THE EFFECTS OF SOCIAL LEARNING AND MARKET PARTICIPATION ON TECHNOLOGY ADOPTION

A study on extension and marketing services at a Farmers association in Zambia

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Abstract

This research aims at increasing the knowledge on the effect of extension services, market access and market participation on technology adoption for smallholder farmers which are a member of an agricultural organisation. In order to learn more about these topics research was carried out at the Nyimba District Farmers Association (NDFA) located in the Eastern Province of Zambia. Members of the NDFA receive extension and other services through Information Centre's (ICs) where trainings are provided on various topics are provided by a member of their own community, called an IC manager (ICM). Based on evidence from earlier research I expected that members who were more similar to their ICM would be more likely to follow trainings, use other services provided by the NDFA and to adopt new techniques. The effect of difference on following training, using services and adopting techniques appears to be mixed, the results indicate that IC managers who are more similar to their members are not always better at ensuring technology adoption. The results also show no effects of using marketing related services on the adoption of new techniques.

Acknowledgements

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List of Acronyms

CAC: Camp Agricultural committees
CF: Conservation Farming
CR: Crop Rotation
DACO: District Agricultural Coordinator
DFA: District Farmers Association
IC: Information Centre
ICM: Information Centre manager
Ka: Zambian kwacha
MAL: Ministry of Agriculture and Livestock
NDFA: Nyimba District Farmers Association
FRA: Food Reserve Agency
FISP: Farmer Input Support Programme
FSP: Fertilizer Support Programme
LF: Lead Farmer
SSA: Sub Saharan Africa
TLU: Tropical Livestock Unit
ZCF: Zambia Cooperative Union
ZNFU: Zambia National Farmers Union

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1 Introduction

It is no secret that the world's population is growing. According to the FAO the world's population is expected to exceed the 9 billion by 2050. They calculate that the total agricultural output has to increase with at least 60% to cope with this population growth (FAO, 2012, 2014). One of the ways through which agricultural output can be increased is through the adoption of new agricultural techniques. However these have yet to be widely adopted, especially in Sub-Saharan Africa (SSA) (BenYishay & Mobarak, 2014). The use of fertilizer for instance is much lower in SSA than in other areas, see Figure 1.1

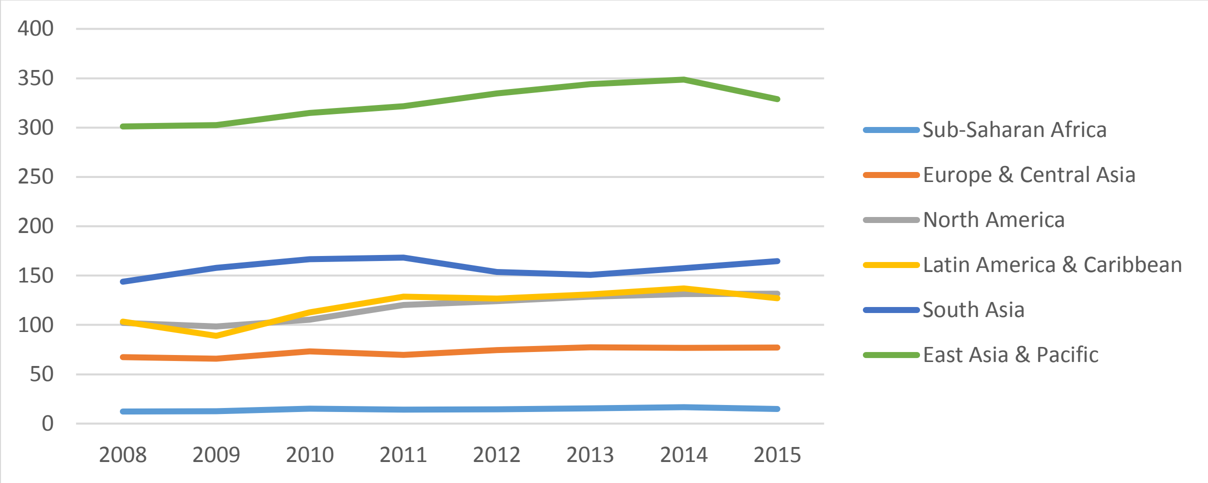

Figure 1.1 Fertilizer consumption in kilograms per hectare of arable land. (Source: World Bank, World Development indicators 2018)

There are many factors which influence the adoption of farmers and the extent of the influence can differ per context. Some of these are market access, education and household size (Arslan, McCarthy, Lipper, Asfaw, & Cattaneo, 2014; BenYishay & Mobarak, 2014). Another factor which has a significant positive influence on adoption is the access to extension services, as found by Arslan et al. (2014). They state that extension services allow farmers to see and experience extension services in their own areas and provide information about new technologies, thus increasing the likelihood that farmers adopt such techniques. However not all farmers have access to such services, increasing the need for more and more effective agricultural extension methods.

One of these methods is the use of lead farmers to provide trainings and other services to farmers in their own region. It is not uncommon for agricultural organisations in developing countries such as farmer cooperatives and associations to use such a system. The lead farmers provide services and form the communicative link between the organisation and the local farmers (BenYishay & Mobarak, 2014; Janvry, Macours, & Sadoulet, 2016; Neubert et al., 2011; Verberk, 2013).

The process of providing extension services by lead farmers can be seen as a form of social learning. A recent study done by BenYishay and Mobarak (2014) found that using lead farmers to deliver extension services was not necessarily the most (cost) effective way of delivering extension services. They found that lead farmers, which were elected by community members, were usually richer, had larger farms and were prominent members of society. The community also elected peer farmers, which were supposed to represent the average farmer, although these farmers were still slightly richer than their peers they were more similar to other farmers than lead farmers. The peer farmers turned out to generate higher uptake levels of new technologies. In general they found that the more similar a peer farmer was to recipient farmers the more effective he was (BenYishay & Mobarak, 2014). The effect of differences between the one providing extension services and its uptake is something which needs to be researched further, and at the beginning of this thesis there was no research available investigating these effects within the setting of an agricultural organisation. This is relevant since it is estimated that agricultural organisations such as cooperatives and farmers associations, had over 120 million members in 2014, all over the world (Grace, 2014).

Another way through which the adoption of new technologies can be increased is through market access. When farmers have no or limited access to input markets it is more difficult for them to adopt yield increasing technologies, such as for instance fertilizer. Access to output markets can also increase uptake of technologies (Abebaw & Haile, 2013). Not only can increased market access increase the adoption of new technologies, it can also increase farmers' income levels and welfare (Barrett, 2008). An important barrier to markets for smallholder farmers are transaction costs (Fischer & Qaim, 2012; Shiferaw, Hellin, & Muricho, 2016; Zeller, Diagne, & Mataya, 1998). Farmers organisations can play an important role in lowering transaction costs and thus increasing market access and participation (Barrett, 2008; Fischer & Qaim, 2012; Markelova, Meinzen-Dick, Hellin, & Dohrn, 2009; Shiferaw, Hellin, & Muricho, 2011; Shiferaw et al., 2016; Zeller et al., 1998).

This research focusses on a farmers association called the Nyimba District Farmers Association (NDFA) which is based in Eastern Province in Zambia. Zambia is a landlocked country located in southern Africa. In 2017 around 58.2% of its population lived in rural areas, and around 55.8% of the working population was employed in agriculture (FAO, 2017; World Bank, 2017). This indicates that in rural areas most people are engaged in agriculture. For the total value added of the agricultural sector several estimates are available ranging from around 20% (ZNFU, GTAZ, & MAZ, 2014) to about 7.3% (World Bank, 2017), both figures represent 2014. Many of the farmers in Zambia are smallholders and their participation to markets are limited also due to a lack of market access (Chipasha, Ariyawardana, & Mortlock, 2017; Mwangi & Kariuki, 2015). If their market access would increase the total value added of the agricultural sector is likely to increase as well. The conditions of Zambian smallholder farmers are similar to that of many other smallholder farmers in SSA, they mainly rely on rain fed agriculture, use little fertilizer and no or little herbicides or fungicides (Mwangi & Kariuki, 2015).

In 2016 the NDFA had around 1150 active members. The vision of the NDFA is to have households that are food and income secure in the whole district though agriculture. The main crops grown in the district are maize, groundnuts, sunflower, soy, sweet potatoes and cotton. Maize is the most important staple crop, the other crops serve mainly as cash crops (de Leede, Sanderse, Miyba, & Kalisha, 2017). Most members of the NDFA grow several crops and also have livestock. The services of the NDFA are focussed on crops, with sunflower being the most important. It operates an oil pressing business which produces sunflower oil and sunflower cake as a by-product, the latter can be used for animal feed (de Leede et al., 2017).

The members of the NDFA are divided in so-called Information Centres (IC's). In total there are 38 IC's of which most are active. Each IC has a farmer who manages the services provided by the NDFA and handles the communication from the members to the central office of the NDFA and vice versa. These farmers are called lead farmers by the NDFA, however in order to avoid confusion with the lead farmers described by BenYishay and Mobarak (2014), the NDFA farmers will be referred to as IC managers (ICMs). The NFDA provides several services to its members. During my research I will focus on the two most important ones: extension services and sunflower related services. The extension services are given by the ICM to their own IC. The objective of this thesis is to learn more about how the services provided by the NDFA and the way these services are provided affect the adoption of new technologies of its members. Hence the following research questions have been formulated:

A. What is the effect of differences between IC managers and their members on service use and technology adoption of their members?
B. What is the effect of the use of sunflower services of members on their adoption of new technologies?

Answering these questions will provide insight in what factors can drive the use of extension and other services of members, and their subsequent effect on the adoption on new technologies. This will add to the scientific debate outlined above, adding a small piece of information. The research contains a literature study and a survey among members of the NDFA performed from October 2017 until December 2017 in Zambia.

The structure of the next chapters is as follows: in chapter 2 I will provide background information on the agricultural sector in Zambia, the influence of the Zambian government on agriculture and some additional information about the NDFA and how it operates. Chapter 3 will explain the theoretical framework used in this thesis. There I will go into detail on the factors influencing technology adoption, the theory behind social learning and the effect of market access and market participation on technology adoption. Chapter 4 describes the methods used to collect data, the mathematical model applied throughout the thesis and its variables, and lastly it explains how the statistical analysis has been performed. Chapter 5 provides descriptive statistics and the results of the statistical analysis. In chapter 6 I discuss the limitations of the study, the key assumptions made throughout the research, and their implications for the research findings. In chapter 7 I answer the research question and give recommendations for further research.

2 The agricultural sector in Zambia

As mentioned in the Introduction more than half of the population of Zambia is still engaged in agriculture (World Bank, 2017), making agriculture a vital sector of the economy or even “the backbone of the economy” (Siame, Lichilo, & Siame, 2017; Zambia Development Agency, 2011). Most of the people involved in agriculture are smallholder farmers.

Access to agricultural and other land is arranged under two tenure systems: State land and customary land. The first accounts for 6% of the total land available, and the latter for the other 94%. State lands are zoned into residential, commercial or industrial use. Customary land falls under the traditional chiefs (Zambian Development Agency, 2014). If someone wants to access customary land, for instance for farming or building a house, they have to receive permission from the local chief.

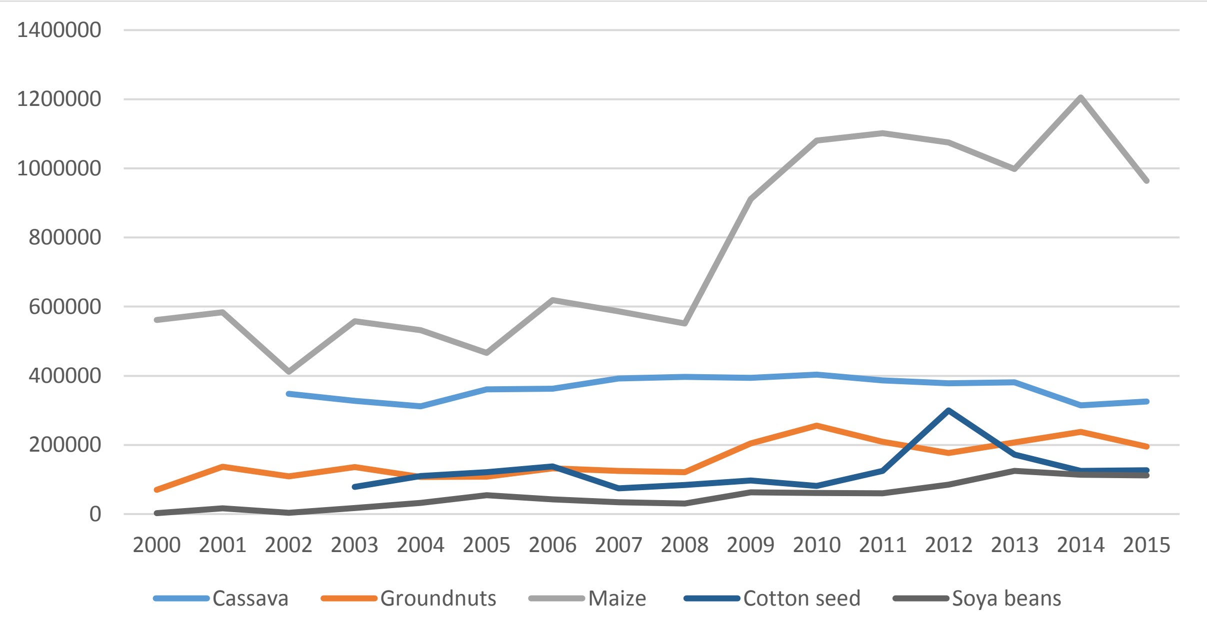

Figure 2.1 Five most common crops in Ha harvested. Source: Zambia Central statistical office

In Figure 2.1 the five most commonly grown crops are visualised. As can be seen maize is by far the most common crop to be grown. (Zambia Central Statistical Office, 2018). Maize is the staple crop for the Zambian population, and about 80% of all maize is grown by smallholder farmers (Zambia Development Agency, 2011). In the next section I will provide information on the influence of the Zambian government on the agricultural sector, in the section after that I will provide some information on cooperatives and farmers associations in Zambia. Lastly I will go into detail about the NDFA and how it operates.

