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Lund University Master of Science in
International Development and Management
August, 2013

- A Case Study on Conservation Agriculture
Adoption in Northern Mozambican Province Nampula

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Abstract

The thesis addresses adoption of conservation agriculture in the northern Mozambican province Nampula. In a situation of food insecurity and increasing pressure on land with soil erosion and reduced yields as a result, conservation agriculture is promoted as an agriculture approach which is environmentally sustainable and which also has potential to improve farmers' livelihoods. The adoption of conservation agriculture is currently limited in Sub-Saharan Africa and by applying a case study design, the thesis aims to contribute to a better understanding of why smallholder farmers adopt conservation agriculture.

The theoretical framework is based in Rogers' Diffusion of Innovations theory and the research question has been explored by conducting qualitative research in four villages where the international humanitarian agency CARE has been introducing Conservation Agriculture. Findings suggest that farmers in the studied villages adopt and also continue to adopt conservation agriculture, but that their adoption is not identical to the one taught in CARE's programmes. Farmers are instead re-inventing the principles according to their own preferences and capacities. Despite a partial adoption farmers have been able to increase yields and the rather immediate increasing yields is also found to be the main reason to why farmers become persuaded to adopt conservation agriculture.

Keywords: Conservation Agriculture, technology adoption/ diffusion of innovation, Mozambique, Africa, qualitative research

Word count: 14 805

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Acknowledgments

I owe my humblest gratitude to a number of people who have been invaluable for this process of good and bad moments.

First of all I want to express my gratitude to CARE Mozambique and all the amazing people I had the opportunity to work with during my fieldwork. Thank you for giving me the possibility to conduct this study and for all advice and support during my time in field. A special thank you goes to Nicholas Dexter, my supervisor at CARE, who always supported me. I also would like to thank all participants in Namotekeliua, Nakulue, Namaponda and Namizope who shared their time and stories with me and patiently answered my many questions.

I would also like to thank my supervisor at Lund University, María Andrea Nardi for all your support and comments along the process. I very much appreciate your critical questions which always made me think deeper and question and clarify my ideas. Also a great thank you to my wonderful thesis group and my faithful thesis writing peers who have been struggling with me in the library during the past months. Thank you for your support and good feedback.

My final thanks go to my amazing family who always supports me when I decide to take off and live on the other side of the world. Without your support this study would also not have been possible.

List of Abbreviations

AESA	Agro-Ecosystem Analyses
CA	Conservation Agriculture
CARE	Cooperative for Assistance and Relief Everywhere
CAWG	Conservation Agriculture Working Group
CLUSA	Cooperative League of the USA
DANIDA	Danish International Development Agency
FAO	Food and Agriculture Organization of the United Nations
FFS	Farmer Field School
GTZ	German Technical Cooperation
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IFAD	International Fund for Agricultural Development
IIAM	Agrarian Research Institute of Mozambique (Instituto de Investigação Agrária de Moçambique)
IITA	International Institute for Tropical Agriculture
MDG	Millennium Development Goals
MINAG	Ministry of Agriculture
MMDA	Mozambique's Ministry for District Administration
NGO	Non-Governmental Organization
PARTI	Platform for Agricultural Research and Technology Innovation
PRA	Participatory Rural Appraisal
P&S	Primerias e Segundas (First and Seconds) ¹
SIDA	Swedish International Development Cooperation Agency
SSA	Sub-Saharan Africa
VIDA	Viable Initiative for the Development of Agriculture
WHO	World Health Organization
WWF	World Wide Fund for Nature

¹ Referring to a popular name of a group of islands where P&S works

1. INTRODUCTION

Mozambique is according to United Nations Human Development Index² one of the world's poorest countries. Poverty is particularly severe in rural areas, where more than 70% of the population live (IFAD 2013; MICS 2008; Mole 2006). With a predominantly rural population and agriculture as main source of employment and livelihood base, Mole (2006:6) states that “agriculture is critical to poverty reduction in Mozambique”. IFAD, the International Fund for Agricultural Development, further states in their Rural Poverty Report (2011:148) that for smallholder agriculture to be a way out of poverty “it must be an agriculture that is productive, profitable and sustainable”.

At present, agriculture is Mozambique's main source of employment and 95% of used farmland is cultivated in small scale by farmers who mainly produce for household consumption (Mole 2006; Tarp et al. 2002). Food productivity is low and many farming households face food insecurity. The on-going land degradation in Sub-Saharan Africa (SSA) and smallholder farmers' reliance on natural resources for their livelihoods generates vicious circles as farmers become forced to increase the pressure on land to maintain production levels. This affects farmers' livelihoods as well as the environment (Cypher and Dietz 2009:348; IFAD 2011:15; Koohafkan et al. 2011:62). According to Nkala et al. (2011:758), these issues are particularly intense in countries like Mozambique where “land scarcity, increasing population pressure, poorly targeted agricultural policies and agricultural management strategies exacerbate the problem”.

As a response to this, there has at international level during the last 20 years been an increasing call for agriculture approaches which are environmentally sustainable³ (Koohafkan et al. 2011; Staatz and Eicher 1998:30) and one of them is Conservation Agriculture (CA) (IFAD 2011; Koohafkan et al. 2011; Reardon 1998). Apart from being a more environmentally sustainable approach it has also been promoted as a means to improve smallholders' livelihoods (FAO 2012). CA is based on three interlinked principles which

² The index measures three dimensions of human development, namely a long and healthy life, access to knowledge and a decent standard of living, which are represented by life expectancy, mean year of schooling for the adult population together with expected years of schooling for children and BNI per capita. The index compares 187 countries, where in 2013 Mozambique was ranked as number 185 (UNDP 2013).

³ Concepts such as Low-Input Sustainable Agriculture, Sustainable Agricultural Intensification, Sustainable Land Management and Green Agriculture are examples of approaches which aim to generate sustainable solutions for how to face the number of challenges connected to agriculture, sustainable resource use and poverty reduction (IFAD 2011; Koohafkan et al. 2011; Reardon 1998).

according to the Food and Agriculture Organization of the United Nations' (FAO) (2012) definition incorporates: 1) Minimal soil disturbance (reduced or no-tillage), 2) Permanent soil cover and 3) Crop rotation or intercropping. The spread of CA in African smallholder systems is encouraged by a number of prominent development organizations with an agenda for rural development⁴ (Milder et al. 2011:20). Among these organizations are the international humanitarian agency CARE together with its alliance partner WWF. The broad promotion of CA adoption among smallholder farmers in SSA has however been criticized by Giller et al. (2009) for not being sufficiently researched.

Against this background and with the belief that it is important to better understand the targeted farmers' perceptions and experiences of CA, this case study approaches the issue about CA's suitability by asking *why* it is adopted. This is perceived as a relevant approach since it is ultimately farmers who use CA in their daily lives. More specifically, by using the case of smallholder farmers in four villages in the Northern Mozambican province Nampula, where CARE has been working with CA, this study aims to explore:

Why do smallholder farmers in Nampula province adopt Conservation Agriculture?

The following sub-questions will be used to answer this question

- How is Conservation Agriculture perceived by farmers?
- How are farmers adopting Conservation Agriculture?
- Which are the main constraints in farmers' adoption of Conservation Agriculture?
- How are farmers gaining knowledge about Conservation Agriculture?

Research has been conducted over CA adoption in different farming systems, and also in different locations in Mozambique⁵. Yet, according to Grabowski and Mouzinho's (2013) inventory report, the concentration of studies on CA in Mozambique is found in the provinces Manica and Sofala. Fewer studies have been conducted in northern Mozambique where Nampula is located. This study is therefore intended as a contribution to the broader understanding of CA adoption in a northern Mozambican completely manual, smallholder

⁴ These organizations include the Food and Agriculture Organization of the United Nations (FAO), the International Fund for Agricultural Development (IFAD), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Institute for Tropical Agriculture (IITA), the German Technical Cooperation (GTZ), the Swedish International Development Cooperation Agency (SIDA) and the Danish International Development Agency (DANIDA) (Milder et al. 2011).

⁵ For example Grabowski and Kerr (2013) in Tetê province, Dambiro et al. (2011) in Cabo Delgado, Nkala et al. (2011) in Manica and Sofala, Nkala et al. (2011) in Manica and Sofala and Thierfelder (2012) in Manica, Sofala and Tetê.

farming system. Nampula is specifically chosen as research site due to the opportunity to conduct research in villages where CA with a similar approach has been introduced over a relatively long time-period. This enables the study to understand adoption with a time perspective.

Applying a qualitative research method based on individual and group interviews, different perceptions and adoption behaviours of CA found in the four studied villages in Northern Mozambique have been mapped out. Due to this, the study has a rather descriptive character which through its in-depth analysis is intended to be used when further developing and adapting CA in northern Mozambique, and possibly also in other parts of SSA with a similar context. A theory which explains diffusion of innovations in a social system is used to explore individual households' CA adoption, thereby recognizing that households are part of a social structure which affects the individual households' behaviours and possibilities. To delimitate the study, farmers' CA adoption will be considered from a livelihood perspective rather from a biophysical. Lastly, different extension methods can be used when implementing innovations like CA and it is recognized that the extension methodology used is important for its adoption. Yet also this aspect falls outside the scope of this study.

Disposition of the paper

The study is structured in the following manner. Chapter two provides a contextual background to the area of study in terms of geography, agriculture and livelihoods together with a deeper understanding of the concept of CA and the two development programs. Chapter three lays out the theoretical framework which mainly is based on Rogers' Diffusions of Innovations theory. Chapter four explains the methodology applied while the analysis is presented in chapter five where the research question is being answered. The analysis is divided into three sub-sections where farmers' perceptions about CA are explored in the first section. The second section explores how CA is being adopted and the third why it is adopted and also includes adoption constraints. The last chapter, number six, concludes the findings.

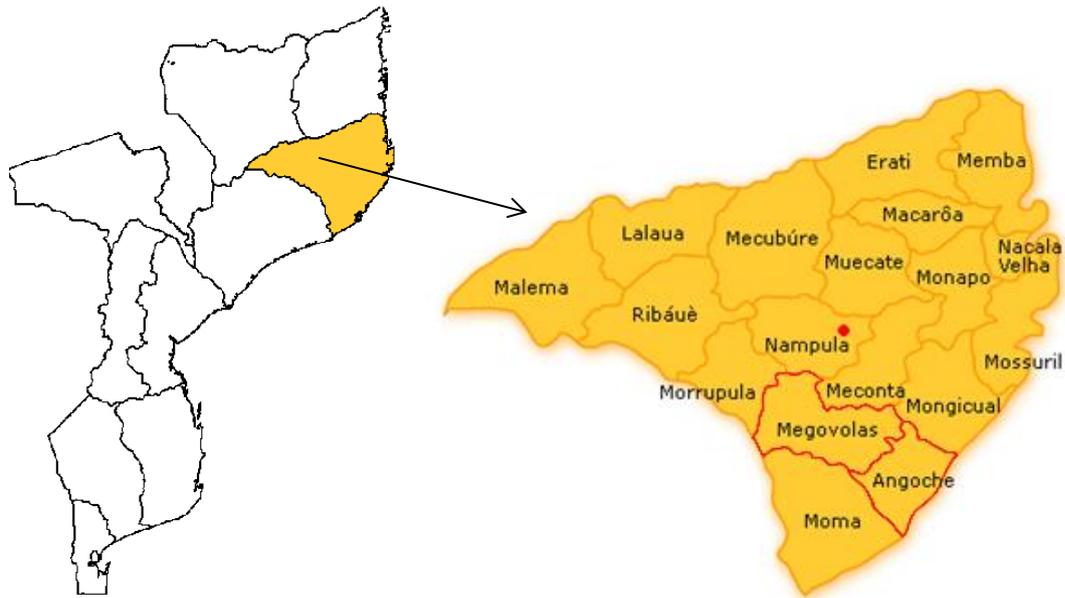
2. PLACING THE STUDY IN CONTEXT

This section intends to give an introduction to the context in which this study is conducted and contains of four sub-sections and provides a background to the geography and demography, the agriculture and rural livelihoods in Nampula, Conservation Agriculture and the two development programs through which CA is introduced.

