Farmer’s perceptions of agroforestry

- A case study about the obstacles and opportunities for agroforestry adoption in Babati, Tanzania

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Abstract

This thesis deals with the perceptions of agroforestry among farmers in Babati, north-central Tanzania. The focus is on which resources farmers perceive that they need to adopt agroforestry and which risks that are connected with agroforestry adoption. It is also to see how farmers perceive that the access to resources changes after agroforestry adoption and how their livelihoods change. The data has been collected through qualitative interviews with agroforestry farmers, conventional farmers and extension officers. After that the data has been analyzed through the sustainable livelihood approach and a risk perception theory. The results show that some of the obstacles or risks that farmers perceive with agroforestry adoption are high input costs, dependency on short-term benefits, competition between trees and crops and lack of education from extension services. Without financial capital and human capital in terms of knowledge there might be too many risks connected with adoption. If agroforestry however is adopted the farmers perceive that the access to firewood, timber and fruits increase which increase their incomes and therefore financial capital. They also perceive that the fruits improve food security and that the timber improves the housing. The firewood is also perceived to improve the situation for women as they do not have to walk as far to collect the firewood. Agroforestry is also perceived to provide environmental services like erosion prevention and increased soil fertility, therefore it increases natural capital. Some trees can also be used as natural pesticides. The increased soil fertility or the access to natural pesticides, however does not seem to affect the use of industrial fertilizers or pesticides. Agroforestry is also not perceived to have any effects on biodiversity or water quality. Even if agroforestry may not be a good choice for all farmers, it can for some farmers increase their ability to cope with stress and shocks like future climate change. This is because the agroforestry system can work as a buffer against increased climatic variability.

Keywords: Sustainable livelihood approach, capital assets, risk perceptions, risk attitudes, agroforestry adoption, Tanzania

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1. Introduction

Most people in sub-Saharan Africa live in rural areas and are directly or indirectly dependent on agriculture for their livelihoods.\(^1\) Agriculture is the foundation of the Tanzanian economy as it stands for about half of the national income. It is also an important food source for the population.\(^2\) In Babati district, Northern Tanzania over 70% of the population is dependent on farming as their main income.\(^3\) Considering this, climate change may have severe consequences on the populations’ livelihood as it may have negative effects on agricultural production. Investments need to be made to improve agricultural productivity, protect poor people’s livelihoods and assure food security.\(^4\)

Agroforestry is a farming system where woody perennials like trees and shrubs are integrated with crops and/or livestock in the same management unit.\(^5\) (Appendix 2, picture 1) In previous studies it has been shown that this farming system can provide a diversified production with a large variety of agricultural- and forest products.\(^6\) This means that agroforestry can work as a buffer against increased climatic variability that will result from climate change.\(^7\) Most rural households in Tanzania depend on the natural resource base at least to some extent.\(^8\) Agroforestry can also be a way to increase access to natural resources for the farmers, for example the access to firewood, the main energy source in Babati.\(^9\) In Tanzania 90% of the energy consumption in Tanzania originates from the trees.\(^10\) (Appendix 2, picture 2) Some trees can also provide the farmers with fruits which increase the food security as the household can collect, process and consume the fruits for themselves. Besides that the fruits can be sold which increases the possibility to buy food and other household goods. Some trees are also used for building material and when the timber is sold this can generate higher incomes. Many trees can also act as wind breaks which protect the crops and prevent erosion.\(^11\)

\(^{1}\) Diao, Xinshen. Hazell, Peter. 2010, p 1375
\(^{3}\) Kavishe, Calyst; Technical advisor in Land management program in Tanzania. Interview 2014-02-20.
\(^{4}\) Arndt, Channing et al. 2012, p 385
\(^{5}\) Senkondo, Ephraim.M.M. 2000, pp 1-2
\(^{6}\) Stainback, Andrew et al. 2012, p 287
\(^{7}\) Shibu, Jose. 2009, pp 2-3
\(^{8}\) Scoones, Ian, p 6
\(^{9}\) Kavishe, Calyst; Technical advisor in Land management programme Tanzania. Interview 2014-02-20.
\(^{10}\) Senkondo, Ephraim.M.M.2000, p 2
\(^{11}\) Kiptot, Evelyne. Franzel, Steven. 2012, pp 39-41
1.1 Why study agroforestry adoption in Tanzania

Agroforestry systems have been widely adopted in Babati, partly because of the LAMP-program which was funded by the government of Sweden, through the Swedish organization Sida. It was meant to improve natural resource management and was targeted towards individual, rural households, cultivators, livestock keepers and pastoralists. It was also targeted towards village level organizations, district councils and selected NGO:s, those who assist rural communities. One important aspect of the LAMP-program was that extension services were directed towards individuals or groups of farmers and pastoralists through multidisciplinary Ward Extension Teams. These trained the farmers and pastoralists in different land management practices like for example agroforestry.\(^{12}\) The LAMP-program in Tanzania lasted for 13 years, between 1992 and 2005.\(^{13}\)

Despite the fact that agroforestry may result in an increase in natural resources, most farmers still continue with conventional agriculture. Maybe that is because agroforestry is not as beneficial as it is portrayed in previous studies or it depends on the households’ access to other types of resources. Financial resources or information and knowledge about agroforestry might be examples of these resources. In this study the sustainable livelihood approach will be used as a theoretical and analytical framework to analyze agroforestry adoption. The framework increases the understanding about how the livelihood of a village, household or group is depending on different resources.\(^{14}\) It divides the resources into five types of capital assets, natural, financial, physical, social and human capital. If a household has access to these capitals it will result in improved livelihood outcomes like higher incomes, better healthcare, better access to quality education and improved food security.\(^{15}\) Studying how the access to the different capitals is connected to agroforestry adoption is a way to get an increased understanding about the obstacles for agroforestry adoption but also the livelihood effects after adoption. The livelihood effects in this study will be analyzed at the local level, both farmers’ perceptions of the effects on their own household and their perceptions of the effects on village level.

\(^{12}\) Havnevik, Kjell. Rwebangira, Magdalena. Tivell, Anders. 2000, pp 6-7  
\(^{14}\) Morse, Stephen. and McNamara, Nora. 2013, pp 19-20  
\(^{15}\) Ibid, pp 19-20
1.2 Aim
The aim of this study is to see how the access to the different capital assets in the SLA-approach affect whether a farmer adopts agroforestry. It is also to see which risks that farmers perceive are connected with agroforestry adoption. Besides that I will also analyze how farmers perceive that agroforestry adoption affects their livelihoods. This will be done by investigating the perceived changes in access to the capital assets after agroforestry adoption. To achieve the aim of this study the research questions are as follows:

How does the farmer’s access to the different capital assets in the SLA-approach influence their agroforestry adoption choices?

How do the farmers’ risk perceptions and attitudes influence their agroforestry adoption choices?

Which changes in the access to the different capitals in the SLA-approach do farmers perceive agroforestry adoption leads to? How do they perceive agroforestry adoption have affected or will affect their livelihood?

2. Theoretical framework
2.1 The Sustainable livelihood approach
The core of the sustainable livelihood approach is the assessment of the five different capital assets which underpins for example a households’ or a village livelihood. When a livelihood is underpinned by an increase in capital assets, the livelihood outcomes might improve. This means for example that incomes might increase, health care and food security improve and the access to quality education increase.\(^\text{16}\) Improved livelihood outcomes might also mean increased well-being and capabilities in terms of for example improved self-esteem, security and happiness.\(^\text{17}\)

There are five categories of capital assets in an SLA. These are natural, financial, human, social and physical capital.\(^\text{18}\) Natural capital is often divided into natural resources and environmental services. Natural resources are for example soil, water and air while environmental services are for example the hydrological cycle and pollution sinks.\(^\text{19}\) Natural capital can also be divided into four types of ecosystem services. Provisioning services are for example food, water, timber and fiber, regulating services for

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\(^\text{16}\)Ibid, pp 19-20
\(^\text{17}\) Scoones, Ian, p 6
\(^\text{18}\) Morse, Stephen. and McNamara, Nora. 2013, p 19
\(^\text{19}\) Ibid, p 28
example regulates climate, floods, disease, waste and water quality, cultural services provide recreational, aesthetic and spiritual benefits and supporting services are for example soil formation, photosynthesis and nutrient cycling.\textsuperscript{20} Natural capital has an anthropocentric meaning in the SLA-approach. It consists of the benefits that humans get from the ecosystem.\textsuperscript{21}

Social capital can be described as connections between people. It is social resources like networks, social claims, social relations, affiliations and associations.\textsuperscript{22} Benefits with social networks like groups can be that they increase the access to resources for the group members. But the networks can also be barriers which limit livelihood options, they can exclude outsiders and restrict individual freedom as a result of rules and regulations put on the group members.\textsuperscript{23} Human capital is skills, knowledge, labour, good health and physical capability. Investment in education and training can therefore lead to increased human capital. Financial capital is the capital base like cash, credit/debt, savings and other economic assets. Physical capital is infrastructure like buildings and roads, production equipment and technologies.\textsuperscript{24}

The different capital assets can be seen as a base for power to act and enter upon changes in society. They can be seen as a support to make a living, making people’s lives more meaningful and challenge the structures under which people make a living.\textsuperscript{25} The SLA-approach gives an understanding about the capital assets available to households, their vulnerability and the involvement of institutions.\textsuperscript{26} Vulnerability depends on the resilience of a livelihood, its ability to recover from stress and shocks. A shock is a more sudden pressure on a livelihood, like a flood or a drought, which can have severe effects on physical and natural capital in a short time period. Stress on the other hand denotes more longer-term pressures. An example is an economic downturn which can last for several years leading to unemployment and dampened markets for labour and produce.\textsuperscript{27} Institutions are for example publically funded extension services which can provide knowledge, advice and help.\textsuperscript{28} Institutions influence people’s natural access to capitals as well as their opportunities and choices.\textsuperscript{29} After the vulnerability context and the institutional context is understood, interventions can be developed to improve the

\textsuperscript{20} Ibid, pp 32-34
\textsuperscript{21} Ibid, pp 32-34
\textsuperscript{22} Ibid, pp 28-29
\textsuperscript{23} Ibid, p 31
\textsuperscript{24} Ibid, pp 28-29
\textsuperscript{25} Ibid, p 30
\textsuperscript{26} Ibid, pp 19-20
\textsuperscript{27} Scoones, Ian, p 12
\textsuperscript{28} Ibid, p 19
\textsuperscript{29}Morse, Stephen. and McNamara, Nora. 2013, pp 35-36
livelihood outcomes and their sustainability. This can for example be done by increasing access to the capital assets or by reducing vulnerability.30

One important difficulty with the SLA-approach is that it has no particular technique or method to analyze and measure the different capitals. Every capital asset might have many different elements and how should these be assessed? Should only some of them be measured or all of them? And if only some of them should be measured, how is it determined which capital assets to measure? Another question is whether capital assets can replace each other or not. Can natural capital for example be replaced by financial or physical capital and how does that affect sustainability?31 In this study I will not rank the different elements of the capital assets which are mentioned in my study, only try to examine which of them that might have had an influence in the agroforestry adoption choices.

