Understanding Adoption of Nitrogen Fixation Technology: a case study on the practices and input use of soybean cultivation by farmers in Apac and Oyam, Uganda

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“If you are a drunkard you can hold on to drinking, and maybe you can leave sugar aside”

~ farmer in Oyam district (translation)

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ABSTRACT

Nitrogen fixation technology packages are introduced by projects in multiple parts in sub-Saharan Africa to enhance soil fertility and legume cultivation, although adoption by farmers remains disappointing. This thesis aims to contribute to a better understanding of nitrogen fixation technology packages adoption by farmers in Oyam and Apac districts, Uganda, and draws on a qualitative approach, including four focus group discussions and 31 interviews with farmers and key informants during fourteen weeks of fieldwork. Based on theory dealing with the social nature of technical practices, the thesis focusses on how farmers understand soil fertility management and soybean cultivation in relation to the practices and inputs promoted by N2Africa and their social life. The findings show that farmers, especially peasant farmers, have difficulties with accessing the inputs in soybean cultivation and the knowledge how to apply these. Furthermore, the findings provide an insight to the socio-cultural preferences, aspirations and responsibilities of socially differentiated farmers that conflict with the use of nitrogen fixation technology packages promoted by N2Africa. As a consequence, farmers resort to partial or non-adoption of the packages, in combination with traditional soil management practices. These insights lead to specific considerations for future research to understand farmers' livelihoods in relation to technology adoption, to adjust extension approaches to increase the adoption of practices and inputs among the socially differentiated group of farmers in Oyam and Apac.

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ACRONYMS AND ABBRIVIATIONS

AFSRT	Agency for Sustainable Rural Transformation
DAP	Diammonium phosphate
D&D	Delivery & Dissemination
FB2F	Farmer-back-to-farmer
FGD	Focus group discussion
ISSD	Integrated Seed Sector Development
LC1	Local counsellor 1
LSB	Local seed business
M&E	Monitoring & evaluation
NAADS	National Agricultural Advisory Service
NGO	Non-governmental organisation
UGX	Ugandan shilling
WUR	Wageningen University and Research
WVU	World Vision Uganda

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1 INTRODUCTION

1.1.1 Soil fertility and legume cultivation

One of the major challenges of production for smallholder farmers in sub-Saharan Africa is low fertility and inefficient management of soils (Giller et al., 2013). Researchers diagnosed that soils' lack of essential nutrients was mainly attributable to poor soil fertility management resulting in low yields (Keino et al., 2015). In western Kenya research showed that poor soybean growth was caused by potassium (K), magnesium (Mg) and phosphorous (P) limitations, as well as of small available quantities of nitrogen (N) (Keino et al., 2015). As one of the ways of to increase soil fertility, researchers recommended the application of fertilizer. However, many smallholder farmers in sub-Saharan Africa lack financial resources and incentives (Liverpool-Tasie et al., 2015). Besides using fertilizer, legume crop yield could be increased by using Rhizobium and Bradyrhizobium as biofertilisers as well (Hassen et al., 2016), for example in soybean cultivation (Giller et al., 2011). With the use of rhizobacteria, inoculants could generate pronounced effects on the soybean growth (Chibeba, 2015).

It is suggested that soybean production in rotation with maize should be promoted through an integrated approach including appropriate soil and crop management techniques (Van Vught, Franke and Giller, 2018). These soil and crop management techniques could include the application of green manure, inoculants, animal manure and fertilizer, among other things. Farmers in Uganda received packages of fertilizer and improved climbing bean seeds to use in their own field, after being demonstrated how to use the packages (Ronner et al., 2018:4). Although 70 % of the farmers continued the cultivation of climbing beans after receiving the packages, the use of the promoted practices dropped considerably to at least one. The adoption of soil fertility enhancing packages by smallholder farmers was often different from what researchers had expected (Ronner et al., 2018:4).

The experience of researchers is that farmers recognize that legume rotation and nitrogen fixation lead to soil fertility improves yields, however they saw it as secondary benefits, after food and fodder (Giller et al., 2013). Even though, farmers were aware of the benefits that legume rotation and nitrogen fixation have on soil fertility, researchers found a low adoption level of promoted practices and inputs among farmers (Ronner et al., 2018:4). Therefore, this thesis focusses on how adoption can be understood by looking at the perspective of farmers on nitrogen fixation technology practices and inputs, soil fertility and soybean cultivation promoted by N2Africa, in relation to their social life in Oyam and Apac, Uganda.

1.1.2 The N2Africa project

N2Africa is a large-scale project that aims at putting nitrogen fixation to work for smallholder farmers in sub-Saharan Africa (N2Africa – www.n2africa.org). The project focusses on increasing production of grain legumes and inputs related to nitrogen fixation in smallholder farming systems on the basis of four major grain legumes: common bean, cowpea, groundnut and soybean (Giller et al., 2013). N2Africa was funded by the Bill & Melinda Gates Foundation and started operating with partners from September 2009 in the Democratic Republic of Congo (DRC), Ghana, Kenya, Malawi,

Mozambique, Nigeria, Rwanda and Zimbabwe, and since 2013 in Ethiopia, Uganda and Tanzania (see figure 1). By linking scientific research to capacity building, educating MSc and PhD candidates, promoting women's empowerment and access to markets through Public Private Partnerships, N2Africa enabled smallholder farmers to benefit from grain legumes through the implementation of effective production technologies including inoculants and fertilizers (N2Africa – www.n2Africa.org).

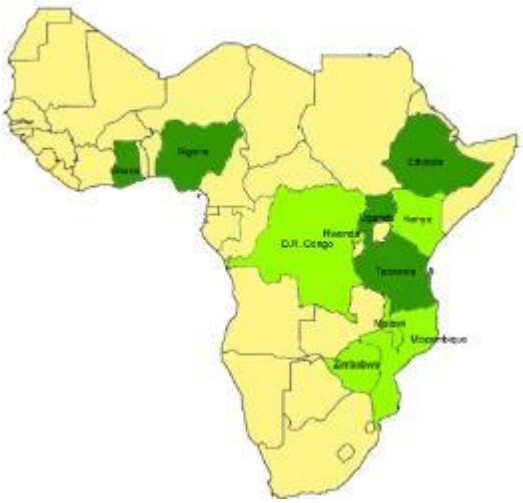

Figure 1: N2Africa country overview

Legumes are plants that fix atmospheric nitrogen into the plant itself and into the soil through symbiosis with Rhizobium bacteria and are mainly cultivated as a crop for the dry seed (Raimi, Adeleke and Roopnarian, 2017; Bezner Kerr et al., 2007). Regarding consumption the legume plants are an important source of fibre, minerals, carbohydrates and proteins (Bezner Kerr et al., 2007). To implement the appropriate intervention in an area, N2Africa used a 'socio-ecological niche' approach to identify the legume and rhizobium combination. These combinations had to be suitable for a type of farm within a given agro-ecology or farming system depending on market opportunities (Giller et al., 2013) and geographical characteristics (Farrow et al., 2014). Matching the legume and rhizobium combination with the 'right' socio-ecological niche was a necessity to improve productivity and yield, resulting in an enhancement of income for farmers (Giller et al., 2013).

Although indicated as an important aspect for tailoring the researcher best-bet technology practices in relation to African smallholder farming systems, social and cultural factors should receive more attention (Ronner, 2018:3). A 'socio-ecological niche' approach (Descheemaker et al., 2016; Ojiem et al., 2006) deemed necessary, when the N2Africa project was introduced, for improved productivity, yield and enhanced income for farmers by "identifying the legume and rhizobium combination that was appropriate for a given type of farm within a given agro-ecology of farming system depending on market opportunities" (Giller et al., 2013, p. 161). However, the socio-ecological niche concept (Descheemaker et al., 2016) used by Ronner et al. (2018:4), presented as an important element of

the 'development-to-research' framework, should have provided more insight in the socio-cultural preferences of a farmer in relation to agro-ecological circumstances of a farming system. In a research on co-design of climbing bean production practices by baskets of options for farmers adapted to the farmers needs Ronner et al. (2018:3) reported on farmers' preference in relation to consumption and agronomic practices (see textbox 1). However, the preferences did not necessarily imply that farmers "act" upon and adopt the preferred technology (Leeuwis and Van den Ban, 2004; Pircher et al., 2013). This suggests that the capturing of farmer agro-ecological and economic preferences may lack a deeper contextualization (Leeuwis and Van den Ban, 2004). Ronner et al. (2018:3) emphasised the necessity of qualitative exploration of the dynamics of production orientation and livelihood strategies, farmers' intrinsic motivations or their risk perception (Ronner et al., 2018:3). In other words, socio-cultural aspects regarding legume related technology practices adoption and soil fertility management.

In a research conducted by N2Africa focussing farmers use and adaptation of improved climbing bean production practices in the highlands of Uganda demonstration and adaptation trials were organised on different locations in Kapchorwa District in eastern Uganda and Kabale and Kanungu District in south-western Uganda (Ronner et al., 2018:4). In four seasons in 2014 and 2015 the demonstration trials 'researcher best-bet technology' were demonstrated to farmers combined of practices that were expected to give the optimal climbing bean yield, based on previous research on legumes in general and climbing beans. Components of the researcher best-bet technology were an improved climbing bean variety, cattle manure, and Triple Super Phosphate (TSP) fertilizer, including applicable planting, staking and weeding practice. Following the demonstration trials adaptation trials in 2014 and 2015 were organised where farmers received a package of improved climbing bean seeds and TSP fertilizer and an instruction leaflet but planted the package without further assistance (Ronner et al., 2018:4).

The results of the adaptation trials after three seasons showed that 85% of the farmers who received improved climbing beans seeds actually planted the seeds and 70% of the farmers re-planted climbing beans one season after the adaptation trial. Of all the farmers who received TSP as part of the adaptation trial, only three farmers did not apply the fertilizer and six only partly to use for other crops or to save it for next season. Overall, during the adaptation trial the farmers adapted the technology by using some of the promoted practices, however the season after the adaptation trial the use of practices dropped considerably. Still, all farmers used at least one of the practices (Ronner et al., 2018:4).

In a survey conducted after the adaptation trials assessed the reasons for (non-)use of any of the practices. With the focus on the reasons for not using certain practices farmers mentioned poor weather conditions, a lack of stacks and a lack of seeds due to destruction of the seed during storage and poor yields in the previous season. With regards to the reasons why farmers did not use TSP fertilizer the research found that farmers perceive their soil was already fertile, that there was no access to TSP fertilizer, and that fertilizer was too expensive (Ronner et al., 2018:4).

Textbox 1: research on climbing bean production practices Ronner et al. (2018:4)

1.1.3 Complexity of soil fertility and the concept of adoption

Scoones (2005) stressed the importance that African farming societies are intimately bound up in social, institutional, cultural and political dynamics in combination with often numerous terms to describe the status and transformation of their soil. The soil fertility management by farmers sometimes extended even into a spiritual world, in which soils needed to be cared for through appropriate behaviour and cultural practice (Scoones, 2005). It is essential to be aware that assessing soil fertility through the calculation of nutrients can be challenged by those with a wider social calculus on the determinants of soil and site fertility (Fairhead and Scoones, 2005). Therefore, the quote "as the perspectives of African farmers can challenge expert soil science conditions and assumptions, engagements with local knowledges need to be more comparative than evaluative; more a conversation than an assessment" (Fairhead and Scoones, 2005, p 34) expressed the importance that social and cultural context may have with regard to technology adoption.

In a case in Malawi, Pircher et al. (2013) presented the importance of differentiated technology needs and the need to find appropriate ways of targeting groups of farmers in farming communities. Gender and the different economic positions of farmers are important factors for understanding the use and adoption of legume technology and soil fertility management (Pircher et al., 2013). This thesis will take into account gender and economic positions of farmers and legume technologies in relation to soil fertility management and soybean cultivation in their community as the social life.

1.2 Problem statement

Previous studies of N2Africa on technology adoption applied a technical lens, mostly focussing on the agro-ecological and economic aspects. While this focus does provide certain insights into the process affecting the adoption of nitrogen fixation technology packages, it may lack a deeper contextualization why farmers act upon and adopt or not adopt technology. The rather disappointing adoption by smallholder farmers of soil fertility management practices and inputs promoted by N2Africa highlights the importance of improving our understanding of social and cultural aspects. This thesis aims to provide better understanding of the adoption of nitrogen fixation technology packages in Oyam and Apac in relation to the socio-cultural preferences of socially differentiated farmers.

Hence, the objective of this thesis is to identify how farmers perceive the practices and inputs promoted by N2Africa in Oyam and Apac district, Uganda. This is realised by moving away from researching agro-ecological and economic preferences as the main focus. Instead, this thesis focusses on how soil fertility management and soybean cultivation is understood by different farmers in relation to their social life, how they act upon it and how this reflects on adoption of nitrogen fixation technologies as measured by researchers. The 'reasons of action' model of Leeuwis and Van den Ban (2004) employs the underlying paradigm, while local knowledge (Fairhead and Scoones, 2005; Scoones, 2005; Oudwater and Martin, 2003) and social differentiation (Cleaver, 2005; Pircher et al.,

2013) are other concepts informing this research. In doing so, the resulting analysis gives insights that could be taken into account when implementing technology package promotion and that could support other projects that seek to improve the implementation and adoption of technology packages or research related to it, improving the livelihoods of smallholder farmers who may have differentiated technology needs. This thesis will apply a socio-cultural perspective to the case study on nitrogen fixation technology adoption as promoted by N2Africa in Oyam and Apac district, Uganda.

1.3 Research questions

Based on the introduction and the problem statement, I formulate the main research question as follows:

How do different farmers in Oyam and Apac understand soil fertility and soybean cultivation in relation to the practices and inputs promoted by the N2Africa project and their social life?

In order to answer the main research question, the following sub-research questions are formulated:

1. *How does social differentiation affect agricultural practices and technology adoption level in Apac and Oyam district, Uganda?*
2. *How do farmers understand soil fertility management in relation to soybean cultivation?*
3. *What are the views of the farmers on the practices and inputs promoted by N2Africa and a) how does these relate to their social life, b) how they act upon it, and c) how does this reflects on adoption as measured by researchers?*

Each sub research question includes a broader perspective. Firstly, focussing on how socially different farmers adopt practices promoted by N2Africa. Secondly focussing on the perspective of farmers on practices related to soil fertility management in relation to soybean cultivation. Finally focussing on how farmers experience inputs and services promoted by N2Africa in relation to their cultural and social situation by positioning themselves in space and time, how they act upon it, and how these aspects affect adoption.

1.4 Outline of the thesis

Chapter 2 outlines the methodology of this thesis in more detail. It describes the methods used during the fieldwork in Oyam and Apac district, Uganda. The data collection consists of focus group discussions (FGDs), semi-structured interviews and observations. The FGDs give a general understanding of the farming communities in Oyam and Apac, whereas the interviews focus on the perspective of individual farmers on soil fertility and soybean cultivation as promoted by N2Africa.