2.1. Geography and demography

The four villages where the fieldwork takes place are located in the province Nampula in Northern Mozambique. Two of the villages are located in the inland district Mogovolas and two in costal Angoche (see maps below). In the last census from 2007, a total of 3,985,285 inhabitants were registered in Nampula. The province is Mozambique's second most populated with an average population density of 50 inhabitants per square kilometre (PEP 2010:13).

The district Angoche is relatively densely populated with, in 2005, 82.5 inhabitants per square kilometre and a total of 273,000. In the district were in the same year 55,000 agriculture holdings registered with an average land size of 0.7 hectares. Soils are sandy and the climate is dry and sub-humid with a yearly precipitation average of 800–1,000 mm (MMDA 2005a). Mogovolas has a slightly lower population density than the province average with its 46 inhabitants per square kilometre and a total of 218,812. Close to 51,000 agriculture holdings were registered in 2005 and the average land size was 1 hectare. Soils are of mixed types and the climate is semi-arid and sub-humid with precipitation ranging between 800-1,200 mm per year (MMDA 2005b).



Maps 1 and 2: Map 1 (to the left) illustrates the administrative borders of Mozambique and the highlighted province is Nampula. Map 2 (to the right) portrays Nampula province and its division into districts. The two districts marked with red are Mogovolás and Angoche. Sources: Map 1 maplibrary.org and Map 2 <http://www.nampula.gov.mz/informacao/perfil-dos-distritos/>

Mogovolás

Namotekeliua⁶

Namotekeliua is located 19 kilometres from the district Mogovola’s capital Nametil and consists of 93 households (Interview with village secretary).

Nakulue

Nakulue is located 37 kilometres from Nametil and 62 kilometres from Angoche (the district capital in Angoche district) and consists of 103 households (Interview with village secretary).

Angoche

Namizope

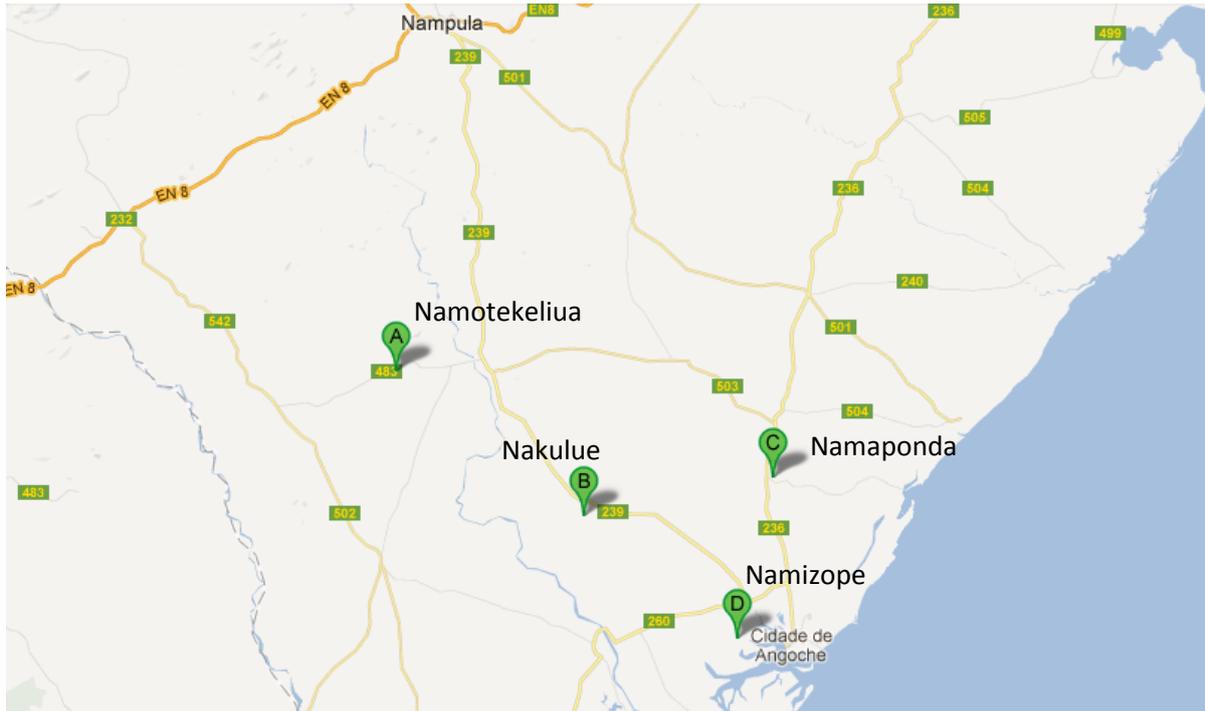
Namizope is located 37 kilometres from Nametil and 62 kilometres from Angoche (following the road) and only 6 kilometres from the sea. 126 households are registered in the village (Interview with village demonstrator).

Namaponda

Namaponda is located 36 km from Angoche, but on a more accessible road than Namizope. Unfortunately there is no available data of the number of households.

Table 1: Location and number of households in the four studied villages

⁶ Namotekeliua is a neighbourhood (*bairro*) in the village Rieque. In order to limit the geographical area, only households in the specific neighbourhood Namotekeliua are included in the study and the name Namotekeliua will therefore be used throughout the paper.



Map 3: Location of the villages Namotekeliua, Nakulue, Namaponda and Namizope
 Source: Google maps

2.2. Agriculture and rural livelihoods in Nampula

Sixty per-cent of the population in Angoche and also in Mogovolas lived in poverty in 2003⁷ (MMDA 2005a:37; MMDA 2005b:36). In Angoche, 85% of the labour force is engaged in agriculture and in Mogovolas it is as many as 97%. (MMDA 2005a:36; MMDA 2005b:35). The crops and animals farmers produce⁸ constitutes the base of most rural livelihoods. Naturally, in villages with proximity to the sea fishing is another important source of livelihood, which is the case in Namizope. To this should be added that markets are influenced by high transportation costs and buyers' control of prices, which affects farmers' income possibilities (Coughlin 2006; Mole 2006). Agricultural productivity is, as in the rest of the country, low in both districts and due to the risk of drought and restricted usage of irrigation, there is a constant risk for crop failure (MMDA 2005a; MMDA 2005b). As a result, farmers in the both districts experience an average of 2.5 months of food shortage per year (MMDA 2005a and MMDA 2005b).

⁷ Mozambique's national poverty line is defined as living under USD 2 per day (Fox et al 2005:2)

⁸ From individual interviews with farmers I found that the crop most commonly sold for cash is groundnuts (and also sesame in Namizope).

As with 80% of Mozambique's agriculture activity, farming in Nampula province is mainly family based, manual and rain-fed (Nakala et al. 2011; MMDA 2005a; MMDA 2005b). Farmers use hand-hoes and machete as main agricultural tools and in 2006 animal traction was used on a mere 0.2% of farm land in the province. Also the usage of inputs such as pesticides, fertilizers and irrigation is low⁹ (Mole 2006:11-12; MINAG 2008). The manual and low input character of agriculture activities makes labour a primary constraint for agricultural production (Mole 2006; Todaro and Smith 2009). To increase production, farmers with more resources can, in exchange for food, hire the more resource poor farmers' labour. Apart from this system, referred to as *ganho-ganho*, labour is restricted to household members (Dexter 2005).

State supported agriculture extension is deficient in Mozambique and the main actors providing technical support to farmers are currently NGOs and cash crop companies via outgrower schemes (Uaiene 2011), which in the case of Nampula mainly is connected to cotton cultivation (Interview with agricultural specialist).

2.3. Conservation Agriculture (CA)

Being focused on soil conservation, CA is born from the no-tillage movement which started in the 1930's in the USA (Friedrich 2011; Hobbs 2008). Today, CA has its broadest adoption in North and South America, and is so far only marginally adopted in Africa¹⁰ (Derpsch and Friedrich 2009:11-12). It should be noted that although CA is promoted as a production increasing set of environmentally sustainable farming principles, CA should not be equalized to organic or ecological agriculture. Instead, just like other smallholder farming, it can be practiced with or without chemical inputs¹¹. Such inputs are however usually applied in a more limited extent than in conventional farming.

With the combined adoption of the three CA principles minimal soil disturbance (reduced or no-tillage), permanent soil cover and crop rotation or intercropping, CA is intended to improve water, soil and plant conservation through increased water infiltration and soil moisture, reduced soil erosion and increased soil fertility (Hobbs et al. 2008, Kassam and

⁹ More specifically, on cultivated land is pesticides applied on 3%, herbicides on 2% and irrigation 6%. The applied chemicals are mainly used for cotton cultivation, which is the region's traditional cash crop.

¹⁰ According to (Derpsch and Friedrich 2009:11-12) is the majority, or 84.6% of land under minimum tillage, which by the authors is used as a proxy for CA, found in North and South America and only 3.7% is found in Africa, Asia and Europe together.

¹¹ In the USA, Brazil and Argentina, CA is usually practiced with fertilizers and herbicides and is also to a large extent mechanized (Hobbs et al. et al. 2008:548).

Friedrich 2011; Milder et al. 2011; Nkala et al. 2011, Owenya et al. 2011). More specifically, the reduced tillage reduces soil disturbance and the risk for soil erosion and flooding by improving water infiltration (Kassam and Friedrich 2011). Also mulch reduces the risk for soil erosion and it also contributes to an increased water infiltration and retention of rainwater which leads to increased soil moisture (Hobbs et al 2008, Nkala et al 2011, Owenya et al 2011, Giller et al 2011). The mulch cover further returns nutrition and soil organic matter to the soil and protects the soil from the sun (Kassam and Friedrich 2011). Intercropping with legumes contributes to increased levels of nitrogen in the soil and it is also a plague controlling measure (Thiombiano and Meshack 2009). With these improvements, which are expected to sustain or increase yields, CARE/WWF sees potential for CA to, apart from providing soil improvements, contribute to improved food security and adequate nutrition and rural poverty reduction (Milder et al. 2011:10-11).

2.3.1. Policy and support for CA in Mozambique

Milder et al. (2011) state that agriculture policies in SSA in general are not very supportive for CA and Thiombiano and Meshack (2009) confirms this by adding that, in Africa, including Mozambique, diffusion of CA has mainly been donor driven. According to Grabowski and Mouzinho's (2013:2) inventory report on CA in Mozambique, a total of 44 different organizations/institutions are actively involved in CA implementation in the country. One of these organizations is CARE and the alliance CARE/WWF.

Saying this, IIAM (the Agrarian Research Institute of Mozambique - *Instituto de Investigação Agrária de Moçambique*) is also conducting research on CA. IIAM together with the Platform for Agricultural Research and Technology Innovation (PARTI) organized the conference "The Future of Conservation Agriculture in Mozambique" in February 2012, with the purpose to gain an overview of the different CA initiatives and also actors working with CA in the country (IIAM 2012). The conference led to the foundation of the Mozambican Conservation Agriculture Working Group (CAWG) (IIAM 2012), in which the Ministry of Agriculture (MINAG) and other actors involved in CA implementation in Mozambique are included.

2.4. The two programs VIDA and P&S

My research focuses on CA as it has been incorporated in two of CARE and CARE/WWF's rural development programs, namely Viable Initiative for the Development of Agriculture (VIDA) and Primeiras e Segundas (P&S). The programme VIDA was implemented between 2002-2006 and had both an agriculture production as well as commercialization approach

where farmer associations received support to identify buyers who offered them fair market prices. P&S is described as an Integrated Conservation and Development Programme (CARE-WWF's blog) and has implemented CA since the farming season 2009/10.

Both programs formed village-based farmer associations, from now on referred to only as associations, during their initiating phases. These associations are used as focal points between the programme and the village¹². In addition to the associations, each village is supported by an extension worker who conducts weekly visits. Also local lead farmers¹³, called *demonstrators* and *animators* [*demonstrador* and *animador* in Portuguese] are trained and used as opinion leaders, providing additional support for farmers who want to learn about CA.