2.1 The agricultural sector and the Zambian government

The Zambian government actively tries to shape the agricultural sector. More than half the country’s population lives in rural areas, and rural poverty remains high at 79% (Mulungu & Chilundika, 2016). Therefore the Zambian government tries to alleviate poverty through several measures, and since maize is the main staple crop, and largely grown by smallholder farmers, an important part of government policy focusses on maize. In 2014 about 60% of the entire budget of the Ministry of Agriculture and Livestock (MAL) went to two support programs with a main focus on maize: buying maize through the Food Reserve Agency (FRA) and the Farmer Input Supply Programme (FISP) which implicitly also supports the cultivation of maize (Neubert et al., 2011; ZNFU et al., 2014). Most of the NDFA members also receive support through the FISP programme and many sell their output to the FRA.

The FRA is tasked with buying maize from farmers and setting a price floor. When the FRA was established in 1996 their original mandate was to ensure adequate food reserves in case of food shortages. However maize prices were low on average, and the smallholder maize production was uncompetitive compared to international maize production. To prevent maize prices from becoming too low and unable to support local production the Zambian government felt it was necessary to intervene in the market. So in 2005 they amended the FRA mandate to include raising maize prices and increasing price stability. Since then they have become the largest domestic buyer of maize in Zambia. In 2011 the FRA purchases 83% of the marketed maize surplus from smallholder farmers. In more recent years the FRA has scaled down its purchases (Mulungu & Chilundika, 2016; Neubert et al., 2011). Officially the main concern for these interventions was to stimulate welfare, given that 80% of the population is engaged in maize production somehow[1]. However the quantity of maize the FRA buys and its price tend to spike in election years (Mulungu & Chilundika, 2016), providing some proof to the claims that the actions of the FRA are at least partially politically motivated (Neubert et al., 2011). All in all FRA policies have had a negative effect on the market: its price floor has acted as a price ceiling, and has prevented larger private parties from entering the market (Mulungu & Chilundika, 2016). Also in recent years FRA payments often have been late creating problems for farmers (Personal interviews, 2017).

Next to the FRA the Zambian government has another program in place to support farmers: FISP. This program started in 2002 as the Fertilizer Support program (FSP). In 2009 it was renamed to FISP. Its target is to increase the agricultural (maize) production of smallholder farmers (IAPRI, 2017; Mofya-Mukuka, Kabwe, Kuteya, & Mason, 2013; Siame et al., 2017). In 2015 the MAL started a pilot using e-vouchers. In the season of 2017-2018 the e-voucher program will be implemented country wide (IAPRI, 2017; Siame et al., 2017). Eligible farmers receive a bank-card on which they need to deposit 530Ka. Once that is done the card is activated and the government deposits additional funds on their bank account. Farmers can use these funds to buy any type of input he or she wishes from certified agro-dealers. Most commonly they are used to buy fertilizer and maize seed. Under the new E-voucher system farmers are supposed to graduate in three years, in other words farmers will only receive E-vouchers for three years and after that they are supposed to be self-sufficient (IAPRI, 2017; Siame et al., 2017). Distribution of FISP and the e-vouchers is done at the level of the Camp Agricultural Committees (CAC). These are geographical clusters covering a certain area. In the CAC there are representatives of each cooperative or farmers association from the area, a representative of the local chief, a community based organisation and a representative of the MAL (Mofya-Mukuka et al., 2013; Siame et al., 2017). The CAC select who is to receive e-vouchers for the coming season. In order to be eligible to receive FISP farmers need to six criteria (Mofya-Mukuka et al., 2013; Siame et al., 2017): First they have to be a member of either a farmers association or a cooperative. Second, they have to be based in the area covered by the CAC. Third, they should own a maximum 5 ha of land. Fourth, they need to be able to make an initial payment, which was 530Ka (Zambian kwacha) in the 2017-2018 season. Fifth, they cannot be benefitting from the Food Security Pack Programme, which is another government support programme. Sixth, they cannot have defaulted from other or previous government programs. Additionally, people working for the Zambian government are excluded from receiving support through government programs such as FISP. As mentioned at the beginning of this section, more than half of the budget of the MAL is generally allocated to the FRA and FISP, and these expenditures have increased. However no significant effect on poverty reduction has been found (IAPRI, 2017; Mofya-Mukuka et al., 2013; Mulungu & Chilundika, 2016; Neubert et al., 2011), indicating that in the current setting the programs are inefficient.

[1] This level might seem inconsistent with the fact that only around 55% of the total population lives in rural areas. However it is common for Zambians in urban areas to have a plot of land somewhere in the countryside where they grow maize.

2.2 Agriculture and farmers organisations

There are many farmers organisations in Zambia, for instance, there are an estimated 22,000 cooperatives (Mutambo, 2017). How many farmers associations exist is difficult to estimate. Both the cooperatives and the associations are regulated by the government. First I will explain how both sectors are structured, after that I will explain the difference between cooperatives and associations in Zambia.

A new cooperative requires at least 10 members to qualify as an official cooperative, and thus be eligible to receive government support. The National structure for cooperatives has four tiers. On the lowest level is the cooperative, on the second the district cooperative union, the third the provincial cooperative union and the highest tier is the Zambia Cooperative Federation (ZCF) (Mutambo, 2017; Neubert et al., 2011). Each district has an extension officer appointed by the government through the District Agricultural Coordinator (DACO). This extension officers are supposed to check the authenticity of cooperatives, however they lack the means to do so. As a consequence many cooperatives are formed for the sole purpose of gaining access to government support such as FISP (Mofya-Mukuka et al., 2013; Mutambo, 2017; Neubert et al., 2011).

Farmers associations are organised in a different though somewhat similar manner as cooperatives. The country-wide structure is two tiered. Officially all associations are affiliated to the ZNFU, which is the first tier, the second tier is the individual associations. There are specialised commodity associations and District Farmer Associations (such as the NDFA). In the past the ZNFU would offer support, similar to what the ZCF is doing. For instance, the NDFA used to have an extension officer providing extension services to members, which was paid by the ZNFU. However due to internal difficulties the ZNFU has been unable to continue this kind of support to most of its associations (Personal interviews, 2017).

There are several differences between cooperatives and farmers associations in Zambia. Cooperatives work with shares which farmers have to buy in order to become a member, whilst associations have a membership fee which needs to be paid annually. As mentioned many cooperatives mainly exist to gain access to government support. Farmers association also receive support but have a broader focus, also providing extension and other services (Personal interviews, 2017).

2.3 Description of the NDFA and its services

In this section some more detailed information about the NDFA will be provided. The NDFA had around 1700 members in 2016 of which 1150 were active. A member is considered active when he or she has paid their annual membership fees. The annual renewal fee is 100Ka, which is roughly equivalent to €8.50. New members pay an additional registration fee of 10Ka. Members pay their fees to their ICM, who collects all the renewals from his IC, and then brings them to the NDFA office. There he receives receipts for each member. ICMs are elected by the members of their IC, so far every ICM elected has been male. According to the NDFA statutes there should be elections every two years. In practice this does not always happen, and ICM can be in place for ten years without being re-elected. Throughout the years the NDFA has provided a wide array of services, which can be divided in several groups: input supply, training, sunflower processing and other services. Each group of services will be explained in further detail.

The NDFA has supplied several types of input in the past. In 2016 the NDFA has provided sunflower seeds; the year before they provided groundnut seeds. In the current season (2017-2018) no seeds where supplied. Several years ago they provided access to a fertilizer scheme managed by the ZNFU, where farmers could access fertilizer at market rates. At the start of the season farmers would make a small payment, the rest would be paid after harvest. However ZNFU increased the after-payments, to sometimes double the amount, which displeased many members. During interviews I learned that members tended to think that the NDFA was responsible for the increase in prices. To prevent those issues from happening again, the NDFA chose to restructure the fertilizer scheme. This year they worked with a private supplier of fertilizer. The initial payments was high, around 2300Ka, and after harvest farmers needed to pay a smaller amount (700Ka). Prices and amounts of fertilizer would be written down in a contract signed by both the NDFA and members, minimizing the chance of conflict. The initial payment turned out to be too high for many farmers, and in December 2017 only seven farmers had applied for the scheme. During our interviews one farmer mentioned "I have never seen so much money (2300Ka) in my life. How am I expected to get fertilizer this way?" (Personal Interviews).

Throughout the years the NDFA has also provided a wide range of trainings. When a new training project is started all ICMs are called to the office. There they are taught in the new topic. Afterwards they receive training material, if necessary, so that they can provide training to the members of their IC. Each ICM consequently is supposed to teach his own IC. The most recent training the NDFA has provided had the following themes: records keeping, entrepreneurship and climate smart agriculture. The training on records keeping was still going on at the time of the research, so few farmers had implemented any records keeping practices. Though several farmers said that they were planning to start keeping records at the beginning of the planting season.

One of the most important business-related services the NDFA offers has to do with sunflower. The NDFA has a processing facility which produces sunflower oil and sunflower cake. The sunflower oil is sold to members and consumers from the NDFA office. Sunflower cake is a by-product of sunflower oil and can be used for animal feed. The NDFA sells its cake to animal feed processors. Members can sell their sunflower to the NDFA for cash. Alternatively, members can also deliver their sunflower to the NDFA and have it processed there for free. The members receive the oil, and the NDFA keeps the cake.

Other than that the NDFA also offers some other services. Most importantly staff members from the office also visit ICs. These visits are done for several reasons. Firstly to provide information on the state of affairs within the NDFA, and second to do follow-ups on trainings provided by the ICM. Lastly it is also a way of keeping informed about the state of affairs within each IC. Another service is the marketing of goods, which was done on several occasions in the past, though not always successfully. Some years ago the NDFA tried to sell maize owned by members to a third party. However this third party did not honour the agreement and decided not to buy the maize, leading to high costs for both the NDFA and several individual members. This had important consequences for the NDFA since many members blamed the NDFA for their incurred costs, and the NDFA had promised to buy machinery for several ICs with the profits from the selling of maize. Since the NDFA did not sell the maize they were unable to buy the machines leading to further discontentment among members (Personal Interviews, 2017). Lastly they also maintain a plant nursery which contains several types of plants and trees. For members they offer certain soil improving plants. Other than that they also sell plants to other off-takers such as local schools.

In the following chapters I will only analyse the services which were provided recently and to a significant amount of members. A last demand for the analysis is that the data collected is solid and unbiased. This was the case for three sunflower related services: selling of sunflower seeds, the purchasing of sunflower output from members and the processing of sunflower into oil. The three most recent trainings have also been analysed. Other services, such as the supply of groundnuts were not provided to all ICs which could lead to a bias in the analysis. This is why I omitted these in the analysis in the coming chapters.

3 Theoretical framework:

Several theories will be used throughout the thesis. First I will briefly discuss how these are expected to related to each other, after that each theory and concept will be explained using relevant literature.

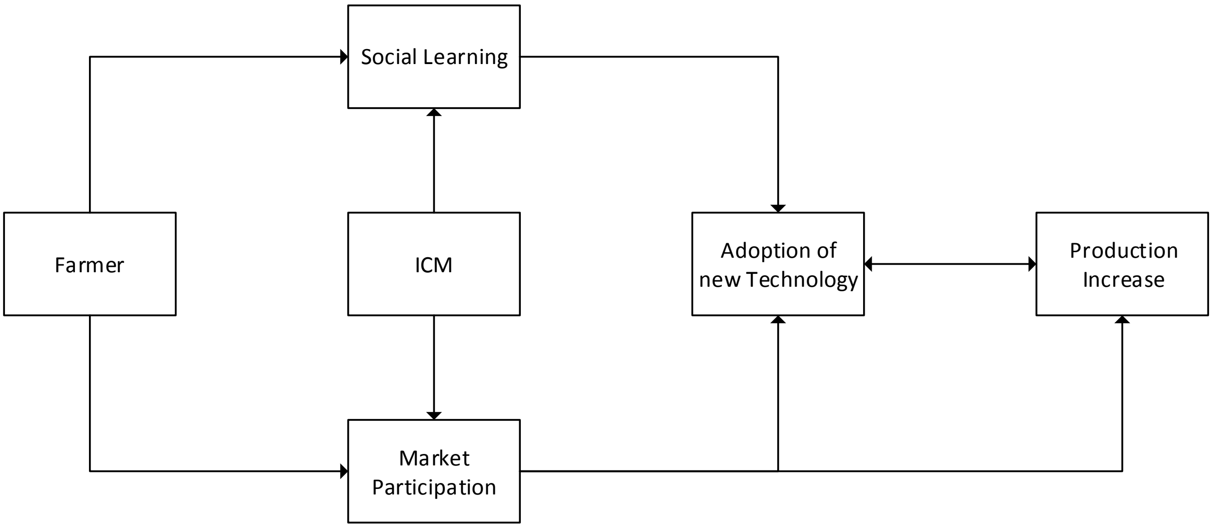

Figure 3.1 Interactions between ICM and member related to technogy adoption

Figure 3.1 displays several processes which are explained in further detail in the rest of this chapter. The figure illustrates the two main processes which are expected to affect the adoption of new technologies which in turn increases production. These processes are social learning and market participation, both are expected to be influenced by the ICM. Social learning takes place during IC meetings where farmers learn of the existence of new technologies and how to apply them. The ICM is the main agent providing extension services, and thus expected to influence the process of social learning and the chances that members adopt these technologies. Secondly there is the aspect of market participation, which is partly influenced by the NDFA, mainly through sunflower related services. Increased participation in the market can mean can increase production, how exactly will be explained later in the chapter, and increase the likelihood that farmers adopt new technologies. The ICM is expected to influence this since he is the main link between farmers and the NDFA office. Lastly it needs to be mentioned that the adoption of new technologies and production increase can reinforce each other. As farmers adopt technologies their production increases, increasing their income which allows them to adopt further technologies and so on (Barrett, 2008). Next I will explain the theories in more detail, first I will explain social learning, next market access and market participation, and lastly I will connect these theories with the theories on technology adoption.

3.1 Social learning

This section will discuss the process of social learning and how it can be applied in an agricultural organisation. First I will provide a definition on social learning, next I will explain its relevance for small holder agriculture, lastly I will connect it to this thesis by explaining the research done by BenYishay and Mobarak (2014).

Social learning is an important element in current extension systems. When a new technology is introduced, trough for instance an intervention, social learning aids in the diffusion of the technology (Conley & Udry, 2010). Social learning can be defined as learning from interactions among multiple inter-dependent stakeholders (adapted from Ison, Röling, and Watson (2007). There are many different definitions of social learning available each in various levels of complexity and differing per research field. For a more elaborate review on social learning see Romina (2014). For this thesis the definition as mentioned above was deemed most suitable.

