action Approach (RAA) seems to be an approach that addresses the issues mentioned above in a way that takes peoples' intention and reasons seriously. Moreover, it does shift the exercise of evaluating the relative importance of various factors from the expert to the farmer. By doing so, the tension on adoption studies as an instrumental tool in the hands of 'powerful deciders' is somewhat relieved, although it can still be used in that way. The empirical base in social psychology that supports the Reasoned Action Approach is strong, and some studies suggest it might well be applied to agricultural contexts (e.g. Wauters et al., 2010; Lalani et al., 2016). How the RAA is applied exactly in this study is explained in detail in section 4.9.5.

4 METHODOLOGY

4.1 Introduction

This chapter presents an overview of the methods used for the data inquiry and analysis, and gives insight in the research process. First, the research questions are further unpacked in **section 4.2**. In **section 4.3**, the choice for of a mixed-methods approach is explained.

In **section 4.4** and **4.5**, the study areas in Kenya and Madagascar are introduced, including the important agro-ecological and socio-historical characteristics, and a background of CA. After some remarks on the use of language and translation (**section 4.6**), the chronology of the research process is described in **section 4.7**, followed by the sampling strategy followed in both countries (**section 4.8**). In **section 4.9**, the research methods deployed for data collection are explained, including the use of semi-structured interviews, a social network analysis, structured questionnaires and focus group discussions. Finally, ethical considerations are discussed (**section 4.10**), and the chapter ends with a discussion of strengths and limitations of the study in **section 4.11**.

4.2 Research questions

Further to the main research questions, introduced in section 1.5, several sub-questions were formulated as a bridge between the research objectives and the research methods.

1) **How does innovation and dissemination of Conservation Agriculture take place in Kenya and Madagascar?**
   a) Who are the key (groups of) actors involved in the promotion of CA and how are they linked in the agricultural innovation system?
   b) What processes take place in the interaction between farmers and other stakeholders at field level
   c) How do stakeholders 'frame' the importance of CA and how do they think about the diffusion and up-scaling of sustainable agricultural practices such as CA?
2) **What influences smallholder farmers' decisions for (non)adoption of CA?**
   a) What is the attitude of smallholder farmers towards CA practices?
   b) What are perceived social norms around adopting CA practices?
   c) What are farmers' perceived and actual degrees of control over the adoption of CA practices?
   d) How do attitudes, social norms and perceived behavioural control relate to intentions and adoption of CA practices?
3) **What opportunities for and limits of agricultural innovation emerge from the cases studied in Kenya and Madagascar?**

a) To what extent does the adoption of CA contribute to capabilities for small-scale farmers in sub-Saharan Africa?
b) What are the factors that are limiting capabilities of smallholder farmers?
c) To what extent do farmers have the capabilities of influencing innovation processes in the agricultural innovation system?

4.3 Mixed methods: between positivism and relativism

This thesis makes use of mixed methods. This is a relatively young paradigm in the philosophy of science that attributes validity to knowledge from both qualitative and quantitative research traditions (Teddlie and Tashakkori, 2009). Mixed methods research can be defined as “the type of research in which a researcher or team of researchers combines elements of qualitative and quantitative research approaches (e.g., use of qualitative and quantitative viewpoints, data collection, analysis, inference techniques) for the broad purposes of breadth and depth of understanding and corroboration” (Johnson, Onwuegbuzie and Turner, 2007).

This contrasts with ‘purist’ quantitative approaches that presume a positivist epistemology, and in which social observations are treated in much the same way as physical scientists observe phenomena in the natural world, i.e. assuming they are governed by universal laws that operate independent from the observer. Science, including social research should in this perspective be objective and detached from a specific time and cultural context (Johnson, Onwuegbuzie and Turner, 2007). On the other hand, ‘purist’ qualitative approaches presume a constructivist epistemology and argue that not one reality exists, but multiple and socially constructed realities co-exist, which are always expressed in a particular time and context. Social research is value-bound, and there is a grey area of overlap between the knower and the known (Johnson and Onwuegbuzie, 2004).

Using mixed methods requires more than using ‘multiple’ methods based solidly on either quantitative methods or qualitative methods (Teddlie and Tashakkori, 2009). The idea is to achieve a level of integration into a coherent research, which generally has two purposes: to confirm or triangulate the results of one data type with the results of another (confirmatory design), or to compensate for the weakness of one data type with the strength of another (complementary design) (Small, 2011). For this thesis I used a confirmatory design of mixed-methods, in which qualitative data and quantitative data have full validity in themselves, i.e. the qualitative data is not used to ‘illustrate’ the quantitative results, and quantitative data is not used to ‘quantify’ the qualitative results. Rather, they offer points for triangulation of findings and help to achieve both broad and deep perspectives on the same topic.

4.4 Study area Kenya: Laikipia County

4.4.1 Description of the area

The study area in Kenya was located in Laikipia County, one of the 47 counties in the Republic of Kenya, located in the Rift Valley Province less than 200 km north of Nairobi. With a size of 9,462 square kilometre, the county extends from the Aberdares mountain range in the west to the foot of Mount Kenya in the east. The equator crosses the county just south of Nanyuki, and latitudes vary between 0º12'S and 0º52'N, while the longitudes vary between 36º12'E and 37º27'E. It is part of the Upper Ewaso Ng'iro North River Basin and the nearer Mount Kenya, the higher the rainfall is, although years occur of total rain failure during which it is not possible to grow a crop (Gichuki et al., 1998). Only 1,984 of the 9,462 square kilometre of the county's surface land is arable, of which 80% is under food crops. Over 60% of the county's households derive their livelihood from agricultural activities, including pastoralism, mixed agro pastoral farming systems, ranching, and crop farming (Agricultural Society of Kenya, 2014).

Within Laikipia, the study area was the sub-county of Laikipia East. Laikipia East is part of the cool highlands which are characterised by the semi-humid to semi-arid (agro-ecological zones III and IV) conditions north-west of Mount Kenya (see Figure 4-1). Mean annual rainfall is 400 mm to 700 mm per year and is highly variable and unreliable. Climate models suggest that the area will face increasing variation in its inter- and intra-annual rainfall distribution, which would adversely affect peoples' livelihoods (Notter et al., 2007). The potential for smallholder farming in the area is inherently limited. Maize, beans and Irish potatoes are the main staple crops. A common cropping system in the study area is to alternate one to three rows of beans with one row of maize, and 'rotate' this system in the next season with four to six lines of Irish potatoes for every row of maize (Min. of Agr., 2013). The large-scale vegetable-, flower- and fruit producers employ local workers, making labour relatively expensive (Min. of Agr., 2013).

The land use near Mount Kenya and the urban centre of Nanyuki is characterised by intensive mixed small-scale farming and several large-scale export-oriented horticultural farms. Further away from the mountain the climate becomes dryer, small-scale farming gradually becomes less intensive and is finally replaced by pastoral range lands, large ranches, tourist lodges and game parks (Min. of Agr., 2013).

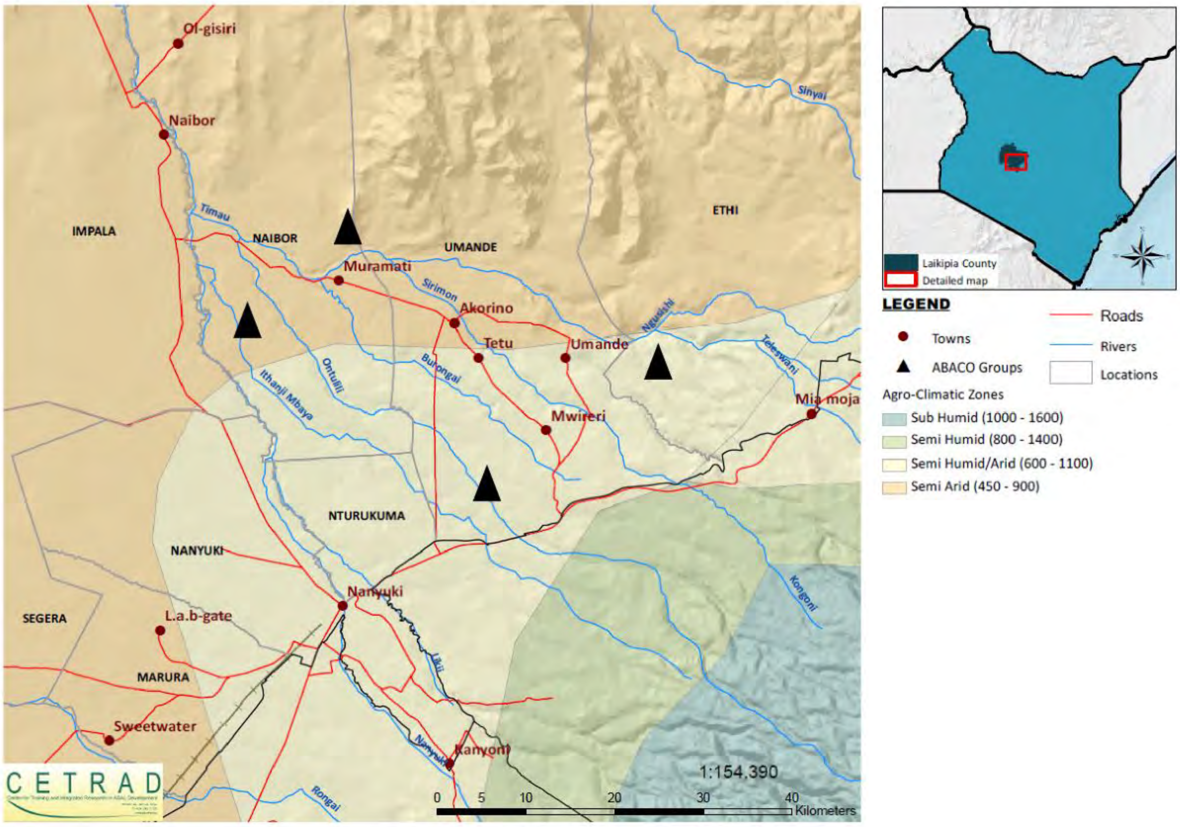


Figure 4-1 Location and agro-climatic zone of four selected Farmer Field Schools in Laikipia East, in central Kenya (designed for this study by the author, data from CETRAD)

The area knows three rain seasons including the long rains (March-June), continental rains (August-September), and the short rains (October-December), resulting in areas with unimodal, bimodal and trimodal rainfall patterns. From the lower mountain slopes downwards, average annual rainfall decreases while evapotranspiration and rainfall variability increase (Gichuki et al., 1998). The concentration of heavy rains during a short period of time shows the need for soil and water conservation. Crop production is further limited by the occurrence of frost and low temperatures on the plateau, as many drought-tolerant crops and fruits do not grow well in a climate with such extremes.

In 2009, the projected population of Laikipia County by 2015 was 457,514, and the ratio of men to women is practically one to one (KNBS, 2009). There are five administrative sub-counties: Laikipia East, Laikipia Central, Laikipia North, Nyahururu and Laikipia West (Agricultural Society of Kenya, 2014). The five main drivers of economic growth in Laikipia County are tourism, beef and dairy, horticulture, agriculture, and ICT and services (Agricultural Society of Kenya, 2014). The main tourist attractions are the privately owned ranches that combine livestock production with wildlife conservation on 75% of the surface of the county. Wildlife conservancies now contain the greatest number and variety of wildlife outside the protected parks, and offer the possibility for safaris.

Originally Laikipia was inhabited by the Masai people, who practised traditional pastoralism on land that was communally owned. During the colonial period, the area was populated by mainly European settlers who started big, extensive livestock farming systems. The area became known as the *White Highlands* (Kohler, 1988). After Kenya's independence in 1963, several land redistribution programmes resulted in the settlement of smallholder farmers, mainly from the Kikuyu and Meru ethnic groups in Laikipia (Ulrich et al., 2012). In the north and east of the county, the Masai were able to maintain a pastoralist lifestyle, but in other parts of the county land is increasingly coming under private ownership for mixed crop-livestock farming. In the last 30 years, the area has undergone very rapid human population growth as a result of the sub-division of large-scale ranches into small-scale farms. This went hand in hand with significant land use changes, especially the conversion of grazing land and natural forest and bush land into small-scale farming areas (Gichuki et al., 1998; Ulrich et al., 2012).

In 1995, immigrants accounted for about 70% of the adult population in the county (Kaumbutho and Kienzle, 2007). Most of the settlers are from the Kikuyu and Meru ethnic groups, and come from high potential agricultural areas such as Meru and Nyeri, due to population pressure in their home areas. As a consequence, they introduced some agricultural management practices that are not always suitable for the (semi)arid conditions in Laikipia (Ulrich et al., 2012). Land holdings are typically around 1.2-2.4 ha in the area. Kohler (1988) argued that plots of this size are by far not big enough to secure subsistence under the given agro-ecological conditions, therefore characterizing it as 'subsistence agriculture' is in many cases an overstatement. Indeed, the area regularly suffers food shortages, and almost half of the population benefits from food aid through the government or the World Food Programme (Kaumbutho and Kienzle, 2007).

4.4.2 CA in the study area

The promotion of CA among smallholder farmers in Laikipia County has mainly taken place through several large projects, amidst many other projects that promoted sustainable development in the area. Starting in 1997, Kenya Network for Draught Animal Technology (KENDAT) started to promote draught-animal technology to support conservation tillage. Since 2000, the Kenya Agricultural Research Institute (KARI) has been testing the suitability of legume cover crops in the Legume Research Network Project (LRNP) (Kaumbutho and Kienzle, 2007).

In 2004 the project 'Conservation Agriculture Project- Sustainable Agriculture and Rural Development' (CA-SARD) was implemented by the African Conservation Tillage Network (ACT-Network) and KARI, in partnership with and funded by the Food and Agriculture Organization of the United Nations (FAO). It was implemented in two phases, CA-SARD I lasting until 2006 and CA-SARD II lasting from 2007-2010. The project was active in Siaya, Bungoma, Nakuru, Mbeere and Laikipia counties in Kenya. The objective of the project was to contribute to growth and improved food security in Kenya by scaling up CA as a sustainable land management tool. The project approach articulated cross-cutting issues that facilitate adoption of CA technology by smallholder farmers, which included involvement of the input supply chain, the CA implement supply chain, agro-processing and market access (Mulinge, 2010).

The CA-SARD project was executed through the Farmer Field School (FFS) approach, with 10 FFSs in Laikipia comprising of 25-30 farmers each, numbers that quickly reduced to about 10-15 farmers each. The extension department of the Ministry of Agriculture (MoA) implemented the project in collaboration with local partners. One of the outcomes was that 1,482 farmers were reached by a trained facilitator who also distributed a reference manual developed by ACT-Network. The evaluation report showed that one of the major difficulties for CA farmers include the high initial cost of starting CA, especially the cost of herbicides, and the lag between the initial point in starting CA and achieving full potential benefits of CA. Also, access to CA equipment was a big problem. Benefits were an increased harvest, and reduced labour for women and children. For children it gave them more time to study and play, while women had enough time to engage in other small business, value adding and marketing of their produce. The evaluation report importantly concluded that increased knowledge of CA is a necessary but not a sufficient condition for farmers to adopt the technology, it needs to be supported with improved institutions (Mulinge, 2010).

The ABACO project followed up on CA-SARD and started its activities in Laikipia in 2011. In the following period, eleven groups were selected to start FFSs and to establish demo plots. The total membership was 270 farmers of which 175 were women (65%). By the end of 2012 two groups fell out and currently there are nine groups with an active membership of 134 farmers of which 82 are women (61%). The FFSs are provided with inputs and equipment by the ABACO project and training by the MoA facilitators. Moreover, two soil moisture CA trial sites were established in early 2011. The main trial crop was maize with soil cover provided by dry mulch, black beans, butter beans and pigeon peas (Min. of Agr., 2013).

Other stakeholders also became involved in the promotion of CA (see section 5.2.1 for a full discussion of the main CA stakeholders), including Syngentha foundation, CETRAD, Lengetia farm and the Olpejeta wildlife conservancy. The latter two employ extension officers as part of their community development programmes in the area around their farm/conservancy. CETRAD covers parts of Daiga and Laikipia Central sub-county, mainly with research projects that try to facilitate CA adoption through farmer resource centres (Min. of Agr., 2013).

4.5 Study area Madagascar: Lake Alaotra

4.5.1 Description of the area

The study area in Madagascar, which I refer to as the Lake Alaotra region, was located in the district of Ambatondrazaka, one of the five districts in the Alaotra-Mangoro region, which is one of the three regions of the Toamasina province (also called Tamatave province), about 175 km North-East of the capital Antananarivo (see Figure 4-2). The town of Ambatondrazaka is the main urban centre in the district, and is home to approximately 70,000 people. Although this is not a high population, it has doubled every 18 years since the 1960s and the area is therefore characterized by rapid population growth. The total population in the Lake Alaotra area is estimated at 670,000 people, of which 540,000 people are depending on agriculture for their livelihoods. The most important crop for most smallholders farmers in the Lake Alaotra region is rice, which they grow in the paddies for subsistence but also to generate income. Self-sufficiency in rice has been frequently used by researchers to draw up farm typologies, and the farmers who are not self-sufficient in rice belong to the poorest households.

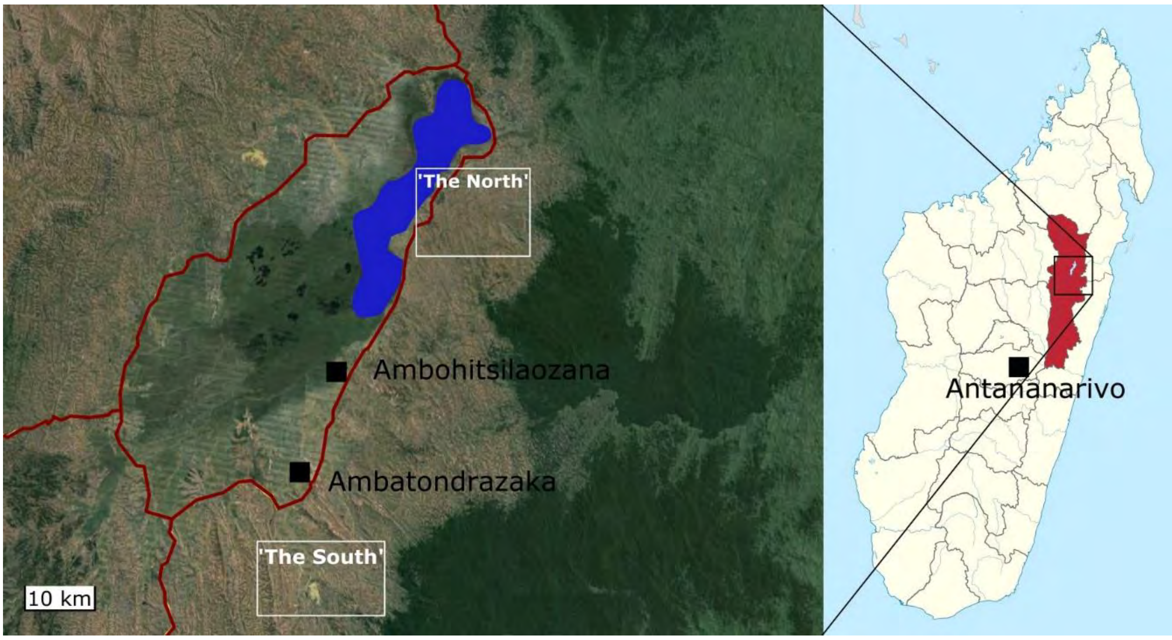


Figure 4-2 Location of the two study sites 'The North' and 'The South' in the Lake Alaotra region in Madagascar

Lake Alaotra is the biggest lake of the country with a length of over 35 km. It is one of the major rice-growing areas of Madagascar with more than 100,000 ha of rice fields with an estimated production of 200,000 ton/year, of which about a third is exported to the urban centres of Antananarivo and Toamasina. The average yields range from 1 t/ha for upland rice to 2.5 t/ha for paddy fields with limited water control (Penot 2010). Exact data of rice production and productivity is not available.

The climatic factor that limits the productivity in the Lake Alaotra region is the long dry season that lasts more than six months. The rain season starts usually in November, and continues to the end of March. During the end of the rain season, cyclones may occur, leading to heavy rainfall. Mean annual rainfall between 1942 and 1988 was 1051 mm near Ambatondrazaka (see Table 4-1). The average annual temperature is 22°C.

Table 4-1 Average rainfall per month in the Lake Alaotra region in Madagascar (Source: CALA measurements from 1942-1988)

Month	Rainfall (mm)	Percentage (%)
January	244	23
February	201	19
March	190	18
April	44	4
May	10	1
June	7	1
July	6	1
August	7	1
September	3	0
October	26	2
November	109	10
December	203	19
Total	**1051**	**100**

Farmers usually have several fields with very different production systems that vary according to the topography, ranging mostly from 750 to 950 meters above sea-level. The general distinction is made between fields on the *tanety* (hillside), *baiboho* (fertile colluvial depositions), and *tanimbary* (semi-irrigated rice paddies). The *tanety* are Ferralsols (texture 39% clay, 29% silt and 32% sand) (Razafimbelo et al., 2010) and are sometimes further classified according to their level of compaction, fertility or degradation status. The higher *tanety* are characterised by the growth of grasses, called *bozaka,* and very large erosion gullies, known as *lavakas*. Some of the lower *tanety* are relatively fertile although still strictly rain-fed, with soils that tend to be chemically poor and relatively acid (PH around 5) due to the granite and migmatite mother material (Husson et al., 2012). The higher *tanety* are used for cattle grazing, and where lower *tanety* are used for agriculture it is for crops like maize, cassava, beans and groundnuts. Soil erosion is a big challenge on the *tanety*, and the *lavakas* are a prominent feature in the landscape.

The *baiboho* fields are Cambisols (texture 20% clay, 38% silt and 42% sand) and relatively fertile and flat. They stand out from the plains around the lake and as such are generally not inundated in the rain season (Razafimbelo et al., 2010). Because of capillary rise from the high water table, the *baiboho* offer the possibility of growing an off-season crop. These fields are suitable for most crops, including vegetables. The *tanimbary*, or rice paddies are distinguished according to the possibility to control the water level. The *tanimbary* are the rice paddies with good water control (French: *rizières irriguées*, or RI), while the term *saro-drano* indicates rice fields with low water control (French*: rizières à mauvaise maîtrise de l'eau*, or simply RMME). The latter are sometimes entirely covered with water when high water levels in the lake make drainage impossible, or fall dry during droughts. Some rice paddies offer the possibility of growing a crop in the counter-season, while others do not. In practice, the topo-sequence offers gradual shifts and the distinction between e.g. the *saro-drano* and *baiboho* is sometimes difficult to make.

4.5.2 Two distinct landscapes: 'The North' and 'the South'

The two research areas selected for this study corresponded with the centres of project activity of the ABACO project, and are referred to as 'the North' and 'the South' (see Figure 4-3). Both areas were located in the district of Ambatondrazaka. Within the district there are 20 communes, locally called *fokontany.*

The study site in 'the North' was located in the *fokontany* of Amparihitsokatra, east of Lake Alaotra. The nearest urban centre is the town of Imerimandroso which has around 11,000 inhabitants, but people rely on Ambatondrazaka for most important input and output transactions. Irrigated rice fields are rare in this area, because there is little flat land between the *tanety* and the shores of Lake Alaotra. Farmers primarily hold land in the rain fed *tanety*, and crop failure due to drought is therefore a risk for these farmers. Production systems are mainly organized around maize, groundnuts and cassava. Cattle are an important element in the farming system, especially because they are used for ploughing. Because of the relatively few rice fields and consequently limited availability of rice residues, there is high demand for crop residues to use as fodder. The villages around Amparihitsokatra are relatively isolated due to the poor road condition, especially in the rain season, and it is difficult to market produce and to find inputs such as fertilizer and herbicides.

The other study site was near the *fokontany* of Ilafy, located in a valley south-east of Ambatondrazaka around the village of Mahatsara. This valley, part of the irrigated valley known as 'PC15', is an important rice production area, where farmers gain the most important part of their income from the rice production. Besides the irrigated rice fields, farmers also have rice paddies of poor water management, and *tanety*. Unlike the north-eastern part of this area, the farms in the south-eastern valley are near the regional capital Ambatondrazaka and are relatively well integrated with the markets. In addition, the city of Ambatondrazaka offers significant opportunities for off-farm employment. As in the north-east, cattle production is well developed and important for the work in the rice fields. However, there is no problem of forage as there is in the north, since large quantities of rice straw are produced on the irrigated rice paddies in all seasons.

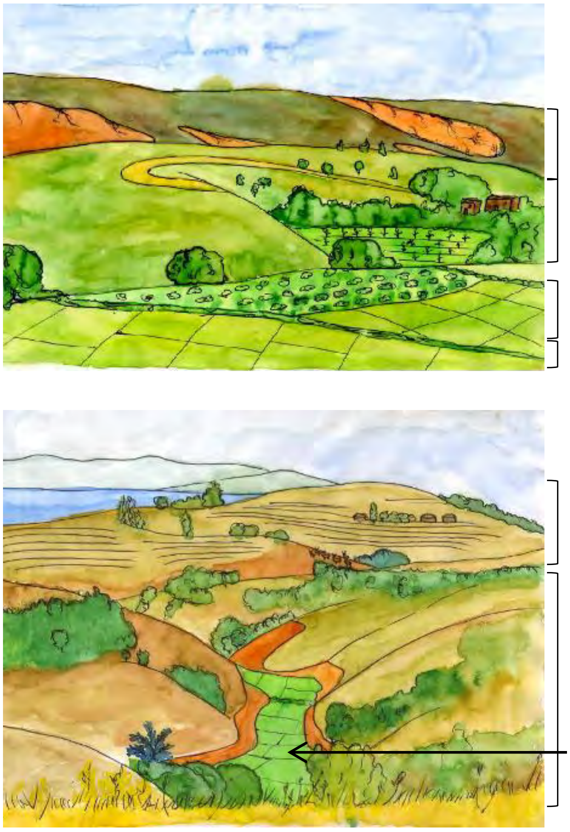


Figure 4-3 Impression of typical landscapes and associated uses of the land in the two study sites in the Lake Alaotra region (adapted from Kendzior, 2013; based on: Fabre, 2011)

4.5.3 CA in the study area

The research on CA in Madagascar started in the early 1990s, motivated by the performance of CA in tropical conditions in Brazil. From 1992, the design of cropping systems has been led by a Malagasy NGO called TAFA, and supported by engineers from CIRAD (Naudin, 2012, p. 8). In 2003 the BV-Lac project started, which grew to an initiative that involved many research and extension institutes to promote sustainable and productive agricultural practices at the watershed level. The full project name was 'mise en valeur et protection des Bassins Versants du Lac Alaotra', hence BV-Lac. The first phase (2003-2008) of the project was evaluated to be following too much a top-down approach that focussed on the field level. The work focussed on technical implementation of CA cropping systems, but little attention was given to trade-offs at farm level and the limitations of CA (Naudin, 2012). The second phase (2008-2013) aimed at a more holistic systems-based approach, which also resulted in many interesting findings and outputs, including a detailed technical manual consisting of many volumes (Husson et al., 2013), studies about the effects of CA on soil erosion (Douzet et al., 2007; Van Hulst et al., 2011), socio-economic impacts of CA (Penot et al., 2010; Mac Dowall, 2011), and reasons for abandonment of CA (Chabierski et al., 2008).

In 2009, the total area under CA in Madagascar was estimated to be close to 5000 ha, of which the two most important centres were the Lake Alaotra region (with around 2000 ha) and the 'Middle-West' (with around 1200 ha), according to the GSDM brochure. However, estimations of the area can be quite different when different estimation methods are used. Rakotondramanana *et al.* (2010) estimated the area covered by CA to be 1400 ha, implemented by more than 1000 farmers. By excluding fields where CA was adopted for the first year and fields covered with only forage from the calculation, Penot *et al.* (2011) estimated the 'real' area under CA to be 419 ha in 2010, adopted by between 600 and 1000 farmers. They found that many farmers adopted the innovative farming systems (Fabre, 2011) and incorporated some improved management elements, without necessarily adopting CA *sensu stricto* as a complete farm management system.

Penot *et al*. (2011) also found that farmers who abandon CA do this usually in the first three years, which includes the opportunistic farmers who seek to benefit from the project opportunities. It is safe to assume that the area under CA is less than 1 ha per farmer, probably around 0.5 ha per CA adopting farmer. These adoption estimates are made after a 10-year project in the area, and in this time little spontaneous adoption was observed. After the project ended in 2013, it was expected that many farmers would abandon the practice (Naudin, 2012). Reasons for abandoning the practice of CA in the Lake Alaotra region were related to difficulties in mastering the complex system, lack of the resources to invest in the initial costs (especially herbicides and seeds), and problems of land tenure security (Penot, Fabre and Domas, 2011). Randrianarison (2013) notes the high amount of technologies suitable for Madagascar, and concludes the following: "*Les problèmes qui se posent concernent plutôt leur diffusion en milieu paysan*". In other words, the primary challenge is not the shortage of technologies, but the effectiveness of getting new technologies to work in practice through extension.

4.6 Languages and translation

The languages spoken in Laikipia County are part of different language families, including Kikuyu, which is a Bantu language and part of the Niger-Congo language family, and the Masai language Maa, which is part of the Nilo-Saharan language family (Ethnologue, 2016). The name of Laikipia County is derived from the Masai language, meaning 'treeless plain'[6]. At the county level, the Masai are an important and interesting group that continue to live as pastoralists in the north and west of the county. Among the mixed farm systems in Laikipia east, however, the dominant ethnic group was Kikuyu whose first language is the Kikuyu language. The second largest group are the Meru who generally moved to Laikipia from the neighbouring Meru County and whose first language is the Meru language. Most farmers have a reasonable understanding of Kiswahili and depending on the level of education also a basic understanding of English. All enumerators that assisted with interviews and field visits were fluent in Kikuyu, Swahili and English, and in some instances they could also speak another language (Meru, Embu, etc.). As such, farmers could in the vast majority of cases be addressed in their mother language, which was then translated into English.

Among the inhabitants of the Lake Alaotra region in Madagascar, two predominant ethnic groups can be distinguished: the Sihanaka, which literally means 'people of the swamps' who are the original inhabitants of the area and are known to be skilled rice growers, and to a lesser extent the Bezalozano who migrated to the Alaotra region from the Moramanga area, south of Alaotra. Some farmers also self-identified as Merina, the ethnic group originating from the capital. The common language is Malagasy, which falls under the Austronesion (Malayo-Polynesian) language family (Ethnologue, 2016), and only slight difference in accents were present within the study area. Most farmers had a very limited understanding of French. The enumerators and translators used in the research were all native Malagasy speakers local to the area, who communicated with me in the French language in which we could communicate fluently. Due to a previous six-month stay in the same area, I was already familiar with the important farming systems and some of the socio-cultural background.

[6] The County government recently announced to consider renaming Laikipia to *Supuka,* which means ´forested countryside´. County governor Joshua Irungu: "The county is planting trees and deserves a new name" (Waithaka, 2016)

4.7 Chronology of the research process

An overview of the research process is given in Figure 4-4. After spending 6 months doing an initial literature review and deciding on suitable methodologies, two periods of data collection were undertaken in each country. The first period in Kenya (July-October 2013) and Madagascar (November 2013-February 2014) served to do most of the data collection. This included the RAA questionnaire about the intentions to adopt CA practices in the next season and the semi-structured in-depth interviews with key stakeholders at the national and local level. The return visit to Kenya (June 2014) and Madagascar (March 2015), served to share preliminary results with stakeholders, including farmers, through Focus Group Discussions, and to follow-up on the RAA questionnaire in terms of farmers' actual adoption (as opposed to the intended adoption). The rest of 2015 served to present the first results at the 1st Africa Congress on Conservation Agriculture in Zambia, and to publish a paper about the adoption of CA in Kenya. Early 2016 was used to write up all the results for this dissertation.

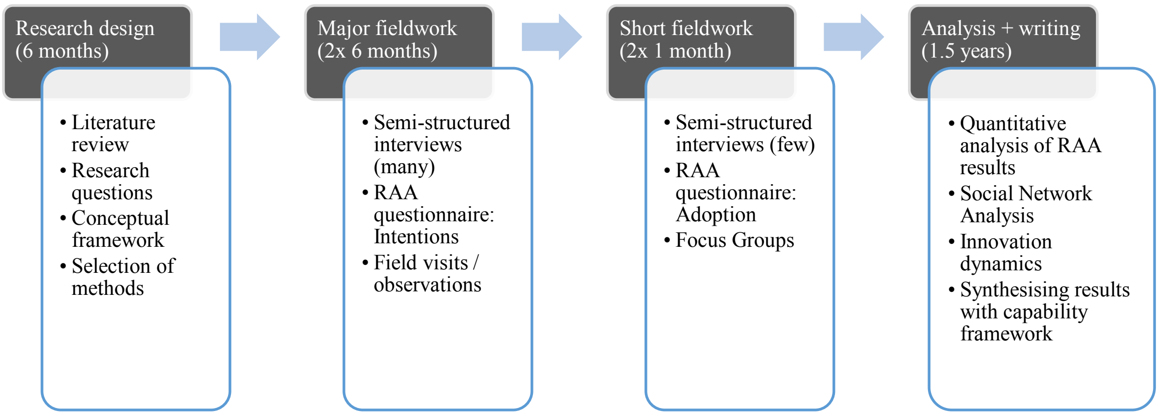


Figure 4-4 Overview of the phases in the research process and the corresponding milestones

4.8 Sampling strategy

4.8.1 Sampling in the ABACO project

In both countries, farmers were selected from the groups that were part of the ABACO project. Detailed information on how these farmers and groups were sampled to become part of the project is not available, although it is clear that two different strategies were followed in Kenya and Madagascar. In Madagascar, new groups were formed for the project on the basis of farmers' interest to participate in co-designing CA systems. In the North, the new group included a pre-existing CA group of female farmers who had continued meeting after the end of the BV-Lac project and could therefore contribute a lot of knowledge to the group. In the South, there was no relevant pre-existing structure in the CA group, and membership was very fluid. Most farmers who joined the group in the South were not very experienced with CA although they were aware of the concept through the previous BV-Lac project.

In Kenya, the ABACO project continued with the same FFSs that were part of the previous CA-SARD projects. Some of these FFSs existed even before that, and were involved in other activities such as the marketing of Aloe Vera. Other FFSs were formed for the CA-SARD project. In the ABACO project, activities tended to focus on 6 or 7 out of the 10 FFSs who were relatively active. The other FFSs had problems of managing group processes, internal conflicts or had given up CA as a result of complete crop failure due to elephants (MoA local, personal communication, 08-09-2013).

4.8.2 Kenya

To limit the scope of the study, four FFSs were selected from nine FFSs involved in CA with the ABACO project. The selection represented the social and agro-ecological variety of Laikipia East in terms of average farm size, labour availability, average rainfall, and soil fertility. Information about these characteristics were obtained through various interviews with extension officers of Laikipia County. On this basis, Kilimo Hifadhi, Muramati, Mazingira and Kalalu FFSs were selected, of which the first two FFSs were located in the semi-arid zone with rainfall ranging from 450-900 mm/year and the last two FFSs were located in the semi humid/arid zone with rainfall ranging from 600-1100 mm/year.

For the adoption study with the RAA, a total of 95 smallholder farmers were interviewed in July-October 2013. One third (33) of the respondents were randomly selected from the four selected FFSs, referred to as ‘members’. From the immediate vicinity of these FFS farmers, another 62 non-FFS respondents were selected through geographical sampling starting with those living nearest to the FFS, referred to as ‘non-members’. The gender ratios were kept proportional with the district averages.

A follow-up questionnaire was held in May-June 2014 among 77 of the same sample assessing the actual adoption of CA practices. The repeat sample is smaller because 18 farmers had either moved away or were not available for an interview. In the repeat sample, the proportion of members was higher because members were easier to locate than non-members, while the gender balance and average age were not significantly different in both samples. To avoid a bias in the results, the panel data of the 77 respondents was used for all the analyses. The characteristics of the sample are described in section 7.2.1.

4.8.3 Madagascar

In Madagascar 100 farmers were selected, of which 30 were members of the ABACO groups. As ABACO was only active in two farmer groups, both were included in the sample and farmers were selected from them. In the commune of Amparahitsokatra, almost all members had to be interviewed to get to the target number of 15 farmers. In the commune of Ilafy, 15 farmers were selected by the chief of the area. Although some preferences for the random sampling could be made clear, little insight could be gained in the motivation of the chief to propose one farmer over another. The gender proportions of heads of households in the FFS sample were kept proportional to the district averages as much as possible. Sampling of non-member farmers followed geographical sampling. Because the villages were very small, and many farmers were away to work on the land, it was a challenge to find sufficient farmers at home that were available for interviews. Therefore, it was a priority to find enough farmers to fill in the questionnaire and less attention could be given to make sure that the sample of non-members was representative in terms of gender and age. This resulting in an overrepresentation of men relative to district averages. Of the non-members, practically everyone had heard about CA through the BV-Lac project that has been actively promoting CA in the area for the last 10 years, although few of them still practiced CA.

A follow-up questionnaire was held in March 2015 among 82 of the same sample assessing the actual adoption of CA practices. The repeat sample is smaller because 18 farmers had either moved away or were not available for an interview. As in Kenya, the proportion of members was higher in the repeat sample because members were easier to locate than non-members, while the gender balance and average age were not significantly different in both samples. To avoid a bias in the results, the panel data of the 82 respondents was used for all the analyses. The characteristics of the sample are described in section 7.2.2.

4.9 Research methods

4.9.1 Overview of methods

For the study of the promotion and adoption of Conservation Agriculture in Kenya and Madagascar, a combination of qualitative and quantitative research methods were used. In a dialectic way the methods and concepts connect the *factors* and determinants that enable or constrain the application of the agricultural practices like CA, with (social) *actors* and their objectives, influence and interaction.

The smallholder farmers are at the centre of this study because they are part of the agricultural innovation system through their interactions with extension officers, through their participation in groups and projects, and through their interactions with agro-dealers and traders when buying inputs and selling outputs. Farmers are also deciding what practices are to be realized on their farm, and as such they are closely connected to the farming system.

Table 4-2 shows a schematic representation of the relation between the studied elements within the innovation system, and the farming system. The methods used to gain insight in the processes in the innovation system are stakeholder analysis based on semi-structured interviews and a Social Network Analysis. The method used to study the adoption of CA is the Reasoned Action Approach, together with FGDs and field observations.

Table 4-2 Overview of applied methods in relation to research questions

Method	Objective	RQ
Semi-structured interviews (4.9.2)	• Identify key stakeholders and their linkages in the innovation system • Understand stakeholders' legitimation and framing of CA	1 a 1 c
Social network analysis (4.9.3)	• Understand linkages between stakeholders in the innovation system	1 a
Literature review (4.9.4)	• Triangulate findings	1 b,c
Structured questionnaire: Reasoned Action Approach (4.9.5)	• Understand reasons for adoption and non-adoption of CA practices	2
Focus Group Discussions (4.9.6)	• Discuss adoption of CA, including gender • Triangulate findings	2 2
Observations and frequent field visits (4.9.7)	• Better understand reasons for adoption and non-adoption of CA practices • understand dynamics in the innovation system at field level and triangulate findings • Triangulate findings	2 1 b

4.9.2 Semi-structured interviews

A total of 21 semi-structured interviews were carried out with stakeholders at the national and local level in both countries, who were involved in the experimentation, extension, and facilitation of CA. An overview of the respondents is given in Appendix V. The objective of these semi-structured interviews was to gain insight in the different stakeholders in terms of the function of the organisation, the extent of political, technological and other influence. The adoption rates of CA were discussed, as well as the possible reasons behind the observed (non-)adoption. The interviews were also used to analyse the language that was used and the justification and rationale for being involved in CA. In relation to the extension approach a multiple choice question was included based on the styles of promotion described by Röling (2009). Respondents, representing their institution, were asked what they saw as their role in the innovation system and the primary legitimation for their involvement in CA. The guidelines for the semi-structured interviews is given in Appendix VI.

4.9.3 Social network analysis

The semi-structured interviews as described in the previous section, included questions that were used to inform the social network analysis. Those questions related to the interactions with other actors, and what the respondents considered the most valuable partnerships. Moreover, a survey (see Appendix VII) was designed to get insight in the interactions between all organisations that influence (positively or negatively) the promotion, facilitation and implementation of CA. The questions were specifically about the interaction with other CA actors, the frequency and means of contact, the reason for being in contact with other actors. Respondents were also asked to describe the role of the other actor vis-à-vis their organisation, whether it was e.g. their partner, service provider, client, facilitator, research specialist, dissemination specialist, technology developer etc. Because the survey was distributed via email, only eight responses were obtained in Kenya, and only four were obtained in Madagascar. Therefore the data was triangulated and completed through key informants at ACT-Network and MoA local in Kenya, and at CIRAD and local ABACO project staff in Madagascar. This information was then used in the NetDraw software as a means to gain insight in the distribution of stakeholder types and their linkages in a social network.

The stakeholders, the nodes in the network, were categorized in seven types: Government Organisation (GO), NGO, farmer/farmer group, private sector, platform, project, and donor. Whether a stakeholder is operating at the regional, national or local level was also imported in the NetDraw software, which was later represented by the node colour. Some stakeholders operate at different levels and could be classified as different types. In such cases a judgement was made of the most pertinent role, or the level where the actor has most influence. For example, in Kenya ACT-Network was included as a national stakeholder (although it is a pan-African organisation) because they had a strong presence in terms of project implementation and interaction with National level stakeholders, while in Madagascar ACT-Network was included as a regional stakeholder because there were few activities at the national level.

The linkages between the stakeholders, the lines in the network, were categorized in five types: knowledge (including consulting, sharing and using knowledge, extension, and research), services (including service provision, technology development, and inputs/outputs), policy (including policy development and advocacy), partnerships (including project partnerships and general networking ties), and financial support.

In order to pull out the most important information, three output maps were created and used for further analysis. The first was a map of the whole network at all levels, allowing to get an overview of the innovation system and see the linkages between regional, national and local level stakeholders. The second was a map of the stakeholders with the highest *degree*, i.e the highest number of linkages with other stakeholders, allowing to see the most central and most connected actors in the network. The third was a map that zoomed in on the farmers and farmer groups, to understand the type of direct linkages farmers have, and to what extent they are connected to other groups of actors.

4.9.4 Literature review

Besides peer-reviewed academic publications, this research is cognisant of official (policy) documents, web-sites and promotion materials of various organisations were consulted. It was used to gain insight in the perception of what constitutes CA, i.e. how it is framed, and how and why CA should be promoted. As with the interviews, special attention was paid to the reasons why farmers should adopt CA, and the language that was used to communicate this message.

4.9.5 Structured questionnaire: Reasoned Action Approach

Questionnaire design: variables and scales

Conservation Agriculture is not a single activity, but a behaviour category consisting of several agricultural practices, that could be studied as ‘behaviours’ in their own right. Seven **distinguishing agricultural practices** have been identified through key informant interviews that are relevant to understand the adoption of CA in Kenya and Madagascar, using the Reasoned Action Approach:

- Ploughing
- Direct planting (planting without ploughing the soil first)
- Spraying herbicides (with a knapsack sprayer)
- Shallow weeding (scraping the weeds from the soil surface)

- Leaving crop residues on the land (including imported mulches from other fields)
- Planting cover crops
- Rotating crops

This research looked both at these constituent practices and at the constructed **behaviour category** of CA which was defined as adopting both direct planting and mulching. Spraying herbicides and shallow weeding were not included in this definition because they are not always strictly necessary for implementing the CA principles as disseminated to and practiced by the farmers. Normally cover crops would be included in this definition, but because non-FFS farmers were not familiar with the concept, their responses regarding the practice of cover crops were not considered to be reliable enough to include. Crop rotation was also excluded, because it proved very difficult to define. Moreover, a basic form of crop rotation was already practiced by most farmers, and relatively little attention was given to this aspect of CA in the trainings at the CA groups or FFSs in either country. Only in Kenya was Shallow weeding considered an important distinct CA practice, as in Madagascar there was no 'conventional' practice of deep weeding that involved turning the soil.

For each practice, **intentions** were assessed in 2013/2014 as likelihood ('very unlikely' to 'very likely' as measured on a 5-point single Likert item from -2 to 2) of adopting the practice in the rain season of 2014. An average of 70% of the responses for the intention were found to be either 'very likely' or 'very unlikely'. Therefore the intention variable was transformed from a 5-scale ordinal into a dichotomous variable in which the outcomes 'likely' and 'very likely' were labelled as intenders, and the other outcomes from 'very unlikely' to 'maybe' were labelled as non-intenders. Adoption of the CA practices was directly assessed in 2014/2015 as a dichotomous variable (yes-no), independent of the surface area of the farm where it was adopted.

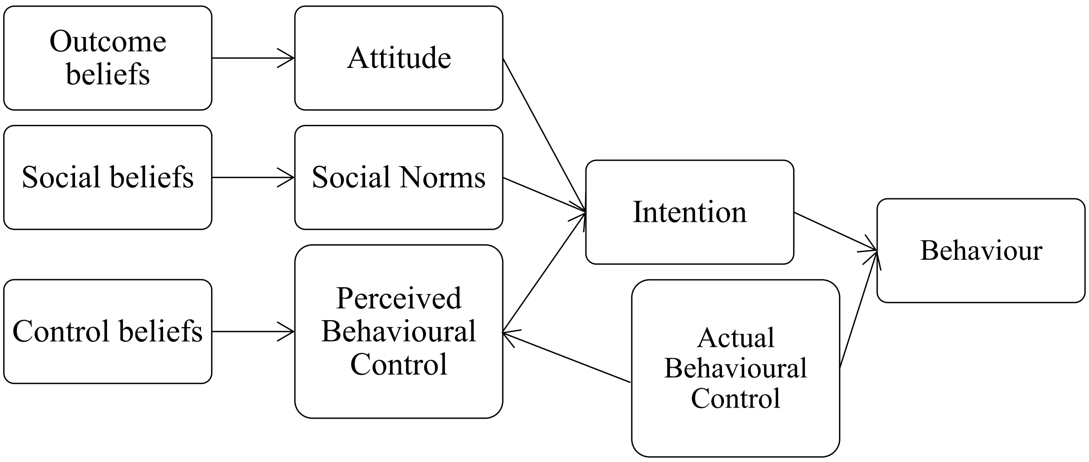


Figure 4-5 Simplified model of the Reasoned Action Approach (Source: Fishbein and Ajzen, 2010)

In the Reasoned Action Approach (Figure 4-5), the constructs of **attitude** (A), **perceived norms** (PN) and **perceived behavioural control** (PBC) are assessed by means of different items to cover different dimensions of the behaviour. Attitude was assessed through three items to incorporate both evaluative (good-bad, foolish-wise) and experiential aspects (unpleasant-pleasant). Injunctive norms were assessed through the perception of whether 'important others' approve of the respondent doing the practice (they think I should not-I should…). The descriptive norms are the perception of how many among the people that are respected and admired by the respondent actually adopt this practice (almost all-almost none). Perceived behavioural control was assessed with two items that are conceptually slightly different (see section 2.5.1). The first element in PBC is perceived ease, referring to internal factors (very difficult-very easy). The second element in PBC is perceived control which refers more to the external factors that may influence the PBC (not at all up to me-up to me). Where internal consistency of these multi-item scales was sufficient, the scales were used; in other cases the single items were used (see section 7.3).

To evaluate the **internal consistency** and reliability of such multi-item scales, it is most common to use Cronbach's Alpha coefficient (Cronbach, 1951). However, in psychometrics the limits of Cronbach's Alpha are regularly debated (e.g. Ten Berge and Sočan, 2004) and the Greatest Lower Bound (GLB) is seen as a more accurate way to assess internal consistency and reliability (Sijtsma, 2009). For two-item scales, better reliability estimates are given by Spearman-Brown coefficient as suggested by Eisinga et al.(2013). In this study, these coefficients are presented together with Cronbach's Alpha.

The respective **outcome-, normative-, and control beliefs** were assessed for spraying herbicides, direct planting and mulching, as shown in Appendix X and XI. A complete list of beliefs was made through key informants and focus group discussions. This included collecting all possible out-comes (good and bad) of the different CA practices, identifying the social referents, that is the people and groups that potentially influence respondents' decision making, and listing the control factors that possibly influence perceived behavioural control with respect to adopting the CA practices. The questionnaire was then tested with three individual farmers.

To assess the outcome beliefs the **expectancy-value model** (Fishbein, 1963; Fishbein and Ajzen, 1975) was applied, relying on the product of belief strength b that a certain behavioural outcome i will occur (very unlikely – very likely), and the evaluation e of the importance of these outcomes. If outcome i would both be very important to the farmer and be considered very likely to occur, the product $b_i.e_i$ would be high and the belief would contribute relatively much to a positive attitude. The correlation of $b_i.e_i$ with intention gives a direct indication of how important that belief was for predicting the intentions. This method, although common in the literature, is not without potential problems because the scaling method (unipolar or bipolar likert items) in multiplicative models like the expectancy-value model influences the found correlation with external criterion like intentions (Bagozzi, 1984; Ajzen, 1991; Gagné and Godin, 2000). It can nevertheless give an extra perspective on the relative importance of the respective beliefs.

According to the same principle, the perceived norms were examined by listing injunctive normative beliefs *n* for social referents *j*, and the farmers' motivation to comply *m* with the opinion of these referents. If the farmer thinks that a social referent e.g. the neighbours do not approve of him practicing direct planting (*n* is negative), but the farmer does not attribute much importance to their opinion (*m* is low), then the product $n_j.m_j$ is low, indicating that the relative contribution to the SN is limited. Similarly, the descriptive normative beliefs *n'* and motivation to comply *m'* were assessed for social referents *j'*. The PBC was examined by listing for each control factor *k* the belief that it will be present *c* and the perceived power *p* of factor *k* to facilitate or impede performance of the behaviour (Fishbein and Ajzen, 2010, p. 129–178). Again, the correlation of $c_k.p_k$ with intentions gives an indication of how important that particular belief was in the forming of intentions. In order to increase the variation in the results for e_i and p_k, farmers were asked to rank the possible outcomes and control factors according to their importance.

Training of enumerators

In Kenya and Madagascar local enumerators assisted in conducting the questionnaire. In Kenya, four local students were found who also had experience with doing surveys. They were all MSc students in agriculture and had ties with the research NGO CETRAD in Nanyuki. The enumerators, two women and two men, were trained for one day during which we did one test interview and discussed the outcome. In Madagascar, three young translators from Ambatondrazaka were hired who had worked with the ABACO project before and were familiar with agriculture.

In both countries, the interviews were done in groups of two, allowing one person to lead the conversation while the other could make notes of observations and explanations made by the farmer. At the end of each work day we came together to discuss and evaluate the days experiences. These were valuable moments in which hypotheses and observations could be discussed, and sometimes suggestions were made to include other questions.

Statistical analysis

Both intention and adoption were modelled as dichotomous variables. Therefore a binary logistic regression was used to understand the relative contribution of a set of independent variables to intentions and adoption of the selected CA practices. In a logistic regression model, the probability Pr that dependent variable Y_i takes the value 1 is given by

$$Pr(Y_i = 1|X) = p_i = \frac{e^{\alpha+\beta X_i}}{1 + e^{\alpha+\beta X_i}}$$

where α is a constant, X_i represents the independent variables and β represents the regression coefficients. The odds that Y_i takes the value 1 is given by

$$\frac{p_i}{1 - p_i} = e^{\alpha + \beta X_i}$$

which can be rewritten as

$$\log\left(\frac{p_i}{1 - p_i}\right) = \alpha + \beta X_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \cdots + \varepsilon_i$$

where α is a constant, the X's are the independent variables, the β's are the regression coefficients, and ε is the error term. In the result section the specific regression models used in this study for intention and adoption of CA practices are further defined.

The relative contributions of attitudes (A), perceived norms (PN) and perceived behavioural control (PBC) in the prediction of intentions (I) to engage in CA practice j were tested with the following logistic regression model

$$I_j = \alpha + \beta_1 A_j + \beta_2 PN_j + \beta_3 PBC_j + \varepsilon_j$$

The adoption, or actual behaviour (B) with respect to CA practices j was examined with the following logistic regression model:

$$B_j = \beta_1 I_j + \beta_2 ABC_j + \varepsilon_j$$

where I is intention and ABC is actual behavioural control. PBC was used as a proxy for ABC, because no standard procedures for assessing actual control are currently available (Fishbein and Ajzen, 2010, p. 64), nor is it likely that a reliable, direct measure of ABC can be developed at all.

The significance of the difference between the -non-parametric- constructs' mean values was established with a Mann-Whitney test, and for simple correlations Spearman's rho (two-tailed) was used.

RAA and mixed methods

Implementing the RAA questionnaire involved a combination of qualitative and quantitative methods. Preparation of the questionnaire relied on quantitative methods of inquiry, including key informants and focus group discussions. While doing structured interviews with the farmers, farmers were generally commenting and explaining their answers. These comments were written down and helped understand in a different way what farmers wanted to say. The questionnaires had a structure that worked from general questions towards specific questions. For example, a farmer would be asked what "people whom (s)he respects and admires think about direct planting".

Although the answer in the questionnaire only required a value between -2 and 2, the issue would usually evoke a clarification or a comment on the side-line that proved very insightful. The questionnaire would continue with asking what the respective social normative ‘referents’, e.g. neighbours, would think, and as such the qualitative and quantitative data proved opportunities for triangulation and an improved insight in the important topics.

4.9.6 Focus group discussions

During the second period of fieldwork in the study areas, focus group discussions (FGDs) were organized. All farmers who already had been interviewed twice for the RAA questionnaires, were invited to come and discuss some of the results. In Kenya, separate FGDs were held with members and non-members. In two cases, the planned FGD with non-members was cancelled as farmers proved not interested. An overview of the FGDs that were held is presented in Table 4-3.

Table 4-3 Overview of Focus Group Discussions about CA in Laikipia East

	FFS location	Who?	Gender	Date
Kenya	Muramati	6 Members	4 M, 2 W	5 June 2014
		5 Non-members	3 M, 2 W	5 June 2014
	Kalalu	8 Members	3 M, 5 W	10 June 2014
		0 Non-members	*Nobody showed up*	
	Mazingira	8 Members	1 M, 7 W	13 June 2014
		7 Non-members	1 M, 6 W	13 June 2014
	Mukima	5 Members	1 M, 4 W	18 June 2014
		0 Non-members	*Nobody interested without hand-outs*	
Madagascar	The North	18 farmers (of whom 4 non-members)	12 M, 6F	12 May 2015
	The South	14 farmers (of whom 3 non-members)	10 M, 4 F	15 May 2015

The FGDs were led by somebody from the enumerator team with enough experience in leading a group discussion. This person would also take notes on flap-over sheets for everybody to see what was discussed. In addition, another translator was present to take ‘rich’ notes of what was being said, including the gender of the speaker and the tone (mild, agitated, serious, joking etc.). The researcher was also present at all the discussions and provided input as interesting topics came up.

During the FGD, the following structure was generally maintained:

1. *Introduction.* What are the things we (the team and the farmers) want to talk about?
2. *Results* questionnaire 2013: Adopting of CA as a function of 'attitude' and 'ability'.
3. *Conservation Agriculture:* What works well? What are the challenges?
4. *CA and gender / youth:* When it comes to CA, is there a gender aspect? In terms of deciding, labour division or access to crop residues, inputs etc.)
5. *CA and neighbours:* Can you give examples of how people talk about CA? What comments do you get from your neighbours?

4.9.7 Observations and frequent field visits

Observations and frequent field visits were used in both study areas to better understand the site-specific dynamic processes that actually unfolded during the time of data collection, but also in documented and narrated history. The collection of qualitative data is not only about behaviour, but about action. The difference is that the word action carries in it the intentions, meaning and consequences of behaviour. Within the objective to describe the innovation history of CA promotion and adoption in two specific study areas, attention was given to causal process tracing (CPT) (George and Bennett, 2004), which exists of detailed narratives, combined with analytic explanation.

In practice, mostly qualitative data was collected through field visits, more specifically through participation in activities, informal interviews and observations of day to day actions and interactions that were directly or indirectly related to the promotion and adoption of CA. This informational base allowed an assessment of whether the causal processes that the various actors hypothesized or implied, are in fact evident in the observed and perceived sequence of events. Special attention was given to power balances, different roles, reasons for abandoning CA, project-related dynamics including opportunism, and sustainable adoption by convinced farmers. Farmers were asked to share their stories of adoption and narratives were collected of abandoning CA practices. This empirical data was contrasted with policy and project reports of NGOs and the local governments to gain insight in their overlap or contradictions. The research was not done in a 'natural' environment of spontaneous and institutionalized CA promotion and adoption, but within the 'artificial' context of a donor supported international project that actively tried to increase CA adoption. Therefore, the case study approach necessarily includes a self-diagnostic element towards the project dynamics and is thus partly reflective.

4.10 Ethical considerations

Throughout the research, ethical principles were observed according to the University of Greenwich ethical guidelines. These include respect for respondents, participant's consent in research activities such as questionnaires and group discussions, confidentiality and anonymity of respondents in reporting, and debriefing of research outcomes.

To ensure that research activities were done in accordance with these ethical principles, translators, enumerators, drivers, and focus group discussion leaders, were regularly reminded to work with integrity and to respect the confidentiality of all respondents. Prior to starting the enquiries and interviews among the farmers, approval from local-level authorities was sought after informing them about all the planned activities. Also informal village leaders were informed before contacting individual farmers, as a way to show respect to the local social order.

For the RAA questionnaires with individual farmers, enumerators explicitly introducing themselves, the questionnaire, the objectives of the research and how much time the questionnaire would take, thus facilitating informed consent. In the first RAA questionnaire farmers' names and age were written down with the objective of finding them again in the next season. In the second RAA questionnaire, only coded identification numbers were used, which were also used when questionnaires were computerized.

Focus group discussions facilitated the debriefing of research outputs with the farmers. Many farmers commented that questionnaires only take up their time and is of little use to them, so the fact that a focus group was organized to share some of the results was appreciated. The planning of the focus group discussions was done in close collaboration with the expected participants regarding the time of day, the place and the required refreshments. In this way, after an intensive FGD, everyone could leave the meeting in good spirit and plenty of food for thought.

The semi-structured interviews with stakeholders at national and local level were started with a clear introduction of the objectives of the questionnaire. All respondents gave permission to record the conversation with a sound recorder, which helped to focus my attention on the conversation. The interviews were anonymized for reasons of confidentiality, although the organisations and date of the interview is mentioned for reasons of accountability.

4.11 Strengths and limitations of the study

A strength of the research as shaped through the methods described in this chapter, is the use of mixed methods. In particular in the RAA, the qualitative inquiry was indispensable in the design of the questionnaire. The quantitative approach and statistical analysis gives the RAA a solid basis to compare the explanatory constructs across different locations and to pull out the most influential of the underlying beliefs. This could be triangulated with the comments made by farmers while explaining their answer. This resulted in data that was very rich in both qualitative and quantitative data, and made sense at both the personal level and at the aggregate level.

One of the limitations of the study was the limited sample size for the RAA of 77 farmers in Kenya and 82 farmers in Madagascar. The trade-off between the depth of the questionnaire and the sample size was decided in favour of depth. The primary objective of using the RAA was to better understand reasons for adoption, which required to go beyond the attitude, social norms and perceived behavioural control, to the underlying outcome-, social- and control beliefs. Furthermore, the decision was made to deconstruct CA into several of the constituent practices which meant that the questionnaire had reached a considerable size. Nevertheless, the sample size was enough to draw interesting and valid conclusions, especially in combination with qualitative findings.

The ABACO project infrastructure facilitated some of the work by giving background information of CA in the area and introducing me to important stakeholders. The project context, however, proved also a limitation to the possibility of honest and objective interaction. As farmers associated me with the project, it is reasonable to expect that their answers are at least partly strategic in that respect. Regularly, farmers made requests for farm inputs or training, and with every contact it was explicitly mentioned that the research was carried out independent of the project and had no influence on the project activities. By being aware of this perception, and triangulating farmers' responses with extension staff and other key informants, the influence on this study was limited.

The selection and training of translators was done with the greatest care, but nevertheless there remained unresolved issues of meaning. For example, the word 'believing', used in the English semi-structured interviews (we strongly believe) has a different feel compared to the French (*nous croyons fortement*). This was part of the continuous interpretative process central to social research in what Habermas calls the different 'lifeworlds'[7] of the researcher and the farmers. As such, results can lose validity if the objectives and concepts used in research are based on a different reference scheme for interpreting events and speech acts than can be comprehended in a different culture. The only mitigation against these problems are the triangulation of findings with respondents, having a familiarity with the area, and of self-awareness.

For the semi-structured interviews, a limitation of the study is that not all stakeholders involved in CA could be interviewed. Sometimes individuals were not available for an interview, and sometimes the interviews took a different turn than expected resulting in data that was not very

[7] The concept of the lifeworld was introduce by Husserl, and generally refers to the naive, pre-theoretical experience of the everyday world we share with others. The phenomenologist Schulz (Schütz, 1945) explains: "All interpretation of this world is based on a stock of previous experiences of it, our own and those handed down to us by parents or teachers; these experiences in the form of 'knowledge at hand' function as schemes of reference" (also see: Drinkwater, 1991, p. 20).

useful. The linkages between stakeholders were also difficult to narrow down to a single type of linkage, as most stakeholders had complex and multiple linkages. Therefore, the social network analysis is only indicative of the innovation system, and should not be considered a precise and comprehensive overview of all the types of linkages that exist between all stakeholders. As such, it is a method that is relatively subjective, even though it builds on diverse sources of inputs.

Another strength of the research is the combination of conceptual thinking with concrete empirical data. The reflections on the AIS approach are informed by both concrete observations, narratives and more abstract theoretical notions. Comparing Habermas' theory of communicative action with AIS thinking revealed interesting parallels, which were illustrated by concrete cases at the field level in both countries.

5 CA IN THE AGRICULTURAL INNOVATION SYSTEM

5.1 Introduction

The Agricultural Innovation Systems (AIS) thinking in agricultural development recognizes that innovation occurs through the interplay between many actors, including farmers, researchers, extension officers, service providers, traders, processors, producers' organisations, NGOs, local and national GOs and 'donor' institutes. The imperative that follows from this observation, is that interactions between actors need to be strengthened in order to facilitate organisational change that enables innovation (Kilelu, Klerkx and Leeuwis, 2013; Hounkonnou et al., 2012).

This chapter sets out to describe the innovation system for Conservation Agriculture in both countries. First an overview is given of the most relevant stakeholders who are involved in CA (**section 5.2**). **Section 5.3** takes up the interactions between the actors at different geographical levels, including the project partnerships in international action-research projects. The social network analysis zooms in on the most connected stakeholders and the smallholder farmers' position in the network. **Section 5.4** continues with briefly describing the different methods and tools of agricultural extension and dissemination of new practices such as CA. **Section 5.5** explores some processes in the innovation system, including different project approaches and new power relations with CA. Based on the semi-structured interviews with the important CA stakeholders, several priorities are identified for improving the innovation system regarding the promotion of CA (**section 5.6**). Finally, two cases are described of institutional innovation that developed in a different direction than anticipated, which shows the fundamental tension in speaking of the AIS as an approach (**section 5.7**).

5.2 Stakeholders involved in CA

5.2.1 Overview of stakeholders Kenya

The stakeholders involved in Conservation Agriculture are many, and as the concept becomes increasingly mainstreamed, the range of actors involved in CA in any way keeps expanding. An overview was made of the most important institutes, companies and (non-) governmental bodies in Kenya that research, develop or promote CA at various geographical levels, based on data collection in 2014. In the following pages the full name of each stakeholder is given, together with a short description, the stakeholder category and the main clients/beneficiaries of the stakeholder.

Regional level

The major stakeholders at the regional and international level that are relevant to CA adoption and promotion in Kenya are presented in Table 5-1. At the regional level, there are several policy stakeholders that increasingly incorporate CA in their international policies targeted at increasing

Africa's agricultural productivity through sustainable and climate-smart agriculture. The New Partnership for Africa's Development (NEPAD) was formed in 2001 with wide support from international, regional, and national actors, and functions as the economic development programme of the African Union (AU). Of particular interest for the promotion of CA in Africa is NEPAD's Comprehensive Africa Agriculture Development Programme (CAADP). There is criticism on these projects, also from African Heads of States and Government, because they are implemented top-down and often rely on simplistic modernization and dependency theories of Africa's development (Matunhu, 2011).

One programme within CAADP in which CA is included, is the Programme on Climate Change Adaptation and Mitigation in Southern and Eastern Africa (COMESA-EAC-SADC region), which is a five-year initiative that started in 2010 with the objective to address impacts of climate change through successful adaptation and mitigation actions. This is one example of a regional project that should enable member states to "increase investments in climate resilient and carbon efficient agriculture and its linkages to forestry, land use and energy practices" (COMESA, EAC and SADC, 2011). The ABACO project was also working in close dialogue with these partners to ensure sustainable roll out of African policy on sustainable CA practices and to influence CA support at policy level through lobby and advocacy (European Commission, 2010).

The second important group of actors at the regional and international level is more involved in networking. ACT-Network (African Conservation Tillage Network) is the key actor with this purpose and as a pan-African organisation they function as a platform for the management and sharing of knowledge and experiences, together with networking and coordination of activities. ACT-Network aims to be a "network of excellence" in promoting sustainable agriculture for improved livelihoods in Africa, and the purpose is described as follows: "To enhance agricultural productivity, sustainable land management and environmental conservation through promotion of conservation agriculture principles and practices in Africa" (ACT-Network, 2012). The Conservation Agriculture Regional Working Group (CARWG), sometimes referred to as Regional CA Taskforce, has a similar objective of increasing stakeholder collaboration, in particular among stakeholders who are implementing CA (research) projects in their respective countries and to share information among the various National CA Taskforces (NCATF).

The East African Farmers Federation (EAFF) interacts regularly with these international stakeholders. Although Conservation Agriculture is not a big priority in their strategic plan, they do incorporate CA in their other programmes and in some instances implement it in their projects (e.g. "Scaling Out Approaches to Climate Smart Agriculture (CSA) in Eastern Africa").

Table 5-1 Regional and International stakeholders relevant to CA in Kenya

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
COMESA	Common Market for Eastern and Southern Africa	A free trade area made up by 20 African countries. COMESA is involved in the programme on climate change adaptation and mitigation in the eastern and southern Africa region.[8]	GO, policy development	National governments, GOs
AU	African Union	One of the important programs in the AU is the Comprehensive Africa Agriculture Development Programme (CAADP[9]) which is part of the New Partnership for Africa's Development (NEPAD). Especially Pillar 1, relating to soil and water management, is relevant for CA.	GO, policy development	National governments
ACT-Network	African Conservation Tillage Network	A pan-African organisation spearheading the promotion and adoption of CA, mainstreaming CA in policy and education, managing information resources and implementing projects across the continent[10]	NGO, networking	National and local ministries, GOs, NGOs, private sector
CARWG / RCATF	Conservation Agriculture Regional Working Group / Regional Conservation Agriculture Task Force	The purpose of CARWG is to coordinate the activities of member organisations working to support the introduction and promotion of CA in the SADC region[11]. The CARWG works in partnership with a network of National CA Task Forces (NCATF) which coordinate stakeholders within individual countries.[12]	Platform, networking, project implementation	NCATFs
EAFF	East African Farmer Federation	Membership based umbrella organisation, representing the interests of farmer organisations in policy, projects and research[13], not focused on CA as such but incorporating CA in their agriculture programmes.	Farmer organisation	National farmer organisations, policy makers
AGRA	Alliance for a Green Revolution in Africa	An organisation with a focus on developing agriculture in Africa.[14] Involved in funding several CA-related projects in Kenya in the last decade. (currently: CA4FS project[15])	Donor, financial support	NGOs/GOs, project implementers

[8] SADC, 2010. Programme on Climate Change Adaptation and Mitigation in Eastern and Southern Africa (COMESA-EAC-SADC). http://www.sadc.int/sadc-secretariat/directorates/office-deputy-executive-secretary-regional-integration/food-agriculture-natural-resources/tripartite-programme-climate-change-adaptation-and-mitigatio/ [08-02-2016]
[9] http://www.caadp.net/ [08-02-2016]
[10] http://www.act-africa.org/ [08-02-2016]
[11] FANRPAN, 2010. Regional Conservation Agriculture Working Group (CARWG) 2nd annual workshop. http://www.fanrpan.org/documents/d01013/ [08-02-2016]
[12] ACT-Network. CARWG & NCATF. http://www.act-africa.org/content.php?com=5&com2=28&com3=50#.Vri2T14Yk8A [08-02-2016]
[13] http://www.eaffu.org/ [08-02-2016]
[14] http://www.agra.org/ [08-02-2016]
[15] http://ca4fs.act-africa.org/ [08-02-2016]

Table 5-1 Regional and International stakeholders relevant to CA in Kenya (continued)

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
EU	European Union	The EU funded the CA2AFRICA project and funded the ABACO project.	Donor, financial support	NGOs/GOs, project implementers
FAO	Food and Agriculture Organisation of the United Nations	The FAO has been a partner and expert in CA-related research and projects from the mid 1990's to present. It supports the RCAWG and NCATF and funded the CA2AFRICA and CA-SARD projects16.	Donor, financial support, networking	NGOs/GOs, project implementers
SIDA	Swedish International Development Cooperation Agency	A constant supporter of CA programmes in various forms. SIDA previously funded the CA-SARD project and currently funds the CAWT project.17	Donor	NGOs/GOs, project implementers
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit	A development company owned by the German government, who supported ACT-Network from its inception in 1998, and is also supporting CA projects.	Donor	NGOs/GOs, project implementers

The third group of stakeholders consists of the 'donors' who financially support scientific studies and projects that adapt and implement Conservation Agriculture. Historically, FAO has been a strong supporter of CA since the mid 1990's and they still support many projects in Kenya and other African countries. Other important donors are the European Union (EU) which supported the ABACO project, the Swedish International Development Cooperation Agency (SIDA) which previously supported the CA-SARD project and currently funds CAWT, and the Alliance for a Green Revolution in Africa (AGRA) which supports the CA4FS project in Kenya.

Other donors who were not relevant for this current research, but were regularly encountered in literature are NORAD (Norwegian Agency for Development Cooperation) currently supporting the International Conservation Agriculture Advisory Panel for Africa (ICAAP) (ACT-Network, 2016), the Australian Centre for International Agricultural Research (ACIAR) which partly funded the FACASI project, the International Maize and Wheat Improvement Centre (CIMMYT) who partners with ICRAF in CA projects, the International Fund for Agricultural Development (IFAD) which funded the SCAP project, the Department for International Development (DFID), and the United States Agency for International Development (USAID).

[16] http://www.fao.org/ag/ca/doc/nakuru_report.pdf [08-02-2016]
[17] http://www.sida.se/English/ [08-02-2016]

National level

At the national level there are many stakeholders that have incorporated Conservation Agriculture in their policies, projects and activities. The stakeholders presented in this section (see Table 5-2) are considered to be the most important for understanding CA in the country, with a focus on activities in Laikipia County.

The National CA Task Force (NCATF) is the national counterpart of the CARWG and has the similar objective of streamlining the upscaling of CA with all the relevant stakeholders. The NCATF has struggled with continuity as most actors are very busy with managing their own projects, but sometimes the partnership is revived (personal communication MoA, 07-10-2013). ACT-Network has a network function and is the natural focal point for organisations who are (getting) involved in CA in Kenya. Although the mandate of the organisation is primarily to bring actors together, ACT-Network has also become involved in project management and implementation (ACT-Network, personal communication, 07-09-2013).

The ministry of agriculture (MoA) has been involved as a stakeholder in most CA related projects in the country, and CA is incorporated in the soil and water management division. Through their countrywide extension network up to the grassroots level and various technology development and training centres they are important for the agricultural sector. However, according to various stakeholders, the mainstream policies, subsidies and extension remain focused on conventional farming systems. The Kenya Agricultural Research Institute (KARI) has contributed to research on CA in various projects. Studying the dynamics of CA in terms of the influence of cover crops and tillage on soil quality is part of the Natural Resources Management Division (KARI, personal communication, 09-09-2013). The University of Nairobi, especially the Department of Environmental and Biosystems Engineering, is including Conservation Agriculture in the curriculum in some of its courses. As it is an engineering department there is interest in the technological aspects of CA, such as sub-soiling, ripping and direct planting.

The World Agroforestry Centre (ICRAF) has joined the Conservation Agriculture movement in Kenya through the Conservation Agriculture With Trees (CAWT) project and in the concept of Evergreen Agriculture. They test and promote technologies which involve incorporating trees into CA systems to strengthen the three CA principles, especially the principle of adequate soil cover which is a major disincentive in adoption of CA (ICRAF, personal communication, 23-08-2013). World Renew has incorporated CA into their agricultural development programmes and with other faith-based organisations they formed a CA-hub to share information and experiences and to have a stronger political voice in the national arena. KENDAT, previously known as "Kenya Network for Draft Animal Technology", currently goes by the name "Kenya Network for Dissemination of Agricultural Technologies". There is a strong focus on CA in their programmes. Where previously

KENDAT was mainly doing research, currently they are implementing the knowledge and are active in the dissemination of CA and training of farmers and service providers (personal communication July 2013). FEMO Works ltd. is a stakeholder with great interest in CA "because it can reduce the cost of production" and they "have a passion for innovation" and as such they have been involved in the NCATF since the beginning (FEMO Works ltd., personal communication 11-07-2013).

There are many more actors involved in CA activities, but because they were not directly relevant for this study they are not included in Table 5-2. They are the International Centre of Insect Physiology and Ecology (ICIPE) which was involved in research and dissemination of Push-Pull technology, the Kenyan Forestry Research Institute (KEFRI) which is partnering with ICRAF in the CAWT initiative, Kenya National Farmers Federation (KENAFF, previously known as KENFAP) who implement some CA projects, Seed Trade Association of Kenya (STAK), Kenya Industrial Research and Development Institute (KIRDI), Centre for Training and Integrated Research in Arid and Semi-arid Lands Development (CETRAD) which also implemented a project in Laikipia, the German Society for International Cooperation (GIZ (*Deutsche Gesellschaft für Internationale Zusammenarbeit*), previously known as GTZ) which has a long history of supporting CA related projects since the mid 1990's, Syngentha Foundation which is involved in various CA projects, the Agricultural Information Resource Centre (AiC) which facilitates information sharing with farmers, including CA knowledge, and finally the United States Agency for International Development (USAID) who also supports various stakeholders and their CA projects.