2.1.2 Sustainable livelihoods and sustainable development
The sustainable livelihood approach is not just about improving people’s livelihoods but also about making them more sustainable. A sustainable livelihood is about having a decent livelihood which can be sustained into the future without compromising other people’s prospects for a decent livelihood along the way.32 When talking about sustainability, sustainable development is often mentioned. The Brundtland commission defined this as:”development that meets the needs of the present without compromising the ability of future generations to meet their needs.” The aspect of future is also considered in the definition of a sustainable livelihood. One difficulty with taking the needs of future generations into account is that there are probably different needs between different generations and future generations cannot speak for themselves.33 The consensus around sustainable development is also that it is necessary for all of us. But the needs of people may also be different in different cultures. If the needs are not similar one society might try to achieve a sustainable development that will be unsustainable for another society. An example of that could be a society that wants fresh air while another society wants to increase the material wealth even if this leads to increased pollution. It is important that not only one livelihood is sustainable but that all livelihoods on a global level are sustainable together.34 For development to be sustainable it is also important that both the economical, ecological and social systems are considered.35 SLA is a human-centered approach to the being and

30 Ibid, p 19
31 Ibid, pp 43-45
32 Ibid, p 6
33 Redclift, Michael. 2005, p 215
34 Ibid, pp 213-215
35 Morse, Stephen. and McNamara, Nora. 2013, pp 3-4
doing of sustainable development. The main focus is on humans even though the approach still puts a value on the nature that exists within those livelihoods.  

2.2 Theories of risk perceptions and risk attitudes

Theories about uncertainty, risk perceptions and risk attitudes have been used in a study about agroforestry adoption by Senkondo. Uncertainty is defined as a state of mind where individual farmers cannot really foresee the potential outcomes from a specific action. Uncertainty is related to the farmer’s familiarity and knowledge about the outcomes. Risk on the other hand means that a particular action can result in either a win or a loss. It is measured through the variance of outcomes. While uncertainty means that the outcomes are unknown and cannot be quantified, risk means that the probability of the different outcomes can be predicted. Uncertainty averse farmers feel the need of more clear information. If a farmer does not have adequate information about a particular technique he may desist from investing in it.

In risk theory and risk analysis there is also a distinction between risk attitude and risk perception. Risk attitude is about how for example farmers evaluate the desirability of an outcome when adopting a particular practice. Risk attitudes are related to feelings which last for a long time. They can be seen as the willingness of a decision-maker to face or avoid a risk. Risk perception is on the other hand often related to a specific technique, location and time. Risk perceptions change more easily for example when new information arises. Risk perceptions depend on factors like household characteristics, the current decision environment, the experience with cropping systems, the nature and characteristics of the cropping system and information availability and processing. If risk perceptions and attitudes affect agroforestry adoption rates it is necessary to get an understanding about what farmers perceive as the sources of risk. It is also important to see how their subjective judgment compares with objective measurements of agroforestry and how their perceptions form and change.

A risk analysis can have a positive approach or a normative approach. A positive approach, which I will use in my study, has the focus on how farmers arrive at various decisions. The basis of this approach is the farmers. A positive approach predicts risky choices based on empirical results. This differs from the normative approach which starts with the researchers’ hypothesis about economically rational, individual decision-making. The positive approach is trying to explain how for example farmers behave

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36 Ibid, p 10  
37 Senkondo, Ephraim.M.M. 2000, p 8  
38 Ibid, pp 4-5  
39 Ibid, p 15  
40 Ibid, p 15
towards risk while the normative approach gives farmers advice on how to behave towards them. In risk analysis there are views that smallholder farmers have a rational behavior although also less rational behavior might occur. This can be defined as bounded rationality. The farmers are assumed to choose the best alternative of those which are available to them. They weigh the income changes and risks connected to a particular technology against the desirability of that technology, taking their economic and natural circumstances into consideration. This is however a subjective weighting of what is most rational. The adoption rates depend on farmer’s perceptions of risks and uncertainties and not so much on the actual risks and uncertainties.41

The purpose of Senkondo’s study is to analyze situations of risk and uncertainty in decision-making related to agroforestry.42 To what extent do the farmers take risk into consideration in their agroforestry production decision-making? The study is similar to my own as it examines factors that can influence agroforestry adoption. Senkondo’s study is, however, more focused on different cropping systems in agroforestry.43 Besides it is a survey study so the results are based on a lot of samples which makes it possible to link risk perceptions with for example households’ characteristics. My study is instead qualitative which makes it more focused on the answers in themselves than getting a lot of samples and linking these with different characteristics. The risk theories also have a lot of mathematical models estimating for example the probability of different outcomes related to agroforestry adoption and the function of farmers’ utility of different agroforestry practices.44 I will not use these models in my study. I will only see which risks that farmers perceive can be minimized with agroforestry adoption and which risks that are increased.

2.3 Obstacles and opportunities for agroforestry adoption in previous studies

In a previous study, obstacles for agroforestry adoption have been shown to be the perceived costs for establishing and managing trees, the time needed for managing the trees and lack of tree management experience. Often landowners do not have the information about tree-establishing costs.45 Farmers also often lack technical information and experiences of the technologies. The lack of knowledge often depends on weaknesses in institutions which should facilitate information access.46 Another study shows that both local and external efforts are needed to raise awareness, knowledge and skills about

41Ibid, pp 12-14
42 Ibid, pp 8-9
43 Ibid, p 43
44 Ibid, pp 18-30
46 Ibid, p 170
agroforestry. According to previous research other obstacles are also inadequate market prices for timber and perceptions that the trees have negative effects on the crops. Some farmers are afraid that the trees are going to encourage weeds and pests as well as compete with the crops for light, water and nutrients. Other obstacles in previous research are that the tree plants can be damaged by pests and animals because of lack of fences. A solution to this could be to plant the trees in boundaries. This will secure landholdings and restrict homestead livestock from leaving the properties and destructing in nearby compounds.

Other obstacles mentioned in previous studies are that many farmers do not have incomes high enough to afford agroforestry inputs and managing the agroforestry practices. One solution to this, presented by the study, is support to the farmers in the form of subsidies or loans. Required support would also include fencing material, pesticides and seeds. Farmers are also often dependent on short-term benefits meaning that they do not perceive that they have the time to wait for the trees to grow up. Population growth can also be an obstacle as it reduces the land size for farmers meaning that they might not have the space for planting trees.

In previous research many benefits and livelihood improvements from agroforestry adoption are also brought up. One benefit is the enhanced environmental conservation. This for example means maintenance of plant biodiversity, reduction of heat stress in crops and reduced soil degradation. Shade provision from extreme heat and environmental aesthetics improvement are other important benefits. Many studies have shown that agroforestry systems conserve biodiversity as they provide habitat for species that can handle disturbance to a certain level. The agroforestry systems decrease the transition rates of natural habitats to cleared habitats by providing a more productive, sustainable alternative to traditional, agricultural systems. Agroforestry systems have also been shown to provide clean water. The vegetation reduces the water velocity thereby promoting infiltration of water into the soil and the retention of nutrients. Agroforestry systems can therefore reduce non point source pollution. Trees with deep root systems can besides that improve the quality of ground water as they take up excess nutrients which have been leached below the rooting system of the crops.

47 Chitakira, Munyaradzi. Torquebiau, Emmanuel. 2010, pp 152-155
49 Chitakira, Munyaradzi. Torquebiau, Emmanuel. 2010, pp 157-158
50 Akpabio, Iniobong. Ibok, Inemisit. 2009, pp 72-74
51 Chitakira, Munyaradzi. Torquebiau, Emmanuel. 2010, pp 157-158
52 Stainback, Andrew et al. 2012, pp 291-292
54 Ibid, p 68
55 Shibu, Jose. 2009, pp 4-5
56 Ibid, pp 7-8
Previous research has shown that trees can hinder soil compaction, which allows water to be infiltrated and reduce water erosion.\textsuperscript{57} There are also trees that can fix nitrogen and when these are intercropped with for example maize, soil fertility is increased and soil erosion reduced. Besides that, leaves from trees can be incorporated into the soil to work as green manure. This technique is called biomass transfer.\textsuperscript{58} In agroforestry systems, shrubs, so called herbaceous legumes, can be planted to provide fodder for livestock and therefore improve livestock productivity. (Appendix 1, picture 3) These shrubs also provide the farmers with firewood and reduce soil erosion if they are planted along boundaries or in terraces.\textsuperscript{59}

The trees can be used as firewood which women consider to be more important than men as it is the women who have to walk long distances to collect firewood. Firewood on the own land means that women can save time for other productive, income-generating activities.\textsuperscript{60} The trees can also be used as timber and act as windbreaks which reduce wind velocity, protect the crops and reduce wind erosion. The increased timber supply can be used to improve the housing for the farmers but it also generates higher incomes as the farmers can sell the timber.\textsuperscript{61} Fruit trees can be planted to provide access to fruits.\textsuperscript{62} Particularly the indigenous fruits are rich in nutrients and therefore increase food security. Women and children are the ones benefitting the most as they are most at risk for running out of food in periods of famine.\textsuperscript{63} The fruits can besides that be sold and this is another benefit for the women as their rights are often limited to tree products with little or no commercial value like fruits and vegetables. Therefore they receive significant financial benefits from the fruits and vegetables, incomes which they can control themselves.\textsuperscript{64}

Another study shows that agroforestry increases incomes to a level high enough to meet the major costs of household healthcare. Agroforestry also improves health as many plants can provide medicines.\textsuperscript{65} The increased incomes from agroforestry besides that help meet the costs of education. As agroforestry is, according to this study, less labour intensive than conventional agriculture this also means that the children of the family can spend more time on education and less on agricultural activities. Therefore this is another reason why education opportunities might be improved after agroforestry adoption.