Chapter 3 presents the theoretical framework applied in this thesis. It provides detailed information about the relevance of a social and cultural focus on technology adoption by smallholder farmers.

The ‘reasons of action’ of Leeuwis and Van den Ban (2004) provides the basis of the theory, supported by literature focussing on local knowledge and social differentiation.

Chapter 4 provides an analysis on the N2Africa project. It describes the objectives established by N2Africa to reach the vision and aims of the project and continues by presenting the activities of the project conducted in Uganda in general and in Oyam and Apac district in particular. Subsequently, It presents data that focus on the categories of farmers in the farming communities in Oyam and Apac provided by the FGD participants and key informants.

Chapter 5 provides empirical information collected in relation to the experience of farmers with inputs and related practices promoted by N2Africa in Oyam and Apac. Furthermore, it elaborates on why farmers did or did not adopt the inputs and related practices in their soybean cultivation.

Chapter 6 presents empirical information collected on soil fertility management practices used by farmers to manage their soil fertility, on what farmers perceived as a fertile soil and on how they experience soil fertility management practices promoted by N2Africa in relation to their social life.

Chapter 7 provides a discussion and conclusion based on the results and the broader context of the study of adoption theories, specifically in relation to the theoretical framework. The structure of this chapter will be based on the ‘reasons of action’ framework of Leeuwis and Van den Ban (2004). Firstly, it discusses the social differentiation of farmers, influenced by the approach of N2Africa that affects adoption among the different categories of farmers in Oyam and Apac. Secondly, it analyses the perspective of the farmers on practices and inputs promoted by N2Africa, in relation to their aspirations and social environment. Thirdly, it presents considerations for future research. Lastly, it provides the answer to the main research question in the conclusion of the thesis.

2 METHODOLOGY

2.1 Introduction

The fieldwork was conducted in Oyam and Apac district, Uganda between 22 March and 22 June 2018 (figure 2). The field work consisted of FGDs that were conducted at cooperatives with the aim to generate an understanding of the categorisation of farmers by farmers. Furthermore, interviews were done with key informants and farmers both involved and not involved in the N2Africa project. These interviews focussed on soybean cultivation and practices, soil fertility and use of pesticides, improved seeds, fertilizer and inoculants. Throughout the fieldwork, observations took place on practices related to soil fertility, soybean cultivation, and interactions between farmers and actors. In the end of writing the thesis I stored all the data to be available for future use.

Figure 2: Locations of Oyam and Apac in Uganda

2.2 Data collection

In the beginning I created an overview of the farmers operating in Oyam district. Multiple key informants were identified via N2Africa agents and interviewed about how they are related with the N2Africa project and the farmers in the district. These key informants were government officials, extension workers, (local) NGO staff, and experts. The semi-structured interviews with the key informants were the first step to generate an overview of the farmers, how they could be categorised and who were actors in the field that influence and interact with the farmers and N2Africa. Subsequently, we organised FGDs with farmers to get a general understanding and a categorisation of the farmers in the sub-counties Acaba, Minakulu, Loro (Oyam) and Ibuje (Apac). The

farmers participating in the FGDs were active members of a cooperative or farmer group present in one of the above indicated sub-counties illustrated in figure 3 (elaborated in section 2.3).

The information of the FGDs and the contacts with the farmers who participated in the FGDs provided lists of farmers who were present in a village chosen by a farmer representative. They listed all the farmers in the villages where the FGDs were to be conducted. Based on certain criteria, I randomly selected and interviewed the farmers. I conducted the interviews to generate an understanding of the perception of farmers on the practices, tools, inputs used in soybean cultivation and soil fertility management.

After generating a general understanding, I selected farmers based on more specific data that I considered interesting and worthwhile of which more detailed information was needed (see section 2.4 for more detail). To get a more dynamic and adequate understanding of certain aspects both farmers and key informants were interviewed. Information that was difficult to collect by interviewing farmers was then asked to key informants. Information gathered from key informants was then used to ask more specific questions to the farmers.

Eventually, my attention turned to Apac district. Apac district functioned as an area of which I checked whether there were differences compared to Oyam district. In Apac district I used the same methods as in Oyam district, however I conducted less FGDs and interviews. The reason of the first and more exploring focus in Oyam district resulted from the fact that Oyam had facilities to operate from and where I could stay during the night (figure 4). Furthermore, Oyam district was considered safer by N2Africa for western scientists to do research, especially during the night.

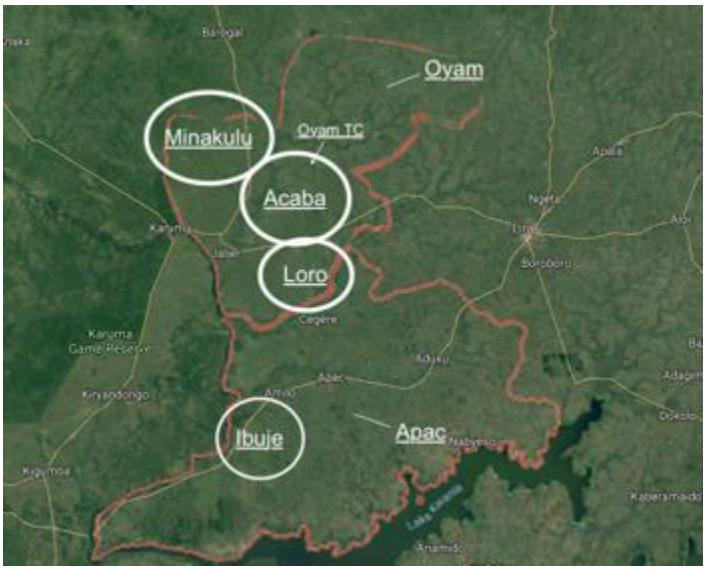

Figure 3: Sub-counties in which I conducted the fieldwork in Oyam and Apac

Figure 4: Oyam TC, Oyam district

2.3 Focus Group Discussions

Focus group discussion (FGD)/interview is a data collection method with a purposeful use of interaction to generate data. Morgan (1996) identifies three major components of focus group research, namely as (1) a data collection method, (2) interaction as a source of data, and (3) an active role of the researcher to create group discussions to collect data. In other words; the group discussion can be seen as a semi-structured group session in which a group existing prior to the research, moderated by the researcher, allows the collection of information on a designated topic through interactive discussions (Carey, 1994; Morgan, 1996). It can provide major insights in beliefs, attitudes, and opinions of the group.

The FGDs took place in four locations in Oyam and Apac district at cooperative and farmers group facilities. The cooperatives were called Oyam Agro (Acaba), Bedijo P. Cooperative (Minakulu), Noteenteko Cooperative (Loro) and the farmer group called Tam Atek Farmer Group (Ibuje) (see table 1). As mentioned in section 2.1, in Apac district all methods were used that were used in Oyam district, only less. This farmer group was selected by the cooperative representatives based on the fact that the individual farmers were involved in the N2Africa project. The FDGs consisted of 10 farmers, all of them member of the farmer cooperative operating in the sub-county. 50 per cent was male and 50 per cent was female. At first, general information was discussed plenary, followed by categorising and indicating characteristics of types of farmers in the sub-county in two groups of 5 participants. Finally, the outcomes were presented and discussed plenary, and the outcomes were combined in approval by the whole group.

District	Oyam			Apac
Sub-county	Acaba	Loro	Minakulu	Ibuje
FGDs	1	1	1	1
Participants (male/female)	10 (5/5)	10 (5/5)	10 (5/5)	10 (5/5)

Table 1: FDGs in different districts and sub-counties

2.4 Interviews

As an interview method I used a semi-structure format, in combination with observations. The semi-structured interview allowed me to receive new ideas to be brought up during the interview depending what the interviewees said and what I observed (Bernard, 2011). In the beginning of the data collection I interviewed 2 key informants with a semi-structured interview through expert sampling, by consulting the N2Africa representative on the ground focussing on both Oyam and Apac district. Later on, in the process, I interviewed an additional three key informants (see table 2). I used certain indicators as guidelines for the interviews, however these did not determine the interview structure. In appendix 1 an example of the semi-structured interview is presented.

District	Oyam	Lira	Apac	Arua
Interviews (total)	1	1	2	1

Table 2: Key informants interviewed for information on farmers in Oyam and Apac

After the FGDs I used the lists of farmers to select farmers based on preferred criteria. The lists were composed by farmers representatives and local counsellor 1 (LC1s) in three villages in three sub-counties in Oyam. In Otulatum was selected in Acaba sub-county, the village Alati B was selected in Minakulu sub-county, and Alidi A was selected in Loro sub-county. Every farmer was listed with the following general characteristics: name, sex, village, land size, crops, tools used. The soybean specific characteristics were: use of improved seeds or not improved seeds, for market or home consumption, and trained by N2Africa or not (see tables 3.1 and 3.2 for an overview of the interviews).

I sampled the farmers by using random sampling (de Vaus, 2001; O'Leary, 2004), based on the list resulting from the FGDs. In Oyam district on every list, three in total (Otulatum, Alati B and Alidi A), I selected farmers based on trained or not trained by N2Africa and using improved seeds or not. The reason for these criteria originated from the FGDs as farmers indicated that the use of improved seeds distinguished modern from the traditional farmers whereas the farmers involved in the N2Africa project compared with those who were not involved could give me an understanding of the impact of the N2Africa project. Worth noting is that on every list the amount of men and women was almost equal and that every farmer cultivated or had cultivated soybean. On every list I randomly selected farmers by numbering the farmers and entered the numbers in Excel. The selection resulted

in four farmers per list, per village, in total 12 interviews. Based on the framework of Leeuwis and Van de Ban (2004) I used a semi-structure format to interview the farmers, as the unit of analysis (O'Leary, 2004), in relation with soil fertility and soybean cultivation. More detail is given in section 7.2.1. An example of a semi-structured interview can be found in appendix 2.

Additionally, I conducted 7 semi-structured interviews were conducted, consisting of the variables of the model of Leeuwis and Van den Ban (2004) to generate an understanding of the farmers' view on promoted inputs and services by the N2Africa project in relation to the context of their social life. Farmers were hand-picked from the three lists. The criteria to select the farmers were based on the use of inputs, specifically fertilizer, land size, and cooperative board membership (see appendix 3). Subsequently, I selected and interviewed the farmers in Apac by the following method: from the location of the FGD we took a road, choosing from three roads, and drove for 5 minutes. After 5 minutes we stopped and the closest household we approached for an interview.

District	Oyam				
Sub-county	Acaba	Loro	Minakulu	Oyam TC	
Village	Otulatum	Alidi A	Alati B	Acouibe	Agoa
Interviews (total)	6	4	4	1	1
Random sampling	4	4	4	0	0
Selected sampling	2	2	1	1	1
N2Africa	4	2	3	0	0
Female	5	4	1	1	0

Table 3.1: Farmers interviewed in Oyam

District	Apac				
Sub-county	Ibuje				
Village	Apele	Agoga	Ajodok A	Acinanga	Arukulong cell.
Interviews (total)	2	2	1	1	1
Random sampling	1	2	1	1	1
Selected sampling	1	0	0	0	0
N2Africa	0	0	0	1	1
Female	1	0	1	0	0

Table 3.2: Farmers interviewed in Apac

In total I interviewed 26 farmers for this thesis, with the assistance of Solomon, of which we conducted nineteen in Oyam district and 7 in Apac district. In addition, we interviewed a total of five key informants. Solomon, a former extension agent of N2Africa, was my interpreter. He arranged the FGDs and interviews and translated all the information I needed from Langi (the local language in Oyam and Apac) to English.

2.5 Observation

I used two different methods of observation during the fieldwork in Oyam and Apac district. Direct unobtrusive observation and participant observation. I used direct unobtrusive observation to focus on actual behaviour, mundane everyday activities, spatial arrangements and physical environment, and social interaction. Participant observation engaged me in activities the farmers engage in every day (Bernard, 2011). The latter observation strategy helped me to generate a more in-depth understanding what farmers experience during the practices by experiencing it myself. These observations took place when I went in to the field with a fellow researcher who had to collect biomass, soil and harvest samples in the garden of the farmers. Together with two interpreters/extension workers and the farmer we collected the harvests from the gardens during harvest period. Although, the farmers were influenced in some sense by our presences during the harvest we asked the farmers what to do and we mimicked them handlings.

Through participant observation it allowed me to establish a long-term relationship with the farmers, to reduce reactivity, gain access to backstage spaces, and use intuitive understanding of processes. More importantly, by experiencing the practices myself with regards to soybean cultivation and soil fertility it gave me an insight in my own self-presentation or bias. This enabled me to develop and check my inferences (Bernard, 2011). By using both observation methods I was able to separate between what farmers say and what they do, and how I experienced the processes.

2.6 Data storage

The data obtained from the FGDs, the interviews and the observations, I stored for the availability for future use. I noted down and transcribed that information on posters used during the FGDs and combined all FGD data in one Word file. With regards to the interviews, I noted down the data in a notebook and recorded it during the interviews on my iPhone. I uploaded the recorded interviews on a hard disk and together with notes of the interviews transcribed the information given by the key informants and farmers. Additionally, I made pictures of my observations and noted these down in a notebook. The pictures and notes are stored on the hard disk. Therefore, when necessary, other researchers can use the data I collected for future research.

3 THEORETICAL FRAMEWORK

3.1 Introduction

This chapter presents the outline of the theoretical framework applied in this thesis. It provides information about the relevance of a social and cultural focus on technology adoption. The 'reasons of action' provides the basis of the theory, supported by literature on local knowledge and social differentiation.

3.2 Establishing the focus

The limitations of researching farmers preferences mainly based on agro-ecological and economic aspect were explained in the introduction. Therefore, theory is required that permits moving beyond agro-ecological and economic aspects of technology and technology adoption concepts. Firstly, the introduction showed the importance of technology adoption and non-adoption by smallholder farmers in relation to soil fertility and soybean cultivation (Ronner et al., 2018:4). Secondly, the introduction showed the focus of N2Africa to understand technology adoption on agro-ecologic and economic aspects which result in limited socio-cultural insight of technology adoption by smallholder farmers (Leeuwis and Van den Ban, 2004). Thirdly, there is a need of contextualizing soil fertility and the concept of adoption in relation to local knowledge and social differentiation on community level (Scoones, 2005; Fairhead and Scoones, 2005; Pircher et al., 2013).

To establish such a contextualised focus requires a theoretical framework that integrates the social nature of technical practices. The 'reasons of action' (Leeuwis and Van den Ban, 2004) is the primary theory providing an understanding of the reasons of farmers in a socio-cultural context which is helpful to understand the outcomes of technology implementation. To understand the socio-cultural context in which farmers live, social differentiation will provide an understanding of the position of farmers in the farming community and the choices that are made (Cleaver, 2005; Pircher et al., 2013). However, the reasons of an action and the socio-cultural context of a farmer alone do not provide the reasons why farmers adopt technologies differently than researchers intended. To generate an understanding of these differences we need to understand the farmers' local knowledge regarding the soil fertility management and soybean cultivation (Fairhead and Scoones, 2005; Scoones, 2005; Oudwater and Martin, 2003). Local knowledge understood as "what farmers know and how they practice, their ways of describing and categorizing soils and land areas, and their land management practices" (Oudwater and Martin, 2003, p. 390).