Social learning appears to be most prevalent in cases where there is a new technology which is unknown to a certain population. An example can be found in the research done by Conley and Udry (2010). They investigated the effect of learning among a group of farmers in Ghana who recently started cultivating pineapples. In order to do this, they measured the effect of social networks on the amount of input used, in this case fertilizer. They found that for new technologies farmers use information gained through their social network to adapt their input use, and that this effect was especially strong for novice farmers. Also they found no effects of learning on known technologies (intercropping cassava and maize). However it needs to noted that learning did not always lead to the most beneficial outcome. After hearing positive news from peer farmers receiving relatively high yields with little or no fertilizer a substantial amount of farmers reduced their fertilizer use, using little or no fertilizer at all. Subsequently this group of farmers produced less efficiently (Conley & Udry, 2010). In short people do use social learning to try and improve their livelihoods but the effects are not always beneficial if the "lessons learnt" are incorrect.

BenYishay and Mobarak (2014) also found evidence for social learning in their study in Malawi and provided some additional useful insights. They studied farmers' knowledge and adoption of new technologies through various "distribution channels" of extension services. Three types of agents were used to distribute knowledge about extension services: extension officers, lead farmers and peer farmers. Half of the distributors were provided with a performance-based incentive. Each extension officer had a certain geographical area to cover, due to shortage of extension workers in Malawi. In some villages the extension worker would train a lead farmer to give extension services, in some a group of peer farmers, and in others the extension worker himself would provide extension services. Before the start of the experiment a selection procedure was held to select peer and lead farmers. The community members provided a short list of who they thought would be suitable lead or peer farmers, and the extension officers selected suitable farmers based on certain selection criteria. For lead farmers these were: to be identified as community leader, be an early adopter of new technologies, be literate and have resources which would aid technology adoption. For peer farmers these were: be an average farmer according to their community, willing to try new technologies and have similar resources compared to other farmers. It was not necessary for peer farmers to be literate. During the experiment BenYishay and Mobarak (2014) measured two things: farmers' knowledge of new technologies and their adoption rates. In the group without incentives the villages with lead farmers showed the highest knowledge and adoption rates. However with incentives the peer farmers proved the most efficient. For lead farmers and extension workers the effect of incentives was limited (BenYishay & Mobarak, 2014). The explanation for the difference was that without incentives the peer farmers put relatively little effort into providing extension services compared to lead farmers leading to low adoption rates. When they were incentivized, effort increased, and peer farmers became more efficient than lead farmers, whether these lead farmers received incentives or not. This was attributed to the fact that the peer farmers were more similar to other farmers than lead farmers. Meaning that other farmers would find it easier to believe that technologies which worked for peer farmers would also work for themselves (BenYishay & Mobarak, 2014). Based on this research I would argue that similar effects could be found for members of the NDFA and that differences between IC managers and members are not only relevant for extension services and technology adoption but for all services offered by the NDFA in which the IC managers play a role. This leads to the following hypothesis: *farmers who are more similar to their ICM are more likely to use services, follow trainings and adopt new technologies taught in extension services compared to members who differ more from their ICM.*

3.2 Market access and market participation

Regarding market access and market participation of smallholder farmers much has been written already. First I will briefly go into the general effect market access and market participation has on smallholder farmers. Next I will go into the effect market access and market participation can have in increasing the adoption of new technologies, last I will connect this to the thesis.

In general the literature finds that having access to markets and participating in them can have a positive effect for the welfare of smallholder farmers and on adoption of new technologies. However access is hampered by various barriers such as poor infrastructure and high transaction costs, and because of these barriers smallholder farmers' market participation is often limited (Barrett, 2008; Chipasha et al., 2017; Fischer & Qaim, 2012; Kaganzi et al., 2009; Markelova et al., 2009; Shiferaw et al., 2011, 2016). Barrett (2008) uses a utility maximisation model to explain why some households do participate in markets and others do not. Each household makes a decision to participate or not depending on its own circumstances affecting the costs and benefits of participation.

Having access to markets can also affect the adoption of new technologies, in several ways. Firstly if farmers have limited access to inputs it is much more difficult for them to use technologies such as fertilizer, simply because they cannot buy them (Abebaw & Haile, 2013). In a case study in Mali Zeller et al. (1998) found that farmers with higher transaction costs for accessing input and output markets were less likely to use new hybrid varieties of maize. The relationship between markets and technology adoption can work both ways. Barrett (2008) states that in order to increase smallholder farmers' participation in markets they need to increase their production through adopting new agricultural technologies. Also if farmers have better access to markets offering better prices, this can increase their income and their incentive to produce (Barrett, 2008; Fischer & Qaim, 2012; Markelova et al., 2009; Shiferaw et al., 2011, 2016; Zeller et al., 1998). Hence market participation and adoption of new technologies can reinforce each other, as also indicated in Figure 3.1. Through increased participation, production and income can increase, which enables farmers to invest and adopt new technologies which in turn increase their production even further.

Various authors have looked into the role for agricultural organisations and collective action to increase farmers' access to both input and output markets. Through agricultural organisations farmers could reduce their transaction costs of selling to markets and access other markets which offer a better price (Barrett, 2008; Fischer & Qaim, 2014; Kaganzi et al., 2009; Markelova et al., 2009; Shiferaw et al., 2011). The NDFA is already assisting members to some degree in accessing input and output markets. As mentioned, the NDFA offers several sunflower related services providing a market for sunflower. This leads to the next hypothesis: *Farmers who have better access to markets and use the NDFA's sunflower services are more likely to adopt new technologies***.**

3.3 Technology adoption

As mentioned in the introduction**,** agricultural productivity levels of smallholder farmers are low, especially in SSA. An important way to increase production is through the adoption of new technologies. First I will define both the terms "technology" and "adoption". Also aside from social learning and market access and market participation there are many other factors which influence technology adoption. The most important ones will be explained in this section using a framework based on (Mwangi & Kariuki, 2015). Lastly this framework will be applied to a technology called Conservation farming (CF).

Technology can be defined as the means and methods of producing goods and services including methods of organisations as well as physical technique (Loevinsohn, Sumberg, Diagne, & Whitfield, 2013). Adoption is defined as the integration of a new technology into existing practice, usually proceeded by a process trying and some degree of adaptation. Dis-adoption is the process of reversion to the previous technology after a new technology was adopted for a short time (Loevinsohn et al., 2013). When measuring adoption it is important to decide whether adoption can be seen as a binary variable or not. Defining adoption as binary variable is common but not always sufficient (Mwangi & Kariuki, 2015). Some authors decide to distinguish between adoption and intensity of adoption (Arslan et al., 2014). However for practical reasons this is not always possible even when it would be desirable (Arslan et al., 2014; Mwangi & Kariuki, 2015).

Mwangi and Kariuki (2015) identify factors which can influence the adoption of agricultural technologies. They divide these factors into four categories: technological, economic, institutional and farmer specific. A fifth category is agro-ecological factors which is not mentioned by Mwangi and Kariuki (2015) but added by Arslan et al. (2014). Each factor can have different effects on adoption depending on the type of technology, graphical location and context. For instance Arslan et al. (2014) and Knowler and Bradshaw (2007) mention that the significance of the effect of factors, such as farm size, education etc., on the uptake of conservation agriculture differs per continent, and can differ within a country as well depending on the circumstances. Next I will explain the how each of the factors mention above can affect the adoption of a new technology.

Regarding technological factors the characteristics of a new technology are important. Trialability is the degree to which a potential adopter can try a technology on a small scale before adopting it completely. The more trialable a technology is the higher the adoption tends to be (Mwangi & Kariuki, 2015). A second technological factor is the perception a farmer has of a technology. This also significantly influences a farmers' decision to adopt. The more a farmer perceives a technology as compatible with his environment and consistent with his needs, the more likely he is to adopt.

There are also economic factors which influence a farmers' decision. The most important ones are the net gains of investing, farm size, labour and the general wealth of the household. First, there is the net gain of the technology for the farmer. In general high costs associated with adoption decreases overall adoption, whereas net benefits have a positive effect on adoption (Barrett, 2008; Mwangi & Kariuki, 2015). The net gain of adoption is also influenced by the other (economic) factors. The size of the farm can have differing effects on net gain and adoption depending on the type of technology. A larger farm makes it easier for farmers to try new technologies (Marenya & Barrett, 2007; Mwangi & Kariuki, 2015). For instance new cultivation methods are easier to adopt, since more land is available, lowering comparative opportunity costs. Also larger farms can offer scale advantages for certain lumpy investments such as farm equipment. However, for other technologies farm size can have a neutral (Bonabana-Wabbi, 2002) or negative effect on adoption. For land-saving technologies and labour-intensive technologies a negative effect can be found. This is because for larger farms there is less need to invest in land saving technologies, and labour tends to be relatively scarcer than for smaller farms (Mwangi & Kariuki, 2015). Also there is a distinction to be made between the overall size of the farm and the crop acreage used for relevant crops. Land size effects are expected to be stronger when crop acreage is used rather than overall size of the farm (Mwangi & Kariuki, 2015). Third, labour is also an important factor affecting adoption of new technologies. For labour-intensive technologies labour availability has a positive effect (Marenya & Barrett, 2007), whilst it can negatively influence the adoption of labour-saving technologies (Mwangi & Kariuki, 2015). Fourth, wealth indicators such as land, livestock and off-farm income are positively correlated with adoption of new technologies (Marenya & Barrett, 2007). In general richer households have more capital to make necessary investments to adopt new technologies. However off-farm employment can also negatively influence adoption of labour intensive technologies since it decreases the amount of labour that is available on farm (Mwangi & Kariuki, 2015).

The next group is the institutional factors, the most important factors are: belonging to a group, access to information, access to extension services and access to credit. Being part of a group enhances social capital, information exchange and trust, and facilitates social learning. Thus farmers who are a member of a social group are more likely to adopt new technologies (Katungi & Akankwasa, 2010). Being a member of the NDFA is thus expected to increase the likelihood that a farmer adopts new technologies. However a counterfactual is missing in the sample to properly test this, since only members were interviewed. Mwangi and Kariuki (2015) and Fischer and Qaim (2014) also mention that the degree of participation is also expected to have a positive effect on social learning and thus adoption. A second factor is the acquisition of information, having information about a technology enables farmers to learn about the existence of a technology and about its effectiveness. In other words it reduces the uncertainty about a certain technology. Thus having access to information has a positive effect on adoption (Bonabana-Wabbi, 2002). However in order to have this effect the information needs to be accurate, consistent and reliable, when this is not the case access to information can have a negative effect on adoption (Mwangi & Kariuki, 2015). Thirdly access to extension services in general has been found having a positive effect on adoption. Farmers are often informed about new technologies through extension services and taught how to apply them. Access to extension service has been found to counter the negative effect of a lack of education on adoption (Bonabana-Wabbi, 2002; Mwangi & Kariuki, 2015). So I expect that farmers which have followed training provided by the NDFA are more likely to adopt new technologies. The last institutional factor mentioned is access to credit. In general it is believed that access to credit increases a farmers' ability to adopt. It allows farmers to concentrate on more risky but also more efficient investments (Mwangi & Kariuki, 2015). Arguably access to credit could also be seen as an economic factor but I have chosen to keep the grouping used by Mwangi and Kariuki (2015). They see access to credit as an institutional factor, but having capital as an economic factor.

Fourth there are farmer-specific factors. Human capital of a farmer is thought to be one of the most important farmer specific factors. In general it is measured through education, age and gender (Arslan et al., 2014; Chomba, 2004; Janvry et al., 2016; Knowler & Bradshaw, 2007; Marenya & Barrett, 2007; Mwangi & Kariuki, 2015). Education is thought to have a positive effect on adoption since it allows farmers to access and process information more thoroughly and thus make a more open rational decision and analyse the benefits of a new technology objectively (Mwangi & Kariuki, 2015). However, a lack of education can be compensated by access to extension services as mentioned earlier. Age has an ambiguous effect on adoption of new technologies. On the one hand older farmers have more experience and knowledge and are thus better able to evaluate technologies. On the other hand older farmers tend to have less interest in long term investment and tend to be more risk averse, which can lead to lower uptake among older farmers (Mwangi & Kariuki, 2015). Another factor which is found to have mixed effect on adoption is gender. Some studies find no significant effect (Marenya & Barrett, 2007), whereas others did find a significant effect depending on the type of technology, meaning that for some technologies men were more likely to adapt (Bonabana-Wabbi, 2002). The main controlling mechanism of the significance of gender appears to be the access to resources. In some contexts men have an increased access to resources, such as credit and information. This enables them to adopt new technologies more easily than their female counterparts (Mwangi & Kariuki, 2015).

Lastly there are the agro-ecological factors, these include: soil type, rainfall patterns and climate (Arslan et al., 2014). These factors have a more indirect effect on the decision of farmers to adopt a technology or not as they influence the net gains of the technology, the exact effects on decision making however often remain unclear (Arslan et al., 2014) and are beyond the scope of this study.

3.3.1 Technology adoption: the example of conservation farming

In this section the factors mentioned above will be applied to the case of conservation agriculture in Zambia. This example was chosen since conservation agriculture is a technology which is used all over the world and is also frequently applied in Zambia, although in a slightly adjusted manner (Arslan et al., 2014; Baudron, Mwanza, Triomphe, & Bwalya, 2007; CFU, 2007). First I will briefly explain what conservation farming entails, next I will explain how the training has been provided in Zambia after that I will explain the effects of the factors mentioned in the previous section on conservation farming.

Conservation agriculture is a technology which aims to increase farm productivity in a sustainable way. It has been advocated as a way to mitigate soil degradation and low productivity. Its three main principles are: crop rotation, permanent organic soil cover, and minimum mechanical soil disturbance (Arslan et al., 2014; Baudron et al., 2007; CFU, 2007; Chomba, 2004; Haggblade & Tembo, 2003). In Zambia conservation agriculture has been adjusted to fit local needs and is called conservation farming (CF). It consists of the following practices: reduced tillage on a maximum of 15% of the fields without soil inversion, digging permanent planting basins (for hoe farmers) or soil ripping (when draft animals are available), leaving crop residue on the field after harvest, rotation of cereals (maize) with legumes and dry season land preparation. (Arslan et al., 2014; CFU, 2007).