The actual extension approach differs between the two programs. In VIDA a demonstration field of 50x50 meters was used and one designated farmer in each village was responsible to maintain the field in accordance to CA practice. All farmers in the village were then able to visit the field to observe and learn about CA. Also in P&S demonstration fields were used as an initial extension methodology. In 2011/2012 was however the approach switched to Farmer Field Schools (FFS) which is a more participatory form of extension since it is based on farmers' active participation and conclusions of what is the most beneficial technique to use personally. The school consists of a 50x50 meters field which is divided into 9 parcels where different techniques and crops are experimented with. The results from the parcels are continuously compared as a base for discussion and drawing of conclusions in so called Agro-Ecosystem Analyses (AESAs).

2.4.1. CA approach in VIDA and P&S

Considering the diversity of CA approaches, the specific CA implemented by CARE in the two programs will be briefly defined.

In both programmes a minimum tillage is encouraged together with dead and living cover crops¹⁴ and a crop rotation based on an intercropping system where the main staple crop, cassava, is intercropped with legumes. For minimum tillage and soil cover, the two programs

¹² The farmer associations are community based organizations of between 20-30 members. More than gaining first-hand knowledge about CA, the associations are also encouraged to keep communal fields where they work the land together and produce and sell groundnuts as a joint group. The associations' main purpose is to strengthen and organize farmers in their production and commercialization of crops.

¹³ The selection of *demonstrator* and *animators* is based on their social position as well as farming abilities.

¹⁴ Velvet beans, lablab, cowpeas and crotalaria are used as living cover crops meanwhile dead cover crops consist of crop residues from previous year's harvest and weed rests.

have slightly different approaches. In VIDA, mulch is concentrated into lines covering the planted seeds, while P&S promotes the usage of mulch over the entire field. Further, in VIDA, minimum tillage was introduced by sowing in small basins, dug into the soil. According to a VIDA programme officer, the basins were difficult to implement since farmers perceived digging basins as too time-consuming, especially since they had to be re-opened every farming season. Due to this, basins are not used in any of the VIDA villages today. In P&S, basins have never been used and tillage is instead encouraged to be reduced to a minimum, applying direct seeding and farmers are encouraged not to stir the soil during weeding. An important difference between CARE's approach in the two studied villages and other CA approaches is the absolutely no-use of chemical inputs and that no specific CA tools are incorporated¹⁵.

3. THEORETICAL FRAMEWORK

A number of scholars have used economic theory to understand farmers' adoption behaviours of agricultural innovations, finding relations between farmers' possible adoption and their resources and access to credit, land and capital. While this certainly has contributed to the field of study, Mbaga-Semgalawe and Folmer (2000) argue that adoption behaviours should be researched using both economic and sociologic perspectives. For the purpose of exploring farmers' adoption of CA, rural sociologist Everett Rogers' theory *Diffusion of Innovations*, first published in 1962¹⁶, will be used as theoretical base. The theory originates in ideas from early anthropology and sociology in the beginning of the 20th century and has today been applied in a broad range of areas including rural sociology, education, public health and economics (Rogers 2003:40-45). As a compliment to the diffusion of innovations theory, there is also a sub-section of why farmers do not adopt agricultural innovations and CA. This section is mainly, but not only, based on findings from previous research on CA adoption in SSA and Mozambique.

3.1. Diffusion of innovations theory

Initially, important concepts will be defined. First, an *innovation* is a technology which is considered as new to an individual or a social system and it can be either hardware or

¹⁵ For example are the organizations CLUSA's (the Cooperative League of the USA) and Total Land Care including fertilizers in their CA implementation in Mozambique (Grabowski and Kerr 2013; Interview with key informants).

¹⁶ Rogers' original work has been published in 5 editions, the last in 2003, which is an indication of its continued relevance. According to Rogers (2003:59-60) is the Diffusion of Innovations theory today mainly used for diffusion of conservation and ecological agriculture innovations as well as for the role of gender in diffusion.

software. A software innovation is information-based and CA therefore falls under this category (Rogers 2003:11-14). Rogers (2003:5) uses the term *diffusion* to describe the adoption of an innovation over time among members of a social system. A social system is defined by Rogers (2003:23) as “a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal” and can, for example, be a village or an institution. *Adoption* is, on the other hand, more individual-based and refers to the process from an individual household’s first awareness of the existence of an innovation, to finally adopting it (Rogers 2003). Therefore, by using a theory which focuses on diffusion in a broader system and applying it on individual households’ adoption, which is the unit of analysis in this study, the intention is to understand individual households’ adoption behaviours as part of a broader social structure, intending to avoid to ‘blame the individual’. To blame the individual is according to Rogers (2003:118-119) a common bias in diffusion research and refers, according to Rogers’ definition, to situations when the individual’s flaws are considered instead of what in the system generate these.

Four main elements for adoption

Rogers (2003) identifies the innovation, communication channels, time and the social system as four main elements determining the adoption rate of an innovation. He argues that the rate of adoption is connected to the innovation and its *relative advantages* to previous techniques, its *compatibility* to the individual and to the social system in which it is introduced, the level of technical and theoretical *complexity*. Adoption is also connected to the *trialability* of the innovation which refers to the possibility to experiment with it before making a final decision of whether to adopt, and finally, the *observability* of results and the innovation itself (Rogers 2003:15-16).

Beyond the specific innovation, also the *communication channels*, through which knowledge about an innovation is spread is essential for its diffusion rate (Rogers 2003:18-19). It is through its communication channels that households first become aware of the existence of the innovation. Mbagalawa and Folmer (2000) describe educational programmes, extension services and social interactions as three key communication channels. According to Rogers (2003:18), the intrapersonal channels, and particularly between *homophilous* households, are the most efficient. *Homophily* is described by Rogers (2003) as the degree to which two individual households have similar characteristics in terms of, for example, socio-economic status, beliefs and educational level. Rogers (2003) however argues that *heterophily*, which is the opposite to *homophily*, yet if more difficult, also is important for the

diffusion of innovations. Knowledge which is transferred between *heterophilous* households allows an innovation to spread between different social networks. With only *homophilous* transfer, knowledge is restricted to the same networks.

Rogers (2003:22-26) further states that the structure of a *social system* can facilitate or impede adoption through its structures and opinion leaders. The social structure consists of the internal hierarchical order as well as the networks through which individuals are interconnected. For example households with social networks where experiences of the innovation are restricted are likely to adopt later (Rogers 2003:24 and 175). Opinion leaders are defined by Rogers (2003:27) as local individuals who through their technical knowledge, together with social position and conformity to social norms, can influence others in the social system to adopt an innovation. Without the support from opinion leaders, diffusion of an innovation will be difficult. Opinion leaders usually hold a relatively high level of formal education and social status (Rogers 2003:316-319). Thus, the issue of *heterophily*, and thereby potentially slower knowledge transfer, is also present between the general villager and opinion leaders.

In terms of time, the diffusion of innovations is slow and this has also been found for CA (Hobbs et al. 2008; Rogers 2003; Thiombiano and Meshack 2009:18). An innovation is usually adopted at different times by different households and an innovation's adoption rate is described with the French sociologist Gabriel Tarde's s-shaped adoption curve. Rogers (2003:41) has divided the curve into 5 broad categories of adopters: *the innovators*, *the early adopters*, *the early majority*, *late majority* and *the laggards*¹⁷. To better understand the time aspect, the innovation-decision process describes the process an individual household goes through when determining to adopt.

The innovation-decision process

The innovation-decision process which consists of five steps; *Knowledge*, *Persuasion*, *Decision*, *Implementation* and *Confirmation*, is one part of the time aspect. The model is useful since it describes the process of innovation adoption and acknowledges that different aspects in this process will affect the time or probability for an individual household to adopt the innovation. It can therefore be used to describe the innovation-decision process of households with different characteristics.

¹⁷ The different categories of adoption will however not be deeper analysed in this study. The s-curve is mentioned as a reminder that it is common that different individuals adopt innovations at different times.

Knowledge - The adoption process initiates when an individual first gains knowledge of an innovation. Rogers (2003: 172-173) divides knowledge into three categories: *awareness knowledge* that the innovation exists, *how-to knowledge* of how to use it and also *principles-knowledge* how an innovation functions and why it is useful. Rogers (2003) argues that a household which lacks *principles-knowledge* runs higher risk of misusing and/or dis-adopting.

Persuasion - The initial knowledge leads to the formation of a favourable or unfavourable view of the innovation and the persuasion stage therefore involves feelings about the innovation together with a process of further collection of information (Rogers 2003:175).

Decision - A household's decision to adopt or to reject an innovation is a result of the knowledge it has gained about the innovation and if this knowledge contains information that is perceived as beneficial to the particular household (Rogers 2003:174-175). These perceptions together with possible trials lead to an adoption or a rejection decision.

Implementation - It is usually a difference between a decision to adopt and the actual action of implementation since the process up until the implementation phase only exists in the mind. It is in this phase, which requires action, that operational problems can appear. During this phase the innovation can be re-invented by the adopter. This occurs if the innovation is perceived as conflicting to local norms or personal preferences and abilities, if it is complicated or if the adopter is lacking sufficient know-how (Rogers 2003:180-188).

Continuation - Implementation is not a static decision. Also, after implementation, the decision process continues. With time, the decision is either reinforced and the household continues using it or the decision is re-evaluated, either as a result of a new innovation or as a result of dissatisfaction, and the household dis-adopts the innovation (Rogers 2003:189-190).

3.2. Adoption constraints

To better understand farmers' innovation-decision process, it is also helpful to understand why innovations are not adopted. One reason that farmers do not adopt an innovation is that they are risk averse. More specific adoption constraints which are related to CA and found in previous research are presented in this section.

Risk minimization

There is an extensive literature about farmers' risk minimization. The limited access to insurance for smallholder farmers signify that risks related to changes in agriculture system directly affect the producer and this has proven to make technology changes which include risks difficult to diffuse. An early success is therefore important for adoption (Yesuf and Bluffstone 2007). Further, due to their limited margins, the most resource poor farmers are particularly risk averse and tend to strive to maximize household survival rather than income, and thereby focus on stable yields rather than possible, but not secure, yield improvements (Cypher and Dietz 2009:357; Todaro and Smith 2009:455). As a consequence also innovations that are technically, culturally and socio-economically suitable can have a low adoption rate. Reardon (1998:447) argues that this can lead to a down-prioritization of resource-conserving innovations with long-term benefits.

Innovation adoption in earlier studies

Further reasons to why farmers do not adopt agricultural innovations and CA are summed up and presented in the below table with empirical findings from previous research.

Findings from previous research on adoption of agricultural innovations/CA		
<i>Author</i>	<i>What</i>	<i>Constraints</i>
Fujisaka (1993: 411-418)	<i>Six reasons why farmers do not adopt innovations intended to improve sustainable agriculture techniques</i>	Problems is not faced with innovation Farmer practice is better Innovation does not work Extension fails Social factors Innovation costs too much
Derpsch and Friedrich (2009:14)	<i>Main global barriers to No-till/ Conservation Agriculture adoption</i>	Mind-set (tradition, prejudice) Insufficient access to know-how Inadequate policies to promote adoption Insufficient availability of adequate machines Insufficient availability of adequate herbicides

Thiombiano and Meshack (2009:17-19)	<i>“Barriers to adoption and scaling-up of Conservation Agriculture in Africa”</i>	Insufficient enabling policy environment Weak capacities at institutional, community and stakeholders levels Insufficient partnership and investments in CA Mind-set, lack of awareness and improper knowledge Inadequate cover crops Insecure land tenure Degraded soils Pests and weeds during the first years Diversity of situations and contexts Capital constraints and the need for external drive
Milder et al. (2011:28-32)	<i>“Principal constraints for CA in Africa”</i>	Agroecological and climatic suitability Knowledge constraints Policy, investment, and land tenure constraints Input Constraints Financial Constraints
Grabowski and Kerr (2013)	<i>Three constraints to CA adoption</i>	Reduced nutrient availability Increased labour requirements Low profitability

Table 2: Findings from previous research on main constrains for adoption of agricultural innovations/CA

From this table I single out four main aspects which seem to be particularly important for innovation adoption 1) access to knowledge 2) characteristics of the specific innovation 3) agricultural policies and support structures and 4) Input and financial constraints.