\textsuperscript{57} Ibid, p 7
\textsuperscript{58} Kiptot, Evelyne. Franzel, Steven. 2012, pp 39-41
\textsuperscript{59} Ibid, pp 39-41
\textsuperscript{60} Ibid, p 45
\textsuperscript{61} Ibid, pp 39-41
\textsuperscript{62} Akpabio, Iniobong. Ibok, Inemisit. 2009, pp 72-74
\textsuperscript{63} Kiptot, Evelyne. Franzel, Steven. 2012, pp 39-41
\textsuperscript{64} Ibid, pp 45-46
\textsuperscript{65} Rahman, Syed et al. 2012, pp 534-537
Young girls can spend more time on education when they do not have to spend the same time on collecting firewood.  

In previous studies agroforestry practices are shown to improve the housing. More houses are made of bricks instead of straw, sand and wood after agroforestry adoption. This is because the farmers, after adoption, have increased their incomes and therefore can afford other types of building materials than before. Besides that, agroforestry has been shown to empower the women and improve their social, economic and decision-making status. This is because after adoption, both men and women work more together with the improvement and propagation of trees. Agroforestry can according to some previous studies be seen as a major strategy for sustainable livelihood development.

3. Study area

3.1 The united republic of Tanzania

The two sovereign states of Tanganyika and Zanzibar became the united republic of Tanzania in April 1964. The united republic of Tanzania lies in eastern Africa and is bordered by Kenya and Uganda in the north, Burundi, Rwanda and the Democratic Republic of the Congo in the west and Malawi, Mozambique and Zambia in the south. To the eastern boarders lies the Indian Ocean. The united republic of Tanzania consists of 30 regions. The capital is Dodoma but Dar el salaam is the major commercial city. The currency is Tanzanian shilling and the official languages are Kiswahili and English.

The population in Tanzania is growing fast; in 2010 it consisted of 43 million people. The population is divided into 158 different ethnic groups and most of the population is rural. Tanzania’s climate is tropical, the temperature rarely falls lower than twenty degrees. The rainfall period in the southern, south-west and central parts of the country is between December and April. In the northern parts and by the northern costs there are on the other hand two rainfall periods which lasts between October to December and March to May. The march to May rainfall period is often referred to as the long rains while the October to December rainfall period is referred to as the short rains.

66 Ibid, pp 534-537
67 Ibid, pp 534-537
About 97% of Tanzania’s food requirement is produced inside the country. Important food crops are for example maize, millet, sorghum, rice, beans, wheat, potatoes, cassava, bananas and plantains. The main cash crops are coffee, cotton, sisal, cashew, tobacco, tea, pyrethrum and sugarcane. Small scale farmers sometimes also plant different types of fruits. Examples of fruits which are produced in the country are guavas, mangoes, bananas, pineapples, pears, apples, oranges and avocados. It is mostly small-scale farmers who produce and consume the fruits. It is also small-scale farmers who are responsible for the vegetables which are mostly produced for the domestic markets. Important vegetables produced for export are for example peas, green beans and baby carrots.

3.2 Babati Town

Manyara region has five districts and one of those is Babati district. The administrative division of the district consists of Babati district council and Babati town council. Babati district council is divided into Mbugwe, Gorowa, Bashnet, Dareda and Gallapo. The district has 21 wards and 95 villages. The total population of the district is estimated to around 312,392 people. The town council of Babati is divided into two divisions, Babati and Kvarraa, and has eight wards and 48 villages. The total population is estimated to about 93,108 people. Babati town is the only town in Babati district and the headquarters of both Manyara region and Babati district. It is the administrative and commercial center of the district and links together the towns Arusha, Singida and Dodoma.

In the district there are five levels of education and these are pre-primary, primary, secondary, vocational training and university. The district has two hospitals and some of the most common clinical problems are malaria, ARI and pneumonia. Of the whole district population, about 52% has access to safe and clean water from gravity piped schemes, deep well pumped schemes, surface pumped schemes and shallow wells. Agriculture is the most important part of the district economy as those employed in agriculture constitute 75% of the labour force. The most important food crops are beans, maize, sorghum, paddy, cassava, millet, leguminous crops, Irish potatoes, sweet potatoes and fruits. The most important cash crops are pigeon peas, ground nuts, simsim, sugarcane, coffee, sunflower, cotton, seed

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74 Kavishe, Calyst, 1
75 National bureau of statistics. 2012, pp 400-402
76 Ibid, pp 413-414
77 Ibid, p 413
78 Kavishe, Calyst, p 1
79 Lindberg, Clas. 1996, p 32
80 Kavishe, Calyst, p 3
beans, wheat and vegetables. The main animals kept are indigenous livestock, goats, donkeys, sheep and chicken.\textsuperscript{81}

The land area of Babati can be divided into five agro-ecological zones depending on the soils, altitude and rainfall. These agro-ecological zones are called humid highlands, sub-humid highlands, semi-humid uplands, semi-humid/semi-arid midlands and semi-arid lowlands. In the humid highlands the main crops are beans, maize and round potatoes. In the sub-humid highlands some important crops are beans, wheat and maize. Some of the main crops in the semi-humid uplands are beans, pigeon peas, maize, sunflower, sugarcane, bananas and avocado. The most important crops in the semi-humid, semi-arid midlands are pigeon peas, beans, maize, sunflower, sugarcane and coffee. In the semi-arid lowlands some important crops are groundnuts, cotton, sugarcane, maize, cassava, mangoes, sunflower and beans.\textsuperscript{82}

4. Methodology

To achieve the aim of this study I have made a qualitative study based on semi-structured interviews. This means that the interview questions are based on some main themes which are explored during the interview.\textsuperscript{83} It also means that the questions are open so that the informants can choose for themselves how to answer them.\textsuperscript{84} Since I wanted to investigate farmers’ perceptions of agroforestry, interviews seemed to be the best method for this. The interviews were conducted during 13 field days in Babati, Tanzania. In total 18 interviews were conducted, 15 interviews with farmers and three interviews with extension officers.

4.1 Informants

My field assistant helped me find informants for the interviews and he also translated the interview questions from English to Swahili and then the informants’ answers from Swahili back to English. The three interviews with extension officers were conducted in Mamire, Singe and Sigino. All of the interviewed extension officers were men. In Mamire a lot of farmers practice agroforestry while in Singe and Singino it is less common. I talked to extension officers from villages with different experiences of agroforestry because I wanted to get their different views of it.

The interviews with the farmers were conducted in seven different villages; these were Bonga, Haraa, Himiti, Managha, Singe, Sigino and Nangara. The size of land they cultivated differed between 2 and 17

\textsuperscript{81} Ibid, p 3
\textsuperscript{82} Ibid, p 2
\textsuperscript{83} Repstad, Pål. 2007, pp 85-86
\textsuperscript{84} Trost, Jan. 2010, pp 40-42
acres. Two of the interviews were conducted with women and the rest with men. Six farmers were interviewed who did not plant trees at all, two from Sigino, two from Himiti, one from Bonga and one from Nangara, all of these were men. Two farmers were interviewed who practiced agroforestry on part of their land, one woman and one man; both these interviews were conducted in Managha. The other seven interviews were made with farmers who practiced agroforestry on all their land, one with a woman and six with men. Of these interviews one was conducted in Himiti, one in Singe, three in Managha, one in Bonga and one in Haraa. Of the farmers practicing agroforestry, those from Himiti and Singe only planted trees for timber and fuelwood while the other farmers planted fruit trees as well. The different villages had different degrees of agroforestry adoption and to get a broad representation of farmers I wanted to get interviews with farmers from many different villages. I also thought that there could be differences between the different villages in incomes, access to education and other factors.

Except for the importance of conducting interviews in different villages it was also important that the differences in incomes between agroforestry farmers and conventional farmers were not too large. Therefore I tried to get a spread in incomes in both groups. Since I could not ask the farmers about their incomes I had to measure it by how many acres they were cultivating. The intention was also that the farmers who did not practice agroforestry should be conventional farmers. Some of them, however, practiced soil conservation methods like contour planting and crop rotation. I also wanted to have as many interviews with men as with women but because of time pressure I had to take all interview opportunities I got during the short time in Babati. Therefore I got more interviews with men.

4.2 Interview questions
The questions that I asked the agroforestry farmers were about the opportunities and benefits they had perceived with agroforestry and how they perceived their lives had changed after agroforestry adoption. I also asked them about the obstacles they had perceived with agroforestry adoption before they started to practice it. When formulating the interview questions I tried to take the different capitals from SLA into consideration. I asked for example about the effects of agroforestry on natural capital like the effects on the soil. I also asked about effects on financial capital like the income effects from selling timber, fruits and sometimes firewood and how this might have affected the farmers’ ability to afford healthcare, education, medicines, and other household goods. Besides that I also asked about how the income changes had affected the farmer’s physical capital like their houses or their access to transport vehicles.
Other things I asked were how the initial access to the different capitals affected agroforestry adoption in the first place. I asked if lack of financial capital could hinder agroforestry adoption or access to natural capital like tree seeds. I also asked if land size affected agroforestry adoption and human capital like knowledge from extension services or other farmers. How social capital affected agroforestry adoption, like interaction with other farmers, involvement in community meetings or interaction with extension services, was another thing I asked. The conventional farmers I asked mostly the same things, I asked about opportunities and obstacles with agroforestry related to the capitals in the SLA-approach but focused more on the obstacles than in the interviews with agroforestry farmers. All the interviews with the farmers lasted between 30 and 45 minutes. The extension officers were also interviewed about the opportunities and benefits with agroforestry, the obstacles for adopting it and what the situation looked like in their village. In these interviews all the capitals from the SLA-approach were also taken into consideration. These interviews also lasted between 30 and 45 minutes. To see the more exact interview questions see appendix 1.