Training on CF has been provided in Zambia since the 1990s. The program was started by the ZNFU, in collaboration with international donors. Extension workers provided training on CF through local District Farmers Associations (DFAs) such as the NDFA. For Zambia there are also some specific factors which have had an influence on adoption. And some factors which do influence certain CF practices but have no effect on others. Furthermore many Zambian farmers tend to partially adopt CF, which can mean that they only apply certain practices or that they only apply CF to a portion of their fields (Arslan et al., 2014).

The major technological factor is the trialability of CF. Several components of the technique are easier to try than others, the digging of planting basins for instance is fairly labour intensive, and when requires special equipment when draft animals are used (Arslan et al., 2014).

The main economic factors are the net gain, labour, land size, the households' wealth and distance to markets. Leaving fields covered in crops or crop residue incurs high opportunity costs for farmers since these are commonly used as fuel and animal feed, which negatively influences the net gain for farmers. As mentioned several CF practices have limited trialability and require an increased amount of labour compared to traditional techniques. Logically household size is found to have a positive effect on the chances of adoption Zambia, mostly on crop rotation (CR), less for other CF practices (Arslan et al., 2014; Chomba, 2004). Limited labour availability has been argued to be the most important barrier to CF adoption in Zambia (Arslan et al., 2014; Haggblade & Tembo, 2003). Land size and wealth are also found to have a positive effect on adoption. Lastly distance to markets has a negative effect on the adoption of CF. This means that farmers further away from markets are less likely to adopt (Arslan et al., 2014; Chomba, 2004).

An important institutional factor in Zambia was the government support CF received. The Zambian government provided subsidies for adopters, creating a financial incentive for farmers to adopt. Around 50% of farmers dis-adopted CF when they no longer qualified for subsidies (Arslan et al., 2014; Baudron et al., 2007). Another factor was the distance to extension service which had a negative impact on adoption, meaning that the greater the distance the less likely a farmer was to adopt CF practices (Arslan et al., 2014; Chomba, 2004).

The main farmer specific factor influencing adoption is the farmers' education level which positively affected the adoption of CR but not of CF. Age and the gender of the farmer appear to have no effect on adoption (Arslan et al., 2014).

Several agro-ecological constraints are limiting adoption. The most important one is the limited rainfall in large parts of Zambia during the dry season. This means that it is difficult for farmers to maintain permanent soil coverage since Zambian smallholder farmers mainly use rainfed agriculture (Arslan et al., 2014). However dis-adoption of CF was significantly lower in Eastern province, where Nyimba district is located, compared to other parts of Zambia. This was attributed to the suitable agro-ecological conditions of the province and the high level of extension services available (Arslan et al., 2014).

4 Methods

This chapter discusses the research methods. First I will explain which methods I used, how I constructed my survey, which sampling methods I have used, and how the survey was conducted. Next I will explain the model used for statistical analysis, which is based on the theories in the previous chapter and which variables I have included and why. Lastly I will explain how I performed my statistical analysis.

4.1 Data collection

This research is done in the form of a case study. Case studies involve careful and complete observation of a social unit, in this case members of the NDFA. Such an approach is most suitable when the objective of the research is to understand certain phenomena in depth rather than breadth (Kothari, 2004). Since little was known on the object of study this approach was deemed most suitable. The most important method of data collection is a survey done among members of the NDFA. Several other methods were used for data triangulation. These are unstructured interviews with staff members of the NDFA, field observations and group interviews with NDFA members. Using several research methods to test findings can increase the internal validity of the research through data triangulation (Bernard, 2011). In the early stages of the research I interviewed staff members on various topics, mainly to get information on the workings of the NDFA and its members. This was done because staff members had the most accurate information about past and present NDFA operations. The interviews were unstructured to allow to uncover new and unexpected data (Bernard, 2011). Field observations were carried out throughout the entire research period in Zambia and were used for data triangulation and to serve as a source of inputs for interviews.

Individual interviews serve as the most important source of quantitative information and will be used for statistical analysis in chapter 5. During the survey trials I noticed that not interviewing all members could create frictions within the IC, since many members wanted to have the opportunity to give their opinion about the NDFA. Also some un-interviewed members might have suspected that respondents received some compensation for their time, which was not the case and I stressed this as often as I could. Therefore I conducted several group interviews, with the help of my translator, to prevent friction within ICs. Even though I did not start the interviews specifically with that purpose, they turned out to be a valuable source of qualitative information. During group interviews I would heard things I would not hear during individual interviews. In the following sections I will provide some additional information on how the survey was constructed, the sampling methods used and how the survey was conducted.

4.1.1 Constructing the survey

For the individual interviews a draft survey was constructed in the Netherlands. The most relevant topics and the best way of constructing questions was determined by doing literature research (Bernard, 2011; Grosh & Glewwe, 2000; Kothari, 2004). At the NDFA the relevance and clarity of each question was evaluated with NDFA staff. After this first evaluation the survey was tested at two ICs, one located close to the NDFA office, and one further away, to cover potential geographical differences. After testing various changes were made. For instance estimating distances proved difficult to many farmers, so where possible this was omitted and travelling time was used. Also it was decided not to ask farmers about their income or output levels since it was deemed unlikely that accurate information would be gained.

4.1.2 Sampling procedure of individual interviews

In order to select respondents of the interviews cluster sampling was used. The members were already divided in ICs which were used as clusters. From each IC I visited I tried to do a total of five interviews, the ICM and four randomly selected members. The ICs were used as clusters to cover potential geographical differences and differences between various ICMs. In order to capture the differences between each IC and ICM cluster sampling was deemed more appropriate compared to other sampling methods (Bernard, 2011; Kothari, 2004).To randomly select members, the membership data of 2016 was used. Data for the year 2015 was not available and the data for 2014 turned out to be too inaccurate to be of any use, due to deaths, members relocating, people discontinuing their membership and also the presence of non-existing people in the membership file. Before the start of our data collection it was uncertain how many ICs I could visit before the end of the assignment due to various circumstances, such as: the availability of transport, quality of the roads, and the start of the rain season. Therefore ICs were randomly selected, two weeks in advance. From each IC, the ICM was selected and four normal members. In case these were unavailable for interviews I selected three back-up farmers in advance.

4.1.3 Sampling methods of group interviews

In several ICs I also carried out group interviews. As mentioned this was done initially done to prevent frictions within ICs. Therefore sampling was not done in a structured matter, basically convenience sampling was used. Only when the situation called for it group interviews were performed. This would be the case whenever members had gathered for a group meeting when I was present. During these meetings I would first conduct the individual interviews and afterwards I interviewed the remaining group. Members who were individually interviewed did not partake in group interviews.

4.1.4 Conducting the survey

Due to time constraints I was only able to visit each IC once, therefore I tried to schedule appointments with ICMs from selected ICs to make sure I would arrive on a convenient time. It happened once for instance that I had to reschedule an appointment due to an unexpected death, and most of the members were attending the funeral.

When making the appointment I also informed the ICM which farmers I wanted to interview. The ICM would then ensure that those people were available when I arrived at the IC. However on several occasions names from my initial selection were unavailable. In those cases I would interview one of the back-up farmers. There were various reasons why selected members were not available. The most common reason was that the selected person did not exist, in other words the sampling frame was not fully accurate. Other than that members could be travelling, visiting weddings or funerals, have relocated, switched IC or have discontinued their membership. In one case a member was unable to respond because she was an alcoholic. After establishing who I was going to interview with the ICM, each member was interviewed individually.

Both individual interviews and group interviews were carried out with the help of a translator, since most members had a limited understanding of English. For both types of interviews a standardised list of questions was made and translated into Nyanga, which was the most common language in Eastern Province. During the interviews my translator would ask the questions in Nyanga, and translate the answers for me and I would write down the answers. By having the answers translated directly during the interviews I would be able to clarify when questions were misinterpreted by members. The implications of the use of a translator and the use of back up farmers will be discussed in chapter 6. The surveys for IC managers and members can be found in the appendix.

4.2 Model and variables

In this section I will explain the models and their components which I used in the statistical analysis, how I selected variables, and after that I will explain which variables will be used to measure each component and why. The dependent variables were selected first, and were chosen as to help answer the research questions as defined in the introduction**.** Hence three groups of dependent variables were used: the use of sunflower related services, the following of training, and changes made on farms by respondents. Throughout the thesis I used the following models for the use for sunflower related services (1) and training (2):

$$(1)\ S_{\alpha} = \beta_1 + \beta_2 D_{ij} + \beta_3 M_j + \beta_4 EC_i + \beta_5 IC_j + \beta_6 F_i + \epsilon_{ij}$$
$$(2)\ T_{\alpha} = \beta_1 + \beta_2 D_{ij} + \beta_3 M_j + \beta_4 EC_i + \beta_5 IC_j + \beta_6 F_i + \epsilon_{ij}$$

For analysing farm changes the following model was used:

$$(3)\ Y_{\alpha} = \beta_1 + \beta_2 D_{ij} + \beta_3 T_{\alpha ij} + \beta_4 S_{\alpha ij} + \beta_5 M_j + \beta_6 EC + \beta_7 IC_j + \beta_8 F_i + \epsilon_{ij}$$

Where S, T and Y are the respective dependent variables for service, training, or farm change α. B_1 is a constant and $\beta_{2\text{-}6}$ are coefficients. The first two models have five components, D, M, EC, IC and F. The D_{ij} stands for the difference between the member and his or her IC manager for farmer i in IC j. M_j stands for the access to markets in IC j. EC_i captures the economic factors which can effect a farmers' choice to use T_α or S_α or to adopt Y_α for farmer i. IC_j stands for the effect of the IC specific characteristics of IC j, these can be seen as the institutional effects. F_i stands for the farmer characteristics of farmer i, and ϵ_{ij} is an error term. The dependent variables are all measured with one dummy variable and each of the components will be measured with several independent variables. In order to find investigate the effect of training and sunflower related services on farm changes a slightly extended model is required (3). The component $T_{\alpha ij}$ stands for training α farmer i has received in IC j, and can be seen as the effect of extension services on technology adoption. The component $S_{\alpha ij}$ stands for the sunflower service α farmer i used in IC j, and can is used as a proxy for the effect of market participation on technology adoption. The other components have the same meaning as with model (1) and (2). Due to the limited scale of the study technological and agro-ecological are not included into the equation.

In total there are eight dependent variables, each related to the activities of the NDFA. All were dummy variables, where 0 meant that they had not used the service or adopted the technology and 1 meant that they had done so. There are three sunflower related services used for analysis: buying sunflower seed, selling sunflower to the NDFA and processing sunflower at the NDFA into sunflower oil. Three trainings have been used for analysis: a training on records keeping training, one on entrepreneurship and one on climate smart agriculture. These were used as these were the three most recent trainings. Regarding farm changes only the use of crop rotation and the use of other conservation agriculture practices has been analysed. These were the only changes where there was a large enough group which had applied the changes for prove useful for analysis. Most farmers had not started keeping records, most likely because they had only just received training on this topic and several farmers were unable to read and write.

After the dependent variables were selected it was time to select the independent variables. First I will explain the general selection process, next I will explain per component which variables have been included and why. Basically four steps were taken to determine which variables to include. The first was to determine the relevance based on literature (Arslan et al., 2014; Awoke, 2014; Barrett, 2008; Baudron et al., 2007; BenYishay & Mobarak, 2014; Bonabana-Wabbi, 2002; de Leede et al., 2017; Fischer & Qaim, 2012; Haggblade & Tembo, 2003; IAPRI, 2017; Loevinsohn et al., 2013; Miller & Mobarak, 2015; Mwangi & Kariuki, 2015; Romina, 2014). The second was to test its quality using Akaike's information criterion and the Baysian information criterion. The third step was my personal assessment of the reliability of the measurements. In short this lead to a very simple conclusion: highly qualitative variables do not provide statistically relevant data. Therefore it was decided to exclude variables pertaining qualitative data such as the general opinion of farmers regarding the NDFA. This data was mainly collected to be able to write a report for Agriterra and the NDFA itself and thus is not a great loss. Lastly there were several related or similar variables of which only one could be used at the same time. This occurred with using land per capita other than using total cultivated land and labour or using dependency ratios over using labour and non-working family members separately. In these cases I ran regressions with both variables to see if there were any differences in the outcomes. In both cases there were no large changes in the outcomes of the regressions so I decided to use those which I deemed most suitable.

The difference component D will be measured with five variables. The first one is the difference in age, measured in years between the farmer and the lead farmer. The second is the difference in education, measured in years of formal education. The third is the difference in the number of adults in the household. Someone is measured as an adult between the ages of 15 and 75, based on Agbonlahor, Adewuyi, and Ogundairo (2016) and Hadley, Belachew, Lindstrom, and Tessema (2014). The fourth is the difference in farm size, measured in acres of land cultivated by the household of the member in the previous growing season. The fifth and last variable is the difference in livestock, measured in tropical livestock units (TLU). This was done by taking the regular TLU, as used in Nugusse, van Huylenbroeck, and Buysse (2013), and adding animals which were not present in this definition. Several farmers in the sample held animals for economic purposes which were not mentioned in the standard TLU conversion, these animals were ducks, guinea fowl and doves. Ducks and guinea fowl were given the same value as chickens, doves the value of half a chicken, which means that one dove represents 0.005 TLU. This was done to represent the economic value of each of these types of animals. So the following method has been used to calculate the number of TLUs for each farmer:

$$(4)\ TLU = Cattle * 0.7 + Pigs * 0.2 + Goats * 0.1 + Sheep * 0.1 + Chicken * 0.01 + Ducks * 0.01 + Guineafowl * 0.01 + Doves * 0.005$$

The market access component M will be measured with two variables: the distance from the IC to Nyimba measured in kilometres and the distance to the closest paved road. The distance to Nyimba measures both the distance to the largest market in the region as the distance to the NDFA. The second variable is the distance from each IC to the closes paved road, measured in kilometres. The only paved road in the district is the Great East Road, which runs from Lusaka to Chipata, and serves as an estimator to access to alternative markets.

The economic component will be measured using several variables mentioned in chapter 3. The first is the farm size, measured in acres of cultivated land. The second is the number of livestock, measured in TLU. This is included as an indicator of wealth. The third is the number of adults in the farmers' household. Since it was impossible to gather enough data to estimate net gains of adoption for each farmer this variable is excluded from analysis.