Table 5-2 National stakeholders relevant for CA in Kenya

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and function	Clients / beneficiaries
NCATF	National Conservation Agriculture Task Force	The NCATF is hosted by the national departments of agriculture and comprises representation from all the main in-country stakeholder groups[18].	Platform, networking	NGOs, private sector (input/output dealers, manufacturers), etc.
ACT-Network	African Conservation Tillage Network	ACT-Network is also present at the national level as a network organisation, linking actors with interest in CA. The main focus is on managing CA knowledge and experiences, and make the knowledge accessible for people [19].	NGO, networking	Wide range of actors, including NCATF members

[18] ACT-Network, 2015. NCATF Conservation Agriculture Awareness Event 2015 held in Nakuru County-Kenya. http://www.act-africa.org/news.php?com=6&item=303#.Vri_iV4Yk8A [08-02-2016]
[19] Personal communication ACT-Network, 17-09-2013

Table 5-2 National stakeholders relevant for CA in Kenya (continued)

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and function	Clients / beneficiaries
MoA	Ministry of Agriculture	The MoA is a key actor at the national level, involved in the various projects and a member of the NCATF. CA is considered part of the Soil and Water Management Division.	GO, policy development	Wide range of actors, including NCATF members
KARI[20]	Kenya agricultural research institute	KARI has been involved in several CA projects, and maintains several test fields in different areas both for formal science and more participatory research with farmers	GO, research	Technical research staff, policy makers
UoN	University of Nairobi	UoN is involved in education and training, and it incorporates CA in some curricula. The UoN brings in technical and research expertise and is a member of the NCATF.	GO, research	Policy actors and NCATF members
ICRAF	World Agroforestry Centre (before: International Centre for Research in Agroforestry)	CGIAR Consortium Research Centre headquartered in Nairobi. Has a wide network of technical research staff. Has experience with 'CA with Trees'.21 ICRAF has a wide network of technical research staff.	NGO, research, project implementation	Wide range of actors, including NCATF members
World Renew	World Renew	A Christian NGO that runs a wide range of projects. It is promoting conservation agriculture in Kenya22. Organised in a CA-hub consisting of mainly faith-based organisations.	NGO, project implementation	Policy actors and NCATF members
KENAFF	Kenya National Farmers' Federation (previously KENFAP)	Representing the interests of farmer organisations in policy, projects and research. KENAFF is a member of the NCATF and has been involved in implementing several CA projects (CA-SARD and FACASI).	Farmer organisation	Policy actors and NCATF members
KENDAT	Kenya Network for Dissemination of Agricultural Technologies (before: Kenya Network for Draft Animal Technology)	This NGO is a specialist in CA and participated both as research and dissemination partner in various CA projects.	NGO, project implementation	Policy actors and NCATF members
FEMO works ltd.	FEMO works ltd.	FEMO works ltd. is a farm implement designer and producer based in Nairobi. The owner and his team have visited other countries including Brazil to learn about CA mechanization and to adapt it to Kenya's environment.	Private sector, technology development	Farmers and farmer groups

[20] Now reconstituted and called KALRO

[21] World Agroforestry Centre, 2014. Conservation Agriculture With Trees: Principles and Practice. http://www.worldagroforestry.org/downloads/Publications/PDFS/TM17693.pdf [08-02-2016]

[22] World Renew, 2014. Sustainable Agriculture in the Rift Valley, Kenya. http://worldrenew.net/our-stories/team/stephan-lutz/sustainable-agriculture-rift-valley-kenya

Local level

An overview of the actors involved in CA in Laikipia County is given in Table 5-3. There are several stakeholders who also operate at the national level, most notably ACT-Network and KARI. They are partners in the ABACO project and the CA4FS project. For the implementation of their projects, they visit the field frequently and contribute to the extension of CA knowledge among the farmer groups they visit. KARI is maintaining several research fields close to the Farmer Field Schools (FFSs) of the ABACO project. This is mainly of interest for generating research outputs, but the experiments are also monitored and evaluated by local farmers.

The local MoA staff has been closely involved in various CA programmes and the training of MoA staff has been a priority over the past years. In the ABACO project, the MoA officers are the principal executers of the project through regular training and supervision of FFSs and the organisation of field days. The Centre for Training and Integrated Research for Arid and Semi-arid Land Development (CETRAD) and Syngenta Foundation have both been involved in several pioneering CA projects in Laikipia and were involved in establishing the Kilimo Salama crop insurance programme, currently known as Acre Africa[23]. Caritas has recently incorporated CA elements in their rural development and food security programmes, and KENDAT is implementing a CA project with a focus on mechanisation through the training and supporting of CA service providers.

The various projects often work with farmers' groups, in most cases organised as FFSs. These FFSs plan and maintain a common experimentation plot dedicated to CA and sometimes FFS members apply this on their own fields. Individual farmers who are not a member of a group are also involved through farmer field days and gain information through the existing social ties with group members. At this local level, agro-dealers are important for acquiring inputs and information, and service providers are crucial to get farm operations done (including CA operations like direct planting, weeding, spraying herbicides). In Laikipia, there are several service providers who are specialized in CA. Small workshops are sometimes involved in the manufacturing of CA implements such as shallow weeders or rippers. Finance institutes from Nanyuki are regularly invited to farmer field days to inform attendees about their services, but they have no direct involvement in CA. Finally, there are several large scale farms who do not only practice CA themselves but also have an extension network in their area to share inputs, equipment and knowledge with smallholder farmers. In Laikipia, a well-known large scale CA farm is Mr Sessions' Lengetia Farm. Similarly, Ol Pejeta Wildlife Conservancy supports CA in the neighbouring communities through their community development programmes.

[23] http://acreafrica.com [10-02-2016]

Table 5-3 Stakeholders with a local office and/or local activities relevant for CA in Laikipia County

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
ACT-Network	African Conservation Tillage Network	Manage the ABACO and CA4FS projects, and as such regularly visit the area and organise trainings and extension.	NGO, networking, project implementation	Farmers and project partners
KARI	Kenya Agricultural Research Institute	KARI maintains several test fields in different areas where they do research on soil moisture retention in CA systems, both for formal science and more participatory research with farmers.	GO, research	Farmers and farmer groups
MoA (loc)	Ministry of Agriculture	The MoA is a partner in several CA projects and has trained extension staff who interact with FFSs, groups, and individual farmers.	GO	Farmers and farmer groups
CETRAD	Centre for Training and Integrated Research for Arid and Semi-arid Land Development	At the local level, CETRAD has implemented a CA project. Currently they do research and facilitate interaction with other stakeholders for information sharing.	NGO, research	Farmers and farmer groups
Caritas	Caritas	NGO with a wide range of interventions in the social and agricultural domains, currently incorporating CA in its food security programmes.	NGO	Farmers and farmer groups
Syngenta Foundation	Syngenta Foundation	The foundation has implemented CA projects and included training on the use of herbicides.	NGO	Farmers and farmer groups
KENDAT	Kenya Network for Dissemination of Agricultural Technologies (before: Kenya Network for Draft Animal Technology)	Is involved in a mechanisation project with two-wheel tractors and the training of service providers. Member of the NCATF and involved in project implementation (including extension).	NGO	Farmers and farmer groups
FFSs	Farmer Field Schools	Adopting, experimenting with and adapting CA practices	Farmers / farmer group	
Farmers		Adopting, experimenting with and adapting CA practices	Farmers / farmer group	
Service providers		Including ploughing, spraying, weeding and direct planting (animal-drawn), some are also giving advice on direct planting.	Private sector	Farmers
Agro dealers		Selling agricultural inputs, including herbicides, fertilizer, (improved) seeds, also giving advice on how to use them.	Private sector	Farmers
Finance institutes		Offering savings and credit, mainly Bank of Africa and SACCO's.	Private sector	Farmers and farmer groups

Table 5-3 Stakeholders with a local office and/or local activities relevant for CA in Laikipia County (continued)

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
e.g. "Mwirero general workshop"		Local, small workshop shallow weeders for project and occasionally individual farmers, making rippers from fork Jembe's.	Private sector	Farmers
Lengetia farm	Mr. Sessions large-scale CA farm	Local hub offering extension and inputs (both seeds and herbicides)	Private sector	Farmers and farmer groups
Ol Pejeta Wildlife Conservancy	Ol Pejeta Wildlife Conservancy	Ol Pejeta supports CA as part of their community projects. They have trained extension officers and facilitate access to seeds and herbicides.	Private sector	Farmers and farmer groups

5.2.2 Overview of stakeholders Madagascar

Regional level

The most important stakeholders for CA are given in Table 5-4. Most of these actors are similar to the regional actors in Kenya. However, because Madagascar is geographically more isolated compared to Kenya, there is much less activity from these stakeholders. Moreover, due to Madagascar's political crisis in 2009, most international donors stopped their support to the country for political reasons. Not only project activities at field level came to a halt, interaction at the international level was also affected. Under the current government, international cooperation is gaining new momentum.

The French Development Agency (AFD) has been a reliable partner of the national stakeholders by supporting various big CA projects, and the FAO is facilitating coordination and interaction at the national and international level through workshops and platform meetings. Finally, the KFW is also an important donor, especially of the PLAE programme (see next section on national actors).

Table 5-4 International and regional actors relevant for CA in Madagascar

Acronym of institute	Full name and translation	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
For RCAWG, COMESA, AU, ACT-Network and EU: see regional level stakeholders in Kenya section 5.2.1.				
AFD	*Agence Française pour le Développement* (French Development Agency)	AFD is a financial institution and the main implementing agency for France's development assistance[24]. AFD is the most important donor of several big CA projects in the last decade, like BVPI and BV-Lac.	Donor, financial support	NGOs/GOs, project implementers
FAO	Food and Agriculture Organisation of the United Nations	The FAO supports the RCAWG and NCATF.	Donor, financial support, networking	NGOs/GOs, project implementers
KFW	*Kreditanstalt für Wiederaufbau* (Reconstruction Credit Institute)	KFW's development bank is supporting many countries with various development programs[25]. In Madagascar they support the anti-erosion programme PLAE in partnership with GSDM[26].	Donor, financial support	NGOs/GOs, project implementers

National level

The most important CA stakeholders at the national level are given in Table 5-5. For streamlining CA knowledge, projects, and financing, the Group for direct planting in Madagascar (GSDM) is the key player at the national level. It is a group with member institutes who all have a voice in the organisation. GSDM also maintains an archive of project data and develops promotion materials for various stakeholder groups. GSDM is involved directly or indirectly in all CA-related activities in the country (GSDM, personal communication, 13-12-2013). Supported by the FAO, the NCATF has been functioning as a platform for CA related activities in the country, including dissemination and research. The Ministry of Agriculture at the national level has not been an important stakeholder since the political crisis in 2009. Currently, they are a partner in the anti-erosion PLAE programme, which is being implemented in several phases in many areas of the country. Although PLAE is a project, it is here considered to be stakeholder because it is engaging with other stakeholders in a range of new programmes.

In the years when CA was being introduced, the NGO TAFA was very important for the development of various technological management options. The NGO BRL was important for the technical support of farmers, introducing the concept to thousands of smallholder farmers. However, since the BV-Lac project ended, these NGOs also ceased their activities. The National Agency for Environment (ANAE) has been involved in the promotion of CA since its introduction in the mid 1990's. Currently there is less activity.

[24] http://www.afd.fr [14-02-2016]
[25] https://www.kfw-entwicklungsbank.de/Internationale-Finanzierung/KfW-Entwicklungsbank/ [13-02-2016]
[26] Personal communication GSDM (13-12-13)

Three stakeholders are particularly involved in research. These are the International Centre for Agricultural Research for Development (CIRAD), the Malagasy National Centre of Applied Research on Rural Development (FOFIFA) and the University of Antananarivo. In close partnership, they have contributed to the current substantial CA knowledge base. They were and are also involved in various CA projects. FOFIFA is also a producer of seeds, including cover crop seeds. The same is true for SD-Mad, although seed production and the accompanying extension were reduced to a minimum after the end of the large CA projects. The Norwegian – Malagasy Centre of Livestock and Agriculture (FIFAMANOR) has various extension networks in the region of Vakinankaratra, where they support CA together with other agricultural options.

Other stakeholders who were not directly relevant for the current study include the Christian farmers' associations FEKRITAMA, representing nine national producers' organisations, the Centre for Experimentation and Diffusion for the Farmers' Management of Sloping Land (FAFIALA), the VERAMA group who have included cover crop development in their agroforestry programmes, the French NGO GRET who have promoted CA as part of their rural development programmes, and several others.

Table 5-5 National stakeholders relevant to CA in Madagascar

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
GSDM	*Groupement Semis Direct de Madagascar* (Group for direct planting in Madagascar)	An umbrella organisation for organisations involved in CA[27]. National focal point for stakeholders interested in agroecology and CA. To share knowledge and experiences.	Platform, networking	Wide range of national and international actors
MoA (national)	Ministry of Agriculture	Since the political crisis in 2009 not really involved in any serious programmes. Otherwise partner in CA projects and partner of GSDM.	GO, policy development	Wide range of actors, including GSDM/ NCATF members
TAFA	*Tany sy Fampandroasoana* (Soil and Development)	TAFA no longer exists. During the BV-Lac project, this NGO was specialized in developing and adapting new CA systems and had technicians and experimental fields.	NGO	n/a
CIRAD	*Centre International de la Recherche Agronomique pour le Développement* (International Centre for Agricultural Research for Development)	The French agricultural research and international cooperation organisation[28]. Often responsible for research component and overall management of CA projects, such as CA2AFRICA and BV-Lac. Member of GSDM and part of URP SCRiD[29].	NGO, research, project implementation	Policy actors and GSDM members

[27] http://gsdm-mg.org/ [14-02-2016]
[28] http://www.cirad.fr/ [14-02-2016]
[29] *Unité de recherche en partenariat "Systèmes de culture et ricicultures durables"* (Sustainable Farming and Rice Cropping Systems)

Table 5-5 National stakeholders relevant to CA in Madagascar (continued)

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
FOFIFA (national)	*Foibem-pirenena ho an'ny fikarohana ampiharina ho fampandrosoana ny eny Ambanivohitra* (National Centre of Applied Research on Rural Development)	National agricultural research centre[30]. Research in CA, cropping technology and seed improvement. There is also a seed production unit with 10 ha growing in CA. Member of GSDM and part of URP SCRiD.	GO, research, project implementation	National MoA, local GOs/NGOs
University of Antananarivo	University of Antananarivo	Member of GSDM and part of URP SCRiD. Involved in research on CA, nutrition and pests / diseases.	GO, research	Policy actors and GSDM members
BRL Madagascar	Bas Rhône Languedoc Madagascar	Independent institution working on rural development. Providing direct technical support on CA for farmers in several projects in Madagascar[31]. Produced technical manuals on CA. Member of GSDM.	NGO, research, extension	Project partners
ANAE	*L´Association Nationale d´Actions Environnementales* (National Agency for Environment)	Agency of ministry of Environment. Partner in the research and dissemination of CA systems since the beginning in the mid 1990's in Madagascar and a member of GSDM[32]. Concerned with reducing impact of agriculture on the environment. Promoting CA in one zone of Lake Alaotra region.	GO, extension	Policy actors and GSDM members
SD-Mad (national)	*Semis Direct de Madagascar* (Direct Planting Madagascar)	Private institution involved in seed production, extension and in various projects[33]. Member of GSDM.	Private sector, extension, inputs	Project partners, private sector
FIFAMANOR	*Fiompiana Fambolena Malagasy Norveziana* (Norwegian – Malagasy Centre of Livestock and Agriculture)	Based in Antsirabe[34]. Mainly active in Vakinankaratra. Strong extension network at field level. Involved in seed production. Founding member of GSDM.	NGO, extension, research	Policy actors and GSDM members
NCATF	National CA Task Force	The NCATF is a multi-stakeholder platform initiated and supported by the FAO with the vision that appropriate CA and Climate Smart Agriculture practices are adopted by farmers[35].	Platform, networking	NGOs, GOs private sector, etc.
PLAE	*Programme de Lutte Anti-Erosive* (Anti-Erosion Programme)	A soil and water conservation programme aiming at reducing soil erosion that incorporates CA in its farm management recommendations[36].	Project, project implementation	Project partners

[30] http://www.fofifa.mg/ [14-02-2016]
[31] http://gsdm-mg.org/membre/brl/ [14-02-2016]
[32] http://gsdm-mg.org/membre/anae/ [13-2-2016]
[33] http://gsdm-mg.org/membre/sd-mad/ [14-02-2016]
[34] http://gsdm-mg.org/membre/fifamanor/ [14-02-2016]
[35] (Rakotondramanana et al., 2014)
[36] http://www.plae.mg/ [14-02-2016]

Local level

The most important CA stakeholders at the local level in the Lake Alaotra region of Madagascar are given in Table 5-6. BV-Lac is mentioned even though the project came to an end in 2013, because it has been the defining face of CA research and dissemination for a decade. Currently, the situation can best be described as 'post-project' and only a fraction of the previously involved NGOs remain active in the area. There are six seed-producers, for CA the most relevant are SD-Mad and Andri-Ko. The latter is still producing seeds for several types of cover crops, but both organisations financially rely on seeds for conventional crops. FOFIFA has a research station where CA is one of the focus areas, together with research on irrigated and dryland rice, which is the most important crop for the area.

The Regional Directorate for Rural Development (DRDR) is a government body in charge of coordinating and supporting rural development. They have an extension network and do trainings, but due to limited funds their capacity and coverage is limited. The same is true for the Agricultural Service Centre (CSA), which is there to advise farmers on agricultural issues and help them directly with information, or bring them in contact with another organisation that can help them. There are also several farmers' organisations, of which VIFAM is the umbrella organisation. Local stakeholders finally include farmers, farmers groups and agro-dealers.

Table 5-6 Actors with a local office or local activities related to CA in Lake Alaotra region

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
BV-Lac	*Mise en valeur et de protection des Bassin Versants du Lac Alaotra* (Improving the productivity and conservation of the Lake Alaotra watershed)	BV-Lac no longer exists. During the time of the project (2003-2013) this was the central stakeholder, coordinating most CA activities in the Alaotra region.	n/a	n/a
FOFIFA (local)	*Foibem-pirenena ho an'ny fikarohana ampiharina ho fampandrosoana ny eny Ambanivohitra* (National Centre of Applied Research on Rural Development)	Research station in Alaotra region. Involved in research, dissemination and seed production.	GO, research, project implementation	Farmers and farmer groups
DRDR	*Directorat Régionale pour le Développement Rural* (Regional Directorate for Rural Development)	DRDR is a government structure in charge of coordinating the rural development in the Lake Alaotra region.	GO, extension	Farmers and farmer groups
CSA Ambatondrazaka	*Centre Service Agricole* (Agricultural Service Centre) Ambatondrazaka	Demand driven information and advice service centre.	GO, services	Farmers and farmer groups

Table 5-6 Actors with a local office or local activities related to CA in Lake Alaotra region (continued)

Acronym of institute	Full name of institute	Short description and link with CA	Stakeholder category and main function	Clients / beneficiaries
VIFAM	Vovonana Iraisan'ny Fikambanana Tantsaha Alaotra Mangoro (Federation of farmers' organisations of the region of Alaotra-Mangoro)	Representatives of several local farmers' organisations in the Alaotra region. Involved in the coordination of regional farmers' structures such as groups, syndicates, cooperatives etc. Partner on a CA platform.	Farmer organisation, services, networking	Farmers and farmer groups
Andri-Ko	Andri-Ko, Ambatondrazaka	Seed production company that produces both staple crops (irrigated and upland rice, sorghum, maize) and leguminous crops that are used as cover crops (dolichos, butter beans, stylosanthes, vetch).[37]	Private sector, inputs, services	Farmers and farmer groups, project partners
SD-Mad (local)	Semis Direct de Madagascar (Direct Planting Madagascar)	SD-Mad has been an important seed producer of rain-fed rice and maize and CA cover crops in various regions in Madagascar, including the Alaotra region[38].	Private sector, extension, inputs	Farmers and farmer groups
Farmers		Adopting, experimenting with and adapting CA practices	Farmers/ farmer groups	
Farmer groups		Adopting, experimenting with and adapting CA practices	Farmers/ farmer groups	
Agro-dealers		Selling agricultural inputs, including herbicides, fertilizer, (improved) seeds, also giving advice on how to use them.	Private sector	Farmers and farmer groups

5.3 Interaction and social networks

In this section some of the linkages between the main identified CA stakeholders are explored through a Social Network Analysis (SNA) as explained in methodology section 4.9.3. Not all stakeholders and linkages can possibly be included in a SNA of this scale. Nevertheless, the number and types of linkages give insight in how the innovation system functions when it comes to CA, and how the individual farmers and farmer groups are embedded in the network. The SNA results are discussed for Kenya in section 5.3.2, and for Madagascar in section 5.3.3. First, section 5.3.1 gives an overview of project partnerships between the actors.

The stakeholders (the nodes in the network) were categorized in seven types, represented in the figures by the node shapes: Government Organisation (GO), NGO, farmer/farmer group, private sector, platform, project, and donor. The linkages between the stakeholders (the lines in the

[37] http://gsdm-mg.org/stock-de-semences-disponibles/ [09-05-2016]
[38] http://gsdm-mg.org/membre/sd-mad/ [11-04-2016]

network) were categorized in five types: knowledge (including consulting, sharing and using knowledge, extension, and research), services (including service provision, technology development, and inputs/outputs), policy (including policy development and advocacy), partnerships (including project partnerships and general networking ties), and financial support.

5.3.1 Project partnerships for CA

Many of the linkages between the stakeholders, as described in the previous sections, have been shaped in the context of projects. In the mid-1990's, stakeholders in both Kenya and Madagascar started experimenting with agricultural systems that would later be called CA. In this pioneering phase, most of the research and dissemination of CA took place in the context of internationally funded projects. Currently, although CA is increasingly incorporated in government structures and NGO programmes, research and dissemination occurs in projects through partnerships between research, government, private sector and other stakeholders. In Table 5-7, a selection of important CA projects and project partners are briefly described[39]. In these partnerships, research institutes and universities are well represented, and the projects often have a strong research component.

Table 5-7 Major past and present (research) projects related to conservation agriculture

Project	Timeframe	Geographic coverage	Short description of project aims & objectives	Main donor	Main partners
CA4CC (CA for Climate Change resilience)	2013-2016	Kenya (and three countries in Africa)	To strengthen knowledge support systems to support policy formulation, decision making and learning to stimulate increased and sustained adoption of CA in addressing the effects of climate change impacts.[40]	NORAD, AGRA	ACT-Network, KARI, EMBRAPA
FACASI (Farm Mechanization & Conservation Agriculture for Sustainable Intensification)	2013-2016	Kenya (and Tanzania)	The overall goal of the project is to improve farm power balance, reduce labour drudgery, and minimize biomass trade-offs in Eastern and Southern Africa, through accelerated delivery and adoption of 2WT-based technologies by smallholders.[41]	AIFSCR	CIMMYT, EIAR, ACT-Network, FAO, ACIAR, KENDAT

[39] Other projects in the past in Madagascar included *Processus écologiques et processus d'innovation technique et sociale en agriculture de conservation* (PEPITES, 2008-2012), and the *Programme d'actions multi pays en agroécologie* (PAMPA, 2008-2013). Other projects in Kenya included Legume Research Network Project (LRNP, 1995-2005), National Agriculture and Livestock Extension Programme NALEP (2000-2005), Conservation Agriculture for Sustainable Agriculture and Rural Development (CA-SARD, 2004-2011), Farm Mechanization and Conservation Agriculture for Sustainable Intensification (FACASI, 2014-2017).

[40] http://www.act-africa.org/content.php?com=5&com2=28&com3=56&com4= [17-3-2016]

[41] http://facasi.act-africa.org/ [17-03-2016]

Table 5-7 (continued) Major past and present (research) projects related to conservation agriculture

Project	Timeframe	Geographic coverage	Short description of project aims & objectives	Main donor	Main partners
ABACO (Agroecology-Based Aggradation-Conservation Agriculture)	2012-2015	Madagascar, Kenya (plus five countries in Africa)	Aims at reducing the vulnerability of smallholder farmers to climatic variability by building capacity through co-Innovation Platforms, and to promote the adoption of CA.	EU	SOFECSA, ACT-Network, CIRAD, FOFIFA, CIRDES, NRI, WUR, Embrapa
CA2AFRICA (CA in Africa: Analysing and FoReseeing its Impact – Comprehending its Adoption)	2009-2011	Madagascar, Kenya (plus seven countries in Africa)	To better understand the reasons for the limited adoption of CA in Africa to assess under which conditions and to what extent CA can strengthen the socio-economic position of smallholder farmers in Africa, by analysing past and on-going CA experiences.[42]	EU	CIRAD, ACT-Network, ICARDA, CIMMYT, INRA, WUR FOFIFA, University of Antananarivo, FOFIFA
BV-Lac (B*assins Versants*, Development of watersheds of Lake Alaotra)	2003-2013	Madagascar	Wide regional project aiming at improving agriculture efficiency of the Lake Alaotra Region both on irrigated and rainfed areas. On rain-fed hills, CA has been promoted as a soil and water saving technology.	AFD	CIRAD, BRL, AVSF, ANAE, SD-Mad, BEST
CAWT (Conservation Agriculture With Trees)	2010-2012	Kenya (plus three countries in Africa)	This project aims at promoting continental wide adoption of conservation agriculture and agro-forestry to sustain the productive potential of the natural resource base and improve food security and livelihoods of smallholder farmers.[43]	SIDA	ICRAF, KENDAT, ACT-Network

[42] http://ca2africa.cirad.fr/ [17-03-2016]
[43] http://www.act-africa.org/content.php?com=5&com2=28&item=60#.Vuqcw3pXpnS [17-3-2016]

5.3.2 Visualising the innovation system in Kenya

For the Social Network Analysis in Kenya, a total of 28 stakeholders and their linkages were inserted into the NetDraw software. Three figures were generated to respectively highlight the overall innovation system at all levels, the group of most connected actors, and the actors with direct linkages with the farmers. In these figures, the node sizes represent the eigenvector centrality calculated in NetDraw, which is an indication of the level of connectedness with, or distance from the entire network. The node shapes represent stakeholder type, and node colours represent level.

An overview of the resulting social network at all levels is given in Figure 5-1. At the regional level, donors are the predominant actor type and they show little interaction among other regional level stakeholders. They mainly have direct linkages with two or three national level stakeholders and in some instances directly with local stakeholders. The FAO and the CARWG stand out in terms of having a network of multiple connections to the national level. ACT-Network could also be considered to be a regional actor, and as such it is in contact with practically all actors at the regional level. The CARWG is a platform to share experiences with CA, and is an initiative funded by the FAO in close collaboration with the ACT-Network. The node sizes show that ACT-Network and the FAO are the most important actors at the regional level.

At the national level, the different types of stakeholders are relatively equally distributed and include GOs, NGOs, a platform and a private sector stakeholder. National stakeholders are very well connected with each other through the NCATF. That particular platform, however, has not been operating at the same level of activity over the last years, so although the linkages appear in the network, they are not always very strong. From the node size it can be derived that the MoA national, ACT-Network and KARI are the more important stakeholders at the national level in terms of how connected they are to the whole network. As shown in Figure 5-1, ACT-Network and KARI are almost always involved in projects, while the MoA is not necessarily involved in the CA projects but maintains contact with stakeholders regarding CA. The linkages that national actors have with the local level are mainly directly with farmers and FFSs, the local MoA and local NGOs, while there are fewer linkages with the private sector.

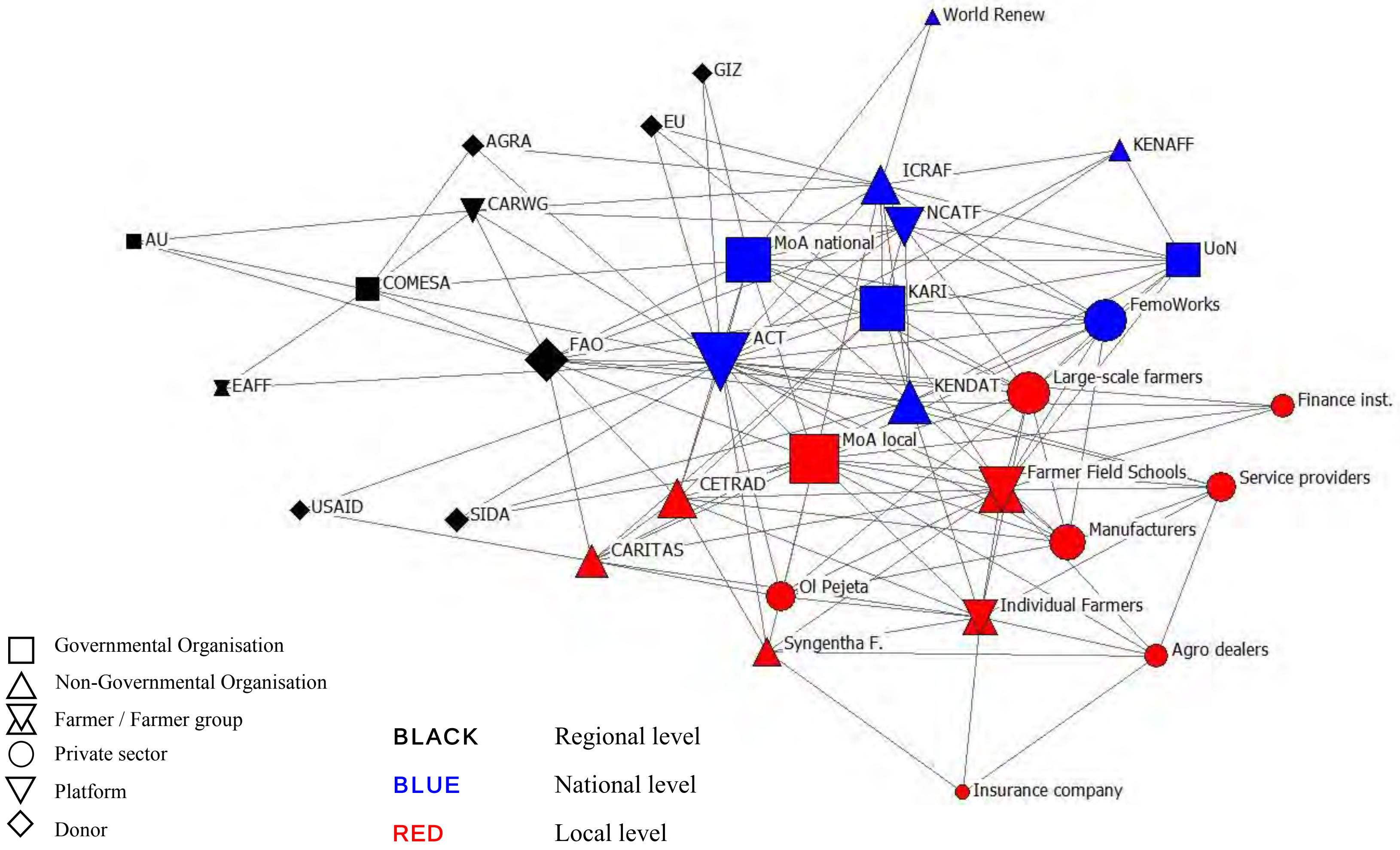


Figure 5-1 Social Network of important CA stakeholders in Laikipia (local level), Kenya (national level) and the regional level (node size: eigenvector centrality)

At the local level, most stakeholders are categorised as private sector stakeholders. The node sizes indicate that the local MoA, FFSs and large-scale farmers are best connected to the whole network, particularly through their links with the national level. The linkages at the local level are shown in more detail in Figure 5-3.

An overview of the nine Kenyan stakeholders with more than 10 linkages is shown in Figure 5-2. The term used for the number of connections is ‘degree’. The actor with the highest degree is ACT-Network, followed by the MoA local and the FFSs with degrees of 17, 15, and 14 respectively. From the regional actors, only the FAO appears in this network, and shows connections with both national and local actors. The involvement of the local MoA in previous and present CA projects is reflected in the high degree. The agricultural extension staff has been trained in CA and they have been actively supporting FFS group processes and connecting farmers with relevant stakeholders. The rationale behind this is that the MoA is a stable presence and therefore investing in their capacity has impact beyond the project time (ACT-Network, personal communication, 09-07-2013). Large-scale farmers are also well-connected stakeholders. In particular Lengetia farm, a member of the NCATF, has strong connections with farmers and with national level actors. The NGOs KENDAT and ICRAF are at the heart of the evergreen agriculture initiative, combining CA with agro-forestry, and as such they are connected to most CA stakeholders.

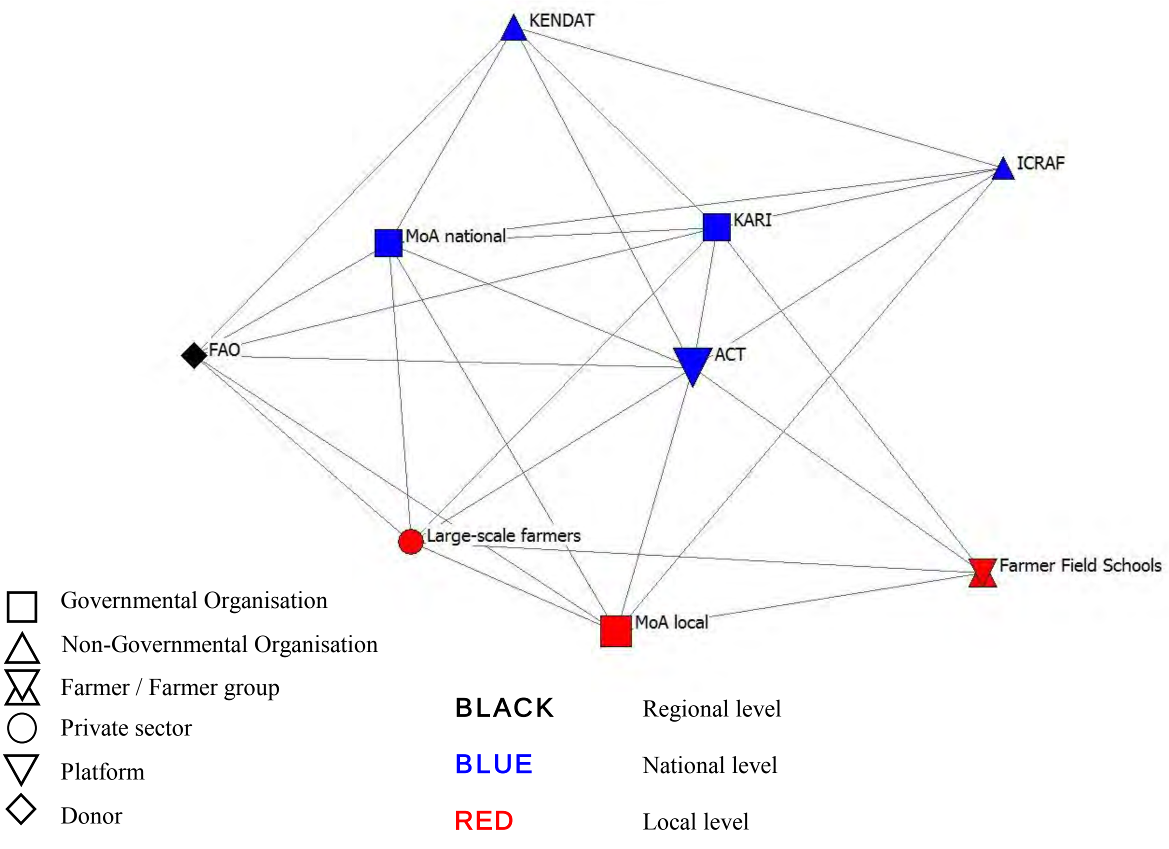


Figure 5-2 Stakeholders in Kenya with degree >10

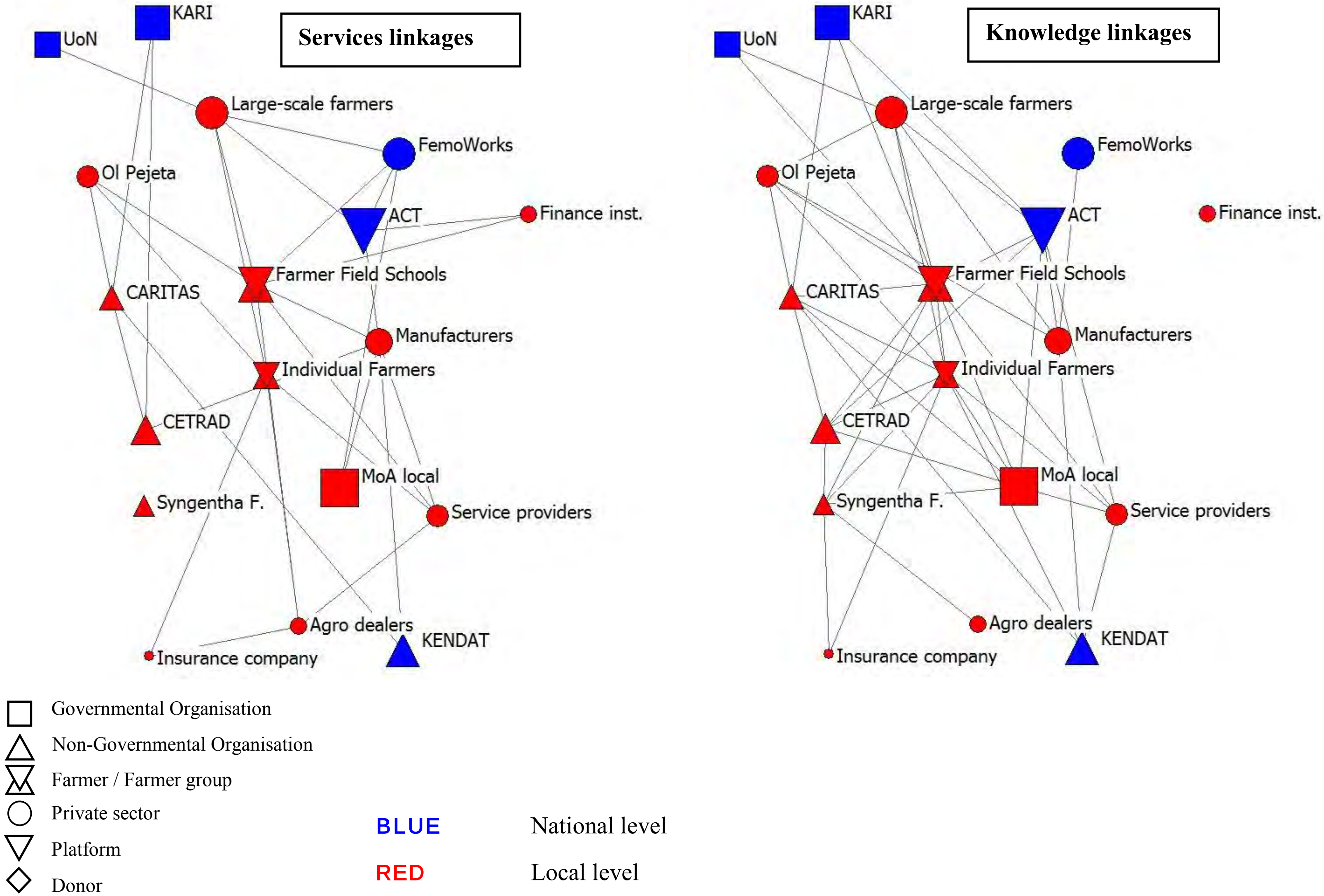


Figure 5-3 Egonetwork of individual farmers and farmer groups in Laikipia with services linkages (left) and knowledge linkages (right)

The egonetwork of the farmers is given in Figure 5-3, referring to the network consisting of those actors that have at least one direct linkage with either individual farmers or the FFS. Most linkages at this level concern either services or knowledge linkages, which are shown in Figure 5-3. Policy/advocacy linkages or donor linkages are almost non-existent, while general partnerships are there among stakeholders at the local and national level, especially with the local MoA and NGOs. The most occurring stakeholder type in the egonetwork of farmers is the private sector, followed by NGOs and GOs.

The large-scale farmers not only share their knowledge but also deliver services in terms of inputs (herbicides, seeds) and equipment. An important observation is that large-scale farmers like Lengetia farm (and similarly the Ol Pejeta wildlife conservancy) have a relatively stable source of income (farming and tourism respectively) and have been present in the area for a long time and probably will be. That makes them very important stakeholders from the perspective of farmers in their direct area. Outside the range of Lengetia farm, services come from the local manufacturers, agro-dealers and service providers, while the knowledge network from the farmers' perspective seems to suggest project-based interaction with NGOs. For their extension activities, even the local MoA largely depends on project funding (MoA local, personal communication, 08-07-13).

5.3.3 Visualising the innovation system in Madagascar

For the Social Network Analysis in Madagascar, a total of 29 stakeholders and their linkages were inserted into the NetDraw software. The same figures were generated as in the previous section for Kenya, in which the node sizes represent the eigenvector centrality calculated in NetDraw, which is an indication of the level of connectedness with, or least distance from, the whole network. The node shapes represent stakeholder type, and node colours represent level.

A representation of the main stakeholders at all levels and their main linkages is given in Figure 5-4. At the regional level there are mainly donors who directly support national stakeholders of which the EU and AFD have most ties with national stakeholders. There is interaction at the regional level at the RCAWG, and the ACT-Network is in contact with most stakeholders at the regional level. Compared to Kenya, the node size of ACT-Network is smaller, mainly because it is less involved at the national level.

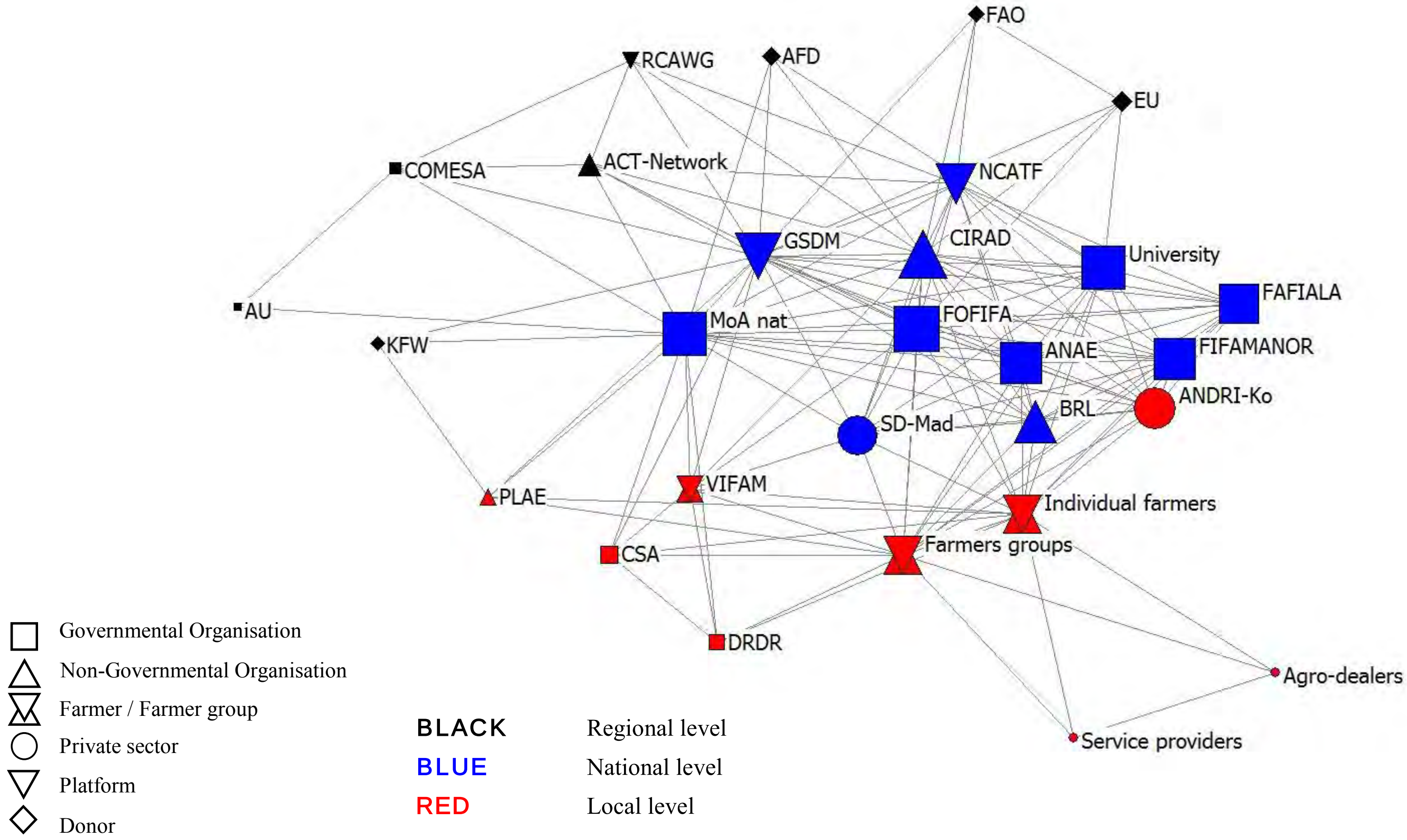


Figure 5-4 Social Network of important CA stakeholders in Lake Alaotra (local level), Madagascar (national level) and the regional level (node size: eigenvector centrality)

At the national level, Figure 5-4 shows a high level of interconnectivity among the stakeholders. The linkage type is mainly ‘partnerships’ between the stakeholders and these partnerships are organised in the GSDM independent of individual projects. Additionally, the NCATF is a platform where the stakeholders meet and discuss and share issues that are relevant for CA in the country. The stakeholder types are mainly GOs, and there two private sector actors and two NGOs (of which one, BRL, is not engaged in any CA-related activities in the country at the moment). So the diverse functions in the innovation system such as research, dissemination, project implementation, technology development etc., are currently largely in the hands of GOs. The importance of GOs in the innovation system means that a strong government that invests in agriculture would be able to coordinate and impact CA activities at a variety of activities, while a weak government would mean that the innovation system (beyond projects) is relatively weak. During the large CA projects in the last decade, the country was hit by a political crisis, which changed the involvement of GOs in CA, and during the projects there were many more NGOs involved. So the roles, stakeholders and linkages have changed drastically several times in the recent history. This means that some of the existing links should partly be perceived as a remnant of the BV-Lac project, while the stakeholders readjust their partnerships to a post-project context.

Links between the national level stakeholders and the local level appear to mainly take place through direct interaction with farmers, farmer groups and the producers’ organisation. The exception is Andri-Ko, which is a partner in the national platforms and selling seeds at the local level. The private sector’s involvement in the CA network is limited to seed producing actors (Andri-Ko, SD-Mad, and FOFIFA).

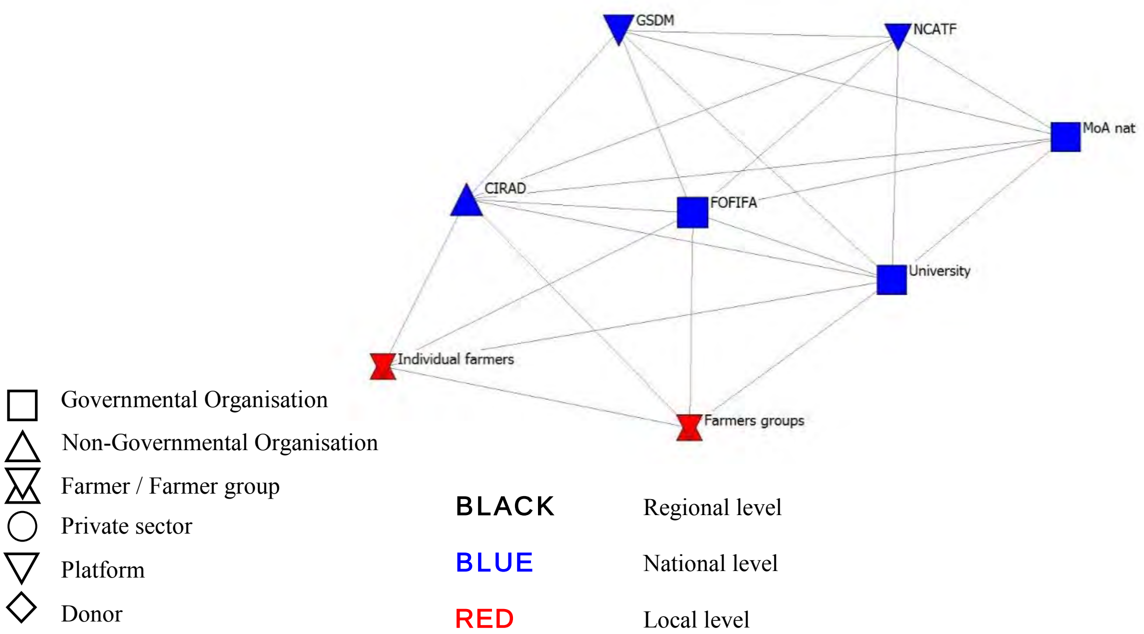


Figure 5-5 CA stakeholders if degree >13

The stakeholders with the highest degree are GSDM, MoA national and CIRAD with degrees of 21, 20 and 19 respectively. The stakeholders in the innovation system with a degree of more than thirteen are shown in Figure 5-5. Farmers and farmer groups have a high degree because most national actors have direct ties with them. This does not mean, however, that all farmers are well-connected or benefit from linkages with national level actors, because such linkages are generally limited to projects, and farmers who are project beneficiaries, that are in turn limited in spatial coverage and timespan. The three stakeholders in the middle of Figure 5-5 are research organisations, who operate in close partnership with each other, as described earlier, as URP-SCRiD. They have close ties with the farmers directly and also with other stakeholders at the national level. GSDM and NCATF are both coordinating stakeholders and as such they have many linkages.

The egonetwork of farmers and farmer groups in the Lake Alaotra region of Madagascar is given in Figure 5-6. The figure shows that farmers have no direct linkages with networking actors, donors and policy actors. The knowledge linkages show again that most stakeholders at the national level deal with the farmers and farmer groups directly. There are no important knowledge sharing platforms at the local level. This contrasts with Kenya, where national stakeholders partner with local NGOs and the local MoA for their various programmes. Also during the BV-Lac project in Madagascar, the project was coordinating knowledge among the many local NGOs and they would be the logical intermediary in between national level actors and farmer groups.

The service linkages concerning CA include seed producers Andri-Ko and FOFIFA. Contrary to Kenya, there are no service providers who are specialized in CA, so service provision and agro-dealers do deliver services, but do not necessarily have knowledge on CA. Similarly, the local GOs like the CSA and DRDR are very limited in the number of farmers they reach with their training and advice. Overall, Figure 5-6 shows how isolated farmers are in this area both regarding knowledge and services, especially outside projects from national level stakeholders.

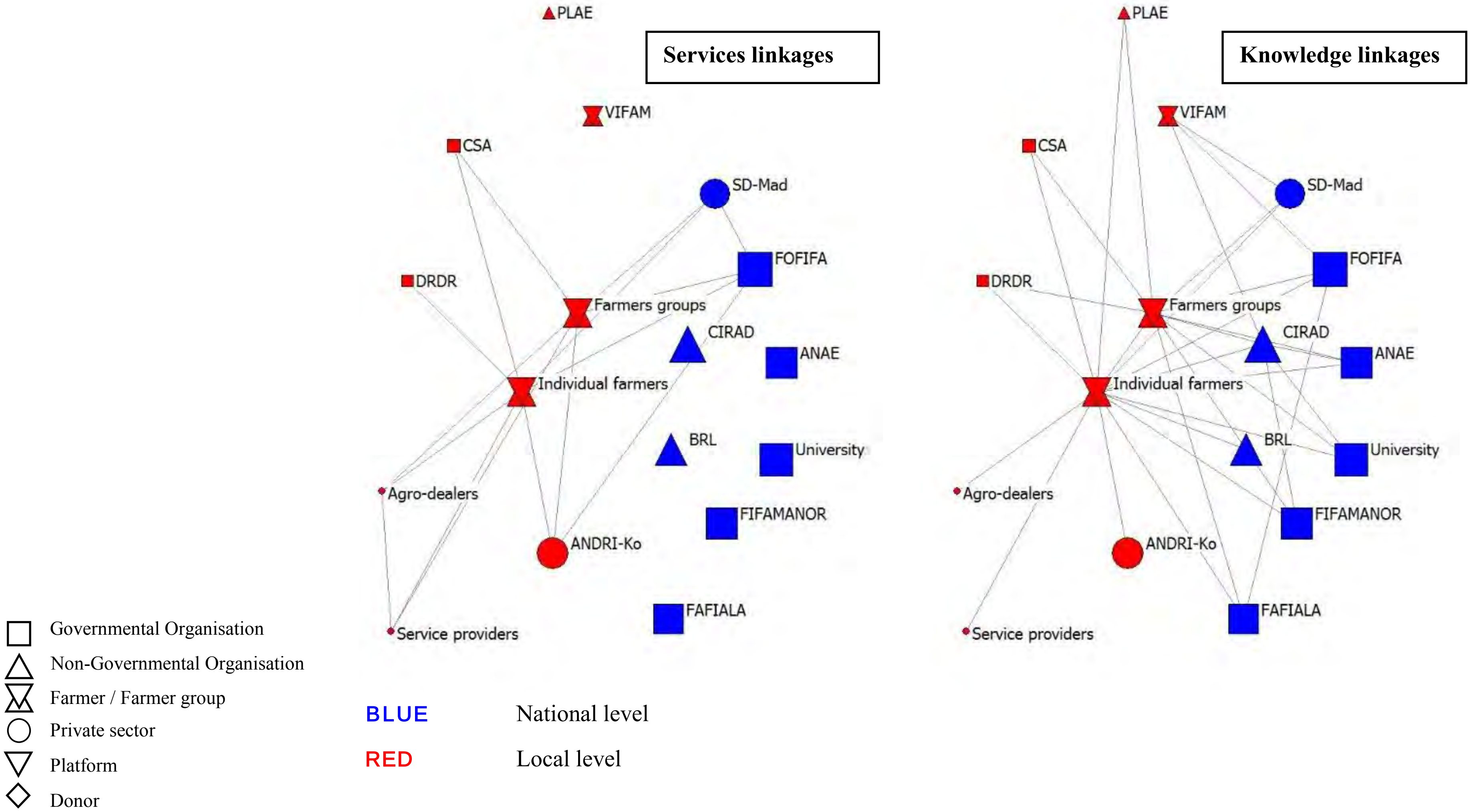


Figure 5-6 Egonetwork of farmers in Alaotra, Madagascar, with knowledge linkages (left) and services linkages (right)

5.4 Methods and tools for agricultural extension

This section briefly discusses and illustrates the main methods and tools that CA stakeholders were using to support the diffusion of CA. They were sometimes directly observed in the field during CA project activities, or sometimes referred to by respondents in the semi-structured interviews. Most of these approaches are also commonly used for supporting the 'upscaling' of other agricultural practices. This is of interest not only to gain an overview of the diversity of approaches for disseminating and sharing information, but also to draw analytical lines between methods of extension and theories of change that are discussed in section 6.5.

5.4.1 Farmer groups: FFS (Kenya) and GSD (Madagascar)

From the side of policy and project implementers that aim at introducing improved agricultural practices like CA, farmer groups are the primary point of contact. The farmer group approach is preferred to the individual farmer approach since many farmers are reached in a shorter period of time. In both study areas the ABACO project worked with farmers' groups, although the groups had a different forming history, composition and functioning.

In Kenya, CA was introduced through Farmer Field Schools (FFSs) that were formed during a previous research project about CA. Some of these groups even existed before that and have multiple purposes (see Box 1).

Box 1 Example of typical FFS in Kenya: Muramati FFS in Laikipia County

"We meet every month on the second Wednesday. We have learned a lot of things over the last years, and are very happy with how CA is working on the demonstration plot. When we meet, we discuss several things, sometimes we discuss the security in the area, protection against wildlife [mainly elephants that sometimes destroy the crops], and there is a social aspect too. There is a merry-go-round, we work in the common demo plot [where there are several CA experimentation plots], or we meet with MoA extension staff for training or a field day. In the beginning, the officers came many times, more than 2 times per month. But now that we understand the principles of CA, they don't come anymore. We started with 24 people in the group, but now we're only 8. Sometimes interested people join for the meeting [the meeting of the FFS where these notes were taken was attended by three men who were on the way to their field and stopped on the way to hear more about CA]" (several group members, personal communication, 06-05-2014).

The respondent at CETRAD explains that farmer groups are the main point for trainings: "We train farmers on how to carry out minimum tillage, using the sub-soiler, rippers, jab-planter, Fitarelli planter, etc. It is very practical, so farmers can see how it is done" (CETRAD, personal communication, 29-07-2013). And referring to FFSs, the respondent at ACT-Network argues: "It is an easier way to enable farmers to experiment with complex technologies. CA is not easy, we are talking about a set of principles that need to work together. It has been good for introducing the concept. It made it possible to explain such a complex technology to farmers. When it comes to scaling up, getting an increased number of farmers to adopt, it is not effective" (ACT-Network, personal communication, 09-07-2013).

From the side of the farmers, being in an FFS also brings several benefits. In a FGD in Mazingira FFS, farmers explained that the advantage of them being a group is that they have more frequent and easy contact with agricultural extension officers. In 2013 the agricultural extension officer informed the FFS about a goat's milk project and a yoghurt making project, so they decided to write a proposal which was accepted. This illustrates how being a functioning group can provide access to additional benefits other than the original objective.

In Madagascar, there were two *groupements de semis direct* (GSDs) that participated in the ABACO project. The groups were created, or reactivated for the ABACO project, although there was at least some overlap with previous GSD that were formed in the course of the BV-Lac project. Nevertheless, membership was very fluid and the creation of the groups was also a moment of renegotiating the objectives of members, old and new. The groups functioned more like co-Innovation Platforms compared to the pre-existing FFSs in Kenya. As in Kenya, the GSD did have a common field where several CA systems were tested and compared. The GSD in the North had members from a wide geographical area, which made it difficult for members living far away to contribute to the common field. Nevertheless, they were interested enough to join the group and regularly come to meetings. In the North, there was a pre-existing sub-group based on family and friendship ties, and there was another group of women who were involved in conserving the forest and planting trees in deforested areas. In the South, GSD members were less experienced with CA and therefore took the opportunity to experiment with a wide variety of CA systems. Formation of the groups and the co-design of experiments is described by Kendzior (2013).

5.4.2 Model farmers

Besides the farmer groups, a popular approach for reaching farmers in both countries is through 'model farmers'. In most cases, model farmers are selected with active involvement from the local community, which ensures that they enjoy the necessary authority. This authority is also often based on a long-build reputation of being a good farmer, or having experience with a particular practice like CA. Not only the farmer, but the entire farm contributes to demonstrating agricultural practices, as visiting farmers can appreciate the planning, management practices, and harvests. It is an example of farmer-to-farmer extension, and it has the benefit that farmers are more likely to accept advice from a fellow farmer from their own area than they would accept advice from extension officers. Although model farmers did not get a salary in Kenya for their contribution to the promotion of CA, they benefited from close ties with the MoA and project staff and were always treated with respect. Presumably the social status is also a motivation to become a model farmer in a project.

5.4.3 Exchange visits, field days

Closely linked to both FFSs and model farms are exchange visits and field days. Where training and field experiments help creating experience and building knowledge in a focussed way at FFSs or at model farms, exchange visits and farmer field days help to spread it to a wider public. An example of what goes on at a typical farmer field day in Kenya is given in Box 2. Exchange visits are a short time cost-effective intervention, where a considerable number of farmers can pick up new ideas quickly, and discuss it with fellow farmers who have experience implementing it in similar conditions to their own.

Box 2 Brief description of a farmer field day (based on participant observation)

At a FFS that is part of the ABACO project, several people have been invited for a farmer field day. Among the participants were the local chief, four researchers, five extension officers, FFS members, and between 10 and 20 visiting farmers. Participants registered at a table.

After some words of welcome by the chief and the responsible extension officers, the guests formed little groups of around five people, and walked to the FFS's experimental fields. On each plot, one or two FFS members explained the objective of the plot, the management, the costs, and the performance. After this little speech, the guests could ask some questions.

At this particular case, plot1 was a monoculture of maize, grown in the conventional way. Plot 2 aimed at integrating livestock and farming by growing 'CA without cover', in other words, only zero tillage. Some of the maize was affected by herbicides, and the farmer explained what had gone wrong in the process. On plot 3 there was a CA intercrop of maize and dolichos. The speaker explained that mulch from dolichos suppresses weeds, and as it has deep roots it helps 'pumping up' deep nutrients. Plot 4 was CA with butterbeans. The speaker explained that it performed badly in the first year, but in the second and third year the reduced evaporation due to the butterbeans and direct planting 'saved the crop'. Some of the quests asked how much work was involved at what stage, which herbicide was used, and similar practical questions.

After the field day, some speeches were given by visitors and group members with the main lessons learned, while tea was served with freshly cooked maize.

The purpose of field days and demonstrations is to transfer a specific set of skills or techniques related to growing a crop under CA, as well as general farming practices such as grain storage and pest control. The demonstration on field days are done to a group of farmers and are targeted to the general farming community. Several group members in Muramati discuss the field day, and argued: “We need demonstration in our own farm. The disadvantage of the field day is that it is theory. There are many techniques that are discussed at once, and you don’t actually see the action, you only see the result. It would be better to have several field days throughout the season where CA activities are demonstrated that can then be copied at the own farm”. So the disadvantage is that more complicated practices, like CA, are difficult to pick up from observing a field at a single moment in time, as it involves various practices at different moments in the growing season. A single visit may not give the confidence necessary to give it a try on one’s own field.

5.4.4 Extension services

In the study sites in Madagascar, no extension services were available outside the project context. At the end of the BV-Lac project, several so-called co-agro’s were selected in an extensive application procedure, who were then further trained in Conservation Agriculture and extension. There was one co-agro in the North and one in the South. This was the strategy to ensure sustainability after the end of the project in the absence of an institutionalized extension system. In the ABACO project, the co-agro’s are used to support the extension at field level, they report every three months to the project coordinators. The co-agro in the North was a lady who was intrinsically motivated, and actively involved in supporting several groups, not only with CA but also with general farming practices. She enjoyed respect in a wide area. The co-agro in the South was less motivated, active and seemed less respected in the community.

In Kenya, the local MoA had a number of extension officers who regularly visited the farmer groups, including the CA FFSs. An interview with one of the extension officers gives an idea of how they work (see Box 3). The statistics given by the respondent paint a picture of limited coverage by extension, as a single extension officer is responsible for more than 40 groups. Moreover, when an extension officer is used in a project, it means that she has to intensify her contact with that group. The reality of limited coverage means that other groups will see less of the extension officer. The district extension officer in Laikipia puts it like this: “Here it is very calm. Except for some of the projects like ABACO we are very limited in our funds and cannot do as much as we want. But with those programs we can comfortably say that something is happening” (MoA local, personal communication, 08-07-2013).

Although not part of the formal extension system in Kenya, Lengetia farm and Ol Pejeta wildlife conservancy also employed agricultural extension officers as part of their community development programmes. Besides extension, they offer inputs like herbicides and seeds at a reasonable price.

Finally, also action research as done during the ABACO project and similar projects contributes to the diffusion of knowledge. During the FGD held for this research, practical advice was shared and learning was happening by all participants. During the FGD in Madagascar where a gross margin analysis was done, farmers who were not a member could learn a lot. About every investment and benefit on the list people were discussing lively, which gave the participants a realistic insight in different ways CA is practiced by different farmers.

Box 3 Interview with an extension worker in Laikipia County, Kenya [27-08-2013]

What is your responsibility?

I deal with farmers. In total, I am responsible for 40-45 groups. Besides the normal extension, the groups are used for several projects. Two of my groups are selected for the Kenya Pollinators project, four of my groups are in the Global Gap Compliance project, and at the moment I deal with two active FFS for the implementation of CA in ABACO project. These are Kalalu and Umande FFS, who started as a self-help group, but were transformed in a FFS during the 1998 CA-SARD project. I train farmers in the CA principles and I train on how to manage group dynamics.

How does a normal week look like for you?

I go to the field almost every day from Monday to Friday. In one week I can cover 3,4 or 5 groups, depending on the number of meetings and trainings I have to attend at the office, and depending on the money that is available for transportation.

What is your dream for Laikipia?

I hope that the farmers that I work with can become experts on their own, to create employment, so that the message can extend to farmers who are not in group.

How do you see the adoption of CA?

It is well taken by farmers, sometimes the farmers are ahead of me when it comes to understanding CA, because it is very complex. I see that there are two main drivers: The high labour cost due to the greenhouses, and the low yields due to the unreliable rainfall. I am mainly concerned with group management and know only the basics of CA, but I don’t have a big in-depth knowledge. The major challenges are to reach farmers with training and CA implements such as direct planters.

5.5 Observed processes in the innovation system

This section describes and combines several processes and phenomenon that were observed in the two study areas, including semantic variation in the meaning of CA, the different project approaches in Madagascar, and how the introduction of CA has influenced power relations in both countries.

5.5.1 Semantic variations and the meanings of 'CA' practices

When farmers, researchers or extension officers speak about CA, they do not always refer to the same. This results in conversations that are based on different presumptions, further complicated by the difficulty of translating the agronomic concepts. Splitting the behaviour category of 'adopting CA' into specific behaviours such as spraying herbicides, mulching or direct planting, forced respondents of the questionnaires to disentangle their beliefs and attitudes. The process often gave rise to confusion.

In Laikipia, spraying herbicides is highly associated with CA, as it is the most common way to control weeds during land preparation when no longer ploughing. Although there is a word in Kiswahili for conservation agriculture (*kilimo hifadhi*), direct planting was often referred to as 'planting with CA' or as 'planting with herbicides/spraying'. Similarly, CA was sometimes referred to as 'planting with *dawa'*. *Dawa* can be translated with 'chemicals' and refers primarily to the use of herbicides in CA, but also to the pesticides that are often considered necessary to grow the cover crops. While doing the survey it was frequently observed that respondents would mix up the terminology in answering questions about herbicides and direct planting. Judging by the language used during the interviews it can be argued that although direct planting is the logical counterpart of ploughing, farmers in Laikipia saw herbicides as the alternative for ploughing, or at least as an important aspect of, or precondition for, direct planting. This association of CA with herbicides may be partly due to the involvement of the Syngenta foundation in the promotion of CA, while current projects only advise to use herbicides in the first years, and only if necessary (CETRAD, personal communication, 29-07-2013).

In Alaotra region, CA was never used as a word, as the NGOs and the project are used to the French concept of SCV (*Semis direct sur Couverture Végétale permanente*). This word for CA, equally known to most farmers, has the word 'cover' in its definition, and is therefore much more distinct in its meaning than 'Conservation Agriculture'. In the Malagasy translation, SCV was referred to as *voly rakotra,* which translates again to English as 'planting with cover'. Previous CA promoting projects operating under the BV-Lac umbrella project, advised farmers, among other things, to get wild grasses that grow on the *tanety* (referred to as *bozaka*) to realise a dense mulch on their lower lands. Many farmers that were interviewed about 'planting with cover', remembered this *bozoka*-type CA, which was generally disadopted as it was a laborious practice. The ABACO project puts more emphasis on planting cover crops, thereby also changing the perception of '*rakotra'* or cover. The translators explicitly defined mulch as 'residues from the crop, a cover crop, or imported *bozaka*', which changed the perception of the practice of *rakotra mata* (dead cover).

When discussing the particular practices, there was a similar mix of questions about one practice, and answers about another practice as was observed in Kenya. This reveals that the perceptions about different practices sometimes shared the same informational basis for attitude formation and decision making. This was especially the case for direct planting and planting a cover crop, and mulching and planting a cover crop, and spraying herbicides and planting a cover crop. The latter can be understood by the fact that some cover crops like stylosanthes or vetch grow strong and continuously up to the beginning of the growing season, requiring herbicides to control the cover crop before planting. In Kenya, the herbicides are used to control the weeds that are on the field at the beginning of the growing season, as none of the cover crops used in Laikipia survives that long. The mix-up between direct planting and planting a cover crop was also different between the two countries; where farmers in Laikipia attributed some positive outcome of CA to the fact of not ploughing, irrespective of the cover management, whereas in Alaotra farmers saw the cover crop as the main source of the benefits of CA.

5.5.2 ABACO and BV-Lac, two project approaches

Whereas the ABACO project as implemented in Kenya constituted a continuation of the previous project's FFS approach, in the Lake Alaotra area in Madagascar, the ABACO project had a fundamentally different approach to promoting CA compared to the previous BV-Lac project. The two projects are difficult to compare because the ABACO project was very small and short compared to the BV-Lac project, which was more like an umbrella for diverse small projects. However, because there were researchers, extension officers and farmers who had experienced both projects, there was the opportunity to reflect. The different approaches were recognized by GO and NGO stakeholders at the national and local level and by farmers alike. The general picture is that the BV-Lac project was very top-down at the outset, and about half-way developed into a more socio-culturally informed approach, while the ABACO project facilitated experiments according to farmers' priorities.

The respondent at GSDM explains that the promotion of CA has gone through several phases in its recent history. In 1994/95 it was rather technology oriented, and the work of the NGO TAFA was very important which resulted in crop systems that were adapted to fit with the various agro-ecological zones in the country. With the BV-Lac project, following the agenda of the big donors, the extension ('la diffusion') of the systems was taken up, but it was not their strength ("Mais ça n'était pas leurs métier") (GSDM, personal communication, 13-12-2013). Although the BV-Lac project manager recognized from the beginning the need for including a social perspective, the project staff remained dominated by a group of technology oriented scientists who had a rather dogmatic approach to SCV (CIRAD, personal communication, 27-02-2014).

Also within the 10-year BV-Lac project, a changing approach can be seen. In 2007, a socio-economist was added to the team and this contributed to the socio-economic elements of the farming systems to the understanding of adoption and farmers' priorities for developing their farming system. This new perspective showed that real adoption had been little successful thus far, and slowly, the blueprint top-down technical advice that was given by the large group of extension officers, shifted towards giving advice and responding to questions of individual and groups of farmers. Nevertheless, as most the team of extension officers remained the same, there was a continuation of previous approaches as well as new approaches. There was also an emphasis on quantitative indicators of success of the project, partly in response to the requirements of the donor (GSDM, personal communication, 13-12-2013). In the course of the project, more emphasis was put on qualitative findings, which showed that farmers partially adopt, abandon, and adapt aspects of CA.

During this research, I experienced the difference in how extension officers interact with farmers. Two of my enumerators had worked for several years as technicians, or extension officers, in the BV-Lac project. The nature of my questionnaires used in this thesis required to ask open questions and be observant and open to understand the respondents motivation, however, the tone of voice and speed with which the two enumerators rushed through the questionnaires suggested a slightly superior attitude towards the farmer, and the respondents appeared intimidated (they were often looking to the ground and giving short answers, mostly affirmative of the questions asked). This was discussed with the other enumerators, who indicated that in their perspective the two enumerators were not very respectful towards the farmers and were telling them what they should be doing. Such attitudes are partly personal, but are likely to be influenced by a project culture.

Both in farmer interviews and FGDs, the contrast is repeatedly made between the BV-Lac project style where you have to do as you are told, and the ABACO project style where you can do what interest you. One man in the North put it like this (agitated): "When we worked with BRL during the project BV-Lac we lived a bit under dictatorship: we could not really grow and learn what we wanted, but had to follow strict instructions. With ABACO it was different because we were free to select the techniques that we were interested in" (FGD, 12-05-2015). This man continues to explain that this is not to say that there were no challenges during the ABACO project, but the challenges were now linked to climate and specific seeds, instead of frustration with the project approach. This was also concluded in previous FGDs, where farmers called ABACO relatively participatory and respecting, with the possibility to float their own ideas.

A woman observes: “These years were a bit like a follow-up of BRL and SD-MAD, and we see it as an improvement. In the earlier experiments with CA we had to use *bozaka* as mulch (a grass that grows on the *tanety*) which was a lot of work”. Although the *bozoka* based mulching systems are very interesting from a technological point of view, and as it grows plentifully on the *tanety,* it was promoted as a promising technology, but the required labour at a busy time in the agricultural calendar made it not an attractive option. With the capability approach in mind, the ABACO project approach in Madagascar seems more appropriate where the project is facilitating in expanding the basket of option that farmers can choose from. This was only possible, however, by building on the knowledge and experiences in the area.

The relative freedom in the approach[44] of ABACO compared to the previous project worked well for the well-organised group who were able to set an agenda and interact strategically with a facilitation project approach. For the less organized and less motivated group it was a bit more difficult to reap benefits. Some farmers expressed the need for more visits from project extension officers to their field, and seemed to benefit little from the group processes. Indeed, in the South the benefits seemed to go to some strong individuals who had the power and capacity to benefit from the project activities. Other stakeholders did mention that top-down project elements are not always a bad idea, as the respondent at ACT-Network argues: “We have seen top-down approaches that were very successful and we have seen bottom-up approaches that are really struggling. Priorities also change, as I said before, it [the FFS approach] has worked very well for the introduction of CA, but when it comes to scaling up the adoption, it has not done very well.” (ACT, personal communication, 09-07-2013).

5.5.3 New power relations with CA

In areas where CA was implemented this resulted in new power relations in local communities in both countries. In Kenya, where there was a relatively large pool of farmers who were interested in CA, the service providers emerged as new powerful figures at the local level. Due to the efficiency of planting and the performance of the crops, farmers preferred to use an animal-drawn direct planter for the purpose. Whereas ploughing services were relatively abundant, service providers for animal-drawn direct planting were scarce and CA farmers became dependent on a few service providers. Due to the limited rainfall in Laikipia, it is very important to plant early and make use of the early rains. In the field, clear visible differences in crop performance could be attributed to different planting times.