3.3 Reason of action

To understand the implementation of a practice and/or a technology by a farmer, we need to understand the social nature of technical practices. Holbraad et al. (2016) indicated that ontology in

the anthropological conceptualisation is focussed on the "multiplicity of forms of existence enacted in concrete practices, where politics becomes the non-sceptical elicitation of this manifold of potentials of *how things could be*" (Holbraad, 2016, p. 1). In other words, seeing the thought and/or perspective of an individual something as valuable as all other thoughts and/or perspectives, and that the interpretation of these thoughts is not fixed and definitive but free for manoeuvre and change (Holbraad et al., 2016). To generate an understanding of the social nature of technical practices of farmers Leeuwis and Van den Ban (2004) present a model of basic variables. These variables give an understanding of individual farmers' practices and how these respond to proposed alternatives. It sets out to explore the analysis of reason and understand what farmers *believe is true*, what they *aspire* to do, what they are *able* or not to do, and what they are *allowed* to do (Leeuwis and Van den Ban, 2004). In addition, in a presentation presented by Leeuwis in 2016 an altered version focusses on the 'identity' of the farmer, the importance of responsibility and trade-off to reach a goal. Similar to the model (Leeuwis and Van den Ban, 2004) this altered version, applying the same analysis of reason, puts the identity central as a dual sense of role position and motivator naming it the different 'reasons of action' (figure 5 and 6) (Leeuwis, 2016).

Figure 5: reasons of action

Figure 6: reasons of action

For the sake of analysis, I will combine the two models. The variables *knowledge – perception of reality*, and *risk perception* as one frame to understand what farmers **believe is true**. Another frame, that will focus on what farmers perceive they are **able** to do by combining *trust in social environment, perception of own role and responsibility,* and *belief in own capacity*. Finally, a frame will be constructed out of the variables *experienced social pressure* and *aspirations* to analyse what farmers **aspire** and are **allowed** to do. Although, the latter framing seems controversial it must be said that all variables are interlinked and interacting that will result in blurred boundaries of the frames. I believe these variables can be examined by interviewing farmers and triangulate these with observation and interviews with actors in the field. In a later stage, the variables can slightly change

through the process of analysis. Nevertheless, by preventing the trap to over-categorise farmers' perspectives and thoughts, resulting in an over-simplification of the socio-economic process of technology production and adoption, I want to emphasise that this analysis will focus on the farmers' perception interpreted by me, a social science researcher who tries to overcome a gap between the science constructed knowledge and belief and that of the farmers' knowledge and beliefs.

In the section above, we touched upon the aspect of reason of doing through identity. However, it is important to take in mind the complexity of identity. Leeuwis and Van den Ban (2004) indicate that farmers can approach a situation from various identities (e.g. as 'a farmer', 'a husband', 'a parent', 'a community member). These situations can change beliefs and aspirations, what they are allowed to and able to. Giddens (1984) explains that the constitution of 'I', is only originating from "the discourse of the Other" (Giddens, 1984, p 43). 'I' is mainly linguistic and does not have an image, whereas the self does. The self is the imaginary projection an individual has of him/herself. To construct the self, an individual should relate him/herself to a social system that consists of social practices what Giddens (1984) calls 'positioning'. Although, I will not go into detail about the constitution of I and self by farmers, but I will consider the identity plurality and positioning in social life that influences the social nature of the implementation of technical practices.

In addition, Giddens (1984) states that attention should be given to the differentiation of 'conscious' and 'unconscious'. For the sake of limiting the complexity of the theory I will focus on the conscious conduct of individuals over time. This is not limited to what is called 'sensibility', but the ability to register a range of surrounding stimuli (Giddens, 1984). Therefore, it is important to note that not only the complexity of identity shapes decision-making. Decision-making can be regarded "as the final outcome of longer lasting learning processes with varying degrees of deliberateness and consciousness" (Leeuwis and Van den Ban, 2004, p 152). They emphasise the relation of 'reflective monitoring of action' (Giddens, 1984).

3.4 Understanding technology

It is important to understand the concept of adoption of technology in relation to soil fertility between farmers and researchers. Glover et al. (2016) explain that technology can be seen as a fluid assembly with results in both social and technical components in space and time. They suggest that adoption literature never really dealt with different ways of usage by the farmer compared to the initial idea of the provider of the technology, and vice versa. Nevertheless, Rhoades and Booth (1982) presented a case study that illustrated the importance of interdisciplinary research in international agricultural development that should *begin* and *end* with the farmer. By explaining the model "farmer-back-to-farmer" (FB2F) they state that "research must strive to close the circle, from identification of the problem to farmers' acceptance and rejection" (Rhoades and Booth, 1982, p 132). The relevance of FB2F to this thesis exists in the importance of 'closing the circle', whereas the adoption of technology cannot be explained solely in terms of agro-ecological and economic aspects but needs understanding of the acceptance and rejection of farmers in social and cultural terms.

In addition, Crane (2014) fine-tunes the model with the emphasis on that we need to go beyond the old dichotomy of "local and scientific knowledge systems" and that both knowledge systems are local with its own interface between technical, institutional and cultural practices. Although, I will not focus in our research on generating an understanding of both the perspectives of the farmers and researchers with regards to the notion of adoption, it is still relevant to be aware both farmers and researchers are receptive to one another regarding the fluidity of the technology.

Drawn from studies of Jansen and Vellema (2011) and Almekinders (2011) the dynamics of technological change can be explained through concrete political, economic and cultural processes. I will use 'technography' as it describes the process of making a technology through the practices and organization of groups of actors (Almekinders, 2011), and "examining material transformation, technology use and performance as a configuration of material and social elements" (Jansen and Vellema, 2011, p 176). In addition, technography examines human to machine/tool interaction, specifically focussed on skill and technique (Jansen and Vellema, 2011). By reverting to Glover et al. (2016), Crane (2014) and Crane (2010) I want to argue that technology adoption is not a fixed aspect that is to be considered successful or not, fragmented through the scope of scientists, but a fluid assembly that is constituted, designed and re-designed through technical, institutional and cultural practices that interact with and between various actors who reproduce the technology to their own perspective of applicability. Then again, it can be argued whether adoption is even applicable in scientific terms due to its fluidity and limitless conceptualisation. However, by demarcating my research I will focus on the practices of farmers, their interaction with actors, and their perspective of reproducing and redesigning a technology to their own needs through space and time.

3.5 Social differentiation

Technologies are adopted or not adopted, depending on the different positions of farmers in the farming community. The poorest people are more dependent on the ability to exercise agency but are less capable to do so effectively (Cleaver, 2005). It is important to realise that structure in farming community gives people different positions (Giddens, 1984; Leeuwis and Van den Ban, 2004). This is equally the case of women in society. Women and resource-poor farmers have less availability and access to resources (e.g. time, money, information, land, etc.) compared to better-off farmers, which can strongly affect the use and adoption of technologies (Pircher et al., 2013).

In sub-Saharan African farming communities, men are mainly responsible for the cultivation and commercialisation of cash crops, and in charge of the farming inputs, livestock management and maintaining of the homestead (Pircher et al., 2013). Women are mainly responsible for work around the house, including child care and cooking, and as well as farm work (Pircher et al., 2013). Due to landownership, the final decision making, and different responsibilities, women and men tend to make different choices than men. In relation to women, Kabeer (1999) describes this situation through the notion of 'choice', in which the ability to choose is central to the concept of power. 'Choice' can be qualified in *the conditions of choice*, referring to the need to distinguish between

choices made from the point of view of alternatives and the absence, or negatively high cost, of alternatives. The *consequences of choice*, the need to distinguish between strategic life choices and second order choices, can be further evaluated for their *transformatory significance.* This term refers to the extent to which choices made have the potential to challenge and destabilize social inequalities or reproduce and express social inequalities.

4 N2AFRICA IN UGANDA AND CATEGORISED FARMERS

4.1 Introduction

Firstly, the objectives of N2Africa are described that were established to realise the vision of the project. Secondly, I present the activities of the project in Uganda followed by the activities in Oyam and Apac district. Lastly, I elaborate on the categories of farmers in the farming communities of the two districts and the characteristics developed by the farmers themselves that were obtained during FGDs and interviews with key informants.

4.2 Approach of N2Africa

N2Africa was organised to reach several objectives throughout the project to gain an understanding and satisfy the needs of diverse groups of farmers. The project started from September 2009 in the Democratic Republic of Congo, Ghana, Kenya, Malawi, Mozambique, Nigeria, Rwanda and Zimbabwe, and since 2013 it deployed activities in Ethiopia, Uganda and Tanzania. In 2013, phase 2 of the N2Africa project established five major so-called 'objectives':

1) Project strategy, coordination and implementation and capacity strengthening to ensure the sustainability of the project through collaboration with national institutes and international initiatives and the alignment with NGOs and extension services to reach large numbers of farmers.

2) Delivery and dissemination, sustainable input supply, and market access done by dissemination campaigns and awareness creation via media. Trainings are provided along the value chain and extension materials for extension staff, private sector and farmers are developed and distributed. These trainings and extension materials include the aspects of legume cultivation, post-harvest technologies, processing, nutrition, and market/business management.

3) In objective "empower women to increase benefits from legume production" N2Africa integrates gender as a cross-cutting theme through gender mainstreaming and focussing on strategic gender activities (labour saving technologies, recognition of women as key players in the value chain and creating market opportunities that can benefit women).

4) In its objective "Tailor and adapt legume technologies to close yield gaps and expand the area of legume production within the farm" N2Africa introduces the best multi-purpose legumes through on-farm testing and selection based on the participation of farmers.

5) The latter objective is closely linked to the fifth objective: "enable learning and assess impact at scale through strategic monitoring and evaluation (M&E)" as for each production area the environmental and socio-economic conditions are characterised to assess key constraints. Niches for legumes in farming systems are identified, legume technologies are tailored and adapted to specific sites and specific famers, and 'best fit technologies' or 'researchers best-bet technologies' at field scale are translated into 'best-fit approaches' at the country or regional scale (N2Africa – www.n2Africa.org). This is done by the use of a 'socio-ecological niche' approach (Giller et al., 2013),

as described in the introduction chapter. In addition, Giller et al. (2013) emphasise the importance of the need to understand the variability between farms and farming systems to satisfy the needs of a diverse group of farmers.

The objectives would contribute, by the use of a socio-ecological niche approach to the vision of N2Africa. N2Africa uses a Monitoring & Evaluation (M&E) framework in which data are collected and feedback loops created between the Delivery & Dissemination (D&D) and research (N2Africa website, objectives). Data collected from the dissemination trials and demonstration plots, the farm households, processors and traders, input suppliers and partners go through a M&E framework. Data from both D&D and M&E are fed into research of which the outcomes flow back again in the D&D (N2Africa – www.n2Africa.org). The latter process is described as the 'development-to-research' framework (see figure 7). This process is to enhance and enabled the realisation of N2Africa's vision: "to build sustainable, long-term partnerships to enable African smallholder farmers to benefit from symbiotic N_2-fixation by grain legumes through effective production technologies including inoculants and fertilizer" (Adjei-Nsiah, 2014, p.6; N2Africa website, Vision of success).

Figure 7: Research, monitoring & evaluation and delivery & dissemination in the Development-to-research framework

4.3 Activities in Uganda

A baseline study was conducted in 2016 in Ethiopia, Tanzania and Uganda to benchmark the legume systems, status of livelihoods based on household characteristics, agricultural production, nutrition and markets, so the project would be able to assess progress and achievements towards the end of the project. 400 households were interviewed in four different target regions in Uganda that corresponded to geographic regions specifically aimed on characteristics in terms of agro-ecology, climate and prevalence of crops and were mainly used for agronomy and dissemination activities and an impact assessment: Eastern, Eastern highlands, Northern and South western Uganda (N2Africa Baseline Report, 2016). Subsequently, action areas were identified within a target region that are sub-national administrative areas, in Northern Uganda: Apac, Kole, Lira and Oyam. Furthermore, agronomic trials and dissemination activities specific villages were selected within the action areas

that were called ‘sites’ in the N2Africa project. The farmer’s fields where agronomic trials were set up were referred to as ‘trial locations’ (Farrow et al., 2014).

Multiple partners were appointed to contribute to the objectives set by the project. Africa 2000 Network Uganda, VECO Uganda, and World Vision Uganda (WVU) were identified as core partners for technology dissemination. Dissemination activities consisted of demonstration trials establishment and dissemination packages including inoculant and P-based fertilizer for soybean distribution, and a comprehensive strategy to address gender issues in legume value chains was developed. In addition, the constitution and facilitation of stakeholder platforms for the target legumes and the engagement of agro-dealer networks in supplying agro inputs are among the sustainable input supply activities (Adjei-Nsiah et al., 2014).

4.4 N2Africa in Oyam and Apac

In Oyam and Apac the N2Africa project implemented demonstration trials, similar as described by Ronner et al. (2018:4). The dissemination partners WVU and Agency for Sustainable Rural Transformation (AFSRT) organised demonstrations to create awareness among farmers about improved legume technologies and capacity building focussed on knowledge and skills particular on agronomy and soil fertility management since 2014. Furthermore, the demonstrations tested the performance of improved soybean namely MAKSOY 2N, 3N, 4N and 5N. Adaptation trials were organised for farmers in which technology packages were distributed. 61 per cent of the participating farmers of the adaptation trials were women.

In co-development with Wageningen University and Research (WUR) N2Africa-Uganda developed protocols for variety x inoculant x nutrient management recommendation studies. In these studies, imported inoculants were tested against nationally produced inoculants that were tested with newly released soybean varieties MAKSOY 4N and MAKSOY 5N on the strategically selected research sites based on production potential and market access (N2Africa report, 2014). Additionally, research was done to evaluate the need of fertilization to increase groundnut productivity of smallholder farmers in Minakulu sub-county of Oyam district, Uganda (Taruvinga, 2014).

Both the dissemination of demonstration and adaptation trials in Oyam and Apac, and the research on soybean varieties and inoculants can be seen as activities for N2Africa’s objectives: 2) Delivery and dissemination, sustainable input supply, and market access, and 4) Tailor and adapt legume technologies to close yield gaps and expend the area of legume production. In addition, the research can as well be part of objective 5) Enable learning and assess impacts at scale through strategic M&E (Adjei-Nsiah et al., 2014).

4.5 Cooperatives and local seed businesses in Oyam and Apac

The AFSRT/N2Africa focused on the organisation of cooperatives in Oyam and Apac. The goal was to improve quality input access for production efficiency as well as output markets using a business led approach. Several cooperative/farmer groups' leaders, of which 1/3 was female, received training on bulking and marketing including business management (N2Africa, 2017). Subsequently, two cooperatives in Oyam (Oyam Agro in Acaba and Bedijo in Minakulu) created out of several farmer groups started an input shop and linked to the private sector (N2Africa, 2017), whereas Loro Noteenteko Cooperative in Loro sub-county was already existing and connected to the project.