The IC component, which stands for the influence of institutions will be measured using one variable. This is the assessment of the IC manager, which was made by the extension officer of the NDFA. I asked him to give each IC manager a grade from 1 (very bad) to 10 (excellent). I chose the extension officer since he was the employee of the NDFA who had the most regular contact with each of the lead farmers. There was additional data gathered on the quality of the NDFA but this proved to be too qualitative to be useful in quantitative analysis.

The farmer component F will be measured through five variables. The first three are used to estimate the farmers' human capital. The first one is a dummy for the gender of the respondent, 0 being female and 1 being male. The second is the age of the farmer. Third is education, measured in years. Next is a dummy variable on the type of member the respondent is, 0 being a normal member and 1 being an IC manager. The final variable is the travel time to the IC which measures the time it takes the farmer to arrive at the IC meetings, measured in minutes. During trials I noticed that farmers found it easier to estimate time, than to estimate distance which is why I chose to use time rather than distance.

Lastly I will explain how the two additional components for the equation on farm changes (3) will be measured. The component T will be measured through the relevant trainings provided by the NDFA. As we have two farm changes, one on crop rotation and one on conservation agriculture only the training on climate change agriculture is deemed relevant. The component S will be measured through the use of the three different sunflower related services, buying sunflower seeds, selling sunflower the NDFA or having sunflower processed at the NDFA. It is important to note that the S and T component are both endogenous, which has important implications for the results. Due to the limited time and resources available I was unable to properly correct for this endogeneity.

4.3 Statistical analysis and procedure

This section describes how the results presented in the next chapter have been calculated. All calculations, tests and regressions have been done using Stata 13.0. First I ran some commands to gain insight in the variables and the potential differences between IC managers and members. In order to do so I calculated the means for the farmer characteristics and the economic component, which are component F and EC explained in the previous section and the dependency ratio. After that I ran two sample t-Tests with equal variances to see whether the means were significantly different from each other. The results can be found in the tables in section 5.1 on descriptive statistics. After that I constructed a correlation matrix and calculated the variance inflation factors for all independent variables used in order to check for collinearity. Both tests indicated that there were no collinearity problems. The correlation matrix can be found in the appendix.

After these tests had been performed it was time to start with the regressions. A regression was run for each dependent variable. In order to start I had to decide which type of regression to use. Since all dependent variables were binary (dummy) variables I chose to use a logistic regression. The data I have collected is structured in ICs, since farmers within ICs are expected to be more similar to each other than farmers from other ICs. The next step was to decide whether to use a fixed or random effects model. A fixed effect model is not effective when variables of interest are expected to be constant for each individual (Dougherty, 2016). Hence I looked into the option of using random effects regression. In order to be able to use them the data needed to meet two criteria: it had to be a random sample from the population and the IC specific variables needed to be independently distributed of variables related to individuals. In order to test whether this is the case it is common to execute a Durbin-Wu-Hausman test (Dougherty, 2016). However this was not possible due to the structure of the data and variables used. Since running a Durbin-Wu-Hausman test was not possible I decided to run both fixed effects and random effects regressions to compare the results. Fixed effects regression omitted all variables related to market access and the IC, whilst random effects did include these in the regression results. Since these were important control variables I decided to use a random effects model. In order to deal with potential heteroscedasticity I used heteroscedasticity-consistent standard errors, also called robust standard errors, as suggested by Dougherty (2016). In the appendix three additional tables can be found using the same model but using a standard fixed effects regression. This is done to show that the results are fairly similar compared to the tables presented in the next chapter.

5 Results

In this chapter the results of the regressions on sunflower services, training and farm changes will be discussed and interpreted. Before that I will start with some descriptive statistics providing information about the farmers and the difference between farmers and lead farmers.

5.1 Descriptive statistics and T-tests

This section will provide some descriptive statistics on the respondents of the survey. Table 5.1 provides information on the means of the respondent members, IC managers and the means of all the respondents combined.

Table 5.1 means of farmers and ICMs

VARIABLES	Members	ICM	Total	T-test
Age (in years)	46.05	49.64	46.78	-1.13
	(15.56)	(12.86)	(15.07)	
Education (in years)	5.745	8.929	6.391	-4.17***
	(3.851)	(2.356)	(3.814)	
Adults (between 15 and 75)	3.464	4.143	3.601	-1.76**
	(1.612)	(2.505)	(1.839)	
Dependency ratio	2.466	2.393	2.451	0.24
	(1.458)	(1.214)	(1.408)	
Travel time to IC (in minutes)	16.85	14.96	16.46	0.41
	(21.87)	(18.14)	(21.12)	
Farm size (in cultivated acres)	6.655	9.420	7.216	-2.40***
	(5.324)	(5.898)	(5.537)	
Livestock (measured in TLU)	4.357	5.700	4.629	-1.25
	(4.872)	(5.865)	(5.095)	
Observations	110	28	138	

Notes: The numbers between brackets are the standard errors of the means. The dependency ratio is calculated by dividing the number of children and elderly by the number of adults. All T-test are single sided, except for the test on age and travel time.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

As can be seen in the table there are some differences between members and IC managers, similar to the differences described between farmers and lead farmers in BenYishay and Mobarak (2014). Based on the results of BenYishay and Mobarak (2014) I theorised that members would have lower education levels, less adults per household, a higher dependency ratio, a smaller farm size and less livestock, so for these variables a one-sided test was carried out. BenYishay and Mobarak (2014) did not report significant differences in age and did not go into detail about travel time so for those variables I carried out a two sided T-test.

The differences with the highest significance levels are the difference in education levels and the difference in farm size where IC managers on average have had several years more education and larger farms. Other than that IC managers had more adults per household, though only significant on a 5% level. The differences between other variables are not significant. Looking at the dependency ratio for instance, which was calculated using the technique applied in Hadley et al. (2014) and Agbonlahor et al. (2016) we do find some small differences in the mean, but these are too small to be significant. It needs to be said that given the relatively small sample size, it is difficult to estimate whether these differences really are insignificant or whether this is because the limited number of observations.

When comparing the data with the findings of BenYishay and Mobarak (2014) some caution is needed. In absolute numbers the differences appear to be quite a bit larger in my sample than the differences reported by BenYishay and Mobarak (2014). However their research takes place in Malawi and not in Zambia so these absolute differences are difficult to interpret. Nevertheless the types of difference are the same, meaning that both IC managers and the lead farmers described by BenYishay and Mobarak (2014) are relatively better off than other farmers.

Table 5.2 Means of male, female members and ICM

VARIABLES	Men	Women	ICM	Total	T-test Men-ICM	T-test Women-ICM
Age (in years)	47.06	45.09	49.64	46.78	-0.72	-1.41
	(16.73)	(14.42)	(12.86)	(15.07)		
Education (in years)	6.870	4.661	8.929	6.391	-2.72***	-5.46***
	(3.619)	(3.786)	(2.356)	(3.814)		
Adults (between 15 and 75)	3.648	3.286	4.143	3.601	-1.04	-1.99**
	(1.761)	(1.449)	(2.505)	(1.839)		
Dependency ratio	2.582	2.354	2.393	2.451	0.56	-0.13
	(1.549)	(1.368)	(1.214)	(1.408)		
Travel time to IC (in minutes)	15.44	18.20	14.96	16.46	0.10	0.65
	(20.83)	(22.94)	(18.14)	(21.12)		
Farm size (in cultivated acres)	7.546	5.795	9.420	7.216	-1.32*	-3.24***
	(6.192)	(4.206)	(5.898)	(5.537)		
Livestock (measured in TLU)	4.941	3.793	5.700	4.629	-0.62	-1.60*
	(4.952)	(4.770)	(5.865)	(5.095)		
Observations	54	56	28	138		

Note: The numbers between brackets are the standard errors of the means. The dependency ratio is calculated by dividing the number of children and elderly by the number of adults. All T-test are single sided except for the test on age and travel time.
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5.2 provides data on the same variables as Table 5.1, but it distinguishes between male and female members. Making the distinction between male and female members provides some interesting insights. In general it can be said that female members differ more from IC managers than male members. They have received less education and have smaller farms compared to IC managers. If we compare Table 5.1 with Table 5.2 it can be observed that the difference in farm size between IC managers and members mainly seems to be caused by the smaller farms of female members, the difference in farm size between male members and IC managers is only significant on a 10% level. However with making distinctions between male and female members we have to be even more careful with drawing conclusions since we split up an already relatively small group. Though the difference is not significant it is interesting to see that for our sample women tend to live slightly further away from ICs than men and IC managers. This could imply that female members tend to live further away from village centres. However since the result is insignificant and further data is lacking it is better to be careful with making assumptions.

Table 5.3 Percentage data on gender, service usage and farm changes

	Members		ICM		Total	
	No.	%	No.	%	No.	%
Respondent characteristics						
Male	54	49.1%	28	100.0%	82	59.4%
Service usage						
Sunflower seeds	45	40.9%	20	71.4%	65	47.1%
Selling sunflower	23	20.9%	16	57.1%	39	28.3%
Processing sunflower	33	30.0%	15	53.6%	48	34.8%
Following training						
Record keeping training	88	80.0%	23	82.1%	111	80.4%
Entrepreneurship training	89	80.9%	24	85.7%	113	81.9%
Climate smart agriculture training	93	84.5%	26	92.9%	119	86.2%
Farm changes						
Conservation farming	34	30.9%	18	64.3%	52	37.7%
Crop rotation	50	45.5%	11	39.3%	61	44.2%
Total	110	100.0%	28	100.0%	138	100.0%

Table 5.3 provides percentage data on several topics, respondent characteristics, the use of services and changes made on the farm after following an NDFA training. Only the services, trainings and farm changes which are analysed in the next sections are presented here. As can be seen in the table on average IC managers are more likely to have used a service related to the use of sunflower compared to members. During interviews I noticed many members where not fully aware of the services the NDFA offered whilst ICMs tended to know fairly well which services were provided and how these worked. This difference in knowledge could explain why ICMs used these services more than members. Following trainings is more evenly distributed, with more or less equal percentages for the records keeping training, the entrepreneurship training and the climate smart agriculture training. When looking at farm changes it can be seen that IC managers are twice as likely to adopt conservation farming, compared to members. The adoption of crop rotation appears to be fairly evenly spread.

5.2 Regressions on the use of services

This section addresses the results from the logistical regressions done related to sunflower services. I performed three regressions, one for each service. First I will discuss the results on the difference variables, next the results on market access, after that I will briefly discuss the significant variables for each component.

Table 5.4 Logistical regressions on sunflower related services

VARIABLES	Sunflower seeds	Selling sunflower	Processing sunflower
Differences between ICM and member			
Difference in age (in years)	0.0223	-0.0436**	-0.000575
	(0.0269)	(0.0212)	(0.0164)
Difference in education (in years)	0.128	-0.273**	-0.0412
	(0.139)	(0.130)	(0.100)
Difference in the number of adults	0.0957	-0.114	-0.0426
	(0.135)	(0.141)	(0.0985)
Difference farm size (in cultivated acres)	0.107*	0.0353	0.0255
	(0.0625)	(0.0401)	(0.0465)
Difference in livestock (in TLU)	0.0154	0.0544	0.0465
	(0.0812)	(0.0848)	(0.0614)
Market access			
Distance to Nyimba (in km)	0.0434***	-0.0348	-0.0854***
	(0.0152)	(0.0218)	(0.0193)
Distance to closest paved road (in km)	-0.00218	0.0943***	0.0640*
	(0.0289)	(0.0358)	(0.0352)
Economic component			
Farm size (in cultivated acres)	-0.0892	0.0836	0.0198
	(0.0802)	(0.0526)	(0.0601)
Adults (between 15 and 75)	-0.222	0.0772	0.0789
	(0.172)	(0.125)	(0.144)
Livestock (measured in TLU)	0.0402	-0.153**	-0.0303
	(0.0830)	(0.0744)	(0.0649)
IC component			
ICM assessment	0.157*	0.0874	0.00689
	(0.0806)	(0.132)	(0.111)
Farmer component			
Gender (0=female 1=male)	-0.117	1.017	1.123**
	(0.490)	(0.808)	(0.456)
Age (in years)	-0.0210	0.0481***	-0.00449
	(0.0235)	(0.0180)	(0.0224)
Education (in years)	-0.0502	0.0565	-0.0395
	(0.137)	(0.117)	(0.105)
Type Member	1.412*	2.241**	1.002*
	(0.743)	(0.934)	(0.593)
Travel time to IC (in minutes)	-0.0202*	-0.0358*	-0.000260
	(0.0116)	(0.0210)	(0.0127)
Constant	1.029	-5.985***	-0.0539
	(2.230)	(2.319)	(1.781)
Observations	138	138	138
Number of ICs	28	28	28

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As we can see in Table 5.4 the results differ per service. The significance of the variables differ substantially for each service which makes it more complicated to make generalised statements. Regarding the differences there are several significant variables. The differences in education and age have a negative effect on selling sunflower. So it appears that farmers which are more similar in age and education levels are better able to persuade their members to sell their sunflower to the NDFA. Difference in farm size has a positive effect on buying sunflower seeds, though this might be a statistical coincidence. Other than that differences appear to have no significant impact on sunflower services.

Market access does appear to be important, though the effect differs per service. The distance to Nyimba has a positive influence on buying sunflower seeds but a negative effect on selling sunflower. This might appear counterintuitive but actually is explainable by looking at the way these services are distributed, and keeping in mind that many farmers reported having issues with transportation. When members bought sunflower seeds from the NDFA these would be delivered to the IC, making it easier for members to access those seeds compared to seeds bought in Nyimba. Also the further away farmers live from Nyimba, the larger the distance to the input-market and the more difficult it might be for them to access alternative sources of inputs. However if members want to sell their sunflower crops to the NDFA after harvest they have to deliver it to the NDFA in Nyimba, explaining why distance has a negative impact here. The proximity to alternative markets is not significant for buying seeds, highly significant for selling sunflower and slightly significant for processing. That it is not significant for buying sunflower is most likely due to the fact that the largest market is based in Nyimba and there are few other places where farmers can get seed with a good quality. The positive effect of distance on selling and processing indicates that farmers who have better access to alternative markets are more likely to use other markets than farmers who live further away.