The reason for choosing a qualitative study instead of a quantitative is that it allowed the extension officers and farmers to give a larger variety of answers and it also gave me the possibility to ask follow-up questions when they arose. A quantitative study would however have given a broader representation of farmers as I would have gotten more samples. For the aim of my study the answers from the questions in themselves was however the most interesting and not the proportion of respondents who gave a particular answer.

5. Result and analysis

5.1 Obstacles and difficulties with agroforestry adoption

When talking to both farmers and extension officers, many different obstacles and difficulties with agroforestry were mentioned. Below I will present the most important obstacles mentioned in the interviews under different thematic areas. The analysis of the different obstacles will be included into the presentation of the obstacles.

5.1.1 Lack of education and collaboration with extension services

Two extension officers perceived the lack of education about agroforestry as a main obstacle. They meant that farmers were not aware of the benefits and opportunities with planting trees. The third extension officer did not perceive education to be an obstacle but at the same time he mentioned that a difficulty was that farmers sometimes used the wrong equipment for preparing the soil which affected soil production in a negative way. Some of the conventional farmers perceived that they had the
knowledge and skills about agroforestry while some perceived that they needed more education to be willing to adopt it. The problem, however, was not that they were not aware of the benefits with planting trees, but that they did not have knowledge about which trees to plant, how long distances to have between the trees, how to dig the holes and which trees and crops that worked well with each other.

Related to the SLA-approach this could be seen as a lack of human capital which among other things includes knowledge and skills. This hindered agroforestry adoption among some of the conventional farmers.\footnote{Morse, Stephen. and McNamara, Nora. 2013, pp 28-29} Many conventional farmers perceived the degree of collaboration between farmers and extension services as low and had not been educated by extension services. Therefore the extension services could not provide the human capital needed. Many conventional farmers also claimed that farmers were not talking so much with each other and in that way shared their knowledge. They did not have any particular explanation for this but perceived this to also be a problem. One agroforestry farmer also said that when other farmers were actually getting education from extension services, they did not spread their new knowledge to other farmers. According to the SLA-approach both the lack of collaboration with extension services and the lack of social relations or networks among farmers can be explained as lack of social capital. The farmers did not have the possibility to attend seminars or community meetings about agroforestry since the extension services did not provide this opportunity. There were also no networks or social relations between farmers where the knowledge could be shared. The social networks and relations could have been a way to provide knowledge resources for the ones included in the networks or social relations.\footnote{Ibid, pp 28-31}

Five of the agroforestry farmers perceived that the collaboration between extension services and farmers were good in their village while four agroforestry farmers perceived it to not be so good. Some farmers had been planting trees since the 1970:s while others had planted trees for only a couple of years. It was mostly the farmers who had been practicing agroforestry for many years who perceived they had much knowledge about agroforestry and also that education about it was good. The farmers who had only been planting trees for a few years did not always perceive the education as good even if they mostly perceived that they had the knowledge needed.

Many of the agroforestry farmers said that they were not aware of the benefits with planting trees before they started to plant them but after tree planting had started their knowledge had increased. The different farmers had got their knowledge and awareness from different sources, for example from the
government, the ministries of natural resources, the LAMP-programme and extension services. The agroforestry farmer in Himiti explained that he had been attending seminars during one week, organized by extension services. The farmers in his village also educated each other about agroforestry after they had been attending the seminars. The agroforestry farmers therefore seem to have had many different sources to get human capital like knowledge and skills from. Their possibility to attend seminars, talk to each other and get educated by the LAMP-programme or extension services gave them access to social capital in terms of social relations, networks and meetings and this in turn provided them with human capital. This can be part of the explanation why they chose to adopt agroforestry. 87

The access to social and human capital for agroforestry farmers minimized their uncertainty about the outcomes of planting trees. As they were provided with knowledge about this they could more easily predict the outcomes of planting crops and trees together. Conventional farmers on the other hand sometimes mentioned their uncertainty about which trees to plant, how to plant the trees and which trees that were suited with which crops. Therefore the outcomes were unknown for them when planting different trees together with different crops. They could not estimate the probabilities of the outcomes when planting trees and crops together. Their uncertainty could probably have changed if new information would have arose, as they all perceived planting trees to be desirable. 88 Their choice to not adopt agroforestry because of lack of knowledge was probably more related to their risk perceptions than their attitudes. Their risk perceptions were related to the knowledge and skills they had at that time and not necessarily to feelings about risks that would last for a long time. 89 Some conventional farmers perceived however that they had the knowledge and skills about agroforestry so in their case uncertainty might not have been an equally important factor to not plant trees.

5.1.2 Livestock eating the tree seeds

Some farmers perceived livestock eating the tree seeds as an obstacle while others did not. It was both the agroforestry farmers, conventional farmers and extension officers who brought up this difficulty. One of the agroforestry farmers mentioned that other trees could be planted like a fence, protecting tree seeds from getting eaten. Another agroforestry farmer perceived it to have been a bigger problem before but it had decreased as people were getting better at keeping their livestock inside. The risk of livestock eating the tree seeds could have two possible outcomes, either the livestock ate up the tree seeds or they did not. Therefore the farmers knew which outcomes to expect; even though they could not calculate the

87 Ibid, pp 28-31
88 Senkondo, Ephraim M.M. 2000, pp 4-8
89 Ibid, p 15
probability of the outcomes exactly they could estimate them. It was therefore probably more a question of risk than uncertainty about the outcomes.\textsuperscript{90}

The risk of livestock eating tree seeds seemed to be more connected to farmer’s risk perceptions than their risk attitudes. The risk seemed to be connected to a specific location for example as it differed between different farmers whether livestock was a problem or not. It also differed in time according to the farmer who considered it to have been a larger problem before people got better at keeping livestock inside. It is also a problem which could potentially decrease even more in time if the knowledge increased about using trees as fences.\textsuperscript{91} Therefore farmers risk perceptions might become more positive with time.

To some extent this problem can therefore be related to knowledge about how to plant the trees. With the SLA-approach in mind the problem is therefore related to lack of human capital.\textsuperscript{92} However I do not only think it was lack of knowledge that provided the problem as it was probably different degrees of the problem with livestock in different villages. Not everyone perceived it to be a problem. In villages where the agroforestry adoption rates were lower it was less boundary planting and it could therefore have been a bigger problem in these villages. It was probably also a question of lack of other types of resources than knowledge that hindered the farmers from planting trees in boundaries.

5.1.3 Competition between trees and crops
Both agroforestry farmers and conventional farmers seemed to think that there would be no problems with competition between trees and crops either for nutrients or shade, as long as you planted the right types of trees and as long as you pruned the trees. One of the extension officers mentioned however that shade competition could be a problem if the trees were planted too randomly and not in rows. One agroforestry farmer also said that maize was a crop that could not be planted with all kinds of trees, for example not together with Grevillea. One agroforestry farmer mentioned that if trees with too shallow roots were planted it could be a problem with competition for nutrients and water. Some of the agroforestry farmers had experienced problems with competition for water and one agroforestry farmer with nutrients competition. When this happened he spread out industrial fertilizers.

\textsuperscript{90} Ibid, pp 4-8
\textsuperscript{91} Ibid, p 15
\textsuperscript{92} Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
Some of the conventional farmers mentioned, which was also brought up earlier, that they did not have the knowledge about how to plant the trees and which trees to plant with which crops. Therefore they sometimes perceived a risk for competition which they might have taken into consideration in their adoption choice. The agroforestry farmers on the other hand mostly seemed to have the knowledge about which trees to plant and which crops that worked well with which trees. But despite that some farmers actually seemed to have perceived competition problems. It is hard to say whether the risk of competition could be decreased with more education or if it was maybe another type of problem that could not be reduced with more education. In that case the risk of competition can be related to farmers’ risk attitudes as they might not so easily change if information and knowledge is not the main issue. It can change with time maybe if the farmers get better access to fertilizers for example so that they can reduce the competition problems.93

One the other hand both conventional farmers, agroforestry farmers and extension officers seemed to agree that competition did not have to be a problem. Therefore it could be considered a problem which can partly be reduced with increased human capital in the form of knowledge and skills. This knowledge and these skills is something which can be provided through increased social capital through community meetings and seminars organized by extension services or social relations between different farmers.94 Therefore the risk of competition might be an obstacle which arises from a combination of farmer’s risk attitudes and risk perceptions.

5.1.4 Land size

Some of the conventional farmers and also some of the agroforestry farmers considered land size as an obstacle for tree planting. The agroforestry farmers said that they would have liked to plant more trees if their land would have been bigger. The land includes natural capital like the natural resource soil and therefore small land size limits the access to this type of natural capital. This can be one reason for why conventional farmers did not planting trees as this type of natural capital is necessary for tree planting.95 Land size as an obstacle might also be related to risk for competition between trees and crops. If the land size does not give enough room for both the trees and the crops the farmers might have to weigh the desirability of agroforestry against the potential risks of competition. In that case it might depend on the farmers’ risk attitude whether they choose to adopt agroforestry or not.96 Land size was however not perceived as one of the largest obstacles since not all farmers thought of it as a problem. It did not seem

93 Senkondo, Ephraim.M.M. 2000, p 15
94 Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
95 Ibid, p 28
96 Senkondo, Ephraim.M.M. 2000, p 15
to be of larger importance for the conventional farmers; most often they had about the same land sizes as the agroforestry farmers and therefore maybe it was not an obstacle that always hindered adoption but more of a difficulty after adoption. The risk is however that it will become a more important obstacle with time if the population continues to increase.