Together with WVU and the Integrated Seed Sector Development (ISSD) N2Africa implemented a partnership strategy to foster the sharing and adoption of the result-oriented local seed businesses model, resulting in local seed businesses (LSBs). This was part of the 'delivery and dissemination' objective of N2Africa (Ampadu-Boakye et al., 2018). LSBs are Ugandan farmers who are trained and produce quality seed of superior varieties supported by ISSD (N2Africa Technical Report, 2017; World Vision Uganda, 2015). These seeds are sold to the market and fellow farmers in the area. In Oyam, WVU coordinated the development of five LSBs. These LSBs are organised from the cooperatives.

4.6 Farmer categorisation

This section elaborates on categorises of farmers in Oyam and Apac district on community level and what characterises them. These farmers categories give an understanding how farmers differentiate themselves in the community and what agronomic, economic and social characteristics they possess. The chapter consists of four categories of farmers with specific characteristics as provided by the farmers during the FGDs in Oyam and Apac district. As presented in chapter 2, the FGDs took place on four locations in Oyam (Acaba, Minakulu, and Loro) and one location in Apac (Ibuje).

The farmers in Oyam and Apac district described medium farmers, apart from commercial, modern and peasant farmers. The category medium farmers seemed to be similar to modern farmers, but the characterization varied somewhat between the different FGDs. I decided to use the categories of modern and traditional farmers, instead of a single large and variable category of medium farmers. More importantly, it will differentiate between those farmers who apply modern practices with those who use traditional practices. The categories and characterizations of farmers described in Oyam for the largest part matched with the description given in Apac. Figure 8 illustrates the percentage of each category of farmers in the farming community in Oyam and Apac as indicated by the participants during the FGDs.

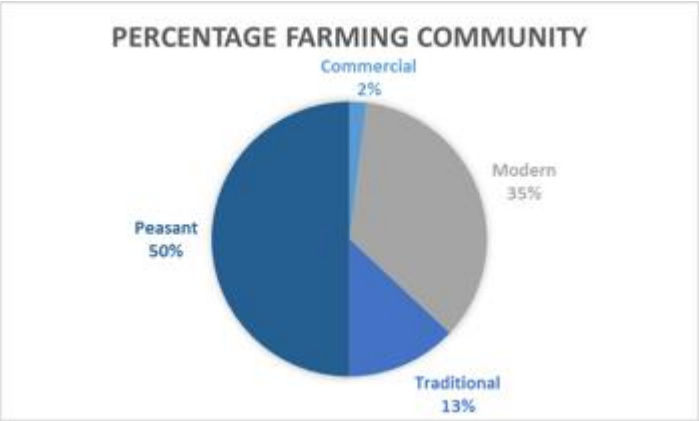

Figure 8: Percentage of different categorised farmers in farming community Oyam and Apac

In addition, table 4 presents an overview of cash crops and food crops, including the crops which are considered important according to the participants. Cash crops are usually produced to sell for cash sales, whereas food crops are produced for home consumption. Nevertheless, according to the farmers, small portions of cash crops can be used for home consumptions and food crops can be sold when the household food situation allows so.

Cash crops	Food crops
Soybean (I)	Maize (I)
Sunflower (I)	Beans (I)
Cotton (I)	Cassava (I)
Maize (I)	sesame (I)
Groundnut	Millet (figure 9)
Tobacco	Rice
	Sorghum
	Peas
	Chia
	Sweet potato
	Banana (sweet)
	Banana (matoke)

Table 4: Cash and food crops in Oyam and Apac district. (I) stands for important

Figure 9: Harvested millet

4.6.1 Commercial farmers

This category of farmers represented an average of 2 percent of the farming community in Oyam and Apac, according to the participating farmers. The participants emphasised that the majority of commercial farmers were men and cultivate 10 or more acres (four hectares) of land. They mainly used tractors, occasionally ox plough, and weeding machines as tools to manage the land and

needed to hire labour. Their main income came from the farm and they had large financial capital to manage their farms. The participants mentioned that these farmers aimed to maximize profit, had access to loans from the bank and were higher educated than the other categories of farmers.

Regarding postharvest management these farmers were able to bulk their cash crops produced, including that of peasant farmers from whom they regularly purchased the produce directly after harvest. They had large and quality storage facilities for the bulked produce and sold the produce in off season when prices were higher. Trucks usually owned by the farmers themselves transported the produce to the markets.

Commercial farmers had access to both national and international markets to sell their produce, and had good linkages with banks, NGOs and the government. In relation to soybean, international markets were mainly located in Kenya from where it is processed and shipped to other countries. Furthermore, commercial farmers had good linkages with peasant farmers and provided them with loans. These commercial farmers had access to and used improved seeds, fertilizers and pesticides which they purchased from agro-input dealers in the Lira and Gulu town. Moreover, they acquired good knowledge of innovative management practices and often trained smaller farmers in land management practices, however, whether this was done in training sessions or individually is not clear. Compared to other types of farmers commercial farmers possessed large numbers of livestock, which they used for both domestic and commercial purposes. Their children went to school, they owned cars for their own usage and had permanent houses with a corrugated roof to live in. They actively bought land to divide over the next generation, so that their children had enough land. According to the participants, the majority of the commercial farmers were not a member of a cooperative as they were able to bulk and store their produce, had access to and could afford quality inputs, and had good linkages with different stakeholders in the sector.

Figure 10: Ox plough of a modern farmer in Acaba sub-county, Oyam district

4.6.2 Modern farmers

The FDG participants considered the farmers with approximately 2 to 10 acres (0.8 to 4 hectares) of land and using oxen (figure 10) for cultivating the land as typically modern farmers. Modern farmers represented 35 per cent of the farming community in Oyam and Apac. Compared to commercial farmers they did not have machinery like tractors and weeding machines. However, labour was hired occasionally, and they practiced group farming. Group farming was an activity in which multiple farmers worked on the land of one farmer, whereas the next day the group would shift to the next farmer in the group. They had on-farm income and possessed a small to medium amount of financial capital, however enough to manage their farm activities.

Modern farmers possessed small to medium storage size facilities and bulked collectively with other farmers. A part of these modern farmers were members of a cooperative. To transport the produce from the farm they used motorcycles and bicycles and, in some instances, they used wheelbarrows. Furthermore, the farmer cooperative gave the modern farmers access to markets, capacity building and connection with NGOs, access to quality seeds and inputs, access to extension services, financial support, and again bulking possibilities. Besides the access and use of quality seeds the majority of the farmers used fertilizer and pesticides. They owned medium numbers of livestock, and some were engaged in beekeeping.

Participants specifically indicated during the FGDs the diversity of crop management activities conducted by this category of farmers. Modern farmers made use of demonstration plots, crop management demonstrations organized by projects, and owned livestock which was well integrated in the management practices. Important to mention is that modern farmers bought and used improved seeds every planting season and used modern management practices to optimize production (e.g. crop rotation, row planting, weeding, etc.). In addition, some modern farmers owned permanent houses and their children went to school. Male and female farmers were equally represented in this group.

4.6.3 Traditional farmers

Traditional farmers were more or less similar to modern farmers and represented approximately 10 to 15 percent of the farming community in Oyam and Apac. Important indicators for the traditional farmers were that they used ox-plough and hand hoes, bought and used improved seeds, however they rarely used fertilizers and pesticides. This type of farmers bought improved seeds only once and used the harvested seeds to sow again in the following season. This could be repeated 5-6 times before buying new improved seeds. Furthermore, these farmers did not use soil fertility management practices, or practices related to input application promoted by N2Africa and other stakeholders. They resorted to the traditional way of sowing and weeding, and (if at all) applied fertilizer and pesticides traditionally (e.g. hand sowing, broadcasting fertilizer and pesticides).

4.6.4 Peasant farmers

These farmers were considered being the least well off and represented approximately 50 percent of the farming community in Oyam and Apac. They had 0-2 acres (0 to 0.8 hectares) of land and cultivated by using hand hoes and family labour due to small financial capital. These farmers could

barely sustain themselves, owned a small amount of livestock and mainly produced for home consumption. If the peasant farmers would produce a surplus this would be sold to the market. They were unable to buy and use improved seeds, fertilizers and pesticides. The seeds they used were local seeds or saved seeds from previous harvests.

Some owned small storages, however the majority did not. In case these farmers would produce a surplus for the market they transported the produce by bicycle or on their heads. Although some of the peasant farmers were targeted by N2Africa and other stakeholders, they did not use modern management practices. They resorted to traditional knowledge of agriculture. According to key informants, they have a high dropout rate as these farmers need to come from far when attending projects and have no means of transport.

It is unclear whether the majority of this type of farmers was male or female, however gender played an important role for these farmers. In principle, women could own land, but it was common that the male is the head of the household and owned the land. If the woman of the household would be interested in soybean production, but the man was not, it would have prevented the cultivation of soybean. This was a phenomenon applicable for all categories, however it was explicitly mentioned by key informants for this type of farmers.

4.6.5 Farmers community in general

Peasant farmers were targeted by N2Africa and other stakeholders to a certain extent. Those who adopted the technologies promoted by the organisations were able to develop themselves to become traditional or modern farmers and produce for the market, according to key informants. Nevertheless, a considerable amount of peasant farmers did not improve their situation due to the above-mentioned land use dispute within households and the long and difficult distance they need to travel to participate in the activities of projects. The indication ‘peasant’ for this category was specifically mentioned by the farmers. In the literature, the definition of peasant farmer is perceived as sensitive. Nevertheless, this definition is extensively used by farmers in Oyam and Apac which can be an indication of the influence of the development idiom used by the government and NGOs.

It is essential to note that, according to the key informants, every farmer could get access to improved seeds and inoculants. Improved seeds were relative expensive to buy individually. So, to have access to cheaper improved seeds farmers needed to become members of cooperative which allowed them to buy the seeds in large quantities and even multiply them. Nevertheless, to become a member of a cooperative, farmers needed to pay registration fees and buy shares of the cooperative. Those farmers who were able to pay registration fees and buy shares were considered active members. Farmers who were unable to do so, or only partly, were considered passive members. Active members were actively approached and invited for projects and to buy inputs, whereas passive members were not informed about inputs and how to apply these and only occasionally invited to project activities. Nevertheless, both active and passive members were obliged to sell collectively and transport their produce from the farm to the collection point. The latter obligation was also one of the reasons why farmers did not become members of cooperative at all, by selling the produce on the farm to middlemen they could reduce the costs of transport.

Especially when farmers were in need of quick money before the harvest, this method was primarily used.

Regarding inoculants, farmers were able to access this input, however with difficulty. There were no sale points in Oyam district, and the material came from Makerere University in Kampala. Individual farmers were not able to order the inoculants, only collectively via the cooperative. Farmer groups, groups consisted of multiple farmers organised for certain occasions, needed to order inoculants via the district. Cooperatives were able to order the inoculants directly with Makerere University, but the orders needed to be picked up from Kampala by a person linked to the cooperative. Both farmer groups and cooperatives needed to order the inoculants one month in advance, which required proper planning.

The farmers participating in the FGDs (see figure 11) were all members of a cooperative or a farmer group in the district. When asked in what category they would place themselves, the majority indicated modern or medium farmers. This created a discussion within the groups as certain participants could not recognise themselves in some characteristics. It became obvious to all of us that farmers in Oyam and Apac could not be divided in fixed categories and that the categorisation should be a fluid structure of the farmers community as farmers can possess characteristics of two or more categories.

To conclude, this chapter explored the objectives of N2Africa had established. The five objectives, with the integration of the socio-ecological niche approach, and the development-to-research framework would contribute to realise vision of the project. Subsequently, the activities related to the objectives were presented that were conducted in Uganda, and Oyam and Apac. The activities consisted of the implementation of demonstration and adaptation plots for farmers, research on soybean varieties, and the organisation and establishment of cooperatives and LSBs by N2Africa and its implementation partners. Finally, the chapter described the categorisation of farmers in the farming community of Oyam and Apac. These categories with specific characteristics, provided by farmers who participated in the FGDs, consisted of: commercial, modern, traditional and peasant farmers. Additionally, the process of cooperative membership and access to inputs related to the cooperatives were described, followed by brief indication on the participants position in the farming communities.

Figure 11: FGD with participants presenting outcomes in Ibubje sub-county, Apac district

5 FARMERS EXPERIENCES ON PROMOTED PRACTICES AND INPUTS

5.1 Introduction

Farmers experienced the inputs promoted by N2Africa differently among farmer categories in Oyam and Apac. The inputs accompanied with practices to apply these should contribute to the soil fertility of the farmers' fields. This chapter gives an understanding of the perception of farmers on the promoted inputs and the related practices, and why they did or did not adopt these in their soybean cultivation. In table 5 an overview can be found that describes the number of categorised farmers interviewed in Oyam and Apac who adopted and did not adopt inputs and related practices, promoted by N2Africa.

	Commercial farmers		Modern farmers		Traditional farmers		Peasant farmers		Total
	n = 3		n = 12		n = 5		n = 5		n= 26
	Adoption	Non-adoption	Adoption	Non -adoptio	Adoption	Non-adoptio	Adoption	Non-adoption	
Improved seeds	3	0	8	4	1	4	0	5	
Rhizobia	1	2	1	11	0	5	0	5	
Fertilizer	2	1	3	9	0	5	0	5	
Pesticides	2	1	11	1	0	5	0	5	

Table 5: Number of farmers In Oyam and Apac who adopted or not adopted inputs and associated practices promoted by N2Africa

This chapter will use detailed data of interviews with farmers regarding the inputs and associated practices promoted in Oyam and Apac. When we asked Francis, a self-proclaimed commercial farmer, whether he used improved soybean seeds, he almost jumped from his seat in joy and answered: yes sir! We Continued with the question why he uses improved seeds. He explained: 'Because these are more profitable. Because if you buy twenty kilograms of improved seeds and you plant, maybe you get 600 to 800 kilograms. But if you plant this local, you buy twenty kilograms maybe you are getting 100 to 200 kilograms only'. While nodding we asked since when he uses the improved seeds. 'Since 2013, sir' he answered. 'Are you satisfied with it?' asked. Yes sir!!

Francis was one of the twenty-six farmers we interviewed about his perspective on soil fertility and soybean cultivation, based on inputs and related practices that were promoted by the N2Africa project from 2013 until 2018. Inputs, like improved seeds, pesticides, rhizobia (earlier referred to as inoculants) and fertilizer, were known among most farmers. However, most of the time it was only from hearing and seeing from fellow farmers. Worth noting is that the majority of the interviewed farmers were an active or passive member of a cooperative in the sub-county. Those farmers who were not a member did have links with farmer groups, groups that were indirectly or not targeted by N2Africa.