[44] For a description of the co-design and co-evaluation processes of CA experiments with the groups in Alaotra, see (Kendzior, 2013)

The new power of these service providers has two dimensions. The first is indeed the service providers' power to determine which farmer gets to plant in time and which farmer has to wait. A second dimension was that the high demand for his services was framed as a success story, which was heard by many visiting NGOs and donors. One service provider in Laikipia in particular had almost reached the status of celebrity: he had featured in a video[45] about CA, he was visited by national and international GOs and NGOs and donor institutes, travelled several times to Brazil to learn about CA, and was regularly invited to national and international conferences about CA. For me it was difficult to interview him, as he was used to ask money for his interviews. When I got an interview, he showed his new two-wheel tractor which he is using to experiment with for a new project.

From the point of view of the government and NGOs it is very useful and effective, as farmers are more likely to take advice from fellow farmers (CETRAD, personal communication, 29-07-2013). And instead of slowly convincing one farmer at the time, such service providers could convince a lot of farmers by demonstrating the functioning of CA in practice. From the perspective of farmers, however, it was difficult to fully rely on his services.

Regarding the influence of the project activities on power relations, it can be observed that the 'entry points' for the project is often a 'strong' farmer, both in the agricultural sense of having a wide knowledge of agricultural practices and farm management skills, and in the social sense of being a respected member of the community. The frequent contact with researchers, extension staff and foreign visitors adds to the social status of these contact or model farmers. As primary point of contact, they are often involved in hosting FFS meetings and

In Madagascar, in particular in the study site in the North, there was a group of farmers that actively shared farming information and cover crop seeds. They also had built up connections with other CA farmers, sometimes as far away as the other study site in the South. As such they had an 'output market' that made CA a little bit more profitable. These connections were not shared with non-members, and several neighbours mentioned that they did not share seeds or information, which made them reluctant to speak with them or to even try CA.

Another element in local power relations in Madagascar was the relationship between cattle owners and CA farmers. Cattle owners became more powerful in the sense that they could decide whether their cattle would feed on mulch or cover crops on lands that were relatively far from the village. This has always been culturally acceptable and the free grazing system worked well as long as all farmers did more or less the same, but with more and more CA farmers it had become a heated issue. They determined whether CA was 'proper farming' and whether the traditional use of the

[45] Accessible at https://www.wocat.net/en/knowledge-base/slm-videos.html

dodoka (the stick placed in fields where cattle should not enter) was valid for specific types of cover crops or not. Some farmers used a leguminous weed as cover crop, which then was not recognized as a real crop. On the other hand, cattle farmers had become stigmatized and were increasingly labelled as a problem. And during the BV-Lac project, CA farmers could count on the support from the project technicians.

5.6 Institutional and technological priorities in the innovation system

In this section, several elements are discussed that could contribute to an institutional environment that is more conducive to the diffusion of sustainable practices like CA, also in terms of what type of stakeholders are under or over represented.

5.6.1 Government extension

When reflecting on the institutional context of CA in Madagascar, several stakeholders mentioned that there are several research institutes, but there is a need for dissemination which is considered primarily a task of the government. A respondent at CIRAD argued: "As a research institute, you could say we are making new knowledge. We put it in a 'diffusible state', and we test the adoption at a small scale. But the actual diffusion is not our task and is done by other stakeholders with whom we work closely together. However, at the moment there is a gap in terms of dissemination" (CIRAD, personal communication, 27-02-2013).

A respondent at FOFIFA national explained a similar process. At FOFIFA they generally test new technologies and new CA systems with 2 or 3 farmers who assist in fine-tuning the technique for two years. Then there is a one-year period where they have a demonstration plot where farmers can theoretically pick up the new practices. "However, it is not really our responsibility. We are primarily there to do research, and that ends when the results are obtained. What we need more in Madagascar is training and technical assistance" (FOFIFA national, personal communication, 28-02-2014).

Also at the local level in the Alaotra area, stakeholders identified the lack of extension services as the weak point in the innovation system. As the seed-producer Andri-Ko argues: "What we are missing is training and the technical assistance for farmers (*encadrement et appui technique)*. There is no need to support new equipment or inputs, that will appear once farmers are aware and willing to adopt the practice. Also, it is a political decision, it is not our responsibility but it is up to the government to support farmers with the available scientific knowledge" (Andri-Ko, personal communication, 21-02-2014). This was also confirmed by FOFIFA local, as the respondent argued that "research is pretty well covered by FOFIFA and CIRAD and even some other NGOs, but what we are really missing is the political decision making. Also we need extension officers to offer information and training" (FOFIFA local, personal communication, 25-02-2014). Due to the political crisis that paralysed national and local politics for many years, the interviewed stakeholders were still working policy document that dated back to 2007. Should the government regain the will and capacity to support agriculture in the Lake Alaotra region through extension, the DRDR would be the natural option. At the time of the study, however, their coverage was very limited, and completely absent in the study sites.

5.6.2 Technology development

At the local level in Kenya, several stakeholders argued that technology development was the most underrepresented element in the innovation system. As already described before, farmers preferred to use the animal-drawn or tractor-drawn direct planters. However, there were not enough service providers to meet the demand. The respondent at CETRAD argued: "Technology is the main thing. There are so many farmers, and there is such a high demand that the service providers cannot meet. If there were only two or three more 2-wheel tractors and motivated service providers, that would make a big difference" CETRAD, personal communication, 05-09-2013). The addition of 'motivated service providers' is an important one. In previous projects in Laikipia, several types of CA equipment have been made available to the groups, however, group ownership of the expensive implements proved ineffective and very few are still being used. From the current service providers it becomes clear that it requires a great deal of perseverance and determination to adjust the equipment to the local needs and to repair broken parts, etc.. Moreover, young men who would normally take up such a role were not eager to invest in agriculture and preferred to work in the city (MoA local, personal communication, 08-2013).

At mr. Sessions' Lengetia farm, two 2-wheel tractors are available for hire by local smallholder farmers. As such he is filling a gap because such services are almost not available. The respondent at KENDAT argues that the lack of technology development is linked to political decision making: "The support service in terms of CA equipment is lacking. For instance, you cannot buy a ripper or a sub-soiler off the shelf. It is easy to buy an animal drawn plough, but you cannot buy the jab planter for direct planting. So there is a big gap in terms of CA equipment within the CA context" (KENDAT, personal communication, 31-07-2013). Similarly, 2-wheel tractors are easy to come by as are the ploughs to connect to it, but the direct planters to attach to a 2-wheel tractor have to be imported from other countries with the risk that it is not suitable for the local agro-ecology or farm systems.

5.6.3 Networks and coordination

Another aspect that the interviewed stakeholders saw as underdeveloped, in both countries, was the coordination and integration of activities related to CA. At national level, stakeholders were formally linked in the NCATF. Nevertheless, as a platform it was very young and the interviewed members were still waiting to see what role it would play although they were in principle not against the idea of the platform. In Madagascar, there was already a strong national-level coordination of activities through the GSDM which reduced the urgency of a national-level platform. In Kenya the respondent at ACT-Network argued: "At the government level we have seen gradual uptake of CA in policy. At the private sector level we have seen private companies coming up to manufacture CA tools and equipment. We've seen on the public sector NGOs coming up with projects. The next step is for these institutions to talk to each other. We have some steps to make in that respect" (ACT-Network, personal communication, 09-07-2013).

At the local level in the Lake Alaotra area, the platform function of coordinating stakeholders involved in agricultural development, not necessarily limited to CA, was performed by BV-Lac for a decade. After the project stopped, they left an empty place and currently there is little coordination of projects in the area. At the local level in Kenya, stakeholders were often not aware that other stakeholders were also involved in CA. In several instances during the interviews, I gave respondents an overview of whom I had talked to and what they were doing regarding CA, to which they responded surprised. Individual stakeholders did have their own channels of sharing the impact of their work and the lessons learned, for example Caritas was sharing information with other Diocese, and CETRAD organized meetings with diverse stakeholders to exchange ideas about CA and similar practices. However, they also recognized the need to coordinate and harmonise their efforts at the county and sub-county level.

5.6.4 Stable markets

The situation in Lac-Alaotra can be characterized as post-project. The BV-Lac project that for a period of ten years has promoted CA, also shaped the institutional landscape in many ways, including balancing supply and demand of CA related produce. In some stages of the project, farmers received seeds free of charge from the project, which meant that seed suppliers had a stable buyer, and farmers had a free or subsidised access to cover crop seeds. The project lasted long enough for farmers to adapt their farming systems to it.

Now that the facilitating role of BV-Lac has disappeared, farmers need to change and adapt to continue the same CA practices. One of the challenges is finding good quality seeds for cover crops and useful varieties of maize and rice. And although farmers complain that there is not enough production of seeds, interviews with seed producers show that there too little demand to sustain the production. Seed producer Andri-Ko is producing cover crop seeds out of personal conviction that CA is something that has the future in the area, not because he is making business with it. It will probably take time for demand and supply to be adjusted to each other in the post-project context.

A similar disruption of the project equilibrium was observed for Glyphosate, the most popular herbicide that is also used in CA systems. During the BV-Lac project, the use of herbicides was also subsidised and demand was more or less stable. In the first year after the project, the agro-dealers speculated that demand would fall sharply after the end of the project. However, during the season there was a huge shortage of herbicides. And the time it takes to import new supplies into the country is several weeks or months, which is too long to respond to such unexpected demand. A respondent at SD-Mad described the agro-dealers as 'speculators' who are not interested in agriculture, but whose priority it is to make money: "If they can make more money by importing sugar, they will leave agricultural products and go for sugar" (SD-Mad, personal communication, 18-02-2014).

For Vetch, however, seed producers see that there is a steady demand. This is because Vetch can be grown off-season on rice fields, thus touching on the principle priority of farmers. There have been many good examples on the road side where people have been able to see that the rice after vetch is of very good quality. Overall, the input supply for farmers is still insecure in the Alaotra region.

5.7 Forcing or facilitating innovation?

In this section I discuss two examples of 'innovation' that take a different direction to that which was envisaged at the outset. This illustrates a fundamental tension in Agricultural Innovation Systems (AIS) thinking when used as an approach for reaching a predetermined objective, such as an increased adoption of CA.

5.7.1 Innovation Platform in Madagascar

The first example of 'unpredictable' innovation comes from a CA Innovation Platform meeting in Madagascar, see Box 4. The platform was initially meant as a supportive institution for the dissemination of CA in the area. According to the objectives of that particular project, however, stakeholders set the agenda of the meetings in order to support 'bottom up' innovations. Indeed, participants discuss agricultural innovation, but CA is not part of their priorities.

The freedom in the process and the structure of participation allowed the members to take a different direction to that which may seem salient from an expert point of view. This platform meeting shows that CA is not seen as pressing an issue for the farmers represented there, and the selected 5 innovations appeal more to the farmers. Therefore, these innovation may prove good for agriculture in general, but it may not fit in the instrumental approach towards an increased adoption of CA.

Box 4 Description of a CA Innovation Platform meeting in Madagascar

At an Innovation Platform meeting in Ambatondrazaka a total of 12 people gathered in December 2014. They represented different farmer organisations (FVRVM and FITAMITO) and the federation MIRAY, together under umbrella organisation VIFAM, the cooperative KOLOHARENA, four farmers from Mahatsara and Amparafarovola, and two people from the ministry of agriculture and fisheries.

The convocation and facilitation was done by a person who has worked for a previous project that operated in the BV-Lac context and aimed at supporting agricultural innovation. The programme for that day, besides some operational points, was to select 5 innovative technologies from a list of 20 innovative technologies that had been drafted in a previous meeting. This was part of a longer process of supporting demand-driven innovation, and the selected 5 technologies would later be further researched and be brought to the attention of as many farmers as possible.

One of the 20 innovative technologies included a Conservation Agriculture rotation with butterbeans. After some discussion agreement was reached on the five innovations to be further promoted: a new kind of weeding tool for the rice paddies with limited water control, an innovative way to grow wild potatoes, a way of growing maize in a nursery first and transplant it in the same way as rice, compost making with earth worms, and the off-season, aboveground growing of sweet potatoes. Indeed, no CA innovation was selected.

5.7.2 Crop insurance in Kenya

The second example of 'unpredictable' innovation is the history of the crop insurance programme *Kilimo Salama* in Laikipia, see Box 5. One of the interesting aspects of this story is that the crop insurance was initially limited to Conservation Agriculture farmers, while this precondition was removed in a later stage. The idea that CA adoption would benefit from an insurance was not very strange, and as the insurance was offered free of charge, it initially functioned as an incentive for farmers to practice CA. However, the need for an insurance proved to be much more fundamental for smallholder farmers. The institutional innovation filled a gap that had little to do with CA, although it can contribute to an institutional environment in which it makes sense to invest in rain-fed agriculture despite adverse climatic conditions.

The two cases are 'innovation narratives', and shows innovation is in some fundamental way a largely spontaneous process. This can also apply to the FFS 'methodology'. Although it can theoretically function as an Innovation Platform where stakeholders meet and decide on appropriate action, in practice it is deployed by projects to achieve an outcome. One of the difficulties of the AIS approach is to make the step from descriptive case studies to inferring prescriptive lessons for innovation, but they seem to include that the process has to be flexible, dynamic and facilitated, among actors with a shared interest (Nederlof, Wongtschowski and Van der Lee, 2011).

Box 5 Description of Kilimo Salama, a CA crop insurance policy in Kenya

The history of the successful for-profit Agriculture and Climate Risk Enterprise Ltd. (ACRE) starts with a project known as *Kilimo Salama* (safe agriculture) in Laikipia County in Kenya. In Laikipia, the highly variable climate and regular crop failures are a serious problem for the smallholder farmers. By 2009, several projects were implemented by the local MoA and NGOs to promote CA as a way to deal with the drought. For these projects, farmers had formed groups which were used by Syngenta Foundation to start a pilot project for a crop insurance in the rain season of 2009.

Based on a climate index obtained from local weather stations and making use of farmers' mobile phones, farmers could be refunded in case of extreme weather. The insurance was only available when buying 8 kg Syngenta certified drought-resistant maize seeds from the local stockist. The stockists were also trained to give advice on using herbicides and fertilizer. The rains in 2009 failed, and depending on the precise location of the 230 initial participating farmers, pay-outs were made. Where people first referred to it as "the thing that came with the seeds", after the first pay-out was made they called it "insurance" (Morelli et al., 2010). The first pay-outs deepened their confidence towards the concept, and made them eventually willing to pay.

In the pilot phase of Kilimo Salama, the crop insurance was only available for Conservation Agriculture farmers. The idea was that farmers could experiment with CA, without the risk of losing everything. A respondent at CETRAD who was involved in this project explains: "We did a project in 97/98 to promote CA, and after three years there were less than a handful of adopters. The drought was so strong that people could not invest. And if you don't harvest, it normally means you cannot invest in the next year, so it is a cycle. People were putting so much work in it, and then there was no result. With the insurance, farmers could adopt CA without that risk. With the insurance, the cycle is broken and farmers can still invest with good seeds and inputs in the next season, and experiment with CA" (CETRAD, personal communication, 05-09-2013). An insurance that started with 230 CA farmers in Laikipia in 2009, has reached, cumulatively, over 800,000 farmers in Kenya, Tanzania and Rwanda by 2015 (http://acreafrica.com/).

5.8 Summary and discussion

Related to the first research question, this chapter set out to understand the functioning of the agricultural innovation system for Conservation Agriculture, by understanding the main CA stakeholders, their interactions, their extension activities, and some of the innovation processes around CA observed in the field.

The overview and description of the main stakeholders provided in section 5.2 showed that different stakeholder types are dominant at different geographical levels. In both countries, donors are the main stakeholder group at the regional level, together with some policy stakeholders like the AU and COMESA. At the national level most stakeholders are involved in implementing CA (research) projects, in Madagascar this level was dominated by research organizations like CIRAD, while in Kenya the national level was characterized by many project-implementing NGOs like KENDAT and ACT-Network in addition to research institutes like ICRAF. At the local level in Kenya, there are several stakeholders that are not project-dependant such as the MoA and Lengetia farm, and project stakeholders that interact with the grassroots level like FFSs, farmers and service providers. The local level in Madagascar is characterized by a lack of permanent stakeholders that are involved in supporting agricultural development, and those that are there have limited resources.

The Social Network Analysis reported in section 5.3 shows that the innovation system in both countries is driven by a push from national level stakeholders who, through project partnerships, engage in the promotion of CA in different ways. There is a difference in the type of key stakeholders between the countries. The central, best connected stakeholders in Madagascar are all research institutes (FOFIFA, CIRAD and UoA), who are involved in action-research in farmers' fields and not so much in dissemination of sustainable agricultural practices like CA. In Kenya, however, ACT-Network and KENDAT appear to be the best connected stakeholders, which are stakeholders that explicitly aim at upscaling CA rather than only researching it.

The innovation system in both countries was relatively strong and dynamic at the national level, where there is a substantial amount of coordination. In Kenya coordination is facilitated by ACT-Network, who is also highly connected with the rest of the network, and the NCATF which functions as a platform for sharing experiences. Similarly, the coordination of CA related activities in Madagascar is done by GSDM, which is also highly connected with the rest of the network, and through the NCATF. Continuity of CA activities at the local level, however, seems to depend highly on project dynamics which in turn are linked to the donor agencies at the regional level. Although the MoA is a central stakeholder in both countries, they are not leading in the promotion of CA.

FFSs are also well connected, but only the few FFSs that feature in projects, for the duration of the project. These projects, as was shown in the same section, generally last between 2 and 4 years, and are sometimes followed by a second phase. This makes the linkages and partnerships between stakeholders very dynamic, as shown by the project landscape that changed considerably over the last decade in both countries. Furthermore, the farmers' *egonet* showed that farmers in Kenya have quite complex services and knowledge networks in which local non-farmer stakeholders also interact with each other, whereas in Madagascar there was little interaction or coordination among stakeholders regarding service delivery and knowledge linkages. In both countries, farmers are relatively isolated regarding knowledge or advocacy linkages, particularly outside projects. In other words, they are dependent on projects for agricultural innovation and they have limited influence on it through their structural linkages, even within project contexts.

The dominant extension approaches in research and dissemination projects, as discussed in section 5.4, are farmer groups (FFSs and GSDs in Kenya and Madagascar respectively), model farmers and exchange visits/field days. The approaches are based on the empowerment of groups of interested farmers in the FFS and model farmers through trainings and experimentations, which is combined with scaling-out elements through the facilitation of farmer-to-farmer contact. Although the ABACO project aimed at using co-Innovation Platforms for upscaling CA, the approach in Kenya continued to be based on a standard FFS approach without significant changes. The co-Innovation Platform used in Madagascar came close to implementing the ideals of the AIS approach.

Zooming in on some of the processes in the innovation system, as was done in section 5.5, it becomes clear that the semantic variation in referring to CA and its constituents was a key element in understanding the meaning and connotations of CA practices in both countries. In Kenya, 'planting with CA' mainly referred to 'direct planting', which was highly associated with herbicides for controlling the weeds. In Madagascar, CA was referred to as SCV in French or as *voly rakotra* in Malagasy, so the CA principle of permanent soil cover is featuring prominently in both definitions of CA that were used in Madagascar. Indeed, farmers sometimes confused CA with outcomes of cover crops or mulching, and the need for herbicides was stressed for controlling the cover crop.

The results show a big difference in farmers' appreciation of the ABACO project approach compared to the previous BV-Lac approach. Farmers expressed the differences in strong wordings, and appreciated the freedom within the ABACO project to pursue their own objectives and to decide on the experiments, whereas the BV-Lac approach was perceived as more prescriptive and dismissive of their views. An example is that transported *bozaka* from the *lavaka* was promoted as mulch, which, although agronomically very interesting, is not attractive from the farmers' perspective due to the required labour. The moment the BV-Lac project stopped, this practice was abandoned.

It was found that the uptake of CA changes power relations in the innovation system in both countries. In Kenya, service providers become powerful due to their influence on who can plant in a timely manner, and the strong position of farmers who are used as contact points for the projects, including model farmers, is further enhanced through the frequent contact with researchers and project staff. In Madagascar, some CA sub-groups were excluding non-members from their knowledge of CA seed markets and farm management with CA. The rise of CA also contributed to the tension between livestock farmers and crop farmers regarding the grazing conventions.

From the perspective of the CA stakeholders at national and local level, the innovation system required technological and institutional changes, as discussed in section 5.6. In Kenya, a lack of technology development was identified, referring to jab-planters, animal-drawn equipment and tractor-implements for direct planting, sub-soiling and ripping. The need for more networking and coordination was mentioned by several stakeholders, especially referring to the local level in both countries. In Madagascar, stakeholders mentioned there was a lack of organisations involved in what was referred to as 'the diffusion of knowledge'. Also the SNA showed an overrepresentation of research institutes and an underrepresentation of diffusions and extension institutes. And finally, the maturing and regulation of markets was mentioned as an institutional development that was necessary to balance the innovation system in the medium term, particularly related to cover crop seeds and inputs such as herbicides.

Finally, the cases of crop insurance from Kilimo Salama (now Acre Africa) and the Innovation Platform in Madagascar as described in section 5.7 show the fundamental difficulties of using the AIS instrumentally, as an approach to promote the diffusions of a specific practice. Initially, crop insurance Kilimo Salama went hand in hand with the promotion of CA, but soon developed into a general crop insurance. The Innovation Platform in Madagascar aimed at supporting watershed development and agricultural innovation in which CA was an important part, although farmers showed more interest in non-CA innovations. The two cases describe successful innovations for farming in general, but were not necessarily successful in promoting CA which was at least part of the initial objectives. It suggests that it is difficult if at all possible to obtain a predefined objective through a largely spontaneous process where many diverse stakeholders are involved. Indeed, innovation is often unpredictable, and ideally an AIS approach should allow for this flexibility, even if it means that initial solutions or objectives have to be changed.

6 INNOVATION NARRATIVES AND THE FRAMING OF CA

6.1 Introduction

This chapter aims at better understanding how important stakeholders think about agricultural change in general and the promotion of Conservation Agriculture in particular. Stakeholders' self-perception regarding the different extension intervention models described by Röling (2009), resulted in an overview of their perceived roles within the innovation system (**section 6.2**). In the same vein, **section 6.3** gives an analysis of how the different CA stakeholders legitimize their involvement in CA, including the question of whether they think there is a strong scientific basis for the promotion of CA.

In line with the contested agronomy argument, outlined in the introduction section 1.4, attention is given to the way CA stakeholders talk about and 'frame' CA (**section 6.4**). In **section 6.5**, an overview is given of the 'theories of change' that CA stakeholders have, reflecting how they believe that their actions result in an impact.

6.2 Perceived roles

This section explores the perceived roles of stakeholders involved in CA regarding their relationship with the farmers. In the interviews, respondents were asked how they see the two-way relation between their organisation and the farmer, and were presented with five options to describe the reason for being involved in the promotion of CA, adapted from Röling's characterization of extension (Röling, 2009b, p. 55, see also Table 2-3). Besides the role of the stakeholder, the description also includes the objective, and the 'point of action' of the intervention. The five options presented to the respondents were:

- We are like a **Strategist**, we identify determinants of farmers' behaviour so that we can design projects to increase CA adoption.
- We are an **Expert** in CA, trying to convince farmers of the benefits of CA in order to reach an increased acceptance and adoption of CA.
- We are like a **Consultant**, identifying the main problems, so that we can remove constraints faced by farmers who try to adopt CA.
- We are like a **Trainer**, focused on the client, engaging in a process of learning with farmers, so that they make sense of CA.
- We are like an **Organizer**, we organize interaction and facilitate group processes on platforms with all relevant CA actors.

An overview of the results is given in Table 6-1, showing that the expert, trainer and organizer were the most frequently mentioned roles. The roles of strategist and consultant were less important, although they were mentioned by some stakeholders.

Table 6-1 Stakeholders' perceived role vis-à-vis farmers in their CA related activities

		Strategist	Expert	Consultant	Trainer	Organizer
Kenya	**ACT-Network**		+		+	++
	Cetrad		++		+	
	Caritas	+			++	
	KENDAT		+		+	++
	ICRAF 1				+	++
	EAFF	++				+
	WorldRenew			++		+
	MoA nat		++			+
Madagascar	**FOFIFA nat**		++			+
	FOFIFA loc		++		+	
	CIRAD		++	+		
	GSDM	++	+	+	+	++
	FIFAMANOR				++	+
	SD-Mad		++	+		
	DRDR				++	+

'++' stands for the first choice and '+' for the second choice.

Instead of selecting one of the options, some respondents mentioned their own metaphors. In Kenya, the respondent from KENDAT who is involved in a CA mechanisation project argued: "We consider ourselves to be a catalyst, we catalyse. We are in between the farmer, the demand side, and the various actors that supply the technology, the supply side. We are in between, we catalyse, we fill up the gaps in information and technology" (KENDAT, personal communication, 31-07-2013). This role comes closest to the organizer. In Madagascar, a respondent at CIRAD argued that their role varies in time. During the projects they operate sometimes like consultants, otherwise more like trainers. But in general they were more like an observer and an analyst (CIRAD, personal communication, 27-02-2013). Most respondents also mentioned having several of the roles that are briefly discussed below.

The metaphor of the 'strategist' was perhaps the least clear option. The suggestion was made that the strategist is the major, almost all-deciding stakeholder, who operates in an instrumental way, in this case towards achieving the objective of an increased adoption of CA. The respondents who selected this option as their first choice, however, do not work directly with farmers and therefore they operate more at the 'strategic' level. Among stakeholders directly involved with farmers, other roles were more often selected.

The most popular first response was that actors see themselves as CA experts, who are trying to convince farmers of the benefits of CA to reach an increased acceptance and adoption of CA. In most cases, this is because the stakeholder is a research institute, or in the case of ACT-Network and GSDM because they are specialists in CA as an NGO. The latter explains: "we are experts and trainers, but not directly for the farmers but for the extension workers *[techniciens]*, and dissemination organisations *[opérateurs]*". Regarding the second part of the phrase about adoption, not all respondents agreed. "As a research institute, you could say we are an expert and we are making new knowledge. We put it in a "diffusional state", and we test the adoption at a small scale. But the actual diffusion is done by other stakeholders with whom we work closely together" (CIRAD, personal communication, 26-02-2014). So being an expert in CA, does not directly mean that one is trying to convince farmers of the benefits of CA.

The role of consultant is typically taken up in a situation of an active demand. As there is no serious active demand from the side of farmers for CA, this role is very limited among the interviewed stakeholders. GSDM mentions this role. As a national focal point for CA, they often operate as a consultant. Again, this is not regarding farmers, but regarding other organisations. At CIRAD the respondent said that only during specific research projects researchers in the field operate as consultants. At World-Renew this was seen as their primary role: "In the areas where we operate, we are approachable for farmers who have questions about CA or about other practices. And we respond as well as we can, so in that sense we are consultants. Overall, we have a facilitation role, so we link farmers with other stakeholders as well" (World-Renew, personal communication, 9-10-2013).

The last two roles of trainer and organizer were often selected by stakeholders who have extension staff who interact with farmers directly. They are roles that require some expertise, and as Table 6-1 shows, many respondents combined the role of expert with that of trainer or organizer. The role of trainer and consultant are similar in their focus on the client, but where the consultant should be an expert in many topics, a trainer is usually an expert in one topic. That is, the trainer is engaging in a process of learning with farmers *about CA*. In many cases, for example at CETRAD, the extension staff are often general agronomists, not specific CA experts.

As a network organisation, ACT-Network considers their role to be an organiser: "We want to create the right environment for farmers but also for the service providers to play a role. […] Our point is to show the options, show the benefits, show the merits of each option. And from this basket of options, as we call it, enable the farmer to choose what's best for himself" (ACT-Network, personal communication, 09-07-2013). A respondent at ICRAF argues "Yes, you have to organize, you can't just train farmers. All these [institutional] processes need organisation and this needs a process where mind-sets are matched with each other, people are learning from each other etc.” (ICRAF, personal communication, 06-09-2013). In the Lake Alaotra region in Madagascar, actors involved in the ABACO project consider their role towards farmers in the project to be organizer. “We have two communities with platforms where we try to facilitate the exchange of knowledge. That is why I choose this last option because that is what we try. They can make decisions and experiment, and we have seen that a rigid top-down approach is not very effective” (FOFIFA national, personal communication, 28-02-2014). In that perspective, being an organizer is to facilitate processes at field level where farmers and other stakeholders can reach a shared understanding and learn from each other about CA.

6.3 Stakeholders’ perceived legitimation

This section explores the perceived basis and legitimation for stakeholders to be involved in CA. Respondents were asked why their organisation is stimulating/facilitating CA, and in the interviews they were presented with five options to describe the reason for being involved in the promotion of CA. Similar to the roles discussed above, the different legitimation are adapted from Röling’s characterization of extension styles (Röling, 2009b):

- There is a **politically accepted decision** to promote CA as sustainable production system.
- We think there is a solid **scientific basis** that supports the versatile benefits of CA.
- We think there is an **active demand** for CA knowledge from the field.
- We think that **there is a need** for CA knowledge, (maybe without people knowing it).
- We **strongly believe** that CA is the best option for achieving improved (rural) livelihoods.

The last option was originally described by Röling as “ideology, hidden social problem”, but was rephrased to be a ‘strong belief’ that CA is the best option. This way of phrasing is linked to the debates between so-called CA believers and heretics (Giller et al., 2009). One of the central arguments of the ‘heretics’ side is to criticize the strong belief as a primary legitimation for the promotion of CA at the scale that it is currently being “pushed”. They argued that this does not follow logically from the scientific evidence, and thereby also implied that the scientific evidence is a more reliable basis for promoting particular agricultural practices. At the moment it is simply good to recognize the contrast between the 2nd and 5th option, which are not necessarily mutually exclusive, but can nevertheless give an indication of the underlying motivation of stakeholders. An overview of the results is given in Table 6-2, showing that the “strong belief” that CA is the best option for achieving improved food security and livelihoods for smallholder farmers was the most important reason together with the “hidden need” and “scientific basis”.

Table 6-2 Stakeholders' perceived legitimation for their 'promotion' of CA.

		Politically accepted decision	Scientific basis	Active demand	There is a hidden need	Strong belief
Kenya	ACT-Network				++	+
	CETRAD				+	++
	Caritas		+			++
	FEMO works ltd.		+			++
	KENDAT				++	++
	ICRAF 1			++	+	
	ICRAF 2		++		+	
	EAFF				+	++
	WorldRenew					++
	MoA nat					++
Madagascar	FOFIFA nat		++		+	
	FOFIFA loc		++		++	
	CIRAD		++			
	GSDM		++		+	+
	FIFAMANOR	+	++			
	SD-Mad			++		+

'++' stands for the first choice and '+' for the second choice.

6.3.1 Politically accepted decision

In neither country was a politically accepted decision a strong basis for stakeholders' involvement in CA. In Kenya, several actors recognized that the policy support for CA is growing, for example in the African Union and COMESA, and in the national government. However, this is seen as the result of a push for CA rather than the reason for it. In Madagascar, the political crisis of 2009 has led to a full stop in the agricultural policy development of which the country is only slowly and recently starting to recover.

6.3.2 A strong scientific basis

Regarding the importance of the scientific evidence as legitimation for CA promotion, the results show a difference between the countries. In Kenya, only three actors mentioned the scientific basis of CA, and then only as second choice. For five actors in Madagascar the scientific basis was the primary legitimation for promoting CA. In both countries actors were aware of the scientific debates about CA, but in Kenya this translated in more scepticism about the scientific foundations of CA. As one respondent in Kenya put it: "there is a scientific basis, but there are a lot of dissenting views" (KENDAT, personal communication, 31-07-2013). Or in the words of a respondent in Madagascar: "From the research we can conclude that CA works! But also, that it does not always work" (CIRAD, personal communication, 27-02-2014).

There are several possible explanations. In Kenya, several respondents mentioned that the way of thinking about CA has changed since the concept started gaining popularity, both for themselves and among other stakeholders. Initially, people and organisations that supported CA were very strict in keeping to the original definition in terms of the three principles. This was sometimes seen as more important than the actual situation of farmers. Over the years, as they recognized that how CA is implemented can differ greatly from one place to another, researchers and development practitioners started to relax on these strict definitions. In Madagascar, a similar process can be seen in terms of dissemination evolving from a strict interpretation of CA systems in the BV-Lac phase I, towards attempts at more adapted, participatory and targeted approaches in BV-Lac phase II. In terms of agronomic research on CA, however, the high agro-ecological variability in the landscape has been recognized from the beginning, which is reflected in the big diversity of proposed CA farm systems (Husson et al., 2013). Moreover, as the stakeholder analysis revealed, there is a strong presence of GOs and research institutes in Madagascar which favours the strong scientific basis. In Kenya the most important and most connected stakeholders were NGOs which often legitimize themselves through a hidden social problem, such as the lack of food security, and the strong belief that CA can contribute towards a solution.

In the interview with ACT-Network, the respondent argued that the scientific basis for promoting CA is certainly there, although there may be a mismatch between the scientific perspective and the common man's view. In Madagascar, a respondent at CIRAD (26-02-2016) also argued that "the time of research is not necessarily the time of adoption", which also implies that the legitimation for research is not necessarily the same legitimation for dissemination. The interviews with researchers in both countries indicated that they see CA as a potentially very important farming system for adaptation to climate change in the future, but they recognize that for now it may not always be the most urgent thing for many farmers. The diagnosis that is often made in scientific research papers of 'severe land degradation', 'important soil erosion' and 'variable climatic conditions' are apparently enough legitimation for research, but do not necessarily warrant successful dissemination to farmers who are only gradually ready to take the risk of changing a farming system and trying a new technology. This difference in time horizon between farmers and scientists is in part responsible for the unsuccessful dissemination of technologies that respond to severe, but future problems, while farmers are currently having smaller but actual problems. Regarding the urgency for change, there is also a difference between Kenya and Madagascar. In the Lac Alaotra region of Madagascar, farmers are generally able to generate a harvest for their family on the fertile *baiboho* lands, especially if they own a substantial enough area of (partly) irrigated rice fields. In Laikipia (Kenya) however, crop failures due to drought are regular, and already highlight an urgency and immediate necessity to change farming practices.

In both countries, stakeholders *make use* of scientific research findings, even if it is not part of how they legitimize their involvement in CA. It appears that in Kenya, scientific research, including agronomy, is mobilized to address the *how* and not necessarily the *why* of CA. a respondent at ICRAF argued about the CAWT initiative: “we think that this is what farmers need, and theoretically CAWT sounds really good. But we have to develop a scientific basis for it” (ICRAF, personal communication, 23-08-2013). This shows that a scientific base is not necessarily the determining factor in innovation; setting a new strategy is about more than following logical scientific imperatives or responding to an active demand. In practice, the expert-identified hidden need precedes an active demand from smallholder farmers, and a conviction or belief can precede the development of a scientific basis for the *how.* Such an approach where development practice and agronomic research go hand in hand, is also shown by ACT-Network: “We do need research to find out how we can best upscale CA” (ACT-Network, personal communication, 09-07-2013).

6.3.3 Active demand for CA from farmers

In the interviews, respondents were generally quick to discard the third option that was presented to them: that the reason why they support CA is active demand from the side of the farmers. Although respondents hesitate about the other options, they generally observe that there is no active demand for CA in either country. The most logical reason is that CA is new to most farmers, and how can one show a demand for something one does not know? Indeed, “*Il faut promovoir d’abord* (you have to promote it first)” was the comment from FIFAMANOR (personal communication, 18-12-2013). Once farmers are familiar with it the active demand can be recognized. In an interview with ICRAF, the respondent said: “This demand was not there before, but once they have introduced [CA], the demand is created” (ICRAF, personal communication, 06-09-2013). So in this perspective, it starts with farmers having a need without even knowing, that changes into an active demand once they have been introduced to the technology. But in terms of legitimating the stakeholders’ engagement in CA, the active demand is not important. This poses a challenge to ‘CA promoting’ stakeholders who are aiming to operate through participatory processes, as their level in terms of knowledge and thinking is different from that of the farmers. In such a situation, managing a participatory process towards CA adoption is very difficult if possible at all.

6.3.4 There is a hidden need for CA

One of the three key types of legitimation is the hidden need for CA, even if farmers do not yet manifest an active demand for it. The stakeholders who selected this option were clearly concerned with the interest of the farmers. At the same time, the assessment of the hidden need for CA is expert-based and the farmers themselves do not (yet) express this. This implies the risk of paternalistic approaches for stakeholders who use this legitimation, as they claim to see something that the farmer does not see. The examples below, however, indicate that this assessment of farmers' needs does often indirectly take into account the farmers' problems and priorities.

The realisation that there is a need for CA integrates personal experience and research: "We have done a baseline study with a lot of farmers, and we can see that sustainable agriculture management practices can be a solution to the problems identified by farmers, including productivity etc., in a sustainable way" (EAFF, personal communication, 12-07-2013). Or: "The demand for CA is not there yet. But we think there is need to change the way farming is done in Africa. Because for the last 40 years our cereal yields have remained at 1 ton/ha. We don't think the external inputs will help. We don't think the mechanisation will help. So we think we must change the way farming is done in Africa. And CA is one of the most promising options" (ACT-Network, personal communication, 09-07-2013). The CA manufacturing stakeholder FEMO works ltd., member of the NCATF in Kenya has travelled to Brazil several times, and has seen how CA can work successfully. His company has manufactured several types of CA equipment, and the respondent explains: "Farmers don't ask it [CA technology], but we know farmers need it. I know farmers need the jab planter, but there is the gap between disseminating that information to the farmer, and the farmer accepting that. That is where the government and other stakeholders come in, the education part of it".

In Madagascar, seed producer SD-Mad highlights that during the BV-Lac project there was an active demand: "Farmers were enthusiastic during the project, partly because there were beneficial arrangements for farmers in terms of support. For widespread demand and adoption, there is a need for supporting institutions like during the project" (SD-Mad, personal communication, 18-02-2014).

6.3.5 Strong belief

The final legitimation for engaging in the promotion of CA was a strong belief that CA is the best option for achieving improved (rural) livelihoods. This option was mainly popular among the stakeholders in Kenya and less so in Madagascar. As explained earlier, this strong belief does not necessarily exclude the possibility that this is to a certain extend based on scientific evidence. Nor does it mean that CA is considered to be the only viable solution for farmers. Indeed, several stakeholders that selected this option explicitly added that there may be other technologies that are also very important. In Madagascar, this was emphasized by GSDM: "I add that we do not think that CA is the only solution to realise an improved agricultural production, but it is an important option. We support agro-ecology and within those principles, CA is one solution. Another is agroforestry, integrated pest management, and good agricultural practices" (GSDM, personal communication, nd).

The respondent from FIFAMANOR did not select the last option, "[…] because there is also other factors. In our region the milk is very important economically, together with potatoes. Also irrigated rice is very important. So CA is not very important. But in those areas where soils are degrading, it is a good option. There you have to find a balance between the different technical options (FIFAMANOR, personal communication, 18-12-2013).

The discussion between CA 'believers' and 'heretics' (Giller et al., 2009), the critique on the mix of religion and farming in Farming God's way, and the attention for the political economy of CA (Andersson and Giller, 2012) have made the so-called neutral and pragmatic approach the norm, and people with strong convictions about farming are disputed. In academic literature, more authors seems to have assumed a more sceptical position regarding CA in Africa, which is also reflected in the answer from researchers in this study. As a researcher at ICRAF explains "I don't want to say 'we strongly believe' because I'm not working with beliefs, I'm working with the realities out there" (ICRAF, personal communication, 06-09-2013). Among NGOs, however, it is still very common to refer to a strong belief. NGOs are often, and almost by definition, legitimated by a hidden social problem and the basis of their programmes is therefore based on a strong conviction that their activities are contributing to solving these problems.

In most instances, respondents illustrate their belief that CA is a very promising technology by narrating a story of an exceptional yield increase that they heard of under CA. At the national MoA in Kenya the respondent explained: "For me, personally, I feel the last one [strongly belief that CA is the best option]. Because, for example our colleague here, before he was introducing CA in his farm he was getting like seven bags of maize, 90 KG bags of maize, but when he started just by subsoiling, that is breaking the hard pan, he was able to improve the yield from 7 to 27 bags. So that one in terms of food security, that one is almost 4 times [She laughs]. By doing that, he was not even fully into CA, he just broke the hard pan, and this is now the second year that he is doing minimum tillage. So we strongly believe that it will be the best option to achieve food security" (MoA national, personal communication, 10-07-2013).

Also at the local level a respondent uses a personal experience to illustrate why he is convinced that CA works: "We strongly believe that CA is the best option in arid and semi-arid lands. We can see that CA in dry areas is doing much better compared to conventional. I know a farmer who planted five acres with a tractor and harvested only 1.5 bags of maize. Then he tried planting one acre with a sub-soiler and he harvested 4 bags of maize! Can you imagine! […] In wetter areas where there is enough rainfall, CA is not the biggest priority" (CETRAD, personal communication, 29-07-2013). Another element in that answer is that CA works well in dry areas, but performs comparatively less in areas with more rainfall. The respondent from KENDAT argues the same: "I believe that CA is the best option, especially in dry areas where moisture management is an issue and soils are so degraded that they cannot virtually produce anything without external inputs. So I believe that CA is the way to go, strongly".

For the private sector stakeholders, the judgement whether CA presents a realistic business opportunity is the central question, which requires a 'leap of faith' to invest even before it becomes commercially interesting: "I know that farmers need the jab planter […] That is where the drive is. At the end of the day there will be a market […]. But right now, the demand is not yet there" (FEMO-works ltd., personal communication, 11-07-2013).

6.4 Narratives and framing of CA

In their pathways approach to political agronomy, Sumberg and Thompson (2012) argue that specific framings and narratives are used by different actors to promote favoured responses. Framing refers to "the process of selecting, emphasizing, and organizing aspects of complex issues, according to overriding evaluative or analytical criterion" (Daviter, 2007). This is an important aspect of the political economy of CA, as framing determines how much attention a problem receives and even implies the approach taken to address it, and thus "prefigures the eventual solution(s)" (Sumberg, Thompson and Woodhouse, 2013). Some 'frames' become dominant, referred to as the motorways that channel most of the agricultural research, and some of them are side routes. Whitfield et al. (2015) distinguish five common narratives for framing the role of Conservation Agriculture in Zambian agriculture:

1. Land Degradation → Soil and Water Conservation → CA
2. Food Insecurity → Increased Food Production → CA
3. Rising Input Costs → Reducing Input Dependency → CA
4. Emissions from Agriculture and Deforestation → Climate Change Mitigation → CA
5. Social Marginalisation → Empowerment → CA

The following section presents narratives that frame CA in different ways. Based on the data collected in this study in Madagascar and Kenya, narratives one and two from Whitfield et al. (2015) are further explored. In addition, CA as climate smart farming and adaptation to climate change is considered, which is linked to -but different from- narrative four from Whitfield et al. that focusses more on emissions and climate change mitigation. Another narrative frames CA as good agricultural practice, and finally an observation is made that CA is sometimes seen as conflicting with organic farming principles. These are not necessarily mutually exclusive ways of framing, and sometimes the distinctions appear at different levels. Nevertheless this section aims to give insight in the variation in speaking about the importance of CA in the innovation system in Kenya and Madagascar.

6.4.1 CA as Soil and Water Conservation

Among several stakeholders, CA was seen as a way of practicing Soil and Water Conservation (SWC). In the policy document of CAADP of the African Union, which is part of NEPAD, CA is considered as part of pillar one, which relates to soil and water management, including SWC. At the national Ministry of Agriculture in Kenya, CA falls under the responsibility of the Land Degradation office which in turn is part of the Soil and Water Management division. This division is also responsible for other areas such as agroforestry and rainwater harvesting and is part of the engineering services directory. One of the consequences of this particular structure is that CA is also framed as a SWC measure.

At CETRAD, CA is also being approached from the angle of SWC. In the interview with the respondent he discussed how similar research in the history of CETRAD has been continually rebranded, first as Conservation Tillage, later as Natural Resources Management, then Soil and Water Conservation, and currently as CA. The actual research interest has stayed the same and consists of measuring the influence of minimum tillage, mulch and crops on basic parameters at the field level, such as the runoff, soil moisture and evaporation.

6.4.2 CA for Improved production and livelihoods

Andersson and D'Souza (2013) argue that after CA was being tested as soil and water conservation measure, the large-scale promotion of CA followed a reframing of CA as a production-enhancing set of practices. This narrative surfaced frequently in the interviews held in Kenya. "Livelihoods are changing. The key was that farmers were not harvesting. You put in your labour, you put in your resources, but in the end of the season you don't get the harvest. So what we first wanted is to help farmers get a yield with CA" (CETRAD, personal communication, 29-07-2013). When talking about possible ways of increasing yields, the respondent at ACT argues: "The fertilizers can help. But they are not enough. Irrigation can help, but we cannot irrigate the whole of Africa. […] Mechanisation can help, but it is not in the mechanisation per se, it is what mechanisation, how do you use the equipment. CA is a cheap option to increase the yields to above the one ton/ha that we have seen for the last decades".

Within the food security narrative around CA, very little reference is made to research that links the presumed relationship between CA and productivity to broader concepts of food security, such as food availability, entitlements, health and nutrition. There is also a lack of understanding about the social, economic, cultural and political drivers of food insecurity at local and national levels (Misselhorn, 2005 and Dorosh et al., 2009).

6.4.3 CA as Climate Smart farming

Especially among policy stakeholders, the importance of CA is highlighted with reference to the current and expected impacts of climate change. Because Conservation Agriculture can conserve moisture in the soil, it is often seen as an important way to make African smallholder agriculture more resilient against erratic rainfall. This is a form of adaptation to climate change, and is sometimes referred to as 'resilient farming' or 'climate-smart agriculture'. For example, the title of the First Conservation Agriculture conference held in Zambia in 2014, was "Conservation Agriculture: Building entrepreneurship and resilient farming systems". At the same conference, the COMESA Secretary General Sindiso Ngwenya said in his speech that "COMESA Ministers of Agriculture, Environment and Natural Resources have identified Conservation Agriculture as a major Climate Smart Agriculture (CSA) practice as it is resilient to Climate Change"[46]. At the national MoA in Kenya CA trainings among farmers are also done in the context of the 'Climate Change Mitigation and Adaptation plan, as it can contribute to "creating climate resilient farms" (Nat MoA, personal communication, 10-07-2013).

Climate-smart farming sometimes also includes mitigation of climate change through reducing net greenhouse gas emissions from agriculture (e.g. Hobbs and Govaerts, 2010; Lal, 2015). A recurring discussion is the possibility of carbon sequestration through an increased above and belowground organic matter content in CA compared to conventional farming systems (e.g. Powlson et al., 2016). During the interviews, however, the mitigation aspect of climate smart farming did not emerge as an important issue for any of the stakeholders. Moreover, climate change mitigation should not be seen as a task for or a priority of the resource-poor farmers, except when they are payed for in the international carbon market to address high level policy objectives.

6.4.4 CA as good agricultural practice

In several instances CA is included in a stakeholders programme under the header of 'good agricultural practice', alongside practices that are equally important. An example is Caritas International, who have included CA in their agricultural development and food security programmes in Laikipia East: "We think along the lines of Low External Input Sustainable Agriculture (LEISA), which includes concepts like water conservation, crop rotations, agronomy of drought escaping crop varieties, fast-maturing crops, pest-resistant crops and of course CA" (Caritas, personal communication, 03-09-2013). The respondent at CETRAD argued that CA is about the way farming is done, and was as such being promoted alongside other good management

[46] http://www.comesa.int/index.php?option=com_content&view=article&id=1084:african-congress-on-conservation-agriculture&catid=5:latest-news&Itemid=41

practices in their CA programme, including the safe use of chemicals, manure management, record keeping and crop protection. Indeed, training farmers in such other practices, can be seen as capacity building that supports the adoption of CA. “With this aspect of the project [training in record keeping], we were enabling farmers to make a decision, either to change to CA or not to do so” (CETRAD, 29-07-2013).

There is also a tendency among the respondents, and equally in scientific literature, to acknowledge the importance of other practices within the framework of the three principles. In this perspective, CA is not seen as a competing concept, but rather as one that can be integrated with other practices. An important example is CA With Trees CAWT and the concept of Evergreen Agriculture, which both include agroforestry in the definition of CA. Others argue to include CA with Integrated Pest Management, or to include soil fertility management as the ‘fourth principle of CA’ (Vanlauwe et al., 2014). The respondent at World Renew argued that for the adoption of CA it is also important that farmers see tangible benefits, and this is where other practices may be of more direct benefit. This is why they are investigating CAWT as it offers the possibility to include nitrogen fixing with potentially medicinal value from trees, together with mulch, fodder, timber and firewood. The combination could convince people more than ‘pure’ CA.

In an interview with the ACT-Network, the respondent emphasized how CA is a way of sustaining the benefits that other practices can bring to the farming systems. As examples, he mentioned how the use of mechanisation, the inclusion of trees, the inclusion of livestock in mixed crop-livestock systems, the use of improved seeds and the use of fertilizer are not sustainable in themselves in the long run. “If they [the mentioned practices] are not done in the context of the three principles, those benefits cannot be sustained. Those benefits cannot be optimized, and that‘s the message” (ACT-Network, personal communication, 09-07-2013). Moreover, these techniques could speed up and increase the benefits of CA, for example an increased production of biomass through inorganic fertilizer which supports the realization of organic cover.

6.4.5 CA as conflicting with Organic Farming principles

The poor food security situation in Laikipia County in Kenya has prompted many development initiatives, some of which have conflicting interests. In most cases they cover different geographical areas or different subject areas, but on some occasions they overlap in place and time. One such example is a disagreement between proponents of CA and proponents of organic farming in Kenya. The contention comes from the suggested use of herbicides for weed control in the initial year of adopting CA, while organic farming aims at farming without phytosanitary inputs.

At the local level in Laikipia, an extension officer narrates that a former extension officer at the MoA got the opportunity to go to the UK for an internship about organic farming. Upon his return, he started working for an NGO who supports organic farming (MoA, personal communication, 27-08-2013). At the national level, the respondent at ACT-Network gave a similar example: "We went to a community to talk about the use of herbicides in CA. The next day they [promotors of organic farming] came to the very same group that we talked to and started contradicting us by telling them you should not use any herbicides at all. Now, we at ACT are not *for* herbicides. I mean, our eventual goal is not to promote herbicides. Our goal is if possible to do away with the herbicides also, but sometimes you need herbicides as an entry point, and sometimes it can simply do a tremendous job" (ACT-Network, personal communication, 09-07-2013).

The organic farming movement is also relatively well organized in Kenya. In 2005, the journal The Organic Farmer (TOF) was launched and well received among farmers in Kenya. It celebrated its 100th edition in September 2013, and with a print run of 32,000 copies and with an estimated number of 7-9 readers per copy they are reaching up to 240,000 readers, while the site biovision-infonet[47] is visited by over 900 people each day (TOF, 2013). Since 2007 they broadcast agricultural advice on the radio, and since 2009 they have TOF field information officers.

6.5 Perceived theories of change

This section explores some of the stakeholders' theories of change' (ToCs), or 'pathways of innovation', as identified in the interviews with CA professionals, including farmers. How do stakeholders think that project and policy efforts ultimately translate in increased diffusion of CA? What processes at local and national level are facilitating the uptake of CA by farmers? A variety of narratives and theories of change were identify. They do not necessarily represent alternatives to one another, but show how different perspectives on the diffusion of technologies and change exist and sometimes coexist.

6.5.1 The business approach to CA

In this theory of change, innovation in smallholder farming including successful diffusion of CA, is expected to come from including farmers in the value chain, encouraging service provision and connecting farmers to markets and approach farming as a business. In this perspective, the private sector plays a regulating role between supply and demand of inputs and outputs, which can include knowledge. The private sector is seen as crucial for providing inputs like herbicides and improved seeds and mechanisation implements like weed scrappers, rippers and direct planters. Regarding outputs, the business ToC suggests that if markets are developed for the cover crops, diffusion of CA could take off. At GSDM and FOFIFA national, respondents observed that the lack of markets for cover crop produce is a serious constraint to adoption of CA by farmers.

[47] http://www.infonet-biovision.org/

This ToC goes beyond the recognition that the private sector has a role to play, and that functioning markets are an important aspect of the institutional environment that could be supportive for CA and agricultural development. It suggests that business is the most important avenue to upscale diffusion of CA. From this perspective, knowledge is seen as a product that is sold, not only to the farmer but also to other stakeholders such as donors. The respondent at ACT-Network in Kenya argues: "The product we sell is knowledge. Knowledge to influence politics. Knowledge to influence farmers". He adds that it is not easy to sell knowledge as such, because some of the donors and development partners ask for impact, and "the link between knowledge and impact can be elusive" (ACT-Network, personal communication, 09-07-2013). He also argues for the private sector to step in the arena to provide services on CA related aspects "in a business manner".

At KENDAT, the respondent explains how they "try to see farmers as entrepreneurs as opposed to just doing farming for the sake of subsistence. In fact, currently we have just started a project where we are going to set up new business centres that rent out equipment for access to CA technology. It is going to be purely business. It has to be a commerciality viable enterprise between the private sector, government, farmers and banks for access to credit" (KENDAT, personal communication, 31-07-2013). At CETRAD the respondent gives the example of a service provider who is very active compared to others with similar equipment. He is very "aggressive" in doing business, which means that he covers great geographical distances and works very hard to make money. "There is this mentality. There have been several projects, with millions of dollars, so many equipment has been given at subsidized costs, and yet so few people adopt. What can you say? More time is needed, more people across the whole spectrum who are convinced. We have to look for people who want to make money. Not to change farmers, but to make money! There are people who have seen the business that CA can bring." (CETRAD, personal communication, 29-07-2013). The firm inclusion of the private sector, or indeed the central position of the private sector as entry point, is meant to make the diffusion of CA not only more effective, but also less dependent on projects and external funding and therefore more sustainable.

6.5.2 Facilitate interaction

The facilitation of interaction functions as a ToC in the sense that some stakeholders consider it key to the upscaling of CA, at one or all geographical levels (regional, national and local). The FAO is supporting the interaction of stakeholders at the regional level through the RCAWG and at the national level through NCATF meetings in both countries, with the idea that increased interaction will be beneficial for the joint influencing of policy and for sharing of knowledge and experiences from the various CA initiatives.

In the strategic plan of ACT-Network, there is a new focus on what they call Communities of Practice (CoP). This is still a concept that has to crystallise in practice, but the idea is that membership of these CoPs is fluid, and organized along local themes where stakeholders have common interests. ACT-Network: “Some stakeholders will have an interest to form a community of practice of disseminators of CA with the aim of influencing policy making. Or the government may decide to start supporting the CA farmers on the Tana river catchment. Because if they are adopting CA on that river catchment, the water going into the hydropower dams will have less silt. That is a common interest. I think that policy will be helped to make CA reach not only the farmers but also the community” (ACT-Network, personal communication, 09-07-2013.

In the project approach of the ABACO project there is also explicit attention for co-innovation and Innovation Platforms at the local level. Similar to the business approach ToC, there is a dual motivation: such co-Innovation Platforms are seen as both more effective and more sustainable (Tittonell et al., 2012). It is more effective because farmers can ideally communicate directly with private sector stakeholders, which should result in the development of innovations that fit with the local demand. It is more sustainable because all stakeholders have an interest to participate in the platform and can therefore guide and sustain themselves. As the respondent at ACT-Network puts it: “That’s the hypothetical setting: If these women farmers in their cooperative can express their concern that the existing equipment is not suitable for girls or for women farmers, that should trickle back to us through the platform, to engage the manufacturer” (ACT-Network, personal communication, 09-07-2013).

Farmer Field Schools can also be perceived as platforms of some kind; vehicles for sharing ideas between farmers, researchers and extension workers. In Kenya a district level network of FFSs has been formed where their members can share ideas and experiences, including CA. KENDAT has also worked with community parliaments, which are bringing actors together and linking them with each other. This ToC is relatively new, and is linked to AIS thinking which is gaining popularity among stakeholders involved in CA. The difficulty of this ToC is that the stakeholders need to be organized (although they should ideally organize themselves), which requires continuous investment in human resources without knowing what will ultimately be gained.

6.5.3 Perfecting the fit: targeting and tailoring innovations

The observation that CA systems do not always fit with local farmers’ circumstance (Giller et al., 2009, 2011) can lead to the logical position of the ToC that aims at improving the fit between technological options and the situation of smallholder farmers at the local level. The objective is in a way similar to the ‘facilitating interaction’ ToC: including a variety of knowledge sources and perspectives in order to be able to connect to the farmer. However, the tailoring approach is more expert based compared to the interaction approach and relies on the inclusion of more diverse expert knowledge. In Madagascar, a respondent at CIRAD mentioned that there is a need for more social expertise in the design of farming systems. A concrete proposal has been put forward by the

Malagasy sociologist Guy Belloncle, who pleads for the development of what he calls *Ingenierie social*. This would be achieved by educating future agricultural professionals with a wider variety of courses that include anthropology, sociology, geography, law, education and management. This 'social agricultural engineer' would be used in agricultural projects to do a 'sociological feasibility study', he would be a negotiator, an 'institution building specialist', and a specialist in participatory evaluation (Belloncle, 2003). Belloncle correctly identifies several underrepresented themes in agricultural development in the country, but it is questionable whether this is best addressed by a better educated 'social agricultural engineer' alone.

6.5.4 Fundamentally constrained, farmer by farmer promotion

The enterprise of supporting and promoting agricultural innovation among smallholder farmers can also be framed as being fundamentally constrained. This ToC emphasizes the fact that smallholder farmers operate under many constraints and that change is therefore always difficult. The capacity of the smallholder farmers is often limited in terms of means for investment. Due to limited education there are varying levels of skills like bookkeeping and planning to make effective use of the available opportunities. In this approach, risk is an important word, because subsistence farmers need to eat, before anything else, and are therefore less inclined to take the risks that are associated with innovations like CA. There is also a category of farmers for whom changing to CA would require more inputs which they simply do not have, e.g. the capital needed for investments in labour for land preparation (instead of using own equipment for ploughing), herbicides (instead of using family labour) and improved seeds (instead of finding seeds locally with friends), may simply not be available for small family farms. Adoption will therefore be more likely on the larger farms that can make such investments, and lack behind on small farms (personal communication with FOFIFA national, 28-02-2014; Andri-Ko, 21-02-2014; and GSDM, 13-12-2013).

At KENDAT the respondent also argued that "The driver for the medium-scale and large-scale farmer is on the reducing inputs, because they can see the money immediately. If they have 7 or 10 hectares on which they are spending 60 litres of fuel per hectare to plough, they save a lot simply by not ploughing. That makes immediate sense. It is not the same for the small holder farmer who is only using his or her labour to do that tillage or traction. But the economics is there." (KENDAT, personal communication, 31-07-2013). Other interviews, however, highlight the examples of some small-holders who are successful in adopting CA, despite these challenges.

Another element that affects the impact of the promotion of new technologies at the landscape level is that farmers only have small farm areas. The respondent at GSDM illustrates this for Madagascar: "The average farm size is between 1.5 and 3 hectares. In the beginning, farmers do approximately 10% of their land with CA, and in the end they do maybe 50%, which is a high estimate. And even then, you have half of the surface on CA! Here in Madagascar we have approximately 10,000 farmers, who together do 5,000 ha. That means 10,000 centres of decision making!" (GSDM, personal communication, 13-12-2013). Each of those farmers has to be convinced, start experimenting on the farm, and slowly increase the surface under CA. Therefore it can be said that the diffusion of new agricultural practices is structurally limited.

6.5.5 Changing the mind-set and mentality

The ToC that focuses on the mind-set can be heard among policy makers, international NGOs and farmers alike. The observation that there is a need for a change of mind-set is primarily associated with the farmers' hesitation to try minimum tillage techniques. For many farmers it is difficult to imagine productive farming without ploughing, it is argued, and they need to change their mind-set. Below, two important aspects of the focus on the mentality regarding the diffusion of new practices are discussed.

If farmers are convinced, they will invest

The accounts of several stakeholders in the Lake Alaotra area suggest that if farmers are convinced of the benefits of a new practice they will find a way to implement it. At FOFIFA national and Andri-Ko, respondents give the example of technological innovations that have happened without a strong 'push' from policy or projects. The *motoculteur*, or *Kubota* is a two-wheel tractor that is widely used in the Alaotra region for transport and farm operation. Respondents narrate how these tractors first appeared in the 1960's and were of Japanese manufacture and rather expensive. When a cheaper Chinese version became available, people bought the *motoculteur* in big numbers. This happened in a time of political and economic crisis in Madagascar, and illustrates how a farmer who is convinced will find a way to make an investment[48]. A second example is the rice hybrids, mentioned by the respondents at FOFIFA local, CIRAD and Andri-Ko. There are several rice varieties that are very expensive compared to using one's own seeds, but give good harvests. These hybrid varieties have existed for almost thirty years, but are currently becoming generally accepted. Despite being expensive, they are very much in demand. This gives some counterweight to the often heard argument that CA is not an option for many farmers because it requires high investments. The respondent at Andri-Ko concludes: "What we can learn from these examples is that if people are really convinced, and if there is opportunity, they will find a way" (Andri-Ko, personal communication, 21-02-2014). In a similar vein he argues that the agricultural advice centre CSA is not necessary for CA to link farmers to the right inputs, because farmers will be able to find it once they are convinced.

[48] This popular account of the success of the *Kubota* two-wheel tractor is not necessarily historically correct. An investigation into the factors that contributed to the widespread adoption of the *Kubota*'s in the Lake Alaotra area point towards the interplay of many factors, including support from the government, increasing prices of cattle due to theft, etc. (Rakotoarimanana et al., 2009)

From 'backward' to 'innovative'

In almost all the interviews the mind-set of farmers was discussed. This often came down to the observation that humans in general do not like change, and smallholder farmers in particular prefer to stick to the techniques that they know to work well. At FOFIFA national, the respondent argues: "CA is perhaps an agriculture of the future. But the problem is with the mentality of the people, because I see that the Malagasy farmers are very much attached to traditional agriculture, so we have to wait longer and be patient to convince them to adopt the technique. It is really necessary that they see somebody who succeeds with that system to try to adopt it". When asked what kind of attitude it is that we need more, she explained: "A mentality leaning towards innovation (*incliné a l'innovation*), and new techniques. But one can only reasonably expect farmers to be appreciative of innovations that are profitable for the farmer, and that they fully understand all aspects of the technology, because they are the ones who depend on it for their food and livelihood of the family, they simply cannot afford to produce nothing" (FOFIFA national, personal communication 29-02-2014).

This ToC is also often mentioned by farmers, who feel that they and other smallholder farmers miss out on a lot of things due to their traditional attitude. In a conversation with a dedicated CA farmer who is well known and respected in his area in Laikipia, Kenya, he reflects on the importance of the mind-set: "I call my neighbours 'let us see', because they sit on the fence, and they look first what will happen at other places. I am the risk-taker, and I call the others 'let us see'". Closer to home he also observes the power of mentalities: "At this moment as we are having this conversation, my step-mother is ploughing on her land. I really do not understand why, because as anyone can easily observe, my crops are higher and the quality of the maize cobs is much better. Still, she is ploughing. She is refusing to change her way of thinking" (farmer in Muramati, personal communication, 22-08-2013). Or in the words of a farmer in Kalalu, Laikipia Kenya: "The neighbours will not easily change. Most people stick with their opinion that planting with CA is not good. Anything contrary to the tradition is not done by them, and that is why this area is staying behind" (personal communication 14-08-2013).

6.5.6 Systems change and growing promotion 'push'

Another ToC emphasises the need for change of the innovation system as a whole. At CETRAD, KENDAT and ACT-Network, respondents mentioned the importance of key persons in the innovation system to start supporting CA to be scaled up successfully. In Kenya, this is the permanent secretary for agriculture. The general opinion is that they rely heavily on mechanisation and fertilizer support, but are not supporting CA. In Madagascar, the lack of political support was also mentioned. At GSDM the respondent argued that although there is a representative from the national MoA in the NCATF, the real 'deciders' have not yet manifested an interest in CA. Another element is that CA does not currently feature in the curriculum of extension officers. It is therefore possible that an extension officer suggests farmers to try CA, while another who is not familiar with CA is very sceptical and communicates the exact opposite. Besides the immediate effect that the farmer is less likely to try CA, the greater effect is that this fosters a sceptical attitude among farmers towards so-called agricultural experts. The inclusion of CA in the curriculum will change the ideas and language that farmers are exposed to.

At ACT-Network the respondent argues: “Ideally we want change at every level. […] The researchers who study CA, the teachers at university, the manufacturers who design CA implements, etc.” (ACT-Network, personal communication, 09-07-2013). He also argues that there is a need for more political and financial ‘push’: “Compared to fertilizer, which is promoted with billboards, radio adverts, heavy subsidies and president speeches, CA is by no means near to that level of promotion. And even with that promotion, fertilizers have not helped to raise yields to other areas. Also looking at the success of CA in Brazil, you have to conclude that it is partly due to investment by the World Bank and other institutes that it has been able to spread” (ACT-Network, personal communication, 09-07-2013).

6.5.7 Spontaneous diffusion of CA

The ToC assuming spontaneous diffusion from farmer to farmer was encountered in almost every interview. It is part of a modernization narrative in which farmers are assumed to progress and intensify their production. This ToC legitimises the popular extension approach of working with model farmers: “When there is a crop failure and the farmer doing CA has done well while the neighbour’s harvest has failed, then the next season the neighbours will definitely be enquiring on this new aspect. So there is a trickledown effect from the model farmers” (ACT-Network, personal communication, 09-07-2013). A precondition for such spontaneous diffusion is that the difference between CA and conventional farms is clearly visible in terms of crop health and yields, and not only evident in the economic aspects of the farm management.

Farmers in Kenya mention a spill-over effect from the project due to farmers’ interaction with their neighbours: “I am not a member of the FFS, but my neighbour is and he has advised me on how to do CA. I started since last season and I belief I will continue with it. I also told my other neighbours and they are starting to use CA as well!”. The truth of such statements is difficult to assess, as farmers may exaggerate their efforts a bit when they perceive that the interviewer is interested in a particular topic. However, several farms were visited in Kenya where indeed non-FFS farmers were practicing CA by copying what members were doing. An extension officer at the local MoA in Laikipa argues: “Farmers are doing their own research, and sometimes they try CA as well. I estimate the number of farmers that do spontaneous adoption at about 5-10%. It is because

CA is not new here, but was already introduced a long time ago, so most people have heard of it" (Extension officer, personal communication, 27-08-2013).

Trickle down from large-scale to small-scale farmers

One particular version of this ToC was observed in Madagascar. The seed producing company Andri-Ko argued that proof of concept for CA has to be given at large-scale farms: "The dissemination *[vulgarisation]* has never really worked in this area, you don't have to be a genius to figure that out. What I think and believe is that we have to give the example on a big scale. People will observe it, see the management, the input the output, the work necessary, and then they will copy it. It is important that people become convinced themselves rather than being told in a project. If they have seen it on demo plots on the roadside, and they didn't ask for help and nobody has come to convince them, that proves it works" (Andri-Ko, personal communication, 21-02-2014). Also in Kenya, respondents at KENDAT and ACT-Network argued that the benefits of CA may be most clearly seen on medium-scale and large-scale farms, and may be a proof of concept of CA for the smallholders, although it can also be argued that the economics at farm level are difficult to compare between smallholders and medium- and large-scale farmers.

6.6 Summary and discussion

In this chapter, variation in stakeholders' views on the promotion of CA were further explored on the basis of the semi-structured questionnaires which included questions about the perceived roles and legitimation for engaging in CA related activities. Furthermore, different ways of framing CA and perspectives on theories of change were identified.

Regarding stakeholders' perceived role in the innovation system, results show that the roles of consultant and strategist, associated with 'identifying determinants', 'designing projects to increase CA adoption' and 'removing constraints for farmers', were not important in either country. In Kenya, most respondent saw their role as being an organizer followed by being a trainer. These roles are associated with a 'focus on the client', a 'process of learning with farmers', 'organizing interaction and facilitating group processes'. In Madagascar, the role most selected was that of expert, which was associated with 'convincing farmers of the benefits of CA' and 'increasing the acceptance of CA'. This is in line with the results from the social network analysis which showed that the dominant stakeholder type in the innovation system in Madagascar was research, while in Kenya it was project implementation.

Regarding the legitimation for being involved in CA activities such as research, dissemination and training, the results show that neither a 'politically accepted decision' nor an 'active demand from farmers' were important factors. The findings in the previous chapter already showed that the political momentum and policy formation at regional and national government level is rather a result than a driving force of the 'push' for CA. The lack of an active demand from farmers for CA was explained by the interviewed stakeholders by the fact that CA is new; one cannot express a demand for something unknown. Indeed, the most important legitimation in both countries was that there is a need for CA, even though this is not manifested yet by an active demand. The identification of a hidden need, therefore leans more on an expert-based assessment of farmers' needs and the priorities of agricultural innovation. This finding is consistent with the perceived roles because the role of strategist is associated with the legitimation through a politically accepted decision, and the role of consultant is associated with the legitimation of an active demand. Both roles and legitimations were not generally selected by respondents. The question remains how CA or other technologies can be 'needed' without being 'demanded'. This is related to farmers' versus experts' identification of agricultural development priorities. This is further discussed in section 8.4

The dominant legitimations differed between the two countries. In Kenya, the strongest legitimation was the strong belief and conviction that CA was the best option for livelihoods of small-scale farmers. The strong belief was in some cases combined with the legitimation based on a strong scientific evidence (Table 6-2), but especially where the strong belief is combined with the legitimation based on an identified hidden need, this supports the observation of an epistemic community that 'pushes' for CA (Andersson and Giller, 2012). These actors do make use of scientific evidence regarding *how* to support CA, but do not necessarily base their involvement with CA, the *why*, on a scientific basis. The respondents in Kenya almost invariably illustrated their strong conviction of the potential of CA with testimonies of farmers who were able to double or triple their yields while minimizing labour. In Madagascar, however, a different pattern was visible. Consistent with the dominance of research organisations, the strong scientific basis was the main legitimation for stakeholders to be involved in CA. This was followed by the identification of a hidden need which, based on the respondents' explanation, is mainly related to expected climate change, i.e. increasing rainfall variability.

This chapter also described how stakeholders frame CA. Especially among policy stakeholders, CA is considered as a Soil and Water Conservation technology. Indeed, the word 'conservation' in CA refers to the improved water availability in the soil, mainly due to the permanent soil cover. More dominant, however, was the narrative of CA as a production-enhancing technology, positively influencing livelihoods and food security. CA is also seen as a climate-smart option, referring to the advantage of CA over conventional farming systems in situations of drought (Hobbs and Govaerts, 2010). Another narrative framed CA as good agricultural practice. Respondents argued that CA leaves many options for specific systems and is more about how agriculture is done. In this frame, there is less attention for the actual practice, but more focus on the underlying management principles which support and sustain other practices. Finally, respondents in Kenya, both at the national and local level, framed organic farming as a movement that hindered the promotion of CA because of the alleged need of herbicides. In both countries, the dominant ‘frame’ of CA was that it improved productivity and livelihoods of smallholder farmers.

Section 6.5 discussed several theories of change, reflecting how respondents, including farmers, think about agricultural innovation and the spread of new ideas and technologies. Particularly in Kenya, several stakeholders adhered to what I termed the business approach to CA, which assumed that the private sector was the main avenue for upscaling CA, with a special role for the service provider who, by pursuing a business opportunity, could catalyse the uptake of CA. Another ToC assumed that from improved interaction between stakeholders at various levels, diffusion of CA would be supported. The ToC aiming at targeting and tailoring, assumes that diffusion will take off once the technology has been refined and adapted to local circumstances. Some respondents in Madagascar argued that diffusion of new technologies is fundamentally constrained as farmers only own small pieces of land. To make an impact at the landscape level, is therefore by definition difficult and requires thousands of farmers to change the way they farm. An important result, highlighted by most respondents, is the need for a mind-set change and a mentality that is more orientated towards innovation, interestingly also often mentioned by farmers. Another ToC was that by concerted action at various levels in the innovation system, a growing momentum among a variety of stakeholders could propel CA towards more massive uptake. This typically includes curriculum development at universities, inclusion of the private sector, and the practical use of research outcomes. Finally, many respondents assume spontaneous diffusion of CA with time, after a certain –unidentified and unidentifiable- threshold has been reached.

Although these results point to interesting differences, some of the clear theoretical distinctions are more difficult to maintain when looking at practical cases. In most cases, respondents expressed their view in a nuanced way, elucidated different elements of sometimes contrasting innovation categories. Indeed, innovation processes are not clear-cut. Regarding the legitimation, it is understandable that experts identify a need before an active farmers’ demand can grow, and in many cases a strong belief or conviction that something can work precedes the development of a scientific basis. These results are further discussed in section 8.4.

7 THE ADOPTION PROCESS

7.1 Introduction

This chapter presents and discusses the results of a study about farmers' reasons for adoption and non-adoption of farming practices in two study areas in Laikipia County in Kenya, and the Lake Alaotra region in Madagascar. For this purpose, several specific practices were considered that are relevant for understanding CA, but the methodology can be equally relevant to understand adoption of other agricultural practices, or even behaviours outside the agricultural domain. The content of this chapter draws not only on the quantitative results from the structured questionnaires, but also on other methods of inquiry, such as focus group discussions (FGD) and farmers' comments made during semi-structured interviews and informal field visits. The followed methodology is described in detail in section 4.9.5.

The introduction continues with describing the relation between CA and conventional farming, general farming challenges, and the costs and benefits are discussed of CA compared to conventional farming in the study areas. The rest of the chapter is structured according to the RAA methodology, beginning with a description of the samples in **section 7.2**, and the internal reliability of the variables in **section 7.3**. The average values of the different RAA variables are given in **section 7.4**, and the outcomes of the regression analysis to understand intention and adoption of CA are given in **section 7.5** and **7.6** respectively. Sections **7.7 to 7.9** discuss the attitudes, social norms and perceived behavioural control in relation to the underlying outcome-, social- and control beliefs. Finally, **section 7.10** synthesises, discusses and summarizes the results presented in this chapter to better understand the intentions and adoption of CA.

7.1.1 CA practices and conventional farming

In order to apply the RAA, CA was defined in terms of the distinct agricultural practices of spraying herbicides, ploughing, direct planting, mulching, and planting cover crops (and for Kenya also shallow weeding). Discussing these practices with farmers and comparing them to conventional farming practices revealed that, except planting a cover crop, none of these practices were new in itself. What was new is the way they are combined.