If specifically considering CA and its characteristics, much of the critique against CA in SSA is according to Milder et al. (2011:22) summed up by Ken Giller and his research team in their 2009 article ‘Conservation agriculture and small holder farming in Africa: the heretics

view'. Apart from their main critique that CA has not been sufficiently researched under different African farming systems, Giller et al. (2009) identify a number of practical issues they suspect will obstruct or slow down CA's adoption rate in African smallholder systems. First, they predict that increasing yields will mainly be experienced in the long-term perspective and that it can take up to ten years before yields increase as a result of improved soil quality. Due to this and considering farmers in SSA's deficient food-security and reliance on farming for their livelihood (and thereby risk aversion), they argue that CA will have a slow adoption rate in smallholder systems (2009:26). The labour burden is expected to decrease in the long term when using CA, but is found to increase during the adoption phase of reduced tillage due to an increased weed growth (Grabowski and Kerr 2013; Hobbs et al. 2008; Nkala et al. 2011). This as well as the malfunctioning markets in SSA, is suspected to reduce CA's adoption rate. Concerning markets, Giller et al. (2009) refer to farmers' limited willingness to grow legumes in a larger extent if the market for legumes is not sufficiently developed. Nkala (2009:771) complements this by identifying farmers' distance to markets as an adoption constraint. Finally, since CA implementation is often donor driven, Giller et al. (2009:29) point to the risk for dis-adoption when incentives or support from a project ends.

4. METHODOLOGY

4.1. Research design and meta-science

The purpose of the study is to gain an in-depth understanding of farmers' perceptions and decisions as to why they adopt or reject CA. With this intention the study is designed using a qualitative research approach. As with most qualitative research, it is understood that data is generated as a construction in the interaction between people with the aim to understand rather than to explain the phenomena of CA adoption (Bryman 2008:366). Contrary to a positivist approach, having an interpretive standpoint signifies perceiving the truth as relative. This implies that the perceptions I present in this study have been constructed between the participating farmers and me and have been filtered through my understanding and sense-making of their words.

The study is designed as a case study. The embedded units of analysis are represented by individual farming households in four villages where CARE has encouraged farmers to adopt CA. The object of study is each farmer's perceptions and connected adoption behaviours of CA. A case study method is used since an in-depth, context specific understanding, with the possibility to capture a holistic perspective of a social phenomenon is desired and which is

something that according to Yin (2009:4) can be obtained with this kind of study. When conducting a case study, it is important to have a robust theoretical foundation which can guide the research when going to field (Yin 2009:3). Yet the study is not completely deductive, it has instead a reductive character since I throughout the research process go back and forth between theory and data to develop my analysis.

4.2. Data collection

The study developed through a process initiated in August, 2012, when I arrived in Nampula, Mozambique to conduct an internship with CARE. The first months were dedicated to reviewing secondary data, developing the research design and becoming familiar with Mozambique. The reviewed literature consisted of academic articles on innovation adoption behaviour and CA, mainly in SSA smallholder systems and as far as possible in Mozambique. As a compliment to literature and as a means to gain a broader understanding of CA and its implementation and adoption in Nampula region, interviews with eight experts, as I will explain further below, were also conducted at an early phase.

Fieldwork took place at two time points, first as a pre-study to gain an initial understanding of farmers' perceptions about CA. The pre-study was conducted in five villages during September in 2012 and together with the literature review it allowed me to develop what Yin (2003:46) refers to as propositions about my area of research. This helped me to structure the research and identify where to continue to search for evidence. A more in-depth fieldwork was later conducted from mid-November to mid-January 2012/13 and the final data analysis and writing took place in Sweden between February and August.

Creswell (2007:132) argues that when conducting a case study and in order to “gain an in-depth picture of the case” it is beneficial to use a range of methods during the primary data collection. Primary data was therefore collected through a combination of group interviews, individual interviews and direct observations. In each village, fieldwork initiated with one group interview. These interviews had two main purposes, first to gain an understanding of how the group of farmers who have received direct training from the programme perceive and adopt CA and also to refine the interview questions for the following individual interviews. Interviews continued with key informant interviews with the associations' leaders and demonstrators who contributed with village specific details. These were followed by individual interviews with farmers in order to gain individual stories of how CA is perceived

and why it is adopted. Lastly and as a compliment to interviews, transect walks were also conducted. This allowed for direct observations of fields which provided a general understanding of how the different CA principles are adopted in the villages. Some fields were also photographed to capture the different CA adoptions.

4.2.1. Sampling informants and selecting sites

The eight informants for the expert interviews were selected based on their local knowledge about CA. They consisted of agricultural researchers and specialists from IIAM, a representative from the NGO CLUSA and representatives from a local farmer association. These interviews took place in Nampula, and mainly in the informants' offices.

Each village was selected with regard to its number of households and their location in relation to nearby rural villages and paved roads. The intention was to conduct research in villages with similar sizes, but with different distances to main roads. The latter was decided as a means to find possible relationships between market opportunities and CA adoption. To be able to understand the time-aspect of CA-adoption, research has been conducted in villages where CA has been introduced at two different time-points. Access to the villages was facilitated through CARE, via their present and previous local contacts. These served as gate openers who arranged the group interviews which initiated the fieldwork in each village. For the group interviews, all members in the associations were invited to participate and the members who chose to participate in these can therefore be considered to be self-selected among association members.

With the theoretical proposition that knowledge spread more slowly between households with *heterophily*, participants for the individual interviews were selected to include farmers from different well-being levels. To achieve this, the initial intention was to conduct a wealth-ranking¹⁸ exercise in each village, as described by Mikkelsen (2005) and Lekshmi et al. (2008). Yet, due to communication barriers and my inexperience with the method this did not turn out as intended. Instead, considering Bryman's (2008:458) argument that a stratified sampling approach permits the researcher to "ensure a wide range of characteristics of interviewees" (which was also the main purpose for conducting a wealth-ranking exercise) a

¹⁸ Wealth-ranking is the original term used for this Participatory Rural Appraisal (PRA) method. Since wealth however has a materialistic connotation it has been criticized for being Eurocentric. Since the method still mainly is known under its original name (Chambers 2008:115-116; Mikkelsen 2005:104-105), wealth-ranking is used here to describe this method. In the analysis is however the word wealth exchanged to well-being since it better reflects the focus on life quality.

purposive sampling method with some influence from wealth-ranking was applied. In order to gain a multifaceted understanding of different farmers' perceptions and adoption behaviours, consideration was also taken to assure a balanced number of CA adopters, dis-adopters and non-adopters, as well as men and women. As a tool for this selection, a table similar to the table below was drawn and filled in together with two men and two women from each village. Before filling in the table, and in accordance with wealth-ranking practice, they were first asked to define characteristics of the well-being groups¹⁹ found in the village. It is certainly recognized that the sampling is subjective. Yet, the main purpose with the ranking is to use it as a tool to assure a broader inclusion of farmers with different pre-conditions. A clear-cut definition was therefore not considered as necessary.

Wealth group	Gender	Adopter	Dis- adopter	Non- adopter
High	<i>Man</i>	Pedro		
	<i>Woman</i>			
Middle	<i>Man</i>	Ernesto		Abdul
	<i>Woman</i>	Rossana, Rosa		Ana
Low	<i>Man</i>		Fernando	
	<i>Woman</i>			Amina

Table 3: Sampling scheme with examples

A total of 39 individual interviews were conducted, 23 of them were men and 16 women, from which seven were women in female-headed households. For more specific details of how many interviews were conducted in each village, including gender, well-being group and status of adopter/dis-adopter and non-adopter see Annex 1.

4.2.2. Interviews

Individual interviews, which were of a semi-structured nature, lasted 30-90 minutes and took place in the vicinity of the participant's house. Interview guides facilitated the interviews and were complemented with probing questions to obtain more detailed answers. The guide

¹⁹ The categories were defined by the households' size of field, food production, house material, animals and possession of goods such as beds and bikes. Detailed information about the well-being categories, as defined in each village is found in Annex 2.

covered the following four main themes. For more specific details about the different questions asked see interview-guide in Annex 3.

- Socio-economic data
- General information about agricultural activities
- Understanding of the concept of Conservation Agriculture
- Personal implementation, perceptions and knowledge about each individual Conservation Agriculture principle

It resulted difficult to conduct fluid, non-structured interviews since only a few of the interviewed farmers expanded on their answers. Thus, interviews naturally became more structured than first intended, to counter the lack of detail in the respondents' answers, despite the contradiction with the benefits of the planned method (Bryman 2008:437). As suggested by Mack et al. (2005), notes were taken during all interviews, and when it was judged suitable to ask for permission, interviews were also recorded with a dictaphone which allowed me to engage more in the interview and not being too diligent on note-taking.

Leslie and Storey (2003:135) state that “language is often a source of strain for many researchers” and being able to speak directly with participants allows the collection of richer data. I am fluent, but not native in Portuguese, the official language in Mozambique. Yet, I do not speak the main language spoken in the villages, *Emekua*, and only 20-30% of the population in Angoche and Mogovolas, where the fieldwork was conducted, speak Portuguese (MMDA 2005a; MMDA 2005b). To overcome the language barrier between *Emekua* and Portuguese, an interpreter was used to facilitate the translation. The choice of using a local or an external interpreter, a man or a woman was carefully considered since it can facilitate and obstruct interviews in different ways (Leslie and Storey 2003:131-135). In the VIDA villages, I finally chose to work with male, bilingual locals. The gender was less of a choice since very few women have a sufficient level of Portuguese. Since the programme is still running in the P&S villages, the respective extension workers in each village facilitated translation in these villages.

Although the interpreters were invaluable for me as gate keepers when introducing me to the participating farmers, and also by translating the interviews, I am aware that gaining answers through a third person's interpretation can alter its content (Devereux 1993; Leslie and Storey 2003: 131-135). Therefore and as suggested by Leslie and Storey (2003), I informed the

interpreter prior to the interviews that I wanted a complete translation of the interviewee's story. I know this was not always respected, but I tried to be attentive and remind the interpreter about his role when I sensed parts of the answer was shortened. As a control measure of the quality of the interpretation, CARE's bilingual driver assisted during the first interviews in each village and was asked to correct misunderstandings and poor translations.

4.3. Data analysis

As data was collected it was continually analysed and transcribing was an important part of this. The transcribing phase, when all interviews were re-listened to, allowed for a second opportunity to reflect upon the interviews and their content and served to provide a more detailed understanding as no other distractions were present. I decided to transcribe interviews directly from *Emekua* to English and thereby not word by word, since the interviewees' exact wording had, in any case, been altered by the translator.

Having finished the data collection, and as recommended by Yin (2009), I considered data from different aspects. First, data from the four villages was scrutinized separately. This allowed me to consider each village individually, to identify differences and similarities between them, and also between the two programs. During this phase the respondents were also organized in accordance to their defined well-being level. Key themes related to the research question and its corresponding sub-questions were then deducted and data was once again reorganized according to these themes and compared between the villages (Yin 2009:156-160). Commonalities and diverging findings were, as suggested by Yin (2009) organised and findings were compared to the theoretical framework. This enabled me to confirm, modify and reject the theory that the study initially departed from.

4.4. Validity and Credibility of data

Generalizations

Due to the character of being a context-specific case study, the findings have a limited generalizability. Yet, since the purpose is to use the findings when developing future CA implementation there is also an interest in being able to use it outside of Nampula province. Instead of claiming generalizability and, as stated in the introduction, I consider my thesis as a piece in the broader understanding of CA adoption, and particularly in northern Mozambique. As an attempt to bridge my findings to the larger body of previous research on CA adoption in SSA, I have constantly compared my findings with previous findings with the intention to reach what Yin (2009) calls theoretical generalization.