5.2 Rhizobia

We asked Francis whether he used rhizobia on his field during soybean cultivation. He started explaining that he used timely weeding, string planting, pesticide spraying and fertilizer during the cultivation of his soybeans. Most of these practices he conducted since 2013. More specifically, Rhizobia was an input he started using in 2014, he continued in his explanation. In 2013 N2Africa set up demonstration plots to introduce and train Francis and his fellow farmers in Minakulu sub-county. After the period of the demonstration plots that was attended to in groups, Francis started to use Rhizobia himself during the adaptation trials, in which every farmer received a package with several inputs. On the question why Francis used rhizobia he answered that the application would result in a high yield of soybean. If he would not apply it, it would result in extremely low yield.

Me: Do you use rhizobia?

Eunice: No, I have only used it during the demonstration of the project but never bought it.

Me: why don't you use it?

Eunice: it is too expensive

Me: How much is rhizobia?

Eunice: I don't know, but assume it is expensive

Me: What do you know about rhizobia?

Eunice: I know that is a bacterium which lives in the soil and forms nodules to fix nitrogen into the soil

Me: But if you know what it is and what it does, wouldn't you like to use it?

Eunice: I would like to use it, but the planning does not allow me. I compose the planning with my husband, but he wants to buy more livestock when money is there to pay for my dowry. He has the last saying in the planning

Me: what do you think about the fact that you know the benefits of rhizobia and you are trained to use it, but you cannot apply your knowledge?

Eunice: it makes me sad. My husband knows the benefits, but he is not willing

Textbox 2: interview with Aceng Eunice in Otulatum about rhizobia (18-05-2018)

Similar to Francis, Acen Silvia explained that she used rhizobia and that the input results in a high soybean yield. Acen is a 66-year-old female farmer who lives in Otulatum village in Acaba sub-county, Oyam (figure 12) . She used the rhizobia every season since the N2Africa project in 2015. Acen indicated that it is easy to apply and that she buys it for 2500 Ugandan Shillings (UGX) per 250 grams of rhizobia. She continued that 250 grams can be mixed with 60 kilograms of soybean seeds before planting.

Although Francis and Acen, two of the twenty-six farmers interviewed, were the only farmers who still applied and bought Rhizobia, most farmers knew about the input. Odwong Colline, a female farmer living in Alidi B in Loro sub-county, explained that she came to know rhizobia in 2017 via a demonstration plot and adaptation trial packages. She indicated the differences between fertilizer: fertilizer is white in colour and rhizobia black, and that rhizobia yields more soybean than fertilizer. Furthermore, she confidently told us that she thought that both inputs should be used separately, not together on one field because rhizobia and fertilizer supply different nutrients. At first, she stated that she was using rhizobia, but after we went into it more detailed it turned out that she only used it during the N2Africa project.

The farmers interviewed gave us the reason why they would not use Rhizobia, however in some cases the actual reason was revealed after asking about the subject

in more detail. In Acaba sub-county, located in the centre of the district, we met Aceng Eunice. She is a farmer of 28 years old living on her homestead together with her husband. Similar to Colline and Francis she cultivates soybean, mainly for cash, and is a member of the local cooperative. She applied timely weeding, string planting and pesticide spraying as well. Among other things, we asked Eunice whether she used rhizobia as she indicated that she participated in the N2Africa project. Her answer was that rhizobia is too expensive and that she is not using it for that reason. Nevertheless, when we continued about the subject it became clear that the main reason of not buying rhizobia was the final decision making of the husband with regards to their financial planning (see textbox 2 for more detail).

Apparently, farmers experience decision making during the financial planning that does not prioritise the cultivation of soybean. Akun Sophia, a 66-year-old female farmer, lives just a few hundred meters away from the homestead of Eunice in Acaba sub-county. When we asked her about why she did not use rhizobia, she told that the input was too expensive. She could not give me an answer on the question how much rhizobia costs and, if not aware of the price, knew that it was too expensive. Nevertheless, Sophia elaborated on the priority within her financial planning that investing in the land is was on second place. Her first priority is paying the school fees of the children. Education is important, she continued, as she and her husband already have the land and get some yield from it. When we asked whether it would not be wiser to first invest in land, getting better yields and more income, and then in pay for school fees, her face changed and pointed at the children wandering around on the homestead: “to see the children at home, it is depressing. The children are ever putting pressure”. Sophia and her husband were not even able to send their children to school as they did not have any money due to a drought the season before that destroyed the majority of the soybean.

Figure 12: Interview with Acen Silvia in Otulatum, Acaba about rhizobia

As indicated above, the majority of the farmers knew about the input, the effects and the benefits which they heard and saw from fellow farmers. However, most did not use rhizobia on the moment we interviewed them as expenses on other aspects in the household had a higher priority. Only one commercial farmer did use the rhizobia. The farmers indicated that the school fees and livestock, and decision making of the husband, are more important than the cultivation of soybean. Furthermore, bad weather circumstances resulting in a low yield in season before forced farmers to neglect the purchase of Rhizobia.

5.3 Fertilizer

Similar to rhizobia, fertilizer is used only by a small number of farmers interviewed. Only five farmers, two women and three men, indicated to use fertilizer for the cultivation of soybean in Oyam and Apac district. One other farmer told me that he used fertilizer, however for another crop. These farmers could be categorised as commercial and modern farmers.

Okori Francis explained to us why farmers come to the decision to not buy and use fertilizers for soybean cultivation in Apac district. He was a farmer cultivating soybean in Apac district. Together with Solomon, I met him for an interview particularly focussed on fertilizer. An agent of N2Africa located in Apac directed us to Francis confident that he used fertilizer. However, shortly after our interview started it became clear that he had not used fertilizer for almost 5 years. Nevertheless, we asked him how he came to use fertilizer and why farmers would use fertilizer, or not. Okori used fertilizer 5 years ago for soybean. After he visited a farmer who used fertilizer he got convinced and started to apply it as well. He understood why farmers would not use fertilizer. Especially, those farmers who have not been trained do not use fertilizer as they are not willing to change, he explained. “They believe that when you use it once, you should continue” he elaborated. Furthermore, he explained that the prices of fertilizer were too high. “A farmer should pay 120.000 UGX for 50 kilograms of diammonium phosphate (DAP) and he or she needs to hire labour” he continued. Okori finished by telling that some farmers are satisfied with the yield they have, and some farmers think fertilizer is not good for their land. He recommended to lower the price of fertilizer as farmers find the price too high. Although the packaging is correct and corresponds with the farmers’ need, he explained, the prices of the crops fluctuate too much to be sure of buying fertilizer.

In Oyam, Opio Tommy explained the perspective of farmers on fertilizer with regard to labour and application. Tommy, who is the chairman of the Loro Noteenteko Cooperative in Loro sub-county in Oyam, frequently interacts with farmers about the use of fertilizer. Being a farmer himself he encounters the perspective of farmers in the field, he told me. He explained that farmers not only think that fertilizer is expensive. Many farmers find it a waste of time to apply it. They find it difficult to estimate how much they need and to divide the labour when introducing fertilizer, he indicated by mimicking the use of a hand hoe. When we asked what he meant with ‘divide the labour’ he moved forward on his chair and told me: “Some farmers use labour for land preparation, weeding and

harvest. If they introduce fertilizer, they need to divide the labour over land preparation, weeding, harvest and fertilizing". He continued by saying: "the application of fertilizer is the most difficult and hindering factor. Again, farmers think that you need to keep on applying fertilizer like the soil is addicted and some share that even though the plants grow healthy, there are no good yields".

As implied in the exchange between Tommy and me, the reason why farmers do not use fertilizer is not only the lack of finance. It illustrates that farmers have difficulties with integrating fertilizer in their way of cultivating soybean. Elem Bob, the N2Africa agent who brought Solomon and me to Okori in Apac, explained his experience with fertilizer and perspective of farmers on fertilizer. Bob explained that those farmers who are not trained do not know how to apply the fertilizer. They use crop rotation and leave some land fallow to increase the soil fertility. Those who are trained do not use fertilizer because they think that their land is still fertile. Some even think that fertilizer needs to be applied every season once they have started using it and that the soil gets addicted to it. But he thinks that the farmers also find it difficult to apply fertilizer. "In the past they broadcasted the fertilizer, but now TSP is promoted" Bob gestured to support his explanation. "TSP needs to be applied with the seed while planting and they think it is a waste of time or investment". "Farmers are also reluctant to apply fertilizer with the seeds because if rain will not be there the seed will dry, because of the fertilizer" he interpreted. Furthermore, Bob indicated that farmers do not want to spend too much money in the garden as well. Instead they prefer to go drinking. "If they buy fertilizer, they cannot drink" Bob explained while pointing at the men sitting near the trading post.

Me: Do you use fertilizer?

Sophia: No, I do not. I do not know where to buy it. Fertilizer you can apply in the garden and it helps to improves soil fertility and you will get a good yield.

Me: Have you used fertilizer in the past?

Sophia: No.

Me: Why don't you use fertilizer?

Sophia: Not available, I do not where to buy it. Sometime back a fellow farmer advised me, because I have been cultivating groundnut and I was not getting a good yield, to try with fertilizer. But that farmer did not tell me where to buy it from.

Me: How do you think you can get the information where to buy fertilizer?

Sophia: I can go and ask the person. But I did not ask before because I did not have cash.

Me: So, you first want to have cash before you ask?

Sophia: Yes!

Me: How much is fertilizer?

Sophia: I do not know how much fertilizer is.

Me: Then how do you know how much you need?

Sophia: Laughing*! At least when you already have something. When money is there I can directly go and buy fertilizer.

Textbox 3: Interview with Akun Sophia in Otulatum about fertilizer (18-05-2018)

Although Bob indicated the reluctance of farmers to not use fertilizer by talking about 'difficult to apply', 'land is still fertile', 'waste of time', 'prefer drinking', etc., many farmers did not describe these reasons. Akun Sophia, earlier introduced, did not use fertilizer. At first, she indicated that fertilizer was too expensive for her and did not know where to buy it. However, when we asked for more detail it became clear that she did not know the price. She stated that she assumed the price of

the fertilizer would be high and before checking the price she wanted to have money first (see textbox 3 for more details).

The majority of farmers who indicated not using fertilizer at that moment or only in the past during the N2Africa project explained it the same way as Sophia: too expensive and no access. Nevertheless, three farmers indicated that their soil was still fertile. Guerre Modesto, a male farmer who lived in Alati B Minakulu sub-county, explained that he did not use fertilizer as he had enough land to rotate the crops and leave some parts fallow to regain fertility. He thinks he is not in need of fertilizer because it will not work as his land is still fertile.

Both Francis, earlier introduced, and Adong Gloria indicated to use fertilizer at the time of the interview. Gloria, a female farmer who is 19 years old, explained that she applied fertilizer since 2014 and that her husband buys it. If she would not apply the fertilizer the soybean plant would not grow healthy, she stated. Similar to Gloria, Francis indicated that the soybean plants grow healthy when applying fertilizer. He explained that by using DAP fertilizer that he would yield more soybean.

Five other farmers pointed out that they lack the knowledge to apply fertilizer in combination row planting. “In the past when my husband and I cultivated cotton we used fertilizer. Last year my husband died. He used to tell me to use a row for seeds and a row for fertilizer, but I believe I have too little knowledge to apply it” Agnes Opio Bonny told me. Agnes is a 30-year-old single mother who lives on and cultivates the land of her husband. She had only two acres of land located ten kilometres away from her house. She does not discuss any farming practices with her surrounding community, she explained. Since her husband died, the late husbands’ family has tried to chase Agnes from the land.

5.4 Improved seeds

Besides Rhizobia and fertilizer, we interviewed farmers about whether they used improved seeds and what their experiences were with the input. None of the traditional farmers and peasant farmers indicated to use improved seeds. Those who used improved seeds were commercial and modern farmers, the majority being male.

One of the peasant farmers gave us an understanding of why she did not use improved seeds. Not far from the paved road that connects Kamdini with Lira town we met Agnes. When we sat done next to her house in the shade children were running around and constantly asking for her attention. Whereas other farmers had family members to look after the children while we conducted the interview, it seemed Agnes had nobody around to help her with the children. For me it was already tiring to have those children around during the interview and I imagined how it would be for a single mother. Agnes was not involved in the N2Africa project and did not use rhizobia, fertilizer or pesticides. Subsequently, we asked her whether she used improved seeds. At first, she indicated that she did. However, after a few more questions it became clear that the seeds were not improved seeds. Solomon explained that the seeds Agnes used were seeds bought from a local produce dealer who buys seeds that are sold as grains by farmers. Apparently, Agnes had no knowledge of improved seeds and the ones she bought were the only seeds she knew.

Different to Agnes, Guerre Modesto, introduced above, participated in the N2Africa project and explained his knowledge about improved seeds as a multiplier. He is one of the seven farmers interviewed who used improved soybean seeds. He used the seeds last year and he is involved in the local seed business, he told us. He continued that local seed businesses buy foundation seeds from seed companies and multiply the seeds for the market. The local seed businesses were organised by N2Africa and are farmers who devote their time on multiplying the foundation seeds. Subsequently, the seeds are certified by district officials and sold at the market as improved seeds, he stated (see also chapter 4; local seed business). Unfortunately, Modesto was not able to buy new seeds every season from the seed companies because of the high costs. Although, he knew that the seeds would degrade while using multiple seasons he was confident he could use these seeds another two seasons. Both Francis and Modesto knew about the improved seeds and were involved in the local seed business. Both participated in the N2Africa project of which they obtained the knowledge of improved seeds, so they indicated.

Otyang George, a male farmer living in Loro sub-county, knows the difference between local seeds and improved seeds. He told us that he used improved seeds since 2016 when he got involved in the project via AFSART (introduced in the previous chapter). George indicated that the differences between the improved variety, MAKSOY 3M, and the local variety are that the local variety grows smaller and the yield is not as good as the improved seeds. Furthermore, the local variety is less resistant than the improved variety. Nevertheless, he still needs to spray pesticides on the fields with the improved seeds.

There were farmers who participated in the N2Africa project but did not use improved seeds. Although, some first indicated being satisfied with the seeds they use, it became clear that they did not tell what they actually think. Molly Obel is a female farmer, living in Acaba sub-county, who did not use improved seeds, however participated in the project. We asked her about the seeds she was using, and she told us that she bought these from a local market in Loro sub-county. It was difficult to understand what she thought about the seeds she was using and why she did not use improved seeds. Eventually, after further questioning, she told us that she was not satisfied with the local seeds (see textbox 4 for more details).

Molly: I buy the seeds from the local market in Loro. I think these are good for me, because I did not have any problems with the yield.

Me: But you said you were not satisfied with the yield?

Molly: At that time, it was not like this time. In the past I was not getting that good a yield.

Me: but you said that you were not satisfied with this yield?

Molly: No, I am still not satisfied. Because when I cultivate a big size of land, I am expecting a big yield, but I am still not getting it.