In Laikipia, direct planting is sometimes practiced by farmers who are caught up by early rains, and are too late with ploughing their land. In order to benefit from the scarce soil moisture, they opt to plant quickly without ploughing, with limited or no weed control. So it is used as an 'emergency practice' which results in less than optimum yields, and therefore it is seen as bad practice, and a 'poor man's practice'. Farmers usually compensate for the lack of ploughing by doing extra thorough deep weeding once the plants have germinated. Direct planting as a productive CA practice, combined with timely weed control and maximum soil cover, was only introduced to Laikipia less than 15 years ago.

In the Alaotra region, direct planting was sometimes practices on the *tanety*, because especially in the South, these hills are economically least important, inciting farmers to minimize their investments like ploughing. On the *baiboho,* farmers generally realise two crops a year, and although many farmers plough twice a year, some choose to plant the second crop without ploughing. Again, in the conventional farming systems this has more to do with economising than with adopting the most productive practice.

In Laikipia, 'deep weeding' is often performed by means of a (fork) *jembe*, and the reasoning behind this practice is similar to ploughing. The hard soil surface is cracked to improve infiltration of rain water, the soil is mixed to improve fertility, weeds are 'buried' to prevent them from coming back, and the roots of the main crop are covered with some additional soil to ensure good growth (farmers' comments during field visits). Deep weeding is thus believed to simultaneously support the growing of a powerful main crop, with well-structured, well-mixed soils without weeds. However, because there is a substantial amount of soil movement, deep weeding is seen as conflicting with the CA principle of minimal soil disturbance by project- and extension staff, and CA farmers. The alternative, shallow weeding, performed by means of a *panga*, is a practice that most farmers are familiar with. For the Kikuyu it has been the traditional way of weeding for many generations. Over the years it got a backward connotation among farmers in Laikipia and it is not considered the best way to deal with the weeds. Before CA was introduced in the area, it was seen as an 'emergency practice' for the 'weak farmers', which enables them to still harvest some maize even though they have not been able to weed properly. Shallow weeding with a *shallow weeder* is relatively new, and it is mainly the FFS members and their direct contacts who have had exposure to the new tool. Both tools achieve the same agronomic effects on the field, but the attitudes towards them are very different, as will be discussed in 7.7.5.

Mulch has been promoted and adopted in both countries for a considerable time, and farmers are generally positive about it. Most farmers grow their vegetables under a mulch cover, while plots with crops like maize are very rarely mulched (field observations). In both countries observations were made of crop residues being burnt, and some farmers use residues in the compost. In both countries, residues have value for cattle owners, and they source the residues also at farms of relatives who do not own cattle.

Similarly, crop rotations have been promoted and adopted for a long time. Farmers argue that it is good to rotate 'long leaves' and 'round leaves', referring generally to maize/rice and leguminous crops like beans, because it increases crop performance and reduces occurrence of diseases. However, most farmers in Laikipia argued that because of their small farm size they are not able to practise crop rotations. Also, the farmers stressed the importance of planting maize every season, which does not allow the practice of rotations. That means rotations are considered to be a good thing, if the farm size allows it. In the discussions with farmers, extension staff made the case for micro rotations in intercropping, where a row of maize was planted where the cover crop used to be last year. This is only possible without ploughing, because the maize stems are needed to identify the previous season's rows.

Intercrops were very common in both countries, although this does not mean that they fulfil the function of cover crops. Indeed, the name 'cover crop' was new to many non-members in Laikipia. The concept of a cover crop and its function in the CA crop system was only introduced to the area when CA was, and has only partly spread to non-members. Interviews with non-members revealed that cover crops were associated with the right type of crops, but not necessarily with the right way of planting. Some non-members argued they planted cover crops, but further questioning revealed that they planted some cowpeas on the border of the land. In general, the cover crops themselves, like cowpeas, dolichos, butterbeans and velvet beans, were already common in both countries, but were rarely planted in association or rotation with maize or rice. Again, what is different in CA is the way the practices are being adopted and combined.

7.1.2 General farming challenges

In the FGDs, general farming challenges were discussed with the farmers. The main outcomes are discussed briefly in this section. The most pertinent of the problems mentioned in the FGDs in Kenya was the erratic rainfall within and between years. The growing season of 2013 was characterised by an excess of rain, causing water logging in the germination period, leading to low germination rates and weak plants. On the other hand, 2014 was characterised by a late onset and an overall shortage of rain. With respect to the excessive rains of the previous season, the farmers did not agree on the influence of CA. Some farmers experienced worse problems of waterlogging especially due to mulching, like a 42 year old male farmer in Mazingira who had not ploughed his land for 6 years, but after the waterlogging saw it necessary to plough again. Other farmers in Kalalu experienced less problems of waterlogging than normal which they attributed to a better soil structure and improved infiltration.

In Madagascar, the FGDs also mentioned the erratic rainfall as a big problem. The rainfall season, which is highly influenced by cyclone weather systems, can come with very intensive rainfall leading to soil erosion on the *tanety* and flooding on the *baiboho* and rice paddies, while the extended dry periods can influence crop performance and yields negatively, especially on the rain fed crops grown on the *tanety*. Contrary to Kenya, crops rarely fail completely, but rainfall variability is still seen as an important factor that determines the outcome of the growing season.

The limited access to capital came forward as a common problem for the farmers in both countries, which is well recognized in literature as a general constraint of smallholder farming in sub-Saharan Africa (FAO, 2011, p. 91). In Madagascar, farmers sometimes lack the money to buy the inputs, especially during planting time. But credits are not attractively available for them as banks use high interest rates on loans. One of the advantages of CA is that labour costs for land preparation can be reduced under certain circumstances. In the FGD it was mentioned that people with a small areas of land, who relied on manual land preparation, are confronted with extra costs in CA as they have to buy herbicides when applying direct planting. Farmers with large farms, on the other hand, can substitute hired animal-drawn or tractor ploughing with herbicides and hiring a direct planter, which actually reduces the costs for land preparation. The overall costs of CA were generally perceived to be lower than conventional farming, but it requires the capacity of small farmers to budget well and save some money to invest in the beginning of the season.

Especially in Kenya, a relatively big part of the FGD was taken up by discussing various pests and diseases experienced on the farmers' fields and their control. Because the FGDs where facilitated by MoA staff, it constituted an opportunity for farmers to get answers to some of their questions. Pests and diseases, according to the farmers, caused substantial percentages of the crops to be lost. Farmers mentioned problems with stem borers, necrosis, whiteflies, aphids, leaf miners, red spider mites, and millipedes, effecting maize, potatoes and legumes. The MoA recognized the importance of the topic for the farmers and responded by suggesting various pesticides that could be bought locally. It was remarkable, however, that the extension staff seemed to disconnect the issue of pests and diseases from the discussion on CA, although the third CA principle of crop rotation and association has a strong link with pest control. After taking the time to discuss the various pests and diseases, the conversation was 'brought back' to CA.

This experience in all FGDs in Kenya and Madagascar illustrates that in the way CA is currently promoted, the focus is mostly on the minimum soil disturbance, and the soil cover through mulch and cover crops. The third principle 'crop rotations' is always mentioned in the trainings, but not explored in-depth, certainly not in a way that is connected with integrated pest management. Farmers were, for example, not aware of the 'push-pull system', which can minimize occurrence of stem-borers in the maize, while providing fodder for the animals from the Napier grass and Desmodium, allowing farmers to leave a higher proportion of maize residues on their soil (e.g. Hassanali et al., 2008). Similarly, other crop rotations may have potential to address farming challenges and truly becoming a third principle of CA.

Other issues that were mentioned in the FGDs with FFS members in Kenya included the varying quality of inputs. In Mazingira, farmers mentioned that failure to use the right 'chemicals', both in CA and conventional farming, has happened several times. In Kalalu, farmers mentioned the lack of certified seeds for planting. In both cases, sub-standard products are sometimes bought because they are slightly cheaper than the standard products, but it comes at the risk of reduced effectiveness. Also, limited availability of equipment, like *jembes* or animal-drawn ploughs, were seen as a constraint to farming. Finally, the focus group in Kalalu identified limited options for the marketing of their produce as a challenges. As most farmers grow the same crops and harvest around the same time, the prices are very low when farmers want to sell, resulting in loss to the farmers.

7.1.3 Gross margin analysis of CA

In the farmers' comments discussed in the previous sections, as well as in the focus group discussions, the cost-saving aspect of CA has regularly been highlighted. In this section the results are discussed of four gross-margin analyses performed with individuals and in focus group discussions with members of the groups in both Kenya and Madagascar. The aim was to understand where, according to hypothetical but realistic scenario's under CA and conventional farming, the financial benefits comes from. The GMA simply adds up all costs and revenues associated with the production of a common crop in the area.

The two gross-margin analyses in Kenya (see Appendix IX) were done and described by Pound (2014) for the ABACO project with two women who were also interviewed for this study. The two women, M. and P., compared the costs and revenues of growing 1 acre of land under maize with zero tillage and in the mulch of the previous crop. Family labour was also priced and included in the analyses. The outcome shows that for M. the conventional system brings an overall loss of 11,590KSh per acre, while under CA she gains a profit of 2,780 KSh per acre. Both her systems are low input systems with no fertilizer, although she uses a foliar vegetative spray under CA. For P., the comparison also turned out positive for the maize grown under CA. Her conventional system is already showing a bigger profit than M.'s conventional system, and in the CA system she uses fertiliser and improved seeds. The gross margin from the acre of maize grown under CA was 29,400KSh, nearly three times that for conventionally grown maize without fertiliser of 11,000KSh.

Besides the observation that gross margins are significantly higher with CA, the exercise reveals that the women define CA beyond the three agro-ecological principles of zero tillage, cover crops and crop rotations, but also in terms of using fertiliser and improved seeds. In the first low input system of M., the difference in gross margins is for 53% due to reducing costs, mainly in land preparation and weeding, and for 47% due to higher revenues, both in the number of bags and the price per bag. In the case of P., the total costs actually increase with 1600KSh, but the costs of weeding and land preparation are less, while the fertiliser are added. The revenues are much higher, again due to a bigger harvest and a higher price per bag.

In Madagascar a similar exercise was done, but this time with the CA groups. They had never done this particular analyses themselves, and there was a lot of discussion about every element of it. Some farmers had brought notebooks with a record of the prices of herbicides, labour, seeds, weeding etc. Instead of maize, the groups compared an imaginary (but realistic) plot of one Makazato (Mz, local unit measuring 10x100m, equals 0.1 ha), on the tanety, cultivated with conventional rice, and 1 Makazato of rice with CA (with mulch of maize+dolique). The results are given in Appendix IX.

In the South, the conventional system had a profit of 174900Ar, while under CA the profit was 336800Ar. That means that the farmers assumed an increase in productivity from 4.5 ton/ha to 6 ton/ha. In the North, the gross margins increased from 147000Ar in the conventional system to 275500Ar under CA. They assumed an increase in harvest from 3.5 ton/ha to 4 ton/ha, but due to an early harvest they could get a higher price per unit weight.

As in Kenya, planting with CA in Madagascar was interpreted in many different ways. In both groups CA implied a different way of planting. Under CA people would plant before the rains, in a line at a certain spacing, resulting in higher yields and fewer seeds. In the conventional system, seeds would be scattered across the field after the rains had come. This means that, with CA, one needs fewer seeds and less insecticide that is used for the treatment of the seeds. In the South, CA also meant adding chemical fertiliser, and in the North CA meant the use of improved seeds, and the possibility to plant without compost (see Appendix IX). The difference in profit in the South is 161900Ar per Mz, which is achieved for 38% by reducing the costs (especially through land preparation and reduced weeding), and for 62% by increasing the revenues through a higher yield. In the North, the difference in gross margins is 128500Ar per Mz, and by chance, this can also for 38% be attributed to reducing the costs, and for 62% to increasing the revenues. However, the higher yield is probably related to the improved rice variety, while the early harvest and higher price per unit weight can be attributed to the early planting under CA.

7.2 Description of the households

7.2.1 Sample description Kenya

From the initial sample of 95 smallholder farmers interviewed in Kenya in 2013, one third (n=33) of the respondents was a member of one of four farmer field schools (FFSs), referred to as ‘members’, while two-thirds (n=62) were not a member of a FFS, referred to as ‘non-members’. There were between 21 and 25 farmers in each of the four locations. More than 55% (n=52) of the sample were women, against 45% (n=43) male farmers. In the repeat sample of 77 smallholder farmers interviewed in 2014, there were 32 members (42%) and 43 women farmers (56%). These numbers reveal a difference in the proportion of members between the two samples and a possible bias in the results. The average age was high with 52.6 years. This finding was confirmed in focus group discussions and by ABACO project staff to be an important social phenomenon (Min. of Agr., 2013).

Some other characteristics of the sample (n=77) are presented in Table 7-1. The average area cultivated in the long rain season of 2014 was almost 0.8 ha. On average, 78% of the total household income comes from agriculture (including dairy, poultry and crop production), and 70% of the farm production is used for household consumption. The most common source of non-farm household income is working as casual labourers in Nanyuki or nearby villages. The farmers own an average of 1.9 heads of cattle, which are primarily held for milk and breeding, and occasionally for ploughing. In the sample, up to seven persons can contribute to the on-farm family labour, with an average of 2.3 persons per household. Experience with CA is limited, especially for non-members (averaging 1.3 years). For members, experience is significantly higher (averaging 3.2 years) due to the ABACO project and previous CA-SARD[49] projects.

Table 7-1 Characteristics of sample for members and non-members of FFS in Kenya

	n	Mean overall	Mean members	Mean non-members	Significance of difference
Age	77	52.6	54.9	51.0	
Land cultivated in 2014 (ha)	77	0.76	0.81	0.72	
Percentage of income from agriculture	77	78	78	77	
Percentage of production for consumption	77	70	66	74	
Heads of cattle	77	1.9	2.3	1.7	
Family labour (persons)	75	2.3	2.6	2.0	
Experience with CA (yr)	77	2.1	3.2	1.3	**

**=significant at 0.01 level.

7.2.2 Sample description Madagascar

The initial RAA questionnaires in the Alaotra region, inquiring about attitudes and related factors, were done with a sample of 97 smallholder farmers. From those 97 farmers, 47 were located in the villages around Mahatsara, South of Ambatondrazaka, referred to as ‘the South’. 50 Farmers were located in the villages east of Lake Alaotra, in the villages around Ambalakondro, North of Ambatondrazaka, referred to as ‘the North’ (see map in methodology section 4.5.2). In total, 40 farmers (41%) in the sample were a member of the ABACO groups, of which 25 where male and 15 female. Out of the 57 non-members there were 34 male and 23 female. In the total sample there

[49] CA-SARD (Conservation Agriculture for Sustainable Agriculture and Rural Development) was a project that was active in Laikipia from 2004 to 2010, in two phases.

were 38 female farmers (39%). In the repeat sample of 82 farmers, there were 31 female farmers (38%), and a total of 38 members (46%). As in Kenya, the proportion of female respondents remained the same, but the proportion of members in the repeat sample was higher than in the initial sample, and to avoid a bias in the result, the panel data of the second sample was used for all the analysis in this chapter. The average age of the sample was almost 46 years and was distributed more equally among the different age groups than in Kenya. Contrary to Kenya, the group members were significantly younger than the non-members (see Table 7-2).

Some more characteristics of the sample are given in Table 7-2, distinguishing between members and non-members, and between the two study sites. The average total land under cultivation in 2015 was 2 ha, with an average of 0.6 ha of *tanety,* 0,6 ha of *baiboho* and 0.8 ha of rice paddies. The total land under cultivation was significantly higher for members (2.5 ha) than non-members (1.3 ha), and not statistically significant different, but substantially (but not statistically significant) higher in the South (2.5 ha) than in the North (1.6 ha). Compared to farmers in the South, farmers in the North have significantly more *tanety* (0.8 and 0.4 ha respectively) and less rice paddies (0.3 and 1.4 ha respectively). Members have significantly more *tanety* than non-members (0.8 and 0.4 ha respectively). The average experience with CA is 3.8 years, and is significantly higher for members (5 years) than non-members who still have a substantial experience with CA of 3 years. On average, 76% of the total household income is derived from agriculture. In the South, this is 85% which is significantly higher than the 67% in the North. This is linked to the larger surface area of rice which brings in a lot of money. Farmers in the South also have more cattle than those in the North (5.2 and 3.7 heads of cattle respectively). Again, this is linked with the importance of rice paddies, where cattle is important for transport and ploughing, and fodder is widely available from the rice stems.

Table 7-2 Characteristics of sample according to membership and location of groups in Madagascar

	n	Mean overall	Mean members	Mean non-members	Sign.	Mean North	Mean South	Sign.
Age	84	**46.1**	50.0	42.6	**	47.9	44.2	*
Land cultivated in 2015 (ha)	84	**2.02**	2.49	1.26	**	1.59	2.45	
Tanety (ha)	84	**0.59**	0.78	0.42	**	0.79	0.39	*
Baiboho (ha)	84	**0.59**	0.78	0.43		0.52	0.67	
Rice Paddy (ha)	84	**0.84**	0.93	0.76		0.28	1.40	**
Percentage of income from agriculture	84	**76**	76.1	75.7		67.0	84.8	**
Percentage of production for consumption	83	**53**	48.8	57.4		57.2	49.6	
Heads of cattle	84	**4.4**	4.6	4.3		3.7	5.2	*
Family labour (persons)	84	**3.0**	2.8	3.3		2.6	3.5	**
Experience with CA (yr)	84	**4.2**	5.2	3.3	**	4.4	4.0	

Mann-Whitney test: **=significant at 0.01 level. *= significant at 0.05 level

7.3 Internal reliability of variables

For reasons described in section 4.9.5 Greater Lower Bounds (GLB, for three-item scales) and Spearman Brown (SB, for two-item scales) coefficients were determined in addition to Cronbach's alpha to evaluate the internal consistency and reliability of the various multi-item RAA constructs (Table 7-3). The calculated GLB and SB values did not differ much from the Cronbach's alpha values. In general, the values below 0.5 were considered unsatisfactory, but although the perceived behavioural control (PBC) of ploughing in Madagascar was 0.6, it was considered unsatisfactory as the statistics were below 0.5 for the PBC of all other practices in Madagascar.

Table 7-3 Internal reliability (Cronbach's alpha, Greater Lower Bounds (GLB) and Spearman-Brown (SB)) of multi-item scales for various CA practices in Kenya and Madagascar

	Construct:	**Attitude**		**Perceived Norms**		**Perceived Behavioural Control**	
	Items:	1. good – bad 2. wise – foolish 3. pleasant – unpleasant		1. others do/ do not approve 2. others do/ do not practice		1. easy – difficult 2. up to me – not up to me	
	Practices (N)	**Alpha**	**GLB**	**Alpha**	**SB**	**Alpha**	**SB**
Kenya	Spraying herbicides (95)	0.99	0.99	0.53	0.53	0.90	0.90
	Ploughing (95)	0.98	0.98	0.61	0.61	0.79	0.79
	Direct planting (95)	0.99	0.99	0.66	0.66	0.89	0.89
	Mulching (95)	0.96	0.98	0.66	0.66	0.80	0.82
	Shallow weeding (95)	0.99	0.99	0.71	0.71	0.84	0.86
	CA (95)	0.98	0.98	0.70	0.70	0.88	0.88
Madagascar	Spraying herbicides (96)	0.85	0.91	0.33*	0.32*	0.28*	0.28*
	Ploughing (96)	0.94	0.95	0.55	0.58	0.60*	0.60*
	Direct planting (91)	0.91	*error*	0.56	0.57	0.45*	0.46*
	Mulching (93)	0.89	*error*	0.46*	0.46*	0.25*	0.27*
	Planting cover crop (94)	0.95	*error*	0.55	0.56	0.38*	0.38*
	CA (89)	0.91	0.95	0.57	0.57	0.40*	0.40*

N = number of valid case on which calculation is based

* = Scale reliability unsatisfactory. Items of this construct are used separately in further analysis.

In Kenya, the RAA constructs were considered satisfactory and support the assumption that the items are an expression of the same underlying variable, although the internal consistency appears to be on the low side for spraying herbicides. In Madagascar, GLB values for attitudes were satisfactory, while SB coefficients for the PBC were considered too low for all actions. For perceived norms, alpha and SB were considered too low for the actions spraying herbicides and mulching, and were therefore deconstructed in the further analyses, including the regression analysis of intentions reported in section 7.3. In those cases, social norms were split up in injunctive norms and descriptive norms, and PBC was split up in perceived ease and perceived control.

The very high alpha coefficients found for the attitude construct, especially in Kenya, suggest that the items did not fully succeed in exploring the whole breadth and diversity of the variable. During the interviews it was sometimes observed that farmers would repeat the same answers for the three attitude items (good, wise, pleasant), probably because the questions were closely related and also as a way to move through the questionnaire more quickly. For future work with the RAA methodology, more diverse questions should be considered for the attitude construct that require respondents to reconsider their answer on the basis of different information.

7.4 Average values of RAA variables

7.4.1 Kenya

The average values of the RAA constructs for Kenyan farmers who intend and those who do not intend to adopt the CA practices are given in Figure 7-1 and Figure 7-2 (precise values are given in Appendix table VIII-1). As explained in the methodology section 4.9.5, intenders refer to those who judged it 'likely' to 'very likely' they would adopt that practice in the next season and non-intenders refer to those farmers who answered ranging from 'very unlikely' to 'not sure'. Adopters and non-adopters were simply assessed as a dichotomous variable (yes-no). Mulching shows the highest number of intenders and adopters, with 63 and 64 farmers respectively, while CA shows the lowest number of intenders with 34 farmers, and spraying herbicides is the least adopted practice with 37 farmers. Generally, the calculated averages are significantly higher for intenders. The exceptions were mulching and CA, where perceived norms are not significantly different from non-intenders. Although adoption levels are significantly higher for intenders, quite some farmers adopt without having shown the intention, or do not adopt despite having shown the intention. Both types of non-intentionality occur roughly in similar measures. Only 27 farmers acted according to their intentions on all actions, while 23 farmers diverted from their intentions on only one practice and 26 farmers diverted from their intentions on more than one practice.

Attitudes towards mulching are, although significantly higher for intenders, very positive for both intenders and non-intenders, suggesting that the effects of mulching are considered to be positive by most farmers, even if they do not intend to practice it. For the other practices, intenders and non-intenders showed very different attitudes, especially for shallow weeding and direct planting. The perceived norms are rather neutral for all actions and not significantly different for intenders and non-intenders of CA. Perceived behavioural control was much higher for intenders, especially for spraying herbicides and direct planting, suggesting that not everyone feels readily able of adopting these practices, even if they wanted to. The underlying reasons behind these observed intention and adoption levels are further explored through regression analyses.

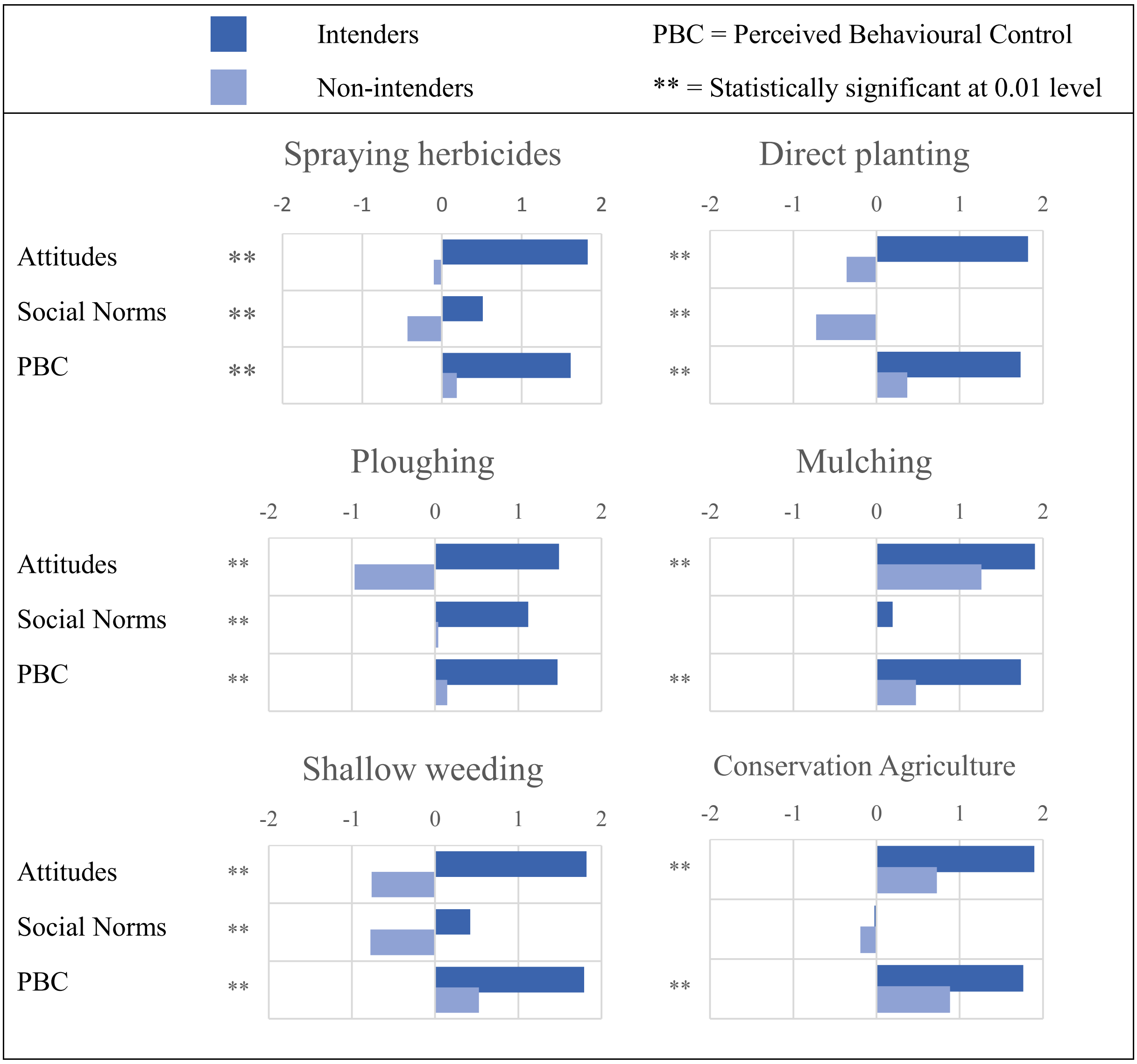


Figure 7-1 Average values of RAA constructs for the various CA practices in Kenya

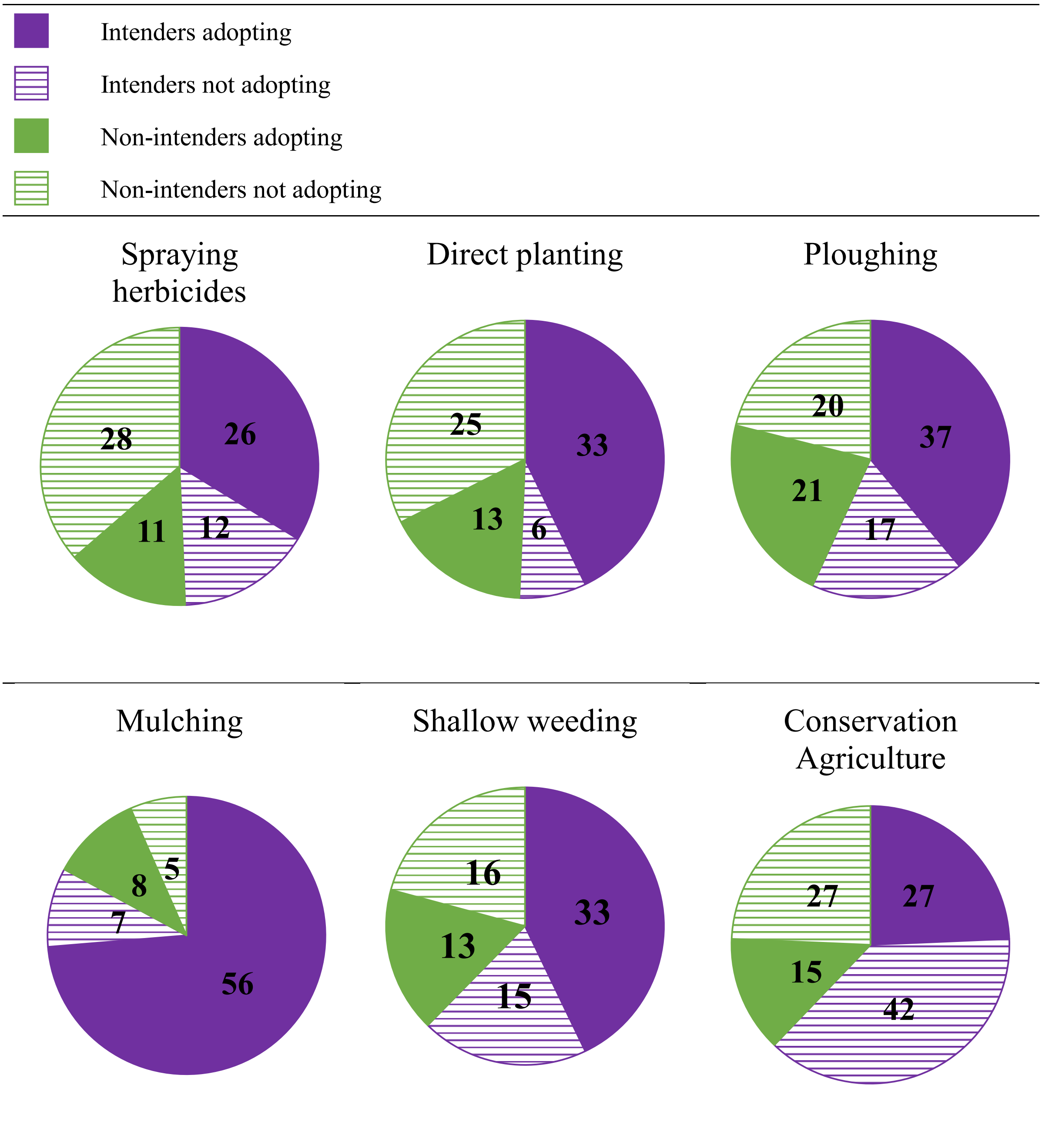


Figure 7-2 Overview of farmers intending and adopting CA practices in Kenya

7.4.2 Madagascar

The average values of the RAA variables for Madagascar are given in Figure 7-3 and Figure 7-4 (precise values are given in Appendix table VIII-2). The highest number of intenders and adopters was found for ploughing with 66 and 62 farmers respectively, and like in Kenya, the lowest number of intenders and adopters was found for CA with 30 and 17 farmers respectively. As in Kenya, there were instances of adopting non-intenders and non-adopting intenders for all practices. The first type of non-intentionality was highest for mulching, while the second type of non-intentionality was occurring in much higher numbers, especially for spraying herbicides, direct planting and planting cover crops.

The biggest difference in attitudes between intenders and non-intenders was found for ploughing, followed by direct planting, towards which non-intenders had a negative attitude. All farmers held relatively positive attitudes towards spraying herbicides and in a lesser degree also towards mulching, planting cover crops and the CA construct, although for all practices intenders had significantly more positive attitudes. The biggest difference in injunctive norms between intenders and non-intenders was found for ploughing, direct planting and mulching, while for the other practices injunctive norms are high for both groups. The descriptive norms were relatively high for spraying herbicides and ploughing, indicating that these are common practices in the social environment of respondents, contrary to direct planting, mulching, planting cover crops and adopting CA.

Despite the close connection between the perceived control and perceived ease, the two elements in the perceived behavioural control showed very different average results. The perceived control was high for all practices (ranging between 1.39 and 1.79), showing that in the perception of the respondents of both groups, adopting the practices was ‘up to them’ and there were little external factors that could stop them if they thought it was easy to adopt it. The perceived ease showed more variation, being significantly higher for intenders than non-intenders, especially for mulching (1.53 and 0.04 respectively).

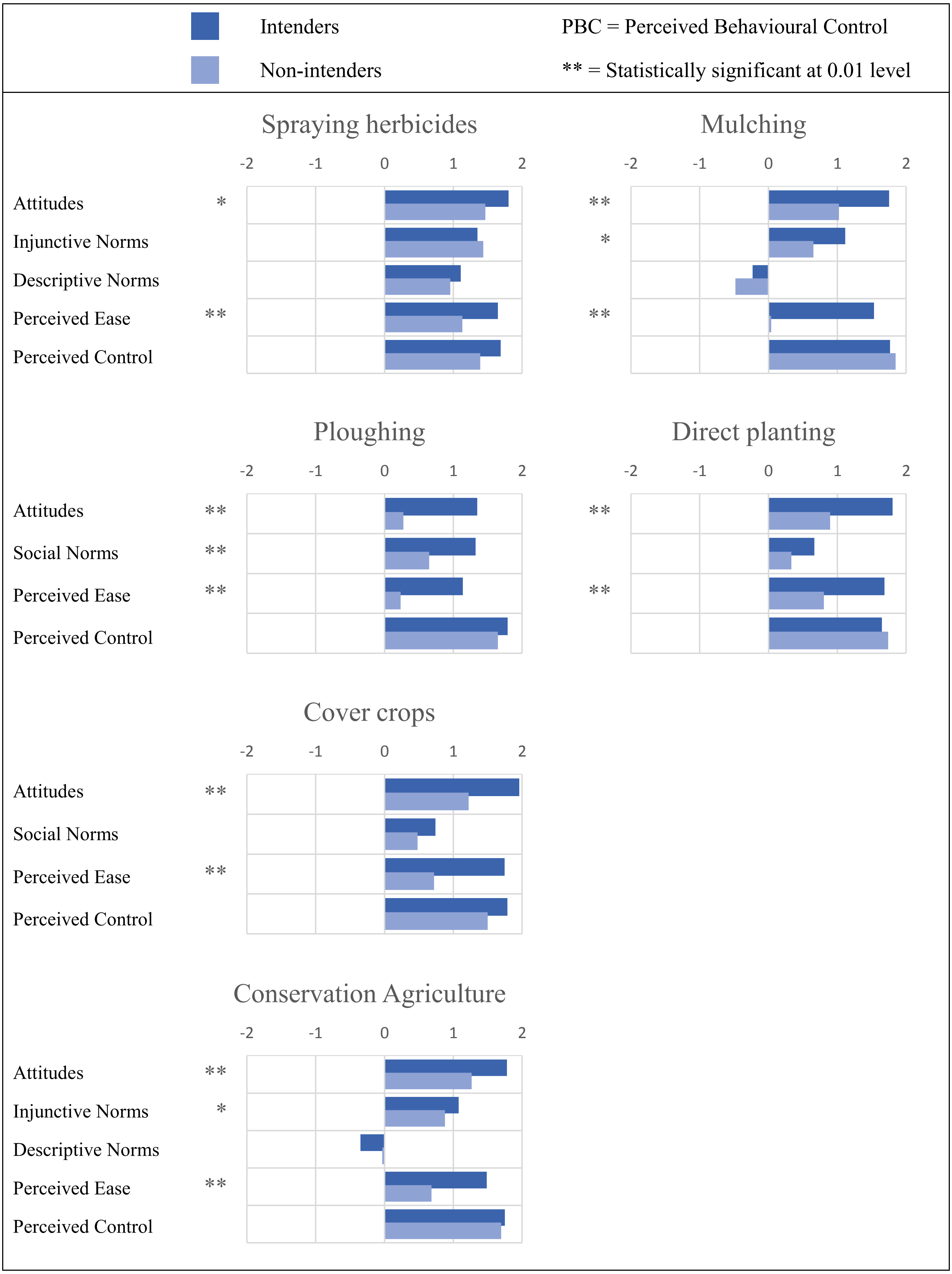


Figure 7-3 Average values of RAA constructs for the various CA practices in Madagascar

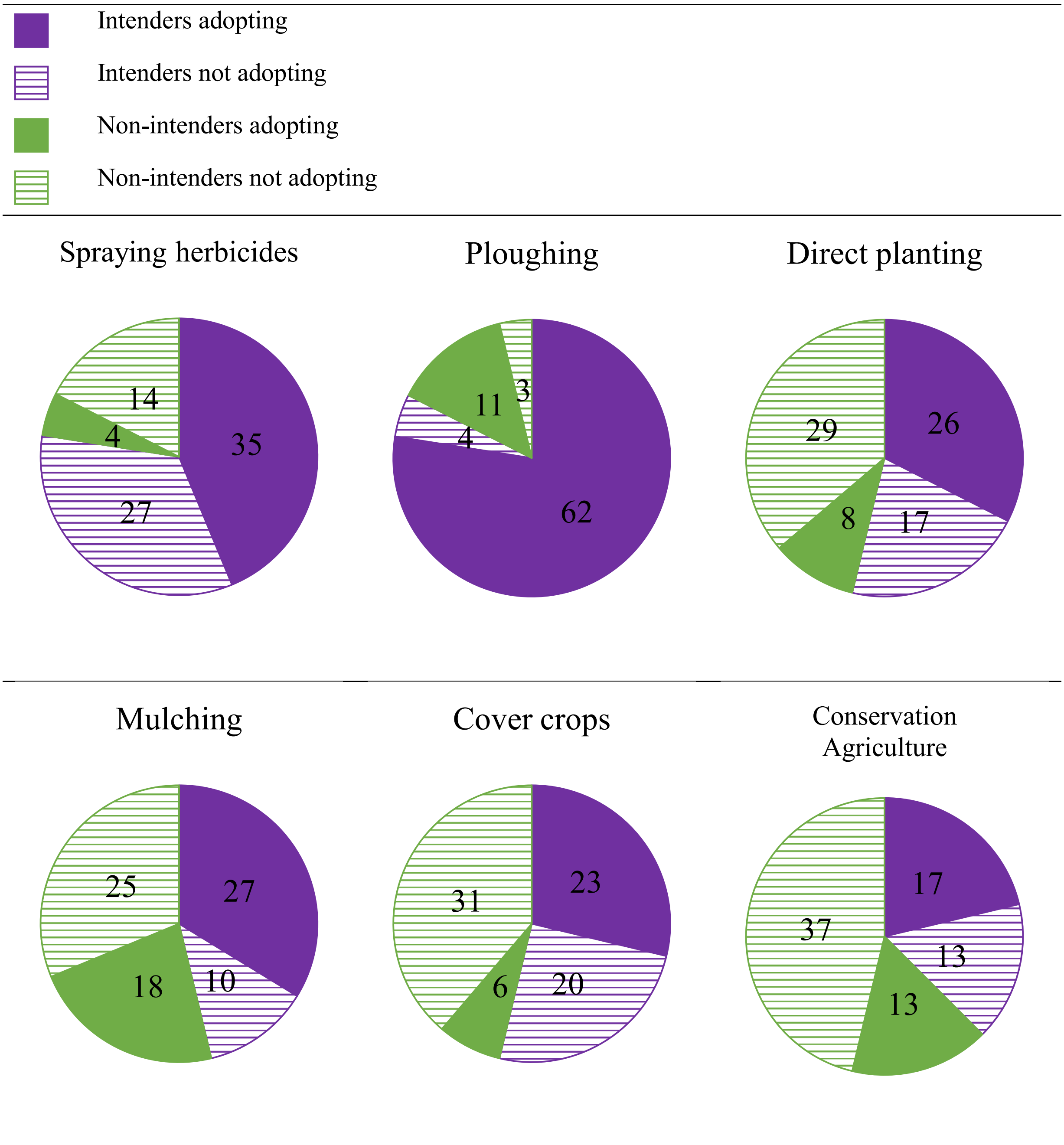


Figure 7-4 Overview of number of farmers intending and adopting CA practices in Madagascar

7.5 Regression models of intention

To understand how the attitudes, social norms and behavioural control contribute to the intentions to adopt CA practices, logistic regression analysis was done. The regression models in Kenya, as described in the methodology section 4.9.5, include the three independent variables of attitudes, perceived norms and perceived behavioural control. The regression models in Madagascar include at least the four independent variables of attitude, social norms, perceived ease and perceived control. For some practices, depending on the internal consistency of the constructs discussed in section 7.3, social norms were split up in the injunctive norm and descriptive norm.

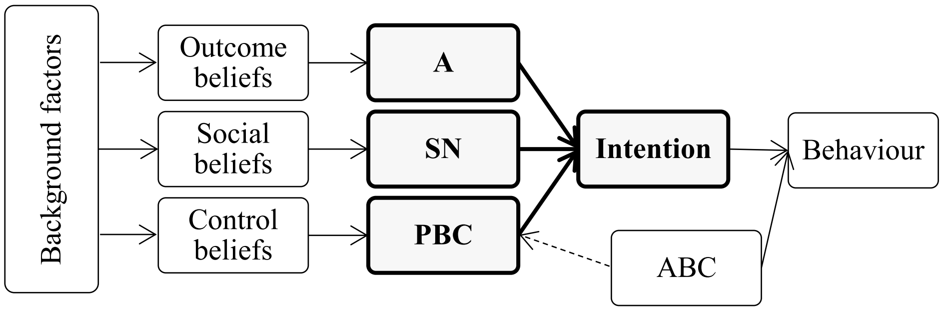


Figure 7-5 Intention and its determinants (in bold) within the RAA framework, where A=attitudes, SN= Social Norms, and PBC= Perceived Behavioural Control.

7.5.1 Kenya

The regression coefficients and the correlation between the RAA constructs for Kenya are given in Table 7-4. The high and significant correlation and regression coefficients show that having the intention to engage in CA practices is mainly explained by having a positive attitude and having a high perceived behavioural control. The regression outcomes show that perceived norms were not a significant predictor for any of the intentions. In other words, social peer pressure had no significant influence on farmers' intentions towards CA practices, although there were some positive and significant correlations. For mulching, PBC was statistically more significant attitude, while this was the other way round for direct planting, shallow weeding and CA. In the case of spraying herbicides, both attitude and PBC were statistically significant at the 0.01 level.

Table 7-4 Regression and correlation coefficients for intention as a function of attitude, social norms and perceived behavioural control in Kenya

		Intention to adopt CA practices				
		Spraying herbicides	Direct planting	Mulching	Shallow weeding	Conservation Agriculture[1]
Attitude	*r*	0.838 **	0.727 **	0.479 **	0.815 **	0.661 **
	β	7.936 **	5.781 **	5.199 *	6.952 **	2.848 **
Perceived Norms	*r*	0.456 **	0.539**	-0.022	0.529 **	0.092
	β	1.053	-0.176	0.955	1.506	-0.445
Perceived Behavioural Control	*r*	0.547 **	0.486 **	0.556 **	0.394 **	0.500 **
	β	4.741 **	3.517 *	4.526 **	3.847 *	1.450 *
Goodness of Fit: Omnibus test		74.428 **	63.165 **	30.672 **	85,705 **	62.444 **

Notes: *r* = correlation coefficient. *β* = regression coefficient

[1]Conservation Agriculture defined as direct planting combined with mulching

**= significant at 0.01 level. *= significant at 0.05 level

7.5.2 Madagascar

The outcomes of the logistic regression analysis for the intention to adopt CA practices Madagascar are given in Table 7-5. In general, intentions to adopt CA practices show high, positive and significant correlations and regression coefficients for attitudes. The perceived ease of mulching, cover crops and the CA construct showed significant regression coefficients, while significant positive correlations were found for the other practices as well. Perceived control and social norms, whether combined or separated, showed no significant and in most instances negative regression coefficients.

Table 7-5 Regression and correlation coefficients for intentions as a function of attitude, social norms and perceived behavioural control in Madagascar

		Intention to adopt CA practices					
		Spraying herbicides	Ploughing	Direct planting	Mulching	Cover crops	CA[1]
Attitude	*r*	0.239 *	0,352**	0.572**	0.401**	0.505**	0.461**
	β	**2,954 ***	**3.504****	**4.468****	**3.795****	**9.035***	**4.033***
Inj. norms	*r*	0.035			0.242*		
	β	-.493			0.916		
Des. norms	*r*	0.120			0.121		
	β	-1.075			-0.852		
Perceived norms	*r*		0.341**	0.204*		0.152	0.051
	β		-1.546	0.157		-0.485	-2.425
Perceived ease	*r*	0.264**	0.281**	0.384**	0.555**	0.450**	0.404**
	β	2.173	1,667	1.652	**4.070****	**2.536***	**4.466****
Perceived control	*r*	0.112	0.193	-0.028	-0.061	0.159	-0.065
	β	1.607	-,758	-1.701	-1.496	0.390	0.021
Goodness of Fit: Omnibus test		74.428 **	21.681**	35.160**	46.334**	33.929**	27.887**

Notes: *r* = correlation coefficient. *β* = regression coefficient. Inj. = injunctive. Des. = descriptive
[1]CA = Conservation Agriculture defined as direct planting combined with mulching
**= significant at 0.01 level. *= significant at 0.05 level

7.6 Regression models of adoption

To understand how intentions relate to actual behaviour (adoption), and whether there is an influence of actual behavioural control (ABC), a binary logistic regression analysis was done. The regression models in Kenya, as described in the methodology section, include the two independent variables of intentions and PBC, while the regression models in Madagascar included intentions, perceived ease and perceived control (see Figure 7-6).

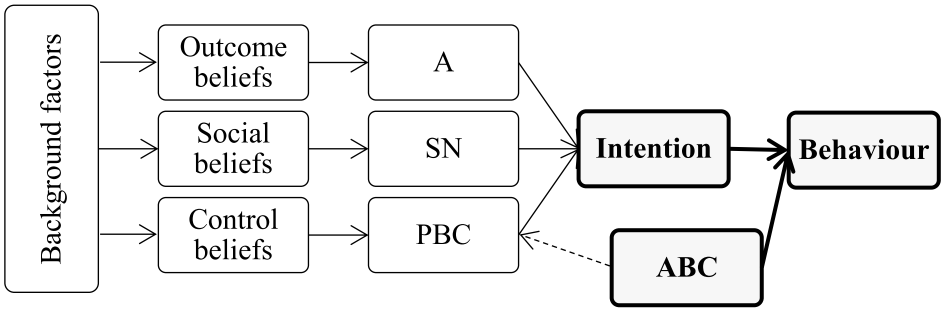


Figure 7-6 Behaviour (adoption) and its determinants (in bold) within the RAA framework. ABC stands for Actual Behavioural Control.

7.6.1 Kenya

According to the RAA model, adoption of the CA practices was modelled as a function of intentions and actual behavioural control (Table 7-6). The results show that no significant regression model was found for mulching and shallow weeding. For the other actions, including the CA aggregate, intentions were a highly significant predictor of adoption. Even though the regression coefficients were not all significant, the correlation between intention and adoption still points at a significant connection between the two. Similarly, there is a positive and significant correlation between actual behavioural control and adoption, although this is not translated in a significant regression coefficient.

A possible explanation for the weaker relation between intentions and adoption found with shallow weeding and mulching, is that these are familiar and well-established practices for both CA farmers and conventional farmers that everyone can adopt with little uncertainty about their consequences. This allows more ad-hoc decision making and last minute adaptation to unexpected circumstances which reduces the importance of intentions, careful planning and deliberation. Another explanation is that the accuracy of expressing intentions is influenced by personality traits, because some farmers held either overly optimistic intentions on several practices, while others were structurally underestimating their future adoption. Obviously, the actual behavioural control, in terms of financial means or knowledge, may also have changed in the time between expressing the intention and actually performing the practice, especially because there was a 9 months' difference between the two.

Table 7-6 Regression and correlation coefficients for adoption as a function of intention and actual behavioural control (ABC) in Kenya

		Adoption of CA practices				
		Spraying herbicides	Direct planting	Mulching	Shallow weeding	CA[1]
Intention	r	0.377**	0.514**	0.282*	0.236*	0.437**
	β	**1.600****	**2.099 ****	1.571	0.772	**1.709****
ABC	r	0.245*	0.359**	0.232*	0.195	0.317**
	β	0.308	0.841	0.117	0.651	0.277
Goodness of fit: Omnibus test		12.926**	21.414**	5.025	4.755	15.836**

Notes: r = correlation coefficient. β = regression coefficient. ABC = actual behavioural control

[1] CA = Conservation Agriculture adoption, defined as direct planting combined with mulching

**=significant at 0.01 level. *= significant at 0.05 level

Although it is against the logic of the RAA to add other explanatory constructs unless they meet several strict criteria as defined by Fishbein and Ajzen (2010, p.282), additional determinants of adoption were considered. The objective was to gain information on which other variables, which in the RAA model are theoretically mediated by intention and PBC, can be linked to adoption directly. Among the household characteristics assessed are living in Kalalu and Mukima respectively, including both FFS members and nearby living non-members. In Mukima there was a remarkable negative attitude towards herbicides and only few farmers who used it. The chairman of the FFS was a staunch opponent of herbicides. Among extension staff it was not a favoured area to visit, because the farmers were difficult to motivate and mainly showed interest in free hand-outs (field observations and personal communication with extension officer, 18-6-2014). Kalalu, on the other hand, was an exemplary FFS that was closest to the main road, much more proactive in their dealings with the extension staff, and characterised by a higher familiarity with and acceptance of modern technologies, such as hybrid seeds, grain storages and herbicides.

Gender, age, percentage of income from agriculture, available HH labour, and being in the other two locations was not significantly correlated with adoption of any of the practices. Experience with CA was positively correlated with adoption of all practices, and FFS membership was correlated with all practices except mulching. The FFS membership contributes little to one’s inclination to adopt a well-known practice as mulching, while it brings advantages for the other practices in terms of access to knowledge (herbicides and direct planting) and equipment (shallow weeding).

Table 7-7 Correlation of significant household and farm characteristics with adoption of CA practices in Kenya

	Adoption of CA practices				
	Spraying herbicides	Direct planting	Mulching	Shallow weeding	CA[1]
% for HH consumption	**-0.328****	-0.193	0.016	-0.188	-0.163
Total area adopted	**0.243***	0.195	-0.088	-0.040	0.076
Being in Kalalu	**0.427****	0.050	-0.042	0.109	0.049
Being in Mukima	**-.512****	-0.010	0.146	-0.074	0.038
FFS membership	**0.244***	**0.477****	0.223	**0.424****	**0.499****
Experience CA	**0.369****	**0.714****	**0.263***	**0.435****	**0.667****
Heads of cattle	-0.050	-0.057	**-0.337****	-0.152	-0.121

[1] CA = Conservation Agriculture adoption, defined as direct planting combined with mulching
**=significant at 0.01 level. *= significant at 0.05 level

Adoption of 'spraying herbicides' was also found to be positively correlated with total land area under cultivation and being in location 1. Having more total land area under cultivation makes it more likely that a farmer will use herbicides, because those farmers are able to make an investment (underlying the PBC) and because it reduces the labour (underlying attitude). No significant correlation is found between total land area under cultivation and direct planting. Spraying herbicides was negatively correlated with being in location 4 and the percentage of produce used for household consumption. Households that sell less of their produce will have less money to spend on e.g. herbicides. Another possible explanation is that farmers who consume most of their produce prefer it to be grown without herbicides, however, this was not confirmed in this study. Being in Kalalu and Mukima has a big influence on adoption, which can be explained from the social environment explained above and the exposure to extension and agro-dealers. Finally, adoption of mulching was negatively correlated with the number of cattle due to competing uses of limited residues in the mixed farming systems.

7.6.2 Madagascar

In Madagascar, the regression models for understanding adoption included, besides intentions, also the two PBC items perceived ease and perceived control (Table 7-8). The model fitting information shows that the regression models for spraying herbicides and ploughing were only significant at the 0.05 level and had relatively low chi-square values. For the other practices the models were significant at the 0.01 level. The results show that intentions have positive and significant regression coefficients for all actions except mulching and the CA construct, and significant direct correlations in all cases. This supports the idea that having the intention is indeed pivotal for actually adopting CA practices.

Table 7-8 Regression and correlation coefficients for adoption as a function of intention and actual behavioural control (ABC) in Madagascar

		Adoption of CA practices					
		Spraying herbicides	Ploughing	Direct planting	Mulching	Cover crops	CA[1]
Intention	*r*	0.299**	0.259*	0.365**	0.359**	0.407**	0.310**
	β	**1.374***	**2.453***	**1.134***	1.035	**1.421***	0.945
Perceived ease	*r*	0.281**	0.012	0.357**	0.430**	0.338**	0.368**
	β	1.744	-1.867	**2.400***	**1.659***	2.126	**3.627***
Perceived control	*r*	0.123	0.191	-0.079	0.189	0.106	0.136
	β	-.022	1.661	-0.393	1.634	0.005	1.442
Goodness of fit: Omnibus test		10.541*	8.364 *	16.742**	19.845**	17.701**	17.739**

Notes: *r* = correlation coefficient. *β* = regression coefficient.

[1] CA = Conservation Agriculture adoption, defined as direct planting combined with mulching

**=significant at 0.01 level. *= significant at 0.05 level

Because CA was defined as adopting both DP and mulching, it is safe to assume that the non-significant *β* for CA is due to the non-significant *β* for mulching. One possibility why the regression coefficient was not significant for mulching is the different perceptions of mulching at the time of the first interviews and the last. As discussed in section 5.5.1, mulch was at first seen as the transported *bozaka* from the *tanety*, but was re-interpreted as referring to mulch from in-field residues as well. Indeed, it was shown in Tabl, that the type of non-intentionality where non-intending farmers adopt nevertheless, was highest for mulching.

Perceived ease of direct planting, mulching and the CA construct showed significant regression coefficients in the prediction of adoption, and significant direct correlations for all practices except ploughing. Although for cover crops and spraying herbicides regression coefficients for perceived ease were not significant, they were positive and relatively high. For ploughing, *β* was negative which has no obvious explanation. Also for the CA construct the significant contribution of perceived ease in explaining adoption, highlights the importance of farmers´ perception of their ´internal´ abilities and knowledge. Perceived control did not prove to be a significant factor in the regression analysis, nor was it significantly correlated to adoption.

As in Kenya, an additional correlation analysis was done to identify possible factors that have a direct influence on adoption (Table 7-9). No significant correlations were found for the number of cattle, the percentage of income derived from agriculture, the percentage of production used for HH consumption, age or gender. The results show that membership was influencing adoption of all practices except crop rotations. Members significantly adopted more herbicides, direct planting, mulching and especially cover crops, and members significantly ploughed less than non-members.

The strong link with the adoption of cover crops can be understood from the fact that the project is supporting the CA groups with seeds for their experiments. Together with the regular visits from project staff, this provides group members with the space to experiment with cover crops on their own farm without taking big risks.

Table 7-9 Correlation of significant household and farm characteristics with adoption of CA practices in Madagascar

	Adoption of CA practices					
	Spraying herbicides	Ploughing	Direct planting	Mulching	CC	CR
Total area rice paddies	**0.229***	-0.031	**0.265***	0.165	0.098	0.002
Total area *tanety*	**0.219***	0.172	0.201	0.148	**0.298****	0.062
Total area *baiboho*	0.198	**0.228***	0.165	0.168	0.009	**0.234***
Member	**0.351****	**-0.235***	**0.491****	**0.310****	**0.598****	0.063
HH labour	0.118	0.139	0.105	**0.232***	-0.049	0.021
Experience CA	0.090	0.009	0.123	0.116	**0.261***	**0.249***
Located in the North	**-0.373****	0.126	**-0.281***	**-0.277***	0.009	0.063

[1] CA is Conservation Agriculture adoption, defined as practicing both direct planting and mulching
**=significant at 0.01 level. *= significant at 0.05 level

The total area of rice paddies is positively and significantly correlated with the adoption of spraying herbicides and direct planting. Farmers with more *tanety* are associated with higher adoption of spraying herbicides and planting cover crops, while farmers with more *baiboho* are associated with higher adoption of ploughing and crop rotations. On the *baiboho* it is often possible to grow a counter-season crop. Therefore it makes sense to have more crop rotations on that land, and it is also more likely that farmers plough this productive land at least once a year. Farmers with more household labour available significantly adopted mulching, while experience with CA was positively linked with planting cover crops and crop rotations. Finally, Table 7-9 shows that farmers in the North sprayed significantly less herbicides, and adopted less direct planting and mulching.

7.7 Understanding attitudes

In this section attitudes towards CA practices are described and further explored in terms of the underlying outcome beliefs (see Figure 7-7). Because the outcome beliefs were different for the different practices, this section is structured according to the different CA practices. The findings are based on a combination of farmers' comments during the field visits, the focus group discussions, and the quantitative outcomes of the RAA structured questionnaire as shown in Appendix X and Appendix XI for Kenya and Madagascar respectively.

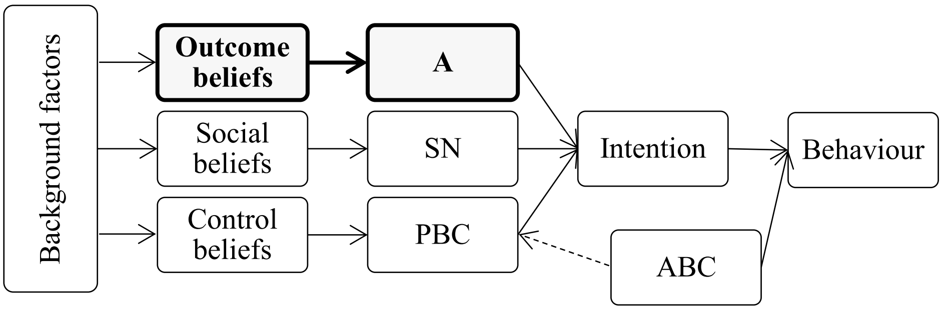


Figure 7-7 Attitudes (A) and underlying beliefs (bold) within the RAA framework

7.7.1 Spraying herbicides

Only 10 years ago, spraying herbicides was not at all a common practice among smallholders in Laikipia. After many years of agricultural projects and a growing knowledge and availability of herbicides, the practice has become more accepted, although, as will become clear, herbicides are still a bit controversial. Negative attitudes about spraying herbicides come mainly from the belief that it has a negative impact on the farmers' health and on the soil fertility. Some farmers also believe it has a negative impact on the cattle that eat the residues of crops that have been treated with herbicides (see Appendix X). In the RAA questionnaire no distinction was made between negative health effects on people due to the act of spraying, and health effects due to eating treated crops. From the comments made by farmers it becomes clear that both were present in Kenya. A 49 year old female non-member in Mukima argues against herbicides for several reasons: "Herbicides have a lot of negative health impacts. Also, it encourages laziness, while I think that the body should be subjected to a lot of exercise. The herbicides may also end up on other crops, like sugarcane that is eaten by the children". Several other farmers in Mukima associate herbicides with breathing problems, allergies, disability and cancer.

In other areas in Laikipia, farmers have more practical difficulties with herbicides. In Kalalu a farmer mentioned negative impacts on the main crop due to bad timing of application, and a 62 year old male non-member in Mazingira mentions the need of organic matter to prevent specific types of herbicides to affect the soil negatively. Several farmers mention that although herbicides are good and effective, repetitive use should be avoided to not damage the soil. For farmers with a small farm, herbicides are an expensive option. Also it is considered to be a difficult practice, because if you get the type of herbicide or the timing wrong you risk losing your crop or wasting money.

Positive attitudes in Kenya are mainly found among FFS members who have had training on how to spray herbicides. According to them, a big advantage compared to ploughing is that spraying herbicides is very easy, it reduces the required labour for weeding, and depending on the farm size and available family labour it reduces costs. A 52 year old female member in Muramati argued that "compared to the stress of looking for tractors for ploughing, spraying herbicides is very fast and easy". The belief that spraying herbicides reduces the needed labour is very strong for both intenders and non-intenders, and the outcome is considered to be important as well. The outcome belief with the strongest link to intentions is the belief that spraying improves the harvest (see Appendix X). A 28 year old female non-member in Kalalu is positive about herbicides: "Thanks to the herbicides I am able to farm a larger portion of my land, because it requires less labour. It also gives higher yields, because the weeds are dead and the roots of the crop are not disturbed during the growing season". In all the focus group discussions in Laikipia it was also mentioned that herbicides have a progressive effect, because any weeds that still emerge later in the season and in the next year, are also easier to control. Finally, farmers in this part of Laikipia do not generally own ploughing equipment and therefore depend on service providers who are not always available at the time you need them. Spraying herbicides can be done by farmers themselves or by one of the many service providers, so that they can plant when they think it is best.

In Madagascar the positive attitude towards herbicides can be explained from the beliefs that herbicides save time, money and improve the harvest. As in Kenya, the strongest link with intention was for the belief that the use of herbicides improve the harvest. A 40 year old male member in the South said "[by using herbicides] I will have a better harvest, both in terms of quality and quantity. Because the crops grow without negative influence of the weeds the harvest is very good". A 60 year old female member in the South argued that glyphosate loosens the soil, and that the harvest improves if the soil is covered by the dead weeds. With respect to the time saving aspect of herbicides, four dimensions were highlighted in the interviews. Six farmers mentioned that it reduces the time compared to weeding, while a 39 year old male member in the North explains that "the use of herbicides reduces the labour compared to ploughing the land, and an additional benefit is that you can manage your time better". Finally, the reduced labour was also reflected in reduced costs. As five farmers in both the North and the South explained, manual labour is so expensive that herbicides are often a good alternative.

In Madagascar, farmers did not generally believe that herbicides had negative health effects (see Appendix XI). In focus group discussions and in the separate comments by farmers, a high level of awareness was shown of the need of protective clothing, like a 51 year old female member in the South who explains that "spraying does not influence your health if you don't spray against the wind and protect yourself with plastics, although [smiling] this year I had a flu after spraying, but I do not think it is related". Nevertheless, some farmers linked herbicides to breathing difficulties and flu. A 51 year old female non-member in the North argued that "to be honest, we do not really know whether herbicides are bad for the health, but we use it a lot". Similarly, some farmers expressed the belief that the use of herbicides lead to compact and infertile soils, while in general this was not seen as a significant problem (see Appendix XI).

The decision to the use of herbicides was largely pragmatic. Ten farmers in both North and South mentioned that the need to spray depends on the abundance and species of weeds, the money available at the beginning of the season and the type of crop. Some farmers disagreed on which areas (*tanety, baiboho* or rice paddies) were particularly suited for herbicides. The general pattern in the Alaotra region is that the use of herbicides seems to correlate with economic importance of fields, therefore it is commonplace in the rice paddies, but gradually less commonly adopted as the geomorphology changes towards the *tanety* (ABACO project staff, personal communication, 4-6-2015).

7.7.2 Direct planting

The outcome beliefs underlying attitudes towards direct planting (DP) were significantly different for intenders and non-intenders in both countries. Compared to what was found for spraying herbicides, there is a higher variation in, sometimes contradictory, outcome beliefs about DP. In Kenya, the biggest difference between intenders and non-intenders, and the highest correlation with intentions, was found for the belief that DP leads to improved infiltration and a reduced evaporation of soil moisture. In Madagascar, the biggest difference was found for the belief that DP leads to an improved harvest, followed by an improvement of soil moisture and an improvement of the soil structure (see Appendix XI).

In Kenya, the negative attitudes towards direct planting are sometimes based on experience with the traditional direct planting. The main objection of farmers is that it will cause the soil to be hard, resulting in lower yields. The argument is that it is necessary to plough to break the soils crust, to create a good soil structure and to allow infiltration of water in the soil. Some farmers also believe that after direct planting, weeding becomes a big challenge. A 67 year old male non-member in Mukima explains that weeding after direct planting is very hard, because the weeds grow faster and the soil is hard. The difficulty of weeding can be interpreted to refer to deep weeding, because for shallow weeding it is even good if the soil is a bit hard. If direct planting is practiced when people are caught up by the rains, it is associated with more work and less production than conventional ploughing. A 61 year old non-member in Kalalu tried to do direct planting in the 2013 season and counted on a service provider with an animal drawn planter. However, the service provider was so busy that she decided to do the direct planting manually. It cost her a lot of time, and she ended up planting late, thus missing precious rainfall.

In Madagascar several negative outcome beliefs were mentioned in the interviews. Several farmers in the South commented that ploughing is good, the deeper the better, for the crop to grow properly. Other farmers commented that DP is "not compatible" with their soil. They could not envisage how DP could work on their land, although they did not necessarily dispute that the concept could work elsewhere. A 57 year old male non-member in the South narrated how he tried DP in 2010 but had a very low harvest. This negative experience held him back to try it again. A striking difference with Kenya was that farmers regularly attributed the outcomes of an improved soil moisture and reduced incidence of weeds on mulching, herbicides or cover crops, whereas in Kenya this was more associated with zero-tillage. A 35 year old male non-member in the South, for example, argues that the effects and performance of DP highly depend on the mulch cover. With respect to the improvement of the soil structure, 8 farmers mainly in the North, both members and one non-members, commented that DP is not a way to improve the soil structure, because even if applied properly the soil compacts progressively and one needs to plough restoratively after four to six years. From these comments it seems as if direct planting is seen as 'closing the soil' which results both in conserving moisture throughout the dry season, but also limiting the infiltration which is associated with compact soils. A 47 year old female non-member in the North puts it like this: "The soil moisture will only be maintained for two or three years, after which the soil is dry and compact".

In Kenya, some farmers commented that the infiltration is not reduced, as discussed earlier, but rather increased. A 40 year old male member in Muramati, where soils usually crack when they are dry, thinks that infiltration is improved by leaving the cracks open, rather than "destroying the cracks" through ploughing. At the same time, he observes that on his CA fields where he practiced direct planting for several years, the soil cracking is becoming less and the soil becomes soft, also leading to better water infiltration. Farmers noted that, on the condition that you know what you are doing, direct planting is easy and it saves a lot of time compared to ploughing. A 42 year old female member in Kalalu argues that with direct planting "there are many benefits. I require less labour so I save money. […] On my field where I am planting directly, the weeds are very easy to uproot even by hand because the soil has become soft". In Kalalu, where soil erosion is a problem for some farmers, it was mentioned that direct planting can stop soil erosion. Together with these positive aspects, the key concern is that the harvest (visibly) improves. As a 55 year old female member in Mazingira puts it: “Whenever neighbours see the good harvest from my farm, and they know I have done direct planting, they become positive about it”.

In Madagascar farmers express similar explanations for a positive attitude towards direct planting. A 35 year old female non-member in the South argues that the soil has become very soft on her farm, and therefore she will continue to practice it. A 46 year old male non-member in the South argues that “with DP there is less work, more harvest and a good time management. That means that with DP you are able to harvest early which means that there is a good difference in the price you can fetch at the market”. The effect of the earlier harvest also becomes clear in the gross margin analyses performed with the groups, as detailed in section 7.1.3. The improved time management is confirmed by a 45 year old female non-member in the North argues that DP is very good for two reasons: “We spend less with CA, and we don’t have to wait with planting until the rains have come”. Several farmers mention that they find have never practiced it and are neutral towards DP. A female non-member in the North explained that she is increasingly positive about DP, but has not yet reached the point where she wants to try it. A 54 year old male non-member in the North explains: “I have never practiced DP, so I have no idea if it is a good thing. The people from this village also don’t know the technique, so we do not talk about it much and I do not know their opinion. For me to practice DP would be difficult because I don’t have the knowledge and experience”. Others have tried DP but still have neutral attitudes, like a 50 year old female member in the North, who explains: “I have observed that DP saves labour. However, I have only tried it on a small plot so far, and I am not sure how it would go on a bigger plot”.

7.7.3 Mulching

Farmers in Laikipia generally had positive attitudes towards mulching, whether they were intending to adopt or not (see Appendix X). They associate it primarily with increased soil fertility and a softer soil, although other outcome beliefs include the limiting of soil erosion, reduced weed pressure and an improved evaporation from the soil. The closest link with intentions to adopt mulching were found for the belief that mulching improves soil structure, followed by a reduced weeding time and an improved soil fertility (see Appendix X). A 53 year old female member in Kalalu allocates a part of the crop residues to mulching and the rest is incorporated in the manure. She explains why she uses mulch: “It helps soften the soil and acts as a barrier for the water and helps to stop the run-off. That way, the nutrients are not washed away, but stay in my field. I also noticed that it helps to control the weeds and that the micro-organisms break the hard pan in the soil. The only challenge is to have enough residues”. Other farmers confirm that it reduces the occurrence of weeds, and the weeds that emerge are less strong. And, according to some farmers, the added soil fertility means that after a while you can do without chemical fertilisers. Negative attitudes towards mulching were also observed. In Laikipia, some farmers commented that mulching makes ploughing more difficult if there are residues in the field. A 37 year old male non-member in Kalalu argues that it is unlikely that there are less weeds with mulching: “the residues make the soil fertile, and fertile soils imply a lot of weeds”.

In Madagascar, farmers were less positive about mulching. When asked about their intention to mulch next season, farmers responded along different lines. Some respondents said “no, the residues are for 100% for the cattle”, while another respondent said “no, I am going to plough” and yet others said: “no, we don’t practice mulching because it is an old technique”. The latter remark has to do with the way mulching has been promoted in the past projects. Extension staff pursued farmers to import *bozoka,* the grasses on the *tanety,* as mulch for their farming systems. This implied a lot of work in terms of cutting and transporting residues, which was soon abandoned by many farmers. During the interviews, it had to be explained to the farmers that mulch (*rakotra mata*, Eng.: ‘dead cover’) does not only refer to imported grasses, but equally to residues from the crop on the field itself, or from cover crops grown in association with it. This ‘old’ perception is still reflected in the strong belief of non-intenders that mulching increases the work load. This belief was also strongly correlated to the intention to adopt mulching (see Appendix XI).

A 40 year old female member in the North mentions that “mulching is not really necessary for my fields, it is only necessary with new CA fields”. Seven farmers in the North associated mulch with rats, and some of them argued that it is important to keep the land borders clean to keep rats out. Another simply claims that there is no big difference between the mulched and conventional plots in terms of yields. Both intenders and non-intenders linked mulching also to positive outcomes, most notably reduced soil erosion, improved soil moisture, and improved soil fertility and structure (see Appendix XI).

7.7.4 Cover crops

As discussed earlier, the result for cover crops in Kenya were omitted from detailed quantitative analyses because non-members were not sufficiently aware of the concept to make a meaningful evaluation of the likelihood of outcomes. However, there were some qualitative comments that give insight in the attitudes towards cover crops in Laikipia. A 53 year old female member in Kalalu argues that “cover crops are very good, because if there is not enough residue to cover the soil, the cover crops grow and are an alternative. Also, there is more fertility in the soil due to the leaves that they shed off and because it is a nitrogenous crop. And cover crops improve the structure. In my experience, especially *Dolichos* roots are good at penetrating the hard pan”. This overview of positive beliefs was typical among the members of the FFS, who have had the opportunity to see and experiment with them with seeds provided by the project. This is also a reason to be critical about the positive comments and apparent positive attitudes, because from the perspective of the farmer it makes sense to be positive and to have a chance to receive more seeds.

Nevertheless, farmers who knew the practice where quite positive in Laikipia, although some problems were reported as well. A 34 year old male member in Muramati confirms the points about shed leaves that provided nutrients, and the breaking of the hard pan by the root system. He adds an interesting point that some cover crops increase the occurrence of pests and diseases on the farm, while others decrease the occurrence of pests and diseases. Other farmers gave comments about both increasing and decreasing pests, although it is difficult to connect specific diseases with a farming system. The chairman of Muramati explained that *Dolichos* and pigeon peas need spraying with pesticides in order to get any seeds. A 77 year old female non-member reported that she planted *Dolichos* and butterbeans, but they performed badly due to whiteflies. Others confirm that unless you spray pesticides, the plants perform very bad and you cannot harvest any or very little seeds. A male non-member in Kalalu adds that cover crops are very good for the household proteins, an opinion shared with several farmers.

In Madagascar there was more familiarity with the principle of cover crops, and adopting farmers enthusiastically explained their adapted cropping systems, with specific varieties as intercrops on the *tanety* and other crops on the *baiboho.* The quantitative assessments of beliefs in the area shows that farmers link cover crops especially with three outcomes, in order of likelihood: an improved soil moisture, an improved soil fertility and structure, and an improved income (see Appendix XI). Out of these outcomes, the improved soil moisture was evaluated as most important, followed by the improved fertility and structure. As in Laikipia, farmers did not observe a big difference in terms of rats and diseases on the farm, although people link cover crops with whiteflies and other pests.

Three farmers in the south commented that although they do not have anything against cover crops, they do not seem to work on their land. A 38 year old male non-member explains his neutral attitude by saying “Cover crops may be good, but it also requires a lot of labour”. This latter point was confirmed by other farmers, like a 51 year old female non-member in the North who argued: “cover crops are very good, but it also depends on the location of the field. Because not all my fields are at a favourable location [close to the homestead], I can only plant cover crops on 20 are [0.2 ha]”. She further explained that the maintenance of a healthy cover crop requires more work than conventional crops throughout the season, which is not practical on fields that are far away. Several farmers commented that cover crops are very good, because it gives another crop to harvest. A 38 year old female non-member observed that cover crops reduced the weeds at first, but after two years the weeds were as strong as before. A 50 year old female member in the North believes that cover crops help conserve humidity in the soil, but adds that sometimes the plants decompose too fast to have an optimal effect.

The close relationship between attitudes and social norms are illustrated by some other comments. A 38 year old male non-member in the South who does not have first-hand experience with cover crops, bases his attitude on what he heard from others: “Apparently cover crops are good for the soil, but I have never tried it”. A 56 year old male non-member in the North comments: “I think cover crops are good and wise, because from what we are able to observe at the farmers of Ambalakondro [the location of a CA group], it looks like it is working well for them”.

7.7.5 Shallow weeding

Shallow weeding was a practice only adopted in Kenya, and one of the surprising successes of the promotion of CA in Laikipia (MoA extension officer, personal communication, 08-2013). The positive attitude towards shallow weeding comes from the belief that it is not only effective in killing the weeds, but also very easy and fast to practice, thereby saving labour, time and money. Moreover, as an adopting 69 year old female non-member farmer in Kalalu explains: “it is a good thing, because it does not destruct the root development of the [main] crop”. Especially with the newly introduced tools, the *shallow weeders*, weeding becomes much less tedious than the work with a fork *jembe*. Also, the new tools eliminate the backward connotation and give shallow weeding a ‘modern’ feel. The 60 year old male chairman of Muramati FFS has observed that his neighbours have much more weeds. “I think it is because if you put the fertile soil on top of the weeds, they will come back stronger. You are not ‘burying’ the weeds but planting them. With shallow weeding we don’t allow the weeds to become strong and control them easily.” Like him, other farmers have developed their understanding of effective weed control.