5.1.5 Labour intensity

An obstacle for agroforestry adoption that the extension officers perceived was that agroforestry is very labour intensive in the beginning. Many trees have to be planted at the same time and a lot of holes have to be dug. After the initial tree-planting, agroforestry however becomes less labour intensive than other agricultural practices. One of the agroforestry farmers also mentioned this obstacle. If the initial tree planting practices are considered labour intensive this can according to the SLA-approach be related to a problem with human capital as labour is counted into this capital asset.\(^{97}\) More human capital in terms of labour might be needed than the farmers actually have access to. This is also a question of financial capital as it costs to hire persons to dig the holes for the trees for example. Farmers either need to have time for digging the holes themselves or money for hiring someone else to do that. The agroforestry adoption choices might depend on the farmer’s risk attitudes, how they weigh the risks of labour intensity against the desirability of agroforestry. How risk averse or risk taking are the farmers when taking this issue into consideration?\(^{98}\)

5.1.6 Climate

One of the extension officers also perceived that climate could be an obstacle as too little rainfall could hinder the fruit trees from growing; the fruit trees particularly needed a lot of water. One of the agroforestry farmers also perceived this as a problem and perceived it to sometimes be too little water even for the timber trees. Some farmers also mentioned that it was sometimes problems with competition for water between trees and crops like, mentioned before. This can according to the SLA-approach be considered as an obstacle which have arose because of lack of natural capital. The water needed for the trees to grow is a natural resource and the amount of this natural resource was not perceived to always be enough according to some of the informants.\(^{99}\) Whether this lack of natural capital could be an obstacle for agroforestry adoption could not be seen in my study as none of the conventional farmers mentioned it as a problem. Since one of the agroforestry farmers mentioned it as a problem it can however be a difficulty after agroforestry adoption which maybe can have the result that

\(^{97}\) Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
\(^{98}\) Senkondo, Ephraim.M.M. 2000, p 15
\(^{99}\)Morse, Stephen. and McNamara, Nora. 2013, p 28
the agroforestry practices stop. If I would have interviewed more conventional farmers this lack of natural capital might also have been mentioned more often.

The lack of water needed for the trees was a risk for the farmer, either there was enough rain or it was not, so there were two possible outcomes. It was however not easy to predict what the outcome would be, it could only be estimated.\textsuperscript{100} Despite that the farmer still seemed to consider it desirable to plant the trees as he did not have any plans to stop. The outcomes of planting the trees were desirable enough for him to be willing to take the risk of too little rainfall. Therefore his risk attitude towards agroforestry did not hinder him from practicing it.\textsuperscript{101}

5.1.7 Input costs

One of the extension officers did not perceive that the input costs for agroforestry was an obstacle while the other two considered them to be too high. They mentioned however that in the long term agroforestry was less costly than other agricultural practices. Most of the conventional farmers also perceived the input costs for agroforestry to be too high. It was digging the holes and buying the tree seeds that were considered costly. Among the agroforestry farmers there were different opinions about if the input costs was an obstacle or not. Some of them considered buying the seeds and digging the holes as expensive while others said it was not so expensive. To dig the holes cost, according to one of the conventional farmers, 500 shilling. According to one of the agroforestry farmers a tree seed for a guava tree cost 3000 shilling while a tree seed for a Grevillea tree (which can be used for timber for example) cost 300 to 500 shilling. Some agroforestry farmers also mentioned that the holes could be dug by the farmers themselves, it was not necessary to hire someone to do that. Many of the agroforestry farmers had got help from extension services which had been giving them free tree seeds and fertilizers. This of course minimized the input costs for tree planting.

When taking the SLA-approach into consideration, the conventional farmer’s perceptions that the input costs were too high can be connected to a lack of financial capital. They did not perceive they had enough cash, incomes or savings to support the costs of tree planting.\textsuperscript{102} The lack of financial capital results in a lack of the natural capital tree seeds.\textsuperscript{103} The natural resource tree seeds had to be bought and without the financial capital needed the farmers could not get the necessary natural capital for planting.

\textsuperscript{100} Senkondo, Ephraim.M.M. 2000, pp 4-8
\textsuperscript{101} Ibid, p 15
\textsuperscript{102} Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
\textsuperscript{103} Ibid, pp 32-34
Lack of financial capital also resulted in a lack of human capital in terms of labour which might have been needed for digging the holes. It is hard to say if the agroforestry farmers had more financial capital than the conventional farmers since I did not know their incomes. When taking their land sizes into account the farmers with the biggest land size was two of the agroforestry farmers who had 17 versus 12 acres. Otherwise agroforestry farmers and conventional farmers had similar land sizes, often between four and eight acres.

A lot of the agroforestry farmers did not need the same financial capital to start however since they had got tree seeds and fertilizers for free. Therefore it might have been easier for them to start practice agroforestry because they had got more support that made them have to spend less financial capital. The conventional farmers who had not gotten this opportunity had to weight the desirability of planting trees against the risk of putting large amounts of financial capital into the tree planting. Their risk attitude, how desirable they considered agroforestry compared to the risks, probably resulted in their choice to not adopt agroforestry. Even though they all perceived themselves to be aware of the benefits of agroforestry this had to be weighed against the risks of adopting it. If they would have been provided with financial capital this might have resulted in a positive change in risk perception connected to agroforestry adoption.105

5.1.8 Dependency on short-term benefits

There were also different opinions about if it was a problem that the farmers were dependent on short-term benefits and did not have time to wait for the trees to grow up. This problem was mostly brought up by the conventional farmers but also by one of the extension officers and some agroforestry farmers. The agroforestry farmers mostly did not perceive this as a problem but said that it could be a larger problem when farmers were not aware of all the benefits with tree planting as well as when they did not have the knowledge about how long time it would take for the trees to grow up. One agroforestry farmer mentioned that it only takes three to four years for fruit trees to grow up, something which maybe all farmers are not aware of.

When taking the perceptions of agroforestry farmers into consideration the unwillingness of waiting for the benefits from the trees was something which could easily be changed if information about the opportunities and benefits of planting trees arose as well as how long time it actually would take for the trees to grow up. In that case the choice to not adopt agroforestry is a question of risk perceptions as risk

104 Ibid, pp 32-34
105 Senkondo, Ephraim.M.M. 2000, p 15
perceptions might change with increased information while risk attitudes are more difficult to change.\textsuperscript{106}

In this case the reason why farmers did not choose to adopt agroforestry was also, according to the SLA-approach, related to farmers’ lack of human capital in terms of knowledge and education.\textsuperscript{107}

However, since all conventional farmers perceived that they were aware of the opportunities and benefits of agroforestry I am not sure it was knowledge that was the problem. The question of short-term benefits might also have been related to other factors like that they could not afford to start plant trees and wait for the benefits from them, which one conventional farmer mentioned. Their risk attitude, something which could not be as easily changed with more information, told them that it was too risky and they had to think about the benefits they could get now and not in the future. Even if some fruit trees only take three to four years to grow it might still be considered to be too long time for some of the farmers.\textsuperscript{108} As was shown earlier the fruit trees which take the shortest time to grow are also the most expensive.

Related to the SLA-approach, this inability to afford agroforestry can be connected to a lack of financial capital in terms of incomes, cash and savings. The farmers might have perceived that they could not afford to wait for the long-term benefits from the trees and they needed to get the short-term money now.\textsuperscript{109} Adopting agroforestry might have resulted in decreased financial capital because of the input costs. In the short term this would have impoverished the farmers and decreased the quality of their livelihood. Because of the financial risks they had to take for agroforestry adoption, it might not have been the best or most rational choice for them.\textsuperscript{110}

\textsuperscript{106} Ibid, p 15
\textsuperscript{107} Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
\textsuperscript{108} Senkondo, Ephraim.M.M. 2000, p 15
\textsuperscript{109} Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
\textsuperscript{110} Senkondo, Ephraim.M.M. 2000, pp 12-14
5.2 Livelihood outcomes after agroforestry adoption

During the interviews the livelihood outcomes that arise after agroforestry adoption were also discussed. These will be presented below in different thematic areas and the analysis will be included in the presentation of the outcomes.

5.2.1 Direct economic outcomes

An economic benefit that one of the extension officers, as well as a lot of the conventional and agroforestry farmers, brought up was that the fruit trees generate incomes when the farmers sell the fruits. All informants also brought up that farmers can sell timber from the trees and sometimes they also sell firewood which increases farmers’ incomes. One of the extension officers also mentioned that the firewood is an economic benefit even if it is only used for own consumption. This is because when the firewood is collected on the own farm it does not have to be bought. Planting fruit trees for own consumption also means that the farmers do not have to buy fruits.

It can here be seen that adopting agroforestry result in an increase in natural capital in terms of natural resources like trees and fruits. These natural resources provide provisioning services like firewood, timber and food. The increased natural capital in turn results in increased financial capital as, most importantly, timber and fruits result in increased incomes when they are sold. The increase in natural capital in terms of firewood and fruits also means that these resources do not have to be bought and this in turn means that farmers save financial capital when having these resources on the farm. Financial capital does not only increase but it also does not have to be spent at the same rate. That the households’ economic situation is improved because of agroforestry means that vulnerability towards stress and shocks is decreased as farmers are no longer dependent only on the crop production. The varied income sources from agroforestry means that the negative effects on farmer’s livelihoods, from drought, floods or other shocks, are decreased.

5.2.2 Indirect economic outcomes

The increased incomes from fruits, timber and sometimes firewood were according to the agroforestry farmers used to improve the houses, for example to change from straw roof to iron roof and buy bricks for house construction. The timber in itself was also used to improve the houses. Both these sources of improvement are, according to the SLA-approach, an improvement in physical capital which includes

111 Morse, Stephen. and McNamara, Nora. 2013, pp 32-34
112 Ibid, pp 28-29
113 Scoones, Ian, p 12
infrastructure like buildings, roads and production technologies and equipment.\textsuperscript{114} One of the extension officers also mentioned that more people in the village owned motorbikes and cars since agroforestry adoption rates had increased. This he meant was because of the increased incomes from agroforestry, even though other factors also might have been influencing. Some of the farmers also said that agroforestry adoption had led to more farmers being able to afford transport like motorbikes, but there were only two of the agroforestry farmers who I interviewed who actually owned a motorbike. Most of them had a bicycle. One farmer said however that although there had become more motorbikes in the area that was probably not only because of agroforestry adoption. This shows that the increased financial capital might have improved physical capital to a small extent in terms of transport, as availability of transport might also be include into physical capital.\textsuperscript{115} In my interview results it is, however, far from clear that there is a correlation between the increased access to transports and agroforestry adoption.