Textbox 4: Interview with Molly Obel in Otulatum about soybean seeds (18-05-2018)

5.5 Pesticides

Pesticide is one of the inputs promoted by N2Africa in Apac and Oyam, and a subject during the interviews with farmers. This input was mainly used by modern farmers of whom the majority was men (see figure 13). None of the traditional and peasant farmers indicated to use pesticides.

Located in between the homesteads of Odyek Frances and Modesto lives Aguma CP. Aguma is a male farmer, 55 years old and did not participate in the N2Africa project. Although we were a bit reluctant to start the interview with him because he was suffering from malaria at that moment, he was happy to sit with us. We set down next to a ruin of an old shed and started the interview. When we asked him about whether he used pesticides he explained that he did not use it all the time, only when the signs appear. These signs of pests are drying of the plants and spots on the leaves in the case of soybean. He explained that he applies the pesticide himself and when he would spray the pesticide the signs would disappear. If not, his yield would be bad.

Four of the seven farmers interviewed in Apac district indicated to use pesticides and shared their content. Sando Eliba, Odong Sam, Ocen Alex and Alaro Grace are all farmers from Ibuje sub-county in Apac district. They indicated to use pesticides to control pests in their soybean field. Eliba explained that he applies the input himself as he owned a spraying pump and bought the pesticides from an input shop in Apac town. He happily told me that the pesticides work very well.

However, the majority of the farmers interviewed did not use pesticides. These seemed to be female traditional and peasant farmers. Secon indicated that she did not use pesticides because it is too expensive. She is a female farmer, living in Minakulu sub-county, who participated in the N2Africa project. Colline, introduced above, also explained that the pesticides are too expensive to buy. She had never used pesticides and she had other investment priorities to consider (see textbox 5 for more details).

Agnes, introduced earlier, indicated that she did not use pesticides and explained a similar reason as Colline. She is aware that the pest will destroy everything if it will occur. However, she does not have enough money and is need of buying more essential things for the family. We asked whether she could take a loan she replied that she could do that. Nevertheless, if she would take a loan from the family, she needed to pay it back in a very short notice and

Me: Do you use pesticides?

Colline: No, I have not sprayed pesticides. Also, not in the past.

Me: why not?

Colline: my soybean has never been affected by pests since I am cultivating soybean. Pesticides is too expensive to purchase. You can buy pesticide in Loro and a bottle is 10000 Ugandan shillings. Buying the pesticides and hiring the pump is 15000 Ugandan shillings.

Me: is that so expensive?

Colline: laughing*

Me: knowing that the pests can destroy you crops, and you will end up with a low yield, would you not consider buying it?

Colline: If you are a drunkard you can hold on with drinking, and maybe you can leave sugar aside. (clarified: the household needs certain expenses which are important, you cannot suddenly decide to buy something new).

Textbox 5: Interview with Odwong Colline in Alidi A about pesticides (18-05-2018)

she did not know how to pay it back as the yield would not be there yet. So, she preferred to take the risk of not using pesticides.

One other farmer indicated that she was not willing to buy pesticides because she considered it poison for the health of a human being. She stated that if she would use pesticides on the plants it will go back to the human. Still, she used pesticides in the past for tobacco, which was before she joined the 'Born Again' church.

Of all the twenty-six farmers who we interviewed only Odyek Francis, a commercial farmer, used rhizobia at the time of the interview. He indicated that the use of rhizobia in soybean cultivation would result in a high yield. However, if he would not apply it the yield would be extremely low. Those farmers who knew about rhizobia indicated that they did not use it as it was too expensive, their husband was not interested and that their priority lay elsewhere. Regarding fertilizer only five farmers indicated that they were using fertilizer. These were mainly modern farmers, both male and female. The main reasons for using it was that the plants would grow healthy, the yield of the soybean would be high, and that fertilizer would benefit the soil fertility. However, those farmers who did not use fertilizer indicated that the input is too expensive, the did not know how to access it and that applying fertilizer brings difficulties: more money is needed to hire labour, knowledge to apply fertilizer was lacking among farmers, their priority lay elsewhere, and two farmers stated that their soil was still fertile. Seven farmers, of the twenty-six, interviewed stated that they were using improved seeds for the higher yields compared to the local variety. Farmers who used improved seeds were mainly modern farmers and two commercial farmers, the majority being men. Moreover, farmers indicated that the improved seeds were more resistant than the local seeds. Those who indicated not using it shared with us that money, access to and lack of knowledge of the improved seeds were problems. Pesticides were applied by eleven farmers of the twenty-six interviewed. The majority, being male modern farmers, indicated that pesticides controls and kills pests and that would result in a good yield. Reasons for not using pesticides differed between a lack of knowledge how to apply the input, too expensive to buy and that priorities lay elsewhere, that soybean was not affected so far and that it is considered poison for the human being.

Figure 13: Bottle with pesticide at Otyang George in Loro sub-county, Oyam district

6 SOIL FERTILITY MANAGEMENT AND THE PERSPECTIVE OF FARMERS

6.1 Introduction

Farmers in Oyam and Apac district conducted soil fertility management related to soybean cultivation that consisted of management practices. These practices contribute to soil fertility related to their perspective of what is a fertile soil. This chapter gives an understanding of what soil fertility management practices farmers used to manage their soil fertility, what farmers perceived as a fertile soil and what they experience regarding soil fertility management practice promoted by N2Africa in relation to their social life. These management practices are not directly related to the application of inputs. In table 6 an overview can be found that describes the number of categorised farmers interviewed in Oyam and Apac who adopted and not adopted inputs and associated practices, including the management practices promoted by N2Africa. However, who adopted inputs and management practices did not necessarily adopt all inputs.

	Commercial farmers		Modern farmers		Traditional farmers		Peasant farmers		Total
	n = 3		n = 12		n = 5		n = 5		
	Adoption	Non-adoption	Adoption	Non -adoption	Adoption	Non-adoption	Adoption	Non-adoption	
Improved seeds	3	0	8	4	1	4	0	5	
Rhizobia	1	2	1	11	0	5	0	5	
Fertilizer	2	1	3	9	0	5	0	5	
Pesticides	2	1	11	1	0	5	0	5	
Management practices	1	2	6	6	1	4	0	5	
Total: inputs + management practices	1	2	6	6	0	5	0	5	26

Table 6: Number of farmers In Oyam and Apac who adopted or not adopted inputs and management practices promoted by N2Africa

6.2 Soil fertility management and knowledge

Before we could understand how farmers experienced soil fertility management practices promoted by N2Africa, we needed to know how they perceived soil fertility and what soil fertility management practices they conducted. The farmers who conducted the management practices promoted by N2Africa and were trained by the project were commercial, modern and traditional farmers, both male and female. However, farmers interviewed who did not participate in the N2Africa project conducted similar management practices during the cultivation of soybean.

Solomon and I sat down with Morris, a farmer whom we asked about the practices he was using to cultivate soybean. He is 31-year-old farmer with seven acres of land. Morris did not participate in the N2Africa project and knew little about it. He used pesticides and improved seeds, but no rhizobia nor

fertilizer. When we asked him about how he could see whether the soil of his land is fertile he explained what he knew. He indicated that a fertile soil has a dark colour and a loosened texture. We continued by asking how he took care of his soil. He indicated that he uses crop rotation, mulching and terracing to keep the soil fertile. Terracing he used because he had some sloped land. Crop rotation and what crops to rotate he learned from Oyam Agro in 2014 and mulching he already practiced for a long time. Furthermore, Oyam Agro trained him in standard spacing, including row spacing, seed spacing, and timely weeding. When we asked under what project Oyam, Agro conducted the training he indicated that he did not know. However, he remembered that he learned string planting, a practice he used for soybean, from the National Agricultural Advisory Service (NAADS) in 2005.

Morris explained the steps he took when cultivating soybean. In February Morris started with the land preparation of the field. This consists of clearing bushes and grass, if any. Immediately after land preparation he does the first ploughing and leaves the field to rest for two weeks. After two weeks he started with second ploughing. Then, two to three days after the second ploughing he began to plant the soybean seeds. During planting, Morris indicated, the men dig the holes for the seeds and the women and children plant the seeds. This planting is done in rows. If he had ploughed the field well during the first and second ploughing, Morris explained, he only needed to weed twice during the growth of the soybeans were growing. The ploughing, planting, weeding and harvest is done by the whole family, however when the field is big, he occasionally hired labourers, the majority women.

Otyang George, similar to Morris and the majority of farmers interviewed, practices land preparation, first and second ploughing, string planting, timely weeding, crop rotation and harvest. He added that threshing, separating the shells from the grains, was done on the field by the women. Furthermore, string planting does not waste land, that it looks better, and that weeding is made easier, he stated. Integrating the residue from the previous season into the land and crop rotation improved soil fertility. When we asked George about how he can see whether his soil is fertile, he explained that looks at the germination and growth of the soybean plants. ‘If the plant is growing healthy the soil is fertile’ he stated.

Other farmers interviewed added that they look at the colour of the leaves and activities of insects in the soil. When these are yellow the soil is not fertile, however when the colour of the leaves is green it indicates to them that the soil of the field is fertile. Atto Ogwang Connie, introduced earlier, shared with me that she observed the soil before planting. Not only did she look at the dark colour of the soil, she also looked at the surface of the soil whether there is defecation of rains worms or entrances of ants’ colonies. When these are present it meant to her that the soil is fertile.

Throughout the process of interviewing the farmers in Oyam and Apac district it became clear that farmers had difficulties with adopting inputs such as fertilizer, rhizobia, pesticides and improved seeds. However, some combination of practices obtained from projects like N2Africa namely land preparation, string planting (with or without actual strings), timely weeding and incorporating

residue in the soil was adopted by all farmers we had interviewed. Unfortunately, none of the farmers could explain me why input use was less adopted than soil management practices.

In another part of Uganda, I met a person who originates from Apac district and explained me the perspective of farmers on inputs like rhizobia, fertilizer, improved seeds and pesticides. Once in every two weeks I went to Arua town, five hours drive to the northwest of the country, to escape the noise and chips-with-goat dishes serviced every day at Rainbow Hotel in Oyam town. The drives were tiring but wonderful, as I had to pass two hundred kilometres of national park with wildlife crossing regularly, and in Arua I could distance myself literally and figuratively from the information I obtained from the fieldwork. Half way during my fieldwork period in Uganda I came across Okot Patrick Newton. I was sitting on the terrace of Hotel Arua in Arua town. While I was enjoying my beer and the company of Lina, the manager of the hotel, Patrick appeared from the darkness of the road and welcomed us. Lina indicated that Patrick was originating from Apac and still had family living there. Patrick and I started to talk, and I asked him why practices were adopted by farmers and inputs were adopted to a lesser extent. Patrick, being a teacher at a primary school in Arua, explained to me that inputs like fertilizer are not part of 'their system', the farmers' way of cultivating crops. He continued that most farmers believe in traditional methods of cultivating soybean and that using fertilizer is not within their system to produce (for more details, see textbox 6).

Me: Why do farmers not use fertilizer?

Patrick: It is not part of their system!

Me: What is their system?

Patrick: The way of cultivating crops, soybean.

Me: Is it possible that farmers only remember what is closest to their system?

Patrick: Most farmers believe in traditional methods of cultivating soybean. Using fertilizer is not within their system to produce. People (farmers) believe in the provision of nature.

Me: What do you mean with nature?

Patrick: They see nature in the weather, in the soil, in the water, in the trees, in the grass, in the animals.

Me: Animals are insects?

Patrick: Even insects.

Me: So, they even see nature in pests and diseases like insects?

Patrick: Yeah, even bacteria they cannot see. Good circumstances of nature is fertilizer. They do not see the connection between "nature" and "science", the practicality of fertilizer.

Me: What is science to them?

Patrick: Everything that is brought by western people and NGOs. Land tenure registration is a western system and fertilizer is a western concept. The farmers believe that fertilizer

Textbox 6: Interview with Okot Patrick Newton in Arua town (12-06-2018)

6.3 Belief

Besides the farmers' practices used to manage the fertility of their soils, we asked the interviewed farmers whether they had traditional believes which would help increase soil fertility or crop yields. All of the farmers indicated that they did not practice any traditional belief, however that they made use of their belief in Christianity.

Me: Do you have any traditional beliefs you practice getting a better soil fertility or higher yield.

Alim: Laughing* You know there is a tradition, I do not know how to describe it, that when before you pay your sin you need to pour down the pods of the beans on the road. So, when the motor vehicles step on it, they belief that when you take it to the garden you get a high yield.

Solomon: So, you get it? When you have threshed your soybean, bean, or groundnut and you bring the empty pods to the road and pour it there. When people step on it, vehicles drive on it they belief you get a higher yield.

Alim: So, that nobody can bewitch it. Because even the witchdoctor can step on it or a good person can step on it. So, there is no need for the seed to be affected by witches.

Me: Ah so mainly to protect your own yield

Alim and Solomon: Ahha!

Me: And when was it that it was used?

Solomon: I saw it even last time.

Me: When was it, where was it?

Solomon: I saw it in Lira.

Me: Ah so people still belief in it. But when was it the last time people used it?

Alim: Even now! But when Christianity came. When the white men came people started to leave it.

Textbox 7: Interview with Alim Tommy in Oyam TC about traditional beliefs (18-05-2018)

When we asked Secon whether she applied certain practices related to traditional believes she explained that she did not practice any of these beliefs. She indicated that these practices were used in the past, but religion had swept away everything considered to be a traditional belief. For her, she prayed before planting and harvest. By bringing ten per cent of her harvest to the Protestant church, she believed that growth of the plants will be better and increase the yield. Similar to Secon, Aguma also brings ten per cent of his seeds and harvest to the Catholic church. At the church the seeds and harvest are blessed. He stated that he believes it works, however it also depends on the weather. Eunice added, although she believed that her praying works, that you cannot just sit down and wait. 'If pests are there, you need to spray' Eunice explained.

Alim Tommy, who lives in Oyam Town Council and considers himself to be a commercial farmer, indicated that he does not practices any traditional beliefs, but some other farmers in the area do. Alim and Solomon explained during the interview that people still practice certain rituals that descend from traditional beliefs by illustrating a specific activity that is conducted by farmers to protect their crops from witchdoctors and to get a higher yield (see textbox 7 for more details). This description gave us an understanding what kind of traditional practices farmers still use in Oyam and Apac, and surroundings.

Throughout the fieldwork we heard multiple stories that people visit witchdoctors when struggling with conflicts and health. In an undocumented conversation in Arua with the *askari* of the house, named Joseph, he told me the story about a land conflict between two families that could not be solved. They negotiated and one of the families was not happy. "The unhappy family went to a witchdoctor that cursed the other family, Joseph explained. Because the family went to the witchdoctor, Joseph thought that the family was desperate.