Negative attitudes towards shallow weeding as part of CA can be understood from farmers’ belief that shallow weeding makes the soil surface to be hard, not allowing the water to infiltrate properly. After shallow weeding, some farmers believe, the weeds come back very fast and strong, and because there is no good mixing of the soil the crop does not grow optimally. Also, the crop roots may not be covered properly by the soil. There is a moral aspect as well, expressed by a 62 year old male non-member in Mazingira: “Shallow weeding is a clear sign of laziness and it is a way of destroying the land”. And although it is relatively fast, shallow weeding is a tiresome practice. For all these reasons, it is seen as a practice that does not allow the crop to grow well.

7.7.6 Ploughing

There are several reasons why farmers have a negative attitude towards ploughing in Kenya. One aspect is that ploughing in Laikipia is mostly done by service providers with an animal drawn plough or a tractor, which are both quite expensive. A 43 year old female member in Mazingira explains that this means that farmers have to pay this money at the beginning of the growing season, generally the season when financial resources are limited. Moreover she explains how service providers dislike the area of Mazingira because it is hilly and rocky. The chairman of Muramati FFS tells a story of a bad experience with ploughing: "One day I decided to hire a tractor to plough the land. It was very expensive, because you have to pay before the growing season, and I had to sell a bull to be able to plough. At the end of the year, we had no harvest at all, because of the drought. So the investment was made for nothing". He also believes that ploughing exposes the soil to intense sun light, thus leading to the loss of soil moisture and less water that is available for crop growth. Other farmers remarked that some nutrients may get lost if you plough thoroughly, and that it makes the soil less fertile. A 61 year old female non-member in Mazingira explains her negative attitude by observing that "Ploughing is not an easy thing in this area. In general I can say that it takes a lot of tedious labour, money and time".

Good outcome beliefs of ploughing were also abundantly stated, and were sometimes held by people who also hold positive attitudes towards, or practice, direct planting. Some farmers remarked that with ploughing there is a good exchange of nutrients between the top soil and the lower soils. A 49 year old female non-member in Mukima argues that "ploughing is the best because it mixes the soil. Another reason why I plough is to create a job opportunity for widows and other poor people in the area". This was confirmed by others who like the fact that ploughing creates important labour opportunities in the area. The belief that ploughing is necessary to grow a crop is a recurrent theme, as illustrated by a 60 year old member in Mazingira who simply states that "in order for crops to grow, ploughing must be done first". Another farmer in Muramati adds that it should be done well: "it is best with a tractor or animal plough, because it loosens and turns the soil deep and well". A 37 year old male member in Kalalu argues that "ploughing is a necessary process that eliminates the weeds, makes the land good for crops and it also makes the subsequent farm operations, like weeding, very easy. The most important is that it allows the roots to penetrate the soil".

In the geo-morphologically diverse farms of the Alaotra region, farmers' beliefs and attitudes towards ploughing differ for the different types of field. On the rice paddies, ploughing is considered absolutely necessary, so every farm with rice paddies holds positive attitudes towards ploughing. On the fertile *baiboho* where rice is grown, ploughing is also often considered necessary. There is the possibility of planting in the counter-season, and some farmers will only plough the *baiboho* once a year while growing two rounds of crops. This was reflected in the comments where farmers often started with the phrase "depending on the field". A 58 year old female non-member in the South finely points out that it is because of ploughing that people have been able to live their lives in the area. Similarly most farmers responded with the simple remark that ploughing is already their habit for many years and has served them well.

Negative outcome beliefs towards ploughing in the Alaotra region were mainly related to the *tanety* that farmers have sometimes completely abandoned, and to a lesser account the *baiboho.* A 35 year old female member in the South explains that ploughing on her farm has caused a lot of erosion and therefore she prefers direct planting. Similarly in the North, a 22 year old non-member explains that “ploughing is not good, because I have already planted a cover crop and I don’t plough any more. Ploughing would make the soil vulnerable to erosion. It would be easy for me [to plough], though, because I have the equipment and cattle”. A 46 year old male member in the South argues that ploughing is not good because the soil is exhausted, referring to his *tanety*. He also says that ploughing is very hard labour on the *tanety* because the soil is very hard, while the returns are sometimes disappointing. In the North, a 53 year old female non-member comments that “if you plough a plot of land every year, it will have difficulty to conserve the soil moisture”.

7.8 Understanding social norms

This section examines the farmers’ normative beliefs as a way to understand social norms by looking at the social normative beliefs (Figure 7-8). In both study areas, explorative questionnaires established a list of ‘referents’ who were the potential sources of social pressure. This section is structured according to those referents, because the list was very similar across the CA practices and only slightly different in the two countries. The identified social entities that potentially influenced farmers through their opinion (injunctive norms) or through what they practiced (descriptive norms), were household members and close family, neighbours, CA groups, elders/chiefs/village leaders, and service providers. In Kenya extension staff was mentioned as a source of injunctive norms, while extension services were completely absent in Madagascar. Another difference between the two countries is that in Laikipia, people were often member of more than one group, where people come together for other reasons but nevertheless discuss their farming issues.

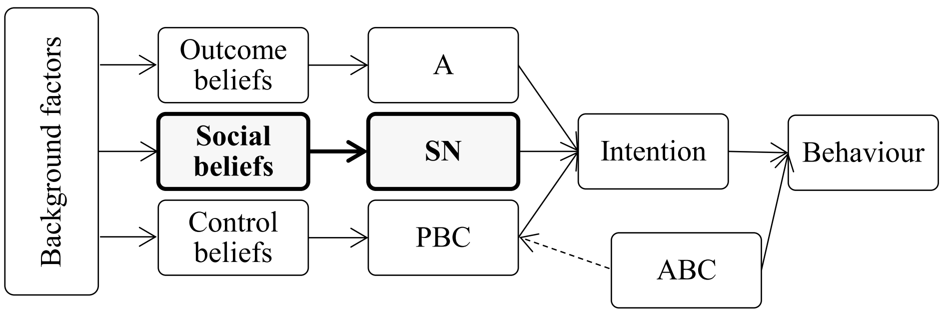


Figure 7-8 Social Norms (SN) and underlying beliefs (bold) within the RAA framework

7.8.1 Household members and family

Household members are generally very important in the decision making process of the head of household. Indeed, in Madagascar many respondents indicated in the questionnaire and in FGDs that decisions are made together, not just by the head of household. In both countries, respondents showed a high motivation to comply with the opinion of the household members and close family (see Appendix X and Appendix XI).

In Kenya, both the injunctive and descriptive normative beliefs of household members and close family were very high for intenders and neutral to negative for non-intenders. Also, the correlation of injunctive and descriptive beliefs of households with intention was very high and significant across the practices, which means that the respondents generally intended to adopt practices according to what the household members thought they should, and according to the perception of what their close family was actually practicing. No significant difference was found between the motivation to comply with injunctive or social normative beliefs and the gender of the head of household, suggesting that male and female headed household equally considered the opinion of their close relatives, even though the opinions differed significantly between intenders and non-intenders.

The comments of the Kenyan farmers illustrate this point. A 70 year old female member in Muramati explained that her children want her to use herbicides. The reason is that they depend on her for some of their money and they know that herbicides are cheaper than what she used to spend for ploughing. Others also mentioned that the household strongly supports direct planting, because it saves a lot of time and money. A 40 year old male member in Muramati relates smiling how his wife always tells him that "removing the trash from the land is like removing the blanket, the soil needs to have a blanket". She pressures him to leave the crop residues on the land. Similarly, negative pressure can come from the household. A 28 year old female member in Kalalu expressed that within the household there is a strong belief that they should use a tractor to plough and have a good harvest.

In Madagascar, the motivation to comply with the opinion of household members was also high. A 32 male non-member in the South explains: "The village is small and we know everybody. They are friends and some of them are family, so I take their opinion in consideration". However, the difference in injunctive belief strength between intenders and non-intenders was not as big as in Kenya. Also, the link of normative beliefs for the household members with intention was not significant for spraying herbicides, direct planting or mulching. Only in the case of planting a cover crop was there a significant link between injunctive normative beliefs significantly correlated with intention. With respect to planting a cover crop, A 54 year old male non-member in the South argues that it is because of his family that he is trying to plant a cover crop. A 51 year old female non-member in the North explains that the people whom she respects and admires are mainly her close family living in the village, but among them there are not many people who plant cover crops. Also with respect to cover crops, a 58 year old female non-member who is starting to experiment with CA comments that the people in her household caution her to start with the simplest CA methods and not to take too much risk.

For the other practices, farmers' comments also reveal a high degree of influence from household members. With respect to mulching, two farmers in the north mentioned that others in their household strongly believe they should not mulch as it would take too much time. When asked about ploughing, a 50 year old man in the South admits that he only became a member of ABACO because his wife pushed him to do so, but that he will give it a go. A 57 year old male non-member in the South explains that his brother has been trying to convince him to try direct planting. A 38 year old female non-member in the North explains that her family does not want her to do direct planting because they do not think she is knowledgeable enough to try it. They suggest to keep to the things she is more sure of.

7.8.2 Gender and intra-household dynamics

This section digs a bit deeper in the issue of gender, intra-household dynamics and CA. The focus group discussions (FGD) that were held in each of the six areas in both countries discussed this issue with respect to CA in general -not about the individual actions-, although farmers sometimes commented on specific practices. Very different pictures emerge from the two study areas. Whereas in Laikipia there is an imbalance in the sense that women do more work on the farm and men have more decision making power on farming operations, in Madagascar men and women are more equally involved in decision making and managing of the farm.

Distribution of benefits

In Kalalu, the FGD participants observed that women are doing most operation on the farm. At the group they have experienced that with CA, there is much less work, so in that sense it is the women who benefit more. Moreover, once men notice that the work is less tedious and the harvests increase, they join more in the work. This reduces the workload even more for women. The women also note that CA is very economical, referring to the reduced costs made for farming. The men in Kalalu FGD only see positive aspects of CA. They explain (to be precise: one man explains with visual and verbal approval of the other men) that there is a substantial labour reduction with CA compared to the conventional farming. They like this because it allows them to do extra income generating activities. Also, the remaining labour is not as tedious as the work under the conventional farming.

In Mazingira, members of the FFS concluded that out of the CA outcomes identified by themselves, the reduced labour and stress in farming was mainly an advantage for women, while the outcome of reduced cost was mainly beneficial for the men. The FGD consisting of both men and women agreed that the men generally manage the money, and therefore also benefit from reduced expenditures. The other, more agronomic benefits, such as an improved soil fertility, were equally shared among both genders within the household.

In Muramati, the advantages and disadvantages that are associated with a shift from conventional to Conservation Agriculture farming are quite equally distributed among households of different gender. As CA is largely associated with spraying herbicides, respondents in the Focus Group Discussion first turn their attention to this issue. For men, the spraying of herbicides is very easy, although it takes some getting used to. It is a very time efficient way to prepare the land and to weed. This results in a lot of time that can be spend in other income generating activities, or for social activities. For women the reduction of labour from using herbicides is also the most important element, although they note that the knapsack is quite heavy to use by women. It is therefore more a men's activity than it is a women's activity. In that sense, spraying herbicides poses a bigger challenge for women than for men, although they still find it much easier than conventional weeding. Women further note that compared to conventional agriculture, the weeds are a lot easier to uproot because the soil is moist and loose, which is attributed to the effects of cover crops. Also, when you practice CA there is more time to attend to family chores without being under pressure. The shift to CA does not bring much differences in terms of gender. When it comes to the other elements of CA, the Focus Group Discussion, consisting of both men and women, don't see any gender-related differences among them.

In the Alaotra region, the group in the South argues that CA reduces the workload for both men and women. A female member comments that she does not have to irrigate the fields when growing a crop off-season, because the soil stays humid under the cover. A male member observes how he does not have to plough any more on the *tanety* to grow a crop. Another man adds that because the soil does not become very hard, the work becomes easier. Both men and women discuss how there is a better harvest under CA and better revenues compared to conventional systems. The disadvantages mentioned by this group are that there are a lot of formalities that come with taking part in the project, and that they have to do a lot of interviews and group discussions. Also, CA only seems to work if you follow the technique by the letter. Both men and women agree that it is inconvenient that they have to use relatively much insecticide and herbicides. Also, fields with CA seem to perform less when there is a lot of rain. Finally, there is always the insecurity of leaving mulch on the land, as it is difficult to prevent cattle owners to enter your land with mulch.

In the discussion of the gender aspects of these advantages and disadvantages it was confirmed that because both men and women work together, they both benefit from practicing CA. A man in the South noted that "because we [men] no longer have to plough, we have less hard work with CA". Another man concluded that this is true, that in general men and women benefit both, but men benefit a bit more as they do a bit more of the physically heavy work.

In the North it was argued by a man that under CA it is the women who benefit the most of doing CA "because it is the women who manage the budget in the household. With CA she does not have to go through the stress and responsibility of doing the calculations and dealing with hired labour that normally comes with ploughing and weeding". A women responded: "to be honest, I think it is the men who do very hard work, and by not having to plough they benefit most". A man brings another point to the discussion, as he feels that because it is the men who do the hard work, they are also blamed if problems appear on the land. However, both men and women laugh at this point and also the speaker seemed to be half joking. Another woman starts about the "most important inconvenience of CA" which is the unauthorized grazing: "This problem effects the whole community, the cattle owners do not acknowledge CA as a farming system and they let their cattle in our lands. This is the biggest problem, and it is the same for men and women".

Moral judgement

Closely related to the distribution within the household of the labour saving benefits of CA, as discussed above, is the moral evaluation of people who do not work hard. Women in Mazingira and Kalalu explained that for women, although they benefit from working less, it is a bit more complicated than for men, because they risk being branded as 'lazy' if they do not work as hard as is normal. As also became clear in the discussion of attitudes, the farmers in this area find it a *moral* necessity and duty for women to work hard all day, while it is relatively common and socially accepted for men to be temporarily without hard work.

This is how one of the attractions of CA, the reduction of labour, can stigmatize adopters. Especially when people combine the observation that someone spends very little time on their land, and that the farm appears untidy due to the residues. One woman in Mazingira argued that this is the only reason she was not adopting CA, because she felt that the women around her pushed her to work 'properly', and 'clean' the land and be a 'good farmer' again. In Madagascar, this moral pressure was not expressed by farmers in the course of this study.

Decision making

A 60 year old female member in Mazingira pointed out that "some members of the FFS do not practice direct planting because the husbands do not support it". An example was found in a 58 year old female non-member in Kalalu who narrates how she was once practicing shallow weeding on the farm when her husband happened to come by. He became angry and said, "why are you doing such a foolish thing? Start doing the right thing again!" Although she felt differently about it, she had no choice but to start deep weeding again, because he was the decision maker. Speaking to the extension officer who was doing the interview about CA must have put her in a situation of conflicting social pressure.

In all groups in Laikipia, but especially in Mazingira and Kalalu, participants of the FGD mentioned that family conflicts sometimes contribute to failure of CA adoption. Because men are most often the decision makers of what happens on the farm, they can do as they see fit on the farm. The same is sometimes true for female heads of households, although they are sometimes still under influence of brothers or other male family members. Some women in the FGD who are member of the FFS are not the decision makers at home. So in this situation the road to adoption is much more complicated, as a convinced woman faces the challenge to convince her husband before they can adopt. The farmers argued that this is difficult, because although the woman can be convinced to try CA, she has only just been trained and the techniques are also new to her. In this situation, even experimenting with CA on a portion of the land may pose a risk for the women who are being watched by a sceptical husband.

It is not uncommon that CA does not work directly because it is complex in terms of timing, and all the group members have made some mistakes at some point. But, as a woman in Mazingira points out, if this happens on the test field at home, the man will be quick to judge and reject the concept. A man in the same FGD points out that women are faster and more eager to adopt CA compared to men; the men sparsely adopt and even if they do it is in the form of providing the women with some money to purchase the herbicides. In Muramati it was observed that generally men, once they are convinced, adopt on a bigger percentage of the land, while for women who adopt there is only actual adoption on a small part of the land due to the 'family conflicts'.

In Mazingira the FGD was the most outspoken about the imbalance in decision making. A man explains how mainly the men are in charge of the bigger animals: "Women can only deal with the chicks and the hens, but even if there is a big cock, it will be the man to decide when to sell it. Sheep and goats and certainly cattle are the responsibility of the men". This has the consequence that feeding the cattle is also an issue for the man to decide, who can therefore object to the idea of using crop residues as mulch. Another man in the group goes further by saying that the trainings are given to the wrong people. First there are too many elderly, and the young farmers are not present. Secondly, the women wish that their men could regularly be trained as well, since they stand in the position of decision making. To prevent this problem, group members in Kalalu, Muramati and Mazingira suggested that when there are trainings, the husbands and wives should also be invited so that they will have the same information base.

7.8.3 (CA) Groups

In addition to household members and relatives, CA groups appear to be an important source of social pressure in both countries. In both countries, the motivation to comply with the opinion of group members is high. As a 25 year old female non-member in Madagascar (the North) points out: “you have to consider the group members’ opinion, even if it is only to respect the members”. Sometimes the motivation to comply is specific to practices, as a 30 year old male member in the South illustrates: “if people in the group only have an opinion about direct planting, then I am not listening, but if they have ideas about cover crops I am very much interested in hearing what they have to say”.

In Kenya, one of the members of Mazingira FFS says that shallow weeding “is the concept we use nowadays”, indicating that it has found its way to become a mainstream practice in her social environment. Indeed, in some instances this social environment for members consists for a big part of other group members. When discussing the issue of mulching, a 70 year old female member in Muramati argues: “Most of the people whom I respect and admire are members of the CA group. I think what they do is reasonable”. Although most of her neighbours think she should give the residues to cattle, the people who influence her most are members of the CA group and thus provide a social environment that stimulates her to leave the residues on the land. For all three actions that were assessed to the beliefs level in Kenya, the descriptive normative beliefs showed a significant difference between intenders and non-intenders. That means that non-intenders did not think that the FFS members actually adopted these practices on their land to the degree that intenders thought they did. In Kenya, both injunctive and descriptive normative beliefs of the FFS where significantly correlated with intentions for the behaviours spraying herbicides and direct planting.

In Madagascar, a strong positive link was found between both the farmers’ injunctive and descriptive normative beliefs about CA groups, and intentions to practice mulching (significant at the 0.01 and 0.05 level respectively). For example, a 60 year old female member in the South argues that especially the group members are pushing her to do direct planting on her farm. The descriptive normative beliefs were only significantly different between intenders and non-intenders in the case of mulching, suggesting that non-intenders did not think that the CA group practiced mulching. This is possibly linked to the perception that mulch refers to the *bozoka* that is imported from the *tanety*, as was the common perception in the South until the ABACO project started. This idea was expressed in the South by 5 farmers, for example a 40 year old female member in the South who comments: “the groups do not really think I should do mulching, it is the living cover crop that is promoted in the group these days”. With respect to spraying herbicides farmers in both the South and North argued that mainly the group members are using herbicides outside the rice paddies. Although CA-groups are a source of social pressure, they do not send a unified message, not even to its members. A 40 year old male member in the North argues that the groups that he belongs to is not in agreement about the technique of planting a cover crop.

7.8.4 Neighbours

In both countries, the opinion of neighbours (or 'others') was an interesting topic of conversation. The feeling that people should decide for themselves was very strong. "*Á chacun sa vie*" makes life a lot easier, explains a 60 year old female member in Madagascar. In both countries farmers repeatedly expressed how they would not in any way confirm to what 'others' say. A 45 year old female non-member gives words to the sentiment that was expressed many times in both countries: "I only listen to the opinions that are relevant to me, and even if I am considering what people say I only keep the good ideas". This was reflected in the low motivation to comply with the opinions of neighbours. In addition, the correlation between injunctive and descriptive normative beliefs about neighbours and intention was for neither of the practices both positive and significant, in either country. In Madagascar the correlation with intention was even negative (see Appendix XI). Nevertheless, individual comments reveal how neighbours still play a role in the attitude towards and the formation of outcome beliefs about technologies like CA, and, vice versa, how farmers influence their neighbours. Also, without explicitly asking questions or asking advice, the farmers were very aware of what others are practicing, and had their opinions and sometimes gossips readily available.

Several examples of positive perceptions of neighbours were observed. Farmers in Kenya reported the neighbours as important sources of information about spraying herbicides, weed management, or CA in general. Nevertheless, it was added that despite the positive attitudes that some neighbours express, many of them are reluctant to adopt CA.

Neighbours can also be a source of scepticism and criticism when it comes to CA, in particular the use of herbicides. During FGDs in Kenya, farmers reported negative attitudes of their neighbours towards herbicides, because it is thought that herbicides destroy soil quality. Apparently, CA and herbicides are related in such a way that having a negative attitude towards *dawa* (or: chemicals) stops people from appreciating CA. In Mukima, these negative perceptions of CA and herbicides were also present among most of the group members. In the other groups, members are generally not impressed by the statements of their neighbours, judged by the low motivation to comply with the opinion of neighbours. A male member in Kalalu FGD argues like this: "We think that among our neighbours there is a lack of knowledge on how the herbicides exactly work, and how and when to apply them".

In discussing the opinions of the neighbours a strong moral aspect of CA was perceived in Kenya, which already became evident in the discussion of gender and household members. A female member explains in the FGD in Mukima: “My neighbours say that it is not godly to do direct planting, because it encourages laziness”. As a 53 year old female non-member in Muramati puts it, referring to the members of the CA group: “It cannot feel good to do what one should not be doing”. In Mazingira a women describes how ‘others’ say: “Those who practise CA are lazy people. The Bible says that a man shall reap the fruits from his hard work, so those who don’t plough go against the word of God”.

In Madagascar, farmers were equally aware of their neighbours’ opinions and displayed very varying perceptions of what neighbours were thinking about CA. With respect to spraying herbicides, four farmers in the South commented that these days everybody starts using the modern techniques like herbicides, suggesting a general and wide adoption of herbicides even on the *tanety*. A 22 year old male non-member in the South explains that his neighbours are pushing him to use herbicides, but “they don’t know that my soils don’t need them”, illustrating the strategic use of herbicides.

With respect to ploughing, three farmers in the south mention how neighbours suggest to try cover crops instead of ploughing, while a 23 year old male member in the North feels that “this year the farmers who were practicing CA have abandoned it and come back to conventional because it was too expensive”. A 56 year old male member in the South observes that only those who received training are practicing CA, and “the reason why people do not practice direct planting is because they have not had the same training as I had”. A 30 year old female non-member explains that nobody talks about the technique of direct planting because nobody knows it.

A 38 year old male non-member in the South sees limited acceptance of direct planting: “It is still a bit weird and awkward for us to plant without ploughing, especially in our village”. In the North it is a bit more common, although a 38 year old male non-member argues that those who actually practice direct planting are very few: “only the members of the group, and those who have plots on heavy slopes plant without ploughing”. A 48 year old female non-member in the North also feels that “only some people plant without ploughing, especially on the lands where it is very impractical to plough”. A 60 year old female non-member ads that she does “not consider the opinion of my neighbours, because if what I do is not working out well, they are mocking me. But I see that direct planting with cover crops is practiced by quite some people around here”. A similar pattern is visible for mulching, as a 45 year old female member admits that “we still make fun of people who apply mulch”, while others explain that neighbours support mulching because it fertilises the soil. When it comes to planting cover crops, farmers are very aware what others are planting. And where mulch is sometimes described as looking ‘messy’, a cover crop often has the looks of abundance, of extra harvest associated with it. In the South, especially vetch and stylosanthes are mentioned as popular crops, while in the North velvet beans and dolichos are also often planted. However, a 45 year old female member comments that those who have equipment still prefer to plough.

7.8.5 Cattle owners

This section digs a bit deeper in one type of neighbours, the livestock owners. Because the perceived behavioural control and normative beliefs are very much related when it comes to this topic, they are combined in this section. A big issue determining the relations between CA adopters and their neighbours is related to the mulching. In Laikipia, where rainfall is limited and therefore biomass is relatively scarce, the cattle owners put pressure on farmers to give or sell their residues, especially to family living nearby. Even if it is not used for cattle, maize stovers are used for making line bounds on the edge of the fields or for cooking, and there are many eyes watching how farmers use their crop residues. Nevertheless, there were no examples mentioned of other farmers entering their land without permission in Kenya.

In Madagascar, the cattle feed mainly on the residues of rice, transported from the rice paddies, but it is common practice of cattle owners to let their herds graze on residues in other farmers' fields, which is seen as a strong cultural and historical right. Two farmers in the South mention how their cattle-owning neighbours discouraged them from using herbicides because it was supposedly not good for their cattle that graze in their neighbours plots. A 68 year old female member in the South complains in general that cattle owners do not care about their plots, and a 45 year old female member in the South narrates how people laugh about those 'who cultivate in the residues' and simply let their cattle enter in their plots.

A 45 year old female non-member in the North argues that "if we plant a cover crop, it is *fady* to enter the land. If there is only mulch, people will have no shame and simply enter the land. And then we have no option but to plough". The general agreement is that cattle are not allowed in the plot if there is a living crop, it is *fady* or taboo. Also in case a farmer does not want his/her plot to be entered by cattle they can put up a sign, called a *dodoka*, most often a long stick with some grass or a plastic bag at the top. This is common practice in rice paddies with seedlings. In that case it is also *fady* to enter the land with cattle. Several farmers in the South argue that if they put the stick in their land, cattle owners do not dare to enter. In the North, however, farmers explained that it depends on the location of the plot. If it is close to the village, cattle owners generally keep to the agreement because it would be noticed if they did not, but the fields that are far from the village are often entered by cattle. Even if there is a living crop and/or a sign that they should keep out. Both in the South and in the North, farmers mentioned that it is one of the biggest challenges for CA farmers, because if cattle enter the plot they do not only eat the cover, they also compact the soil.

A 67 year old female non-member suspects that the cattle owners target the CA farmers on purpose. During the focus group discussion in the North, farmers spoke about the problem in an agitated way. A woman argues “this inconvenience with CA concerns the whole community. The cattle-owners don’t acknowledge CA as a farming system and they let their cattle in our lands, even though we put the sign that would normally stop them”. Another woman argues “I think we need help in protecting our lands against grazing. During BV-Lac, for example, the project handed out little plates to put on the land with the project logo on it to make clear that the herds are not allowed on the land. This should be done again, because that is the only way that people will give us at least some respect for our farming”. A man responds by saying that “the people in our environment totally lack respect! I don’t think we should depend on the project for getting respect, because when the project is over, the problem will come back!” Another man adds “this problem has always existed in the area, and we should try to do our best with the signs in the land. We should also try to find ways to get financial compensation for the damage they do!” This tension was firmly expressed, but people also expressed they did not want to jeopardize the unity of the community, and they were looking for ways to diplomatically tackle the problem.

7.8.6 Other social referents

Elders, chiefs and village leaders

In Laikipia County of Kenya, the traditional power structures coexist with the official government system. Among the respondents were mainly people from the Meru and Kikuyu tribes who have different forms of leadership. Among the Kikuyu, leadership is in hands of chiefs, while among the Meru, leadership is with the elders. Traditionally, both would have a say over many aspects of everyday life by taking decisions on important issues that affect the community, and in conflict resolution. But their influence has degraded over the last decades and although the chiefs and elders fulfilled some social functions, farmers in Laikipia did not really value their opinion about farming practices. The quantitative data of farmers’ normative beliefs about chiefs and elders was emitted from the results, because many farmers were not aware who exactly their chiefs and elders were, let alone what their opinion was about CA.

Some farmers did know them, and at a farmer field day in Mazingira where results from a CA experimental plot where demonstrated, an elder was present. A 60 year old female member in Mazingira formulates a common reaction: “The elders? [laughing] they never practice CA despite attending field trainings. They are too old to change their way of farming and nobody listens to what they say about farming”. There are, nevertheless, people who have had contact with chiefs or elders about CA. A 63 year old male non-member in Mazingira, was recently “convinced” by a practicing village elder and by neighbours who encouraged him to try “planting with CA”. So now he will give it a try on a portion of his land to see if and how it works.

In the study areas in the Alaotra region, there were democratically elected village leaders, who were very much at the heart of village decision making processes. All respondents were aware of the opinion of the village leaders and they could therefore be a source of social pressure. The results show however that the injunctive normative belief for village leaders was positive but moderate for all actions, ranging between 0.07 and 0.60 (see Appendix XI). The descriptive norms show that in the perception of farmers few village leaders actually adopt CA practices. Moreover, the motivation to comply was low, indicating an indifference from the side of farmers to the opinion of village leaders about the agricultural practices. A 54 year old male non-member in the North argues that “even if we know the technique, we always need to give heed to the experience of others. The elders stay the elders, and they are the ones with more experience than us”. A 37 year old male member in the North argues that there is variation in the opinions of the village leaders. According to him, only those elders who are in the group actually practice CA. In both the South and the North, farmers commented that the leaders of the village are generally no big supporter of direct planting, and they keep supporting ploughing.

Service providers

In Kenya, the perceived labour reducing aspect of CA was generally welcomed by the farmers themselves, but also caused some tensions with people who work as service providers and seasonal labourer on other farms. In the explorative questionnaires, service providers were identified as potentially influencing decision making for spraying herbicides and direct planting. It was found that for farmers experimenting with herbicides and direct planting, *conventional* service providers who do ploughing, planting and weeding, where a source of negative social pressure. They feel that with CA they are denied a job. The chairman of Muramati FFS explains that his choice for CA has caused some angry reactions: “If I call some service providers to ask if they can help with some work on my farm they do not respond because they know I am a CA farmer. They say: ‘What do you need me for? You can do your own farming, so good luck with your CA!’ ”. This experience was also confirmed by other farmers and in the FGD in Muramati, but, as a 64 year old male member in Mazingira puts it, “It is the owner that tells the service provider what to do”.

The increasing use of herbicides has led to new service provision of spraying. They are a source of positive pressure, because they go around and sometimes convince farmers. Where farmers’ injunctive normative beliefs of service providers are negative for direct planting, they are positive for spraying herbicides. Similarly, the motivation to comply to the opinion of service providers is low for direct planting and high for spraying herbicides. In FGDs in both Mazingira and Kalalu it was mentioned that service providers (for herbicides) also know a lot about herbicides, and are a valued source of information.

In Madagascar, the opinion of service providers was not mentioned as a possible source of pressure on any actions. Field visits and informal interviews with farmers confirm the attitude that the farmer who hires people is the one who tells them what to do, but farmers nevertheless depend on the willingness and experience of the service providers if they want to adopt. A farmer in the South narrated how he told service providers for planting to do direct planting, but they removed all the mulch. In FGD in both North and South it was mentioned that service providers sometimes ask higher prices for direct planting compared to conventional planting because it takes more time.

Extension

In Laikipia East, farmers' access to extension support is generally limited, because the Ministry of Agriculture is limited in terms of human and financial resources to fully realise their objectives. But being a member of an FFS and participating in the ABACO project is used as a way to have more frequent visits from extension staff and researchers. Some non-members were also able to benefit from some of these visits, while non-members who were a bit more isolated, both geographically and socially, indicated they rarely see support from extension staff. The normative beliefs held about extension in Laikipia show that both the injunctive belief strength and motivation to comply was slightly positive for spraying herbicides, and highly positive for direct planting and mulching. The opinion of extension officers was also highly and significantly correlated with intentions to practice direct planting and mulching. In an interview with a farmer in Muramati, she explains that it is because those techniques have been introduced to the area by extension officers, therefore their opinion about it is very important to them.

In Madagascar, there was currently no extension service provided to farmers that were interviewed. Only those who were members of the group had regular contact with the project staff. Although they primarily dealt with organisation of the group plots, project staff also visited some of the fields of individual farmers in the process. Farmers wishing agricultural advice could visit an office of the CSA (agricultural advice centre) in Ambatondrazaka, who would provide *fiches techniques* (information sheets) with respect to the details of certain crops, which were also available for the cover crops *vesce* and *dolique.* Few farmers, however, make use of this service. Farmers mainly mentioned the use of local agrovets as source of information rather than the practically non-existing official extension service.

7.9 Understanding perceived behavioural control

In this section attitudes towards CA practices are described and further explored in terms of the underlying outcome beliefs (see Figure 7-9). This section is structured according to the different CA practices because the control beliefs were different for each practice.

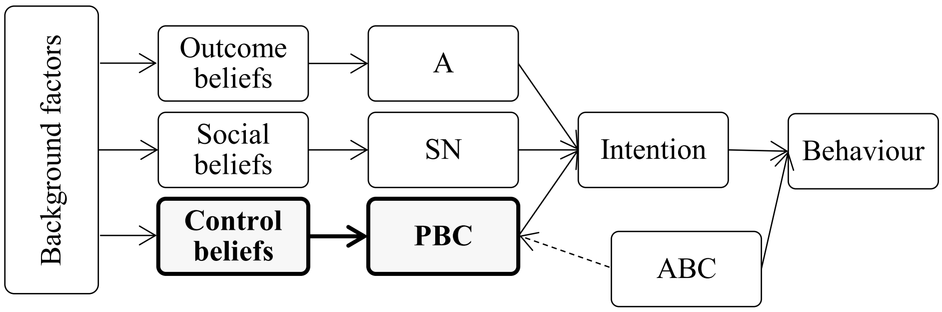


Figure 7-9 Perceived Behavioural Control (PBC) and underlying beliefs (bold) within the RAA framework

7.9.1 Spraying herbicides

In Kenya, results show that intenders were very confident that the control factors listed in the RAA questionnaire would be present in the next season. For non-intenders this was significantly lower, and included a negative control belief for 'knowing which herbicide to use'. All control factors had significant correlations with intentions, although having equipment seems to be the least important (see Appendix X). An important aspect of the perceived behavioural control for the practice of applying herbicides, for both group members and non-members, is experience, which underlies the confidence of applying herbicides correctly. A 53 year old male member in Muramati explains that he tried to apply herbicides two times. "The first time it killed my maize as well, and the second time it failed to kill the weeds. But my uncle, who practices CA, is a very good farmer, and I cannot deny that he has much better crops than I have. So I am going to try again this season". This farmer is clearly struggling to adopt it due to poor knowledge, while at the same time he is convinced that it is a good thing. Group members in the different areas have seen such examples many times and argue that it is very important to know exactly which product to use and when to apply it. The importance of money is difficult to evaluate. The quantitative data suggests that having enough money to buy herbicides is a significant factor in the perceived behavioural control, although mainly so for non-intenders. Previous adopters may have experienced that the money previously used for ploughing becomes available for the spraying.

In Madagascar, most farmers are used to spraying herbicides on the rice paddies and *baiboho*, so in that sense they have experience and are already used to it. A 54 year old male non-member in the

South, however, mentioned that although he knows which herbicides to use on the rice paddies, he is not too sure what to use on the *tanety* and *baiboho.* Several farmers, both members and non-members in the North and South, are sure that they can find out what dose of which herbicides to use because they will not hesitate to ask their neighbours or the sellers. A 38 year old female non-member in the North stresses that weeds keep changing and the weed control in terms of types of herbicides and doses should always change accordingly. Many farmers indicated they own or share knapsack sprayers, or can hire them at low cost. With respect to money availability at the start of the next season, farmers agree that this always depends on the outcome of the current season, so they cannot be very sure. A 45 year old female non-member in the North illustrates how closely control factors and attitudes are linked, when explaining that "the price is the main issue, to be honest, it is mainly that it is difficult to find good and reliable products. That is why we try to avoid using phytosanitary products on our farm". In general, farmers argue nevertheless that it is very important to make sure they have enough money to invest, although farmers also indicated that the management of the rice paddies is more important than the crops they grow on the *tanety*. Together, this explains why only the money availability was significantly correlated with intention (see Appendix XI).

7.9.2 Direct planting

In terms of behavioural control over direct planting as a productive practice (that is: not as an 'emergency option'), the key issue identified in Kenya is knowledge and experience. The quantitative data shows that intenders are confident that they have enough knowledge about direct planting, have enough labour, equipment and money, while non-intenders are significantly less sure (see Appendix X). The closest link with intention was found for the control factors 'having knowledge' and 'having favourable soils', and to a lesser extent 'having money'. The latter was generally considered important for farming, but many of the experienced CA farmers acknowledged that for direct planting in itself no extra money is required. The favourable soils refer mainly to the moisture content, because if the soil is too wet, the mud will stick to the jab planter or the animal drawn planter, making it difficult to plant. Similarly, if the soil is too dry, it is too hard to penetrate for planting.

Many farmers have witnessed people trying to "plant with CA" and fail, as there are several things that can go wrong. Experimentation to acquire experience is acknowledged as being important. A 74 year old female non-member in Mazingira explains that she is experimenting now, because "for people to be able to judge the real effects [of direct planting] on water infiltration or harvest, they need to have done it themselves. It is not enough to have seen it elsewhere". Another farmer even goes further and argues that it will require more experience to know the real consequences on the soil, something in the order of five years, again illustrating the perceived importance of knowledge through experience.

For direct planting in Madagascar, the control factors of having enough money, equipment and knowledge, were significantly higher for intenders than for non-intenders, while there was no significant difference for having enough equipment. Only having knowledge showed a significant direct correlation with intention to practice direct planting. With respect to the knowledge aspect, several farmers argue that direct planting is easy because they have already experimented with it. Or, as a 28 year old female member in the North puts it: "it is not very difficult or easy, it just takes getting used to it by trying". Conversely, some farmers (both members and non-members) argued that direct planting is still a bit difficult for them because they do not have experience. As they are in one of their first seasons, they do not know exactly what to expect. The need for technical assistance was also stressed. As in Kenya, a farmer in the South argued that direct planting can be difficult in certain climatic situations or states of the soil.

Farmers agreed that no special equipment is needed besides what is already available. A 35 year old male non-member in the South comments smiling: "all you need for direct planting is a spade and a seed basket". Also it was generally agreed that money was not the issue because direct planting is either cheaper than or comparable to conventional planting. Labour availability was also not a problem in the area. So both the qualitative and quantitative results point at the importance of knowledge and experience as important control factors for the adoption of direct planting.

7.9.3 Ploughing

As noted before, ploughing, is a costly practice in Laikipia for the many farmers that do not own ploughing equipment. The money is not always available at the beginning of the season, although it is seen as such a central practice that farmers generally find a way to get their land ploughed, even if this involves tapping into family members' time or money. Another aspect of the perceived behavioural control (PBC) for ploughing is the availability of service providers who are in high demand right after the first rains, they are often not available when you need them. This forces some people to plant late and therefore have a less favourable start to the growing season than those who can plant early.

In the Alaotra region, seven farmers commented that ploughing is very easy for them because they own both ploughs and bulls. Others explain that it is very easy, as long as you pay for the service providers. Some of the farmers without the equipment to plough argued it would be very difficult for them to do ploughing and that it would depend on the financial situation. A 59 year old female member in the North argues that it depends on the structure of the soil, because if the soil is relatively loose, it is very easy to do the ploughing, whereas if it is highly compacted, ploughing is a big challenge. There were several instances where farmers commented that thanks to CA, the soil has become soft which allows them to do ploughing more easily than before CA.

7.9.4 Mulching

Regarding the perceived behavioural control over mulching, farmers in Kenya argue that their control is limited due to cattle feed shortages. In some areas like Muramati, farmers often have more land than they can cultivate and therefore also have a lot of pasture for the cows and small grazers. However, in more densely populated areas like Kalalu, farmers argue that there is a need to feed the cattle with crop residues. A 49 year old female non-member in Mukima argues that it depends on the weather whether there is enough food for the livestock. Only if there is enough rain, when there is enough feed, can people use crop residues for mulching. But in most seasons, the demand for feed is high and people can sell their residues. Several farmers believe that if you have cattle, you cannot do mulching. A 69 year old female non-member in Kalalu puts the dilemma like this: “I give everything to the cattle. Mulching would be difficult because it would create a lack of cattle feed. But my neighbours say that it increases soil fertility, so I am tempted to try it”. Some farmers in Kalalu are growing Napier grass, Kikuyu grass and Desmodium to feed the cattle in addition to the crop residue, leaving a proportion of the maize stovers available for mulching.

The quantitative data for Kenya (see Appendix X) shows that intenders are very sure that there is no unauthorised grazing of their residues. The difference between intenders and non-intenders was biggest, and highly significant, for the belief strength of the control factor ‘having enough biomass’. This was also evaluated as the most important factor in case someone wanted to realize a significant mulch cover, and a high, positive and significant correlation was found for this control factor and the intention to practice mulching. Surprisingly, the ability to feed the cattle (without using the crop residues) was not significantly correlated with intentions. This could be explained by a different way of thinking between farmers and researchers. In a situation where keeping and feeding the cattle is a non-negotiable given, farmers do not see the limited crop residues as a ‘trade-off’ or a ‘lack of fodder’, but they simply observe a ‘lack of biomass’ for mulching. The conflicts with cattle owners, including how this affects perceived behavioural control over adopting mulching are discussed in section 7.8.5.

In Madagascar, farmers mentioned several control factors that determine their ability to realize a mulch cover if they wanted to. Especially in the South, farmers were associating mulching with importing *bozaka* from the *tanety* and therefore associated it with the ability and effort of transportation. A 35 year old female member in the South explains that “the main reason why I don’t apply mulch is because I don’t have cattle or a cart to transport the biomass”. A 38 year old male non-member in the south explains that he does transport crop residues on a cart, but that is only for fodder, not for mulching. Despite the work, a 46 year old male non-member reported buying crop residues from his neighbour to realize a mulch, which gave very good results. Several others transport residues or *bozaka* for the mulch, but only if the source field is very close to the target plot. Only one farmer, a 38 year old male non-member in the North, mentioned land tenure insecurity as a reason why he does not adopt one of the CA practices, in this case mulching: "I think that the fertility and structure of the soil would improve by using mulch, but because I am renting the plot from someone else, I am not very motivated to do mulching. I suspect the owner would take the plot back if it would improve".

Especially in the North, farmers have found a way of realising a mulch cover without the need to transport. A 45 year old female non-member in the North puts it like this: "I never transport mulch any more. Now I use cover crops". The ability to realize a good mulch cover is therefore linked with the ability to realise a cover crops, as is illustrated by a 42 year old male member in the North who explains: "Whether I will be able to adopt mulching depends on whether I will find the good seeds to plant a cover crop". Another farmer in the north adds that you need good rains at the beginning of the growing season so that the cover crops grow well and can ultimately produce a solid level of mulch. A 67 year old female member in the North stresses the importance of knowing how to sustain the cover throughout the growing season, which is crucial for the mulch to have effect.

In Madagascar, intenders are significantly more certain than non-intenders to have enough biomass for mulching in the next season. The mean perceived power, that is the importance of the control factor, is low for intenders and high for non-intenders, indicating that especially non-intenders associate mulching with the need of transporting crop residues or *bozaka*. The most important control factors for both groups of farmers were the prevention of unauthorized grazing and having enough biomass. Having enough biomass was significantly correlated with having the intention to mulch, which, as was shown above, is linked to the ability to successfully grow a cover crop.

7.9.5 Cover crops

In Madagascar, the results show that there are three important control factors that influence the use of cover crops: the access to seeds, the availability of money, and the knowledge of how to plant the cover crops. For these control factors, intenders were significantly surer that they would be present next season than non-intenders. The highest importance was attributed to availability of seeds and money, followed by the knowledge on how to plant the crops. The link with intention was high and significant for all three control factors, but highest for access to seeds. The climate was generally not seen as a limiting factor, as there is generally enough rainfall to grow a cover crop. At least six farmers in both South and North argued that it is difficult to find seeds. A 58 year old female member in the North tells that it has happened to her that she had money available but was unable to find the suitable seeds to plant a cover crop. A 31 year old male non-member in the

South tells that it is not easy to find seeds these days, while before they used to be handed out for free. This practice of free or cheap handouts that has been in place for ten years has not resulted in sustainable demand and supply of seeds for small holder farmers.

Farmers with recent experience of practicing CA, however, find it very easy to find seeds. *Mukuna* is available everywhere, argues a farmer in the North, and *niebe* is for sale in every shop, explains another farmer in the North. Other farmers grow their own seeds, the most notable example is the CA group in Ambalakondro (the North) who not only grow seeds of cover crops for their own use, but also sell it to other farmers who want to plant it or eat the *mukuna*. A 37 year old male non-member points out that to plant and maintain a cover crop requires a lot of care and attention, much more than with conventional crops. And a 53 year old female non-member in the North argues that planting a cover crop is not entirely 'up to her', because not everybody that you hire to do the work is familiar with the technique, so it depends on their experience as well.

7.9.6 Shallow weeding

The practice of shallow weeding is generally considered easy and up to the farmer to apply it or not, making the perceived behavioural control high. The only remark made by some farmers was that the equipment, that is the shallow weeders, were not available to them. It has proven quite tricky to design a functional shallow weeder, because it needs to be both robust and sharp, and the metal plate needs to be at the right angle for comfortable use. Because of their popularity they are increasingly available at local blacksmiths. Shallow weeding in the traditional way with a panga remains an option all along. Another remark was that shallow weeding works best when the soil is a bit hard and dry, so after a period of much rainfall there can be a delay with weeding, when waiting for the soil to dry. But generally the perceived behavioural control was very high.

7.10 Synthesis: understanding intentions and adoption of CA

The results of the regression analysis for both countries show that intentions to adopt CA practices are mainly influenced by attitudes, followed by perceived behavioural control. From the comments that farmers made, it was possible to understand where both positive and negative attitudes come from, and how they link to intentions. A summarizing figure of the results for Kenya is given in Figure 7-10 and for Madagascar in Figure 7-11.

7.10.1 Intentions to practice CA in Kenya

Attitudes had the strongest influence on intentions to adopt CA. Attitudes to shallow weeding and direct planting are very different for intenders and non-intenders (see Figure 7-1) and can be traced back to various opposing beliefs about the consequences (see Appendix X). Both actions exist in the area as traditional practices that are normally not considered to be productive, but may be adopted when farmers are late with weeding or ploughing respectively. Negative attitudes towards shallow weeding (using the *panga*) come from its backward connotation as a traditional practice, and the belief that it is not very effective in controlling weeds. Positive attitudes towards shallow weeding come from the belief that it is both easy and effective. Farmers with either beliefs may adopt, but for the first it is a way to cope with limited labour or bad planning, rather than being a positive choice. For the latter, shallow weeding (using the *shallow weeder*) is a positive choice reflected in the intention. Similarly, direct planting is seen by intenders as a labour-efficient way to reduce evaporation, improve soil structure and infiltration, and achieve a higher harvest (see Appendix X). For non-intenders the negative attitude is explained by the opposite beliefs, especially that direct planting is bad for the soil structure and leads to bad harvests. Spraying herbicides is also a positively perceived practice among the intenders, especially for improving the harvest and saving time. Non-intenders seem to associate it also with several negative outcomes, such as various human diseases and a reduced soil fertility in the long run.

Mulching was perceived as a positive practice by most farmers, especially due to the belief that it reduces evaporation and improves soil structure and fertility. Mulching has been promoted for several decades through extension, and most farmers have positive experiences with the practice (e.g. with growing vegetables and potatoes). That explains why for mulching not attitude but PBC was the more significant predictor of intention.

Social norms, whether split into injunctive and descriptive norms or combined into a single scale, showed no statistically significant regression coefficients in the prediction of intentions. This was a surprising finding, as one would expect that in small rural communities there would be considerable social pressure on what normal or good farming would look like. During the interviews, farmers proudly expressed a high degree of social independence and individual decision-making which can partly be explained by the fact that the farmers are relatively new settlers in the area, and therefore are not as open to social pressure from neighbours as might be expected in close rural communities. Moreover, social norms are closely related to attitudes and control, and it was observed that outcome beliefs are often socially informed (e.g. a farmer who thinks direct planting improves soil moisture because all the group members say so), and that control beliefs are linked to social networks (e.g. a farmer whose friend owns a knapsack makes spraying herbicides easy, or cattle owners letting cattle graze without a farmers consent).

Nevertheless, except for mulching and CA, high and significant correlations still suggest that there is a link between the perceived norms and intentions. The qualitative data and normative beliefs showed that the main sources of social pressure are other members of the household, the FFS-members, and extension officers (in that order, see Appendix X). Extension was valued for their advice on especially direct planting and mulching, although farmers would not necessarily conform to their opinion. The traditional structures with chiefs (Kikuyu) and elders (Meru) fulfilled some social functions, but did not much influence agricultural decision making (see Appendix X).

Together with attitudes, **perceived behavioural control (PBC)** was found to influence intentions significantly. This was particularly so for mulching, where the control belief underlying the PBC which has the closest link with intentions is the confidence of being able to produce enough biomass, and not the competition with cattle. This points to difference in framing between what researchers call 'competition' and what farmers call 'a lack of biomass' production in a situation where feeding cattle is a given, not a decision. The second relevant control factor found for mulching is the ability to prevent unauthorized grazing (see Appendix X). Not having enough biomass could be seen as a matter of knowledge, but especially in Kenya, this is also a agronomic constraint in a situation of very limited rainfall and cattle to feed throughout the dry season. For spraying herbicides and direct planting, knowledge seems to be the most important in the PBC. For spraying, the most important control factor is primarily which herbicides to use, and secondly knowing when and how to use it. The availability of equipment appears to be the least important control factor, as farmers explained it can easily be borrowed or hired. Having enough money to purchase herbicides is also an issue, although intenders are quite certain they have enough money for this in the beginning of the growing season. The main control factors underlying PBC for direct planting are having the knowledge to plan the farming operations properly, and to have favourable soils (meaning that the soil is not too wet or too dry at the time of planting).

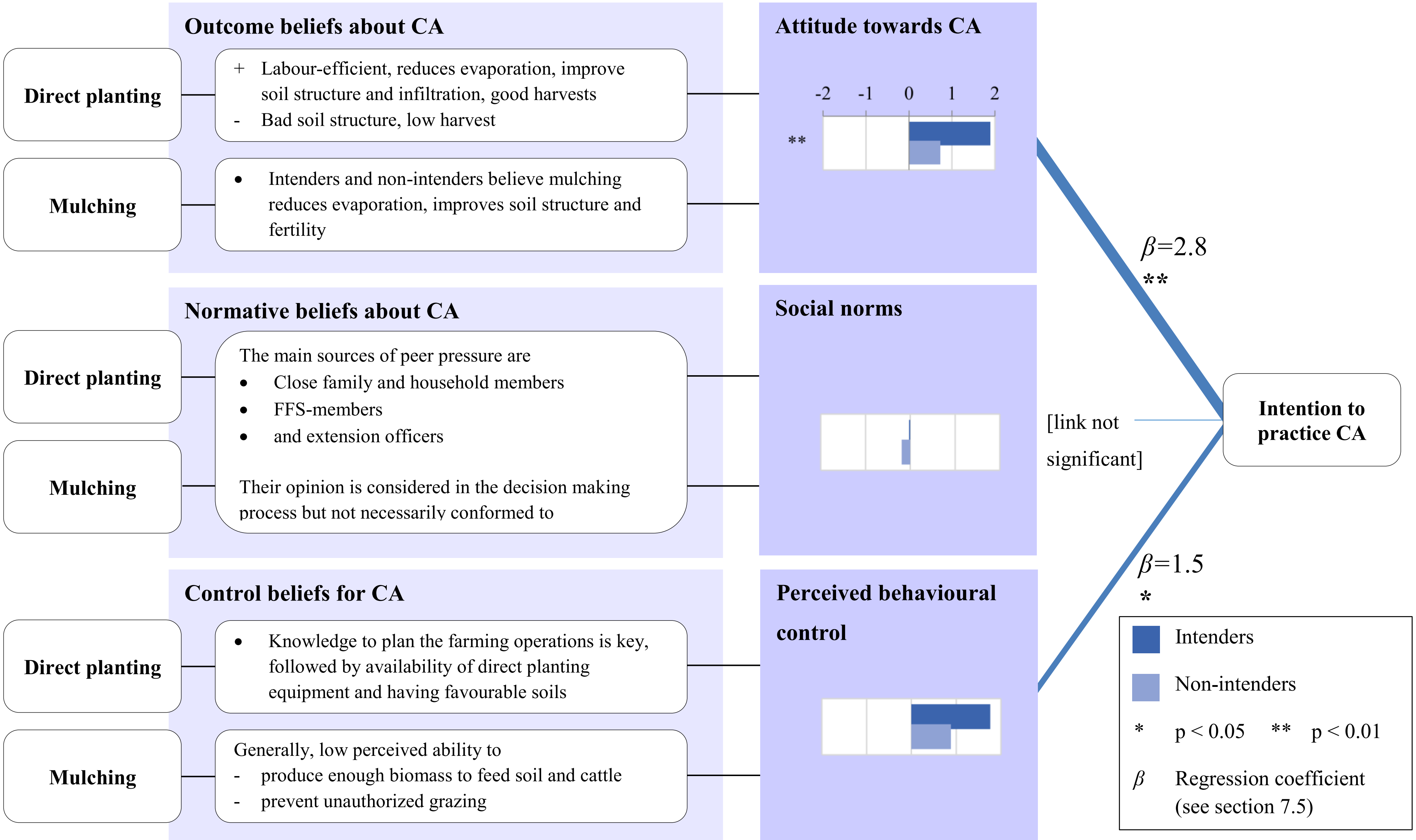


Figure 7-10 RAA summary for Kenya, showing which beliefs contribute to intentions to practice CA (defined as mulching and direct planting)

7.10.2 Intentions to practice CA in Madagascar

Attitudes towards spraying herbicides were relatively positive for both intenders and non-intenders (Tabl), as they both link it with reduced expenses and, most importantly, an improved harvest. The qualitative data suggested that the attitude about herbicides becomes less positive for use outside the rice paddies, especially on the *tanety*. Intentions of direct planting and ploughing are also mainly determined by the attitudes; they can be understood from the outcome beliefs associated with the practice, especially the belief that it leads to an improved harvest, followed by the belief that direct planting leads to improved soil moisture and soil structure (see Appendix XI). As much as direct planting was seen as a harvest-improving and water-conserving technique, comments suggest that these outcomes were mainly attributed to the planting of cover crops rather than the simple fact of ‘not ploughing’. The importance of attitude for intentions is closely linked with the perception of required labour intensity. Non-intending farmers strongly believe that mulching constitutes a lot of work, because previous projects promoted the practice of importing *bozaka,* the cut-and-carry grasses from the *tanety*, which was unattractive for many farmers although it works well from an agronomic point of view. The outcomes of the regression analysis for planting cover crops suggests that especially attitude is important (β=9.035). This appears to contradict the other data, because both intenders and non-intenders linked cover crops with improved soil moisture, improved soil fertility and structure, and an improved income. Moreover, the farmers generally commented that seeds are difficult to find and the knowledge of how to plant the cover crop successfully was missing, suggesting that the perceived behavioural control would be more important.

As in Kenya, results do not suggest that **social norms** have a significant direct influence on intentions to adopt CA practices. For the individual practices and the CA construct, the perceived norms showed negative but not statistically significant regression coefficients. For ploughing, direct planting and mulching, however, direct correlations were positive and significant at the 0.05 level. For mulching, the strongest link with intention was found for CA groups, which links again with the new interpretation of mulch as residues of cover crops as opposed to the transported mulch. For direct planting and ploughing, qualitative data suggests that both household members and CA groups are influencing intentions, and to a lesser extent neighbours.

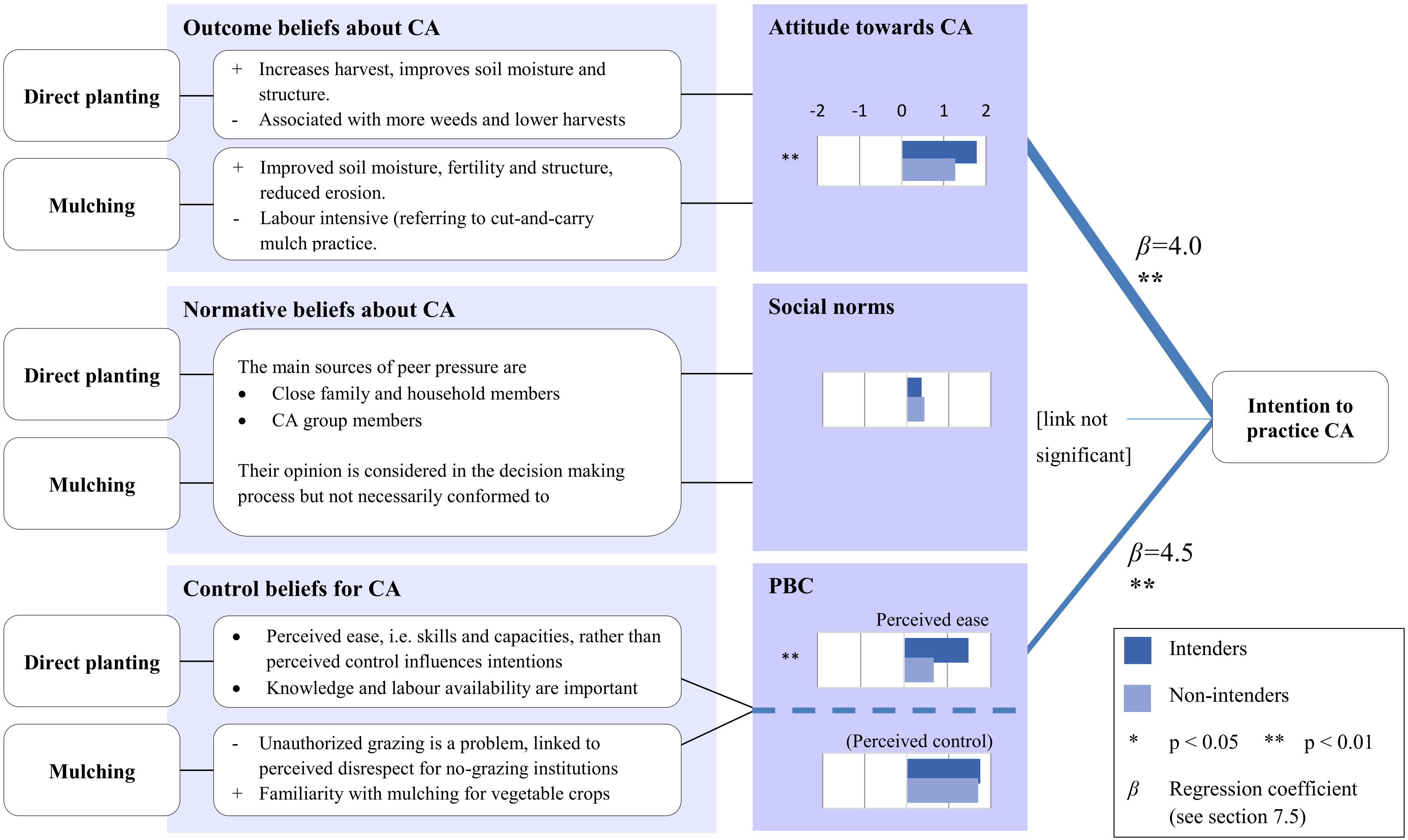


Figure 7-11 RAA summary for Madagascar showing which beliefs contribute to intentions to practice CA (defined as mulching and direct planting)

With respect to the **perceived behavioural control**, the results show an interesting distinction between the 'internal' perceived ease and the 'external' perceived control. The first is more linked to personal skills, abilities and motivation, while the latter, expressed as the degree that performing an action was 'up to me', is linked to the perceived ability to overcome external constraints. Where perceived ease varies greatly for the behaviours in question, perceived control is seen as a personality disposition that generally varies little between actions. Clearly, intentions are chiefly influenced by the perceived ease, especially for mulching, planting cover crops and the CA construct, suggesting that farmers see little external factors that would stop them from adopting these practices outside their internal confidence. As discussed in section 7.9.4, the PBC over mulching was strongly linked with the farmers' confidence that he/she would have enough biomass for a significant mulch, which in turn was linked to the confidence in knowing how to plant cover crops and sourcing the right seeds. Also, the unauthorized grazing is a serious constraint limiting the PBC, especially on those plots that are far away from the homestead. Once cattle enter, they not only eat the mulch, they also compact the land. Both require restoration of crop productivity by ploughing. Farmers in the CA groups would have had trainings on planting cover crops, and have engaged in their own experiments with different types of cover crops providing valuable experience to take home to their own farm. Also, a group, they would have had free hand outs of seeds, which could help kick-start their growing of own seeds, reducing the perceived ease.

7.10.3 Adoption of CA practices in both countries

The results of the binary logistic regression analysis show that intentions are significant factors in the explanation of adoption, while the importance of PBC is different in both countries: In Kenya, only intentions produced significant regression coefficients, while in Madagascar also the perceived ease was found to influence adoption of several practices.

Although intentions were generally significant factors, the link with adoption was weaker than expected. There were significant numbers of non-intenders that adopted nevertheless, and intenders who did not actually adopt. In Kenya, this is potentially explained by the fact that mulching and shallow weeding were considered to be very easy and within a farmers' control, reducing the relative importance of having the intention and allowing ad-hoc non-adoption.

In Madagascar, the low link between intention and adoption of mulching can be explained by the different perceptions of mulching that are likely to have changed during the research. The results show that perceived ease does not only affect adoption indirectly through intention, but also has a strong independent effect on adoption. Significant β coefficients were found for direct planting, mulching and the CA construct.

For Kenya, the additional correlation analyses showed that experience with CA was the main factor outside the RAA factor influencing adoption of the CA practices, which was closely related to FFS membership. Spraying herbicides was also correlated with several factors, of which the locations Kalalu and Mukima were important ones. Mulching was correlated with the number of cattle owned in the household. In Madagascar, membership of the CA group was the most influential factor, while experience with CA was only significantly correlated with planting cover crops and crop rotations. Also in Madagascar there were significant differences between the locations, as farmers in the South adopted more herbicides, direct planting and mulching than farmers in the North. In neither country were age, gender, or percentage of income derived from agriculture significantly correlated to the adoption of any of the CA practices.

8 GENERAL DISCUSSION AND CONCLUSIONS

8.1 Introduction

This final chapter gives an overview and critical discussion of the main findings of this PhD research, leading to overall conclusions and implications for policy and future research. **Section 8.2** summarizes the background and rationale of the study, and reminds the reader of the main research questions. **Section 8.3** provides a recapitulation of the main findings of the three result chapters. **Section 8.4** aims at discussing the results by bringing them into a critical dialogue with the literature and theoretical perspectives. This is followed by recommendations for policy (**8.5**) and future research (**8.6**). The chapter, and indeed the thesis, ends with a closing remark in **section 8.7**.

8.2 Background and rationale of the study

One of the policy priorities for achieving increased and sustained food security is to improve the productivity of small-scale farmers (Foley et al., 2011; Hounkonnou et al., 2012). Concerns about widespread degradation of land and water resources, together with other negative environmental impacts, show the limits of highly intensive production systems (FAO, 2014b). These environmental impacts highlight the need for sustainable intensification in SSA (Tittonell, 2014), where agriculture is also under increased pressure due to changing climates (Milder, Scherr and Majanen, 2011). Conservation Agriculture (CA) is being promoted in this context as an option for the sustainable intensification of small-scale agriculture in SSA.

Conservation Agriculture is usually defined as any farming system based on the principles of 1) minimum soil disturbance; 2) permanent soil cover; and 3) maximum crop diversity through rotation/association (FAO, 2014a). Driven by increased soil organic matter and higher biodiversity, CA has the potential to reduce soil erosion, increase yields, increase soil fertility, improve the water balance, reduce pests and control weeds, without a lot of external inputs (Hobbs, Sayre and Gupta, 2008; Thierfelder and Wall, 2009; Doré et al., 2011; Bunch, 2014; Corbeels et al., 2014; Baudron, Andersson, et al., 2012; Nichols et al., 2015; Verhulst et al., 2010). Nevertheless, the suitability of CA for smallholder farmers in SSA is sometimes questioned due to increased pressure on labour, limited access to suitable inputs and limited primary production of and competition for biomass (Giller et al., 2009; Gowing and Palmer, 2008). The adoption of CA remains subject to many social, biophysical, technical, financial, infrastructural and political constraints (Friedrich and Kassam, 2009). Due to these discussions, CA is considered an example of what is often referred to as 'contested agronomy' (Sumberg and Thompson, 2012).

The objective of this research was to contribute to the understanding of the dynamics of agricultural innovation systems, in particular the relation between the promotion of CA and the reasons for (non-)adoption of CA in smallholder farming systems in sub-Saharan Africa, by combining qualitative and quantitative research methods. The following research questions were informing the research process:

1. **How does innovation and dissemination of Conservation Agriculture take place in Kenya and Madagascar?**
2. **What influences smallholder farmers' decisions for (non)adoption of CA?**
3. **What opportunities for and limits of agricultural innovation emerge from the cases studied in Kenya and Madagascar?**

The research took place in Laikipia County in Kenya and the Lake Alaotra area in Madagascar. The Laikipia County of Kenya is characterized by limited annual rainfall, ranging between 400 and 600mm. CA farming generally consists of leaving varying proportions of residues on the field and manual or animal-drawn direct planting of maize with a cover crop of dolichos, butter beans or pigeon peas, followed by spraying herbicides before germination of the crops. During the growing season, weeds are controlled manually or with a shallow weeder or *panga*. Conservation Agriculture has been introduced in 1997 through a Farmer Field School (FFS) approach and continues to be disseminated through FFSs.

The Lake Alaotra area in Madagascar is characterized by highly variable rainfall distribution, both within and between years, averaging 1051mm per year. The CA system depends on the topography, but generally consists of controlling cover crops and weeds with herbicides or manual slashing followed by manual direct planting of upland rice or maize with a cover crop of cowpea, dolichos, rice bean or stylosanthes. The rotations were developed in 1992, and further researched and disseminated through a large 10-year project known as BV-Lac. This project dominated the institutional landscape, but since the political crisis in Madagascar foreign investment has gradually reduced and the project ended in 2013. Currently there is little project activity concerning CA in the Lake Alaotra area.

An important starting point for the first question was to gain an overview of all the stakeholders in the innovation system who are involved in CA. The stakeholder analysis included identification of the stakeholders' type (GO, NGO, private sector, farmer, network), the main role of the stakeholder (research, extension, policy development, technology development) and the geographical level (regional, national or local). Social Network Analysis was used to map how the stakeholders are linked in networks and sub-networks across the geographical levels and which stakeholder types are most dominant at each level. More precise insight in the connectedness of stakeholders, in particular the smallholder farmers, was gained by considering the type of linkages (knowledge, services, policy/advocacy, financial, network).

The observation that CA is an example of contested agronomy (Sumberg and Thompson, 2012) pointed towards the importance of how stakeholders frame CA and their activities to promote it. Following Röling's (1996, p. 55) classification of extension models, the perceived roles, objectives and legitimation of promotion were discussed with stakeholders at the national and local level in semi-structured interviews. Another point of contention is how research influences the diffusion of new technologies such as CA, or indeed, how promotion activities lead to an impact in farmers' lives. The research therefore set out to gain insight in the theories of change explicitly and implicitly held by stakeholders in the innovation system, which could then be linked to the extension and innovation processes, and paradigms and approaches towards innovation.

Regarding the second research question, this study discussed some limitations of conventional adoption studies. In line with the capability approach framework, an argument was presented to explore a social-psychological approach towards better understanding CA adoption, in particular the Reasoned Action Approach. This approach conceptualises adoption from intentions, which in turn depend on attitudes, social norms and perceived behavioural control. In other words, it aims to understand to what extend farmers feel willing, socially stimulated, and able to adopt CA related practices. These categories were further unpacked by looking at outcome-, normative- and control beliefs.

Finally, the third research question is answered here by combining the results of the previous chapter with the conceptual framework. Some analytical connections are made between the empirical data and what it means in terms of farmers' capabilities. Moreover, the concept of communicative action is evoked to understand the limits of and opportunities for agricultural development thinking and practice that can enable an agricultural innovation approach that truly contributes to sustainable technological and institutional innovation.

8.3 Main findings

8.3.1 CA in the agricultural innovation system

- The Social Network Analysis (SNA) of the main CA stakeholders in the innovation system, shows that the innovation system in both countries is driven by a push from national level stakeholders who, through project partnerships, engage in the promotion of CA in different ways. At the national level, interaction is quite strong and well organized in Innovation Platforms, while at the local and regional levels, there is less coordination between stakeholders and less continuity outside the lifetime of the various CA research projects.
- There is a difference in the type of key stakeholders between the countries. The central, best connected stakeholders in Madagascar are all research institutes who are involved in action-research on farmers' fields and not so much in dissemination of sustainable agricultural

practices like CA. In Kenya, however, project implementing NGOs are the dominant, best connected stakeholders who aim at upscaling CA.

- At the local level in Kenya, there are several stakeholders that are not project-dependent and NGOs that interact with the grassroots-level stakeholders. The local level in Madagascar is characterized by a lack of permanent non-project stakeholders involved in supporting agricultural development; those present have limited resources.
- Farmers mostly depend on projects for agricultural innovation and they have limited influence on projects and policy through their structural linkages, even within project contexts. The farmers' ego-network shows that smallholder farmers have few if any policy/advocacy linkages. Services linkages are most important at that level. Most knowledge linkages are not sustainable beyond the project lifetime, in particular in Madagascar.
- The dominant extension approaches in research and dissemination projects are farmer groups (FFSs and GSDs in Kenya and Madagascar respectively), model farmers and exchange visits/field days. The groups in Madagascar have many characteristics of a co-Innovation Platform and can be associated, while the FFS in Kenya are more a continuation of an FFS approach. As such, the approaches reflect elements of different underlying paradigms of agricultural innovation, ranging from more modernist diffusion theory towards Agricultural Innovation Systems (AIS) thinking.
- The way stakeholders in the innovation system talk about CA differs between stakeholders and between countries. In Kenya, farmers use 'planting with CA' mainly to refer to 'direct planting', which is in turn highly associated with herbicides for controlling the weeds. In Madagascar, CA is referred to as SCV (direct planting under permanent soil cover) in French or as *voly rakotra* (planting in cover) in Malagasy, so the CA principle of permanent soil cover features prominently in both definitions of CA. In both countries, respondents sometimes confuse 'CA' with outcomes of key individual practices such as spraying herbicides, direct planting or planting a cover crop.
- The results from Madagascar show a big difference in farmers' appreciation of the ABACO project approach compared to the previous BV-Lac approach. Farmers expressed the differences in strongly worded terms, and appreciated the freedom within the ABACO project to pursue their own objectives and to decide on the experiments, whereas the BV-Lac approach was perceived as more prescriptive and dismissive of their views. An example is that transported *bozaka* (natural grasses) from the *tanety* (hillsides) was promoted as mulch, which, although agronomically very interesting, is not attractive from the farmers' perspective due to the required labour. The moment the BV-Lac project stopped, this practice was largely abandoned.
- It was found that the uptake of CA changes power relations in the innovation system in both countries. In Kenya, service providers become powerful due to their influence on who can

plant in a timely manner. The strong position of farmers who are used as contact points for the projects, including model farmers, is further enhanced through the frequent contact with researchers and project staff. In Madagascar, some CA sub-groups were excluding non-members from their knowledge of CA seed markets and farm management with CA. The rise of CA also contributed to tension between livestock farmers and crop farmers regarding the grazing conventions.

- CA stakeholders at national and local level in the innovation system identified the need for technological and institutional changes, as discussed in section 5.6. In Kenya, a lack of technology development was identified, referring to jab-planters, animal-drawn equipment and tractor-implements for direct planting, sub-soiling and ripping. The need for more networking and coordination was mentioned by several stakeholders, especially referring to the local level in both countries. In Madagascar, stakeholders mentioned there was a lack of organisations involved in what was referred to as 'the diffusion of knowledge'. The SNA also showed an overrepresentation of research institutes and an underrepresentation of diffusion and extension institutes. The maturing and regulation of markets was mentioned as an institutional development that was necessary to balance the innovation system in the medium term, particularly related to cover crop seeds and inputs such as herbicides.
- Finally, the cases of crop insurance from Kilimo Salama (now Acre Africa) and the Innovation Platform in Madagascar as described in section 5.7 show the fundamental difficulties of using the AIS instrumentally, as an approach to promote the diffusions of a specific practice. Initially, crop insurance Kilimo Salama went hand in hand with the promotion of CA, but soon developed into a general crop insurance. The Innovation Platform in Madagascar aimed at supporting watershed development and agricultural innovation in which CA was an important part, although farmers showed more interest in non-CA innovations. The two cases describe successful innovations for farming in general, but were not necessarily successful in promoting CA which was at least part of the initial objectives. Indeed, innovation is often unpredictable, and ideally an AIS approach should allow for this flexibility, even if it means that initial solutions or objectives have to be changed.

8.3.2 Framing CA and agricultural change

- Semi-structured interviews with CA stakeholders at the national and local level in Kenya and Madagascar included questions about how respondents see their role in the innovation system, legitimation for their involvement with CA, and their theories of change. In neither country did respondents identify with the role of 'strategist' or 'consultant', which is in line with the finding that in neither country did stakeholders base the legitimization of their involvement in CA on a 'politically accepted decision' or an 'active demand from farmers'.