One of the extension officers said that in the village where he worked there were now more secondary schools than before agroforestry adoption rates had increased. Before there had been no secondary schools but now there was one in each ward. There were also more and more students attending secondary school something which he perceived to be because of agroforestry. This was probably a bit exaggerated since other factors also might have influenced. The conventional farmers often said that they did not have enough incomes for school, health care and nutritious food. Agroforestry farmers on the other hand said that the increased incomes from agroforestry made it easier for them to afford education for the children, healthcare, medicines and different kinds of food than before. After adoption many farmers could afford food like rice, fish and meat. Before agroforestry adoption many of them had only been planting maize and had then mostly been eating \textit{ugali} (maize porridge).

The ability to afford healthcare and medicines means, according to the SLA, an increase in financial capital. To afford school for the children means that human capital increases as the children’s education opportunities improve.\textsuperscript{116} The improved health from the healthcare also means an improvement in human capital. The ability to afford more different kinds of food will maybe result in a more nutritious diet. One of the extension officers brought up that the fruit trees increase food security as the farmers can consume the fruits themselves, not only get incomes from them. This fruit consumption will probably also conspire to a more varied and nutritious diet. The more nutritious and varied diet might

\textsuperscript{114} Ibid, pp 28-29
\textsuperscript{115} Owenya, Marietha et al. 2012, p 15
\textsuperscript{116} Owenya, Marietha et al. 2012, p 15
improve the health of the whole household.\textsuperscript{117} The possibility to buy other types of food and consume more fruits can also be seen as an increase in natural capital, as food is categorized as a provisioning service.\textsuperscript{118} But when the agroforestry farmers said that their food habits had changed and improved, they sometimes said that they had only been plating and eating maize before. The conventional farmers that I interviewed often planted pigeon peas for example which could be sold to make the farmers able to buy other types of food. Some of them also planted beans as food crops. Therefore the improved food habits of agroforestry farmers might not only have been because of the agroforestry practices but also because of an improvement in livelihoods among all farmers during the recent years. The improvements in food security from agroforestry, which at least the fruit trees resulted in, however decreased the farmer’s vulnerability toward different kinds of risks.\textsuperscript{119} As the risks of coming climate change might reduce food security, agroforestry can be a way to decrease this risk.\textsuperscript{120}

5.2.3 Effects on and improvements for women’s situation

One of the extension officers mentioned that planting of fruits improves the situation for women as the collection and processing of fruits as well as selling them provides incomes that women can control themselves. They also save time when they do not have to walk so far to collect the fruits. This means that social capital for women is increased as they save time for rest and other income-generating activities.\textsuperscript{121} All of the extension officers also said that agroforestry improves the situation for women because of closer access to firewood and charcoal. This saves time for the women as they do not have to walk as far to collect it when the trees can be planted on the households’ own farmland. The farmers also mentioned this opportunity for women. One conventional farmer who did not plant trees for example said that his wife had to walk for three hours back and forth to get firewood. Some farmers planted pigeon peas which could also be harvested and used as firewood. But this was often a complement to firewood from the trees.

The closer distances to collect firewood result in better access to this natural capital. Firewood can be seen as a provisioning service which comes from the natural resource trees.\textsuperscript{122} The increased access to firewood could be seen as increasing social capital for women as they could now get more time for rest or other income generating activities like processing and selling fruits for example.\textsuperscript{123} Since the pigeon

\textsuperscript{117} Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
\textsuperscript{118} Ibid, pp 32-34
\textsuperscript{119} Senkondo, Ephraim.M.M. 2000, pp 167-168
\textsuperscript{120} Scoones, Ian, p 6
\textsuperscript{121} Owenya, Marietha et al. 2012, p 15
\textsuperscript{122} Morse, Stephen. and McNamara, Nora. 2013, pp 32-34
\textsuperscript{123} Owenya, Marietha et al. 2012, p 15
peas could be used for firewood this could also decrease women’s labour time to a small extent. The pigeon peas however mostly seemed to have worked as a complement to the trees, so the trees were probably also needed to improve women’s situation. One extension officer also said that agroforestry makes men and women work more together and makes women more involved into the agroforestry production decisions. This means that new social relations have been created where these production decisions are discussed. Therefore this can be seen as an improvement in social capital which improves the livelihood for all members of the household.124

5.2.4 Effects on environmental services
One of the extension officers brought up that some trees fix nitrogen and that the trees provide organic matter to the soil as the leaves are composted. He also brought up that some trees can hinder the compaction of the soil and enhance water penetration. Pigeon peas, a crop which many conventional farmers plant, could however also reduce soil compaction and fix nitrogen according to this extension officer. The extension officer also said that agroforestry systems create a microclimate which provides a good proportion of shade and collects moisture. As the vegetation collects and takes up rain it also prevents water erosion. The other two extension officers mentioned ecological benefits like that the trees increases soil fertility and act as windbreaks which reduces wind erosion. The farmers also brought up the benefits of erosion prevention and that the trees can act as windbreaks. But when I asked the conventional farmers if they had perceived a problem with erosion they often did not perceive it to be a problem. Therefore the farmers do not necessarily have to plant trees to reduce this problem. Many farmers also thought that the trees could increase rainfall. Soil fertility could also increase as well as crop production according to the farmers.

All of these ecological benefits which were brought up by both farmers and extension officers can according to the SLA-approach be seen as an increase in natural capital as the trees seems to have provided different types of ecosystem services. Nitrogen fixation, provision of organic matter in to the soil, hindering of soil compaction and erosion prevention can be seen as environmental services and when categorizing them into ecosystem services they can be seen as supporting services as this includes for example soil formation and nutrient cycling. Since pigeon peas could also, according to one of the extension officers, reduce soil compaction and fix nitrogen, these ecosystem services do not come exclusively with agroforestry. Also erosion did not necessarily have to be a problem when not practicing agroforestry. The farmers could therefore experience the benefits of some of these ecosystem services

124 Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
without adopting agroforestry. That the trees can provide a microclimate with a proportional amount of shade and moisture can be seen as a regulating service as the trees regulates the climate. That the farmers perceived that the trees increase rainfall is also a perceived regulating service. The increased soil fertility can be seen as an increase in the supporting service, soil formation.\textsuperscript{125} That this in turn result in increased crop production means an increase in provisioning services like food from the food crops and an increase in financial capital if the production of cash crops increases.\textsuperscript{126} The increases in soil fertility, erosion prevention, nitrogen fixation and creation of a microclimate decrease the risks of decreased agricultural production and food security as a result of climate change.\textsuperscript{127}

None of the farmers or extension officers perceived that agroforestry improved water quality and they had not seen any biodiversity effects either. Therefore the farmers did not perceive that agroforestry improved natural capital in terms of the provisioning service water or in terms of the natural capital biodiversity which could have provided many different ecosystem services and natural resources.\textsuperscript{128} Agroforestry therefore does not decrease the risks of biodiversity threats or decreased water quality according to the farmer’s perceptions. But maybe this was because they had not thought about this as biodiversity effects might not affect their daily lives.

5.2.5 Effects on fertilizers and pesticide use

A lot of the agroforestry farmers used leaves from the trees as fertilizers and also used natural pesticides from the trees. One of the extension officers said that this improved farmers’ health as they did not have to use industrial fertilizers or pesticides. However, five of the nine agroforestry farmers used industrial pesticides and three used industrial fertilizers because they perceived them to work better or because the natural fertilizers were not enough. Those who only used natural pesticides and fertilizers used it either because they thought it worked better or because it was cheaper. Some farmers said they did not have to use pesticides at all. Only two of the farmers brought up the impact on health from industrial fertilizers and pesticides and one of those used industrial pesticides despite that. According to the farmer’s answers it can therefore not be concluded that agroforestry have a positive impact on human capital in terms of health in relation to pesticide and fertilizers use.\textsuperscript{129} Actually the conventional farmers used less industrial fertilizers and pesticides than agroforestry farmers. It was only one of them who used industrial pesticides and one who used industrial fertilizers. This is because they perceived they could

\textsuperscript{125} Ibid, pp 32-34
\textsuperscript{126} Ibid, pp 28-29
\textsuperscript{127} Scoones, Ian, p 6
\textsuperscript{128} Morse, Stephen. and McNamara, Nora. 2013, pp 32-34
\textsuperscript{129} Ibid, pp 28-29
not afford industrial pesticides and fertilizers. Therefore there seems to be a risk that agroforestry instead have negative health effects as the increased financial capital makes farmers able to afford the industrial fertilizers and pesticides. This probably also increases the risks of negative environmental effects as the industrial fertilizers and pesticides risks to pollute the water and the rest of the surrounding environment. Therefore this might also have negative effects on natural capital as water quality and overall environmental quality might be decreased.130

5.2.6 Other effects and opportunities

It has been mentioned above that agroforestry saves labour time for the farmers. One of the extension officers mentioned that the trees can prevent the growing of weeds which means that less labour time is needed to eliminate the weed. None of the farmers brought this up; I do not know if it is because they were not aware of this or if it was because it was not really an effect from agroforestry, even if the extension officer thought so. Most of the farmers however perceived agroforestry as less labour intensive than other agricultural practices because it takes less time to collect the firewood. This means that social capital increases as the farmers save time for other income generating activities or for rest.131

Some farmers mentioned that there are trees which can be used as medicines and one of the extension officers told me that there is a tree which can cure malaria. One farmer also said that you can have bees in the trees that produce honey which can also be used as a medicine. This means that some of the trees can improve the health of the farmers and therefore increase the households’ human capital.132 According to one of the farmers, avocado leaves can also be used as fodder for cattle and there are shrubs and grasses which can be used as fodder for cows. This means that the farmers can get a more varied diet as they can get milk from the cows when they have shrubs to feed them with. This might also improve the health of the farmers and therefore increased the human capital asset.133 One of the extension officers mentioned that boundary planting has the benefit of protecting the farm and minimize land conflicts. When the farmers can use the land they have without conflicts arising this will be a security for the household. They have a specific area for natural capital like trees, crops and other natural resources and these provide them with different ecosystem services.134 This indirectly means a security for them in terms of the financial, social, human and physical capital that emerges from the natural capital in an agroforestry system.