Triangulation

To increase construct validity and, in that sense, assessing the accuracy of findings, data has been triangulated by using multiple sources of information and also different methods of data collection (Creswell 2007). More specifically, this has been realised by cross-comparing data from the different villages, programmes and participants with the interviews from key informants and observations. Also, CARE employees have regularly been consulted and their experiences have been used to compare findings with.

Vested interests

Fieldwork was conducted in cooperation with CARE, which I at the time also was interning with. When initiating interviews I was therefore careful to underline that I not work for CARE and also that I did not collect material for a possible new/prolonged programme. I am, however, aware of that many villagers still perceived me as a representative for CARE, which in turn is likely to have affected participants' answers. As an attempt to avoid the risk of reducing the reliability of data due to this, and also as an ethical measure, all interviews began with an explanation of the purpose of the study and my role as a student writing a Master's thesis. This was also repeated during interviews when necessary.

4.5. Ethical considerations

I am a young, white woman who has conducted research about farmers' choices and perceptions about agriculture techniques in a culture in which I was a foreigner. As discussed above, I used local translators with a relatively higher social status than many of the farmers I interviewed. These aspects have most likely influenced the dynamics in interviews, possibly making some of the participants feel slightly uncomfortable and others perhaps even special to be chosen to explain about something they are experts in. In the communities where my fieldwork took place, it is generally men who talk meanwhile women sit in the background. Some women might therefore not have been accustomed to express their opinion, and particularly not to a stranger. My main concern when approaching potential interview participants was therefore to inform them that participation in the interview was completely voluntarily and that they also were allowed to abort the interview at any time or pass on any question they felt uncomfortable to answer. Only one of the asked participants took the opportunity to deny his participation and my sincere hope is therefore that each participant in this study feels that their contribution to this story has been a voluntarily choice. As a custom, participants were also informed that the information they share would be used anonymously. The names mentioned in the analysis are therefore fictitious.

4.6. Limitations

Limited time for conducting field study

The primary information is based on my six months' experience in Mozambique and approximately five weeks of interviewing, with limited opportunity to return to the same villages after more thorough data analyses. A more optimal situation would have been to return to the field again to fill in holes and go deeper into interesting aspects. This was not possible however, since deeper reflections of all collected data were not reached before returning back to Sweden due to time limitations in field.

Defining CA

One important aspect of the fieldwork was to ensure that the understanding of CA was the same between me and the interviewed farmer. CA has been introduced under the *Emekua* term *Olima Wu Suka [Conserving Agriculture]*, which is also the term used during interviews. It however became clear that the participant farmers' understanding of CA is broader than just intercropping, cover crops and reduced tillage. Instead these three techniques are just three among many practices farmers learn in the respective programs²⁰. To avoid that the entire programme was being referred to incorrectly, the individual CA principles were therefore discussed separately. Yet, the individual principles were also not known by their names by the participating farmers so instead, each technique was described. This method certainly reduced the interviewed farmers' ability to freely influence the definition of CA, but it was applied so as to reduce miscommunication. The reduced tillage was particularly challenging to define due to its subjective character and questions about the adoption of reduced tillage were therefore constantly refined during fieldwork. Some farmers were also asked to demonstrate how they till.

5. ANALYSIS

In the following chapter I will address the research question of why smallholder farmers in Nampula province adopt CA. The chapter is organised into three sub-sections with the aim to shed light on smallholder farmers' perceptions of CA, how and finally also why they are motivated to adopt it. First and as a means to demarcate CA, the reader will be introduced to how the implemented CA is perceived by the interviewed farmers in relation to other farming practices. In the second sub-section I let the cases of five farmers together with my own

²⁰ Among other things, the programs also include training in post-harvest practices, marketing and seed selection.

observations exemplify different adoption behaviours and thereby increase the understanding of farmers' multifaceted adoption behaviours. These cases and observations are later referred to in the third sub-section where I explore the reasons and constraints to why farmers adopt CA. The section includes CA and its characteristics, adoption constraints and farmers' access to knowledge about CA.

5.1. Farmers' perceptions of Conservation Agriculture

Rogers (2003) states that it is important to define the boundaries between the innovation and previous practices and as a means to do so, this first sub-chapter aims to reflect the interviewed farmers' perceptions of CA and how the CA principles stand in relation to other farming practices. I begin this section with a statement provided by Ernesto, a farmer in Namotekeliua, which encapsulates many of the interviewed farmers' perceptions of CA.

“When I saw these practices I liked what I saw, I could observe the demonstration field and found it [CA] to be better than my techniques. I especially like the usage of seed spacing. The seed spacing can increase yields, and that is what I like. I also like that the mulch can maintain soil fertility²¹”.

It should particularly be noted how the advantages with the different principles are separated by Ernesto, something which was common in all interviews. Due to this, and also due to farmers' perceptions of CA as consisting of a broader range of practices than the three normally defined as CA, the principles are also presented separately in this section.

Mulch

Thiombiano and Meshack (2009) argue that farmers like to have clean fields since it is a symbol of hard work. This was also stated by the interviewed soil specialist who explains that this makes mulch more challenging to implement. Further, in African smallholder systems the practice of slash-and-burn agriculture is traditionally practiced as a mean to increase soil fertility²² (Reardon 1998; Todaro and Smith 2009). Due to recent changes leading to shorter fallow periods and increased pressure on soils, farmers have been encouraged to stop these practices. As a consequence, when not burning it becomes natural to leave crop residues on

²¹ All quotations have been translated to English from *Emakua* and Portuguese

²² The improved soil fertility generated by slash-and-burn agriculture is however only temporary, and these systems have therefore been of a shifting character, where farmers move on to new fields after 2-3 years of cultivating the same land (Todaro and Smith 2009). The shifting agriculture has changed as farmers have become more bound to villages and as population growth increase, so has the pressure on land. The time land is left in fallow has therefore reduced, which lead to a vicious circle of increased nutrition mining and decreased agricultural productivity (Cypher and Dietz 2009; Reardon 1998:447).

the field. It is therefore common that the interviewed farmers relate mulch with not burning and it was frequently mentioned that if a farmer still burns his field, then he is also not practicing CA. During interviews mulch is mainly appreciated for its capacity to retain soil humidity and also to increase soil fertility which is stated by farmers to improve crop growth and crop quality. The increased soil humidity also reduces the risk for crop failure.

Intercropping

Mixing crops in the same field is described as a common practice and the above cited soil specialist therefore refers to intercropping as “almost a natural practice” for farmers. As reflected in Ernesto’s above quotation, to most farmers the main innovation with intercropping is the practice of planting crops in lines, using ropes and seed spacing between crops. Farmers therefore associate intercropping with planting in lines. In terms of advantages, intercropping (and planting in lines) is the CA principle the interviewed farmers directly associate with increasing yields.

Tillage

Traditional farming practices in Africa did not incorporate tillage, but as a result of colonization it has become an established practice where farmers believe in the importance of working the soil (Haggblade and Tembo 2003:14; Thiombiano and Meshack 2009). Farmers in the four villages use hand-hoes and machete to prepare the land and since they do not use machinery or draft animals a number of interviewed farmers therefore consider themselves to already be applying minimum tillage. This observation reflects the subjectivity of reduced tillage. During interviews, the practice was, in general, not mentioned as often as the other two CA principles.

Finally, as a last remark, it should be considered that cotton tradesmen, via outgrower schemes, have been among few sources of agriculture extension farmers have been in contact with. Since colonisation they have taught farmers to farm in a manner which favours cotton production (but not necessarily soils). This training included monoculturing and the cleaning of fields by burning crop residues after harvest and intercropping, for example, was strongly advised against (Interview with agriculture specialist in Nampula). Some of the CA practices therefore directly contradict what farmers have learned previously.

5.2. Exploring how farmers adopt Conservation Agriculture

This section has two parts and in the first, five farmers and their adoption of CA are portrayed. The intention with using individual cases is to increase the voices of individual farmers and highlight farmers' multifaceted adoption behaviours and perceptions.

For the cases, three men from the same village, Namotekeliua, are selected in order to portray male-headed households of each of the three well-being levels and also adoption behaviour (adoption, dis-adoption and no-adoption). Considering that men are more verbal and that they provided richer explanations than women during interviews only men are selected for these cases. To also gain the perspective of female-headed households, two women from such households are selected, one with medium and one with low well-being level. Since a broad CA adoption is reliant on non-association members' adoption, I chose to portray two women who have never been members of the farmer association.

5.2.1 Case stories

Pedro –late adopter and non-member of the association

Pedro is an elderly²³ man with a relatively high level of well-being in his village²⁴. He lives together with his wife and four children. He has never been member of the farmer association or any other community based group, stating that “I would like to [be a member], also in the savings group, but I am afraid that it would take too much of my time”. Not being member of the farmer association, Pedro was not one of the early adopters. Instead, and despite that CA was introduced in Namotekeliua in 2002, it was only three years ago that Pedro initiated the practices. He explains that he adopted CA since “I saw other people leave crop residues on their fields and plant in lines and I could confirm that it increased their yields”.

Today Pedro is a partial CA adopter. He intercroops cassava with groundnuts, but only on parts of his field. He also leaves a partial soil cover with mulch and he claims that he does not till deep, explaining that age prevents him from doing so²⁵. He also explains that since it takes more time for him to plant in lines instead of just sprinkling the seeds, which is the common practice, he does not intercrop on his entire field. He also finds it time-consuming to organize mulch in lines and explains that he does not have enough labour for these practices. He states “I know that other people find that they can use less labour, but I find it to be more work. We are both old and it [referring to using seed spacing] takes more time to measure”. Pedro also

²³ Pedro does not know his age, but he probably over 60 years old.

²⁴ Pedro cultivates on 2 hectares of land and owns 5 bovines, goats and chickens as well as fruit trees.

²⁵ If his tillage is reduced or minimal in accordance to CA standards is difficult to tell, but nonetheless, he has seemingly not changed it with the intention to reduce his soil disturbance.

alters his use of mulching as he explains that he only leaves the finer crop residues and continues to burn the larger trunks.

Abdul– *non-adopter and non-member of the association*

Abdul, described to have a medium well-being level²⁶, is a 38 year-old man living together with his wife and seven children. During the program, VIDA, Abdul gained his main source of income from wage employment outside the village, and was therefore not very engaged in farming. Now he has left this job and is slowly starting to use CA. Abdul explains:

“Before, I didn’t know anything about the [CA] techniques since I was quite absent. I could see how people changed farming techniques but I didn’t know what they learned /.../ I wanted to learn because I could see how people changing techniques gained a higher yield, and I realised that it was a big change between the old and new techniques [in terms of yield]”.

Abdul has always mixed cassava and beans on the same field and has just recently started to intercrop the plants using ropes and seed spacing. Supporting him to change farming techniques is his brother in law, the local farmer demonstrator. Yet, since Abdul still burns his fields he states that he has not adopted CA yet. He expresses, however, that he would like to since when planting in lines during the previous farming cycle he found it to be labour saving during both weeding and harvest.

Fernando –*dis-adopter and member of the association*

Fernando is 40 years of age and lives together with his wife and five children. He gains his main source of income from agriculture and is described as having a lower well-being level. Fernando learned CA as a member of the farmer association, and is still member of it. He explains that during the program, the members of the association used to work as a team and assist each other at the fields. They also earned more money from their products since VIDA facilitated their commercialisation. The phasing out of the programme resulted in prices falling to the levels gained before the programme and farmers again preferred to work separately, everyone being responsible for their own work and production. Since Fernando cannot afford to hire extra labour (*ganho-ganho*), he says that he has dis-adopted CA. He explains, “when using seed spacing according to CA practice, it [intercropping] takes 5 days on my land, but with ‘the old technique’ it takes 2 days”. He declares that his dis-adoption is a response to the increased labour requirements he experiences when intercropping. Despite

²⁶ Abdul has one field, one bovine and a few goats.

this, when Fernando's fields are observed during the interview, it is noticed that he still plants cassava in straight lines, leaving room for beans in between²⁷. He had thus not completely dis-adopted the practice, but instead stopped using ropes and seed spacing for legumes and thereby adapted the practice to his capacity/preferences.