- Overall, both countries combined, the most important legitimation for stakeholders to be involved in CA was that there is a ‘hidden need’ for CA, even though this is not manifested yet by an active demand. The identification of a hidden need, therefore leans more on an expert-based assessment of farmers’ needs and the priorities of agricultural innovation.
- In Madagascar, the most selected role was that of ‘expert’, which was associated with ‘convincing farmers of the benefits of CA’ and ‘increasing the acceptance of CA’. This is consistent with the results from the social network analysis which showed that the dominant stakeholder type in the innovation system in Madagascar was research, while in Kenya it was project implementation. In line with these results, the strong scientific basis was the main legitimation for stakeholders to be involved in CA. This was followed by the identification of a hidden need which, based on the respondents’ explanation, is mainly related to expected climate change, i.e. increasing rainfall variability.
- In Kenya, most respondents saw their role as being an ‘organizer’ followed by ‘trainer’. These roles are associated with a ‘focus on the client’, a ‘process of learning with farmers’, ‘organizing interaction and facilitate group processes’. The strongest legitimation was the belief and conviction that CA was the best option for livelihoods of small-scale farmers. The strong belief was in some cases combined with the legitimation based on a strong scientific evidence (Table 6-2), but especially where the strong belief is combined with the legitimation based on an identified hidden need, this supports the observation of an epistemic community that ‘pushes’ for CA (Andersson and Giller, 2012). Respondents in especially Kenya frequently used narratives of personal experiences, to illustrate why they are so strongly convinced of the potential of CA to positively influence yields.
- In Kenya, respondents make use of scientific evidence regarding *how* to support CA, but do not necessarily base their involvement with CA, the *why*, on a scientific basis.
- Five narratives were identified that frame CA in different ways: CA as a Soil and Water Conservation technology, CA as a production-enhancing technology for improved livelihoods, CA as a climate-smart farming option, CA as good agricultural practice and CA as conflicting with organic farming. Results suggest that in both countries, the dominant ‘frame’ of CA is that it improves productivity and livelihoods of smallholder farmers.
- A total of seven theories of change were identified in this study: The business approach to CA, facilitating interaction, perfecting the fit (targeting and tailoring innovations), fundamentally constrained farmer by farmer promotion, changing the mind-set and mentality, systems change and growing promotion ‘push’, and finally spontaneous diffusion of CA.
- Particularly in Kenya, several stakeholders adhered to what I refer to as the business approach to CA, which assumed that the private sector was the main avenue for upscaling CA. Within this approach there is an important role to play by the service provider who, by pursuing a business opportunity, could catalyse the uptake of CA.

- The theory of change aiming at targeting and tailoring, found to be dominant in Madagascar, assumes that diffusion will take off once the technology has been refined and adapted to local circumstances. As such it is closely related to the ToC assuming spontaneous diffusion of CA.
- The ToC featuring the need for systems change by concerted action at various levels in the innovation system, was pointed out in both countries.
- Although these results point to interesting differences, some of the clear theoretical distinctions are more difficult to maintain when looking at practical cases, and the observed approaches and innovation processes contain elements of theoretically contrasting categories.

8.3.3 RAA methodology

- This study shows that the application of the Reasoned Action Approach increases the understanding of intention and adoption of Conservation Agriculture practices. The main advantage of the RAA over other decision models is that it not only reveals factors influencing adoption, but it also shows why and how these factors influence intentions through the attitudes, social norms and perceived behavioural control and their underlying beliefs.
- This study shows that important insights can be gathered from examining the constituent practices of CA separately, rather than considering CA as a single practice. In Kenya, the results show that farmers held negative attitudes towards shallow weeding, as they associated it with traditional practice which does not optimally control the weeds, although they had a strong behavioural control, suggesting they were capable to practice it if they wanted to. For mulching this was the other way round; Farmers generally had positive attitudes towards mulching and associated it with increased soil fertility and reduced erosion, but the perceived behavioural control was low because there was not enough biomass to realize an effective mulch cover.
- It is recommended to further develop the RAA constructs in future studies because there is some overlap between them. For example, the attitude towards herbicides may be negative because it is very expensive, but in the way the RAA was applied in the questionnaire, being expensive was only considered in the perceived behavioural control. There is also overlap in the definition of the practices because in Kenya direct planting was sometimes confused with CA as a whole, as was spraying herbicides, and in Madagascar direct planting was sometimes confused with planting a cover crop.
- In this study, the RAA methodology was applied to more than six practices in two countries, with considerable differences between the agro-ecological and socio-political contexts between the samples. Although the general structure of the questionnaire was the same, the differences are clearly reflected in the underlying beliefs. This shows that the methodology is highly repeatable and allows for comparing very diverse situations.

8.3.4 Adoption process

- In this study intenders refer to those who judged it 'likely' to 'very likely' they would adopt a certain practice in the next season and non-intenders refer to those farmers judged it 'very unlikely', 'unlikely', or 'not sure'. Adopters and non-adopters were simply classified according to whether they adopted the practice or not, irrespective of the surface area.
- Overall, strong evidence was found for the importance of attitude and perceived behavioural control in contributing to intentions to adopt CA practices. The most important of these was attitude, which corresponds to the claim that CA adoption requires a certain (change of) mind-set.
- The outcome beliefs underlying attitudes towards all CA practices show why: the outcome beliefs for intenders and non-intenders were significantly different (see Appendix X and Appendix XI). The importance of attitude, and the ability to understand the underlying beliefs for specific practices, gives important clues for improving and tailoring extension and training to groups of certain attitudinal disposition.
- In Kenya, direct planting was seen as the most crucial and defining CA practice, and attitudes towards it differed greatly for non-intenders and intenders. Intenders linked it with better soil structure, improved water infiltration and better harvests, while non-intenders believed quite the opposite. In Madagascar, direct planting was equally seen as a harvest improving and water conserving technique, although comments clarified that these outcomes were mainly attributed to the planting of cover crops.
- Attitudes towards mulching were positive in Kenya, for non-intenders as well as intenders, while in Madagascar there were very different outcome beliefs about the labour required for mulching. Non-intenders linked mulching with *bozaka* as imported biomass, which was seen as a bad practice, while intenders saw cover crops as the source of the mulch and therefore had more positive attitudes.
- The regression analyses did not reveal a statistically significant effect of perceived norms on intentions and behaviour, although some correlations with intentions were positive and significant.
- Gender relations influence the decision-making process in Kenya in several ways: FGDs showed that women are more represented in the trainings, and more inclined to try CA than men, but the men are the main decision-makers. As men are in charge of the bigger animals, they may be reluctant to use crop residues as mulch rather than feed. The FGD participants suggested inviting male and female members to the trainings to avoid this intra-household tension. In Madagascar, household decision making was not apparently dominated by either gender.

- The outcomes of CA impact men and women differently. In Kenya, FGDs showed that as women do most farm operations, they benefit relatively more from the reduced work requirements of CA. Men benefit relatively more from the reduced costs with CA. The extra time is convenient for men as social norms allow them to do other jobs and socialise. Women, however, are socially expected to work hard and risk being branded as 'lazy' if they practice CA, in particular if others view the land as 'untidy' due to the mulch.
- The link between intention and adoption was weaker than expected, for which several explanations have been put forward in this study.
- Together with attitudes, perceived behavioural control was found to influence intentions significantly. In Madagascar, the 'internal' perceived ease was significantly correlated to intention, while the 'external' perception of autonomy was not, suggesting that there were few external factors that could not be overcome by more motivation and knowledge
- Several control beliefs were relevant for understanding perceived behavioural control. For spraying herbicides and direct planting, knowledge seems to be most important in both countries, in terms of which herbicides to use and the timing of operations respectively. For mulching, however, the ability to have enough biomass was considered crucial. This can partly be seen as a matter of knowledge, but especially in Kenya, it is also an agronomic constraint in a situation of very limited rainfall and cattle to feed throughout the dry season.
- In Madagascar, the unauthorized grazing is a serious constraint limiting the perceived behavioural control, especially on those plots that are far away from the homestead. Once cattle enter, not only do they eat the soil cover, but they also compact the land. Both require restoration by ploughing.

8.4 Critical discussion of results

In this section the results, as summarized above, are further discussed, triangulated, and brought into dialogue with the literature. The themes discussed cut across the result chapters and aim at addressing the third research question: What opportunities for and limits of agricultural innovation emerge from the studied cases in Kenya and Madagascar? This involves drawing analytical lines between the results and the concepts introduced in the literature study and the conceptual framework. These concepts include the notion of contested agronomy, the various paradigms of innovation (with technological and institutional dimensions) and the distinction between purposive action and communicative action. This comes together in the central interest in smallholders' capabilities, both to pursue (agricultural) options that she finds valuable and to challenge the structures under which she operates.

8.4.1 Epistemic communities and the 'push' for CA in Kenya and Madagascar

The results of this thesis show that the stakeholders at the national level were well connected to the whole agricultural innovation system, and well organized in national level Innovation Platforms. It was concluded that these stakeholders are the driving energy behind the promotion of CA, also following priorities of donor organisations. Results further showed a difference in the roles and objectives of the main stakeholders within the innovation systems. In Kenya, the stakeholders with the highest degree in the social network were NGOs whose main priority was project implementation and stimulating diffusion, while in Madagascar the stakeholders with the highest degree in the social network were research GOs and NGOs whose main priority was to research CA. In terms of stakeholders' legitimation of their involvement in CA, results show that in Kenya 'strong belief' was very important, illustrated by personal testimonies of yield-improving CA systems. In some instances this 'strong belief' was combined with the legitimation of an expert-defined need for CA. In those cases it is clear that the legitimation is not following from science-based imperatives, although scientific knowledge is clearly used in the process.

It is argued that, following Andersson and Giller (2012), the concept of epistemic communities can be helpful to think about the role of knowledge systems in society. Epistemic communities are defined as "a network of professionals with recognised expertise and competence in a particular domain and an authoritative claim to policy relevant knowledge within that domain or issue-area" that provide "one of the major channels by which overarching regime principles, norms and rules are articulated for the international community, and disseminated internationally" (Haas, 2001). It is similar to the idea of a paradigm in the sense that it primarily governs "not a subject matter but a group of practitioners" along the lines of shared values and assumptions about the validity of knowledge (Kuhn, 1970, p. 180). It is also related to the intersubjective notions in Habermas' theory of social action, in which actors *within* epistemic communities, by means of communication, have reached a shared understanding. However, as social entities, with considerable political power, epistemic communities do not necessarily operate on the same communicative-rational basis in agreement of goals, methods and values. The goal of the Agricultural Innovation Systems (AIS) approach is, according to Röling (1996, p. 55), to reach a shared understanding at a higher level of aggregation, in other words, also *between* epistemic and other communities in society. In this process, conflicts will inevitably emerge between the interests of individuals and (epistemic) groups (expressed through a strategic rationality) on one hand and the collective interest (expressed through communicative rationality) on the other hand.

There are several factors in the context of the study areas that contribute to the formation of epistemic communities, in which the major dynamics are uncertainty, interpretation, and institutionalization (Haas, 1992). The uncertainty in small-scale agriculture is evident; the complexity of smallholder farming in Africa in relation to climate change, food security, economic development and environmental sustainability, is huge. In this complexity, policy makers and deciders are looking for credible and promising answers, that preferably address several problems at once. Anderson and Giller (2012) have shown how CA has been interpreted by an epistemic community of faith-based organisations, research and policy institutes, as an option that can increase yields and improve resilience to climate change by using agro-ecological principles. Another factor of influence in both countries was indicated by the respondents: the 'real deciders' in the Ministry of Agriculture were few and therefore powerful, highlighting the need to come together in consolidated efforts to influence them. Moreover, as funding for research projects has taken a hit in the global economic crisis after 2008, for GOs and NGOs to continue their activities, closing ranks in interdisciplinary and international partnerships[50] around an interpretation of a way forward in the complex situation is also an effective way to mobilize funds. The importance of projects in the institutional landscape in the studied countries and some inherent limitations are further discussed in the next section.

8.4.2 The institutional context of CA: dominant role for (research) projects

This study showed that many linkages between stakeholders, in particularly at the local level, are project dependent. In Madagascar, after the large BV-Lac project came to an end, the local innovation system is characterized by an institutional vacuum. In Kenya there were CA stakeholders with a permanent, non-project presence in the area, such as Lengetia farm and Ol Pejeta conservancy (who had included CA in their community involvement programmes), the MoA (who had been trained in CA and continued to be a source of knowledge for farmers after the project's end), and locally based NGOs (such as CETRAD and Caritas). Nevertheless, their impact did not achieve a full geographical coverage. The SNA in Kenya showed that especially knowledge linkages between farmers and other stakeholders depend on projects. Farmer service linkages were relatively stable in Kenya due to the diversity at the local level, while in Madagascar farmer service linkages with the private sector also changed after the end of the BV-Lac project.

At all geographical levels, it was observed that the project approach towards introducing sustainable agricultural practices like CA induced opportunistic attitudes among most people involved, which limits the impact of projects and undermine their sustainability. Indeed, in line with the social actor perspective (Long and Long, 1992), farmers make strategic use of what projects have to bring. In the Mukima area in Kenya this was particularly evident, as farmers explicitly requested inputs and financial support, and once they understood that ABACO was about

[50] This is not to say that forming these partnerships is necessarily an organic process; also within the ABACO project partnership there were disagreements about how the project should be implemented and what the priorities were. This is part of a continuous process of negotiating and reaffirming the very basis of partnership (Helena Posthumus, personal communication, 26-02-2016).

knowledge sharing, they did not attend trainings or FGDs. Researchers, including me, also made use of the project to get field data that suited our personal interest. Researchers that take part in projects are under pressure to publish for the donors and in the academic world, while there is no accountability within the project framework towards the local level stakeholders. For NGOs and GOs, the international projects are as much a strategic way of acquiring funding for the continuation of their research agenda, as they are an opportunity to contribute to development and social change.

In his critical review of theory and practice of participation in development projects, Oakley (1995) argues that "although projects continue to be the basic instrument of development implementation, they are not necessarily the most conducive vehicle to promote participation", as projects have a strong emphasis on timing, objectives, measurable outputs and budgets. He rhetorically asks this question: "Can a process which seeks to tackle basic psychological, cultural and political aspects of people's exclusion and to build an authentic basis for their participation really be encapsulated within the framework of a development project?" (Oakley, 1995, p. 24). In the current research, several respondents rejected the notion that they were part of a political system with a claim of doing 'only research'. However, as shown in this study and as highlighted in the gathering literature around contested agronomy, science as a whole, and specific scientific disciplines, operate under certain assumption with political implications (e.g. Fairhead, Leach and Manor, 2012; Sumberg, Thompson and Woodhouse, 2013), and the framing of research objectives and policy priorities is inherently political (Whitfield et al., 2015). The argument presented in the following sections is that a mechanistic understanding of participation and the role of stakeholder interaction in innovation systems, based on purposive-rational action, leads to a persistence of technocrat approaches in agricultural development.

Farmers' power and capabilities to effectuate change in the agricultural innovation system

The results showed that the promotion of CA has changed power relations in local communities, in particular in relation to service providers, model farmers, CA groups and in the relationship between cattle owners and crop farmers. In the conceptual framework, this was indicated by a feedback arrow from 'achievements' to 'capabilities'. In line with the capability approach, it can be argued that although the ABACO project included sophisticated models of a farmer participation through 'co-Innovation Platforms' (Posthumus et al., 2011), farmers' power and capabilities to exercise influence over and effectuate change in the innovation system were indeed limited. The SNA showed that farmers and farmer groups have very little advocacy or policy linkages, and while farmers were central within the platforms, they had little to no influence on the project objectives, the styles of participation, or indeed the budget.

8.4.3 Variety in narratives that frame the importance of CA

In line with the contested agronomy argument, outlined earlier, the research gave attention to variation between stakeholders regarding how they 'frame' CA, referring to 'the process of selecting, emphasizing, and organizing aspects of complex issues, according to overriding evaluative or analytical criterion' (Daviter, 2007, p. 654; cited in Sumberg, Thompson and Woodhouse, 2013). Let us first establish that calling CA an example of contested agronomy is itself a form of framing, with the effect of directing a body of research towards a political economic analysis of the areas of contention in agronomic research and agricultural practice. The term Conservation Agriculture is also a frame. Indeed, the farming practices examined in Kenya might as well be called a maize-legume intercrop with minimum tillage, and the most popular 'cover crop' in Madagascar -vetch grown on the *baiboho*- could perhaps more accurately be called a green manure applied in counter-season. The literature showed that when people talk about CA, they may refer to other closely related concepts, most notably Conservation Farming and Conservation Tillage (Wall et al., 2013). This study showed that CA had different meanings in the two countries. In Madagascar, CA was referred to as SCV or *voly rakotra,* both having the notion of cover in the definition, which was also observed to be the central feature of CA by farmers. In Kenya, however, the central feature of CA seemed to be direct planting (direct planting was referred to as 'planting with CA'). Herbicides were seen as a way to control weeds before direct planting (Kenya) or as a way to control cover crops before planting (Madagascar).

In their assessment of narratives for framing CA in Zambia, Whitfield et al. (2015) argue that these narratives, including the scientific ones, are inherently political. Andersson and D'Souza (2014) showed that CA 'for soil and water management' lost eminence in a context of growing food insecurity, but after re-framing CA as 'production and productivity increasing' concept, it was re-established as a policy priority. In this study, five narratives were identified, of which the most salient was 'CA for improved productivity and livelihoods', also recognized by Whitfield et al. and Andersson and D'Souza. In none of these narratives are the interests and perspectives of smallholder farmers directly addressed. The argument for the climate change mitigation narrative of CA is weak (Andersson and Giller, 2012) and it seems right to question whether climate change mitigation is the task for the poorest, food insecure households to take up. The climate change adaptation argument has a stronger basis, as CA seems advantageous especially in dry areas/periods (Wall et al., 2013) which is something that is also in the interest of farmers.

8.4.4 Extension approaches, theories of change and innovation paradigms

The discussion now turns away from narratives and frames to the extension approaches used in the promotion of CA, and the associated theories of change and innovation paradigms.

CA 'Innovation Platforms' and Agricultural Innovation Systems thinking

Innovation Platforms that bring stakeholders together around a commodity, e.g. in value chains or industries, are very common and generally effective (Hall et al., 2007), whereas knowledge- and learning-based IPs, as is fitting with the knowledge-intensive nature of CA, still draw largely on research stakeholders for initiating and facilitating the platforms. This study showed that in the ABACO project sites, two very different materializations of local Innovation Platforms were realized. In Kenya farmers were organized in FFSs, while in Madagascar new co-innovation groups were formed. The interviews with local stakeholders showed that local project staff in both countries had difficulty with the concept of Agricultural Innovation Systems (AIS). As discussed in chapter 2.2.4, Nederlof et al. (2011) suggest some useful distinctions of IPs in practice. Both CA Innovation Platforms can be classified as being orientated towards 'learning and research'.

As argued in chapter 2, the innovation paradigms can be seen as differing in the degree of farmer participation. One of the principal characteristics of the AIS approach is that it increases farmer participation by bringing them into direct contact with a diversity of other stakeholders. However, as the ´learning and research´ type of IP still leans on research stakeholders, it is not a fundamental departure from the other innovation paradigms. It is hard to discern the extent to which farmers really have an influence on the terms of participation in IPs, or whether they just ´play along´ with the participatory ´game´ without real substance to their influence (Blanc-Pamard and Fauroux, 2004). It is clear that co-Innovation Platforms were seen by the project as the best way to approach their involvement in CA (Tittonell et al., 2012), which gives rise to the possibility that IPs are introduced in a ´top-down' manner. The local IPs in Madagascar, although they were very successful in achieving co-innovation by adapting local CA systems through collaboration with researchers and input dealers, are very unlikely to continue after the end of the project.

Two theories of change identified in this study from interviews with stakeholders fit well within the paradigm of AIS. The first is the 'business approach' to CA, which fundamentally puts different stakeholders at the centre of innovation process, i.e. private sector and service providers instead of the research stakeholders. The second is the 'facilitate interaction' ToC, where the interactive principles of the AIS approach are more explicitly recognized. In both theories of change, the role of policy and projects is to facilitate, where the accent is less on the technology and more on the institutional context of farmers, not on the knowledge but on the conditions that support learning. The corresponding legitimization is the identification of a hidden need and as such the intervention engages in improving the innovation capacity.

Both ToCs that fit well in the AIS thinking were found in Kenya at the national level, which suggests an interesting contrast between the local and national level, and between the studied countries. In Kenya, where the key stakeholders at the national level were policy implementing NGOs, legitimizing their involvement in CA with a 'hidden need' and 'ideology' (see chapter 6.3) and pursuing the diffusion of CA through strategic action, while the IPs at the local level presented a continuation of previous more linear approaches. In Madagascar the opposite appears the case, where the local level IPs during the ABACO project were almost a textbook example of the AIS paradigm put into practice (Kendzior, 2013), but the respondents at the national and local level outside the project, dominated by research stakeholders, exhibited a more purposive-rational approach to innovation, legitimized by the strong scientific basis.

The persistence of the linear Transfer of Technology model of innovation

Throughout the history of international development, the linear 'transfer of technology' (TOT) model has been a dominant way of thinking about innovation in all sectors, including agriculture. Supported by Western rationality and widespread assumptions about human nature that we now call 'modernist', the progress of society was seen as a mainly technological process of bringing the 'backward' societies to the level of the 'advanced' or 'modern' societies (e.g. Blanc-Pamard and Fauroux, 2004; Arce and Long, 2000). These assumptions have now been criticized repeatedly and convincingly. Nevertheless, results presented in this thesis show that elements of the TOT model of innovation remain present.

Chambers and Jiggins (1987) argue that "while the linear sequence has been modified by building in 'feedback loops' and iterative cycles of referral and evaluation, the determination of priorities, diagnosis, evaluation and prescription remain in the control of scientists" (Chambers and Jiggins, 1987, p. 13), and "information is obtained from farmers and processed and analysed in order to identify what might be good for them" (ibid.). The results presented in this thesis show that technology-oriented and expert-based promotion of sustainable agricultural practices remains a common feature in the studied innovation systems.

This is illustrated by the 'targeting' and 'spontaneous diffusion' Theories of Change (ToCs) identified in this study as important, mainly in Madagascar. The literature review also identified 'targeting' as a frequently recurring objective of international research projects who operate in highly diverse and complex localities in SSA (e.g. Tittonell et al., 2012). These ToCs see innovation as a matter of refining the technologies to a level where it will be spontaneously diffused among the farming population either directly (by copying the successful, innovative neighbour adopter) or indirectly (by eliminating the 'laggards' from the competitive economy). As such it can be classified within the FSR paradigm (Hall, 2007), although elements from the TOT model are there, especially regarding the 'driver' which is a supply push from research rather than active demand from the field. The consultant-like extension model of supporting innovation seems not to be applicable to the promotion of CA in the study areas, as it assumes an active client with an active demand.

8.4.5 The role of adoption studies depends on the paradigm of Agricultural innovation

In chapter 2 and 3 I argued that conventional approaches to studying adoption of technologies in smallholder farming have limitations that are increasingly recognized. Andersson and D'Souza (2013) point out that current CA adoption studies are often methodologically weak, biased by the promotional project context in which they are often carried out, and prone to inherent limitations of farm-scale analyses of standard household surveys. Instead of only establishing a correlation between adoption and independent variables, it is important to conceptualize how a factor has an influence on adoption (Beedell and Rehman, 2000).

In the context of a paradigm shift from intervention to interaction (see section 8.4.9), the increasingly popular AIS perspective on agricultural development (Hall et al., 2007; Posthumus et al., 2011) deeply changes the role of adoption studies by not putting the emphasis on 'determining factors' that influence adoption but rather on 'understanding reasons' for adoption (Van Hulst and Posthumus, 2016), or indeed 'understanding actors'. The adoption study then does not inform a purposive rational intervention process through a linear process of dissemination, but rather helps reaching a shared understanding among a diversity of stakeholders in the innovation system, the main goal of communicative action. The adoption study ideally considers and feeds back to many actors, bringing new understanding and inspiring new partnerships between them (Röling, 2009a; Röling et al., 2012).

8.4.6 The centrality of attitudes in the adoption process

The expectancy-value model used in the Reasoned Action Approach (RAA) to better understand attitudes provided interesting results. The outcomes suggest that attitudes are the main factor influencing intentions to adopt CA, supporting the often quoted importance of a mentality or 'mind-set' change (e.g. Wall, 2007). This finding is in line with a recent study applying the Theory of Planned Behaviour to CA adoption in Mozambique, identifying attitudes towards CA as the main driver of intentions, followed by perceived behavioural control and then social norms (Lalani et al., 2016).

An interesting proposition in the RAA is that intentions depend on perceptions, not on real measurable determinants or even scientifically accepted facts. This implies that gaining more agronomic facts is not enough to influence farmers behaviour, as it will only be through an evaluation of *perceived* outcomes that an attitude will change, contributing to intentions to engage in adoption of CA (Nguyen et al., 2016). The dominance of research stakeholders in the innovation system in Madagascar can therefore not be expected to spontaneously change farmers' perceptions of their agricultural practices. The co-Innovation Platforms in Madagascar were very effective in simultaneously adapting CA to local conditions and facilitating a process of joint learning (Wall et al., 2013). The FFSs in Kenya can also be seen as playing this role to some degree. In line with Lalani et al (2016), FFS membership was associated with a higher intention to adopt CA, which is partly due to the peer pressure from the groups. There are several possible explanations for not finding a significant regression coefficient for social norms in explaining intentions in this study. In Kenya, the recent settlement history could play a role, and in both countries farmers stressed the importance of independence as a farmer. Another option, to be explored by future research, is that social norms inform perceived behavioural control and attitudes, rather than influencing intentions separately.

The examination of farmers' outcome beliefs shows that the evaluation of the importance of potential outcomes is relative to the farmers' 'means to achieve', or resources, and as such is different for each farmer. For example, a household with little labour resources may be very interested in a labour-saving technology, while a family with high labour availability or a small farm will find the labour saving less important. A farm with high weed infestation will attribute more importance to chemical weed control than a farm where weeds are already under control. This points again to the need for local innovation system to accommodate for such high diversity. The next section discusses the extent to which the innovation approaches actually address farmers' constraints.

8.4.7 Does the agricultural innovation system address farmers' adoption constraints?

This section brings out some points regarding the extent to which the promotion activities and innovation priorities connect to the identified constraints in the adoption study. Respondents at the national and local level in Kenya identified the need for improving CA technology development, referring to developing equipment for planting with minimum soil disturbance. However, results of the RAA suggest, that attitudes are the main factor explaining intentions to adopt CA. The results of unpacking the perceived behavioural control, being the second most important factor in the adoption process of CA, indicate that knowledge about direct planting and the ability to grow enough biomass are the main control factors, rather than the availability of equipment. FGDs suggested that some farmers would adopt CA if service providers with animal-drawn direct-planting implements were reliably available, while other farmers (e.g those with sloping, rocky lands, or those with very small lands) would not benefit from improved access to service providers. And although service providers also contribute to the distribution of knowledge, the salient control beliefs contributing to farmers' perceived behavioural control do not suggest that intentions to adopt CA would drastically increase by further developing the technology development sub-system in the innovation system. This points to a difference between what stakeholders in the innovation system perceive to be important and how farmers make the decision to implement CA.

Stakeholders in both countries identified the need to improve networking and interaction among stakeholders. Apart from the local level hubs or platforms, the relevance of this priority is difficult to assess from the perspective of identified constraints in the farmers' adoption process. At the regional and national level stakeholder platforms have recently been created. The practical use of these platforms cannot yet be determined, but if they prove to be sustainable institutions they can be expected to lead to an increase in shared knowledge and experiences. At the local level, where knowledge about new agricultural practices is less accessible than at the national level, the knowledge sub-system would clearly benefit from an improved interaction among stakeholders, and also from interaction with stakeholders at the national level. Since local-level stakeholders have regular contact with farmers, improving the knowledge sub-system would, although not necessarily directly affecting farmers' access to knowledge, facilitate the sharing of knowledge, initiatives and project and extension approaches. The local level coordination can be arranged in different ways, but would normally be done by the stakeholders themselves in a multi-stakeholder platform, or being facilitated by the local ministry of agriculture where there is currently no capability to effectively take up this role. This identified area that needs more attention in the innovation system connects well with the observation that knowledge is an important constraint to the adoption of CA in both countries.

Another weak point in the innovation system, according to the interviewed respondents in Madagascar, was the need for more stable input and output markets, referring primarily to cover crop seeds. Interviews with seed producers suggested a lack of demand of cover crop seeds, while interviews with farmers suggested a lack of supply. Results showed that the availability of seeds was the major control factor in the perceived behavioural control over planting cover crops, together with the availability of money and knowledge. Realizing cover crops with sufficient biomass was generally perceived as the aspect of CA contributing most to its benefits in terms of soil fertility, suggesting indeed the need to improve this sub-system in the innovation system.

8.4.8 Creating capabilities for farmers is more important than promoting CA

In line with the literature, this study shows that CA may not always be the most important priority for farmers in SSA. Mapfumo et al. (2014) identify a critical need "to shift from the current debate on the 'uniquely' defined principles of CA, and whether CA works or not, to a focus on the quest to meet the unique needs of farmers in ways that still address broader concerns of food security, systems resilience and sustainability" (Mapfumo et al., 2014, p. 119). Even from a solely agronomic stance, the extent to which CA is the most appropriate option to achieve higher productivity is found to depend on soil fertility status (Guto et al., 2011). Similarly, for smallholder on low-productive farms in Mozambique, Roxburgh and Rodriguez (2016) estimated that with simple principles of 'good agronomic practice' alone (such as suitable plant populations, row spacing and sowing dates), maize production "could be increased by 120% from 309 kg/ha to 682 kg/ha, among 17% of the population of farmers" (Roxburgh and Rodriguez, 2016).

As argued in Chapter 3, the perspective of capabilities is helpful to distinguish between the means and objectives of agricultural development. This study clearly shows that in some cases CA is a powerful means towards creating capabilities through increasing productivity, reducing labour, and improving the livelihood options for farmers, while in other cases it is not. Capabilities also depend on the farm resources such as land, human resources such as labour, and also on personal objectives and priorities of the household. And capabilities depend on the contextual factors such as labour markets and knowledge systems. The promotion of the cut-and-carry *bozaka* mulching system in Madagascar shows that increasing farmers' knowledge of one specific practice does not necessarily lead to more capabilities if it is not in line with the other resources such as labour. Therefore, the imperative is to make a wide range of options accessible to farmers from which they can choose what they consider valuable. There is an important role for research and projects to play, but the objective of these projects should not be stated in terms of *achievements*, but in terms of *capabilities*.

The innovation history of the crop insurance Kilimo Salama showed that it did not result in more adoption of CA (*achievement*) but expanded options for CA and non-CA farmers alike (*capabilities*) by reducing the risks of investing in crop production in highly variable climatic conditions that characterise central Kenya. An interesting question to add, is this: who decides what capabilities are expanded? Clearly, the capabilities framework draws attention not only to how and why farmers decide which capabilities they choose to pursue and materialize into actual achievements (substantive freedom), but also to their influence in the policies and projects that affect their capabilities (agency freedom). Both forms of freedom are further discussed in the next section in relation to the processes in the innovation system and the theory of communicative action.

8.4.9 From *intervention* to *interaction* for agricultural innovation

The tensions identified at the local and national levels in both countries are perhaps best understood in a context where thinking and practice is moving from an intervention to an interaction paradigm of agricultural development and innovation. The project history in Madagascar described in section 5.5.2 provides an interesting case study to recognize how the project approaches can vary and evolve. What started as a rigid, technology-based top-down approach towards disseminating CA in the Alaotra region, became more inclusive of socio-cultural aspects and farmers' perceptions. This transition was great enough for most respondents to refer to the project phases as BV-Lac I and

BV-Lac II. The ABACO project, then, was a fundamental break from an expert-based extension approach, as farmers were free to join the CA group, co-design experiments according to their interest. The AIS perspective may ask for an even wider interpretation of participation, not just for the short term enjoyment of project benefits, but as "a much more deep-rooted process within the political, social and economic framework of their environment" (Oakley, 1995). Although people can be persuaded, or sometimes coerced, to participate in the first sense, participation in the second sense depends on the complex of capabilities people have. It is a political concept, in which innovation is not designed, but an emerging property from interaction, local, unique in its institutionalisations, subject to -and vehicle for changing- power dynamics.

The theoretical contradictions emerging from the inherent flexibility and dynamism of IPs and the strong tendency to design in development projects, as illustrated by the example of the Innovation Platform described in Box 4, are similar to those emerging during the rise of the 'participation' agenda in the early 1990's. In Madagascar, Blanc-Pamard and Fauroux (2004) demonstrated that following demands from donor organisations, participation processes that became part of project implementation are in fact quite alien to local governance systems in rural Madagascar, which he terms 'illusionary participation'. Indeed, farmers 'play along' with the game of participatory approaches on which they have no real influence except to participate or not to participate. Roncoli et al. (2011) showed how participation is culturally defined by comparing Western style participation "based on values of equity, fairness, and legitimacy, and understood largely in terms of individual expression and affirmation, […] grounded in Western ideas of the democratic process and epitomized by the ability to express one's opinions and to affect decisions by voting on propositions" with the Kiganda style of participation as "informed by cultural norms of social interaction, which stress courtesy, modesty, reserve, and respect. In this perspective, the purpose of participation is to demonstrate unity and to reach decisions by consensus" (Roncoli et al., 2011, p. 128). Similarly, IPs may very well require non-Western modes of facilitation in order to be sustainable and effective.

Röling argues that the approaches used for the promotion of CA, and the theories of change they assume, lean on the more top-down modernistic approaches, although they are trying to tackle the problems that arise from the dominance of the modernist worldview (Röling, 2009b, p. 205). This is why the critique of modernism and the predominance of purposive rationality (e.g. Horkheimer, 2012; and later Habermas, 1984, 1997) is relevant to find a way out of the paradoxes of 'participation' and 'innovation' as development *approaches*. The results and discussion showed that the innovation systems are characterized by a 'push' from national level stakeholders. The dominance of the current project-based approach to facilitating agricultural development presents a continuation of previously hegemonic linear *intervention* relationships between projects and the small-scale farmers. Even if participatory elements are included in such programmes, they remain based on what Habermas calls an incomplete rationality, that is rationality dominated by purposive rationality through instrumental and strategic action (Habermas, 1984). Indeed, even farmers have internalised this paradigm[51], and in both countries there were farmers who were expecting to be told by the project what good farming is. Although there is a legitimate place for all types of rationalities and action, we do well to heed Horkeimer's critique of instrumental reason and to understand the repressive consequences that *Zweckrationalität* (instrumental rationality, as it is called by Max Weber) can have in social interactions.

Following this line of reasoning, a central proposition of this thesis is that the dominance of purposive rationalities, with the resulting process- and substantive un-freedom of smallholder farmers, have become institutionalised in development practice. This to such an extent that the participation agenda in agricultural development has not (yet) fully been able to counter it, as it was incorporated into the dominant purposive thinking. In the transition from intervention to interaction, there is then a need for a counter institutionalisation of communicative rationality and action. One important implication is that the fundamental constraints to improving farmers' livelihoods through effective development programmes lies in a changing approach of project and policy implementation bureaucracies, and in reshaping the structures and institutions at higher levels, an inference made by both Röling (2009) and Drinkwater (1991, p. 270). It requires professionals to grow in values like understanding, humility, flexibility and patience (Oakley, 1995; Bawden, 1991).

The discussion suggests that moving away from a narrow definition of innovation as 'new technology' towards one that is primarily orientated towards the organisational and institutional dimension of innovation, is critical, both from the moral imperatives following from a constructivist epistemology, but also with a view to increasing the impact of research. Habermas' theory of communicative action gives some handholds in the paradigmatic complexity of agricultural development by distinguishing between purposive and communicative rationality and action. Habermas' critical theory provides a theoretical basis for escaping the performative contradiction of using participation as a means towards predefined project solutions. Indeed, participation as a way of expanding agency freedom, should be seen as an end, in a similar way that Sen argues that freedom in general, should be seen as the objective of development. Although the challenge is huge, the process of institutional innovation through more communicative action is one way to contribute to creating capabilities for sustainable agriculture in Africa.

In this study and in the wider literature, the targeting/tailoring and Innovation Platforms appear to be two important approaches followed to overcome the 'disappointing adoption' of promising

[51] The internalization of capitalist bureaucracy leaning on purposive rationality in the naïve everyday experience is what Habermas refers to as 'colonization of the lifeworld' (Finlayson, 2005)

technologies for the sustainable intensification of smallholder agriculture in SSA. Without arguing that one approach is better than another, it is important to observe that they differ in fundamental ways. The targeting approach remains expert-based and technology-oriented, in which farmer participation is used as a means in a purposive-rational process, both instrumental and strategic, with the objective of developing technologies and policies with a better fit to the farmers' situation. The Innovation Platforms as a materialization of AIS thinking should draw on communicative action in which participation is both a means and an end, with a view of facilitating not only technological but also institutional aspects of innovation.

An agricultural innovation system informed by more communicative and less purposive action could go beyond dichotomies of exogenous versus endogenous innovation, traditional versus scientific knowledge, or institutional versus technological development, to reach shared understanding at different levels of social aggregation, appropriate to specific context as experienced by the different stakeholders.

8.5 Policy implications

Before providing some handholds for policy, it is important to start with a meta-perspective on policy implications, as it is precisely this link between knowledge and 'development' that was touched upon in this thesis. More than anything, the critical discussion of the results point towards the complex relation between research, policy, farmers' agency freedom and impacts on farmers' substantive freedom. All stakeholders in the Agricultural Innovation System operate on the basis of explicit or implicit theories of change. As was shown in this study, novel approaches to agricultural change and innovation operate in a context where dominant narratives and frames have become institutionalised in policy and practice. This holds a warning not to be too ambitious with project or policy objectives and to avoid simplistic theories of change that are not warranted by theory and experience.

8.5.1 Policy and projects should aim at creating capabilities

The conceptual framework developed on the basis of the capabilities approach gives valuable input to the debate on the means and objectives of rural development in SSA. The literature about CA and similar practices in SSA regularly highlights the importance for farmers of having a multitude of management options, a large 'window of opportunities' or a 'basket of technological options'. As further developed in Chapter 3, I would argue that this aspiration for a variety of options is indeed crucial and can effectively be founded in a capabilities approach to development. An implication of using the capabilities approach is that not *achievements* but *capabilities* should be the objectives of policy and projects. Since farmers are very diverse in their resource endowments and preferences, a focus on achievements (such as increasing the adoption of CA to *x* hectares in year *x*) is not necessarily beneficial for those who are not interested in the practice, or have more interest in something else. However, a focus on *capabilities* (such as training and making available CA tools) ideally contributes to creating real opportunities to adopt the practice if farmers wish to do so. CA is not a goal in itself, but in some cases it can be an effective means towards achieving individual or group objectives. In a similar way the capabilities approach suggests that agricultural innovation should not be pursued as a goal in itself, but valued for what it can contribute to the 'doings and beings' that men and women value, i.e. the capabilities.

8.5.2 Facilitating the adoption of CA in Kenya and Madagascar

This thesis offers also more practical guidance for expanding farmers' capability to adopt CA. In both countries attitudes and perceived behavioural control were the primary elements in explaining intentions to adopt CA practices. The assessment of the innovation processes in relation to the understanding of the adoption process suggests that allowing a process of experimentation and learning is important for two reasons. First, it allows farmers and other actors to re-examine their outcome beliefs, which fosters a change towards more realistic attitudes (which ultimately may or may not be positive). Second, learning and experimentation also contribute to an improved perceived behavioural control in various ways. Actual behavioural control, this study suggests, could benefit from the close involvement of different actors, including service providers, agro-dealers and extension services. This could contribute to expanding the options available to the farmer for sustainable agriculture.

8.5.3 Participation and the move from purposive to communicative action

The recognition that innovation is unpredictable and cannot fully be imagined or designed by a single stakeholder but rather emerges from a process of interactions, highlights a tension with development projects that rely on purposive rational approaches. This study shows that farmer participation and innovation platforms are sometimes used in a purposive rational way, as a means to attain project outcomes, such as an increased adoption of CA. The radical nature of the interactional paradigm of Agricultural Innovation Systems, which goes beyond the idea of participation, is difficult to translate into practice because the purposive rationality is so dominant and institutionalized. Once we agree with the conclusion that institutional factors are as important as technological change, or indeed are the preconditions for the adoption of new technologies, the logical policy imperative is to change institutions. Once the proposition that institutions can change becomes more broadly held, the scope for policy choices is drastically increased. Following Habermas (1987) the challenge for policy and projects is that of engaging in and supporting processes of communicative action. As such, farmers' agency freedom to participate in innovation processes is more than a means towards achieving project objectives. I argue it is both the means and end of development, and the recommendation and challenge emerging for policy and development projects is to facilitate, support and expand farmers' agency freedom as well as their opportunity freedom. If the objective of sustainably intensifying small-scale agriculture in Africa is approached in this broad sense, the scale of required change is enormous, because it depends on initial change in the attitudes and institutions of development professionals, researchers and donors. Where learning and experimentation are recommended for farmers, the same is recommended for projects and policy approaches, in which long-term facilitation-based projects without rigid pre-determined and expert-defined objectives may very well have a legitimate place in the agricultural innovation system, and contribute to sustainable institutional development.

8.6 Future research

8.6.1 Understanding adoption of sustainable agricultural practices: the potential of the Reasoned Action Approach

This study identified the Reasoned Action Approach (RAA) as a useful heuristic for understanding adoption, which gives more attention to the lived experience perceptions of benefits compared to conventional 'factors-influencing-adoption' approaches. Although there are also limits to this approach, it gives insight in the elements that influence intentions to practice CA related practices in Kenya and Madagascar. As the RAA is not often applied to understand adoption of agricultural practices, future research is needed to better understand the strengths and limitations.

Improvement of RAA constructs' items and scales

Both social norms and perceived behavioural control were assessed with scales that combined two items that are conceptually different (injunctive and descriptive norms, perceived ease and perceived control, respectively). In Kenya, internal consistency was satisfactory, while for Madagascar it was not. As such, future research can set out to explore more accurate ways to capture the diversity of a variable like 'social norms' by including more than these two items. The opposite applies to the attitude construct. The values of Cronbach's Alpha, used as a measure to establish the internal consistency, were very high (close to 1) for the attitudes scale. This suggests that the items used did not succeed in capturing the breadth of the variable, and need improving for future research.

In this study, CA was researched by looking at the constituent practices of CA, while the adoption of CA was constructed by combining results found for the practices of mulching and direct planting. The results pointed at different attitudes towards the different practices, and in future research this differentiation should be considered. As was found in Kenya, the attitude towards CA as a behaviour category can be negative because farmers have a negative attitude towards a single practice like spraying herbicides. Research that assesses the constituent practices of CA separately as well as jointly could give more insight into this aspect of adoption.

As discussed in the methodology section 4.9.5, there are some econometric debates around the expectancy-value model that require attention, in particular regarding the process of the identification of salient beliefs that have a strong impact on intentions. This is because the scaling method (unipolar or bipolar likert items) in multiplicative models like the expectancy-value model influences the found correlation with external criterion like intentions

The role of social norms

Surprisingly, this study did not find a statistically significant contribution of social norms to the intention to adopt CA practices. Nevertheless, the qualitative data suggested importance of peer pressure and copying behaviour from respected farmers. This suggests the need to improve the social norms construct for it to reflect this peer pressure. Further research can aim at clarifying the precise role of social norms. In Kenya, further research should find out whether the limited influence of social norms is sufficiently explained by Laikipia's particular history of recent settlement, or whether it is indicative of a more common individualistic farming decision making. It is also possible that the normative influence of important others is partly reflected in attitudes, which would suggest the need to change the logic of the RAA framework.

Study the link between intention and adoption

The weak link between intentions and adoption of CA practices identified in this study highlights the need for further research, preferably with larger sample sizes. In this study, the time between assessment of intentions and adoption was close to one year. Reducing this time to several months is a good starting point to further clarifying the relation between intentions and adoption. The intensity of intention and adoption, in terms of percentage of the farm where a practice is adopted, is another element to consider in future research.

8.6.2 What are the disbenefits to farmers of technological and institutional innovation?

The contemporary literature seems to suggest that when it comes to technology, agricultural innovation and social capital, 'more' is generally better. As argued in this thesis, based on concepts from political philosophy and critical social theory, this assumption can be critiqued: only those technological and institutional innovations that create capabilities of individuals, households and groups in rural society should be valued. An interesting starting point for future research is to identify what types of social connectedness can actually be a disbenefit to farmers, and in a similar way future research could identify who 'loses' from innovation processes, including agricultural technology. Indeed, innovation has the potential to be socially disruptive and future research can provide insights in these unintended and often unobserved consequences of innovation on the capabilities that farmers actually attain.

8.6.3 Theories of change and agricultural innovation

This study has identified several theories of change that explicitly or implicitly guided action of stakeholders, including farmers. Although it is common for development agencies of various sorts to present a theory of change in project proposals, the identification of theories of change held, explicitly or implicitly, by other development actors is not a prominent feature in the research literature. Given the complexity of rural SSA, any single theory of change is inevitably incomplete and an operationalisation and simplification of a dynamic innovation system. Together with attention to 'framing' and narratives in the promotion of sustainable agricultural practices, it would be interesting to contrast theories of change, including those held by farmers, village leaders, development professionals, etc. in further research.

8.7 Concluding remark

The title of this thesis reflects a view of the main priorities for global agricultural development, and in the literature discussed in this thesis one can find many examples of research and projects that aim at achieving precisely that. It was also put forward, however, that there is a need for a more fundamental change in thinking and practice, based on less purposive and more communicative action. In line with Röling (2009a), I cannot conclude by leaving the impression that the agricultural innovation system perspective, although it offers us a refined paradigm of agricultural innovation, is likely to produce the radical change that is necessary to merge global food security objectives with environmental sustainability and social justice:

"If one considers the enormity of a human society that has become alienated from its ecological roots, that is finding it impossible to curb its devouring greed, or to create the kind of equity that would stop the mad race for more, and that seems totally incapable of applying even widely shared understanding because of short-term political or economic considerations, one can only laugh at the idea that 'innovation systems' would create space for change. The true challenge is a global institutional transformation, in which humans begin to widely share the conviction that it is our own economy, our own competition, nationalism and religious fervour our own institutions and life styles that need to change" (Röling, 2009a).

REFERENCES

Aarts, H., Verplanken, B. and Van Knippenberg, A. (1998) Predicting behavior from actions in the past: Repeated decision making or a matter of habit?, *Journal of Applied Social Psychology*, 28(15), pp. 1355–1374.

ACT-Network (2012) *African Conservation Tillage Network. Strategic Plan 2013-2022*,.

ACT-Network (2014) *Book of Condensed Papers of the First Africa Congress on Conservation Agriculture*, Lusaka, African Conservation Tillage Network (ACT).

ACT-Network (2016) International Conservation Agriculture Advisory Panel for Africa (ICAAP-Africa), [online] Available at: http://icaap.act-africa.org/.

AGRA (2014) *Africa agriculture status report 2014: Climate change and smallholder agriculture in sub-saharan Africa*, Nairobi, Kenya.

Agricultural Society of Kenya (2014) *Enhancing Technology in Agriculture and Industry for Food Security and National Growth. Mount Kenya Agricultural Show*, Nanyuki.

Ajzen, I. (2005) *Attitudes, personality and behavior*, New York, Open University Press.

Ajzen, I. (2012) The Theory of Planned Behavior, In Lange, P. A. M., Kruglanski, A. W., and Higgins, E. T. (eds.), *Handbook of theories of social psychology*, London, Sage.

Ajzen, I. (1991) The theory of planned behavior, *Organizational Behavior and Human Decision Processes*, 50(2), pp. 179–211.

Alkire, S. (2002) *Valuing Freedoms. Sen's Capability Approach and Poverty Reduction*, Oxford, Oxford University Press.

Allport, G. W. (1954) The historical background of modern social psychology, In Lindzey, G. (ed.), *Handbook of social psychology: Vol. 1, Theory and method*, Cambridge, Massachusetts, Addison-Wesley.

Altieri, M. A. (2002) Agroecology : the science of natural resource management for poor farmers in marginal environments, 93, pp. 1–24.

Altieri, M. a. (1999) The ecological role of biodiversity in agroecosystems, *Agriculture, Ecosystems & Environment*, 74(1-3), pp. 19–31.

Andersson, J. A. and D'Souza, S. (2014) From adoption claims to understanding farmers and contexts: A literature review of Conservation Agriculture (CA) adoption among smallholder farmers in southern Africa, *Agriculture, Ecosystems and Environment*, Elsevier B.V., 187, pp. 116–132.

Andersson, J. A. and Giller, K. E. (2012) On heretics and God's blanket salesmen: contested claims for Conservation Agriculture and the politics of its promotion in African smallholder farming, In Sumberg, J. and Thompson, J. (eds.), *Contested Agronomy : agricultural research in a changing world*, New York, Routledge, p. 219.

Arce, A. and Long, N. (2000) *Anthropology, Development and Modernities: exploring discourses, counter-tendencies and violence*, London and New York, Routledge.

Arnstein, A. (1969) A ladder of citizenship participation, *Journal of the American Institute of Planners*, 26, pp. 216–233.

Bagozzi, R. P. (1984) Expectancy-value attitude models: an analysis of critical measurement issues, *International journal of research in marketing*, 1, pp. 295–310.

Bandura, A. (1982) Self-efficacy mechanism in human agency, *American Psychologist*, 37, pp. 122–147.

Banerjee, A. and Duflo, E. (2011) *Poor Economics: A Radical Rethinking of the Way to Fight Global Poverty*, New York, Public affairs.

Baudron, F., Andersson, J. A., Corbeels, M. and Giller, K. E. (2012) Failing to Yield? Ploughs, Conservation Agriculture and the Problem of Agricultural Intensification: An Example from the Zambezi Valley, Zimbabwe, *Journal of Development Studies*, 48(3), pp. 393–412.

Baudron, F., Jaleta, M., Okitoi, O. and Tegegn, A. (2013) Conservation agriculture in African mixed crop-livestock systems: Expanding the niche, *'Agriculture, Ecosystems and Environment'*, Elsevier B.V.

Baudron, F., Mwanza, H. M., Triomphe, B. and Bwalya, M. (2007) *Conservation Agriculture in Zambia: a Case Study of Southern Province.*, Nairobi.

Baudron, F., Tittonell, P., Corbeels, M., Letourmy, P. and Giller, K. E. (2012) Comparative performance of conservation agriculture and current smallholder farming practices in semi-arid Zimbabwe, *Field Crops Research*, 132, pp. 117–128.

Bawden, R. (1991) Systems Thinking and Practice in Agriculture, *Journal of Dairy Science*, 74(7), pp. 2362–2373.

Bayard, B. and Jolly, C. (2007) Environmental behavior structure and socio-economic conditions of hillside farmers: A multiple-group structural equation modeling approach, *Ecological Economics*, 62(3-4), pp. 433–440.

Beedell, J. and Rehman, T. (2000) Using social-psychology models to understand farmers' conservation behaviour, *Journal of Rural Studies*, 16(1), pp. 117–127.

Belloncle, G. (2003) *Sept Priorités Pour Développer Madagascar*, Antananarivo, Madagascar, Foi et Justice.

Berdegué, J. and Escobar, G. (2002) Rural diversity, agricultural innovation policies and poverty reduction,.

Ten Berge, J. M. F. and Sočan, G. (2004) The greatest lower bound to the reliability of a test and the hypothesis of unidimensionality, *Psychometrika*, 69(4), pp. 613–625.

Beuchelt, T. D. and Badstue, L. (2013) Gender, nutrition- and climate-smart food production : Opportunities and trade-offs, *Food Sec*, 5, pp. 709–721.

Biggs, S. (1987) *Proposed Methodology for Analysing Farmer Participation in the ISNAR OFCOR Study*, London.

Blanc-Pamard, C. and Fauroux, E. (2004) L'illusion participative, *Autrepart*, Presses de Sciences Po (P.F.N.S.P.), n° 31(3), pp. 3–19.

Bolliger, A., Magid, J., Jorge, T., Amado, C., Neto, F. S., Ribeiro, M., Calegari, A., Ralisch, R., Neergaard, A., Fatima, M. De, Calegar, A. and De Neergaard, A. (2006) Taking Stock of the Brazilian "Zero Till Revolution": A Review of Landmark Research and Farmers' Practice, *Advances in Agronomy*, 91(06), pp. 47–110.

Borges, J. A. R., Oude Lansink, A. G. J. M., Marques Ribeiro, C. and Lutke, V. (2014) Understanding farmers' intention to adopt improved natural grassland using the theory of planned behavior, *Livestock Science*, 169, pp. 163–174.

Brooks, S. (2014) Enabling adaptation? Lessons from the new 'Green Revolution' in Malawi and Kenya, *Climatic Change*, Springer Netherlands, 122(1-2), pp. 15–26.

Bunch, R. (2014) Let's dream big! How can we cover millions of hectares with Conservation Agriculture, In *Proceedings of 1st Africa Congress on Conservation Agriculture*, Lusaka.

Burger, P. and Christen, M. (2011) Towards a capability approach of sustainability, *Journal of Cleaner Production*, Elsevier Ltd, 19(8), pp. 787–795.

Burton, R. J. F. (2004) Reconceptualising the “behavioural approach” in agricultural studies : a socio-psychological perspective, *Journal of Rural Studies*, 20, pp. 359–371.

Burton, R. J. F. (2014) The influence of farmer demographic characteristics on environmental behaviour: a review., *Journal of environmental management*, 135, pp. 19–26.

Burton, R. J. F. and Wilson, G. A. (2006a) Injecting social psychology theory into conceptualisations of agricultural agency: Towards a post-productivist farmer self-identity?, *Journal of Rural Studies*, 22(1), pp. 95–115.

Burton, R. J. F. and Wilson, G. A. (2006b) Injecting social psychology theory into conceptualisations of agricultural agency: Towards a post-productivist farmer self-identity?, *Journal of Rural Studies*, 22, pp. 95–115.

Chabierski, S., Penot, E., Husson, O., Dabat, M., Andriamala, H. and Domas, R. (2008) *Determinants of DMC technologies adoption among smallholders in the Lake Alaotra area, Madagascar*,.

Chambers, R. and Conway, G. (1992) *Sustainable rural livelihoods: practical concepts for the 21st century*, *IDS Discussion Paper*, Brighton.

Chambers, R. and Jiggins, J. (1987) Agricultural research for resource-poor farmers part II: A parsimonious paradigm, *Agricultural Administration and Extension*, 27(2), pp. 109–128.

Chauhan, B. S., Singh, R. G. and Mahajan, G. (2012) Ecology and management of weeds under conservation agriculture: A review, *Crop Protection*, (38), pp. 57–65.

Chiputwa, B., Langyintuo, A. S. and Wall, P. C. (2011) *Adoption of conservation agriculture technologies by smallholder farmers in the Shamva District of Zimbabwe: A Tobit application*, Texas, USA.

COMESA, EAC and SADC (2011) *Programme on climate change adaptation and mitigation in the Eastern and Southern Africa (COMESA-EAC-SADC) region*,.

Conner, M. and Armitage, C. J. (1998) Extending the theory of planned behavior: A review and avenues for further research, *Journal of Applied Social Psychology*, pp. 1429–1464.

Corbeels, M., Graaff, J. De, Hycenth, T., Penot, E., Baudron, F., Naudin, K., Andrieu, N., Chirat, G., Schuler, J., Nyagumbo, I., Rusinamhodzi, L., Traore, K., Dulla, H. and Solomon, I. (2013) Understanding the impact and adoption of conservation agriculture in Africa: A multi-scale analysis, *‘Agriculture, Ecosystems and Environment’*, Elsevier B.V.

Corbeels, M., de Graaff, J., Ndah, T. H., Penot, E., Baudron, F., Naudin, K., Andrieu, N., Chirat, G., Schuler, J., Nyagumbo, I., Rusinamhodzi, L., Traore, K., Mzoba, H. D. and Adolwa, I. S. (2014) Understanding the impact and adoption of conservation agriculture in Africa: A multi-scale analysis, *Agriculture, Ecosystems & Environment*, 187, pp. 155–170.

Crocker, D. A. (2008) *Ethics of Global Development*, Cambridge, Cambridge University Press.

Cronbach, L. J. (1951) Coefficient alpha and the internal structure of tests, *Psychometrika*, 16, pp. 297–334.

Daviter, F. (2007) Policy framing in the European Union, *Journal of European Public Policy*, Routledge, 14(4), pp. 654–666.

Derpsch, R. and Friedrich, T. (2010) The adoption of Conservation Agriculture worldwide, In *16th ISCO Congress*, Santiago, Chile.

Derpsch, R., Friedrich, T. and Sol, S. (2009) Development and Current Status of No-till Adoption in the World, In *Proceedings on CD, 18th Triennial Conference of the International Soil Tillage Research Organization (ISTRO)*.

DFID (1995) *Stakeholder Participation and Analysis*, *Social Development Division*, London, Department for International Development.

Doré, T., Makowski, D., Malézieux, E., Munier-Jolain, N., Tchamitchian, M. and Tittonell, P. (2011) Facing up to the paradigm of ecological intensification in agronomy: Revisiting methods, concepts and knowledge, *European Journal of Agronomy*, 34(4), pp. 197–210.

Douzet, J.-M., Muller, B., Scopel, E., Albrecht, A., Rakotoarisoa, J. and Rakotoalibera, M. H. (2007) Réduction du ruissellement et de l'érosion par les SCV pour les cultures pluviales des hautes terres malgaches., In *Les sols tropicaux en semis direct sous couvertures végétales*, Antananarivo, Madagascar, Université d'Antananarivo.

Mac Dowall, C. (2011) Socio-economic assessment of the impact of adoption of Conservation Agriculture (CA) on farming systems in the region of Lake Alaotra, Madagascar, Isara Lyon.

Drinkwater, M. (1991) *The state and agrarian change in Zimbabwe's communal areas.*, Palgrave Macmillan.

Eisinga, R., Grotenhuis, M. te and Pelzer, B. (2013) The reliability of a two-item scale: Pearson, Cronbach, or Spearman-Brown?, *International journal of public health*, 58(4), pp. 637–42.

Ekboir, J. (2002) Part 1. Developing no-till packages for small farmers, In Ekboir, J. (ed.), *CIMMYT 2000-2001 World Wheat Overview and Outlook: Developing No-Till Packages for Small-Scale Farmers*, Mexico, DF, CIMMYT, pp. 1–38.

Enyong, L. A., Debrah, S. K. and Bationo, A. (1999) Farmers' perceptions and attitudes towards introduced soil-fertility enhancing technologies in western Africa, *Nutrient Cycling in Agroecosystems*, Springer, 53(2), pp. 177–187.

Erenstein, O. (2003) Smallholder conservation farming in the tropics and sub-tropics: a guide to the development and dissemination of mulching with crop residues and cover crops, *Agriculture, Ecosystems & Environment*, 100(1), pp. 17–37.

Erenstein, O. (1999) *The Economics of Soil Conservation in Developing Countries: The Case of Crop Residue Mulching*, *Mansholt Studies*, Wageningen, The Netherlands.

Ervin, C. A. and Ervin, D. E. (1982) Factors Affecting the Use of Soil Conservation Practices : Hypotheses , Evidence , and Policy Implications, *Land Economics*, 58(3), pp. 277–292.

Ethnologue (2016) Languages of the world, [online] Available at: http://www.ethnologue.com/ (Accessed 24 July 2016).

European Commission (2010) *European Commission Grant Application Form ABACO project*,.

Fabre, J. (2011) *Evaluation technico-economique des effets des Systemes de Culture Sous Couverture Vegetale dans les exloitations agricoles du Lac Alaotra, Madagascar*, Montpellier.

Fairhead, J., Leach, M. and Manor, K. A. (2012) Anthropogenic dark earths and Africa: A political agronomy of research disjunctures, In Sumberg, J. and Thompson, J. (eds.), *Contested Agronomy: Agricultural Research in a Changing World*, London, Routledge.

FAO (2014a) Conservation Agriculture web page, [online] Available at: http://www.fao.org/ag/ca/6c.html (Accessed 24 January 2016).

FAO (2012) FAOSTAT, [online] Available at: http://faostat.fao.org/site/377/DesktopDefault.aspx?PageID=377#ancor.

FAO (2011) *Save and grow, A policymaker's guide to the sustainable intensification of smallholder crop production*, Rome, FAO.

FAO (2014b) *The State of Food and Agriculture: Innovation in family farming*, *FAO, Rome*, Rome.

Fernandez-Cornejo, J. (2007) *Off-Farm Income, Technology Adoption, and Farm Economic Performance*, *Economic Research Report*.

Fielding, K. S., Terry, D. J., Masser, B. M., Bordia, P. and Hogg, M. A. (2005) Explaining landholders' decisions about riparian zone management: the role of behavioural, normative, and control beliefs., *Journal of environmental management*, 77(1), pp. 12–21.

Finlayson, J. G. (2005) *Habermas: A Very Short Introduction*, Oxford, Oxford University Press.

Fishbein, M. (1963) An investigation of relationships between beliefs about an object and the attitude toward that object, *Human Relations*, 16, pp. 233–240.

Fishbein, M. and Ajzen, I. (1975) *Belief, attitude, intention, and behavior: An introduction to theory and research*, Reading, Addison-Wesley.

Fishbein, M. and Ajzen, I. (2010) *Predicting and changing behavior; the reasoned action approach*, New York, Taylor & Francis Group.

Foley, J. A., Ramankutty, N., Brauman, K. A., Cassidy, E. S., Gerber, J. S., Johnston, M., Mueller, N. D., O'Connell, C., Ray, D. K., West, P. C., Balzer, C., Bennett, E. M., Carpenter, S. R., Hill, J., Monfreda, C., Polasky, S., Rockström, J., Sheehan, J., Siebert, S., Tilman, D. and Zaks, D. P. M. (2011) Solutions for a cultivated planet, *Nature*, 478(7369), pp. 337–342.

Fowler, R. and Rockstrom, J. (2001) Conservation tillage for sustainable agriculture, *Soil and Tillage Research*, 61(1-2), pp. 93–108.

Friedrich, T., Derpsch, R. and Kassam, A. (2012) Overview of the global spread of Conservation Agriculture, *Field Actions Science Reports*, Special Is, pp. 1–7.

Friedrich, T. and Kassam, A. (2009) *Adoption of Conservation Agriculture Technologies : Constraints and Opportunities*, Rome.

Frost, A. (2014) Research Into Use, [online] Available at: http://www.researchintouse.com/.

Gagné, C. and Godin, G. (2000) The theory of planned behavior: Some measurement issues concerning belief-based variables, *Journal of Applied Social Psychology*, 30, pp. 2173–2193.

George, A. L. and Bennett, A. (2004) *Case studies and theory development in the social sciences*, London, MIT Press, Cambridge, Mass.

Giampietro, M. (2003) *Multi-Scale Integrated Analysis of Agro-ecosystems*, Boca Raton, Florida, CRC Press.

Gichuki, F. N., Liniger, H., MacMillan, L. C., Schwilch, G. and Gikonyo, J. K. (1998) Scarce Water: Exploring Resource Availability, Use and Improved Management, *Eastern and Southern Africa Geographical Journal*, 8, Special, pp. 15–28.

Giller, K. E., Corbeels, M., Nyamangara, J., Triomphe, B., Affholder, F., Scopel, E. and Tittonell, P. (2011) A research agenda to explore the role of conservation agriculture in African smallholder farming systems, *Field Crops Research*, Elsevier B.V., 124(3), pp. 468–472.

Giller, K. E., Rowe, E. C., Ridder, N. De and Keulen, H. Van (2006) Resource use dynamics and interactions in the tropics : Scaling up in space and time, 88, pp. 8–27.

Giller, K. E., Witter, E., Corbeels, M. and Tittonell, P. (2009) Conservation agriculture and smallholder farming in Africa: The heretics' view, *Field Crops Research*, 114(1), pp. 23–34.

Govaerts, B., Sayre, K. D. and Deckers, J. (2005) Stable high yields with zero tillage and permanent bed planting?, *Field Crops Research*, 94(1), pp. 33–42.

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

De Graaff, J., A., A., Bodnár, F., Kessler, A., Posthumus, H. and Tenge, A. (2008) Factors influencing adoption and continued use of long-term soil and water conservation measures in five developing countries, *Applied Geography*, 28, pp. 271–280.

Guto, S., Pypers, P., Vanlauwe, B., De Ridder, N. and Giller, K. E. (2011) Socio-ecological Niches for Minimum Tillage and Crop-residue Retention in Continuous Maize Cropping Systems in Smallholder Farms of Central Kenya, *Agronomy Journal*, 103, pp. 1–11.

Haas, P. M. (1992) Introduction: epistemic communities and international policy coordination, *International Organization*, 46(01), p. 1.

Haas, P. M. (2001) *Policy Knowledge: Epistemic Communities*, *International Encyclopedia of the Social & Behavioral Sciences*, New York, Elsevier.

Habermas, J. (1997) Modernity: an unfinished project, In D'Entrèves, M. P. and Benhabib, S. (eds.), *Habermas and the unfiinished project of modernity: critical essays on the discourse of modernity*, Cambridge, Massachusetts, MIT Press, p. 315.

Habermas, J. (1990) *Moral Consciousness and Communicative Action*, Cambridge, Massachusetts, MIT Press.

Habermas, J. (1984) *The Theory of Communicative Action. Vol. 1: Reason and the Rationalisation of Society*, Boston, Beacon Press.

Haggblade, S. and Tembo, G. (2003) *Conservation farming in Zambia*, *Discussion Paper*, Washington DC.

Hall, A. (2007) *Challenges to Strengthening Agricultural Innovation Systems: Where Do We Go From Here?*, *UNUMERIT Working Paper*, Maastricht.

Hall, A., Janssen, W., Pehu, E. and Rajalahti, R. (2007) *Enhancing Agricultural Innovation: How to go beyond the strengthening of research systems*, Washington, DC, The World Bank.

Harland, P., Staats, H. and Wilke, H. A. M. (1999) Explaining Proenvironmental Intention and Behavior by Personal Norms and the Theory of Planned Behavior1, *Journal of Applied Social Psychology*, 29(12), pp. 2505–2528.

Hassanali, A., Herren, H., Khan, Z. R., Pickett, J. A. and Woodcock, C. M. (2008) Integrated pest management: the push-pull approach for controlling insect pests and weeds of cereals, and its potential for other agricultural systems including animal husbandry., *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 363(1491), pp. 611–21.

Hobbs, P. R. (2007) Conservation Agriculture : What Is It and Why Is It Important for Future Sustainable Food Production ?, In *Paper presented at international workshop on increasing wheat yield potential, CYMMIT , Obregon, Mexico, 20–24 March 2006*.

Hobbs, P. R. and Govaerts, B. (2010) How conservation agriculture can contribute to buffering climate change, In Reynolds, M. P. (ed.), *Climate Change & Crop Production*, 1st ed, CABI.

Hobbs, P. R., Sayre, K. and Gupta, R. (2008) The role of conservation agriculture in sustainable agriculture., *Philosophical transactions of the Royal Society of London. Series B, Biological sciences*, 363(1491), pp. 543–55.

Horkheimer, M. (1986) *Critical Theory, selected essays*, New York, Continuum.

Horkheimer, M. (2012) *Critique of instrumental reason*, London, Verso.

Hounkonnou, D., Kossou, D., Kuyper, T. W., Leeuwis, C., Nederlof, E. S., Röling, N., Sakyi-dawson, O., Traoré, M. and Huis, A. Van (2012) An innovation systems approach to institutional change : Smallholder development in West Africa, *Agricultural Systems*, Elsevier Ltd, 108, pp. 74–83.

Hounkonnou, O., Kossou, O. K., Kuyper, T. W., Leeuwis, C. and Richards, P. (2005) Convergence of sciences : the management of agricultural research for small-scale farmers in Benin and Ghana, *NJAS - Wageningen Journal of Life Sciences*, pp. 343–367.

Van Hulst, F. J., Naudin, K., Domas, R., De Graaff, J., Visser, S. and Scopel, E. (2011)

Conservation agriculture potential effects on soil erosion for rainfed crops in the Lake Alaotra region in Madagascar, In *Resilient food systems for a changing world / 5th World Congress of Conservation Agriculture (WCCA)*, Brisbane, Australia.

Van Hulst, F. J. and Posthumus, H. (2016) Understanding (non-) adoption of Conservation Agriculture in Kenya using the Reasoned Action Approach, *Land Use Policy*, 56, pp. 303–314.

Van Hulst, F. J. and Posthumus, H. (2014) Understanding (non-)adoption of CA: contributions from Social Psychology, In *1st Africa congress on conservation agriculture*, Lusaka.

Husson, O., Charpentier, H., Michellon, R., Raharison, T., Rasolomanjaka, J., Enjalric, F., Naudin, K., Rakotondramanana and Séguy, L. (2012) *Les systèmes SCV à proposer en climat de moyenne altitude (600-1100 m) avec longue saison sèche (>6 mois). Lac Alaotra et Moyen-Ouest*, *Manuel pratique du semis direct à Madagascar*, *Manuel pratique du semis direct à Madagascar*, Antananarivo, Madagascar.

Husson, O., Séguy, L., Hubert Charpentier, R., Roger Michellon, Tahina Raharison, Krishna Naudin, Frank Enjalric, Narcisse Moussa, C. R., Rasolomanjaka, J., Bouzinac, S., Chabanne, A., Boulakia, S., Tivet, F., Chabierski, S., Razafintsalama, H., Rakotoarinivo, C., Andrianasolo, H., Chabaud, F.-X., Tahina, R., Pierson, R. and Ramaroson, I. (2013) *Manuel pratique du Semis direct sur Couverture Végétale permanente (SCV) Application à Madagascar*,.

IIRR and ACT (2005) *Conservation Agriculture: A manual for farmers and extension workers in Africa*, Nairobi, International Institute of Rural Reconstructio; African Conservation Tillage Network.

Jat, R. A., Wani, S. P. and Sahrawat, K. L. (2012) Chapter Four – Conservation Agriculture in the Semi-Arid Tropics: Prospects and Problems, *Advances in Agronomy*, 117, pp. 191–273.

Johnson, B. and Lundvall, B. . (2003) National systems of innovation and development, In Muchie, M., Gammeltoft, P., and Lundvall, B. . (eds.), *Putting Africa first*, Aalborg, Aalborg University Press.

Johnson, R. B. and Onwuegbuzie, A. J. (2004) Mixed Methods Research: A Research Paradigm Whose Time Has Come, *Educational Researcher*, 33(7), pp. 14–26.

Johnson, R. B., Onwuegbuzie, A. J. and Turner, L. A. (2007) Toward a Definition of Mixed Methods Research, *Journal of Mixed Methods Research*, 1(2), pp. 112–133.

Joll, N. (2010) Contemporary Metaphilosophy, *Internet Encyclopedia of Philosophy*, [online] Available at: http://www.iep.utm.edu/con-meta/#SH4b (Accessed 31 May 2016).

Kaiser, F. G. (2006) A moral extension of the theory of planned behavior: Norms and anticipated feelings of regret in conservationism, *Personality and Individual Differences*, 41(1), pp. 71–81.

Karlström, M. (1996) Imagining democracy: political culture and democratisation in Buganda, *Africa*, Cambridge University Press, 66(04), pp. 485–505.

Kassam, A., Friedrich, T., Shaxson, F. and Pretty, J. (2009) The spread of Conservation Agriculture: justification, sustainability and uptake, *International Journal of Agricultural Sustainability*, 7(4), pp. 292–320.

Kaumbutho, P. and Kienzle, J. (eds.) (2007) *Conservation agriculture as practised in Kenya: two case studies*, Nairobi, African Conservation Tillage Network (ACT); Centre de Coopération Internationale de Recherche Agronomique pour le Développement; Food and Agriculture Organization of the United Nations.

Kendzior, J. (2013) *Smallholder perceptions of Conservation Agriculture based on ten co-designed field experiments in the Lake Alaotra region, Madagascar*, Wageningen.

Kessler, C. A. (2006) Decisive key-factors influencing farm households' soil and water conservation investments, *Applied Geography*, 26(1), pp. 40–60.

Keter, S. (1989) *Farmers' perception/acceptance of water and soil conservation techniques*, Nanyuki.

Kilelu, C. W., Klerkx, L. and Leeuwis, C. (2013) Unravelling the role of innovation platforms in supporting co-evolution of innovation: Contributions and tensions in a smallholder dairy development programme, *Agricultural Systems*, 118, pp. 65–77.

Kirkegaard, J. A., Conyers, M. K., Hunt, J. R., Kirkby, C. A., Watt, M. and Rebetzke, G. J. (2013) Sense and nonsense in conservation agriculture: Principles, pragmatism and productivity in Australian mixed farming systems, *Agriculture, Ecosystems and Environment*, Elsevier B.V., 187, pp. 133–145.

KNBS (2009) *The 2009 Kenya Population and Housing Census*, Nairobi.

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

Knox Mcculloch, A., Meinzen-dick, R. and Hazell, P. (1998) *Property Rights, Collective Action and Technologies for Natural Resource Management: A conceptual Framework*, *SP-PRCA*, Washington, DC.

Kohler, T. (1988) Landbesitz und Landnutzung im Umbruch: Das Beispiel des Laikipia Distrikts nordwestlich des Mt. Kenia, *Erdkunde*, 42(1), pp. 37–49.

Kuhn, T. S. (1970) *The structure of scientific revolutions*, *Enlarged*, 2nd ed, University of Chicago Press.

Kurukulasuriya, P., Mendelsohn, R., Hassan, R., Benhin, J., Deressa, T., Diop, M., Eid, H. M., Fosu, K. Y., Gbetibouo, G., Jain, S., Mahamadou, A., Mano, R., Kabubo-Mariara, J., El-Marsafawy, S., Molua, E., Ouda, S., Ouedraogo, M., Séne, I., Maddison, D., Seo, S. N. and Dinar, A. (2006) Will African Agriculture Survive Climate Change?, *The World Bank Economic Review*, 20(3), pp. 367–388.

Lal, R. (2015) Sequestering carbon and increasing productivity by conservation agriculture, *Journal of Soil and Water Conservation*, 70(3), p. 55A–62A.

Lalani, B., Dorward, P., Holloway, G. and Wauters, E. (2016) Smallholder farmers' motivations for using Conservation Agriculture and the roles of yield, labour and soil fertility in decision making, *Agricultural Systems*, 146, pp. 80–90.

Lapar, M. (1999) Adoption of soil conservation: the case of the Philippine uplands, *Agricultural Economics*, 21(3), pp. 241–256.

Läpple, D. and Kelley, H. (2013) Understanding the uptake of organic farming: Accounting for heterogeneities among Irish farmers, *Ecological Economics*, 88, pp. 11–19.

Lawrence, A. (2006) No personal motive? volunteers, biodiversity, and the false dichotomies of participation, *Ethics, Place and Environment*, 9, pp. 279–298.

Van der Lee, F. M., Kayula, F. M., Makasa, V. and Heemskerk, W. (2011) Conservation agriculture in Zambia, In Nederlof, E. S., Wongtschowski, M., and Van der Lee, F. (eds.), *Putting heads together . Agricultural innovation platforms in practice*, Amsterdam, KIT.