6.4 Culture

Throughout the process of interviews with farmers on soil fertility management it became clear that culture is an important factor influencing the perspective of farmers on inputs and practices used. More than 50 kilometres south of the paved road going from Lira to Kamdini Solomon and I met Elem Bob, a local agent of N2Africa in Apac district. As described earlier, Bob explained that farmers perceive the application of fertilizer as a risk. Besides thinking that fertilizer can dry up the seeds after planting farmers perceived the application as difficult and prefer to not spend too much time in the garden. During the interview Bob and Solomon indicated multiple times that male farmers do not want to spend more time in the garden, weeding and digging, than they think is necessary. Solomon stated that the women stay in the field after the men leave for the village. 'After they have worked in the garden the men do not go home to do household activities, but they go to their friends and spend the day drinking' Bob added.

We continued on the subject what would be the reason of why men drink alcohol and what would be the consequences. We asked Bob whether it is a problem that men drink. He convincingly nodded: 'Yes! It is a problem. Men become lazy!'. 'But why do they do it and it is perceived as normal?' we questioned him. Bob continued by explaining that although alcohol is as a problem in Oyam and Apac, primarily among men, it has its benefits. Men drink in a group of friends almost every day if they have enough money. Solomon added: 'every day somebody else is paying a round drinks for the whole group'. 'This means that one should always have money if he wants to drink with friends', Bob continued. According to him, the group of men share a lot of information with each other about all kind of things and help each other. When one of the group members is in need of money or needs assistance with labour the whole group helps, Bob indicated. Nevertheless, Bob and Solomon perceived the alcoholic activities of male farmers as problematic that impair farmers' ambitions and aspirations. They explained that farming is perceived, by farmers, more as a necessity than a profession, a means to earn money to be able to spend the day as every day. When we asked whether it would be difficult for a farmer to step out of the group, Solomon interpreted that the pressure from the group is strengthened by the perception of the group. In other words, Solomon explained: 'the group members tell each other that a man who stays home is not man enough'. In addition, the women do not want the men to hang around the house during the day.

With the knowledge of why male farmers drink with friends and the consequences for the cultivation of soybean, we wanted to understand why it seemed that drinking alcohol is more important than investing in the land. After a half hour drive from the place Solomon and I met Bob, we arrived at the district headquarters. We walked in the main office building and when we asked for the District Agriculture Officer, we were kindly asked to take place in her office to wait a bit. Ten minutes later Okore Betty walked in. She welcomed us as the District Agriculture Officer of Apac district and was pleased to see us. When we asked her to tell us something about the agricultural input adoption of farmers in Apac she started by telling: 'Uganda in general has a history of low adoption due to the lack of knowledge among farmers regarding the inputs, low accessibility and high costs. When we

followed up whether she could be more specific regarding fertilizer, she mentioned something what was different from what we heard from farmers. She indicated that the quantity of the fertilizer delivered to those farmers who use it is inappropriate. Interestingly enough, when we gently confronted her with what we heard from farmers she stated that this was the feedback they receive from farmers. She continued that farmers perceive their soil as still fertile and stick to their pattern of cultivating soybean. Farmers are also not used to fertilizer and use crop residue to incorporate in the soil, she added. We explained her that we were wondering whether the adoption of inputs could depend on the priority's farmers have when receiving money from their harvest. Betty shared that farmers, have a budget which is made up in four components: school fees, health of the family, leisure and other things. Sixty per cent of the farmers' budget is going to school fees, twenty per cent to health of the family, ten per cent to leisure that consists of drinking and betting, and ten per cent to other things. After Betty explained the budgeting of farmers, we asked why farmers cannot use the ten per cent for leisure on investment in inputs. She laughed and stated that men are not expected to stay home all day (see textbox 8 for more details).

By concluding this chapter, every farmer interviewed used land preparation, string planting, timely weeding and incorporating residue in the soil. The latter practice and crop rotation were mainly mentioned as practices of soil fertility management. Farmers indicated that soil was fertile when the it had a dark colour and a loose texture, the colour of the leaves of the plants were green and when the plant grow healthy. When we asked why practices of soil fertility were adopted, but inputs to a lesser extend the answer was given that inputs promoted are not part of farmers' system to cultivate soybean. Furthermore, farmers told me that the majority of them is Christian, however some still practice traditional beliefs that could help soil fertility and increase the harvest. Such as traditional beliefs, farmers' risk perception of using fertilizer, the preference of male farmers to drink alcohol with fellow men and the budget prioritisation can be seen as cultural aspects that influence the adoption of inputs.

Betty: Farmers spend their money on, first, school fees, then on health of the family and then on leisure.

Me: What are the percentages? On school fees, health and leisure.

Betty: School fees sixty per cent, health twenty per cent, leisure ten percent and ten per cent on other things. Things that can happen.

Me: Is that ten per cent for leisure a lot?

Betty: Yes, it is a considerable amount.

Me: Why do farmers not spend this money on for example fertilizer?

Betty: Men are not expected to stay home all day. They need to gather information during drinking. They need to save money for their turn to buy booze.

Me: Is your husband also gathering information?

Betty: laughing*

Me: What if he does not come to drink?

Betty: They call you where you are to drink. It is difficult to withdrawal from the group. They help each other financially, etc.

Textbox 8: Interview with Okore Betty in Apac about budgeting (26-06-2018)

7 DISCUSSION AND CONCLUSION

7.1 Introduction

The previous three chapters provide empirical information to the sub-research questions that arise from the objective of this thesis: "to provide better understanding of the adoption of nitrogen fixation technology packages in Oyam and Apac in relation to the socio-cultural preferences of socially different farmers".

1. *How does social differentiation affect agricultural practices and technology adoption levels in Apac and Oyam district, Uganda?*
2. *How do farmers understand soil fertility management in relation to soybean cultivation?*
3. *a) What are the views of the farmers on the inputs and services promoted by N2Africa and how does these relate to their social life, b) how they act upon it, and c) how does this reflect on adoption as measured by researchers?*

7.2 Social differentiation and the N2Africa approach

The levels of adoption by farmers in Oyam and Apac were different among the categories presented in chapter 4. However, it is important to have an understanding how these categories have come to being and how these differences between the categories of farmers were constituted. Throughout the FGDs farmers had similar ways of categorising the farming community. The farmers who participated in the four FGDs were all members of a cooperative, except for the FGD in Apac, and most of them saw themselves as modern farmers.

In this thesis, twenty-six farmers were interviewed of whom twelve were categorised as modern farmers. According to the FGDs in chapter 4, this category of farmers represented approximately 35 per cent of the farming community in Oyam and Apac. Modern farmers had more land, livestock, inputs, and were more market oriented, etc., compared to traditional and peasant farmers. Apart from these aspects, modern farmers were more likely to be a member of a cooperative compared to the other three categories. Commercial farmers were not interested in being a cooperative member due to their own bulking capacity, according to the FGD participants. Data on whether modern farmers already represented a considerable part of the farming community before N2Africa started, and developed of cooperatives, lack in this thesis.

However, key informants indicated that peasant farmers had a high dropout rate during the project's implementation period due to the distance they had to travel to the trials and the lack of transport. Although key informants shared that N2Africa targeted modern, traditional and peasant farmers, I assume that in practice N2Africa mainly targeted modern and traditional farmers in Oyam and Apac. Peasant farmers had little land and few other assets, criteria that deemed to be important in studies conducted by the project (Ronner et al., 2018:3; Franke et al., 2014). The distance peasant farmers needed to travel while lacking transport and the financial obligations to be a member of a cooperative prevented peasant farmers from developing themselves to modern or traditional farmers.

Additionally, N2Africa mainly focused on the economic and agro-ecological aspects of farming systems by promoting practices and inputs. Although the inputs were for free and handed out during the adaptation trials of the project, after project termination the inputs needed to be purchased by farmers themselves. Peasant farmers were not able to adjust these practices and inputs in their farming system, due to the lack of labour, energy and the financial needs to obtain these. Inputs were too expensive to buy and apply, and knowledge of inputs and management practices were mainly available via the project and/or cooperative. These were hard to reach due to the distance and the shares and contributions that needed to be paid. Peasant farmers were unable to negotiate arrangements to their advantage and are excluded from effective participation and access to institutions and knowledge, which aligns with what Cleaver (2005) called the inability to exercise agency. Therefore, these farmers resorted to traditional practices, and sometimes witchcraft, to keep their soil fertile. Indirectly, by setting up cooperatives and target farmers who met the preferred criteria, N2Africa and other technology-oriented projects re-confirmed the existing social differentiation and the strengthened the inability of the poorest farmers to exercise agency effectively and thus did not diminish the gap between different categories of farmers.

7.3 Reasons of action

7.3.1 Farmers' conflicting aspirations

To ensure the well-being of the family, all categories of farmers organised a financial budget after the harvest that considers the expenses for the following season. Expenses consisted of school fees, health care, investment in the field, unforeseen costs and leisure (see chapter 6). The expenses illustrated a responsibility shared by both the husband and wife to ensure the well-being of the family. Although the men were responsible for the cash crops and received most of the money, and the women were responsible for the food crops and household, in the majority of the cases both husband and the wife decided together about the expenses in the budget. I found that together they decided about the budget for the well-being of the family, although the husband made the final decisions.

In relation to the final decision making, the money allocated for leisure is only intended for the husband. The leisure activities mainly existed out of drinking with fellow male farmers after working in the field. Besides leisure it allowed them to obtain information and create a social network. Key informants expressed that male farmers did not want to spend too much time working in the field and considered it important to participate in the drinking activities. It is said in the group that 'a man who is sitting home during the day is not man enough', which pressurised and stimulated the husband to participate in the leisure activities. This process relates to what Leeuwis and Van den Ban (2004) called 'cultural aspiration'. However, while the husband made the final decision in the household expenses and claims money for leisure activities, I assume the wife was forced to choose for strategic life choices in securing the well-being of the family (Kabeer, 1999). I found that the husband claimed power over the money for leisure and the wife expressed her dislike of the husband hanging around the house. This could give her the feeling of autonomy in an unequal power balance

with her husband and to focus on her aspirations, what could relate to transformatory significance (Kabeer, 1999).

In contrary to Pircher et al. (2013), both men and women interviewed in Oyam and Apac shared the aspiration for higher soybean yields, to have inputs and the knowledge to obtain these, although they indicated they lacked the finance to purchase inputs. Mainly women indicated finance as not simply having a lack of money. They expressed that they were not able to justify the purchase of inputs and extra investments in relation to their socio-cultural aspirations and responsibilties. It conflicted with the husband and wife's cultural aspirations and social responsibilities. Due to the fact that they needed money for school fees, healthcare, leisure and unforeseen events they did not have the financial means to justify extra investments for the field than already accounted for. This situation was based on cultural aspiration and responsibilities in the social life of farmers involving social norms and values. The social norms and values were translated into concrete collective expectations and prescriptions with regards to human behaviour in specific circumstances (Leeuwis and Van den Ban, 2004). Therefore, the cultural aspirations and expectations pressured and stimulated the farmers to allocate money to school fees, healthcare, leisure and unforeseen expenses rather than extra investments in the field and hence to disregard acting upon the technical and economic aspirations.

7.3.2 Social environment and management practice

Besides cultural aspirations and expectations, a famer's belief in his or her own capacity resulted in the neglect of technical and economic aspirations. The farmers' belief in his or her own capacity played a considerable role in not investing extra money in the field. Both male and female farmers in Oyam and Apac interviewed, although not all, indicated that they have insufficient knowledge of applying the inputs. Fifteen of the twenty-six farmers used one or more inputs in Oyam and Apac, showed in chapter 5. Especially rhizobia and fertilizer were mentioned as difficult to apply by both farmers who were trained and those who were not trained. Only two of the twenty-six farmers interviewed applied rhizobia and five farmers applied fertilizer.

Moreover, the applicable knowledge, competences and skills to apply the inputs were difficult to obtain for farmers. To access rhizobia and improved seeds farmers needed be a member of a cooperative. Active members could purchase inputs and receive knowledge in the form of trainings via the cooperative, whereas passive members could only partly. However, not all farmers were able become an active member of a cooperative as explained in chapter 4. This situation created inclusive and exclusive processes that disadvantage the poorest farmers (Cleaver, 2005) and prevented them from becoming an active member of a cooperative. This resulted in the exclusion of poor farmers from knowledge, training and certain inputs.

The exclusion from knowledge, competences and skills to apply inputs forced farmers to resort to more traditional management practices, indicated as well by (Leeuwis and Van den Ban, 2014). Farmers in Oyam and Apac primarily assessed soil fertility on how the soil and plants look like, and some based their assessment on the organisms that live in the soil. Based on these observations, together with experiences shared by other farmers, and what they experienced themselves they

decided whether certain management practices are favourable in their social and agro-ecological context. In contrast to the use of fertilizer, pesticides and inoculants, leaving the crop residue on the field and/or integrating it in the soil for decomposition was more applicable for farmers. These management practices were easier to incorporate in their former soil fertility management, before the introduction N2Africa. Row planting with a string, as promoted by N2Africa was more time consuming, indicated by farmers. However, some farmers adjusted this practice by planting the seeds without using the strings. Integrating and incorporating these management practices in the farmer's soil management had no additional cash costs, it saved energy and did not consume more time in the field compared to former practices used by farmers. Therefore, cultural and technical knowledge which is interlinked with social knowledge and skills and their way of understanding soil fertility management, allowed the farmer to adjust practices to social and agro-ecological context (Oudwater and Martin, 2003).

7.3.3 Risk perception and social life

The majority of farmers did not adopt the technology package as intended by the project and western researchers of N2Africa. Although, there were farmers who integrated and adjusted some practices and inputs promoted by N2Africa in their way of soybean cultivation and soil management (see table 6 in chapter 5), these cases were few. As described in the previous section, farmers lacked knowledge to apply inputs and resorted to more traditional practice, which resulted in partly adopting practices and inputs promoted by N2Africa.

Moreover, besides the lack of knowledge of input use, farmers perceived the use of inputs as a risk. In chapter 6, farmers and key informants in Oyam and Apac described that applying fertilizer is perceived as a risk for their livelihood. Besides farmers' belief that fertilizer could increase the yield of soybean, they were aware of potential consequences. Farmers indicated that when fertilizer was applied once, they believed it needed to be applied every season. The soil would get 'addicted' to the fertilizer, which would force them to keep applying. Even though, the crops would grow healthy some shared that the yields would still be low. Another risk mentioned by farmers is that fertilizer could destroy the seeds planted. When the seeds would be planted and the fertilizer added in the same whole, the fertilizer would dry the seeds when rain will not fall. These consequences could cause outcomes like seed germination failure and low yields, according to the farmers. Hence, farmers view the allocation of money to buy and use inputs as conflicting with their social responsibilities and as a risk for their livelihood. Rather than adopting the full technology package anticipated by researchers, farmers tend to partly adopt practices and inputs and to adjust these to their own perspective of applicability (Crane, 2014; Jansen and Vellema, 2011).

7.4 Future research considerations

These considerations are derived from the previous sections in order to improve the understanding of farmers livelihood in relation with technology adoption and thereafter adjust extension approaches and increase the adoption of practices and inputs among the socially different farmers in Oyam and Apac.