130 Ibid, pp 32-34
131 Owenya, Marietha et al. 2012, p 15
132 Morse, Stephen. and McNamara, Nora. 2013, pp 28-29
133 Ibid, pp 28-29
134 Ibid, pp 32-34
6. Discussion

In my study many obstacles for agroforestry adoption were found, one of those was the high input costs. This was also mentioned in a previous study which said that farmer’s incomes were often too low for the agroforestry inputs. The solution to this could be subsidies and loans and support in terms of seeds, fertilizers and fencing material.\textsuperscript{135} As was also shown in my study some of the agroforestry farmers had been provided with seeds and fertilizers from extension services and this seemed to have made their adoption choice easier.

In another study it was also shown that the tree-establishing costs are often unknown for the farmers. The study also brought up the time needed for managing the trees and lack of tree management experience.\textsuperscript{136} In my study one extension officer and one of the agroforestry farmers also mentioned the time needed for managing the trees in the initial phase of the tree planting. They perceived that this could be an obstacle even if less labour would be needed after the initial phase. I also discovered lack of tree management experience in my study as many conventional farmers often did not know how to plant the trees and which trees to plant with which crops. Both my study and this previous study conclude that this lack of knowledge is a result of weakness in institutions, extension services for example, which should provide access to information.\textsuperscript{137} In Senkondo's study the importance of extension services spreading information and knowledge about agroforestry, to decrease farmers’ uncertainties about it, is also brought up.\textsuperscript{138} In my study it was rather clear that the farmers who had chosen to adopt agroforestry had had better access to extension services. It was also shown that conventional farmers did not share so much knowledge with each other, something which has not been mentioned much in previous studies.

Another obstacle that I found in my study was that the farmers perceived a risk of livestock eating the tree seeds. This was however more of a difficulty mentioned by the agroforestry farmers who had decided to plant trees anyway. This difficulty has been mentioned in a previous study that meant that this problem can be solved if the farmers plant other trees in boundaries.\textsuperscript{139} This solution was also brought up by one of the farmers in my study. Another obstacle for adoption in my study was the risk that the trees would compete with the crops. Most farmers however seemed to perceive that this does not have to be a problem as long as you know how to plant the trees and which trees to plant, something which particularly the conventional farmers seemed to be unsure of. In previous studies it has also been

\textsuperscript{135} Chitakira, Munyaradzi. Torquebiau, Emmanuel. 2010, pp 157-158
\textsuperscript{137} Ibid, p 170
\textsuperscript{138} Senkondo, Ephraim.M.M. 2000, p 136
\textsuperscript{139} Akpabio, Iniobong. Ibok, Inemisit. 2009, pp 72-74
shown that farmers perceive that the trees can have negative effects on crops. Senkondo's study for example brings up the risk of competition.\textsuperscript{140} Another previous study also takes up that farmers perceive that there can be negative effects on crops from the trees, both in terms of competition for light, water and nutrients and because the trees can promote pests and weeds. In this previous study, inadequate market prices for timber are also perceived as obstacles for the farmers.\textsuperscript{141} In my study problems with prices for timber were not mentioned at all.

The problem that the land size would be too small was however brought up in my study. This was a problem mentioned by both conventional farmers, hindering them from adoption, and agroforestry farmers. Obstacles were also that the benefits would lie too far in the future. Both these obstacles are mentioned in a previous study where it is brought up that farmers sometimes are dependent on short-term benefits and that land size is a growing problem as population is increasing.\textsuperscript{142} A risk which was discovered in Senkondo's study that I did not find was the difficulty of ploughing with tractors because of tree roots and close distances between the trees.\textsuperscript{143} An obstacle that the informants in my study brought up and that have not been mentioned in previous studies is that it sometimes can be too little rainfall for the fruit trees.

According to the results from my study there were also a lot of benefits and opportunities with agroforestry, for example that agroforestry increases the incomes from fruits, timber and sometimes firewood. The fruits also increases food security as they can be used for own consumption. The financial benefits from timber and fruits were also found in previous studies as well as the benefit of increased food security from the fruits.\textsuperscript{144} The incomes from firewood were on the other hand only found in my study. In previous studies the benefits of firewood which are mentioned is mostly closer access to the firewood, which saves labour time.\textsuperscript{145} According to Senkondo’s study agroforestry practices play an important role in supporting the household economy. It can therefore work as a buffer that decreases different types of risks like drought and floods for example.\textsuperscript{146}

My study, as well as previous studies, also reached the conclusion that the trees can improve the housing by providing timber.\textsuperscript{147} The housing also improves because of increased incomes as the farmers

\textsuperscript{140} Senkondo, Ephraim.M.M. 2000, pp 121-123
\textsuperscript{141} Valdivia, Corinne. Barbieri, Carla, Gold, Michael. 2012, pp 161-163
\textsuperscript{142} Stainback, Andrew et al. 2012, pp 291-292
\textsuperscript{143} Senkondo, Ephraim.M.M. 2000, p 123
\textsuperscript{144} Kiptot, Evelyne. Franzel, Steven. 2012, pp 39-41
\textsuperscript{145} Ibid, p 45
\textsuperscript{146} Senkondo, Ephraim.M.M. 2000, pp 167-168
\textsuperscript{147} Akpabio, Iniohong. Ibok, Inemisit. 2009, pp 72-74
can afford bricks for example.\textsuperscript{148} Like my own study, previous studies have shown that agroforestry make farmers more able to afford healthcare and medicines. It was also shown both in my own study and in previous studies that many plants or trees in an agroforestry system can be used as medicines.\textsuperscript{149} Therefore agroforestry can have positive health effects both according to previous studies and my own study. Besides that, my results show that agroforestry can make farmers able to afford education for their children more easily. A previous study also mentions this opportunity, but brings up that education might also improve because agroforestry is less labour intensive than other agricultural practices, therefore giving more time for the children to spend on education.\textsuperscript{150} I did not get this result in my study, probably because the informants were not completely in agreement about the labour intensiveness of agroforestry as some meant that it is very labour intensive in the beginning.

My informants also had different opinions about whether agroforestry increased the access to transports like motorbikes or cars. Some farmers and one of the extension officers thought that the increase in transports in the villages depended partly on agroforestry adoption. The correlation between agroforestry and increased access to transports has not been brought up at all in the previous studies and therefore does not seem to have been studied much before. This correlation, however, was not very clear in my study either. My results also show that the increased incomes from the agroforestry practices to a small extent leads to a more varied diet as farmers can buy more different types of food as a result of the incomes from agroforestry. In previous studies changed diet is only mentioned in terms of the fruit consumption, not that the farmers can buy more varied types of food. It was however not clear in my study if the changed food habits only depended on agroforestry adoption or if the wealth, that make more farmers able to afford new food habits, had also increased as a result of other factors.

In my study the most important benefit for women mentioned was that they did not have to walk as far to collect firewood. Therefore they got time for other income generating activities or rest for example. This opportunity has also been mentioned in previous studies.\textsuperscript{151} One of the extension officers mentioned that women benefit from fruit trees as they control the incomes from the fruits themselves. He also meant that the fruit trees provide benefits for women as they do not have to walk so far to collect the fruits. In a previous study the financial benefits for women from the fruit trees were also shown.\textsuperscript{152} That women saved time for other things when they could collect the fruits on the own farm,

\textsuperscript{148} Rahman, Syed et al. 2012, pp 534-537
\textsuperscript{149} Ibid, pp 534-537
\textsuperscript{150} Ibid, pp 534-537
\textsuperscript{151} Kiptot, Evelyne. Franzel, Steven. 2012, p 45
\textsuperscript{152} Ibid, pp 45-46
was not mentioned in any of the previous studies. None of the farmers that I interviewed mentioned this either. The household probably do not consume as much fruits if they do not plant the fruits on the own farm so maybe the women did not always save so much time because of the fruit trees. In a previous study it was however shown that women also benefit from the fruit trees because of the increased food security. Women and children are most at risk for running out of food in periods of famine.\textsuperscript{153} I did not get this result, maybe because I only got the chance to interview two women. Another previous study shows that women’s social, economic and decision-making status improves after agroforestry adoption as they are more involved in the agroforestry production decisions.\textsuperscript{154} This was also mentioned by one of the extension officers in my study but not by any of the farmers. If I would have got the opportunity to interview more women I might have got other results. The women might have perceived other improvements for women’s situation or maybe negative effects for women from agroforestry that the men did not bring up. It is hard to say something about how the women’s situation had changed or improved after adoption without getting their perspective.

In my study it was also shown that agroforestry provides many environmental services. The informants mentioned that the trees can prevent erosion, something that has also been shown in previous studies.\textsuperscript{155} Both in my study and previous studies the benefits of nitrogen fixation from the trees and the increase in soil fertility, by incorporation of leaves into the soil, was also mentioned.\textsuperscript{156} But even though many farmers knew that soil fertility increases with agroforestry this does not seem to have decreased their use of industrial fertilizers. The agroforestry farmers in my study actually used industrial fertilizers to a larger extent than the conventional farmers. In my study it was also shown that some trees could be used as natural pesticides. This neither seems to have affected the agroforestry farmer’s use of industrial pesticides as they used industrial pesticides to a larger extent than conventional farmers. Therefore the industrial fertilizer and pesticide use seems to almost increase after agroforestry adoption. This was not found in any of the previous studies.

Many farmers in my study also thought that the trees increase rainfall. The increase in rainfall might be an example of a perceived benefit and not an actual benefit. This has not been mentioned in previous studies, probably because the previous studies about the environmental benefits in most cases do not study perceptions. I do not know however, where this perception comes from. A few trees on the farm can probably not affect the climate. In previous studies there is often concluded that agroforestry

\textsuperscript{153} Ibid, pp 39-41  
\textsuperscript{154} Rahman, Syed et al. 2012, pp 534-537  
\textsuperscript{155} Shibu, Jose. 2009, p 7  
\textsuperscript{156} Kiptot, Evelyne. Franzel, Steven. 2012, pp 39-41
increases biodiversity.\textsuperscript{157} This had not been perceived by the farmers in my study. Probably because the biodiversity effects does not affect their livelihoods directly and therefore is not that important to them. Neither did they perceive that agroforestry had an effect on water quality which has been shown in previous studies.\textsuperscript{158}

6.1 The sustainability and future of agroforestry
Agroforestry is maybe not a rational choice for all farmers, the input costs might for example be too high which makes the farmers loose financial capital instead of making it increase, at least in the short term. However, the perceptions of what is most rational are decided by the farmer’s subjective weighting of the risks with agroforestry. Therefore the farmers make the choices which they think are the most rational even if it might not necessarily be so.\textsuperscript{159} Many farmers after all choose to adopt agroforestry and this can be because of the capital assets which have been shown to increase. The increased capital assets decrease the farmer’s vulnerability to stress and shocks. A shock like a flood for example, might not cause water erosion to the same extent in an agroforestry system. Stresses, like long-term climate change, which might have severe consequences on agricultural production and food security, may also have smaller effects on agroforestry households.\textsuperscript{160} A potential threat to agroforestry adoption in the future might be the population growth. This is because it will decrease the land size available for every farmer therefore making it more difficult to have room for the trees.