Leeuwis, C. and Van den Ban, A. (2004) *Communication for Rural Innovation. Rethinking Agricultural Extension*, Oxford, Blackwell Science.

Long, N. and Long, A. (1992) *Battlefields of knowledge the interlocking of theory and practice in social research and development*, London, Routledge.

Long, N. and Van der Ploeg, J. D. (1989) Demythologising planned intervention, *Sociologia Ruralis*, 29(3/4), pp. 226–249.

Lynne, G. D., Franklin Casey, C., Hodges, A. and Rahmani, M. (1995) Conservation technology adoption decisions and the theory of planned behavior, *Journal of Economic Psychology*, 16(4), pp. 581–598.

Machado, P. L. O. D. A. and Silva, C. A. (2001) Soil management under no-tillage systems in the tropics with special reference to Brazil, *Nutrient Cycling in Agroecosystems*, 61, pp. 119–130.

Mapfumo, P., Mtambanengwe, F., Nezomba, H. and Manzeke, M. G. (2014) Options for adaptation of Conservation Agriculture practices on nutrient-depleted soils by smallholder farmers in Southern Africa, In *Proceedings of 1st Africa Congress on Conservation Agriculture1st Africa congress on conservation agriculture*.

Martin, A. and Sherington, J. (1997) Participatory research methods—Implementation, effectiveness and institutional context, *Agricultural Systems*, 55(2), pp. 195–216.

Matunhu, J. (2011) A critique of modernization and dependency theories in Africa: Critical assessment, *African Journal of History and Culture*, 3(5), pp. 65–72.

Mazvimavi, K. and Twomlow, S. (2009) Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe, *Agricultural Systems*, 101(1-2), pp. 20–29.

McLellan, D. (ed.) (2000) *Karl Marx: selected writings*, 2nd ed, Oxford, Oxford University Press.

Milder, J. C., Scherr, S. J. and Majanen, T. (2011) *Performance and Potential of Conservation Agriculture for Climate Change Adaptation and Mitigation in Sub-Saharan Africa*,.

Millennium Ecosystem Assessment (2005) *Ecosystems and human well-being: synthesis*, Washington, DC, Island Press.

Min. of Agr. (2013) *Laikipia East, Conservation Agriculture Brief*, Nanyuki.

Mohler, C. L. and Teasdale, J. R. (1993) Response of weed emergence to rate of Vicia villosa Roth and Secale cereale L. residue, *Weed Research*, 33, pp. 487–499.

Morelli, E., Onnis, G. A., Ammann, W. J. and Sutter, C. (eds.) (2010) *Microinsurance: Innovative Tool for Risk and Disaster Management*, Napoli, Italy, Global Risk Forum Davos.

Mulinge, W. M. (2010) *Promotion of Growth and Improved Food Security through the Scaling Up Of Conservation Agriculture (CA) As a Sustainable Land Management (SLM) Tool: CA-SARD Project M&E Impact Study*, Nairobi.

Muroki, R. W. (n.d.) *External Intervention in Smallholder Crop Farming within Laikipia: Influence and Contributions on Actors' Dimension*, Laikipia.

Naess, L. O., Hagemann, M., Harvey, B., Urban, F., Hendel-Blackford, S. and Höhne, N. (2014) *Improving Co-benefits and 'Triple Win' Impacts from Climate Action: The Role of Guidance Tools*, London.

Narayan, D. and Pritchett, L. (1996) *Cents and Sociability: Household Income and Social Capital in Rural Tanzania*, *Policy Research Working Paper*, Washington, DC.

Naudin, K. (2012) You can't eat you mulch and have it too - Cropping system design and trade-offs around biomass use for Conservation Agriculture in Cameroon and Madagascar, Wageningen University.

Naudin, K., Bruelle, G., Salgado, P., Penot, E., Scopel, E., Lubbers, M., de Ridder, N. and Giller, K. E. (2014) Trade-offs around the use of biomass for livestock feed and soil cover in dairy farms in the Alaotra lake region of Madagascar, *Agricultural Systems*, 134, pp. 36–47.

Naudin, K., Gozé, E., Balarabe, O., Giller, K. E. and Scopel, E. (2010) Impact of no tillage and mulching practices on cotton production in North Cameroon: A multi-locational on-farm assessment, *Soil and Tillage Research*, 108(1-2), pp. 68–76.

Nederlof, E. S., Wongtschowski, M. and Van der Lee, F. (eds.) (2011) *Putting heads together. Agricultural innovation platforms in practice*, Amsterdam, The Netherlands, KIT.

Nguyen, T. P. L., Seddaiu, G., Virdis, S. G. P., Tidore, C., Pasqui, M. and Roggero, P. P. (2016) Perceiving to learn or learning to perceive? Understanding farmers' perceptions and adaptation to climate uncertainties, *Agricultural Systems*, 143, pp. 205–216.

Nichols, V., Verhulst, N., Cox, R. and Govaerts, B. (2015) Weed dynamics and conservation agriculture principles: A review, *Field Crops Research*, 183, pp. 56–68.

Notter, B., MacMillan, L., Viviroli, D., Weingartner, R. and Liniger, H.-P. (2007) Impacts of environmental change on water resources in the Mt. Kenya region, *Journal of Hydrology*, 343, pp. 266 – 278.

Nussbaum, M. (1988) Non-Relative Virtues: An Aristotelian Approach, *Midwest Studies in Philosophy*, 13(1), pp. 32–53.

Nussbaum, M. (2000) *Women and Human Development: The Capabilities Approach*, Cambridge, UK, Cambridge University Press.

Nussbaum, M. C. (2001) *Women and Human Development: The Capabilities Approach*, Cambridge University Press.

Nussbaum, M. and Sen, A. (1993) *The Quality of Life*, Clarendon Press.

Oakley, P. (1995) *People's Participation in Development Projects: A critical review of current theory and practice*,.

Ojiem, J. 0. (2006) *Exploring socio-ecological niches for legumes in western Kenya smallholder farming systems*, Wageningen.

Pannell, D. J., Llewellyn, R. S. and Corbeels, M. (2013) The farm-level economics of conservation agriculture for resource-poor farmers, *Agriculture, Ecosystems and Environment*, Elsevier B.V., 187, pp. 52–64.

Pant, L. P. (2014) Critical Systems of Learning and Innovation Competence for Addressing Complexity in Transformations to Agricultural Sustainability, *Agroecology and Sustainable Food Systems*, 38(3), pp. 336–365.

Penot, E., Fabre, J. and Domas, R. (2011) The real adoption of Conservation Agriculture (CA) in the Lake Alaotra area after 10 years of diffusion, In *5th World Congress of Conservation Agriculture (WCCA): Resilient food systems for a changing world*, Brisbane.

Penot, E., Scopel, E., Domas, R. and Naudin, K. (2010) La durabilité est elle soluble dans le développement ? L'adoption des techniques de conservation de l'agriculture dans un contexte d'incertitudes multiples au lac Alaotra, Madagascar, In CIRAD and INRA (eds.), *Quelles constructions individuelles et collectives des régimes de protection et d'adaptation en agriculture?*, Montpellier, France.

Posthumus, H., Mur, R., Wongtschowski, M., Pound, B., Misiko, M., Andersson, J., Triomphe, B. and Mapfumo, P. (2014) A reflection on the role of innovation platforms for Conservation Agriculture in Africa, In *Proceedings of 1st Africa Congress on Conservation Agriculture*, Lusaka, AC- Network, pp. 179–183.

Posthumus, H., Pound, B., Andrieu, N. and Triomphe, B. (2011) Enhancing adoption of conservation agriculture practices through co-innovation platforms in sub-Saharan Africa, In *5th World Congress of Conservation Agriculture*, Brisbane.

Pound, B. (2014) *Report on a livelihoods study, Laikipia East, Kenya*, Greenwich.

Powlson, D. S., Stirling, C. M., Thierfelder, C., White, R. P. and Jat, M. L. (2016) Does conservation agriculture deliver climate change mitigation through soil carbon sequestration in tropical agro-ecosystems?, *Agriculture, Ecosystems & Environment*, 220, pp. 164–174.

Prager, K. (2002) *Akzeptanz von Maßn ahmen zur Umsetzung einer umweltschonenden Landbewirtschaftung bei Landwirten und Beratern in Brandenburg.*, *Series Kommunikation und Beratung 48*, Weikersheim: Margraf.

Prager, K. and Posthumus, H. (2010) Socio-economic factors influencing farmers' adoption of soil conservation practices in europe, In Napier, T. L. (ed.), *Human dimensions of Soil and Water Conservation*, Nova Science Publishers, Inc.

Pretty, J. (2003) *Social capital and connectedness : Issues and implications for agriculture , rural development and natural resource management in ACP countries*, *CTA Working Document*.

Pretty, J. N., Noble, A. D., Bossio, D., Dixon, J., Hine, R. E., Penning De Vries, F. W. T. and Morison, J. I. L. (2006) Resource-Conserving Agriculture Increases Yields in Developing Countries, *Policy Analysis*, 40(4), pp. 1114–1119.

Price, J. C. and Leviston, Z. (2014) Predicting pro-environmental agricultural practices: The social, psychological and contextual influences on land management, *Journal of Rural Studies*, 34, pp. 65–78.

Quinn, C. and Burbach, M. E. (2008) Personal characteristics preceding pro-environmental behaviors that improve surface water quality, *Great Plains Research*, 18(1), pp. 103–114.

Rakotoarimanana, A., Grandjean, P., Penot, E. and Dabat, M.-H. (2009) Le boom des motoculteurs au Lac Alaotra à Madagascar, *Grain de sel*, 48, pp. 19–20.

Rakotondramamanana, Husson, O. and Enjalric, F. (2010) *Documentation et synthèse de l'agriculture de Conservation à Madagascar*, Antananarivo, Madagascar.

Rakotondramanana, RakotoHarivony, N., Enjalric, F., Raharison, T. and RASOLOMANJAKA, J. (2014) Pooling effort of all stakeholders to upscale Climate Smart and Conservation Agriculture within National Task Force on Conservation Agriculture, In *Agroecology and Sustainability of Tropical Rainfed Cropping Systems*, Antananarivo, Madagascar.

Randrianarison, N. (2013) Processus d'innovation et conditions de maintien des agriculteurs : La diffusion des innovations dans la paysannerie Malgache, cas de la region du Lac Alaotra, Université Montpellier.

Razafimbelo, T., Albrecht, A., Feller, C., Ravelojaona, H., Moussa, N., Razanamparany, C., Rakotoarinivo, C., Razafintsalama, H., Michellon, R., Naudin, K. and Rabeharisoa, L. (2010) Stockage de carbone dans les sols sous systèmes de culture en semis direct sous couvert végétal (SCV) dans différents contextes pédoclimatiques à Madagascar, *Étude et Gestion des Sols*, 17(2), pp. 143–158.

Richard, R., De Vries, N. K. and Van Der Pligt, J. (1998) Anticipated regret and precautionary sexual behavior, *Journal of Applied Social Psychology*, 28(15), pp. 1411–1428.

Richards, P. (2010) *A Green Revolution from below? Science and technology for global food security and poverty alleviation*, Wageningen.

Robeyns, I. (2005) The Capability Approach: a theoretical survey, *Journal of Human Development*, 6(1), pp. 93–117.

Rockstrom, J., Kaumbutho, P., Mwalley, J., Nzabi, A. W., Temesgen, M., Nya, L. M.-, Barron, J., Mutua, J. and Damgaard-Larsen (2009) Conservation farming strategies in East and Southern Africa: Yields and rain water productivity from on-farm action research, *Soil Tillage Research*, 103, pp. 23–32.

Rodin, J. (1990) Control by any other name: Definitions, concepts, and processes, In Rodin, J. and Schooler, C. (eds.), *Self-directedness: Cause and effects throughout the life course*, Hillsdale, Lawrence Erlbaum Associates.

Rogers, E. M. (1983) *Diffusion of innovations*, New York, Free Press.

Röling, N. (2009a) Pathways for impact: scientists' different perspectives on agricultural innovation, *International journal of agricultural sustainability*, 7(2), pp. 83–94.

Röling, N. (2009b) Uitgangspunten, In Röling, N. G., Kuiper, D., and Janmaat, R. (eds.), *Basisboek Voorlichtingskunde*, 2nd ed, Amsterdam, Boom, p. 344.

Röling, N. G., Hounkonnou, D., Offei, S. K., Tossou, R. and Van Huis, A. (2004) Linking science and farmers' innovative capacity: diagnostic studies from Ghana and Benin, *NJAS - Wageningen Journal of Life Sciences*, 52(3-4), pp. 211–235.

Röling, N. G., Kuiper, D. and Janmaat, R. (eds.) (1996) *Basisboek voorlichtingskunde*, 2nd ed, Amsterdam, Boom.

Röling, N., Hounkonnou, D., Kossou, D., Kuyper, T. W., Nederlof, S., Sakyi-Dawson, O., Traoré, M. and van Huis, A. (2012) Diagnosing the scope for innovation: Linking smallholder practices and institutional context, *NJAS - Wageningen Journal of Life Sciences*, 60-63, pp. 1–6.

Roncoli, C., Orlove, B. S., Kabugo, M. R. and Waiswa, M. M. (2011) Cultural styles of participation in farmers' discussions of seasonal climate forecasts in Uganda, *Agriculture and Human Values*, Springer Netherlands, 28(1), pp. 123–138.

Rotter, J. B. (1966) Generalized expectancies for internal versus external control of reinforcement., *Psychological monographs*, pp. 1–28.

Roxburgh, C. W. and Rodriguez, D. (2016) Ex-ante analysis of opportunities for the sustainable intensification of maize production in Mozambique, *Agricultural Systems*, 142, pp. 9–22.

Schutter, O. De (2010) *Agroecology and the Right to Food - Report submitted by the Special Rapporteur on the right to food*, Rome.

Schütz, A. (1945) On Multiple Realities, *Philosophy and Phenomenological Research*, 5(4), pp. 533–576.

Scoones, I. (1998) *Sustainable rural livelihoods: a framework for analysis*, *IDS Working Paper*.

Sen, A. (1999) *Development as Freedom*, Oxford University Press.

Sen, A. (1979) *Equality of What? The Tanner Lecture on Human Values*,.

Sen, A. (2009) *The idea of justice*, Cambridge, Massachusetts, The Belknap Press of Harvard University Press.

Sijtsma, K. (2009) On the Use, the Misuse, and the Very Limited Usefulness of Cronbach's Alpha., *Psychometrika*, 74(1), pp. 107–120.

Silici, L. (2009) The Role of Social Capital in the Adoption and the Performance of Conservation Agriculture. The Practice of Likoti in Lesotho, Università degli Studi Roma Tre.

Small, M. L. (2011) How to Conduct a Mixed Methods Study: Recent Trends in a Rapidly Growing Literature - information for practice, *Annual Review of Sociology*, 37, pp. 57–86.

Solow, R. M. (2000) Notes on social capital and economic performance, In Dasgupta, P. and Serageldin, I. (eds.), *Social Capital: A Multifaceted Perspective*, Washington, DC, World Bank.

Somda, J., Nianogo, A. J., Nassa, S. and Sanou, S. (2002) Soil fertility management and socio-economic factors in crop-livestock systems in Burkina Faso: a case study of composting technology, *Ecological Economics*, 43(2-3), pp. 175–183.

Spielman, D. J. (2006) Systems of Innovation: Models, Methods, and Future Directions, *Innovation Strategy today*, pp. 55–66.

Stern, P. C. (2000) Toward a coherent theory of environmentally significant behavior, *Journal of*

Social Issues, 56(3), pp. 407–424.

Stonehouse, P. D. (1996) A targeted policy approach to inducing rates of conservation compliance in agriculture, *Canadian Journal of Agricultural Economics*, 44, pp. 105–119.

Sumberg, J. and Thompson, J. (eds.) (2012) *Contested agronomy: Agricultural research in a changing world*, New York, Routledge.

Sumberg, J., Thompson, J. and Woodhouse, P. (2013) Why agronomy in the developing world has become contentious, *Agriculture and Human Values*, Springer Netherlands, 30(1), pp. 71–83.

Taylor, S. and Todd, P. (1995) An integrated model of waste management behaviour: a test of household recycling and composting intentions, *Environment and Behavior*, 27, pp. 603–630.

Teddlie, C. and Tashakkori, A. (2009) *Foundations of Mixed Methods Research*, SAGE Publications Ltd.

Terry, D. J. and Hogg, M. A. (1996) Group Norms and the Attitude-Behavior Relationship: A Role for Group Identification, *Personality and Social Psychology Bulletin*, 22(8), pp. 776–793.

Thierfelder, C. and Wall, P. C. (2009) Effects of conservation agriculture techniques on infiltration and soil water content in Zambia and Zimbabwe, *Soil and Tillage Research*, 105(2), pp. 217–227.

Tittonell, P. (2014) Growing more with less - the future of sustainable intensification, In ACT (ed.), *Proceedings of 1st Africa Congress on Conservation Agriculture*, Lusaka.

Tittonell, P., Scopel, E., Andrieu, N., Posthumus, H., Mapfumo, P., Corbeels, M., van Halsema, G. E., Lahmar, R., Lugandu, S., Rakotoarisoa, J., Mtambanengwe, F., Pound, B., Chikowo, R., Naudin, K., Triomphe, B. and Mkomwa, S. (2012) Agroecology-based aggradation-conservation agriculture (ABACO): Targeting innovations to combat soil degradation and food insecurity in semi-arid Africa, *Field Crops Research*, Elsevier B.V., 132, pp. 168–174.

Tittonell, P., Vanlauwe, B., Leffelaar, P. A., Rowe, E. C. and Giller, K. E. (2005) Exploring diversity in soil fertility management of smallholder farms in western Kenya: I. Heterogeneity at region and farm scale, *Agriculture, Ecosystems & Environment*, 110(3-4), pp. 149–165.

Tittonell, P., Vanlauwe, B., Leffelaar, P. A., Shepherd, K. D. and Giller, K. E. (2005) Exploring diversity in soil fertility management of smallholder farms in western Kenya: II. Within-farm variability in resource allocation, nutrient flows and soil fertility status, *Agriculture, Ecosystems & Environment*, 110(3-4), pp. 166–184.

TOF (2013) TOF 100 special edition, *The Organic Farmer*, Nairobi.

Tripp, R. (2006) *Is low external input technology contributing to sustainable agricultural development?*, *Natural Resource Perspectives*.

Ulrich, A., Ifejika Speranza, C., Roden, P., Kiteme, B., Wiesmann, U. and Nüsser, M. (2012) Small-scale farming in semi-arid areas: Livelihood dynamics between 1997 and 2010 in Laikipia, Kenya, *Journal of Rural Studies*, 28(3), pp. 241–251.

UNDP (2015) *Sustainable Development Goals*, UNDP.

Vanlauwe, B., Wendt, J., Giller, K. E., Corbeels, M., Gerard, B. and Nolte, C. (2014) A fourth principle is required to define Conservation Agriculture in sub-Saharan Africa: The appropriate use of fertilizer to enhance crop productivity, *Field Crops Research*, 155, pp. 10–13.

Verhulst, N., Govaerts, B., Verachtert, E., Castellanos-Navarrete, A., Mezzalama, M., Wall, P., Chocobar, A., Deckers, J. and Sayre, K. D. (2010) Conservation agriculture, improving soil quality for sustainable production systems, In Lal, R. and Stewart, B. A. (eds.), *Advances in Soil Science: Food Security and Soil Quality*, Boca Raton; FL, CRC Press, pp. 137–208.

Vignola, R., Koellner, T., Scholz, R. W. and Mcdaniels, T. L. (2010) Decision-making by farmers regarding ecosystem services : Factors affecting soil conservation efforts in Costa Rica, *Land Use*

Policy, Elsevier Ltd, 27(4), pp. 1132–1142.

Waithaka, E. (2016) Laikipia may be renamed Supuka, says county chief, *The Star Newspaper*, Nairobi, Kenya.

Wall, P. C. (2007) Tailoring Conservation Agriculture to the Needs of Small Farmers in Developing Countries, *Journal of Crop Improvement*, 19(1-2), pp. 137–155.

Wall, P. C., Thierfelder, C., Ngwira, A., Govaerts, B., Nyagumbo, I. and Baudron, F. (2013) Conservation Agriculture in Eastern and Southern Africa, In Jat, R. A., Sahrawat, K. L., and Kassam, A. (eds.), *Conservation Agriculture: Global Prospects and Challenges*, Wallingford, CABI.

Wauters, E., Bielders, C., Poesen, J., Govers, G. and Mathijs, E. (2010) Adoption of soil conservation practices in Belgium: An examination of the theory of planned behaviour in the agri-environmental domain, *Land Use Policy*, 27(1), pp. 86–94.

Whitfield, S., Dougill, A. J., Dyer, J. C., Kalaba, F. K., Leventon, J. and Stringer, L. C. (2015) Critical reflection on knowledge and narratives of conservation agriculture, *Geoforum*, 60, pp. 133–142.

Wicker, A. W. (1969) Attitudes versus Actions: The Relationship of Verbal and Overt Behavioral Responses to Attitude Objects, *Journal of Social Issues*, 25(4).

Woodhill, J. (2010) Capacities for Institutional Innovation: A Complexity Perspective, *IDS Bulletin*, 41(3), pp. 47–59.

Woolcock, M. and Narayan, D. (2000) Social Capital: Implications for Development Theory, Research, and Policy, *The World Bank Research Observer*, Oxford University Press, 15(2), pp. 225–249.

World Bank (2012) *Agricultural Innovation Systems: an investment sourcebook*, Washington DC.

Yazdanpanah, M., Hayati, D., Hochrainer-Stigler, S. and Zamani, G. H. (2014) Understanding farmers' intention and behavior regarding water conservation in the Middle-East and North Africa: a case study in Iran., *Journal of environmental management*, 135, pp. 63–72.

Young, K. R. and Cousens, R. D. (1999) Factors affecting the germination and emergence of wild radish (Raphanus raphanistrum) and their effect on management options, In Bishop et al., A. C. (ed.), *12th AustralianWeeds Conference*, Hobart, Tasmania.

APPENDICES

Appendix I Condensed Conference Paper for 1st ACCA

This condensed paper was submitted for the first Africa Congress on Conservation Agriculture (1ACCA) on 18th – 21st March 2014 in Lusaka, Zambia (ACT-Network, 2014). The paper was accepted and presented at the same conference.

Understanding (non-)adoption of CA: contributions from Social Psychology

Van Hulst FJ[1], Posthumus H[1,2]
[1]Natural Resources Institute. University of Greenwich, Chatham ME4 4TB, United Kingdom
Corresponding author: f.j.vanhulst@gre.ac.uk
[2]Royal Tropical Institute. Amsterdam, The Netherlands

Keywords: Minimum tillage, reasons for adoption, attitude, social norms, perceived control

Introduction

Conservation Agriculture (CA) has been promoted in sub-Saharan Africa in recent years to improve food security and adapt to climate change, in particular erratic rainfall and more frequent droughts (Tittonell et al., 2012). In order to achieve such an impact, CA has to be tailored to the agro-ecological and socio-economic context of smallholder farmers. However, even with a perfect fit, the choice to adopt CA or something else has to be made by the smallholder. While respecting this freedom, it is imperative to understand the reasons why farmers do the agricultural activities that they do in order to achieve food security in a sustainable manner. The current study takes a socio-psychological approach to understand (non-)adoption of CA practices by using the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 2010). This contrasts with approaches that try to explain (non-)adoption with demographical characteristics (e.g. education level), production factors (e.g. access to market), attitudinal constructs (e.g. perception of land degradation) or personality traits (e.g. innovativeness).

Within the theory of reasoned action (see Figure 1) it is assumed that social behaviour ultimately follows from the information or beliefs that people hold about the behaviour under consideration. The intention to implement CA practices, i.e. the 'action', is mediated by 1) the attitude towards the action; 2) the social norms with respect to the action; 3) the perceived behavioural control over the action. The social norms consist of both an injunctive norm, which is the perception of what others think they should do, i.e. peer pressure, and a descriptive norm, which is the perception of what others actually do. Together these three factors will determine whether someone has the intention or not to engage in a specific action. Besides the intention, the importance of abilities and environmental factors is included as actual control (Fishbein and Ajzen, 2010).

Materials and methods

The study was undertaken in Laikipia East District of Laikipia County in the Rift Valley Province of Kenya. Laikipia East is part of the cool highlands which are characterised by the semi-humid to semi-arid agro-ecolocial zones north-west of Mount Kenya. Mean annual rainfall varies between 400mm and 700mm per year and maize, beans and potatoes are the main staple crops (Min. of Agr., 2013). Four Farmer Field Schools (FFS) were selected to represent the agro-ecological variety of Laikipia East, from which a sample of 33 respondents was selected. Another sample, consisting of non-FFS farmers (n=62) was selected with the criterion that they came from the immediate vicinity of the FFS farmers from the first sample. The gender ratios were kept proportional with the district averages. Four specific agricultural practices have been identified that are relevant to understand the adoption of minimum tillage, using the Theory of Reasoned Action: *ploughing*, *direct planting* (planting without ploughing first), *spraying herbicides* and *shallow weeding* (scraping the weeds from the soil surface without turning it). The survey was developed on the basis of focus group discussions; questions about intentions and perceptions were based on a Likert scale (1-5) to indicate likelihood or influence.

Results and discussion

Attitudes and mindset change. The results (Figure 2) show significant differences between FFS farmers and non-FFS farmers. For ploughing, non-FFS farmers show positive attitudes while FFS farmers show negative attitudes towards ploughing. If it is assumed that the attitudes of all farmers were similar before group formation, it can be stated that the FFS has induced a “mindset change”. There are some farmers who hold relatively positive attitudes towards both ploughing and direct planting, which they practice on different parts of their land. This suggests that abandoning ploughing on the whole land is more related to a negative attitude towards ploughing than to a positive attitude towards direct planting. When it comes to the effectiveness of shallow weeding, beliefs of FFS farmers and non-FFS farmers are almost the opposite, but perceived control is high for both groups. Shallow weeding is seen as a traditional practice which makes it a familiar technique, but also gives it a backward connotation to the non-FFS farmers. To improve the adoption of shallow weeding, as an alternative for deep weeding or herbicides, the focus should be on influencing the negative attitude. FFS farmers indicated that their change in attitude was generally triggered by ‘seeing’ how it works on the demonstration plots and by ‘experimenting’ on their own farm. Moreover, trainings and extension contributed to the basic knowledge and exposure to information and new ideas. Many farmers however indicated that it is difficult to change. Farmers who have heard and seen the same things, may ultimately draw different conclusions.

Social Norms. The social norms are rather neutral for all actions, and few significant differences are found between FFS and non-FFS farmers. Most farmers indicated that although they will consider the opinion of other people, they make their decisions independently. This social independence was proudly expressed by many farmers, and is partly due to the fact that most farmers are relatively new settlers in the area. Injunctive norms are significantly different, presumably because FFS membership reflects (pre-existing) social networks and thus social pressure. For the descriptive norm the values remain rather neutral because neighbouring farmers practice a mix of conventional and CA farming.

Perceived control. For all three CA practices considered, the perceived control is significantly higher for FFS farmers than for non-FFS farmers, indicating that the FFS influenced the perceived control over CA. In the case of direct planting and spraying herbicides, the attitude of non-FFS farmers is neutral (not negative), but their perceived control over these actions is limited. From what farmers explained about their perceived control, two aspects can be distinguished: access to the different kinds of inputs, and the knowledge and capacity to use them. So besides capacity building it is necessary to achieve a higher actual control that will positively influence the perceived control and therefore the intention to engage in spraying herbicides and direct planting which are crucial components of CA in Laikipia, Kenya.

In conclusion it can be noted that there is a dual function for information and training, as it influences both attitude and perceived control. Farmers will not necessarily conform to the opinion of extension officers; trainers should appeal to this independent attitude of farmers, and facilitate their making of an informed decision together with other relevant actors. The involvement of actors from the financial sector and local manufacturers would be imperative to establish positive change in the farmers' actual and perceived control over CA practices by improving accessibility to inputs and equipment.

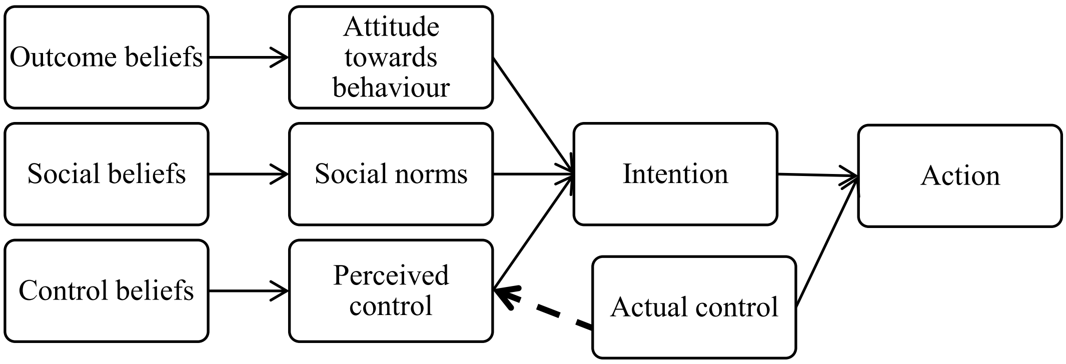
References

Fishbein, Martin, and Icek Ajzen. 2010. Predicting and Changing Behavior; the Reasoned Action Approach. New York: Taylor & Francis Group.

Ministry of Agriculture. 2013. "Laikipia East, Conservation Agriculture Brief". Nanyuki, Kenya.

Tittonell, Pablo, E. Scopel, N. Andrieu, H. Posthumus, P. Mapfumo, M. Corbeels, G.E. van Halsema, et al. 2012. "Agroecology-based Aggradation-conservation Agriculture (ABACO): Targeting Innovations to Combat Soil Degradation and Food Insecurity in Semi-arid Africa." Field Crops Research 132 (June): 168–174. doi:10.1016/j.fcr.2011.12.011.

Figure 1 Simplified model representing the Theory of Reasoned Action, (Fishbein & Ajzen 2010)



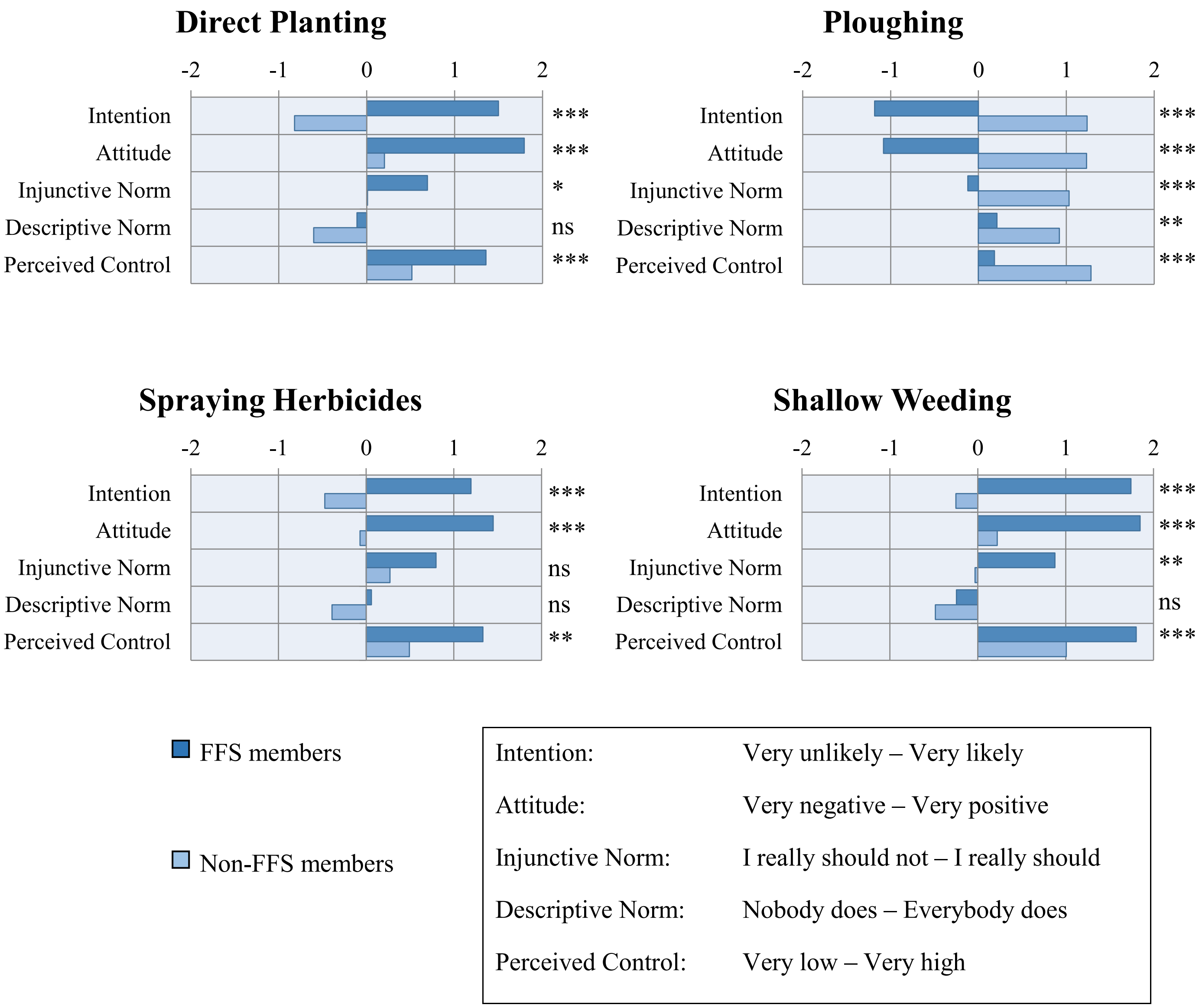


Figure 2 TRA results for four agricultural practices related to minimum tillage in Laikipia County, Kenya. Statistical significance of difference between FFS and non-FFS farmers: *** = p<0.001, ** = p<0.01, * = p<0.5; ns = not significant.

Appendix II Article published in Journal of Land Use Policy (Van Hulst and Posthumus, 2016)

Land Use Policy 56 (2016) 303–314

Contents lists available at ScienceDirect

Land Use Policy

journal homepage: www.elsevier.com/locate/landusepol

Understanding (non-) adoption of Conservation Agriculture in Kenya using the Reasoned Action Approach

Freddy J. Van Hulst[a,*], Helena Posthumus[a,b]

[a] Natural Resources Institute, University of Greenwich, Chatham Maritime, ME4 4TB, United Kingdom
[b] Royal Tropical Institute, Postbus 95001, 1090HA Amsterdam, The Netherlands

ARTICLE INFO

Article history:
Received 14 October 2015
Received in revised form 5 January 2016
Accepted 2 March 2016
Available online 11 May 2016

Keywords:
Reasoned Action Approach
Attitude
Perceived norms
Perceived Behavioural control
Adoption

ABSTRACT

In recent years, Conservation Agriculture has been promoted in sub-Saharan Africa as an alternative farming system for smallholder farmers to address declining soil productivity and climate change. CA has to be tailored to the agro-ecological and socio-economic context of smallholder farmers to achieve impact. But even if there is a 'perfect fit', the farmer still has his or her own reasons to choose whether to switch to CA or not. This paper explores the reasons why farmers choose for CA or conventional farming, using the Reasoned Action Approach. Based on findings from a recent study in Kenya among CA farmer field school members and their neighbours, the farmer's decision making is analysed by distinguishing three elements in the decision-making process: the farmer's attitude towards CA, the farmer's perception of the social norms towards CA, and the farmer's perceived behavioural control (PBC) over practicing CA. Strong evidence was found that attitude and PBC are contributing to intentions to adopt CA practices. It is concluded that experimentation and learning are key to support intentions and adoption of CA, because they contribute both to realistic attitudes towards CA and an improved perceived behavioural control.

1. Introduction

Conservation Agriculture (CA) has been promoted in sub-Saharan Africa in recent years to improve food security and adapt to climate change, in particular erratic rainfall and more frequent droughts (Tittonell et al., 2012). In order to achieve such an impact, CA has to be tailored to the agro-ecological and socio-economic context of smallholder farmers (Giller et al., 2011, 2009; Knowler and Bradshaw, 2007). However, even if the CA system would have a perfect fit, the choice to adopt CA or other agricultural practices has to be made by the smallholder. While respecting this freedom, it is important to understand the reasons why farmers apply certain farming practices that they do in order to support food security in a sustainable manner.

1.1. Understanding the adoption of CA

Technology adoption is often assessed with a dichotomous variable (e.g. Corbeels et al., 2013), or the level or intensity of adoption (e.g. Mazvimavi and Twomlow 2009; Arslan et al., 2013). As such, only the outcome of a decision-making process is measured. Some argue that, before deciding on the adoption of a technology (e.g. soil conservation practices), a farmer undergoes a–not necessarily linear–process of different phases. These include a cognitive phase where problem/opportunity recognition and awareness are key, a normative phase where ability and willingness are key, and a 'conative' phase where experimentation and continued use of a practice are determined (De Graaff et al., 2008; Ellis-Jones and Mason, 1999; Prager and Posthumus, 2010). In the case of CA, tangible benefits are typically achieved after several years of implementation (similar to soil conservation practices), making the cognitive and normative phase of the adoption process more important. It requires commitment on the side of the farmer to change the farming system to CA before potential benefits are achieved.

Many factors have been found that potentially influence the uptake of agricultural technologies and practices by smallholders in each phase, including the features of the technologies (such as their profitability, level of complexity of use, level of investment required, and compatibility with the overall farm management etc.), the features of the household (such as available labour, wealth, gender, innovativeness, attitudes, off-farm commitments, etc.), the features of the farm fields (such as soil type, steepness of slopes, degradation status, total area etc.), and various external factors (such as land tenure security, access to markets, available

* Corresponding author at: Natural Resources Institute, University of Greenwich Central Avenue, Chatham Maritime, Kent ME4 4TB, United Kingdom.
E-mail addresses: fjvanhulst@mail.com, f.j.vanhulst@greenwich.ac.uk (F.J. Van Hulst).

http://dx.doi.org/10.1016/j.landusepol.2016.03.002
0264-8377/

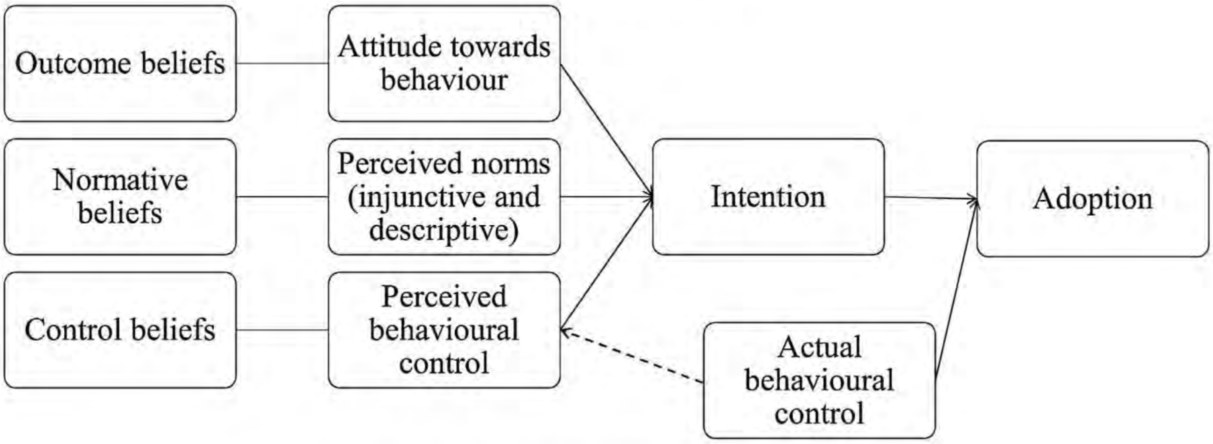


Fig. 1. Simplified model of the Reasoned Action Approach. Based on Fishbein and Ajzen (2010).

extension, infrastructure etc.) (see for example Ervin and Ervin, 1982; Feder et al., 1982; Lynne et al., 1988; Sinden and King, 1990; Wilson, 1996; Posthumus et al., 2011, 2010).

More specifically to the adoption of CA in sub-Sahara Africa, an important constraint is the limited availability of crop residues for mulching (e.g. Baudron et al., 2013). Also, it has been observed that CA may increase the labour requirements for weeding, especially if no herbicides are used (Chauhan et al., 2012). Others point at the limited attention for intra-household relations and gender in the adoption process (e.g. Beuchelt and Badstue 2013). The importance of a supporting institutional environment is also considered important, especially after the widespread adoption of CA in Brazil could be linked to the success of 'innovation networks' and close links with agrochemical companies (Gowing and Palmer 2008). A self-assessment tool applied in Kenya and Tanzania identified limited access to in- and output markets, adapted CA equipment, and reliable extension services as major hindering factors for the adoption of CA (Ndah et al., 2015). And although CA can be linked with higher yields and lower production costs (e.g. Mazvimavi and Twomlow 2009), it often takes several years before the benefits of CA become available (Hobbs et al., 2008).

Despite these insights, a critical reflection on the role of the 'adoption study' seems justified. The increasingly popular Innovation Systems perspective on agricultural development (Hall et al., 2007; Posthumus et al., 2011), has important implications for the role of adoption studies. Rather than giving feedback to one key actor who pursues technology adoption through a linear process of dissemination, the adoption study ideally considers and feeds back to many actors, bringing new understanding and inspiring the partnerships between them (Röling, 2009; Röling et al., 2012). In their review on farmers' adoption of CA, Knowler and Bradshaw (2007) show that there are no universally significant factors that affect Conservation Agriculture adoption, although financial viability and social capital seem to be two key factors.

Andersson and D'Souza (2013) point out that current CA adoption studies are often methodologically weak, biased by the promotional project context in which they are often carried out, and prone to inherent limitations of farm-scale analyses of standard household surveys. Instead of only establishing a correlation between adoption and independent variables, it is important to conceptualize *how* a factor has an influence on adoption (Beedell and Rehman, 2000). Because of the multi-layered and complex nature of farmers' livelihoods objectives and related decision making, profit-maximising economic models are intrinsically limited in achieving that end (Lynne et al., 1988). And although there has been an increasing interest in motives, values and attitudes that determine the decision-making processes of individual farmers, there is a tendency within some studies to revert to an over-simplistic model of the attitude–behaviour relationship (Burton, 2004). He suggests that studies of various behaviours can improve by using concepts from social-psychology, especially the Reasoned Action Approach (RAA, Fishbein and Ajzen, 2010) seems worth exploring.

1.2. ABACO project

The EU-funded ABACO (agro-ecology based aggradation-Conservation Agriculture) project (2011–2015) for semi-arid regions emerged as a need for action to promote CA, bringing together a large number of partners working on CA in Africa, including those from international and national research centres, and the African Conservation Tillage (ACT) network. ABACO aimed at establishing site-specific co-innovation platforms to develop and promote CA practices that rely on agro-ecological principles and aggradative measures to restore soil productivity in semi-arid regions of sub-Saharan Africa (Tittonell et al., 2012).

1.3. Conservation Agriculture in Kenya

CA has been introduced to Laikipia county in Kenya, the study area, through several projects starting in 1997, mostly by means of extension, training and the forming of Farmer Field Schools (FFS) (Kaumbutho and Kienzle, 2007). The FFS members were introduced to CA in 2007–2008 during the CA-SARD research project. The ABACO project established demonstration plots with the FFS members to experiment with, and evaluate, a number of different treatments based on the CA principles of 1) minimum soil disturbance; 2) permanent soil cover; and 3) crop associations and rotations.

Some farmers experiment with potatoes under CA, but the majority of farmers apply CA to their maize crop. Mulch is mainly realised from crop residues and sometimes supplemented with tree branches and grasses, while cover crops are realised with Dolichos (*Dolichos lablab*), Butter Beans (*Phaseolus coccineus*) or Pigeon Peas (*Cajanus cajan*). For conventional land preparation mechanical or manual ploughing is done, while under CA most farmers first slash the weeds manually, then do manual or animal-drawn ripping and direct planting, and spray a Glyphosate-based herbicide (mostly Weedall) (Min. of Agr., 2013). Conventional weeding is done with a *fork jembe* (which turns the soil) while many CA farmers do 'shallow weeding' with a *panga* or a specially designed *shallow weeder*.

1.4. Reasoned Action Approach

This study takes a socio-psychological approach to understand (non-) adoption of CA practices by using the Reasoned Action Approach (RAA) (Fishbein and Ajzen, 2010; Van Hulst and Posthumus, 2014). The RAA (see Fig. 1) is an improvement of the theory of planned behaviour (TPB, see Ajzen, 1991), which in turn was developed from the theory of reasoned action (TRA, see Fishbein and Ajzen, 1975). The model states that a person's actual behaviour, i.e the engagement in an 'action', here called adoption, is directly guided by his or her behavioural intentions, which in turn are informed by 1) the attitude towards the action; 2) the perceived norms with respect to the action; 3) the perceived behavioural control over the action. There are two components of perceived norms: Injunctive norms are the perception of what others think you should do, while descriptive norms are the perception of what others actually practice. The importance of actual abilities and environmental factors for turning intention into actual adoption, is included as actual control (Fishbein and Ajzen, 2010; p. 22).

One level deeper, the constructs are further explained by outcome-, normative- and control beliefs. These beliefs are formed under influence of many other background factors such as personality and previous experience and age. A conventional factor influencing adoption like 'land tenure security' is in the RAA model a background factor which helps influencing certain outcome or control beliefs. It may lead to the outcome belief that 'I am not sure to benefit from investments on my land', which in turn would foster a negative attitude towards the practice. Or it might lead to the belief that 'the owner of the land does not allow me to practise this', which would influence control beliefs, thus contributing to a negative perceived behavioural control. Both beliefs, according to the RAA, negatively influence the intentions and ultimately adoption of this technology.

So far, the RAA (or TPB) has not been applied to study the adoption of CA practices, but it has been applied successfully to similar domains, including soil erosion (Lynne et al., 1995, 1988) and soil and water conservation (Trumbo and O'Keefe, 2005; Wauters et al., 2010; Yazdanpanah et al., 2014). Although the RAA seems very suitable, there are ongoing debates about including other variables in order to increase the model's predictive power. The most important candidates are self-identity (Burton, 2004; Pelling and White, 2009), moral norms (Kaiser, 2006) or past behaviour (Conner and Armitage, 1998). For basic future comparison, this study uses the unmodified Reasoned Action Approach (RAA) to better understand reasons for (non-) adoption of CA practices in Laikipia, Kenya.

2. Materials and methods

2.1. Description of the study area

The study was undertaken in Laikipia East District of Laikipia County in the Rift Valley Province of Kenya. Laikipia East is part of the cool highlands which are characterised by the semi-humid to semi-arid (agro-ecological zones III and IV) north-west of Mount Kenya, just North of the equator. Mean annual rainfall is 400 mm–700 mm per year and is highly variable and unreliable. Climate models suggest that the area will face increasing variation in its inter- and intra-annual rainfall distribution, thus adversely affecting peoples' livelihoods (Notter et al., 2007).

The land use near Mount Kenya and the urban centre of Nanyuki is characterised by intensive mixed small-scale farming and several large-scale export-oriented horticultural farms. Further away from the mountain the climate becomes dryer, small-scale farming is gradually becoming less intensive and is finally replaced by pastoral range lands, large ranches, tourist lodges and game parks (Min. of Agr., 2013). Following the independence in the 1960s, land redistribution programs resulted in the settlement of smallholder farmers, mainly from the Kikuyu and Meru ethnic groups, in Laikipia. Many originated from highly productive areas, often continuing their farming practices on the less productive dry-land areas (Ulrich et al., 2012).

The potential for smallholder farming in the area is inherently limited. Maize, beans and Irish potatoes are the main staple crops (Min. of Agr., 2013). A common cropping system in the study area is to alternate one to three rows of beans with one row of maize, and 'rotate' this system in the next season with four to six lines of Irish potatoes for every row of maize. The large-scale vegetable-, flower- and fruit producers employ local workers, making labour relatively expensive.

2.2. Sample and data collection

Four FFS were selected from ten FFS involved in CA with the ABACO project, to represent the social and agro-ecological variety of Laikipia East in terms of average farm size, labour availability, rainfall, and soil fertility. From these groups a total of 33 respondents were randomly selected. From the immediate vicinity of these FFS farmers, another 62 non-FFS respondents were selected through geographical sampling starting with those living nearest to the FFS. The gender ratios were kept proportional with the district averages.

A complete list of beliefs was made through key informants and focus group discussions. This included collecting all possible outcomes (good and bad) of the different CA practices, identifying the social referents, that is the people and groups that potentially influence respondents' decision making, and listing the control factors that possibly influence perceived behavioural control with respect to adopting the CA practices. The questionnaire was then tested with three individual farmers. A first structured questionnaire was held among 95 smallholder farmers in July–October 2013, assessing the intention to apply CA practices in the coming crop season. A follow-up questionnaire was held in May–June 2014 among 77 of the same sample, assessing the actual adoption of CA practices. The repeat sample is smaller because 18 farmers had either moved away or were not available for an interview. In the repeat sample, the proportion of members was higher because members were easier to locate than non-members, while the gender balance and average age were similar in both samples. The panel data of the 77 respondents was used for the analyses. The survey was developed according to the steps provided by Ajzen (1991) and Fishbein and Ajzen (2010).

2.3. Variables and scales

Conservation Agriculture is not a single activity, but a behaviour category consisting of several agricultural practices, that could be studied as 'behaviours' in their own right. Four distinguishing agricultural practices have been identified that are relevant to understand the adoption of CA in Laikipia, using the Reasoned Action Approach: *spraying herbicides*, *direct planting* (planting without ploughing first), *mulching* and *shallow weeding* (scraping the weeds from the soil surface without turning it). This paper looks both at these constituent practices and at the constructed behaviour category of CA which was defined as adopting both direct planting and mulching. Spraying herbicides and shallow weeding were not included in this definition because they are not always strictly necessary for implementing the CA principles as disseminated to and practiced by the farmers. Normally cover crops would be included in this definition, but because non-FFS farmers were not familiar with the concept, their responses regarding the practice of cover crops were not considered to be reliable enough. Crop rotation was also excluded, because a basic form of crop rotation was already practiced by most farmers, and relatively little attention was given to this aspect of CA in the trainings at the FFS.

Intention was assessed in 2013 as likelihood ('very unlikely' to 'very likely' as measured on a 5-point single Likert item from −2 to 2) of adopting the practice in the rainy season of 2014. An average of 70% of the responses for the intention were found to be either 'very likely' or 'very unlikely'. Therefore the intention variable was transformed from a 5-scale ordinal into a dichotomous variable in which the outcomes 'likely' and 'very likely' were labelled as intenders, and the other outcomes from 'very unlikely' to 'maybe' were labelled as non-intenders. Adoption of the CA practices was directly assessed in 2014 as a dichotomous variable (yes–no), independent of the surface area of the farm where it was adopted.

In the Reasoned Action Approach, the constructs of attitude (A), perceived norms (PN) and perceived behavioural control (PBC) are assessed by means of different items to cover different dimensions of the behaviour. Attitude was assessed through three items to incorporate both evaluative (good–bad, foolish–wise) and experiential aspects (unpleasant–pleasant). Injunctive norms were assessed through the perception of whether "important others" approve of the respondent doing the practice (they think I should not–I should...). The descriptive norms were the perception of how many among the people that are respected and admired by the respondent actually adopt this practice (almost all–almost none). Perceived behavioural control was assessed with two items, one covering internal factors (very difficult–very easy) and one covering external factors (not at all up to me–up to me).

To evaluate the internal consistency and reliability of such multi-item scales, it is most common to use Cronbach's Alpha coefficient (Cronbach, 1951). However, in psychometrics the limits of Cronbach's Alpha are regularly debated (e.g. Ten Berge and Sočan, 2004) and the Greatest Lower Bound (GLB) is seen as a more accurate way to assess internal consistency and reliability (Sijtsma, 2009). For two-item scales, better reliability estimates are given by Spearman-Brown coefficient as suggested by Eisinga et al. (2013). In this study, these coefficients are presented together with Cronbach's Alpha.

The respective outcome-, normative-, and control beliefs were assessed for spraying herbicides, direct planting and mulching, as shown in the appendix. To assess the outcome beliefs the expectancy-value model (Fishbein and Ajzen, 1975; Fishbein, 1963) was applied, relying on the product of belief strength b that a certain behavioural outcome i will occur (very unlikely–very likely), and the evaluation e of the importance of these outcomes. If outcome i would both be very important to the farmer and be considered very likely to occur, the product $b_i.e_i$ would be high and the belief would contribute relatively much to a positive attitude. The correlation of $b_i.e_i$ with intention gives a direct indication of how important that belief was for predicting the intentions. This method, although common in the literature, is not without potential problems because the scaling method (unipolar or bipolar likert items) in multiplicative models like the expectancy-value model influences the found correlation with external criterion like intentions (Ajzen, 1991; Bagozzi, 1984; Gagné and Godin, 2000). It can nevertheless give an extra perspective on the relative importance of the respective beliefs.

According to the same principle, the perceived norms were examined by listing injunctive normative beliefs n for social referents j, and the farmers' motivation to comply m with the opinion of these referents. If the farmer thinks that a social referent e.g. the neighbours do not approve of him practicing direct planting (n is negative), but the farmer does not attribute much importance to their opinion (m is low), then the product $n_j.m_j$ is low, indicating that the relative contribution to the SN is limited. Similarly, the descriptive normative beliefs n' and motivation to comply m' were assessed for social referents j'. The PBC was examined by listing for each control factor k the belief that it will be present c and the perceived power p of factor k to facilitate or impede performance of the behaviour (Fishbein and Ajzen, 2010; pp. 129–178). Again, the correlation of $c_k.p_k$ with intentions gives an indication of how important that particular belief was in the forming of intentions (see Appendix). In order to increase the variation in the results for e_i and p_k, farmers were asked to rank the possible outcomes and control factors according to their importance.

2.4. Statistical analysis

Both intention and adoption were modelled as dichotomous variables. Therefore a binary logistic regression was used to understand the relative contribution of a set of independent variables to intentions and adoption of the selected CA practices. In a logistic regression model, the probability Pr that dependent variable Y_i takes the value 1 is given by

$$Pr(Y_i = 1|X) = p_i = \frac{e^{\alpha+\beta X_i}}{1 + e^{\alpha+\beta X_i}}$$

where α is a constant, X_i represents the independent variables and β represents the regression coefficients. The odds that Y_i takes the value 1 is given by

$$\frac{p_i}{1-p_i} = e^{\alpha+\beta X_i}$$

which can be rewritten as

$$\log\left(\frac{p_i}{1-p_i}\right) = \alpha + \beta X_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots + \varepsilon_i$$

where α is a constant, the X's are the independent variables, the β's are the regression coefficients, and ε is the error term. In the result section the specific regression models used in this study for intention and adoption of CA practices are further defined.

The relative contributions of attitudes (A), perceived norms (PN) and perceived behavioural control (PBC) in the prediction of intentions (I) to engage in CA practice j were tested with the following logistic regression model:

$$I_j = \alpha + \beta_1 A_j + \beta_2 PN_j + \beta_3 PBC_j + \varepsilon_j$$

The adoption, or actual behaviour (B) with respect to CA practices j was examined with the following logistic regression model:

$$B_j = \beta_1 I_j + \beta_2 ABC_j + \varepsilon_j$$

where I is intention and ABC is actual behavioural control. PBC was used as a proxy for ABC, because no standard procedures for assessing actual control are currently available (Fishbein and Ajzen, 2010; p. 64), nor is it likely that a reliable, direct measure of ABC can be developed at all.

The significance of the difference between the -non-parametric-constructs' mean values was established with a Mann-Whitney test, and for simple correlations Spearman's rho (two-tailed) was used.

3. Results and discussion

3.1. Sample description

From the sample of 77 smallholder farmers, over 40% (n = 32) of the respondents was a member of a FFS, referred to as 'members', while almost 60% (n = 45) were not a member of a FFS, referred to as 'non-members'. More than 56% (n = 43) of the sample were women, against 44% (n = 34) male farmers. The average age was high with 52.6 years, and slightly higher for group members. This finding was confirmed in focus group discussions to be an important social phenomenon. Farmers argued that young farmers are more interested in making fast money in the city or by working in the greenhouses, rather than engaging in non-irrigated subsistence agriculture, which benefits most from CA.

The average area cultivated in the long rainy season of 2014 was 0.77 ha. On average, 78% of the total household income comes from agriculture (including dairy, poultry and crop production), and 70% of the farm production is used for household consumption. The most common source of non-farm household income is working as casual labourers in Nanyuki or nearby villages. The farmers own an average of 1.9 heads of cattle, which are primarily held for milk and breeding, and occasionally for ploughing. In the sample, up to seven persons can contribute to the on-farm family labour, with an average of 2.3 persons per household. Experience with CA is limited, especially for non-members (averaging 1.2 years). For members, experience is significantly higher (over 3 years) due to the current ABACO project and previous CA-SARD projects (Table 1).[1]

3.2. Internal consistency of variables

The internal reliability and consistency of the three multi-item scales were tested for the four CA practices (Table 2). The resulting GLB and Spearman-Brown coefficients were equal to or very similar to the Cronbach's alpha. The outcomes were considered satisfactory and support the assumption that the items are an expression of the same underlying variable. However, the very high alpha coefficients and GLB found for the attitude construct suggest that the items did not fully succeed in exploring the whole breadth and diversity of the variable. During the interviews it was sometimes observed that farmers would repeat the same answers for the three attitude items (good, wise, pleasant), probably because the questions were closely related and also as a way to move through the questionnaire more quickly. For future work with the RAA methodology, more diverse questions should be considered for the attitude construct that require respondents to reconsider their answer on the basis of different information.

3.3. Attitudes, perceived norms and perceived behavioural control

The average values of the RAA constructs for farmers who intend and those who do not intend to adopt the CA practices are given in Table 3. Mulching shows the highest number of intenders and adopters, (63 and 64 farmers respectively), while CA shows the lowest number of intenders (34 farmers), and spraying herbicides is the least adopted practice (37 farmers). Generally, the calculated values for the constructs are significantly higher for intenders than non-intenders. That shows that intenders have a more positive attitude towards the practices, experience more social pressure to adopt, and perceive a higher degree of capability to perform the practice. Intenders also adopt significantly more than non-intenders. The exceptions were mulching and CA, where perceived norms are not significantly different between intenders and non-intenders.

Attitudes towards mulching are, although significantly higher for intenders, very positive for both intenders and non-intenders, suggesting that the effects of mulching are considered to be positive by most farmers, even if they do not intend to practice it. For the other practices, intenders and non-intenders showed very different attitudes, especially for shallow weeding and direct planting. The perceived norms are rather neutral for all actions and not significantly different for intenders and non-intenders of CA. Perceived behavioural control was much higher for intenders, especially for spraying herbicides and direct planting, suggesting that not everyone feels readily able of adopting these practices, even if they wanted to.

Although adoption levels are significantly higher for intenders, several farmers adopted CA practices without having shown the intention, or do not adopt despite having shown the intention. Only 27 farmers acted according to their intentions on all actions, while 23 farmers diverted from their intentions on only one practice and 26 farmers diverted from their intentions on more than one practice.

3.4. Regression models of intention

The regression coefficients and the correlation between the RAA constructs are given in Table 4. The high and significant correlation and regression coefficients show that having the intention to engage in CA practices is mainly explained by having a positive attitude and having a high perceived behavioural control. The regression outcomes show that perceived norms were not a significant predictor for any of the intentions. In other words, social peer pressure had no significant influence on farmers' intentions towards CA practices, although there were some positive and significant correlations.

During the interviews, farmers proudly expressed a high degree of social independence and individual decision-making which can be explained by the fact that the farmers are relatively new settlers in the area, and therefore are not as susceptible to social pressure from neighbours as might be expected in close rural communities. The traditional structures with chiefs (Kikuyu) and elders (Meru) fulfilled some social functions, but did not influence agricultural decision making (see Appendix). Except for mulching and CA, high and significant correlations still suggest that there is a link between the perceived norms and intentions. The questionnaire revealed that farmers would sometimes consider the opinions of other members of the household, the FFS-members, and extension officers (in that order, see Appendix), although they would not necessarily conform to their opinion.

Attitudes to shallow weeding and direct planting are very different for intenders and non-intenders (see Table 3) and can be traced back to various opposing beliefs about the consequences (see Appendix). Both actions exist in the area as traditional practices that are normally not considered to be productive, but may be adopted when farmers are late with weeding or ploughing respectively. Negative attitudes towards shallow weeding (using the *panga*) come from its backward connotation as a traditional practice, and the belief that it is little effective in controlling weeds. Positive attitudes towards shallow weeding come from the belief that it is both easy and effective. Farmers with either beliefs may adopt, but for the first it is a way to cope with limited labour or bad planning, rather than being a positive choice. For the latter, shallow weeding (using the *shallow weeder*) is a positive choice reflected in the intention. Similarly, direct planting is seen by intenders as a labour-efficient way to reduce evaporation, improve soil structure and infiltration, and achieve a higher harvest (see Appendix). For non-intenders the negative attitude is explained from the opposite beliefs, especially that direct planting is bad for the soil structure and leading to bad harvests. Spraying herbicides is also a positively perceived practice among the intenders, especially for improving the harvest and saving time. Non-intenders seem to associate it also with several negative outcomes, such as various human diseases and a reduced soil fertility in the long run.

For mulching, only PBC showed a significant regression coefficient, while attitude towards mulching was not a significant determinant of intentions. Mulching was perceived as a positive practice by most farmers, especially due to the belief that it reduces evaporation and improves soil structure and fertility. Mulching

[1] CA-SARD (Conservation Agriculture for Sustainable Agriculture and Rural Development) was a project that was active in Laikipia from 2004 to 2010, in two phases.

Table 1
Characteristics of sample for members and non-members of farmer field schools.

	n	Mean overall	Mean members	Mean non-members	Sig. of difference
Age	77	52.6	54.9	51.0	
Land cultivated in 2014 (ha)	77	0.76	0.81	0.72	
Percentage of income from agriculture	77	78	78	77	
Percentage of production for consumption	77	70	66	74	
Heads of cattle	77	1.9	2.3	1.7	
Family labour (persons)	75	2.3	2.6	2.0	
Experience with CA (yr.)	77	2.1	3.2	1.3	**

** = significant at 0.01 level.

Table 2
Internal reliability and consistency of multi-item scales for four CA practices.

Construct	Attitude		Perceived Norms		Perceived Behavioural Control	
Items	good–bad wise–foolish pleasant–unpleasant		others do/do not approve others do/do not practice		easy–difficult up to me–not up to me	
	Cronbach's Alpha	GLB[a]	Cronbach's Alpha	Spearman–Brown	Cronbach's Alpha	Spearman–Brown
Spraying Herbicides	0.99	0.99	0.55	0.55	0.90	0.90
Direct Planting	0.99	0.99	0.69	0.69	0.89	0.89
Mulching	0.96	0.98	0.66	0.66	0.80	0.82
Shallow Weeding	0.99	0.99	0.71	0.71	0.84	0.86

Note: calculations based on 77 valid case for each practice.
[a] GLB: Greatest Lower Bound.

Table 3
Mean values of RAA variables for intenders and non-intenders.

	Spraying herbicides					Direct planting				
	Overall mean	Std. Dev	Intenders (n = 38)	Non-intenders (n = 39)	Sig	Overall mean	Std. Dev	Intenders (n = 39)	Non-intenders (n = 38)	Sig
Adopters (n)			26	11				33	13	
Adoption[a]	0.48		0.68	0.28	**	0.60		0.85	0.34	**
A[b]	0.73	1.42	1.83	−0.10	**	0.63	1.59	1.82	−0.36	**
PN[b]	0.08	1.12	0.51	−0.43	**	−0.31	1.11	0.01	−0.73	**
PBC[b]	0.82	1.23	1.61	0.19	**	0.88	1.41	1.73	0.37	**

	Shallow weeding					Conservation Agriculture[c]				
	Overall mean	Std. Dev	Intenders (48)	Non-intenders (29)	Sig	Overall mean	Std. Dev	Intenders (n = 34)	Non-intenders (n = 42)	Sig
Adopters (n)			33	13				27	15	
Adoption[a]	0.60		0.69	0.45	*	0.55		0.79	0.36	**
A[b]	0.85	1.58	1.82	−0.76	**	1.29	0.84	1.90	0.73	**
PN[b]	0.05	1.18	0.42	−0.78	**	−0.08	0.80	−0.03	−0.19	
PBC[b]	1.25	1.19	1.79	0.53	**	1.32	0.83	1.76	0.88	**

	Mulching				
	Overall mean	Std. Dev	Intenders (n = 63)	Non-intenders (n = 13)	Sig
Adopters (n)			56	8	
Adoption[a]	0.84		0.89	0.62	*
A[b]	1.76	0.55	1.90	1.26	**
PN[b]	0.09	1.12	0.19	0.00	
PBC[b]	1.42	1.01	1.73	0.47	**

** = significant at 0.01 level; * = significant at 0.05 level.
[a] Dichotomous variable (0 or 1).
[b] Scale variable (-2 to 2).
[c] Conservation Agriculture defined as direct planting combined with mulching.

Table 4
Correlations and logit model prediction of Intentions from attitudes, perceived norms (PN) and perceived behavioural control (PBC) in Kenya.

		Spraying herbicides	Direct planting	Mulching	Shallow weeding	Conservation Agriculture[a]
Attitude	r	0.697**	0.686**	0.401**	0.831**	0.660**
	β	7.016**	6.074**	3.267	6.605**	2.953**
PN	r	0.433**	0.348**	0.022	0.492**	0.079
	β	1.256	−0.771	0.043	1.181	−0.535
PBC	r	0.571**	0.465**	0.498**	0.497**	0.500**
	β	3.976*	3.708*	5.581**	4.322*	1.698*
Goodness of Fit	Omnibus test	57.047**	52.063**	25.598**	66.557**	52.710**

Notes: r = correlation coefficient. β = regression coefficient.
** = significant at 0.01 level; * = significant at 0.05 level.
[a] Conservation Agriculture defined as direct planting combined with mulching.

Table 5
Regression coefficients of binary logistic model (RAA model) to predict adoption of CA practices in Laikipia, Kenya.

		Spraying herbicides	Direct planting	Mulching	Shallow weeding	CA[a]
Intention	r	0.377**	0.514**	0.282*	0.236**	0.437**
	β	1.600**	2.099**	1.571	0.772	1.709**
ABC	r	0.245*	0.359**	0.232*	0.195	0.317**
	β	0.308	0.841	0.117	0.651	0.277
Model fitting information	Omnibus test	12.926**	21.414**	5.025	4.755	15.836**

Notes: r = correlation coefficient. β = regression coefficient.
** = significant at 0.01 level; * = significant at 0.05 level.
[a] CA is Conservation Agriculture adoption, defined as practicing both direct planting and mulching.

Table 6
Correlation of significant non-RAA factors with adoption of CA practices in Laikipia, Kenya.

	Spraying herbicides	Direct planting	Mulching	Shallow weeding	CA[a]
% for HH consumption	−0.328**	−0.193	0.016	−0.188	−0.163
Total area adopt	0.243*	0.195	−0.088	−0.040	0.076
Location 1	0.427**	0.050	−0.042	0.109	0.049
Location 4	−.512**	−0.010	0.146	−0.074	0.038
FFS membership	0.244*	0.477**	0.223	0.424**	0.499**
Experience CA	0.369**	0.714**	0.263*	0.435**	0.667**
Heads of cattle	−0.050	−0.057	−0.337**	−0.152	−0.121

** = significant at 0.01 level; * = significant at 0.05 level.
[a] CA is Conservation Agriculture adoption, defined as practicing both direct planting and mulching.

has been promoted for several decades through extension, and most farmers have positive experiences with the practice (e.g. with growing vegetables and potatoes), which is also reflected in a low standard deviation of the attitude variable (see Table 3). Surprisingly, the underlying control belief that has the closest link with intentions is the confidence of being able to produce enough biomass, and not the competition with cattle. This shows that what researchers call 'competition' is framed by farmers in terms of a lack of biomass production in a situation where feeding cattle is a given, not a decision. The second relevant control factor found for mulching is the ability to prevent unauthorized grazing (see Appendix). For spraying herbicides, the most important control factor is primarily which herbicides to use, and secondly knowing when and how to use it. The availability of equipment appears to be the least important control factor, as farmers explained it can easily be borrowed or hired. Having enough money to purchase herbicides is also an issue, although intenders are quite certain they will have enough money for this at the start of the growing season. The main control factors underlying PBC for direct planting are having the knowledge to plan the farming operations properly, and to have favourable soils (meaning that the soil is not too wet or too dry at the time of planting).

Findings for the CA aggregate show that intentions to practice CA are mainly determined by having a positive attitude (mainly influenced by the direct planting component of CA), and secondly by having the perceived behavioural control (mainly influenced by the mulching component of CA).

3.5. Regression models of adoption

According to the RAA model, adoption of the CA practices was modelled as a function of intentions and actual behavioural control (Table 5).[2] The results show that no significant regression model was found for mulching and shallow weeding. For the other actions, including the CA aggregate, intentions were a highly significant predictor of adoption. Even though the regression coefficients were not all significant, the correlation between intention and adoption still points at a significant connection between the two. Similarly, there is a positive and significant correlation between ABC and adoption, although this is not translated in a significant regression coefficient.

A possible explanation for the lack of explaining power of the regression model and weak relation between intentions and adoption found with shallow weeding and mulching, is that these are familiar and well-established practices for both CA farmers and conventional farmers, that everyone can adopt with little uncertainty about their consequences. This allows more ad-hoc decision making and last minute adaptation to unexpected circumstances which reduces the importance of intentions, careful planning and deliberation. Another explanation is that the accuracy of expressing intentions is influenced by personality traits, because some farmers held either overly optimistic intentions on several practices, while others were structurally underestimating their future adoption. Obviously, the actual behavioural control, in terms of financial means or knowledge, may also have changed in the time between expressing the intention and actually performing the practice.

Although it is against the logic of the RAA to add other explanatory constructs unless they meet several strict criteria (such as being conceptually independent of the existing predictors, and being potentially applicable to a wide range of behaviours, see Fishbein and Ajzen (2010, p. 282), additional determinants of adoption were considered (Table 6). The objective was to gain information on which other variables, that in the RAA model are theoretically mediated by intention and PBC, can be linked to adoption directly in this particular case. Among the household characteristics assessed are location 1 and 4, referring to the area around FFS 1 and 4, including members and non-members. Location 4 was an area where there was a remarkable negative attitude towards herbicides and only few farmers who used it. The chairman of the FFS was staunch opponent of herbicides. Among extension staff it was not a favoured area to visit, because the farmers were difficult to motivate and mainly showed interest in free hand-outs (field observations and personal communication with extension officer, 18-6-2014). Location 1, on the other hand, was an exemplary FFS that was closest to the main road, and much more proactive in their dealing with the extension staff, and characterised by a higher familiarity with and acceptance of new technologies, such as hybrid seeds, grain storages and herbicides.

[2] As mentioned in the methodology, perceived behavioural control is used as a proxy for actual behavioural control.

Gender, age, percentage of income from agriculture, available HH labour, and being in location 2 or 3 were not significantly correlated with adoption of any of the practices. Experience with CA was positively correlated with adoption of all practices, and FFS membership was correlated with all practices except mulching. For a well-known practice as mulching the FFS membership contributes little to one's inclination to adopt, while it brings advantages for the other practices in terms of access to knowledge (herbicides and direct planting) and equipment (shallow weeding).

Adoption of 'spraying herbicides' was also found to be positively correlated with total land area under cultivation and being in location 1. Having more total land area under cultivation makes it more likely that a farmer will use herbicides, because those farmers are able to make an investment (underlying the PBC) and because it reduces the labour (underlying attitude). No significant correlation is found between total land area under cultivation and direct planting, underlining the observation that spraying herbicides is seen as the laboursaving element of CA, whereas the labour requirements for actual planting is comparable to the conventional system (group discussion at FFS, 10-6-2014). Spraying herbicides was negatively correlated with being in location 4 and the percentage of produce used for household consumption. Households that sell less of their produce may have less money to spend on e.g. herbicides. Another possible explanation is that farmers who consume most of their produce prefer it to be grown without herbicides, however, this was not confirmed in this study. Being in location 1 and 4 has a big influence, which can be explained from the social environment explained above and the exposure to extension and agro-dealers. Finally, adoption of mulching was negatively correlated with the number of cattle as this reduces the availability of residues for mulching in the mixed farming systems.

4. Conclusions

This study shows that the application of the Reasoned Action Approach increases the understanding of how attitudes and beliefs influence adoption of Conservation Agriculture practices. The main advantage of the RAA over other methods is that it not only reveals factors influencing adoption, but is also capable to trace back why and how these factors influence intentions through the attitudes, social norms and perceived behavioural control and their underlying beliefs.

This study further shows that important insights can be gathered from examining the constituent practices of CA separately. The results show that farmers held negative attitudes towards shallow weeding while having a strong behaviour control, and for mulching this was the other way round. It is recommended to verify and improve the items that assess the RAA constructs in future studies, because some of the constructs were difficult to distinguish from each other. For example, the attitude towards herbicides may be negative because it is very expensive, although in the way the RAA was applied in the questionnaire, being expensive was considered in the perceived behavioural control only. Also in the definition of the practices there is overlap, because sometimes direct planting was confused with CA as a whole, as was spraying herbicides.

Overall, strong evidence was found of the importance of attitude and perceived behavioural control in contributing to intentions to adopt CA practices. The most important of these was attitude, which corresponds to the claim that CA adoption requires a certain mind-set (change). The outcome beliefs underlying attitudes towards all CA practices show why: the outcome beliefs for intenders and non-intenders were significantly different (see Appendix). The importance of attitude, and the ability to understand the underlying beliefs for specific practices, gives important clues to improve and tailor extension and training to groups of certain attitudinal disposition.

The regression analyses did not reveal a statistically significant effect of perceived norms on intentions and behaviour, although some correlations with intentions were positive and significant. Further research should find out whether this is explained by Laikipia's particular history of recent settlement, or if this is a more widely applicable to individualistic farming decision making. It is also possible that the normative influence of important others is partly reflected in attitudes.