Next I will briefly go into the other significant variables per component. When looking at the economic and IC component only livestock and ICM assessment are both significant but only once. Livestock has a significant effect for selling sunflower. It is not unlikely that this is a statistical coincidence. ICM quality only appears to matter for the buying of sunflower seeds. This provides some evidence that better ICMs are better at conveying the benefits of buying sunflower from the NDFA opposed to using recycled seed or getting it from an alternative buyer.

For the farmer component several variables are significant though only the type of member matters for all three services. Gender has a positive effect on processing sunflower, meaning that men are more likely to use the service. It is possible that it is easier for men to travel than for women, making it easier for them to deliver their sunflower output and collect their sunflower oil a few days or weeks later. Buying sunflower requires no or limited travel and selling sunflower requires that members go to the NDFA only once, which could explain why it is only significant for the processing service. However this is the only regression where gender was a significant variable, so it might be a statistical coincidence. Age has a positive effect on selling, which would mean that older farmers are more likely to sell to the NDFA. The type of membership is significant for all services. The most likely explanation would be an asymmetric distribution of information between members and ICMs. During interviews I also asked respondents which services they knew and ICMs tended to have a fuller understanding of the services and how they worked as I also mentioned in the previous section. This makes sense because ICMs interact more with the NDFA office and thus hear about the services that are provided on an earlier stage. Members depend on their ICMs for information about the services that the NDFA provides which might be provided late or not at all. The unequal distribution of information can also be related to the travelling time to the IC which negatively affects both the buying of seeds and the selling of output. This might be because the members who lived further away attended less meetings and received less information about the services, or found it more difficult to transport their sunflower from the IC to their farms, in the case of buying seeds.

5.3 Training and farm changes

The following section describes the regression results on the three most recent trainings provided by the NDFA and the farm changes made by NDFA members. First I will explain the results on the trainings on records keeping, entrepreneurship and on climate smart agriculture. Next I will explain the results on farm changes. For each table I will first discuss the results on the differences between ICMs and members, then the results on market access and after that the significant results for each component.

Table 5.5 Logistical regressions on training

VARIABLES	Records keeping	Entrepreneurship	Climate smart agriculture
Differences between ICM and member			
Difference in age (in years)	0.0189	-0.0635***	-0.0663***
	(0.0293)	(0.0229)	(0.0198)
Difference in education (in years)	-0.00778	-0.119	-0.212
	(0.146)	(0.115)	(0.143)
Difference in the number of adults	0.00196	0.0775	0.161
	(0.0922)	(0.109)	(0.104)
Difference farm size (in cultivated acres)	-0.0247	-0.0284	0.0671
	(0.0404)	(0.0604)	(0.0559)
Difference in livestock (in TLU)	-0.0195	0.128**	-0.00962
	(0.0410)	(0.0518)	(0.0431)
Market access			
Distance to Nyimba (in km)	0.0535**	-0.00827	0.0230
	(0.0218)	(0.0163)	(0.0177)
Distance to closest paved road (in km)	-0.0129	0.0343	0.0299
	(0.0290)	(0.0309)	(0.0328)
Economic component			
Farm size (in cultivated acres)	0.0185	0.216**	-0.0743
	(0.0562)	(0.0909)	(0.0733)
Adults (between 15 and 75)	-0.0894	-0.239	-0.206
	(0.165)	(0.164)	(0.252)
Livestock (measured in TLU)	0.0175	-0.0415	0.119
	(0.0730)	(0.0846)	(0.130)
IC component			
ICM assessment	0.0308	-0.00619	0.112
	(0.204)	(0.125)	(0.205)
Farmer component			
Gender (0=female 1=male)	0.0557	0.795	0.467
	(0.642)	(0.519)	(0.694)
Age (in years)	0.00350	0.0224	0.0345
	(0.0346)	(0.0268)	(0.0228)
Education (in years)	-0.172	-0.0592	-0.0610
	(0.136)	(0.129)	(0.143)
Type Member	0.224	0.437	0.851
	(0.656)	(1.040)	(0.805)
Travel time to IC (in minutes)	-0.0410***	-0.0276**	-0.0112
	(0.0126)	(0.0139)	(0.0210)
Constant	2.071	0.510	-0.253
	(2.470)	(1.351)	(2.668)
Observations	138	138	138
Number of ICs	28	28	28

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Contrary to what I expected Table 5.5 shows that few of the differences between ICMs and members have a significant impact on training. For the record keeping training none of the difference variables were significant. The difference in age has a negative effect on following the entrepreneurship training and climate smart agriculture training. This would indicate that farmers which are more similar in age are slightly more likely to have followed these trainings. Difference in livestock has a positive effect on following the entrepreneurship training which is not what I expected based on BenYishay and Mobarak (2014). However, since the amount of livestock can also be seen as a wealth indicator, it is possible that IC managers with relatively more cattle are seen as more successful, and thus better suited to be giving a training on entrepreneurship.

Looking at the market access it can be seen that only the distance to Nyimba is significant, and only for the training on records keeping. I did not expect to find any effect of market access on following training so this is somewhat surprising.

Looking at the economic and IC components we see that farm size is the only significant variable, and only for the training on entrepreneurship. As larger farms tend to have more output and hence more which could potentially be sold on markets this is not necessarily a surprising result.

For the farmer component the only significant variable is the travel time to the IC which negatively impacts both the records keeping training and the training on entrepreneurship. The negative effect is not surprising as it implies that the longer farmers have to travel to get to the IC meeting to receive training the less likely they are to do so. During interviews I also heard that members were not always informed of meetings by their ICM. It could be the case that ICMs are reluctant to visit members which live further away as this would cost them more effort, which could be an alternative explanation for the negative effect.

All in all there is not a single variable which is significant for all three trainings. There is some evidence that the difference between the IC manager and members influences the following of trainings but the effect depends on the type of training and the type of variable. This variation could be caused by the fact that the trainings cover different topics. The training on climate smart agriculture is the only training which focusses directly on farming practices, the other two are about teaching farmers to adopt a more business-like approach on farming.

Table 5.6 Logistical regressions on farm changes with and without training and sunflower services

VARIABLES	Crop rotation	Conservation Farming	Crop rotation	Conservation Farming
Differences between ICM and member				
Difference in age (in years)	0.0733***	-0.0215	0.0509**	-0.0221
	(0.0239)	(0.0169)	(0.0212)	(0.0154)
Difference in education (in years)	0.161*	0.144**	0.0669	0.118**
	(0.0957)	(0.0601)	(0.0972)	(0.0535)
Difference in the number of adults	-0.0220	0.0122	-0.0363	-0.00552
	(0.0810)	(0.0701)	(0.0808)	(0.0594)
Difference farm size (in cultivated acres)	0.128*	-0.0773***	0.0974*	-0.0856***
	(0.0698)	(0.0298)	(0.0543)	(0.0280)
Difference in livestock (in TLU)	-0.0268	0.0557*	-0.00607	0.0567**
	(0.0529)	(0.0324)	(0.0525)	(0.0284)
Market access				
Distance to Nyimba (in km)	0.0188	0.0206	0.00735	0.0137
	(0.0162)	(0.0155)	(0.0119)	(0.00874)
Distance to closest paved road (in km)	-0.00265	-0.0192	0.00595	-0.0171
	(0.0299)	(0.0193)	(0.0236)	(0.0156)
Training and sunflower services				
Buying sunflower seeds	-0.963*	-0.533		
	(0.494)	(0.490)		
Selling sunflower	0.00506	0.326		
	(0.482)	(0.592)		
Processing sunflower	0.503	-0.0582		
	(0.504)	(0.580)		
Climate smart agriculture training	2.333***	-0.173		
	(0.799)	(0.687)		
Economic component				
Farm size (in cultivated acres)	-0.0718	0.129***	-0.0316	0.138***
	(0.0772)	(0.0477)	(0.0710)	(0.0448)
Adults (between 15 and 75)	0.139	-0.0267	0.167	-0.00698
	(0.114)	(0.100)	(0.105)	(0.104)
Livestock (measured in TLU)	-0.0624	-0.0345	-0.0764	-0.0442
	(0.0621)	(0.0486)	(0.0642)	(0.0447)
IC component				
ICM assessment	0.00926	0.306***	-0.00903	0.271***
	(0.127)	(0.0855)	(0.117)	(0.0698)
Farmer component				
Gender (0=female 1=male)	0.207	0.105	0.422	0.146
	(0.356)	(0.522)	(0.340)	(0.485)
Age (in years)	-0.0605***	0.0293*	-0.0479**	0.0306*
	(0.0188)	(0.0170)	(0.0189)	(0.0158)
Education (in years)	-0.0891	-0.119*	-0.106	-0.103*
	(0.101)	(0.0705)	(0.104)	(0.0611)
Type Member	-0.808	1.483**	-0.567	1.361**
	(0.631)	(0.686)	(0.640)	(0.627)
Travel time to IC (in minutes)	-0.0146*	0.00783	-0.00790	0.00843
	(0.00843)	(0.00954)	(0.00743)	(0.00933)
Constant	2.167	-4.032***	2.876*	-4.323***
	(1.927)	(1.537)	(1.537)	(1.332)
Observations	138	138	138	138
Number of ICs	28	28	28	28

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The last regressions I did were on the changes made on the farm, Table 5.6 shows the results for the regressions on crop rotation (CR) and conservation farming (CF). Due to the endogeneity of sunflower services and training I decided to run the regressions twice to observe the differences. As can be seen in the table the results are fairly similar decreasing the likelihood of severe endogeneity problems. As I explained in chapter 3 conservation farming, or conservation agriculture, is a package of several measures. Due to time constraints and translation issues it was measured using a single dummy variable, this means that some caution is needed when interpreting these regression results. Next I will discuss results per component.

There are several difference variables which are significant. The difference in age is significant for CR, however contrary to previous regressions where age was significant now it has a positive coefficient, meaning that a larger age difference increases the chances of a member having implemented. Difference in education is significant for three of the four regressions, all with positive effects. This is unexpected, for CF it could be related to the negative effect of education, which is also unexpected. It could be explained by earlier research results reporting that proper extension services can compensate for the lack of education (Bonabana-Wabbi, 2002; Mwangi & Kariuki, 2015). Difference in farm size is significant for all four regressions, but with opposite effects for CR and CF. On CR the effect is positive, indicating that farmers which differ more from their ICM are more likely do adopt CR. The negative effect of CF it implicates that farmers with farm sizes more similar to their IC managers are more likely to adopt. This is also most likely related to the overall positive impact of farm size, meaning that larger farmers are more likely to implement conservation farming. This makes sense as several CF practices require a certain scale before they become profitable (Haggblade & Tembo, 2003). The last difference which is significant is the difference in livestock which has a positive effect on CF, which is not so easy to explain but could be a statistical coincidence.

The results on market access, sunflower services and training show that market access has no effect on the adoption of CR or CF. Market participation, measured using sunflower services, has no or a negative effect, which is the opposite of what I expected. Only buying sunflower seeds is significant, but only barely so, this might mean that it is a statistical coincidence. The lack of effect could be explained through two things. The limited effect of market access could be explained through a limited degree of market participation. If farmers do not participate or hardly participate in markets the effect of market access disappears. The lack of effect on sunflower services, which I used as a proxy of market participation could indicate that the effect of the use of sunflower services is too small to induce farmers to increase their production. The following of training only appears to have an effect on CR. Members who have followed the training on climate smart agriculture were more likely to adopt CR. This shows that following training can have an effect on farm practices, which is what I expected. This effect is not present for CF which might be because of the technical differences between the both techniques. Adopting CF is more difficult and has more barriers as explained by Arslan et al. (2014), which might explain why the effect of training has disappeared.

Looking at the economic and IC components only farm size and ICM assessment are significant and only for CF. As I explained earlier the positive effect of farm size is most likely related to the fact that adoption of CF requires a certain scale. For CR scale is much less important, which also explains why farm size has no significant effect. ICM assessment has a positive influence on the adoption of CF, so it appears that ICMs which performed better according to the extension officer of the NDFA were more successful in assisting their members to adopt CF. It needs to be said that this is the only regression where it consistently had a highly significant impact, raising some questions about the efficiency of the variable.

Lastly I will discuss the farmer component. Age has a significant effect on both CR and CF but the effect is negative for CR and positive for CF. Mwangi and Kariuki (2015) found that age can have an ambiguous effect on adoption, as mentioned in chapter 3. Again this might be explained by looking at the technical aspects of each technique. It appears that younger farmers tend to implement the relatively easy technique CR, whilst older farmers prefer the more difficult CF. This would indicate that more experienced farmers are more likely to adapt more difficult techniques, which is not surprising. The type of membership also matters but only for CF. This probably has a similar explanation as with the effect of age. ICMs have better access to information as mentioned above, which would allow them to learn more about how to implement CF. BenYishay and Mobarak (2014) also mention that lead farmers tend to be more experienced farmers, which would make it easier for them to adopt relatively complex techniques. These two factors most likely explain the effect the type of membership has on CF. The last significant variable is the travel time to the IC, which would indicate that members who live closer to the IC are more likely to adopt CR. However, it is only significant for the regression which includes the effects of training and sunflower related services, so it might be a statistical coincidence.

Taking a combined look at the regressions on both crop rotation and conservation farming, it becomes clear that contrary to my expectations there are no variables which have the same influence on both CR and CF. Other than that there are several difference which are significant for either one of the regressions but the type of effect, negative or positive, also varies. Many of these differences can be explained by looking at the type of technique, which increases the need to look closely to the type of technology which is to be adopted and its characteristics.

6 Discussion

This chapter will pay attention to the limitations of the study, and some of the assumptions made throughout the research. First I will address the limitations of the research in the data collection phase and second the limitations on the findings of the research.

6.1 Limitations of the data collection phase

When selecting the research methods I tried to choose the most efficient methods in order to collect as much useful data as possible in the time available. Still it is important to realise that the manner in which data has been collected can affect the data. For instance the fact that I conducted all interviews myself could have influenced the results. Many of the respondents of had not seen a white person or a "muzungu" for a year or more. This might have several effects, on the one hand respondents might have been reluctant to tell certain things to a stranger, and on the other hand being an outsider also gave me a certain impartiality. Another important implication was the need of a translator in order to conduct interviews, which might have biased the results as well. The first "researcher effect" I tried to minimise by clearly stating our purpose before each interview, the effect of the use of a translator I tried to minimise with two measures. The first was to always use the same translator, ensuring that every respondent received similar treatment, the second was to practice the interviewing as much as possible before the start of the data collection phase.