This research did not study the cooperatives in Oyam and Apac, Uganda. To become an active member of a cooperative a farmer needed to buy shares of the cooperative and pay contribution. If able, this member would have access to inputs and knowledge of how to apply these via the cooperative. However, passive registered members, who had not bought shares or paid contribution, were not informed actively. Non-members, especially women, did not have any access to inputs and knowledge of input application, only (if at all) via fellow farmers. As farmers use the terms 'active' and 'passive' members it is possible that cooperatives, indirectly western institutions, label farmers and creates a wealth and privilege differentiation among farmers, which can affect how farmers interact with each other with regard to knowledge sharing. However, cooperatives were never mentioned by farmers nor by key informants as influential institutions determining the social relationships among farmers. It would be interesting to further research and understand how cooperatives and extension approaches play a role in the establishment of social relationships among farmers and subsequently strengthen the positions of the different categories of farmers presented in chapter 4. Subsequently, by applying this knowledge farmers could play a more active role during future technology-oriented projects in the dissemination process of inputs and practices amongst other farmers.

Although, this thesis gave an understanding of how farmers experienced soil fertility management and what practices they conducted, it provided insufficient information to make claims concerning the perspective of farmers on their soil management knowledge. Farmers could have been investing in improving land with regard to soil fertility, however these efforts were overlooked as investment by intervening institutions, as described by Fairhead and Scoones (2005). These investments might have been shaped and prioritized over generations and adjusted to the aspirations in contrast to practices and inputs promoted by western institutions. Therefore, it would be interesting to better understand the farmer's perspective of soil management in relation to local knowledge that lead to investments that are more applicable to their livelihoods. In combination with the following consideration, this information could enable future projects to construct and align intervention with the prioritised soil management practices perceived by farmers and even support these practices with agronomic research.

Research that would focus more on the economic aspects on farmers' household budgeting could give an understanding of the farmers' livelihood decision making. Through the research it became clear that farmers make a budget to allocate their financial assets to multiple aspects of their livelihood. Due to cultural aspiration and social responsibility certain expenses were prioritised that made farmers unable to invest in inputs. However, this research did not focus on the actual budgeting of a farmer household after a harvest. A research focussing on the household budgeting in

Oyam and Apac would generate an understanding of the farmers' priorities for future investments. This can enable future technology-oriented projects to give farmers training on budgeting applicable to their household situation. Together with the knowledge of the farmer's prioritised soil management practices farmers can develop adequate budgeting in line with their cultural aspirations.

A research consideration that requires natural science rather than social sciences. Multiple farmers interviewed for this thesis revealed they experienced low productivity of soybean despite the application of fertilizer. Although, this research did not find any evidence to support this claim or deny it, it would be recommended to further research these claims to understand the farmers' experience with soybean cultivation. This research will need a technical approach determining what could be the cause of the low yields of soybean despite the fertilizer application, although there might an interplay with be social factors influencing the low productivity.

Related to the latter consideration is the need of research into the soils' 'fertilizer addiction' as reported and feared by farmers. Agronomical such a situation might occur when farmers substitute the practice of green manuring and regular fallow periods by the application of fertilizer only. In that case the resulting progressive decrease in soil structure would diminish the water and free minerals retention capacity of the soils, producing an ever-increasing 'fertilizer addiction'. Further research could be undertaken to determine whether farmers have applied such a substitution in the past and based on what sort of (incomplete) extension advice.

7.5 Conclusion

This thesis shows a difference in adoption among the different categories of farmers in Oyam and Apac and how this is related to the approach of N2Africa. Of the twenty-six farmers interviewed mainly modern farmers, of whom 50 per cent, adopted practices and inputs promoted by the project compared to the other categories of farmers. Many of these modern farmers were active or passive members of a cooperative and had access to knowledge and inputs. Although, N2Africa targeted modern, traditional and peasant farmers during demonstration and adaptation trials, especially peasant farmers were unable in developing themselves through the project. The approach of N2Africa stimulated farmers to purchase inputs and to conduct practices after the end of the project that were not adjustable to the peasant farmers livelihood. The peasant farmers dropped out during the project period due to travel distance and lack of transport to the trials, and were financially unable to become a member of a cooperative. This strengthened the social differentiation of the farming community in Oyam and Apac which was contributed by the approach of N2Africa. Technology oriented projects should be aware of the social processes and the role of cooperatives in the farming community in relation to the social differentiation in order to reach peasant farmers. Subsequently, the needs of peasant farmers could be more recognised and the intervention approach could be adjusted to their local knowledge of soil fertility management and to investments more applicable for them.

By exploring the social and cultural aspects of farmers' perspective on soil fertility management and soybean cultivation, this thesis shows that cultural aspirations and social responsibilities of farmers, regardless of what category, conflict with adopting practices and inputs promoted by N2Africa. Although, farmers had economic and technical aspirations to increase yields and to use new inputs and related practices, the financial budget did not allow them to act upon these aspirations. Cultural aspirations and social responsibilities restricted farmers to justify the allocation of money to extra investments in their field. In addition, this was enhanced by the farmer's feeling of having insufficient knowledge to apply inputs. To obtain the knowledge, competences and skills to apply inputs farmers needed to be an active member of a cooperative. Due to financial constraints the majority of farmers were not able to become an active member and were excluded from access to inputs and knowledge how to apply these. Strengthened by the perception that inputs pose a risk to the livelihood of the household and the cultural aspirations farmers had, they resorted to practices that were adjustable to their social and agro-ecological context. Thus, farmers only applied practices and inputs promoted by N2Africa as far as it was applicable to their own way of soil fertility management and soybean cultivation. Future research to understand the farmer's perspective of soil fertility management in relation to their local knowledge and household budgeting, can contribute to approaches that take into account practices more applicable to the social and agro-ecological context of farmers and their priorities for future investments.

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APPENDIX 1

Farming community: semi-structured interview guide Key informants

Name:
Phone number:
M/F
Expertise/role:
Age:
District:
Town/village:

1. Qualitative interview introduction

Primary goal: To generate an understanding of the farmers through the perception of the you (the key informants) and how you categorise farmers in Apac or Oyam.

2. Verbal consent

Would you like to participate in this interview?
Verbal consent was obtained from the study participant
Verbal consent was NOT obtained from the study participant

3. Background

Invite interviewee to briefly tell me about him/herself: General information about background... mostly about experiences and perspectives on farmers in Apac or Oyam and what their relationship is with the farmers.

4. Farmers present in Apac or Oyam

Can you tell me about the farmers in Apac or Oyam?

- How would you categorise them/What is the difference between farmers?
- What are their activities?
    - What do they cultivate?
    - Etc. (keep in mind the following topics)
        - land size
        - infrastructure accessibility
        - crop production
        - water accessibility
        - male and female headed households
        - household composition
        - livestock and cattle
        - extension services availability
        - farmer cooperatives

5. Actors in the field involved with farmers

Can you tell me about the actors in the field that interact with farmers?

- How would you categorise them/how are they related to the farmers?
    - What service do they provide?
    - Etc. (keep in mind the following topics, related to the above)
        - Institutional
        - Social
        - Cultural
        - Political
        - Technical
        - Economic
        - Seasonal

6. Change over time and place

Do you see a change in the farming community the past year (10y)?

- How did this change take place/ have there been events that influenced farmers permanently?
    - Who or what influenced them?
    - Etc. (keep in mind the following topics, related to the above)

APPENDIX 2

Soil fertility, Nitrogen fixation and Soybean cultivation: semi-structured interview guide Farmers

Name:
Phone number:
M/F
Expertise/profession/title:
Age:
District:
Town/village:

1. Qualitative interview introduction

Primary goal: To generate an understanding of the farmers' perspective on soil fertility, nitrogen fixation and soybean cultivation in relation to their self-perceived identity.

2. Verbal consent

Would you like to participate in this interview?
Verbal consent was obtained from the study participant
Verbal consent was NOT obtained from the study participant

3. Background

Invite interviewee to briefly tell me about him/herself: General information about background... mostly about experiences and perspectives on soil fertility, nitrogen fixation and soybean cultivation on the farmland.

4. Knowledge and believe of the soil in relation to nitrogen fixation and soybean

Can you tell me about the soil of your land/ can you tell me about how you know your soil is fertile?

- How can you see your soil is fertile?
    - Can I see it?
- What do you know about your soil/how do you care for the soil?
    - What crops do you grow?
        - Why do you grow these crops?
            - Via whom/what did you get to know this crop?
        - What effects have the crops on the soil?
            - How do you know?
            - How can you see?
    - Do you dig the land?
        - If yes, when and why do you dig the land?
        - If no, why not/who does?
    - What practices do you do/what do you apply or remove?
        - Why?
        - What do you do with soybeans? And other crops?
    - Who executes the practices/who applies or removes what?
        - Why?
        - What does that person do with soybeans? And other crops?
    - What is your experience with these practices?
        - Have you experienced it yourself or have your heard about it?
        - With whom do you share your experience?
    - What do you think will happen if you do or do not dig/apply or remove?
        - Technical, economic, social
- Do you believe that your behaviour reflects the soil fertility/do you communicate with the soil of the land?
    - What behaviour do you do to make sure the soil is fertile?
        - Do you have rituals to make the soil fertile?
        - Why? Why not?
    - Do you pray for the soil to be fertile?
        - If yes, what do you say in your prayer?
        - If not, why not?
    - What is your experience with praying?

    - What do you think will happen when you pray /or not pray?
        - Technical, economic, social
- What do you know about fertilizers/how do fertilizers contribute to the soil?
    - Do you apply fertilizer?
        - If yes, can I see the fertilizer? Why do you use it?
        - If no, why not?
    - Have you applied fertilizer in the past?
    - What is your experience with fertilizer/ how do you feel about fertilizer?
    - Have you experienced it yourself or have you heard about it?
    - What do you think will happen when you use/or not use fertilizer?
        - Technical, economic, social
- What do you know about pesticides/how do pesticides contribute to the soil?
    - Do you apply pesticides?
        - If yes, can I see the pesticide? Why do you use it? Who applies it?
        - If not, why not?
    - Have you applied pesticides in the past?
    - What is your experience with pesticides/ how do you feel about pesticides?
        - Have you experienced it yourself or have you heard about it?
        - With whom do you share your experience?
    - What do you think will happen when you use/or not use pesticides?
        - Technical, economic, social
- What do you know about inoculants/how do inoculants contribute to the soil?
    - Do you apply inoculants?
        - If yes, can I see the inoculants? Why do you use it? Who applies it?
        - If not, why not?
    - Have you applied inoculants in the past?
    - What is your experience with inoculants/ how do you feel about inoculants?
        - Have you experienced it yourself or have you heard about it?
        - With whom do you share your experience?
    - What do you think will happen when you use/or not use inoculants?
        - Technical, economic, social
- Do you know about nitrogen fixation?
    - How do you call nitrogen fixation?
    - How do you know about nitrogen fixation?
        - Who told you about nitrogen fixation?
        - Do you believe in nitrogen fixation?
    - Why do you cultivate soybeans? Why not?
    - How do you know about soybeans?
        - Who told you about soybeans?
        - Do you believe soybeans is good for the soil? Why? Why not?
    - Why do you use inoculants? Why not?
    - How do you know about inoculants?
        - Who told you about inoculants?
        - Do you believe inoculants are good for the soil? Why? Why not?
- What do you know about soil erosion/ how do you know the soil is not fertile? (mainly to verify the answers of the questions above).

APPENDIX 3

Nitrogen fixation technology adoption in social life: semi-structured interview guide Farmers

Name:
Phone number:
M/F
Expertise/profession/title:
Age:
District:
Town/village:

1. Qualitative interview introduction

Primary goal: To generate an understanding of the farmers' perspective on the nitrogen fixation technology adoption in relation to the context of their social life.

2. Verbal consent

Would you like to participate in this interview?
Verbal consent was obtained from the study participant
Verbal consent was NOT obtained from the study participant

3. Background

Invite interviewee to briefly tell me about him/herself: General information about background... mostly about experiences and perspectives on the nitrogen fixation technology adoption in relation to the context of their social life.

4. Experience and perspective on the nitrogen fixation technology

Can you tell me about the actors you are involved with/ can you tell me about those people who give you services?

- Do you receive any services?
    - What kind of services do you receive?
    - Who provides you with those services?
    - What do you do with those services?
    - What do you think about those services?
        - Why do you think you receive those services?
    - What are the main benefits and constrains?
- Do you receive any inputs?
    - What kind of inputs do you receive?
    - Who provides you with those inputs?
    - What do you do with those inputs?
    - What do you think about those services?
        - Why do you think you receive those inputs?
    - What are the main benefits and constrains?
- Do you still receive those inputs and services? (fertilizer, pesticides, improved seeds, N2Africa)
    - Since when did you receive these inputs and services?
        - Did you receive any similar inputs and services 5 years ago?
    - Who provided the inputs and services 5 years ago?
    - What are the main differences between now and 5 years ago?
        - How did you feel about the inputs and services 5 years ago?
        - What do you feel about the inputs and services you receive at the moment?
        - How do you feel about the inputs and services of 5 years ago when you look back to it?
        - What were the main benefits and constrains 5 years ago regarding the inputs and services?
- What do you think about the actors with whom you are involved with?
    - Who were the actors with whom you were involved with 5 years ago?
        - How did you know about those actors?
        - Who introduced you to those actors?
        - How did these actors present themselves to you?
        - What did these actors provide to you?
        - How do you feel about those actors?
        - How did these actors communicated and worked with you and fellow farmers?

                - Do you think you can talk in the name of fellow farmers regarding these actors?
                    - Why? Why not?
            - What are the main benefits and constrains?
    - Who are the actors with whom you are involved with at the moment?
        - How did you know about those actors?
        - How did these actors present themselves to you?
        - Who introduced you actors?
        - What do these actors provide to you?
        - How do you feel about those actors?
        - How do these actors communicate to and work with you and fellow farmers?
            - Do you think you can talk in the name of fellow farmers regarding these actors?
                - Why? Why not?
        - What are the main benefits and constrains?
- What is your work experience with the actors at the moment?
    - How do the actors present themselves to you?
        - What do you think about their behaviour?
        - Do they listen to you?
            - Why? Why not?
    - How do the actors communicate to you?
        - What language?
        - Formal or informal?
        - Individually or in a group?
        - Do they treat every farmer the same?
            - Why? Why not?
        - Do you believe what they say?
            - Why? Why not?
    - How do the actors work with you?
        - What language?
        - Formal or informal?
        - Individually or in a group?
        - Do they treat every farmer the same?
            - Why? Why not?
        - Do you believe what they say?
            - Why? Why not?
    - What are the main benefits and constrains with the actor?
    - What is the experience of fellow farmers with the actor?
        - Do you think you can talk for your fellow farmers regarding the actors?
            - Why? Why not?
    - What do other members of you community think about the actors? (Leeuwis Model!!!)
        - What is the experience of the community with the actors?
        - … ask questions that are related to the community (social life) and the actors!