The link between intention and adoption was weaker than expected, for which several explanations have been put forward in this study. It does not follow that the RAA is not suitable for adoption studies, but rather highlights the need for further research, preferably with larger sample sizes. Reducing the time between the assessment of intentions and adoption to several months is a good starting point to improve the relation between the two, as it allows people to base their responses on the same information.

Allowing a process of experimentation and learning is central, for it allows farmers and other actors to re-examine their outcome beliefs, and thus changing attitudes (which ultimately may or may not be positive). Learning and experimentation, in various ways, also contribute to an improved perceived behavioural control, while actual behavioural control could benefit from the close involvement of different actors, including service providers, agro-dealers and extension services. This could contribute to expanding the options available to the farmer for sustainable agriculture.

Acknowledgements

This study was partly funded by the European Union through the ABACO project (DCI-FOOD 2010/230-178), and the Natural Resources Institute of the University of Greenwich. The authors also thank two anonymous reviewers for their comments.

Appendix A.

Outcome-, normative- and control beliefs underlying attitudes, perceived norms and perceived behavioural control, for spraying herbicides, direct planting and mulching.

Appendix II

Spraying Herbicides (SH)											
Outcome beliefs *i*		Mean belief strength $b(-2$ to $2)$			Mean evaluation e (2–5)			$b \times e$ (−10 to 10)			Correlation with intention
By spraying herbicide, I would. . .		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e*-Intention
A	reduce soil fertility	−0.95	−0.18	**	−4.16	−3.97	ns	−4.47	−1.46	**	0.330**
	harm animals that eat the residues	−1.52	−0.76	**	−2.00	−2.00		3.00	1.54	**	0.391**
	reduce labour and drudgery	1.93	1.53	**	3.00	2.87	ns	5.95	4.82	ns	0.318**
	risk my own health	−0.91	−0.08	**	−2.00	−2.00		1.95	0.10	**	0.378**
	reduce the harvest	−1.57	−0.55	**	−2.00	−2.00		3.37	1.28	**	0.563**
	get rid of *all* the weeds	1.02	0.67	ns	2.37	2.67	ns	2.47	1.72	ns	0.143
Injunctive normative beliefs *j*		Mean normative belief $n(-2$ to $2)$			Mean motivation to comply m (−2 to 2)			$n \times m$ (−4 to 4)			Correlation with intention
These people think I should practice SH:		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m*-Intention
Inj. N	household members	1.88	0.02	**	1.49	1.18	ns	2.86	−0.02	**	0.591**
	neighbours	0.68	−0.08	**	−0.11	−0.04	ns	0.43	0.27	ns	0.148
	CA FFS	1.81	1.02	**	1.05	0.57	*	2.38	1.19	**	0.326**
	other groups	0.68	−0.16	**	−0.14	−0.08	ns	0.16	−0.02	ns	0.150
	extension	0.77	0.48	ns	0.27	0.04	*	2.74	2.22	ns	0.205
	service providers	1.62	1.41	ns	1.64	1.18	ns	0.98	0.53	ns	0.208*
Descriptive normative beliefs j'		Mean normative belief n' (−2 to 2)			Mean motivation to comply m'(−2 to 2)			$n' \times m'$ (−4 to 4)			Correlation with intention
These people actually practice SH:		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m'*-Intention
Des. N	household members	1.05	−1.25	**	1.49	1.18	ns	1.74	−1.14	**	0.487**
	neighbours	−0.02	−0.59	**	−0.11	−0.04	ns	0.18	0.12	ns	0.028
	CA FFS	1.16	−0.03	**	1.05	0.57	*	1.82	0.78	**	0.364**
	other groups	−0.34	−0.71	ns	−0.14	−0.08	ns	0.25	0.16	ns	0.070
Control beliefs *k*		Mean belief strength $c(-2$ to $2)$			Mean perceived power p (0–3)			$c \times p$ (−6 to 6)			Correlation with intention
If I wanted to spray herbicides, I would. . .		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p*-Intention
PBC	know which to use	1.50	−0.41	**	2.08	1.79	ns	3.08	−1.21	**	0.613**
	know when & how to use	1.70	−0.20	**	1.61	1.64	ns	2.92	−0.03	**	0.556**
	have enough money	1.68	−0.02	**	1.66	1.85	ns	1.82	−0.08	**	0.406**
	have equipment	1.69	0.55	**	0.68	0.38	ns	0.92	0.33	ns	0.237*

Appendix II

Direct Planting (DP)											
Outcome beliefs i		Mean belief strength b (−2 to 2)			Mean evaluation e (2–5)			b × e (−10 to 10)			Correlation with intention
By practicing direct planting I would. . .		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	b.e-Intention
A	reduce labour and drudgery	1.98	1.31	**	3.05	2.82	ns	6.00	3.76	*	0.286*
	reduce weeds on the field	1.71	0.33	**	2.51	2.53	ns	4.23	0.68	**	0.475**
	increase harvest	1.56	0.02	**	4.03	3.92	ns	6.31	-0.37	**	0.656**
	improve infiltration	1.80	-0.04	**	3.05	2.76	ns	5.67	-0.24	**	0.681**
	reduce evaporation	1.88	0.11	**	3.05	2.76	ns	5.82	0.32	**	0.708**
	improve soil structure	1.78	-0.13	**	2.77	2.61	ns	5.10	0.08	**	0.654**
Injunctive normative beliefs j		Mean normative belief n (−2 to 2)			Mean motivation to comply m (−2 to 2)			n × m (−4 to 4)			Correlation with intention
These people think I should practice DP:		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	n.m-Intention
Inj N	household members	1.83	-0.25	**	1.50	1.04	*	2.98	-0.15	**	0.553**
	neighbours	0.44	-0.39	**	0.07	-0.34	*	0.93	0.43	ns	0.184
	CA FFS	1.69	0.81	**	1.38	0.40	**	2.62	1.09	**	0.420**
	other groups	0.61	-0.44	**	0.10	-0.28	ns	0.73	0.04	**	0.304**
	extension	1.78	1.16	**	1.63	1.00	**	3.07	1.61	**	0.397**
	service providers	0.02	-0.8	**	0.05	-0.33	ns	1.10	0.33	ns	0.187
Descriptive normative beliefs j'		Mean normative belief n' (−2 to 2)			Mean motivation to comply m' (−2 to 2)			n' × m' (−4 to 4)			Correlation with intention
These people actually practice direct planting		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	n'.m'-Intention
Des. N	household members	0.88	-1.06	**	1.50	1.04	*	2.10	-0.82	**	0.506**
	neighbours	-0.32	-0.78	**	0.07	-0.34	*	0.32	0.49	ns	-0.076
	CA FFS	1.21	-0.03	**	1.38	0.40	**	2.16	0.53	**	0.453**
	other groups	-0.37	-0.75	*	0.10	-0.28	ns	0.46	0.19	ns	0.085
Control beliefs k		Mean belief strength c (−2 to 2)			Mean perceived power p (0–3)			c × p (−6 to 6)			Correlation with intention
If I wanted to practice direct planting, I would. . .		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	c.p-Intention
PBC	have money	1.12	0.35	**	1.41	1.47	ns	1.21	0.32	*	0.235*
	have equipment	1.41	0.35	**	1.00	1.13	ns	1.21	0.37	ns	0.193
	have labour	1.39	0.69	**	0.67	0.68	ns	0.79	0.37	ns	0.143
	have knowledge	1.46	-0.13	**	1.79	1.53	ns	2.64	-0.05	**	0.484**
	have favourable soils	0.27	-0.24	ns	1.08	0.84	ns	0.51	-0.76	**	0.323**

Appendix II

Mulching (M)											
Outcome beliefs *i*		Mean belief strength *b* (−2 to 2)			Mean evaluation *e* (2–5)			$b \times e$ (−10 to 10)			Correlation with intention
By mulching, I would. . .		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e*-Intention
A	improve fertility	1.96	1.72	**	4.05	4.15	ns	7.98	6.92	ns	0.158
	improve soil structure	1.95	1.72	**	2.78	2.23	ns	5.47	3.77	**	0.340**
	reduce weeding time	1.70	1.33	*	2.53	2.46	ns	4.47	2.92	*	0.253*
	reduce erosion	1.96	1.78	**	2.14	2.46	ns	4.20	4.00	ns	−0.005
	improve soil moisture	1.87	1.72	*	2.83	3.31	ns	5.42	5.77	ns	0.007
	reduce evaporation	1.95	1.78	*	2.83	3.31	ns	5.55	5.92	ns	−0.007
Injunctive normative beliefs *j*		Mean normative belief *n* (−2 to 2)			Mean motivation to comply *m* (−2 to 2)			$n \times m$ (−4 to 4)			Correlation with intention
These people think I should mulch:		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m*-Intention
Inj. N	household members	1.69	0.39	**	1.34	1.28	ns	2.81	0.72	**	,382**
	neighbours	0.44	−0.17	*	−0.10	0.22	ns	0.73	0.22	ns	0.080
	CA FFS	1.51	0.88	*	0.97	1.00	ns	2.14	1.31	ns	0.174
	other groups	0.47	−0.22	*	−0.01	0.11	ns	0.55	0.11	ns	0.097
	extension officers	1.68	1.06	*	1.71	1.29	**	3.18	1.47	**	,319**
Descriptive normative beliefs j'		Mean normative belief *n'* (−2 to 2)			Mean motivation to comply *m'* (−2 to 2)			$n' \times m'$ (−4 to 4)			Correlation with intention
These people practice mulching:		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m'*-Intention
Des. N	household members	1.30	−0.89	**	1.34	1.28	ns	2.45	0.22	**	,397**
	neighbours	−0.18	−0.83	**	−0.10	0.22	ns	0.36	0.28	ns	0.042
	CA FFS	1.17	0.38	**	0.97	1.00	ns	2.23	0.85	**	,337**
	other groups	−0.17	−0.67	*	−0.01	0.11	ns	0.33	0.27	ns	0.027
Control beliefs *k*		Mean belief strength *c* (−2 to 2)			Mean perceived power *p* (0–3)			$c \times p$ (−6 to 6)			Correlation with intention
If I wanted to mulch, I would be sure there is. . .		Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p*-Intention
PBC	no unauthorised grazing	1.99	1.56	**	1.53	0.69	*	3.67	2.00	*	,238*
	enough biomass	1.29	0.39	**	1.70	2.08	ns	2.55	−0.08	**	,365**
	firewood (without the residues)	1.56	0.94	*	0.91	1.15	ns	2.44	0.92	ns	0.206
	fodder (without the residues)	1.10	0.33	*	1.41	1.77	ns	2.28	0.92	ns	0.129

References

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211.

Arslan, A., Mccarthy, N., Lipper, L., Asfaw, S., Cattaneo, A., 2013. Adoption and intensity of adoption of conservation farming practices in Zambia. Agric. Ecosyst. Environ., http://dx.doi.org/10.1016/j.agee.2013.08.017.

Bagozzi, R.P., 1984. Expectancy—value attitude models: an analysis of critical measurement issues. Int. J. Res. Mark. 1, 295–310.

Baudron, F., Jaleta, M., Okitoi, O., Tegegn, A., 2013. Conservation agriculture in African mixed crop-livestock systems: expanding the niche. Agric. Ecosyst. Environ., http://dx.doi.org/10.1016/j.agee.2013.08.020.

Beedell, J., Rehman, T., 2000. Using social-psychology models to understand farmers' conservation behaviour. J. Rural Stud. 16, 117–127, http://dx.doi.org/10.1016/S0743-0167(99)00043-1.

Beuchelt, T.D., Badstue, L., 2013. Gender, nutrition- and climate-smart food production: opportunities and trade-offs. 709–721. doi:10.1007/s12571-013-0290-8.

Burton, R.J.F., 2004. Reconceptualising the behavioural approach in agricultural studies: a socio-psychological perspective. 20, 359–371. doi:10.1016/j.jrurstud.2003.12.001.

Chauhan, B.S., Singh, R.G., Mahajan, G., 2012. Ecology and management of weeds under conservation agriculture: a review. Crop Prot., 57–65.

Conner, M., Armitage, C.J., 1998. Extending the theory of planned behavior: A review and avenues for further research. J. Appl. Soc. Psychol.

Corbeels, M., De Graaff, J., Hycenth, T., Penot, E., Baudron, F., Naudin, K., Andrieu, N., Chirat, G., Schuler, J., Nyagumbo, I., Rusinamhodzi, L., Traore, K., Dulla, H., Solomon, I., 2013. Understanding the impact and adoption of conservation agriculture in Africa: a multi-scale analysis. Agric. Ecosyst. Environ., http://dx.doi.org/10.1016/j.agee.2013.10.011.

Cronbach, L.J., 1951. Coefficient alpha and the internal structure of tests. Psychometrika 16, 297–334.

De Graaff, J., Amsalu, A., Bodnár, F., Kessler, A., Posthumus, H., Tenge, A., 2008. Factors influencing adoption and continued use of long-term soil and water conservation measures in five developing countries. Appl Geogr. 28, 271–280, http://dx.doi.org/10.1016/j.apgeog.2008.05.001.

Eisinga, R., te Grotenhuis, M., Pelzer, B., 2013. The reliability of a two-item scale: Pearson, Cronbach, or Spearman–Brown? Int. J Public Health 58, 637–642, http://dx.doi.org/10.1007/s00038-012-0416-3.

Ellis-Jones, J., Mason, T., 1999. Livelihood strategies and assets of small farmers in the evaluation of soil and water management practices in the temperate inter—Andean valleys of Bolivia. Mt. Res. Dev. 19, 221–234.

Ervin, C.A., Ervin, D.E., 1982. Factors affecting the use of soil conservation practices: hypotheses, evidence, and policy implications. Land Econ. 58 (3), 277–291.

Feder, G., Just, R.E., Zilberman, D., 1982. Adoption of Agricultural Innovation in Developing Countries: A Survey. the World Bank, Washington DC.

Fishbein, M., 1963. An investigation of relationships between beliefs about an object and the attitude toward that object. Hum. Relat. 16, 233–240.

Fishbein, M., Ajzen, I., 2010. Predicting and Changing Behavior; the Reasoned Action Approach. Taylor & Francis Group, New York.

Fishbein, M., Ajzen, I., 1975. Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. Addison-Wesley, Reading.

Gagné, C., Godin, G., 2000. The theory of planned behavior: some measurement issues concerning belief-based variables. J. Appl. Soc. Psychol. 30, 2173–2193.

Giller, K.E., Corbeels, M., Nyamangara, J., Triomphe, B., Affholder, F., Scopel, E., Tittonell, P., 2011. A research agenda to explore the role of conservation agriculture in African smallholder farming systems. Field Crops Res. 124, 468–472, http://dx.doi.org/10.1016/j.fcr.2011.04.010.

Giller, K.E., Witter, E., Corbeels, M., Tittonell, P., 2009. Conservation agriculture and smallholder farming in Africa: the heretics' view. Field Crops Res. 114, 23–34, http://dx.doi.org/10.1016/j.fcr.2009.06.017.

Gowing, J.W., Palmer, M., 2008. Sustainable agricultural development in sub-Saharan Africa: the case for a paradigm shift in land husbandry. Soil Use Manag. 24, 92–99, http://dx.doi.org/10.1111/j.1475-2743.2007.00137.x.

Hall, A., Janssen, W., Pehu, E., Rajalahti, R., 2007. Enhancing Agricultural Innovation. In: How to go Beyond the Strengthening of Research Systems. The World Bank, Washington, DC.

Hobbs, P.R., Sayre, K., Gupta, R., 2008. The role of conservation agriculture in sustainable agriculture. Philos. Trans. R. Soc. Lond. B. Biol. Sci. 363, 543–555, http://dx.doi.org/10.1098/rstb.2007.2169.

Kaiser, F.G., 2006. A moral extension of the theory of planned behavior: Norms and anticipated feelings of regret in conservationism. Pers. Individ. Dif. 41, 71–81, http://dx.doi.org/10.1016/j.paid.2005.11.028.

In: Kaumbutho, P., Kienzle, J. (Eds.), 2007. Conservation agriculture as practised in Kenya: two case studies. African Conservation Tillage Network (ACT); Centre de Coopération Internationale de Recherche Agronomique pour le Développement, Food and Agriculture Organization of the United Nations, Nairobi.

Knowler, D., Bradshaw, B., 2007. Farmers' adoption of conservation agriculture: A review and synthesis of recent research 32, 25–48. doi:10.1016/j.foodpol.2006.01.003.

Lynne, G.D., Franklin Casey, C., Hodges, A., Rahmani, M., 1995. Conservation technology adoption decisions and the theory of planned behavior. J. Econ. Psychol. 16, 581–598, http://dx.doi.org/10.1016/0167-4870(95)00031-6.

Lynne, G.D., Shonkwiler, J.S., Rola, L.R., 1988. Improving attitude-behaviour prediction models with economic variables: farmer actions toward soil conservation. J. Soc. Psychol. 128, 19–28.

Mazvimavi, K., Twomlow, S., 2009. Socioeconomic and institutional factors influencing adoption of conservation farming by vulnerable households in Zimbabwe. Agric. Syst. 101, 20–29, http://dx.doi.org/10.1016/j.agsy.2009.02.002.

Min. of Agr., 2013. Laikipia East, Conservation Agriculture Brief, Nanyuki.

Ndah, H.T., Schuler, J., Uthes, S., Zander, P., Triomphe, B., Mkomwa, S., Corbeels, M., 2015. Adoption Potential for Conservation Agriculture in Africa: a newly developed assessment approach (QAToCA) applied in Kenya and Tanzania. L. Degrad. Dev. 26, 133–141, http://dx.doi.org/10.1002/ldr.2191.

Notter, B., MacMillan, L., Viviroli, D., Weingartner, R., Liniger, H.-P., 2007. Impacts of environmental change on water resources in the Mt. Kenya region. J. Hydrol. 343, 266–278, http://dx.doi.org/10.1016/j.jhydrol.2007.06.022.

Pelling, E.L., White, K.M., 2009. The theory of planned behavior applied to young people's use of social networking web sites. Cyberpsychol. Behav. 12, 755–759, http://dx.doi.org/10.1089/cpb.2009.0109.

Posthumus, H., Gardebroek, C., Ruben, R., 2010. From participation to adoption: comparing the effectiveness of soil conservation programs in the Peruvian Andes. Land Econ. 86 (4), 645–667.

Posthumus, H., Pound, B., Andrieu, N., Triomphe, B., 2011. Enhancing adoption of conservation agriculture practices through co-innovation platforms in sub-Saharan Africa. In: 5th World Congress of Conservation Agriculture, Brisbane.

Prager, K., Posthumus, H., 2010. Socio-economic factors influencing farmers' adoption of soil conservation practices in europe. In: Napier, T.L. (Ed.), Human Dimensions of Soil and Water Conservation. Nova Science Publishers, Inc.

Röling, N., 2009. Pathways for impact: scientists' different perspectives on agricultural innovation. Int. J. Agric. Sustain., 83–94.

Röling, N., Hounkonnou, D., Kossou, D., Kuyper, T.W., Nederlof, S., Sakyi-Dawson, O., Traoré, M., van Huis, A., 2012. Diagnosing the scope for innovation: Linking smallholder practices and institutional context. NJAS Wageningen J. Life Sci. 60–63, 1–6, http://dx.doi.org/10.1016/j.njas.2012.06.004.

Sijtsma, K., 2009. On the use, the misuse, and the very limited usefulness of Cronbach's alpha. Psychometrika 74, 107–120, http://dx.doi.org/10.1007/s11336-008-9101-0.

Ten Berge, J.M.F., Sočan, G., 2004. The greatest lower bound to the reliability of a test and the hypothesis of unidimensionality. Psychometrika 69, 613–625, http://dx.doi.org/10.1007/BF02289858.

Tittonell, P., Scopel, E., Andrieu, N., Posthumus, H., Mapfumo, P., Corbeels, M., van Halsema, G.E., Lahmar, R., Lugandu, S., Rakotoarisoa, J., Mtambanengwe, F., Pound, B., Chikowo, R., Naudin, K., Triomphe, B., Mkomwa, S., 2012. Agroecology-based aggradation-conservation agriculture (ABACO): targeting innovations to combat soil degradation and food insecurity in semi-arid Africa. Field Crops Res. 132, 168–174, http://dx.doi.org/10.1016/j.fcr.2011.12.011.

Trumbo, C.W., O'Keefe, G.J., 2005. Intention to Conserve Water: Environmental ValuesReasoned Action, and Information Effects Across Time. Soc. Nat. Resour. 18, 573–585, http://dx.doi.org/10.1080/08941920590948002.

Ulrich, A., Ifejika Speranza, C., Roden, P., Kiteme, B., Wiesmann, U., Nüsser, M., 2012. Small-scale farming in semi-arid areas: livelihood dynamics between 1997 and 2010 in Laikipia, Kenya. J. Rural Stud. 28, 241–251, http://dx.doi.org/10.1016/j.jrurstud.2012.02.003.

Van Hulst, F.J., Posthumus, H., 2014. Understanding (non-) adoption of CA: contributions from Social Psychology. In: 1st Africa Congress on Conservation Agriculture, Lusaka.

Wauters, E., Bielders, C., Poesen, J., Govers, G., Mathijs, E., 2010. Adoption of soil conservation practices in Belgium: An examination of the theory of planned behaviour in the agri-environmental domain. Land Use policy 27, 86–94, http://dx.doi.org/10.1016/j.landusepol.2009.02.009.

Wilson, G.A., 1996. Farmer environmental attitudes and ESA participation. Geoforum 27 (2), 115–131.

Yazdanpanah, M., Hayati, D., Hochrainer-Stigler, S., Zamani, G.H., 2014. Understanding farmers' intention and behavior regarding water conservation in the Middle-East and North Africa: a case study in Iran. J. Environ. Manage. 135, 63–72, http://dx.doi.org/10.1016/j.jenvman.2014.01.016.

Appendix III Reasoned Action Approach questionnaire: Intentions (English)

This questionnaire was developed on the basis of the Reasoned Action Approach. It was held in Kenya in 2013 to assess farmers' intentions to adopt CA practices in 2014. It was held in 2014 to assess farmers' intentions to adopt CA practices in 2015. This particular questionnaire shown below is the English version held in Kenya, while a French questionnaire was developed for use in Madagascar.

Questionnaire about the long rain season of 2014 (next April)

Date and location of interview, Enumerator. Name, age, gender of respondent. ABACO group membership (yes/no).

Land under production: How many acres of maize, beans, potatoes and wheat planned to plant in long season 2014?

1. Direct assessment of intentions, attitudes, Social Norms and Perceived Behavioural control

The questions in this section were applied to the following practices: ploughing, direct planting, spraying herbicides, cover crop, mulching, shallow weeding (Kenya only), crop rotations

1.1. How likely: I will adopt this practice on my land in the long rain season 2014

Very unlikely			Possible			Very likely

1.2. On how many acres?	acres
1.3. For mulching: What percentage of the residues will you leave on the land?	%
1.4. For cover crops: What cover crop?	Dolichos / Butter bean / Cowpeas / Pigeon peas / Other:

Do you think, that your ploughing adopting this practice on your land in the long rain season 2014 is

1.5. Very bad			Neutral			Very good
1.6. Very foolish			Neutral			Very wise
1.7. Very unpleasant			Neither			Very pleasant

1.8. The people who are important to you, do they think that

You really should not adopt this practice			They have no opinion			You really should adopt this practice

1.9. Of the people whom you respect and admire, how many adopt this practice?

Very few			Moderately			Very many

1.10. If you wanted to adopt the practice next season, it would be

Very difficult			Average			Very easy

1.11. If you wanted to adopt this practice, it would be

Not at all up to me			Somewhat up to me			Completely up to me

2. Indirect assessment of attitudes, Social Norms and Perceived Behavioural control: underlying beliefs

The questions in this section go up to the 'belief level', and were only applied to the following practices: direct planting, spraying herbicides, mulching and planting cover crops.

2.1. Direct planting

2.1.1. Outcome beliefs

How likely: By Direct planting I would...

... reduce labour days and drudgery.

Very unlikely			Possibly			Very likely

... make weeding easier.
... increase water infiltration.
... reduce evaporation from the soil.
... improve the soil structure.

How important?

For me, reducing labour days and drudgery is:

Not at all important			Neutral			Very important

For me, increasing water infiltration is:

For me, reducing evaporation from the soil is:

1.1.1. Normative beliefs

Referents that influence the decision to do Direct planting

My husband/wife and others in the household think that:

I really should not			No opinion			I really should

My neighbours think that:
My CA group/FFS thinks that:
Other groups that I belong to think that:
My chiefs and elders think that:
My extension officers and NGOs think that:
My service providers think that:

When it comes to Direct planting, I strongly consider the opinion of...

... my husband/wife and others in the household

I strongly disagree			Undecided			I strongly agree

... my neighbours
… my CA group/FFS
... other groups that I belong to
... my chiefs and elders
... my extension officers and NGOs
... my service providers

How many actually do Direct planting?

Of my husband/wife and others in the household:

None	Few	some	A lot	All

Of my neighbours:
Of my CA group/FFS:
Of other groups that I belong to:
Of my chiefs and elders:
Of my extension officers and NGOs:
Of my service providers:

Control factors

How sure are you?

That if you wanted to do Direct planting in the long rain season of 2014,

…you would have enough money?

Certainly not			Neutral			Very sure

… equipment would be readily available to you?
…you would have enough labour?
… you know exactly how Direct planting works?
… your soil is not too wet / too dry?

How important is it?

If I want to do Direct planting...

Having sufficient money is

Not at all important			Of average			Very important

		importance		

Availability of equipment is
Having enough labour is
Knowing exactly how it works is
The soil not being too wet / too dry is

2.2. Spraying herbicides [in the long rain season 2014]

2.2.1. Outcome beliefs

How likely: By spraying herbicides I would...

… affect soil fertility negatively.

Very unlikely			Possibly			Very likely

… harm the animals that feed on residues.
… reduce labour days and drudgery.
… affect my health negatively.
… negatively affect the quality of the main crop.
… kill every kind of weed.

How important?

For me, having crop residues that don't harm animals, is:

Not at all important			Neutral			Very important

For me, not affecting the quality of the main crop with herbicides, is:

1.1.1. Normative beliefs

Referents that influence the decision to spray herbicides

My husband/wife and others in the household think that:

I really should not			No opinion			I really should

My neighbours think that:
My CA group/FFS thinks that:
Other groups that I belong to think that:
My chiefs and elders think that:
My extension officers and NGOs think that:
My service providers think that:

When it comes to spraying herbicides, I strongly consider the opinion of...

... my husband/wife and others in the household

I strongly disagree			Undecided			I strongly agree

... my neighbours

… my CA group/FFS
... other groups that I belong to
... my chiefs and elders
... my extension officers and NGOs
... my service providers

How many actually do spray herbicides …

Of my husband/wife and others in the household:

None	Few	some	A lot	All

Of my neighbours:
Of my CA group/FFS:
Of other groups that I belong to:
Of my chiefs and elders:
Of my extension officers and NGOs:
Of my service providers:

Control factors

How sure are you? That if you wanted to spray herbicides in the long rain season of 2014,

… you would know which herbicide to use?

Certainly not			Neutral			Very sure

… you would know when to use the herbicide?
… you would know how to use the herbicides?
… you would have sufficient money to apply herbicides?
…equipment will be available to you when you need it?

How important is it? If I want to spray herbicides...

Knowing which herbicide to use is

Not at all important			Of average importance			Very important

Knowing when to use the herbicide is
Knowing how to use herbicides is
Having sufficient money is
Equipment being available when I need it is

2.3.Leaving crop residues on land [in the long rain season 2014]

2.3.1. Outcome beliefs

How likely: By leaving crop residues on the land I would...

… increase the soil fertility.

Very unlikely			Possibly			Very likely

… improve the soil structure.
… reduce weeds.
… reduce run-off and erosion.
… increase water retention and soil moisture.
… reduce evaporation.

How important?

For me, reducing run-off and erosion is:

Not at all important			Neutral			Very important

For me, increasing water retention and soil moisture is:

1.1.1. Normative beliefs

Referents that influence the decision to leave Crop Residues on the land as mulch

My husband/wife and others in the household think that:

I really should not			No opinion			I really should

My neighbours think that:
My CA group/FFS thinks that:
Other groups that I belong to think that:
My chiefs and elders think that:
My extension officers and NGOs think that:

When it comes to Leaving crop residues on the land, I strongly consider the opinion of...

... my husband/wife and others in the household

I strongly disagree			Undecided			I strongly agree

... my neighbours
… my CA group/FFS
... other groups that I belong to
… my chiefs and elders
... my extension officers and NGOs

How many actually leave crop residues as mulch?

Of my husband/wife and others in the household:

None	Few	some	A lot	All

Of my neighbours:
Of my CA group/FFS:
Of other groups that I belong to:
Of my chiefs and elders:
Of my extension officers and NGOs:

Control factors

How sure are you? That if you wanted to leave residues on the land in the long rain season of 2014,

… nobody comes on your land without your permission?

Certainly not			Neutral			Very sure

… you have enough biomass to keep the soil covered?
… you will have enough firewood without using the residues?
… you will have enough feed for your cows without using the residues?

How important is it? If I want to leave crop residues on the land...

Nobody coming on my land without my permission is

Not at all important			Of average importance			Very important

Having enough biomass to keep the soil covered is
Having enough firewood without using the residues is
Having enough feed for your cows without using the residues is

2.4. Planting cover crop [in the long rain season 2014]

2.4.1. Outcome beliefs

How likely: By planting a cover crop I would...

… contribute to household food.

Very unlikely			Possibly			Very likely

… increase soil fertility.
… reduce water loss through evaporation.
… improve soil structure.
… reduce occurrence of pests and diseases.

How important is it?

For me, the contribution of cover crops to the household food is:

Not at all important			Neutral			Very important

For me, reducing occurrence of pests and diseases is:

2.4.2. Normative beliefs

My husband/wife and others in the household think that:

I really should not			No opinion			I really should

My neighbours think that:
My CA group/FFS thinks that:
Other groups that I belong to think that:
My chiefs and elders think that:
My extension officers and NGOs think that:

When it comes to planting cover crops, I strongly consider the opinion of...

... my husband/wife and others in the household

I strongly disagree			Undecided			I strongly agree

... my neighbours
… my CA group/FFS
... other groups that I belong to
... my chiefs and elders
... my extension officers and NGOs

How many actually plant a cover crop?

Of my husband/wife and others in the household:

None	Few	some	A lot	All

Of my neighbours:
Of my CA group/FFS:
Of other groups that I belong to:
Of my chiefs and elders:
Of my extension officers and NGOs:

2.4.3. Control beliefs

How sure are you? That if you wanted to plant a cover crop in the long rain season of 2014,

… seeds are readily available?

Certainly not			Neutral			Very sure

… you have sufficient money to plant a cover crop?
… the rainfall will be good for the cover crop?
… you will know which cover crops to use?

How important is it? If I want to plant cover crops...

The availability of seeds is …

Not at all important			Of average importance			Very important

Having sufficient money is …
Good rainfall is …
Knowing which cover crops to use is …

Appendix IV Reasoned Action Approach follow-up questionnaire: Adoption

Date of interview, Enumerator. Name, age, gender of respondent. ABACO group membership (yes/no). Land under production: How many acres of maize, beans, potatoes and wheat planted in long season 2014?

1. General questions

What part of the production is for household consumption?
What part of the **total income** is from agriculture?
Since how long do you have knowledge of Conservation Agriculture farming?
Since how long are you practicing Conservation Agriculture farming?
How many cattle do you have? (cows/oxen)

2. Spraying herbicides [in the current long rain season]

This year I have sprayed herbicides (yes/no).
On how many acres?
What type of herbicide?
If no, why not?

If you want to spray herbicides, what are the three most important things to be able to do so?

	Number 1, 2 and 3
Knowing which herbicide to use	
Knowing when and how to spray the herbicides	
Having sufficient money is	
Equipment being available when I need it is	
Other	

3. Ploughing [in the long rain season 2014]

This year I have ploughed part of my land (yes/no).
On how many acres?
If no, why not?
What type of equipment? Equipment is owned/hired/borrowed
On conventional plots I plough every season/year
On CA plots I plough every year/2years/3years/other: /never
Did you apply ripping/sub-soiling?

4. Direct planting [in the long rain season 2014]

This year I have done direct planting on part of my land (yes/no).
On how many acres?
If no, why not?
What type of equipment? Equipment is owned/hired/borrowed

If you want to do direct planting, what is most important to be able to do it?

	Number 1, 2 and 3
Availability of equipment	
Having sufficient money	
Having enough labour	
Knowing exactly how it works	

The soil not being too wet / too dry	
Other	

5. Leaving crop residues and mulch on land [in the long rain season 2014]

This year I have done mulching on part of my land (yes/no).
On how many acres?
If yes, what percentage of crop residues were retained?
What was the source of crop residues? Crop residues from land, residues from cover crops, imported mulches from other field.
If no, why not?

If you want to leave crop residues on your land, what is most important to be able to do so?

	Number 1, 2 and 3
No persons or animals coming on my land without	
Having enough biomass to keep the soil covered	
Having enough firewood without using the residues	
Having enough feed for your cows without using the residues	
Other	

6. Planting cover crop [in the long rain season 2014]

This year I have planted a cover crop on part of my land (yes/no).
On how many acres?
If yes, what type of cover crop?

If you want to plant a cover crop, what is most important to be able to do so?

	Number 1,2 and 3
The availability of seeds	
Having sufficient money	
Good rainfall	
Knowing which cover crops to use	
Having opportunity to sell the produce	
Other	

7. Shallow weeding [in the long rain season 2014]

This year I have practiced shallow weeding on part of my land (yes/no).
On how many acres?

8. Planting crops in rotation [in the long rain season 2014]

This year I have practiced crop rotations on part of my land (yes/no).
On how many acres?

9. General questions

When you are making decisions about your farming system, what are the most important considerations for you?

	Number 1 and 2
Reduce the required family labour	
Reduce production costs	
Increase the production	
Reduce risk of crop failure	
Other	

When you are making decisions about your farming system, what are the most important considerations for you?

	Number 1, 2 and 3
Better conserve moisture in the soil	
Improve the soil structure	
Improve the soil fertility	
Reduce pests and diseases	
Reduce run-off and erosion	
Reduce the influence of weeds	
Other	

When you are making decisions about your farming system, whose opinion do you sometimes consider? Especially:

	Number 1, 2 and 3
My husband/wife and others in the household	
My service providers	
The FFS that does CA	
Other groups that I belong to	
My chiefs and elders	
My extension officers and NGOs	
My neighbours	

Appendix V Overview of semi-structured interviews

Table V-1 Overview of semi-structured interviews held in Kenya

Organisation	Acronym	Function of organisation	Date of interview
African Conservation Tillage Network	ACT-network	Projects and networking	09-07-2013
Ministry of Agriculture, National	MoA national	Government policy	10-07-2013
Femo works ltd.		Manufacturing	11-07-2013
East African Farmer Federation	EAFF	Policy, advocacy	12-07-2013
Centre for Training and Integrated Research for ASAL (Arid & Semi-Arid Lands) Development	CETRAD	Research and dissemination	29-07-2013
Centre for Training and Integrated Research for ASAL (Arid & Semi-Arid Lands) Development	CETRAD	Research and dissemination	05-09-2013
Kenyan Network for Dissemination of Agricultural Technologies	KENDAT	Research and dissemination	31-07 - 2013 and 07-08-2013
National Environment Management Authority	NEMA	Government policy	01-08-2013
Ministry of Agriculture, County	MoA local	Extension	Various, end 2013
World Agroforestry Centre	ICRAF	Research and project implementation	23-08-2013
World Agroforestry Centre	ICRAF	Research and project implementation	06-09-2013
Kenya Agricultural Research Institute (now known as KALRO- Kenya Agricultural and Livestock Research Organization)	KARI	Research organisation	09-09-2013
World Renew	World Renew	Project implementation	09-10-2013
Caritas	Caritas	Project implementation	03-09-2013
Lengetia Farm		Large-scale farmer	04-09-2013

Table V-2 Overview of semi-structured interviews held in Madagascar

Organisation	Acronym	Function of organisation	Date of interview
Groupement Semis Direct Mad	GSDM	Networking at national level	13-12-2013
Fiompiana Fambolena Malagasy Norveziana	FIFAMANOR	Dissemination (Antsirabé)	18-12-2013
Processus écologiques et processus d'innovation technique et social en agriculture de conservation	ANR-PEPITES	Facilitation of Innovation Platform	23-01-2013
Semis Direct – Madagascar region Lac Alaotra	SD-Mad local	Producer of seeds	18-02-2014
Centre Service Agricole Ambatondrazaka	CSA Ambaton-drazaka	Information and advice	18-02-2014
Directorat Régionale pour le Développement Rural	DRDR	Government, dissemination	19-02-2014
Andri-Ko	Andri-Ko	Producer of seeds	21-02-2014
Foibem-pirenena ho an'ny fikarohana ampiharina ho fampandrosoana ny eny Ambanivohitra (region Alaotra)	FOFIFA (region Alaotra)	Research, dissemination, seeds	25-02-2014
Centre International de la Recherche Agronomique pour le Développement	CIRAD	Research	26-02-2014
Centre International de la Recherche Agronomique pour le Développement	CIRAD	Research	27-02-2014
FOFIFA, see above (national)	FOFIFA	Research, dissemination	28-02-2014

Appendix VI Guidelines for semi-structured interviews.

These were the guidelines for the semi-structured interviews held with actors involved in the promotion, facilitation or implementation of CA at the national or local levels.

General introduction of organisation

- Please describe what your organisation has got to do with Conservation Agriculture, and what are your experiences with CA?
- What are the main functions or what is the mandate of your organisation? (provide a brief description of the main functions)

Function	Description
Entrepreneurial	
Knowledge development	
Knowledge diffusion	
Policy development	
Resources mobilization	
Networking and linking actors	
Technology development	
Other:	

- Conservation agriculture. For improved livelihood, or better environment? Which comes 1st?
- CA is not the only sustainable land use system. Agroforestry, sustainable resource management, integrated pest management, Push-pull system, integrated soil fertility management, evergreen agriculture
- What do you think is the position of CA amongst other sustainable agricultural practices?
- Can you briefly describe the process of how you got involved in the promotion of CA? (when, why)
- What has changed since the time that it began?
- What is the centre of the influence / power of your organisation? (Please give example)

Political:	Large influence on policy		Some influence on policy		No influence on policy
Social:	Large influence on opinion of other stakeholders		Some influence on opinion of other stakeholders		No influence on opinion of other stakeholders
Economic:	Large influence on mobilization of resources		Some influence on mobilization of resources		No influence on mobilization of resources
Research:	Large influence on research		Some influence on research		No influence on research
Farmers:	Large influence on farmers		Some influence on farmers		No influence on farmers

Appendix VI

Styles of supporting Conservation Agriculture

- Why is your organisation stimulating/facilitating CA? Select one that fits best:
  - There is a politically accepted decision to promote CA as sustainable production system
  - We think there is a solid scientific basis that supports the versatile benefits of CA
  - We think there is an active demand for CA knowledge from the field
  - We think that there is a need for CA knowledge, (maybe without people knowing it)
  - We strongly belief that CA is the best option for achieving improved (rural) livelihoods
- What do you see as the 2-way relation between organisation and the CA user? Select one that fits best:
  - We are like a **Strategist**, we identify determinants of farmers behaviour so that we can design projects to increase CA adoption
  - We are an **Expert** in CA, trying to convince farmers of the benefits of CA to reach an increased acceptance and increase adoption of CA
  - We are like a **Consultant**, identifying the main problems, so that we can remove constraints faced by farmers who try to adopt CA
  - We are like a **Trainer**, focused on the client, engaging in a process of learning with farmers, so that they make sense of CA
  - We are like an **Organizer**, we organize interaction and facilitate group processes on platforms with all relevant CA actors.

Pathway to impact

- What chains are involved, from organisation headquarters to farmers?
- What is the most challenging link? Can you give an example?
- Technology development should go hand in hand with Institutional development to achieve innovation. What is necessary next in terms of Technology development?
- What is necessary next in terms of institutional development?

Interactions in the network

- With which actors do you most closely work together in the promotion of CA?
- Can you give an example of good and fruitful cooperation with (an)other organisation(s)?
- What is the secret? How can this be extended?
- Do you feel well understood and involved by other actors dealing with CA?
- What is necessary to improve the cooperation for successful up scaling of CA?

Appendix VII Survey about interactions between CA actors

Interactions with other organisations

Objective: The goal of these questions is to get insight in the interactions between all organisations that influence (positively or negatively) the promotion, facilitation and implementation of Conservation Agriculture (CA) in Kenya. The results are part of a social network analysis, as part of my PhD research that I do together with ACT-network. The results will obviously be made available to you.

Explanation: There are 7 questions. The answers to the first 6 questions can be given in the table on the next page. The columns in the table correspond with the questions, an example is given in the first row. For question 7 you do not need the table, just write it under the question. Thank you for your cooperation!

Question 1. Please take some time to think of all the organisations *that are supporting or obstructing the promotion of CA*. If necessary, add actors to the table that are missing. (See table on next page)

Question 2 to 6 apply only to the actors *with which there was interaction.*

Question 2. Please mark how often you *normally* have contact with all these actors *concerning CA*.

W eekly (= frequent) **M** onthly (= regular) **Y** early (= incidental)

Question 3. What was the type of contact? (More answers possible)

E-mail **T** **e**lephone
I nformal meeting **A** ll previous answers
F ormal meeting **O** ther, please specify:

Question 4. What is the main purpose of having contact with this actor?

e.g. We try to mainstream CA policy. Or: We work together in project x.

Question 5. How would you characterize the relation? What role does each actor fulfil *for your organisation*? More answers are possible:

e.g. This actor is our … Partner, donor, service provider, client, commissioner, consultant, facilitator, trainer, research specialist, dissemination specialist, technology developer, etc.

Question 6. Please indicate with which 3 actors you have the strongest relation *in promotion of CA.*

Question 7. What is your Unique Selling Point, your added value? What makes your organisation unique amongst these stakeholders?

Appendix VII

Q1 Actors	Q2	Q3 Type of contact	Q4 Purpose of contact	Q5 This actor is our	Q6
EXAMPLE	*M*	*E,T,F*	*Discussing progress of project x*	*Partner, client*	*x*
Nat. M.o.Agr.					
County M.o.Agr.					
EAFF					
ACT-network					
ICRAF					
FAO					
DFID					
USAID					
SIDA					
KARI					
KEFRI					
KENDAT					
KENFAP					
KENADA					
STAK					
FEMO works ltd.					
Syngenta found.					
CETRAD					
CIRAD					
ICIPE					

Appendix VIII Average values of RAA variables

Table VIII-1 Mean values of RAA variables for intenders and non-intenders in Kenya

	Spraying herbicides			**Direct planting**			**Ploughing**		
	Intenders (n=38)	Non-intenders (n=39)	Sig	Intenders (n=39)	Non-intenders (n=38)	Sig	Intenders (n=54)	Non-intenders (n=41)	Sig
Adopters (n)	26	11		33	13		37	21	
Adoption[1]	0.68	0.28	**	0.85	0.34	**	0.93	0.57	**
Attitudes[2]	1.83	-0.10	**	1.82	-0.36	**	1.49	-0.97	**
Perceived Norms[2]	0.51	-0.43	**	0.01	-0.73	**	1.12	0.04	**
Perceived behavioural control[2]	1.61	0.19	**	1.73	0.37	**	1.47	0.15	**
	Mulching			**Shallow weeding**			**Conservation Agriculture**		
	Intenders (n=63)	Non-intenders (n=13)	Sig	Intenders (n=48)	Non-intenders (n=29)	Sig	Intenders (n=34)	Non-intenders (n=42)	Sig
Adopters (n)	56	8		33	13		27	15	
Adoption[1]	0.89	0.62	*	0.69	0.45	*	0.79	0.36	**
Attitudes[2]	1.90	1.26	**	1.82	-0.76	**	1.90	0.73	**
Perceived Norms[2]	0.19	0.00		0.42	-0.78	**	-0.03	-0.19	
Perceived behavioural control[2]	1.73	0.47	**	1.79	0.53	**	1.76	0.88	**

[1] Dichotomous variable (0 or 1)
[2]Scale variable (-2 to 2)
Mann-Whitney test: **=significant at 0.01 level. *= significant at 0.05 level

Table VIII-2 Mean values of RAA variables for intenders and non-intenders in Madagascar

	Spraying herbicides			**Ploughing**			**Direct planting**		
	Intenders (n=62)	Non-intenders (n=18)	Sig	Intenders (n=66)	Non-intenders (n=14)	Sig	Intenders (n=43)	Non-intenders (n=37)	Sig
Adopters (n)	35	4		62	11		26	8	
Adoption[1]	0.56	0.22	**	0.94	0.79		0.60	0.22	**
A[2]	1.80	1.46	*	1.35	0.27	**	1.80	0.89	**
Inj. Norms[2]	1.35	1.43		0.96	0.12	**	1.16	0.52	**
Des. Norms[2]	1.11	0.96		1.69	1.18	**	0.18	0.13	
Social Norms[2]	1.23	1.20		1.33	0.65	**	0.67	0.33	
Perc. difficulty[2]	1.65	1.13	**	1.14	0.24	**	1.69	0.80	**
Perc. control[2]	1.69	1.39		1.79	1.65		1.65	1.74	
	Mulching			**Cover crops**			**Conservation Agriculture**		
	Intenders (n=37)	Non-intenders (n=43)	Sig	Intenders (n=43)	Non-intenders (n=37)	Sig	Intenders (n=30)	Non-intenders (n=50)	Sig
Adopters (n)	27	18		23	6		17	13	
Adoption[1]	0.73	0.42	**	0.53	0.16	**	0.57	0.26	**
A[2]	1.75	1.03	**	1.96	1.22	**	1.79	1.19	**
Inj. Norms[2]	1.12	0.65	*	1.24	0.88		1.15	0.77	*
Des. Norms[2]	-0.23	-0.48		0.23	0.08		-0.24	0.04	
Social Norms[2]	0.44	0.09	*	0.74	0.48		0.45	0.40	
Perc. difficulty[2]	1.53	0.04	**	1.74	0.72	**	1.52	0.83	**
Perc. control[2]	1.77	1.85		1.79	1.50		1.68	1.72	

[1] Dichotomous variable (0 or 1)
[2] 5-point likert item (-2 to 2)
Mann-Whitney test: **=significant at 0.01 level. *= significant at 0.05 level

Appendix IX Gross margin analyses comparing CA and conventional.

Gross margin analyses by two female farmers in Mazingira in Laikipia County of Kenya about growing a one acre crop of maize are given in Table IX-1, Table IX-2, Table IX-3 and Table IX-4. The FGD was done and the results described by Pound (2014).

Table IX-1 Gross margin analysis of a one acre maize crop (conventional) in Mazingira, Kenya (I)

Activity or input	K Sh
Slashing of weeds for land preparation	600
Ploughing (tractor)	3000
Digging holes	800
Seeds: 6 packets of 2kg at 240/packet	1440
Planting: 3 Mandays at 200	600
1st weeding: 4 mandays x 4 labourers at 250	4000
2nd weeding: 2 mandays x 4 labourers at 250	2000
3rd weeding: 2 mandays x 4 labourers at 250	2000
Harvesting: 5 mandays x 4 x 250	5000
Shelling: 5 bags at 100/90kg bag	500
5 bags at 30	150
Miscellaneous costs	500
Total cost of production	**20590**
Total revenues: 5 bags at 90 kgs at 20/kg	**9000**
GROSS MARGIN (LOSS)	**-11,590 K Sh**

Table IX-2 Gross margin analysis of a one acre maize crop (CA) in Mazingira, Kenya (I)

Activity or input	K Sh
Slashing of weeds for land preparation	600
Herbicide for pre-germination spray: 1 litre of glycel	600
Seed: 4 packets at 240	960
Direct planting (on contract with animal draft service providers)	1200
Spraying labour: 1 manday at 250	250
1st weeding: One litre 2-4D at 500	500
Spraying labour: 1 manday at 250	250
Dimethoate insecticide: 200ml at 200	200
Foliar vegetative spray: 500gms at 250	250
Spraying labour: 2 mandays at 250	500
2nd weeding (shallow weeder): 4 mandays at 250	1000
3rd weeding (shallow weeding) 2 mandays at 250	500
Harvesting: 6 mandays x 4 x 250	6000
Shelling: 7 bags at 100/90kg bag	700
7 bags at 30	210
Miscellaneous costs	250
Total cost of production	**12,970**
Total revenues: 7 bags at 90 kgs at 25/kg	**15,750**
GROSS MARGIN (PROFIT)	**2,780 K Sh**

Table IX-3 Gross margin analysis of a one acre maize crop (conventional) in Mazingira, Laikipia County, Kenya (II)

Activity or input	K Sh
Ploughing (ox-plough)	1,800
Harrowing	1,500
Seeds: 10 packets of 2kg at 240/packet	2,400
Planting: 3 Mandays at 150	450
1st weeding: 4 mandays x 4 labourers at 150	2,400
2nd weeding: 2 mandays x 4 labourers at 150	1,200
Harvesting: Cutting stover 2 mandays at 150	300
De-husking: 6 mandays x 2 x 150	1,800
Shelling: 5 mandays x 2 x 150	1,500
10 bags at 15	150
Miscellaneous costs	500
Total cost of production	**14,000**
Total revenues: 10 bags at 2,500	**25,000**
GROSS MARGIN (PROFIT)	**11,000 K Sh**

Table IX-4 Gross margin analysis of a one acre maize crop (CA) in Mazingira, Laikipia County, Kenya (II)

Activity or input	K Sh
Slashing of weeds for land preparation	400
Herbicide for pre-germination spray: 1 litre of weedall	800
Seed: 4 packets at 300	1,200
Fertiliser (50 kg DAP)	2,500
Direct planting (on contract with animal draft service providers)	1,500
Spraying labour	400
1st weeding: shallow weeder: 4 mandays at 250	1,000
2nd weeding: uprooting weeds: 2 mandays at 250	500
Topdressing (50kg CAN)	1,500
Application labour: 2 mandays at 250	500
Harvesting: 6 mandays x 2 x 250	3,000
Shelling: 15 bags at 80/90kg bag	1,200
15 bags at 40	600
Miscellaneous costs	500
Total cost of production	**15,600**
Total revenues: 15 bags at 3,000	**45,000**
GROSS MARGIN (PROFIT)	**29,400 K Sh**

Two gross margin analyses are presented below for Madagascar. It concerns growing 0.1 ha of rain fed rice on the *tanety*, in what the respondents in the FGD called 'conventional' and 'with CA'. For CA it was assumed that there was an intercrop of maize and *dolichos* in the previous season.

Table IX-5 Gross margin analysis with focus group about growing 0.1 ha of rice conventional and with CA in Mahatsara ('the South'), Alaotra region, Madagascar

Conventional rice	
Ploughing	8,000 Ar
Harrowing	8,000 Ar
Planting (à 3000 Ar/md)	12,000 Ar
Seeds (1 vata = 15kg)	15,000 Ar
Insector (seed treatment, 4 bags à 500 Ar for the seeds)	2,000 Ar
1st Weeding (8md)	24,000 Ar
2nd Weeding (6md)	18,000 Ar
3rd Weeding (4md)	12,000 Ar
Treatment herbicides	600 Ar
Harvest	3,000 Ar
Threshing and transport	22,000 Ar
Total Costs (3 weedings)	**125,100 Ar**
Harvest (30 vata, or 450 kg (~4,5t/ha) à 10000	300,000 Ar
Gross Margin (3 weedings)	**174,900 Ar**

CA rice (after Maize + Dolique)	
Preparation of field	Family labour
Glyphosate (herbicide, 0.5 liter)	7,000 Ar
Planting (à 3000 Ar/md)	12,000 Ar
Seeds (6kg)	6,000 Ar
Insector (seed treatment, 2 bags à 500)	1,000 Ar
NPK (fertilizer, 5kg à 2000)	10,000 Ar
2,4D (herbicide) + cypermethrine	2,200 Ar
Harvest	3,000 Ar
Threshing and transport	22,000 Ar
Total Costs	**63,200 Ar**
Harvest: 40 vata, or 600 kg (~6 t/ha) à 10000 Ar	400,000 Ar
Gross Margin (with compost)	**336,800 Ar**

Table IX-6 Gross margin analysis with focus group about growing 0.1 ha of rice conventional and with CA in Ambalakondro ('the North'), Alaotra region, Madagascar

Conventional rice	
Ploughing	10,000 Ar
Planting à 2500 Ar/md	10,000 Ar
Seeds (1 vata = 14kg)	10,000 Ar
Seed treatment insecticides	3,000 Ar
Bird watching	6,000 Ar
Compost (1 cart) + transport	9,000 Ar
1st Weeding	20,000 Ar
2nd Weeding	20,000 Ar
Harvest	5,000 Ar
Threshing and transport	10,000 Ar
Total Costs (2 weedings)	**103,000 Ar**
Harvest (25 vata, or 350 kg (~3,5t/ha) à 10000	250,000 Ar
Gross Margin (2 weedings)	**147,000 Ar**

CA rice (after Maize + Dolique)	
Preparation of field	Family labour
Planting à 2500 Ar/md	12,500 Ar
(Improved) Seeds (6kg)	10,200 Ar
Seed treatment insecticides	1,800 Ar
Bird watching	6,000 Ar
Compost * (1 cart) + transport	9,000 Ar
Harvest	5,000 Ar
Threshing and transport	10,000 Ar
Total Costs (with compost)	**54,500 Ar**
(early) Harvest: 30 vata, or 420 kg (~4 t/ha) à 11000 Ar	330,000 Ar
Gross Margin (with compost)	**275,500 Ar**

* in the group there was discussion whether compost would be necessary under CA, because there is already so much biomass and nutrients. In this exercise, compost was still added to the equation.

Appendix X Outcome-, normative- and control beliefs underlying attitudes, perceived norms and perceived behavioural control, for spraying herbicides, direct planting and mulching in Kenya

Spraying herbicides (SH)											
Outcome beliefs *i*		**Mean belief strength *b*** (-2 to 2)			**Mean evaluation *e*** (2 to 5)			***b* x *e*** (-10 to 10)			**Correlation with intention**
By spraying herbicide, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e* - Intention
A	reduce soil fertility	-0.95	-0.18	**	-4.16	-3.97		4.47	1.46	**	0.330**
	harm animals that eat the residues	-1.52	-0.76	**	-2.00	-2.00		3.00	1.54	**	0.391**
	reduce labour and drudgery	1.93	1.53	**	3.00	2.87		5.95	4.82		0.318**
	risk my own health	-0.91	-0.08	**	-2.00	-2.00		1.95	0.10	**	0.378**
	reduce the harvest	-1.57	-0.55	**	-2.00	-2.00		3.37	1.28	**	0.563**
	get rid of *all* the weeds	1.02	0.67		2.37	2.67		2.47	1.72		0.143
Injunctive normative beliefs *j*		**Mean normative belief *n*** (-2 to 2)			**Mean motivation to comply *m*** (-2 to 2)			***n* x *m*** (-4 to 4)			**Correlation with intention**
These people think I should practice SH:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m* - Intention
Inj. N	household members	1.88	0.02	**	1.49	1.18		2.86	-0.02	**	0.591**
	neighbours	0.68	-0.08	**	-0.11	-0.04		0.43	0.27		0.148
	CA FFS	1.81	1.02	**	1.05	0.57	*	2.38	1.19	**	0.326**
	other groups	0.68	-0.16	**	-0.14	-0.08		0.16	-0.02		0.150
	extension	0.77	0.48		0.27	0.04	*	2.74	2.22		0.205
	service providers	1.62	1.41		1.64	1.18		0.98	0.53		0.208*
Descriptive normative beliefs j’		**Mean normative belief *n’*** (-2 to 2)			**Mean motivation to comply *m’*** (-2 to 2)			***n’* x *m’*** (-4 to 4)			**Correlation with intention**
These people actually practice SH:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m’* - Intention
Des. N	household members	1.05	-1.25	**	1.49	1.18		1.74	-1.14	**	0.487**
	neighbours	-0.02	-0.59	**	-0.11	-0.04		0.18	0.12		0.028
	CA FFS	1.16	-0.03	**	1.05	0.57	*	1.82	0.78	**	0.364**
	other groups	-0.34	-0.71		-0.14	-0.08		0.25	0.16		0.070
Control beliefs *k*		**Mean belief strength *c*** (-2 to 2)			**Mean perceived power *p*** (0-3)			***c* x *p*** (-6 to 6)			**Correlation with intention**
If I wanted to spray herbicides, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p* - Intention
PBC	know which to use	1.50	-0.41	**	2.08	1.79		3.08	-1.21	**	0.613**
	know when & how to use	1.70	-0.20	**	1.61	1.64		2.92	-0.03	**	0.556**
	have enough money	1.68	-0.02	**	1.66	1.85		1.82	-0.08	**	0.406**
	have equipment	1.69	0.55	**	0.68	0.38		0.92	0.33		0.237*

Direct planting (DP)											
Outcome beliefs *i*		**Mean belief strength *b*** (-2 to 2)			**Mean evaluation *e*** (2 to 5)			***b* x *e*** (-10 to 10)			**Correlation with intention**
By practicing direct planting I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e* - intention
A	reduce labour and drudgery	1.98	1.31	**	3.05	2.82		6.00	3.76	*	0.286*
	reduce weeds on the field	1.71	0.33	**	2.51	2.53		4.23	0.68	**	0.475**
	increase harvest	1.56	0.02	**	4.03	3.92		6.31	-0.37	**	0.656**
	improve infiltration	1.80	-0.04	**	3.05	2.76		5.67	-0.24	**	0.681**
	reduce evaporation	1.88	0.11	**	3.05	2.76		5.82	0.32	**	0.708**
	improve soil structure	1.78	-0.13	**	2.77	2.61		5.10	0.08	**	0.654**
Injunctive normative beliefs *j*		**Mean normative belief *n*** (-2 to 2)			**Mean motivation to comply *m*** (-2 to 2)			***n* x *m*** (-4 to 4)			**Correlation with intention**
These people think I should practice DP:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m* - intention
Inj N	household members	1.83	-0.25	**	1.50	1.04	*	2.98	-0.15	**	0.553**
	neighbours	0.44	-0.39	**	0.07	-0.34	*	0.93	0.43		0.184
	CA FFS	1.69	0.81	**	1.38	0.40	**	2.62	1.09	**	0.420**
	other groups	0.61	-0.44	**	0.10	-0.28		0.73	0.04	**	0.304**
	extension	1.78	1.16	**	1.63	1.00	**	3.07	1.61	**	0.397**
	service providers	0.02	-0.80	**	0.05	-0.33		1.10	0.33		0.187
Descriptive normative beliefs j'		**Mean normative belief *n'*** (-2 to 2)			**Mean motivation to comply *m'*** (-2 to 2)			***n'* x *m'*** (-4 to 4)			**Correlation with intention**
These people actually practice direct planting		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m'* - intention
Des. N	household members	0.88	-1.06	**	1.50	1.04	*	2.10	-0.82	**	0.506**
	neighbours	-0.32	-0.78	**	0.07	-0.34	*	0.32	0.49		-0.076
	CA FFS	1.21	-0.03	**	1.38	0.40	**	2.16	0.53	**	0.453**
	other groups	-0.37	-0.75	*	0.10	-0.28		0.46	0.19		0.085
Control beliefs *k*		**Mean belief strength *c*** (-2 to 2)			**Mean perceived power *p*** (0-3)			***c* x *p*** (-6 to 6)			**Correlation with intention**
If I wanted to practice direct planting, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p* - intention
PBC	have money	1.12	0.35	**	1.41	1.47		1.21	0.32	*	0.235*
	have equipment	1.41	0.35	**	1.00	1.13		1.21	0.37		0.193
	have labour	1.39	0.69	**	0.67	0.68		0.79	0.37		0.143
	have knowledge	1.46	-0.13	**	1.79	1.53		2.64	-0.05	**	0.484**
	have favourable soils	0.27	-0.24		1.08	0.84		0.51	-0.76	**	0.323**

Mulching (M)											
Outcome beliefs *i*		**Mean belief strength *b*** (-2 to 2)			**Mean evaluation *e*** (2 to 5)			***b* x *e*** (-10 to 10)			**Correlation with intention**
By mulching, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e* - Intention
A	improve fertility	1.96	1.72	**	4.05	4.15		7.98	6.92		0.158
	improve soil structure	1.95	1.72	**	2.78	2.23		5.47	3.77	**	0.340**
	reduce weeding time	1.70	1.33	*	2.53	2.46		4.47	2.92	*	0.253*
	reduce erosion	1.96	1.78	**	2.14	2.46		4.20	4.00		-0.005
	improve soil moisture	1.87	1.72	*	2.83	3.31		5.42	5.77		0.007
	reduce evaporation	1.95	1.78	*	2.83	3.31		5.55	5.92		-0.007
Injunctive normative beliefs *j*		**Mean normative belief *n*** (-2 to 2)			**Mean motivation to comply *m*** (-2 to 2)			***n* x *m*** (-4 to 4)			**Correlation with intention**
These people think I should mulch:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m* - Intention
Inj. N	household members	1.69	0.39	**	1.34	1.28	ns	2.81	0.72	**	,382**
	neighbours	0.44	-0.17	*	-0.10	0.22		0.73	0.22		0.080
	CA FFS	1.51	0.88	*	0.97	1.00		2.14	1.31		0.174
	other groups	0.47	-0.22	*	-0.01	0.11		0.55	0.11		0.097
	extension officers	1.68	1.06	*	1.71	1.29	**	3.18	1.47	**	,319**
Descriptive normative beliefs j'		**Mean normative belief *n'*** (-2 to 2)			**Mean motivation to comply *m'*** (-2 to 2)			***n'* x *m'*** (-4 to 4)			**Correlation with intention**
These people practice mulching:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m'* - Intention
Des. N	household members	1.30	-0.89	**	1.34	1.28		2.45	0.22	**	,397**
	neighbours	-0.18	-0.83	**	-0.10	0.22		0.36	0.28		0.042
	CA FFS	1.17	0.38	**	0.97	1.00		2.23	0.85	**	,337**
	other groups	-0.17	-0.67	*	-0.01	0.11		0.33	0.27		0.027
Control beliefs *k*		**Mean belief strength *c*** (-2 to 2)			**Mean perceived power *p*** (0-3)			***c* x *p*** (-6 to 6)			**Correlation with intention**
If I wanted to mulch, I would be sure there is…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p* - Intention
PBC	no unauthorised grazing	1.99	1.56	**	1.53	0.69	*	3.67	2.00	*	,238*
	enough biomass	1.29	0.39	**	1.70	2.08		2.55	-0.08	**	,365**
	firewood (without the residues)	1.56	0.94	*	0.91	1.15		2.44	0.92		0.206
	fodder (without the residues)	1.10	0.33	*	1.41	1.77		2.28	0.92		0.129

Appendix XI Outcome-, normative- and control beliefs underlying attitudes, perceived norms and perceived behavioural control, for spraying herbicides, direct planting, mulching and planting cover crops in Madagascar

Spraying Herbicides (SH)											
Outcome beliefs *i*		**Mean belief strength *b*** (-2 to 2)			**Mean evaluation *e*** (2 to 5)			***b* x *e*** (-10 to 10)			**Correlation with intention**
By spraying herbicide, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e* - Intention
A	reduce soil fertility	-1.61	-1.87		-3.77	-4.30		6.14	8.09	*	0.216*
	reduce labour and drudgery	1.41	1.09		2.35	2.78	*	3.22	3.13		0.016
	risk my own health	-1.41	-1.00		-2.00	-2.00		2.81	2.00		-0.139
	get rid of *all* the weeds	1.22	1.26		2.51	2.48		2.93	3.30		0.025
	Reduces expenses	1.39	0.74	*	3.43	3.13		4.77	1.87	*	0.265*
	reduce the harvest	-1.70	-0.96	**	-4.81	-4.78		8.03	4.70	**	0.289**
Injunctive normative beliefs *j*		**Mean normative belief *n*** (-2 to 2)			**Mean motivation to comply *m*** (-2 to 2)			***n* x *m*** (-4 to 4)			**Correlation with intention**
These people think I should practice SH:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m* - Intention
Inj. N	household members	1.69	1.40	*	1.29	1.30		2.29	2.05		0.081
	neighbours	0.88	0.73		0.07	0.17		0.66	0.86		-0.063
	(CA) groups	1.65	2.00		1.29	0.63		2.42	2.00		0.042
	village leaders	0.60	0.50		-0.17	0.09		0.03	0.55		-0.095
Descriptive normative beliefs j'		**Mean normative belief *n'*** (-2 to 2)			**Mean motivation to comply *m'*** (-2 to 2)			***n'* x *m'*** (-4 to 4)			**Correlation with intention**
These people actually practice SH:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m'* - Intention
Des. N	household members	0.55	-0.09		1.29	1.30		1.24	0.43		0.138
	neighbours	0.51	0.22		0.07	0.17		0.51	0.83		-0.062
	(CA) groups	1.64	1.43		1.29	0.63		2.64	1.86		0.148
	village leaders	0.24	-0.22		-0.17	0.09		0.20	0.65		-0.115
Control beliefs *k*		**Mean belief strength *c*** (-2 to 2)			**Mean perceived power *p*** (0-3)			***c* x *p*** (-6 to 6)			**Correlation with intention**
If I wanted to spray herbicides, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p* - Intention
PBC	know which to use	1.41	0.78	*	2.03	2.09		2.77	1.35		0.180
	know when & how to use	1.58	0.91	*	1.00	1.35		1.49	1.13		0.082
	have enough money	0.99	0.48	*	2.05	1.91		2.07	0.70	**	0.273**
	have equipment	1.28	1.65		0.89	0.52		1.41	0.83		0.099
	other				1.41	1.93	*				

Direct planting (DP)											
Outcome beliefs *i*		**Mean belief strength *b*** (-2 to 2)			**Mean evaluation *e*** (2 to 5)			***b* x *e*** (-10 to 10)			**Correlation with intention**
By practicing direct planting I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e* - Intention
A	reduce labour and drudgery	1.08	0.78		2.53	2.22		2.55	1.78		0.158
A	reduce weeds on the field	-0.45	0.27	*	2.43	2.59		-1.08	0.87	*	-0.257*
A	improve soil moisture	1.27	0.49	**	3.98	3.80		5.18	2.00	**	0.363**
A	improve harvest	1.35	0.27	**	4.71	4.91		6.43	1.36	**	0.427**
A	improve soil structure	1.16	0.47	**	2.67	2.78		3.18	1.18	**	0.290**
A	improve soil fertility	1.32	0.67	**	3.65	4.17	*	4.76	2.93		0.192
Injunctive normative beliefs *j*		**Mean normative belief *n*** (-2 to 2)			**Mean motivation to comply *m*** (-2 to 2)			***n* x *m*** (-4 to 4)			**Correlation with intention**
These people think I should practice DP:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m* - Intention
Inj. N	household members	1.56	0.46	**	0.96	1.33		1.40	0.72		0.171
Inj. N	neighbours	0.55	0.27		-0.33	-0.02		0.00	0.29		-0.042
Inj. N	(CA) groups	2.00	1.00	**	1.52	1.25		3.03	1.71		0.308
Inj. N	village leaders	0.39	0.07		-0.25	-0.12		-0.08	0.12		-0.101
Descriptive normative beliefs j'		**Mean normative belief *n'*** (-2 to 2)			**Mean motivation to comply *m'*** (-2 to 2)			***n'* x *m'*** (-4 to 4)			**Correlation with intention**
These people actually practice DP:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m'* - Intention
Des. N	household members	-0.10	-0.57		0.96	1.33		0.17	-0.76		0.176
Des. N	neighbours	-0.27	-0.33		-0.33	-0.02		0.63	0.13		0.168
Des. N	(CA) groups	1.33	1.14		1.52	1.25		2.24	1.14		0.209
Des. N	village leaders	-0.41	-0.64		-0.25	-0.12		0.16	0.00		0.064
Control beliefs *k*		**Mean belief strength *c*** (-2 to 2)			**Mean perceived power *p*** (0-3)			***c* x *p*** (-6 to 6)			**Correlation with intention**
If I wanted to practice direct planting, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p* - Intention
PBC	have money	0.94	0.54	*	2.22	2.09		1.86	1.04		0.183
PBC	have labour	1.67	1.04	**	0.84	0.96		1.32	0.93		0.112
PBC	have knowledge	1.80	0.40	**	2.18	2.35		3.78	0.83	**	0.295**
PBC	have equipment	1.60	1.24		0.82	0.59		1.30	0.57	*	0.190
PBC	other				1.41	1.93	*				

Mulching (M)											
Outcome beliefs *i*		**Mean belief strength *b*** (-2 to 2)			**Mean evaluation *e*** (2 to 5)			***b* x *e*** (-10 to 10)			**Correlation with intention**
By mulching, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e* - Intention
A	improve moisture	1.93	1.58	**	3.98	3.83		7.65	6.23		0.199*
	increases pests	0.63	1.13		2.58	2.26		1.70	2.60		-0.107
	improves fertility & structure	1.81	1.32	**	3.08	3.49	**	5.63	4.44		0.147
	increases labour	-0.37	1.35	**	2.33	2.56		-1.12	3.50	**	-0.570**
	reduces erosion	1.53	1.36		2.72	2.46		4.23	3.26		0.155
	reduces weeds	0.47	0.47		2.56	2.46		1.26	1.11		0.006
Injunctive normative beliefs *j*		**Mean normative belief *n*** (-2 to 2)			**Mean motivation to comply *m*** (-2 to 2)			***n* x *m*** (-4 to 4)			**Correlation with intention**
These people think I should practice mulching:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m* - Intention
Inj. N	household members	1.76	0.33	**	1.00	1.38	*	1.63	0.67		0.176
	neighbours	0.44	0.27		-0.37	0.19	*	0.42	0.39		-0.027
	(CA) groups	1.09	0.00	**	1.27	1.41		2.55	0.00	**	0.470**
	village leaders	0.44	0.10	**	-0.42	0.14	*	-0.19	0.06		-0.081
Descriptive normative beliefs j'		**Mean normative belief *n'*** (-2 to 2)			**Mean motivation to comply *m'*** (-2 to 2)			***n'* x *m'*** (-4 to 4)			**Correlation with intention**
These people actually practice mulching:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m'* - Intention
Des. N	household members	-0.34	-1.06	**	1.00	1.38	*	-0.54	0.58	**	-0.272**
	neighbours	-0.49	-0.89	*	-0.37	0.19	*	0.09	0.16		-0.024
	(CA) groups	1.09	-0.50	**	1.27	1.41		2.18	1.00	*	0.320*
	village leaders	-0.56	-0.96	*	-0.42	0.14	*	-0.30	0.06	*	-0.216*
Control beliefs *k*		**Mean belief strength *c*** (-2 to 2)			**Mean perceived power *p*** (0-3)			***c* x *p*** (-6 to 6)			**Correlation with intention**
If I wanted to mulch, I would be sure there is…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p* - Intention
PBC	no unauthorised grazing	0.42	0.43		2.40	2.09		0.72	0.47		0.081
	enough biomass	1.23	0.49	**	2.19	2.19		2.72	1.34	*	0.256*
	fodder (without the residues)	1.67	1.04	*	0.30	0.32		0.59	0.11		0.199
	means of transport	0.97	0.92		0.70	1.23		0.78	0.92		-0.097

Planting cover crops (CC)											
Outcome beliefs *i*		**Mean belief strength *b*** (-2 to 2)			**Mean evaluation *e*** (2 to 5)			***b* x *e*** (-10 to 10)			**Correlation with intention**
By planting a cover crop, I would…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*b.e* - Intention
A	improve moisture	1.96	1.71	*	3.94	3.86		7.70	6.59		0.175
	increase pests	0.83	0.61		2.53	2.28		2.40	1.53		0.148
	improve fertility & structure	1.87	1.43	**	3.17	3.44		5.95	4.96		0.074
	get more income	1.60	1.39		2.00	2.00		3.19	2.78		0.147
	reduce weeds	0.51	0.59		2.40	2.60		1.38	1.55		-0.018
Injunctive normative beliefs *j*		**Mean normative belief *n*** (-2 to 2)			**Mean motivation to comply *m*** (-2 to 2)			***n* x *m*** (-4 to 4)			**Correlation with intention**
These people think I should practice cover crops:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n.m* - Intention
Inj. N	household members	1.84	0.82	**	1.48	1.45		2.80	1.59	**	0.292**
	neighbours	0.60	0.60		-0.02	0.06		-0.02	0.85	*	-0.241*
	(CA) groups	1.77	1.00	*	1.60	0.60	*	2.97	2.00		0.238
	village leaders	0.49	0.13		0.00	-0.13		0.11	0.17		0.04
Descriptive normative beliefs j'		**Mean normative belief *n'*** (-2 to 2)			**Mean motivation to comply *m'*** (-2 to 2)			***n'* x *m'*** (-4 to 4)			**Correlation with intention**
These people actually practice cover crops:		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*n'.m'* - Intention
Des. N	household members	-0.41	-0.55		1.48	1.45		-0.32	-0.61		0.062
	neighbours	-0.53	-0.31		-0.02	0.06		0.49	0.96	*	-0.207*
	(CA) groups	1.29	1.00		1.60	0.60	*	2.29	1.60		0.157
	village leaders	-0.60	-0.53		0.00	-0.13		0.49	0.28		0.085
Control beliefs *k*		**Mean belief strength *c*** (-2 to 2)			**Mean perceived power *p*** (0-3)			***c* x *p*** (-6 to 6)			**Correlation with intention**
If I wanted to plant cover crops, I would be sure there is…		Intenders	Non-Intenders	Sig.	Intenders	Non-intenders	Sig.	Intenders	Non-intenders	Sig.	*c.p* - Intention
PBC	CCco seeds	1.79	0.33	**	2.15	2.27		3.79	0.78	**	0.522**
	CCco money	1.40	0.31	**	2.02	2.10		2.91	0.65	**	0.394**
	CCco knowledge	1.70	0.51	**	1.21	1.22		2.06	0.10	**	0.364**
	CCco climate	0.89	0.28	*	0.55	0.35		0.66	0.28		0.185
	CCco Other				0.02	0.10					