A second issue is the potential selection bias. Selection bias is a bias in the results due the manner through which respondents were selected (Bernard, 2011). There are two factors which contribute to a potential selection bias. The first is the imperfect sampling frame, the second is the use of back-up farmers both of which are mentioned in section 4.1.4. The main cause for selecting back-up farmers was the imperfect sampling fame which was the list of NDFA members from 2016. Many farmers on the list simply did not exist, hence I had to select extra farmers in order to compensate for this. If I assume that there was no bias in the imperfection of the sampling frame, the threat to the validity of the results is greatly reduced. In some cases I used back-up farmers because members were away, but this was only in a few instances. By setting meetings in advance, and travelling to farmers when they were not at home but at the farm we limited the use of back-up farmers as much as possible.

The use of interviews as the main tool of data collection also has some implications for the internal validity, which is the ability of a research design to measure what it aims to measure (Kothari, 2004). One of the things I wanted to measure, for instance, was whether farmers had adopted certain technologies or not. This I did by asking them, not by observing them on their farms, which might have been more reliable. However this also would have been very time consuming, especially for certain techniques such as crop rotation. So a very important assumption I have made is that the answers I received through the interviews are correct. I tried to ensure this by only using data about which I was reasonably certain that it was reliable. There were two main reasons for not receiving reliable data. The first was when I suspected that I received socially desirable answers. This occurred when I asked farmers about membership fees and participation in IC meetings. Many farmers told me that they "always paid their membership fee on time" and "never missed an IC meeting", which I knew could not be true for all members. The second reason was that I sometimes suspected that farmers were unable to provide accurate answers. Certain date could be difficult for farmers to estimate, such as the distance from their homes to their IC's, so instead I decided to ask them their travel time. The trick of course was knowing when the information was reliable, this I tried to test by using data triangulation when possible.

Related to the previous topic of data collection it is important to note that I asked farmers which technologies they had adopted after following NDFA training. It is possible that there were certain farmers which received training from other sources and thus implemented new technologies. This was deemed unlikely by NDFA staff members due to the fact that there were few other organisations which provided extension services and that these required financial compensation for providing training, but it is important to keep in mind.

Lastly I would like to address that when doing an interview there is a limited amount of questions which can be asked, and hence only a limited amount of topics which can be covered in an interview. When constructing the survey I had to decide which questions were most relevant and which to leave out. Two topics which were left out were off farm employment and local credit markets. From employees of the NDFA I heard that most farmers only worked on the farm and that most farmers did not have access to a formal source of credit, which is why I decided to not include these topics in the survey. Had I included these it might have led to additional insights.

6.2 Limitations on the findings

Next I will address the limitations of the results found in this thesis. The most severe limitation is the relatively small sample used, which makes it more difficult to draw solid conclusions from the regression results. Also it made it more difficult to make distinguish between male and female members, from the descriptive statistics it became clear that female members as a group tend to differ more from IC managers than male members. I tried running some regressions with each as a separate group some of which with promising results but others would not converge, most likely due to the small sample. This is why I decided not to go into further detail on this topic.

Related to the small sample is the fact that the significance of certain variables depended on both the type of variables and the total number of variables included. Some variables which were significant in the current specification of the model were not significant in earlier versions and vice versa. I tried to control for this in two ways, first by using a specification which was straightforward as possible, by only including the variables which were deemed most relevant. Second, by keeping the changing significance in mind when drawing my conclusions and putting most stock in the variables which were consistently significant.

Also the results and the following conclusions are only as good as the supporting data. As pointed out by Mwangi and Kariuki (2015) adoption of certain technologies can be partial. Due to time constrains and language barriers I was unable to gather information on the degree of adoption, though this is not an uncommon problem according to Arslan et al. (2014) it is still a limiting factor and needs to be taken into account when drawing conclusions from the results.

Regrettably there were two factors on which I was unable to gather reliable data, and thus had to make certain assumptions. In their research BenYishay and Mobarak (2014) mention the effect of the amount of effort made by lead and peer farmers to provide extension services. Since I lacked a way to properly measure effort I used the variable ICM assessment in order to control at least for some degree for the general quality of each lead farmer, but this is an imperfect measurement tool at best. So in general I have assumed that IC managers put in similar amounts of effort when delivering extension services. The second assumption has to do with the size of each IC. I know for certain that there are differences between IC's in the amount of members they have, however due to the lack of complete data on NDFA membership I was unable to control for these differences. Thus I had to assume that the size of IC's does not significantly influence use of services or the adoption of new technologies.

The last point which I will discuss is the use of endogenous variables in the regressions on farm change. Using endogenous variables is risky as it can inadvertently alter the results. I tried to check for this as best I could by running the regression twice, once with the endogenous variables and once without. The results are fairly similar decreasing the likelihood of a severe endogeneity bias.

7 Conclusion

In this final chapter the research questions will be answered and recommendations for further research will be given. The objective of this thesis was to learn more about how the services provided by the NDFA and the way these services are provided affect the adoption of new technologies of its members. To my knowledge this has not been researched before in the setting of a farmers organisation. In order to meet the research objective I formulated two research questions, the first on the effect of differences between ICMs and members on the use of services and technology adoption, the second on the effects of market access and market participation on technology adoption. In the following sections I will first confirm or reject the hypotheses, next I will answer both research questions, and I will conclude with come recommendations for further research.

The first hypothesis was that "*farmers who are more similar to their ICM are more likely to use services, follow trainings and adopt new technologies taught in extension services compared to members who differ more from their ICM".* In order to answer this question several regressions were performed and discussed in chapter 5. When looking at the results on sunflower related services I conclude that the expected effect can only be observed for selling sunflower to the NDFA, where members who were more similar to their ICM in terms of age and education were more likely to sell than other farmers. Next I ran regressions of to look into the effect of differences between IC managers and their members on training. Here I also found mixed results. For the records keeping training there appeared to be no difference which significantly affected the following of training. Difference in age had a negative impact on following both the entrepreneurship training and the training on climate smart agriculture. This indicates that members which are more similar in age to their ICM are more likely to have followed these trainings. Differences in livestock had a positive impact on the training on entrepreneurship, meaning that members with a larger difference in livestock were more likely to follow the entrepreneurship training. A potential explanation is that having livestock is often seen as a sign of wealth, making the IC managers with relatively more livestock potential better candidates for a training on entrepreneurship. Lastly we turn to the results on the farm changes, several differences had a significant impact though this differed per farm change. Difference in education had a positive effect on both changes. Difference in farm size had a positive effect on CR but a negative effect on CF. Lastly difference in livestock had a positive effect on the adoption of CF. For CR it would mean that the ICMs which were older, had more education and larger farms where better in explaining CR. For CF ICMs which were better educated and wealthier, but have a similar farm to their members appear to be the best at explaining CF to their members. All in all there is not a single difference which is consistently significant for all regressions nor is it always the case that smaller differences always lead to higher uptake rates in my sample. The effects of difference appear to differ per variable and per type of service, training or type of technology, sometimes being positive whilst at other times being negative. So overall I can neither fully accept nor fully reject my first hypotheses.

The second hypothesis was that *"farmers who have better access to and participate more in markets are more likely to adopt new technologies".* Access was measured by taking the distance to Nyimba, where the largest market in the region is based. Participation was measured by measuring the use of sunflower related services. When looking at the regressions on sunflower related services we see that the two variables on distance are significant fairly often, compared to other variables. As explained earlier, the opposite effect of the distance to Nyimba for buying seeds and processing sunflower can be explained by looking at the way the services are set up. The seeds are delivered to members, so it makes sense that members living further away are more likely to buy seeds as it more difficult for them to go to Nyimba to get seeds from an alternative seller. In order to have the sunflower output processed however farmers need to deliver it to the NDFA themselves which explains the negative coefficient. The distance to the closest paved road is significantly positive for both selling sunflower to the NDFA and having it processed at the NDFA. This makes sense as distance to the closest paved road is used to measure access to alternative markets. So the more difficult it is for farmers to access alternative markets, the more likely they are to use NDFA services. Looking at the regressions on farm changes we find that the neither use of sunflower services nor market access appears to have no significant effect on adopting new farm practices. So based on the results of the regressions there appears to be some effect on market access on the use of sunflower services. However, there appears to be no effect of access to markets or market participation, measured in the use of sunflower services, on the adoption of new technologies. Hence I have to reject my second hypothesis.

When answering the research questions some caution is necessary, as the sample on which the regressions are based are relatively small. Regarding the first research question I can conclude that the effect of extension services provided by the IC managers and more specifically the effect of the differences between IC managers and members appears to be mixed. When looking at the regressions on the uptake of farm changes we see that for CR there is a clear positive effect of the training provided on adoption. However this same effect is not found for CF. As CF is a relatively intensive technology to adopt it is possible that there are other unobserved factors which limit farmers ability to adopt. During the group interviews I did found some evidence for this, several farmers reported that they were unable to adopt certain CF practices because they lacked the means to do so. The effect of the differences between IC manager and member is also mixed, difference appear to have some impact on the use of sunflower services, the following of training and the adoption of new technologies. However it does not appear to be the case that increased similarity is always beneficial, in several regressions it a positive result for certain factors was found.

For the second research question, regarding market access and market participation, the results appear to be clearer. Access measured in distance does have an effect on using services, though the type of effect depends on how the service is distributed. Market participation, measured in the use of sunflower related services appears to have no effect on the adoption of new farm practices. It needs to be said however that this is only a part of the actual market participation of members, as farmers also sell part of their output on markets, which was not accounted for in the regressions due to endogeneity problems. Also the fact that the use of sunflower services does not appear to influence technology adoption, does not mean that members do not benefit from the use of these services. Many farmers which used sunflower services stressed that they were quite happy with these services. Several of them stated that their harvest had increased through the use of NDFA seeds, many others that their income and livelihood had improved by selling their sunflower to the NDFA or using its processing services.

The one thing I can conclude with certainty is that I have more questions now than at the beginning of the thesis, several of which would interesting for further research. As I mentioned I did not separate male and female members into groups due to the small sample size. However looking at the descriptive statistics provided in section 5.1 and at some of the preliminary regressions I ran, I did find some hints that this could be an important factor. Even more interesting would be to see the effect of females in the role of IC managers and the effect it could have on adoption. Since there were no female IC managers I was unable to investigate this. Another potential subject would be the effect of distance to cities or towns on technology adoption and its connection to differences between IC managers and members. I ran some regressions excluding farmers living closes to Nyimba and found that the effects of difference between IC managers and members became stronger and more significant. Again this was not included in this thesis due to the small sample size, which might mean that the result was just a statistical coincidence. However I did find some qualitative evidence that farmers living closer to Nyimba were in general slightly richer and differed less from their ICM compared to members living further away. Also members living further away from the closest town might have less access to other sources of information making their membership to a farmers organisation more important than members living closer to a city or town.

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Appendices

Table A.1 Random effects regressions on sunflower

VARIABLES	Sunflower seeds	Selling sunflower	Processing sunflower
Differences between ICM and member			
Difference in age (in years)	0.0223	-0.0436*	-0.000575
	(0.0191)	(0.0238)	(0.0188)
Difference in education (in years)	0.128	-0.273**	-0.0412
	(0.104)	(0.118)	(0.116)
Difference in the number of adults	0.0957	-0.114	-0.0426
	(0.108)	(0.124)	(0.118)
Difference farm size (in cultivated acres)	0.107**	0.0353	0.0255
	(0.0473)	(0.0519)	(0.0487)
Difference in livestock (in TLU)	0.0154	0.0544	0.0465
	(0.0649)	(0.0682)	(0.0571)
Market access			
Distance to Nyimba (in km)	0.0434***	-0.0348*	-0.0854***
	(0.0148)	(0.0186)	(0.0201)
Distance to closest paved road (in km)	-0.00218	0.0943***	0.0640**
	(0.0250)	(0.0314)	(0.0286)
Economic component			
Farm size (in cultivated acres)	-0.0892	0.0836	0.0198
	(0.0557)	(0.0642)	(0.0573)
Adults (between 15 and 75)	-0.222	0.0772	0.0789
	(0.145)	(0.157)	(0.157)
Livestock (measured in TLU)	0.0402	-0.153**	-0.0303
	(0.0649)	(0.0741)	(0.0663)
IC component			
ICM assessment	0.157	0.0874	0.00689
	(0.102)	(0.123)	(0.122)
Farmer component			
Gender (0=female 1=male)	-0.117	1.017	1.123**
	(0.464)	(0.628)	(0.530)
Age (in years)	-0.0210	0.0481*	-0.00449
	(0.0200)	(0.0252)	(0.0204)
Education (in years)	-0.0502	0.0565	-0.0395
	(0.109)	(0.119)	(0.118)
Type Member	1.412**	2.241***	1.002*
	(0.594)	(0.658)	(0.603)
Travel time to IC (in minutes)	-0.0202*	-0.0358**	-0.000260
	(0.0111)	(0.0175)	(0.0111)
Constant	1.029	-5.985***	-0.0539
	(1.703)	(2.181)	(1.748)
Observations	138	138	138
Number of ICs	28	28	28

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.2 Random effects regressions on training

VARIABLES	Records keeping	Entrepreneurship	Climate smart agriculture
Differences between ICM and member			
Difference in age (in years)	0.0189	-0.0635**	-0.0663**
	(0.0238)	(0.0282)	(0.0293)
Difference in education (in years)	-0.00778	-0.119	-0.212
	(0.143)	(0.163)	(0.180)
Difference in the number of adults	0.00196	0.0775	0.161
	(0.152)	(0.147)	(0.171)
Difference farm size (in cultivated acres)	-0.0247	-0.0284	0.0671
	(0.0589)	(0.0755)	(0.0744)
Difference in livestock (in TLU)	-0.0195	0.128*	-0.00962
	(0.0669)	(0.0718)	(0.0735)
Market access			
Distance to Nyimba (in km)	0.0535**	-0.00827	0.0230
	(0.0237)	(0.0199)	(0.0228)
Distance to closest paved road (in km)	-0.0129	0.0343	0.0299
	(0.0378)	(0.0429)	(0.0431)
Economic component			
Farm size (in cultivated acres)	0.0185	0.216	-0.0743
	(0.0729)	(0.136)	(0.0901)
Adults (between 15 and 75)	-0.0894	-0.239	-0.206
	(0.195)	(0.209)	(0.258)
Livestock (measured in TLU)	0.0175	-0.0415	0.119
	(0.0851)	(0.108)	(0.126)
IC component			
ICM assessment	0.0308	-0.00619	0.112
	(0.158)	(0.157)	(0.180)
Farmer component			
Gender (0=female 1=male)	0.0557	0.795	0.467
	(0.630)	(0.637)	(0.683)
Age (in years)	0.00350	0.0224	0.0345
	(0.0251)	(0.0274)	(0.0278)
Education (in years)	-0.172	-0.0592	-0.0610
	(0.146)	(0.167)	(0.177)
Type Member	0.224	0.437	0.851
	(0.696)	(0.880)	(0.912)
Travel time to IC (in minutes)	-0.0410***	-0.0276**	-0.0112
	(0.0137)	(0.0115)	(0.0133)
Constant	2.071	0.510	-0.253
	(2.093)	(2.412)	(2.399)
Observations	138	138	138
Number of ICs	28	28	28