Rossana—*woman in female-headed household who practice CA*

Rossana lives in Namaponda and is an elderly woman²⁸, described as having a medium well-being level²⁹. She lives in the annex house next-to her daughter, a member of the local farmer association and the FFS. Rossana has learned to practice CA from her daughter and is now using cover crops for mulch, conducting a (self-defined) minimal tillage and intercropping groundnuts with cassava (planting in lines, not using ropes, but a pre-defined spacing). She explains, however, that due to time constraints she still plants some of the beans without seed spacing and ropes.

As with many other farmers, Rossana has noticed an increased production since switching to CA and she also explains that the soil quality has improved. While the soil fast became exhausted before, she is now able to stay on the same field for a longer time. Through the way she explains CA and the consequences generated when burning fields it seems like she has gained rather detailed information about CA³⁰.

Amina – *woman in female-headed household who partly practice CA*

Amina is a 40-50 year-old woman, living in Namotekeliua and described as having a lower well-being level³¹. She learned CA through being member of the woman's association during the programme. She explains that she does not burn crops on her field, instead covering seeds with dead cover crops which she gathers into lines. Yet, despite still being a member of the association, the support from the group does not seem to be sufficient for her to recall all the steps of CA. She recognizes this and says that since the demonstrator now is dead "I have no-

²⁷ The interview took place just before the planting season of beans and only cassava had been planted.

²⁸ Rossana is around 60-70 years old

²⁹ Rossana has a field of approximately 1,5 hectare where she is able to employ *ganho-ganho* to work for her during weeding and harvest. She describes herself as food secure, especially since she can use the surplus to pay for labour as well as to buy non-farm food.

³⁰ Rossana for example explains "when conserving and not burning the grass, the soil has a good structure and is rich and when planting the seeds, the soil remains fertile", showing that she understands the connection between soil, soil structure and her yields.

³¹ Amina is a woman in a female-headed household, has never been to school and is living alone. She sits with a group of other single woman when we meet her. One of them introduced with the last name "The-one-who-does-not-work", which indicates that these women do not have an important position in the village.

one who controls if I am doing it correctly, I miss that. The demonstrator showed how to use the techniques and if I forgot something he would remind me”. The fact that she describes that she separates the crops into two fields and intercrops groundnuts with beans instead of intercropping cassava and legumes indicates that she has forgotten, or not fully understood, the idea behind intercropping. She also does not mention tillage.

5.2.2 Observations

In this section my observations of CA adoption in the four villages are accounted for, both in terms of how CA adoption changes over time and also how CA is adopted by the interviewed farmers.

CA adoption over time

As mentioned above, diffusion of CA has, in general, been slow in Africa as well as in South America (Hobbs et al. 2008; Thiombiano and Meshack 2009:18). In Brazil and Argentina, two of the countries with the largest areas under CA today, the diffusion rate was slow during the first decade and then increased rapidly (Hobbs et al. 2008).

To consider how CA diffuses over time in this case I look at the two villages where the VIDA programme ended six years ago. Two findings are of particular interest. First, that it is observed that more farmers start to adopt one or more of the CA principles also after the end of the programme. Second, that those farmers who are described as dis-adopters, due to having left the farmer association, are found to continue practicing CA on their own fields and that it resulted difficult to identify other dis-adopters.

This study cannot generate conclusions about CA’s diffusion rate in the studied villages. Yet, since it shows that it is difficult to identify farmers who have dis-adopted CA, I conclude that adoption has increased rather than decreased over time. In the four studied villages, CA adoption was initiated through a development programme and the programme’s active encouragement of farmers to adopt these techniques. Yet, considering the above findings, the adoption of CA, and also its continuation, does not seem to be reliant on the continuation of a programme. The late adopters Pedro and Abdul are examples of this. Giller et al.’s (2009) prediction that donor driven CA implementation would lead to dis-adoption by the end of the programme does therefore not seem to hold in the studied villages. That being said, and referring to Fernando and other farmers in Namotekeliua’s statements, it is clear however, that the end of the VIDA programme, and especially its advantages, has discouraged them. I

therefore conclude that the design of a programme and how it is phased out affects farmers' general approach to CA.

Observations of how CA is implemented

From the above cases and observations, it has been determined that farmers in the studied villages practice CA. As will be indicated by the three photos below, it is however relevant to consider how the principles are adopted. Milder et al's. (2011:18-19) literature review of CA adoption in SSA as well as Grabowski and Kerr's (2013) study of CA in Tetê province in Mozambique find that CA often is not adopted according to how it is 'intended' by the implementing organization and that partial adoption instead is common.

The first photo illustrates the FFS's demonstration field in Namizope, where farmers conduct supervised and supported CA on a rather small parcel. The two others are photos of individual farmers' fields, one from Namizope and one from Namaponda. The difference between the photos from the FFS and farmers' individual fields is notable, particularly in terms of the mulch layer. The observed private fields in the four villages are more similar to the two latter photos. The observation that the soil cover is not-permanent is also something that is found in the two above mentioned studies. This lack of cover is both a result of insufficient cover crops and also of termites and the hot climate which contribute to a fast decomposition of the existing cover crops. Another factor is that farmers do not add more mulch when the original layer has decomposed and that the soil is therefore left with very limited cover at times³². One of the interviewed CARE employees explains that it is only when a new field is cleared that there are enough cover crops to cover the entire field. On the other hand, the conflicting uses for mulch, such as for fuel and livestock feed, found by Grabowski and Kerr in Tetê (2013) were not mentioned nor observed during interviews.

As noted in the above cases, farmers face challenges related to intercropping and the issue of planting crops in line. This is also observed in farmers' fields where crops planted in lines are of different levels of straightness, implying that some farmers, as exemplified by Rossana and Fernando, do not apply ropes when they intercrop cassava with legumes.



Photo 1: Field at the Farmer Field School in Namizope.



Photo 2. Field in Namizope



Photo 3: Field in Namaponda



Lastly, the actual implementation of tillage is difficult to grasp, particularly due to the subjectivity in what 'reduced' tillage is. Yet, considering how farmers refer to CA and also considering direct observations of fields where one or two other CA principles are adopted, it is suspected that in general, farmers are not reducing tillage sufficiently for it to be considered as reduced or minimal tillage. This is also noted in Ernesto in Namotekeliua's above quotation when he describes advantages with CA and not mentions reduced/minimal tillage at all. This is also common in other interviews. The interviewed key informants also confirm that mulch and intercropping in general are easier to implement than reduced tillage; one of the interviewed CARE employees explains "It is difficult to promote zero tillage since we can't offer herbicides and the first weeds that comes after the rains are very violent and difficult to manage if not through tilling."

Considering the above photos and although it can be concluded that farmers, both members and non-members of the farmer association, adopt CA, it is also relevant to question how CA is implemented since this also is likely to affect the biophysical impact of CA. Also when referring to CA and its adoption and benefits it should be understood through the manner in which it is adopted.

5.3. Exploring why farmers adopt CA

Concluding that farmers adopt CA, the analysis continues to explore what factors influence their adoption and in this section the diverse reasons behind households' adoption or rejection of CA will be explored.

5.3.1. CA and its characteristics

Rogers (2003) states that the innovation and its characteristics determine the adoption and adoption rate of an innovation and lists five main characteristics that he defines as the most relevant. The question of why farmers adopt CA will be examined in this section considering these characteristics. This will pay particular respect to CA's observability, relative advantage, complexity and compatibility. The fifth aspect, trialability is not mentioned since it is mainly connected to the possibilities provided by the extension methodology, and therefore lies outside the scope of this study.

Relative advantage

An innovation's relative advantage is an important aspect for its diffusion and Rogers (2003) argues that it is not the technical advantages that are the most important, but the perceived ones. Naturally, one person's perception is likely to differ from another farmer's and Pedro's

and Abdul's diverging statements of CA's labour requirements is one example of this. Aspirations of increasing yields is, however, the absolute most common reason given for why the interviewed farmers have adopted one or more of the CA principles and this is also reflected in the above cases. Connected to increasing yields, is improved access to food and increased income. Farmers in the different villages explained that the crops they grow under CA have better quality. Groundnuts are described as larger and richer in milk. One of these farmers is Rosa, a middle-aged woman in Namaponda. She explains how the food supply in her household has improved, both in quantity and quality saying "The children grow and gain weight. I am eating food of good quality now, and my children are healthy. We have a high level of nutrition in the household".

As pointed out by Nkala et al. (2011), increased food security and income do not have to be direct results from increased food production. One challenge is the low market prices for food crops in Mozambique. Grabowski and Kerr (2013) find that CA adoption not is profitable for farmers in Tetê province at current market prices for maize and costs for labour and chemical inputs, and that this holds back adoption of CA. Chemical inputs are not used in the studied villages, but the issue of prices is raised in all four villages and particularly in the VIDA villages. There, present prices are compared to the higher prices gained during the program. In the P&S village Namaponda, the village secretary concludes the consequences with poor market prices by explaining "The production is higher, but then there is no one who buys [to an adequate price] and we end up with the production at home. We can increase food security, but it is difficult with commercialisation and the majority persist with challenges." The poorly functioning market therefore seems to constrain farmers from reaching the full potential of increased incomes when adopting CA. Further, for households which already cover their households' food requirements, the main incentive when increasing yields through adopting CA would be to sell more and gain higher incomes. It is therefore interesting to note that although the increasing yields seem to have contributed to many farmers' CA adoption it does not convince everyone at once. Pedro's and Abdul's late interest and adoption of CA is an indication that CA can be down-prioritized by farmers with a higher well-being level, or another main source of income. That is, although being aware of the benefits CA can generate, increasing yields is not necessarily perceived as sufficiently persuading in order to change farming habits.

Observability

Both Pedro and Abdul, who have never been members of the association, mention that they

became interested in CA since they saw other farmers increase their yields by changing farming practices. This, together with other non-CA adopting farmers' confirmation that they have seen fellow-farmers practice CA, and that these farmers' CA adoption has resulted in yield increases lead me to conclude that CA's observability is high. The observability can be considered as high particularly in terms of increasing yields and also of the adoption of mulch and planting in line. Reduced tillage has, on the other hand, a more abstract character. This is both for non-adopters, who do not observe when other farmers reduce their tillage, and also in terms of improved soil structure for CA practicing farmers. Reduced tillage is the least mentioned CA principle I conclude that a likely explanation is its limited observability.

Complexity

Also the long-term soil improvements have a limited observability. This, together with another of Rogers' (2003) key characteristics of an innovation, namely the level of complexity, are likely explanations to why also this aspect is less mentioned during interviews. This conclusion is strengthened by the previously cited agricultural specialist, who states "Farmers are not able to see the improvements of the soil /.../ they can see differences with the market, if the product generates good income, but not if the soil improves". He uses farmers' generally low educational level as an explanation to the deficient knowledge about the relationship between soil quality and good yields and asks, "why conserve something that is not regarded as important?" From his field visits, he has instead concluded that farmers identify rain as the most important factor for good yields.

Compatibility

Finally, and as a general observation, both interviewed key informants and also earlier research from Mozambique (as stated in the theory) indicate that CA which requires farmers' economic investments in fertilizers and tools risk leading to an adoption which ceases when input support ends. Tripp (2006) (as cited in Grabowski and Kerr 2013:3) argues that innovations that are not compatible with farmers' economic resources, are not adopted. Grabowski and Kerr (2013) further find that farmers perceive that fertilizers, either chemical or compost, is necessary in order to practice CA. They therefore conclude that farmers are more restricted to use CA for staple crops since food production with fertilizers at present market prices, only is profitable for cash crops. With this in mind it is interesting to conclude that in this case, where farmers' economic inputs are restricted to an increased labour demand, dis-adoption do not seem to be common. A connection between these aspects cannot be drawn with this data, but the observation that the particular CA implemented in the four villages is

adapted to farmers' resource constraints and also the poorly developed market for agricultural inputs is worth noting.