As long as there is room for the trees agroforestry however seems to provide a sustainable livelihood which is about having a decent livelihood today without compromising other people’s prospects for a decent livelihood in the future.\textsuperscript{161} Like mentioned before it is however hard to say what future generations want as they cannot speak for themselves.\textsuperscript{162} But they probably do not want more erosion problems, deforestation and decreased agricultural production. In my study agroforestry has been shown to both reduce erosion and increase agricultural production, therefore making it a more sustainable alternative for the future. Many of the capital assets have been shown to increase after agroforestry adoption; therefore providing a support for a decent livelihood both today and in the future. All farmers however do not have the opportunity to adopt agroforestry and in the short term it might not be a good choice for all farmers because of the many risks connected to adoption like high input costs or

\textsuperscript{157} Shibu, Jose. 2009, pp 4-5
\textsuperscript{158} Ibid, pp 7-8
\textsuperscript{159} Senkondo, Ephraim.M.M. 2000, pp 12-14
\textsuperscript{160} Scoones, Ian, p 6
\textsuperscript{161} Morse, Stephen. and McNamara, Nora. 2013, p 6
\textsuperscript{162} Redclift, Michael. 2005, p 215
competition problems because the farmers do not know how to plant the trees. With financial support and education it might however become a sustainable alternative for more farmers.

6.2 Method discussion

I think the SLA-approach worked well as an analytical approach when trying to find the difficulties for agroforestry adoption as well as the increase in resources and livelihood effects, resulting from adoption. The different capital assets made it easier to illustrate how farmer’s access to resources influenced the adoption process or how their access to resources was influenced by adoption. A difficulty with the framework was the term sustainable livelihood or sustainability because it is supposed to take future generations into consideration. But how can we know what future generations wants or needs? Another thing which was really hard to analyze though the SLA-approach was how agroforestry affected women’s situation. The framework does not really include gender aspects. What could be seen in my study was that social capital for women increased, but even if social capital would have increased only for the men this would probably have been seen as a livelihood improvement for the whole household. Differences between men and women might have been important to study since they may be affected differently from agroforestry adoption. On the other hand I got very few interviews with women so gender aspects would have been hard to analyze anyway.

I think that the theory of risk perception and risk attitude worked as a good complement to the SLA-approach especially when analyzing the obstacles and difficulties with agroforestry adoption. Some of the obstacles could not be analyzed so well only through the access to capital assets. That livestock eat up tree seeds for example is not directly related to lack of a particular resource, maybe fences, but I think the problem was also related to in which villages the farmers lived. The opportunities of agroforestry were however not so easy to analyze with this theory. I also think that the risk theory might have worked better in a survey study like Senkondos study because then farmers risk-taking or risk averseness could then have been more easily set in relation to household size or wealth. I could not see these correlations as easily from my interview answers.
7. Conclusion

The results I got show that there are both obstacles and opportunities with agroforestry adoption. Lack of education and money to finance the input costs might be the main ones. Agroforestry might not be a good choice for everyone as the high input costs for example might result in negative economic consequences for the household compared with if they continue with conventional agriculture. Many benefits from agroforestry can be achieved by farmers without planting trees. Contour planting for example can also prevent soil erosion and pigeon peas can to a small extent be used as firewood. For many farmers the risks connected to agroforestry adoption may overweight the desirability to adopt it. All the farmers that I talked to, however, seemed to be willing to practice agroforestry if they would have had the opportunity. Some of the most important benefits mentioned were that the trees provide timber, firewood and fruits and that the trees prevent soil erosion and increase soil fertility. Climate change which might threaten agricultural production and food security, makes agroforestry seem like a sustainable alternative as it both increases soil fertility, prevents erosion, increase the incomes and the food security. A sustainable agricultural alternative is necessary in Babati where 70 % of the population is dependent on farming as their main income. But to make the farmers consider agroforestry a desirable alternative, support in terms of education, seeds, fertilizers and so on is needed if these are lacking. Otherwise the risks with adoption will outweigh the opportunities.
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9. Appendix

9.1 Appendix 1: Interview guides

9.1.1 Interview guide for agroforestry farmers

Name, members of the household, acres cultivated, acres of agroforestry.
Which food crops and which cash crops are cultivated?
Which trees are planted on the farm and what are trees used for?
Which agroforestry techniques are used?
For how long have you planted trees on your land?
How did you come in contact with agroforestry/ Which were the main reasons for you to start practice agroforestry?
How do you perceive the soil fertility of your land? How do you perceive crop production?
Have you had any problems with erosion?
Do you perceive you income from crops and/or trees is enough for school for the children/ healthcare and medicines/ food and other household goods/housing/ transport etc.?
How do you perceive agroforestry has affected your income?
If the incomes have been affected in a positive way, how has that affected your life?
  - Ability to afford healthcare/medicines
  - Send children to school
  - Buy other types of food and household goods
  - Improve the housing
  - Availability of transport
If there is a lot of agroforestry adoption in the area, how has that affected:
  - Transports in the area
  - Houses
  - Children at school
  - Ability to afford healthcare for people in the village.
Which ecological effects have been perceived from agroforestry?
  - Soil fertility
  - Soil erosion
  - Crop production
  - Water quality
  - Biodiversity
Are you using industrial or natural pesticides/ fertilizers? Why?
Which effects do you perceive agroforestry have for the women in the household?
- How has the workload in the household changed and how has that affected women? Is agroforestry more or less labour intensive compared with other agricultural practices?
- How did you get firewood before and how do you get it now? How long was the distance before?
Did you perceive any barriers or difficulties for adopting agroforestry before you started to practice it?
- Input costs
- Lack of knowledge and education about benefits with it/ how to plant the trees/ which trees to plant etc.
- Competition between trees and crops for nutrients/shade/water
- Land size
- Dependency on short-term benefits
- Livestock eating up the tree seeds
Have you perceived any difficulties with agroforestry after you started practicing it?
How do you perceive the access to education and information about agroforestry in this village?
- Education from extension services and collaboration between extension services and farmers
- Sharing of knowledge between farmers

9.1.2 Interview guide for conventional farmers
Name, members in the household, amount of acres cultivated.
Which cash crops and food crops are cultivated?
How do you perceive soil fertility on your land and do you have problems with erosion?
How do you perceive crop production?
Do you perceive that the incomes you get from the crops are enough?
- For school
- Healthcare/medicines
- Food, other household goods
- Transport
- Housing
How do you get firewood? How long distance do you have to go to get it?
Are you using natural or industrial pesticides or fertilizers? Why?
Have you considered planting trees on your land?
Have you practiced agroforestry before?
- If you have, why did you stop?
- How did you come in contact with agroforestry? (extension services, other farmers etc.)

Which effects do you think agroforestry would have on:
- soil fertility, erosion, crop production
- use of industrial/natural fertilizers or pesticides
- water quality
- biodiversity
- Income and ability to afford healthcare/medicines/education/transport/food/other household goods

Do you think that there could be any negative consequences with planting trees on your land?
- Competition between trees and crops for nutrients/shade/water
- Benefits from the trees comes too far in the future
- Land size
- Livestock eating tree seeds

How do you perceive the input costs for starting to plant trees?

Do you think that planting trees works better in some environments or climates?

Do you perceive that you have enough knowledge about agroforestry or do you perceive that you have the possibility to get more information about it if you want to start practice it?

How do you perceive the education from extension services and the collaboration between extension services and farmers?

How do you perceive the interaction between farmers, are they sharing their knowledge about agroforestry with each other?

9.1.3 Interview guide for extension officers

Is agroforestry common or widespread in this village?

Which agroforestry techniques are mostly used?

Which trees are mostly planted and what are they used for? Which crops are mostly planted?

Which are the main reasons for farmers to start practice agroforestry?

Which are the benefits with agroforestry?
- Timber production leading to increased incomes, better housing etc.
- Growing of fruits, increased income, benefit for women, increased food security
- Fuelwood, don’t have to buy fuelwood, do not have to walk to far, incomes from selling firewood, benefit for women.
- Biodiversity
- Water quality
Less erosion
- increased soil fertility and increased crop production
- Other benefits?

How does agroforestry affect the use of natural or industrial fertilizers or pesticides?
Is agroforestry more or less labour intensive compared with other agricultural practices?
How does agroforestry affect the situation for women? How does the share of work change between men and women?
Which barriers might exist for agroforestry adoption? Are there different barriers for different farmers?
Is there a risk that you help farmers start practicing agroforestry but that they do not continue to practice it after the help stops?
Can there be any difficulties with agroforestry after the farmers have started to practice it?
- Competition between trees and crops, land size, dependency on short-term benefits, livestock eating tree seeds etc.

How do you think the farmers perceive the input costs of agroforestry? Do you think financial support could be a way to increase agroforestry adoption rates?
How do you perceive farmer’s knowledge in the village?
- Awareness of the benefits
- Do they know how to plant the trees and which trees that are suited with which crops

What can be done to improve farmer’s awareness and knowledge?

9.2 Appendix 2: Pictures

Picture 1. Part of an agroforestry farm in Haraa where they planted coffee, maize, beans, bananas avocado, mango trees, orange trees, Grevillea and Eucalyptus.
Picture 2. Eucalyptus tree in Haraa used for timber and firewood.

Picture 3. Fodder shrubs for cows in Haraa.