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.3 Random effects regressions on farm changes

VARIABLES	Crop rotation	Conservation Farming	Crop rotation	Conservation Farming
Differences between ICM and member				
Difference in age (in years)	0.0733***	-0.0215	0.0509**	-0.0221
	(0.0240)	(0.0194)	(0.0207)	(0.0186)
Difference in education (in years)	0.161	0.144	0.0669	0.118
	(0.119)	(0.104)	(0.104)	(0.101)
Difference in the number of adults	-0.0220	0.0122	-0.0363	-0.00552
	(0.104)	(0.111)	(0.100)	(0.108)
Difference farm size (in cultivated acres)	0.128**	-0.0773*	0.0974**	-0.0856**
	(0.0569)	(0.0442)	(0.0492)	(0.0436)
Difference in livestock (in TLU)	-0.0268	0.0557	-0.00607	0.0567
	(0.0606)	(0.0503)	(0.0568)	(0.0496)
Market access				
Distance to Nyimba (in km)	0.0188	0.0206	0.00735	0.0137
	(0.0180)	(0.0168)	(0.0139)	(0.0141)
Distance to closest paved road (in km)	-0.00265	-0.0192	0.00595	-0.0171
	(0.0274)	(0.0280)	(0.0249)	(0.0263)
Training and sunflower				
Climate smart agriculture training	2.333***	-0.173		
	(0.853)	(0.656)		
Buying sunflower seeds	-0.963**	-0.533		
	(0.482)	(0.481)		
Selling sunflower	0.00506	0.326		
	(0.543)	(0.550)		
Processing sunflower	0.503	-0.0582		
Economic component	(0.542)	(0.525)		
Farm size (in cultivated acres)	-0.0718	0.129**	-0.0316	0.138**
	(0.0651)	(0.0583)	(0.0589)	(0.0579)
Adults (between 15 and 75)	0.139	-0.0267	0.167	-0.00698
	(0.155)	(0.141)	(0.144)	(0.138)
Livestock (measured in TLU)	-0.0624	-0.0345	-0.0764	-0.0442
	(0.0735)	(0.0650)	(0.0675)	(0.0628)
IC component				
ICM assessment	0.00926	0.306**	-0.00903	0.271**
	(0.105)	(0.122)	(0.0985)	(0.116)
Farmer component				
Gender (0=female 1=male)	0.207	0.105	0.422	0.146
	(0.500)	(0.484)	(0.454)	(0.473)
Age (in years)	-0.0605***	0.0293	-0.0479**	0.0306
	(0.0228)	(0.0204)	(0.0209)	(0.0199)
Education (in years)	-0.0891	-0.119	-0.106	-0.103
	(0.117)	(0.105)	(0.106)	(0.104)
Type Member	-0.808	1.483**	-0.567	1.361**
	(0.598)	(0.618)	(0.542)	(0.562)
Travel time to IC (in minutes)	-0.0146	0.00783	-0.00790	0.00843
	(0.0120)	(0.00989)	(0.00980)	(0.00957)
Constant	2.167	-4.032**	2.876	-4.323**
	(2.000)	(1.826)	(1.762)	(1.731)
Observations	138	138	138	138
Number of ICs	28	28	28	28

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A.4 Correlation matrix

	Difference in age (in years)	Difference in education (in years)	Difference in the number of adults	Difference farm size (in cultivated acres)	Difference in livestock (in TLU)	Distance to Nyimba (in km)	Distance to closest paved road (in km)	Farm size (in cultivated acres)	Adults (between 15 and 75)	Livestock (measured in TLU)	ICM assessment	Gender (0=female 1=male)	Age (in years)	Education (in years)	Type Member	Travel time to IC (in minutes)
Difference in age (in years)	1															
Difference in education (in years)	-0.0427	1														
Difference in the number of adults	0.1085	-0.1736	1													
Difference farm size (in cultivated acres)	0.1396	0.0979	0.1039	1												
Difference in livestock (in TLU)	0.1766	-0.1174	0.4667	0.4395	1											
Distance to Nyimba (in km)	0.0436	-0.3151	0.0385	0.0074	0.0674	1										
Distance to closest paved road (in km)	0.2040	-0.0856	0.1792	-0.0163	0.1790	0.2915	1									
Farm size (in cultivated acres)	0.2221	0.1044	0.2471	0.5757	0.2908	0.0091	0.2098	1								
Adults (between 15 and 75)	0.1323	-0.0393	0.4953	0.1152	0.2103	-0.0232	-0.0268	0.2512	1							
Livestock (measured in TLU)	0.1665	-0.1104	0.2810	0.3316	0.5729	0.0052	0.1593	0.5288	0.4091	1						
ICM assessment	-0.0187	-0.1048	0.0751	-0.1222	-0.0309	-0.1221	-0.1871	-0.0892	-0.0429	-0.1120	1					
Gender (0=female 1=male)	0.1342	0.3270	0.1087	0.1578	0.0118	-0.0559	0.0957	0.2129	0.1424	0.1361	-0.0121	1				
Age (in years)	0.6600	-0.0277	-0.0054	0.0958	0.0107	-0.0339	-0.0949	0.1665	0.1836	0.1684	-0.0839	0.0932	1			
Education (in years)	0.0212	0.8331	-0.0803	0.0736	-0.0583	-0.1985	-0.0066	0.1435	-0.0442	-0.0807	0.0352	0.3763	-0.0328	1		
Type Member	0.0968	0.2959	0.0802	0.1427	0.0467	0.0306	0.0303	0.2016	0.1491	0.1065	-0.0099	0.4169	0.0961	0.3369	1	
Travel time to IC (in minutes)	0.0393	0.0338	-0.0085	-0.0426	0.1042	-0.0923	-0.1226	-0.0439	-0.1084	0.0544	-0.0677	-0.0680	0.0362	0.0120	-0.0360	1

Survey IC managers

Questions

Farmer Characteristics

1. Name farmer
2. Of what IC are you a member?
3. How old are you? *In years*
4. How long have you been in school? *total number of years*
5. How many people eat and sleep at your house?
6. How many of those are between 15 and 70?
7. How many dependants do you have? *in number of people (excluding people living at home*
8. What is your marital status?
9. Do you have a prominent role in the community *or in church*

Farm Characteristics

10. What is the size of land you use for farming? *in acres*
11. Do you usually sell farm output Crops/livestock
    a. (Almost) Every year (100-75%)
    b. Most years (75-51%)
    c. Sometimes (50%)
    d. Rarely (50-25%)
    e. (Almost) Never (25-0%)

(If the farmer sells output, ask question 12 and 13, otherwise continue to 14)

12. Where do you usually sell your goods?
    a. Local market
    b. Regional market
    c. Local trader
    d. Other
13. How much do you have to travel to sell your goods? In KM
14. Did you receive an assistance of any organisation in the last two years? Aside from NDFA, including government
15. Do you know if other members received any assistance of other organisations in the last two years? If yes, which ones?

Crops and Livestock

16. Which crops do you grow, *how much of each in acres*
17. What kind of livestock do you have?

NDFA characteristics

18. What is your travel time to your IC? In minutes
19. When did you become a member of the NDFA? Date of the year
20. What were our most important reasons for becoming a member of the NDFA?
21. Did you pay your membership fee each year?

(If no, then ask question 22, otherwise continue to 23)

22. What is the reason that you did not pay your membership fee in the past
23. Do you perform any (formal) roles within NDFA?
24. Do you know which services are provided by the NDFA? and how they work?
25. Have you used services provided by the NDFA in the last year? (2016) If yes, which ones
    a. Input, maize seed
    b. Input sunflower seed
    c. Input fertilizer
    d. Input other

e. Selling output sunflower
f. Selling output other
g. Cooking oil
h. Other services

26. Which trainings have you followed?
    a. Training record keeping
    b. Training entrepreneurship
    c. Training climate smart agriculture
    d. Training other

(If a training has been followed, ask 26, otherwise continue to 27)

27. Have you changed (farm) practices after following a NDFA training

Attitude NDFA

28. What are the main things you like about the NDFA?
29. What are the main things you dislike about the NDFA?
30. Do you think there are things the NDFA should improve?

(If yes then ask 31 otherwise continue to 32)

31. What do you think the NDFA could improve? *or start doing*
32. Do you think there are things that the NDFA is doing well? *if so, what?*
33. Has your life improved through your membership of the NDFA?
34. What do you think of the NDFA leadership?
    1= dislike very much, 2=dislike, 3=neutral, 4=like, 5=like very much
35. What is your opinion of the NDFA
    1= dislike very much, 2=dislike, 3=neutral, 4=like, 5=like very much
36. What is your opinion about the IC?
    1= dislike very much, 2=dislike, 3=neutral, 4=like, 5=like very much

IC Attitude

37. How often are IC meetings held?
38. How often have you attended these meetings this year?
    1. Always (100%)
    2. Almost always (99-75%)
    3. More than half (75-51%)
    4. Half (50%)
    5. Less than half (49-25%)
    6. Almost never (25-1%)
    7. Never (0%)
39. What were your main reasons for attending IC meetings?
40. What were your main reasons for not attending IC meetings?
41. How different do you think you are from other members in your IC?
    1=very different, 2=different, 3=neutral, 4=similar, 5=very similar
42. What is your opinion about other members? *of your IC*
43. What do you think are the main reasons for farmers to participate in IC activities?
44. What do you think are the main reasons for farmers not to participate in IC activities?
45. Do you think there are things your IC can improve?

(if yes then ask 42, otherwise end of interview)

46. What can be improved in your IC?

End of interview

Survey Members

Questions

Farmer Characteristics

1. Name farmer
2. Of what IC are you a member?
3. How old are you? *In years*
4. How long have you been in school? *total number of years*
5. How many people eat and sleep at your house?
6. How many of those are between 15 and 70?
7. How many dependants do you have? *in number of people (excluding people living at home)*
8. What is your marital status?
9. Do you have a prominent role in the community *or in church*

Farm Characteristics

10. What is the size of land you use for farming? *in acres*
11. Do you usually sell farm output Crops/livestock
    a. (Almost) Every year (100-75%)
    b. Most years (75-51%)
    c. Sometimes (50%)
    d. Rarely (50-25%)
    e. (Almost) Never (25-0%)

(If the farmer sells output, ask question 12 and 13, otherwise continue to 14)

12. Where do you usually sell your goods?
    a. Local market
    b. Regional market
    c. Local trader
    d. Other
13. How much do you have to travel to sell your goods? In KM
14. Did you receive an assistance of any organisation in the last two years? Aside from NDFA, including government
15. Do you know if other members received any assistance of other organisations in the last two years? If yes, which ones?

Crops and Livestock

16. Which crops do you grow, *how much of each in acres*
17. What kind of livestock do you have?

NDFA characteristics

18. What is your travel time to your IC? In minutes
19. When did you become a member of the NDFA? Date of the year
20. What were our most important reasons for becoming a member of the NDFA?
21. Did you pay your membership fee each year?

(If no, then ask question 22, otherwise continue to 23)

22. What is the reason that you did not pay your membership fee in the past
23. Do you perform any (formal) roles within NDFA?
24. Do you know which services are provided by the NDFA? and how they work?
25. Have you used services provided by the NDFA in the last year? (2016) If yes, which ones
    a. Input, maize seed
    b. Input sunflower seed

c. Input fertilizer
d. Input other
e. Selling output sunflower
f. Selling output other
g. Cooking oil
h. Other services

26. Which trainings have you followed?
    a. Training record keeping
    b. Training entrepreneurship
    c. Training climate smart agriculture
    d. Training other

(If a training has been followed, ask 26, otherwise continue to 27)

27. Have you changed (farm) practices after following a NDFA training

Attitude NDFA

28. What are the main things you like about the NDFA?
29. What are the main things you dislike about the NDFA?
30. Do you think there are things the NDFA should improve?

(If yes then ask 31 otherwise continue to 32)

31. What do you think the NDFA could improve? *or start doing*
32. Do you think there are things that the NDFA is doing well? *if so, what?*
33. Has your life improved through your membership of the NDFA?
34. What do you think of the NDFA leadership?
    1= dislike very much, 2=dislike, 3=neutral, 4=like, 5=like very much
35. What is your opinion of the NDFA
    1= dislike very much, 2=dislike, 3=neutral, 4=like, 5=like very much
36. What is your opinion about the IC?
    1= dislike very much, 2=dislike, 3=neutral, 4=like, 5=like very much

IC Attitude

37. How often are IC meetings held?
38. How often have you attended these meetings this year?
    a. Always (100%)
    b. Almost always (99-75%)
    c. More than half (75-51%)
    d. Half (50%)
    e. Less than half (49-25%)
    f. Almost never (25-1%)
    g. Never (0%)
39. What were your main reasons for attending IC meetings?
40. What were your main reasons for not attending IC meetings?
41. What is your opinion about the contact farmer? *of your IC*
42. How different do you think your contact farmer is from you?
    1=very different, 2=different, 3=neutral, 4=similar, 5=very similar
43. How different do you think your contact farmer is to other members? *in your IC*
    1=very different, 2=different, 3=neutral, 4=similar, 5=very similar
44. What is your opinion about other members? *of your IC*
45. Do you think there are things your IC can improve?

(if yes then ask 45, otherwise end of interview)

46. What can be improved in your IC?

End of interview