Immediate benefits

In addition to the relative advantages of CA, the immediate character of the benefits seems to be important to farmers' CA adoption. CA is mainly promoted for its long-term environmental and livelihood benefits. Yet, during interviews, CA's immediate benefits are more frequently mentioned than the long-term ones. This is also the case in the VIDA villages where CA was introduced ten years ago.

Lead farmers in both VIDA and the P&S villages state that it was difficult at first to convince farmers to adopt CA, especially since the principles were new to farmers, but that this changed as farmers became able to verify that yields increased³³. A statement from the demonstrator in Namotekeliua³⁴ indicates that the initial resistance was overcome after just one farming cycle. The reported immediate yield increases, which also have been found in other studies on CA in Mozambique (Dambiro et al. 2011; Grabowski and Kerr 2013; Milder et al. 2011; Nkala et al. 2011) contradicts Giller et al.'s (2009) predictions that yields will only increase in the long term. An interesting aspect which could explain these immediate increases is provided by Milder et al. (2011:22). They point out that, apart from the CA-specific factors (for example increased nutrients from cover crops and improved water retention), other factors such as farmers planting in lines, using seed spacing and planting in a more timely fashion when rains fall are also important contributions to the increasing yields. Disregarding the reason behind the yield increases, their immediate character seems to be important for farmers' CA adoption. Based on Giller et al.'s (2009:31) argument that farmers in SSA tend to prioritize immediate benefits and also that the most resource poor farmers are the most risk averse, I argue that it would be difficult to persuade smallholder farmers to adopt CA if immediate benefits, and then particularly increasing yields, were not generated.

To conclude this section, and in terms of Rogers' five main characteristics of an innovation explaining the adoption and adoption rate of an innovation, the immediate character of CA's benefits seems to be important to persuade smallholder farmers to adopt the principles. As an

³³ In both Namizope and Namaponda, where CA just recently has been introduced, it is stated that production has more than doubled among farmers who have switched to CA. This seems to be rather high, but it nonetheless gives an indication that farmers perceive that their yields have increased substantially.

³⁴ He states that "*It was difficult in the beginning to convince people to leave what they were doing and to adopt the new techniques. It was difficult since they didn't know these techniques from before /.../. The following year, many people already were implementing the techniques in their own fields*".

innovation, CA appears to hold relative advantage over other farming techniques³⁵, be compatible to farmers' recourses and hold a partial observability (which seemingly is reflected in which CA principles farmers adopt). On the other hand, certain aspects of CA are rather complex, particularly considering farmers' generally low educational level. In terms of the specific characteristics of CA, I therefore argue that its complexity and partial lack of observability pose the main constraints for a broader CA adoption.

5.3.2. Adoption constraints and re-inventions

The interviewed farmers do not mention many challenges with CA. The most commonly mentioned is labour constraints and this challenge, together with poorly functioning markets are discussed in this chapter.

Labour constraints

The different perceptions of whether labour requirements increase or decrease as a result of CA adoption seems to reflect two main aspects. First that different farmers have different pre-conditions for CA, including their resources and knowledge and also that the labour burden increases and decreases during specific steps in the process. This latter aspect affects certain households more than others. Pedro, for example, explains his age to be a restriction and female-headed households, consisting of fewer adults, also tend to face more labour restrictions (Henshall Momsen 2004:Chapter 6). Also, the possibility to pay for *ganho-ganho* influences a household's access to labour at labour intense time periods.

Increased labour requirements due to increased weed growth as found elsewhere³⁶ is not mentioned during interviews. (This can be a further indication that the level of tillage is not reduced sufficiently). Instead, it is intercropping which is perceived to affect the labour burden. By some farmers, it is explained to facilitate weeding and thereby reduce the time required for it. Conversely, as mentioned in the above cases with Pedro, Fernando and Rossana, the labour requirement increases when intercropping with ropes and seed spacing. As already noted and as a response to the increasing labour requirement it is found that farmers engage in what Rogers (2003) refers to as re-invention, instead of completely

³⁵ It is recognized that most likely it is easier for the interviewed farmers to mention the positive aspects about CA to, a to them, representative from the programme introducing CA. Yet, since no open dislike against the principles are raised, CA's relative advantage to other farming techniques is assumed. This is also supported by farmers' new and continued CA adoption together with the simple but important statement given by Rita in Nakulue "if it would turn out to be difficult, I would drop it", which clearly indicates that farmers would not do something they perceive as less advantageous than what they already do.

³⁶ Increased labour is for example found in Grabowski and Kerr's (2013) study in Tetê province and by Haggblade and Tembo (2003) in Zambia.

rejecting CA. This finding challenges Giller et al.'s (2009) argument that labour constraints will reduce CA's adoption rate.

Re-inventions

Re-inventions and also partial adoption are found to be common in the four villages, mainly so among farmers who have learned CA from fellow farmers. The adaptation of intercropping, not using ropes and seed spacing or only using it for certain crops, is found in all four villages, something that the extension worker in Namizope refers to as planting in 'mental lines'. The translator in Namotekeliua explains that it is a measure against labour bottlenecks created during the intense, but short and unpredictable rain-period. This is when the top layer of the soil becomes soft enough to be tilled and therefore the time when beans and groundnuts are planted. To avoid the risk of not being able to plant the entire field in case of a short rain period, some farmers decide to not plant legumes in lines or instead just intercrop with 'mental' lines. Cassava can, on the other hand, be planted before the rains and is therefore not as critical in terms of labour demand, which explains Fernando's and Rossana's mixture of planting cassava in straight lines and applying 'mental' lines for legumes.

A further adaptation of CA is that reduced tillage is relegated when it is not perceived as beneficial. During the group interview in Namizope, it is expressed that minimum tillage is not effective on certain types of weeds that have a more complicated root systems and, as a response, reduced tillage is not applied where this kind of weeds grow.

Apart from the adaptation of the individual CA principles, the observation that farmers for different reasons pick and choose between the three principles, only adopting one or two of them is also an example of common re-inventions of CA.

Poorly functioning markets

Other obstructions can be more difficult for the individual farmer to overcome. Poorly functioning markets is one of these. As already concluded, markets in rural Nampula province are poorly developed and farmers' access to adequate prices for their crops is identified as a constraint to a broader CA adoption. Giller et al. (2009) and Nkala et al. (2011) also raise markets as a challenge for CA adoption. Although the four villages are located with different proximity to paved roads and rural villages, no striking difference of marketing possibilities is found between them. Instead, individual farmers have different access to markets, depending

on their production (and thereby sale) possibilities, as well as physical strengths to carry products to a market or if they have access to a bike or a motorcycle.

To conclude this section of constrains it is found that certain implementation challenges can be avoided and do not have to result in rejection of CA. Re-inventions facilitate farmers' adoption of CA by bridging its implementation challenges and thereby enabling farmers to adopt CA according to their preferences and capacities to reach some of CA's benefits. Considering Giller et al.'s (2009) call for local adaptation of CA, farmers' re-inventions are an interesting contribution of how to adapt CA to local conditions in the future. It is also an interesting example of smallholders risk aversion since Fernando, and other farmers who re-invent CA, are aware that their yields could increase further if, for example, they planted in lines. Yet, to avoid risk they alter the CA principles and thereby reduce their potential yield increases. With consideration of farmers' re-inventions further research should focus on how these affect the expected soil improvements. In contrast to the increased labour demand, obstructions related to the market are found to be more challenging for the individual farmer to overcome.

5.3.3. Access to knowledge

Beyond the specific innovation and as described in Rogers' (2003) innovation-decision process, the adoption of an innovation is a process which initiates with an individual gaining knowledge about it. Uaiene (2011) and Heffernan et al. (2008) have found that techniques that are both technically and culturally appropriate can still have a low adoption rate if knowledge about its existence or benefits is difficult to access. Similarly to markets, access to adequate knowledge can therefore pose a structural problem which is difficult for the individual farmer to overcome and which can slow down or limit CA's adoption rate. On the other hand, access to adequate knowledge is likely to facilitate adoption. This section therefore intends to shed light on how farmers gain knowledge about CA.

Since all but one of the interviewed farmers are aware of the existence of the CA principles, the main knowledge differences between farmers are in their how-to and principles-knowledge. In the four villages, the two main sources of information about CA are found to be the farmer association and fellow-farmers³⁷. Since the farmer associations have been the

³⁷ It should also be added that in Nakulue, one farmer also mentioned the radio and a further one the church as sources of information about CA. This indicates that other information channels are also used and that they also have potential to be used more broadly.

link between the respective programs and the villages they have been important communication channels to diffuse, and particularly to initiate CA adoption in the four villages. During interviews, it is clear that lead farmers, who have gained additional training by CARE together with the farmers with more important positions in the village or association, are those who provide the more detailed technical descriptions and general knowledge about CA. There is also a knowledge difference between association members and non-members. Considering this, it is suspected that how-to and principles-knowledge is reduced when passed between farmers. This finding should be considered with Thiombiano and Meshack's (2009:17-19) conclusion that "lack of knowledge on how to undertake Conservation Agriculture and its benefits is the most common reason for its slow adoption in Africa". Further, Rogers (2003) states that lack of principles-knowledge lead to an increased risk for misuse of an innovation. The quality of knowledge is therefore likely to affect how farmers adopt CA, both from a technical perspective and also with respect to how carefully the principles are adopted. This follows the same argument as provided by the agricultural specialist in relation to CA's complexity. Without sufficient principles-knowledge of why to reduce tillage or why to intercrop cassava with legumes it is less likely that the farmer adopt the principles.

Apart from quality, access to information is also crucial. Since a broad CA adoption is reliant on non-members' adoption it is possibly the issue of how these farmers learn and also adopt CA that is the most interesting. Rogers (2003) as well as Heffernan et al. (2008) find that it is more likely for an individual household with close relations to a source of information to adopt an innovation. The importance of social networks and *homo/hetrophily* between farmers is also exemplified by Abdul, Rossana and Amina's CA adoption. Rossana and Abdul portray households who, due to family connections, and most likely social position in the village, have been able to gain adequate knowledge about CA. With her detailed knowledge, Rossana's example challenges the idea that female-headed households always are those with least access to information. Instead, it indicates that perhaps more important than gender, social networks and social status are important for the diffusion of knowledge (which certainly also can be connected to gender). The case of Amina, who has forgotten or not completely understood the idea behind CA, indicates on the other hand that other farmers need access to additional support also after having participated in a programme. However, in the two VIDA villages, a supporting structure beyond the previous demonstrators and the association leaders is not found.

The *heterophily* between association members and non-members, particularly those with a lower well-being level, seem to be a further constraint to broader diffusion. This challenge is exemplified by Ana, a farmer in Namotekeliua who is described as having a middle well-being level. During the interview, she confirms that she is familiar with CA and that she has tried to plant in lines, but that since she was unsure of how to do it she only tried it one year and then returned to her old practices as her attempt was not successful. She explains “It is difficult to go and ask someone [for advice] when they all are very busy when the rain starts to fall”. Her statement indicates that the distance between her and the farmers who hold knowledge about CA is too far for her to consult them during busy times. Considering that association members tend to have a middle or higher well-being level (Interview with CARE employee), it is suspected that farmers with a lower well-being level initially have more restricted access to information about CA. To avoid that farmers with a low well-being level become late adopters as a result of limited experience from CA in their social networks, lead farmers’ approval and active promotion of CA is relevant. A good example of this is found in Namizope where the demonstrator and animators are encouraged to provide additional support to women in female-headed households during their adoption phase.

Since access to knowledge is the first step in Rogers’ (2003) innovation-decision process, knowledge about CA seems to be a bottleneck for the farmers with least access to this knowledge to adopt CA. I conclude this since my findings indicate that once farmers have know-how and principles-knowledge and become persuaded and decide to implement the CA principles, it is found that they continue to use them in one way or another. Other farmers instead seem to stay with the mere knowledge of CA’s existence and its possibility to increase yields, without knowing how to adopt. Access to knowledge is also relevant in order to overcome the challenges posed during the adoption phase. The quality of the extension method and also the individual communication networks which can facilitate or obstruct a farmer from gaining this knowledge are therefore important.

6. CONCLUSION

Departing from Rogers’ (2003) Diffusion of Innovations theory, this study has intended to explore how and why farmers in northern Mozambican smallholder systems with different well-being levels adopt CA. The reasons behind why a household adopts or rejects CA are certainly complex and multifaceted. Conservation Agriculture itself also gathers several approaches under its title and its different shapes are as diverse as industrialised farming and

smallholder farming. It was therefore important for me to first define what kind of CA is introduced in the villages in this case and also how CA is perceived and adopted by the interviewed farmers. Through group and individual interviews in the studied villages it was found that CA is perceived as a broad number of practices which farmers pick and choose from together with other practices they have learned during the respective programmes. CA, as understood by farmers, is therefore not restricted to the three CA principles of reduced tillage, permanent soil cover and crop rotation as defined by the FAO.

It is found that both farmers who have participated in the CARE supported farmer associations as well as other farmers in the villages have adopted CA. It is also found that farmers who have adopted CA continue with the practices in one or another way. If considering which of the individual principles farmers practice, mainly mulching and intercropping (or planting in lines) are mentioned. Mulching is particularly associated with increased soil moisture and reduced risk for crop failure, while planting in lines is perceived as a measure to increase yields. Tillage is the CA principle which is mentioned the least and it also seems to be the least adopted.

Although farmers' CA adoption can be confirmed, it is found that the principles might not be adopted exactly as introduced by CARE. Instead is CA adopted in accordance to farmers' individual preferences and capacities in terms of which principles to adopt and also how much to adopt. The partial adoption with consideration to number of CA principles adopted appears to be more common among farmers who have not learned CA via the program. Yet, through interviews and observations of farmers' fields it is found that both association members and non-members apply an insufficient level of mulch to provide a permanent crop cover. The main challenge in farmers' CA adoption is expressed to be increased labour requirements, particularly when planting crops in line and using seed spacing. As a response to this, many farmers use what is referred to as 'mental lines' instead of applying ropes and seed spacing when intercropping. The labour constraints have therefore not necessarily generated a complete rejection or dis-adoption of CA. Instead adaptations are a common scenario between full adoption and rejection. Farmers are consequently not merely receivers of information about CA, they also form CA according to their own capacity, and certainly also to their access to knowledge. I therefore argue that farmers' adaptations should be considered for future CA implementation as a means to bridge implementation challenges. Considerations should, however, be taken into how the soil conservation is affected by such adaptations.

Among factors persuading farmers to adopt CA, increasing yields is described as the most important. The soil conserving aspects for which CA is mainly promoted by its advocates can on the other hand neither be confirmed nor rejected with this qualitative study which mainly is based on farmers' own perceptions. Yet, these are less frequently mentioned during interviews with farmers. Farmers' focus on the immediate benefits is perhaps not a surprising finding considering that soil improvements are developed in a long-term perspective and also that they are of a more complex nature. Further, with theoretical support in risk minimization I argue that farmers' livelihood situation is a likely explanation to their focus on immediate benefits as it does not allow for risk taking and awaiting long-term gains. A conclusion is therefore that the immediate benefits and particularly the yield increases are important for farmers' decision to adopt CA.

Despite a general awareness knowledge about the CA principles in the four villages, access to adequate how-to and principles-knowledge seems to pose constraints for farmers' CA adoption, full or partial. Since farmers with better positions in the villages seem to hold more detailed knowledge about CA I conclude that also in this case, farmers' individual networks and the experience of CA in these networks is important. That being said, households from both higher and lower well-being levels decide to adopt or to reject CA. The reasons behind their adoption and rejection appear, however, to be based in different motives. As a final conclusion I therefore point out that farmers' different well-being levels and thereby social status and capacities, in addition to their aspirations are important aspects which should be considered when developing new projects involving CA. Particularly if specific groups are targeted.

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8. ANNEXES

8.1. Annex 1 - List of interviews

1.1 KEY INFORMANTS		
Role	Interview language	Date
Country Director of NGO working with CA	English	26 th of November 2012
3 representatives of a farmer association	Portuguese	28 th of November 2012
Agriculture researcher and coordinator of a project incorporating CA.	Portuguese	29 th of November 2012
Researcher in rural socio-economics	Portuguese	11 th of December 2012
Agricultural specialist and researcher	Portuguese	13 th of December 2012
CARE employees	English and Portuguese	Continuously
NAMOTEKELIUA		
Farmer demonstrator	Portuguese	5 th of December 2012
Translator	Portuguese	5 th of December 2012
Village Secretary	Portuguese	5 th of December 2012
NAKULUE		
President of the farmer association	Portuguese	17 th of December 2012
Village secretary (and translator)	Portuguese	17 th of December 2012
NAMIZOPE		
Extension worker AENA	Portuguese	17 th of January 2013
Farmer demonstrator	Portuguese	17 th of January 2013
NAMAPONDA		
Extension worker AENA	Portuguese	18 th of January 2013
Local village leader	Portuguese	18 th of January 2013
Secretary in the farmer association	Portuguese	18 th of January 2013

1.2 GROUP INTERVIEWS		
Village	Interview language	Date
NAMOTEKELIUA		
13 members of 3 different farmer associations – 8 men and 5 women	Emakua to Portuguese	5 th of December 2012
NAKULUE		
11 members of the farmer association – 6 men and 5 women	Emakua to Portuguese	17 th of December 2012
NAMIZOPE		
12 members of the farmer association – 7 men and 5 women	Emakua to Portuguese	17 th of January 2013
NAMAPONDA		
13 members of the farmer association – 4 men and 9 women	Emakua to Portuguese	18 th of January 2013

1.3 INDIVIDUAL INTERVIEWS														
		Adopter				Dis-Adopter				Non-Adopter				Total
		N1	N2	N3	N4	N1	N2	N3	N4	N1	N2	N3	N4	
High	Man	2	1	1										4
	Women									1				1
Middle	Man	3	3	1	2		1			2	2			14
	Women	1	2	1	2									6
Low	Man		2			1				1			1	5
	Women	2	1			1				1	3	1		9
Total		8	9	3	4	2	1	-	-	5	5	1	1	39
N1= Namotekeliua N2= Nakulue N3= Namizope N4= Namaponda														

8.2. Annex 2 – Well-being levels as defined during wealth ranking

MOGOVOLAS	
NAMOTEKELIUA	NAKULUE
<p>Wealth ranking</p> <p>High; 1 ha field where there is good production, house with zinc roof, bed, varied food; maize flour, cassava flour, cows, goats, chickens, duck, sewing machine, motor bike, fruit trees</p> <p>Middle: 0,5 ha field with normal production, goat and chickens, house with straw roof, fruit trees, they eat their own production, sewing machine</p> <p>Low; 30x40 field, food production is not enough, chicken, bike</p>	<p>Wealth ranking</p> <p>High – produce bovines, has, motorbike and bicycle, large family</p> <p>Middle – is able to eat but has difficulties with the food sometimes, can produce 2 bags of groundnut, has chickens</p> <p>Low – a house without much in it (no furniture etc.), lack food and do <i>ganho-ganho</i> in order to obtain food.</p>
ANGOICHE	
NAMIZOPE	NAMAPONDA
Not available	<p>Wealth ranking</p> <p>High; 1-2 ha fields, house with zinc roof, sufficient food, motorcycle, bicycle, mattress, wooden chairs, bank account, ducks, goat, possibly bovines</p> <p>Middle: 1 ha fields, sufficient food, bicycle, savings, chickens, plastic chairs</p> <p>Low; Up to 0,5 ha fields, less food secure, chickens, work as <i>ganho-ganho</i>, visit the village medicine man instead of the hospital</p>

8.3. Annex 4 – Interview guides

8.3.1. Individual interview

Entrevista Pessoal

(Fazer comentários sobre material da casa, tamanho, coordenatos de GPS; da comunidade, a casa onde fazemos a entrevista e na machamba)

1. Socio-economico

- Edade
- Nivel de escolaridade
- Quantas pessoas na casa
- Mais que a machamba, tem outros fontes de rendimento? Quais?
- Alguém na casa participa numa organização communitaria?
- Como descrevia sua situação de segurança alimentar na casa

2. Actividades agrícolas

- Quantas pessoas na casa trabalha na machamba?
- Quantos ha tem a machamba?
- Que culturas? Tem animais?
- Onde vende os produtos? Quanto tempo demora para chegar ao mercado?
- Como prepara o solo? Que faz para aumentar a fertilidade do solo?
- Usa pesticidas/fertilizantes? Semente/estacas melhoradas? Onde adquire aquelas?

3. Desafíos na agricultura

- Qual são os maiores desafios de agricultura em nível da comunidade? Você também enfrenta problemas com estos desafios? Como adapta as suas actividades agrícolas para evitar estos desafios?
- Que faz para melhorar a productividad em sua machamba?

4. Agricultura de Conservação (AC)

- Explica o que é AC? Será que voeê practica AC em sua propria machamba?
- Quanto tempo fica o capim na machamba? Que faz quando acaba?

- Pode mostrar como prepara o solo com a enxada? É diferente de como fazia antes? Em que maneira é diferente?
- Que culturas usa em consorciação

→ SIM

- Me pode explicar o processo como foi que você começou usar AC?
 - (Desde quando, em quantos ha, como aprendeu, quem lhe ensinou)
 - Quantas pessoas conhece que já usam AC?
 - Você já ensinou alguém mais usar as técnicas?

 - Por que começou praticar AC na sua machamba? Qual das técnicas da AC gosta mais? (e usa mais) Porque? (vantagens com AC)

 - Qual são os maiores desafios e riscos com AC? Como enfrenta estes desafios?
 -
-

→ NÃO

- Porque não?
 - Qual desafios conhece sobre a Agricultura de Conservação?
 - Qual benefícios conhece sobre a Agricultura de Conservação?
 - Como recebeu esta informação?
-

→ TERMINOU

- Por que adoptou? (Qual practicas usou)
 - Por que terminou? (Depois de quantos anos?)
-

8.3.2. Group Interview

Entrevista em grupo

- Que é Agricultura de Conservação?
 - Em geral, porque adoptam os produtores AC?
(Benefícios de Agricultura de Conservação) (Brainstorm → Rank).

 - Porque alguns produtores não usam AC?
Desafios/riscos de Agricultura de Conservação

 - Como é a practica geral da Agricultura de Conservação na comunidade

 - (Quantas pessoas? Qual prácticas? Por que? Desde quando? Quem na comunidade usa CA?)
-

8.3.3. Interview with the farmer demonstrator

Entrevista com o Demonstrador

- Quantas familias vivem na comunidade?
- Qual organizações communitarias existem na comunidade?
- Qual é a função da associação? (mas que receber informação?) Quem pode ser membro da associação?
- Pode descrever como praticam agricultura nesta comunidade? Como é o solo preservado tradicionalmente? Como aumentam a produção?
- Qual são os maiores dificuldades na agricultura em nível da comunidade? Como adaptam-se as pessoas a essas dificuldades?
- Como é o nível de segurança alimentar na comunidade?
- Ondé está o mercado mais próximo? Quanto tempo demora para chegar ao mercado onde se vende os produtos?
- Desde quando começaram a aprender as practicas de AC na comunidade? Como é a informação de novas tecnologias como AC transferidos na comunidade?
- Qual são os opiniões gerais sobre AC?
- Practicam os produtores na comunidade as tecnicas da AC? Por que? Quem na comunidade pratica AC? Agora, a practica da AC está a crescer? Descer?
- Será que todas estas tecnicas são novas para as produtores? / São parecidas as practicas que já existíam aqui desde antes?