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ADOPTION OF AGROFORESTRY TECHNOLOGY IN MALAWI: HINDRANCES EXPERIENCED BY FARMERS IN NSANJE DISTRICT

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ABSTRACT

Agroforestry technology is one of the sustainable land management practices used to mitigate land degradation, which is affecting smallholder farmers in Malawi. Decline in soil fertility due to land degradation is leading to food insecurity. The government of Malawi, through the Department of Land Resource Conservation, is promoting use of agroforestry trees to improve soil fertility and for other benefits which are acquired by agroforestry trees. Despite government efforts, adoption among farmers is very low. This research examines hindrances faced by smallholder farmers at Mpatsa Extension Planning Area, Nsanje district in the adoption of agroforestry technology. Qualitative methods were used. Both focus group discussions with farmers and key informant interviews were conducted to obtain data from both adopters and non-adopter farmers. The results from a thematic analysis showed that socio-economic, physical, and institutional factors hinder farmers in adopting agroforestry technology. Among them are unsecure land rights, land holding size, drought, flooding, landscape, lack of seed, nursery equipment and extension services, and poor timing. This study offers a preliminary insight which can contribute to the upscaling of agroforestry technology by addressing the challenges outlined by smallholder farmers in Mpatsa Extension Planning Area.

Key words: Agroforestry adoption, land degradation, soil fertility, food insecurity, Malawi

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ABBREVIATIONS

ADD	Agricultural Development Division
AFSP	Agroforestry Food Security Programme
AIP	Agricultural Input Project
CARD	Churches Aid Relief Development
CSA	Climate Smart Agriculture
DAO	District Agriculture Office
EPA	Extension Planning Area
FGD	Focus Group Discussion
GRÓ LRT	GRÓ Land Restoration Training Programme
MGDS	Malawi Growth Development Strategy
NAIP	National Agriculture Investment Plan
NGO	Non-Governmental Organisation
PAO	Principal Agricultural Officer
SDG	Sustainable Development Goals
SVADD	Shire Valley Agricultural Development Division
T/A	Traditional Authority

1. INTRODUCTION

1.1 Background

In Malawi, agriculture is the backbone of the economy and is essential to ensure food and nutritional security for most people, since 85% of the population live on smallholder farms (NAIP 2018). However, agricultural productivity is not increasing due to depletion of soil fertility and climate change effects, which are leading to food insecurity (Sanchez 2002). Anthropogenic activities such as forest conversion for human use and poor agricultural practices have led to land degradation depleting soil fertility (Meijer et al. 2015). Land degradation is the main cause of reduction in soil fertility due to the removal of vegetative cover which exposes the land and makes it vulnerable to erosion either by water runoff or wind (Tilman et al. 2002). To mitigate the challenges imposed by land degradation and climate change on livelihoods of smallholder farmers, adoption of climate resilience technologies such as sustainable land management practices is essential in farming.

The government of Malawi, through the department of Land Resources Conservation under the Ministry of Agriculture and Water Development, has taken significant steps to respond to land degradation and climate change. The strategies focus on sustainable land management practices to address the adverse effects of climate change and depletion of soil fertility for crop production in the country (Malawi Government 2017). Agroforestry is one of the technologies being promoted to minimise land degradation and mitigate climate change impacts. It is a system that manages the natural resources biologically by incorporating soil fertility enhancing trees on farmland to sustain production and increase environmental benefits for land users (FAO 2015). Apart from increasing soil nutrients and improving soil structure, agroforestry trees are also a source of firewood and fodder for livestock (Ajayi et al. 2007).

Enhanced community resilience to climate change impacts and unsustainable land management is one of the intermediate results emphasized in Malawi Growth Development Strategy III by the government of Malawi (Malawi Government 2017). However, despite the efforts made by the government to promote sustainable land management practices and climate change resilience strategies, such as agroforestry technology among smallholder farmers, the hectarage under agroforestry in most areas is not increasing. Based on personal experiences as a Land Resource Conservation Officer in Nsanje district, southern Malawi, there is a lack of information about the reasons for low adoption of agroforestry technology in the district. Nsanje district has experienced a major decline in forest cover in recent decades, leading to loss of topsoil, which was been driven by the cutting down of trees and cultivating on steep slopes leading to increased runoff (Omuto &Vargas 2019). The Mpatsa Extension Planning Area (EPA) in Nsanje district is one of the EPAs with a very low adoption rate of agroforestry among smallholder farmers. There is a lack of knowledge as to why the adoption is low compared to the other four EPAs in the district.

1.2 Project objective

The objective of this research was to determine factors affecting the adoption of agroforestry technology for soil fertility improvement in the southern part of Malawi.

1.3 Research questions

The study's research questions are:

i) What factors are affecting farmers' adoption of agroforestry technology?
   - Are different factors affecting adoption in lowland and upland areas?
   - What challenges do various farm households face in implementing agroforestry technologies?

ii) What are the benefits of agroforestry farming practices for smallholder farmers who have adopted the practice?

1.4 Relevance of the study to Malawi

Malawi is currently implementing a development policy agenda to achieve development ambitions set out in the Malawi Growth and Development Strategy (MGDS) (Malawi Government 2017). The strategy identifies five key priority areas with agriculture and climate change management being the first priority. Agroforestry technologies have proved to be effective in combating climate change and improving soil fertility (Kwesiga et al. 2003). This study will contribute to this goal by adding knowledge of factors that lead to low adoption of agroforestry technologies, which is critical for planning and designing outreach programmes for improving soil fertility. In addition, it will also assist in obtaining food security and reducing poverty in the country. This study will more specifically add a basis for scaling up the adoption of agroforestry technologies in Mpatsa EPA where adoption of the technology is currently very low.

2. FORMER STUDIES

The major problem faced by Malawi is food insecurity, which can be related to high population pressure, reduced land holding capacity and poor soil management practices leading to depletion of soil fertility (Gruhn 2000). According to the Ministry of Environmental Affairs (2002), soils in Malawi have inadequate nitrogen, sulphur, phosphorus, and most macronutrient elements leading to low crop yields. Chinangwa (2006) conducted a study in southern Malawi on development of soil fertility and her results showed that 62% of farmers perceived that soil fertility will continue to decline, 21 % said that soil fertility will increase and finally 17% of farmers thought that there will be no change. According to Kwesiga et al. (2003), in southern Africa the populations of both people and livestock are increasing. This has led to loss of vegetative cover, thus causing numerous environmental challenges such as reduction in soil fertility. This has a negative impact on food security and threatens the livelihoods of people. Agroforestry technology is a possible solution to redress the socio-environmental challenges faced by smallholder farmers in southern Africa in a sustainable manner. Inorganic fertilizers are very expensive, and the majority of small holder farmers cannot afford to apply fertilizer in their fields (Kwesiga et al. 2003).

The department of agricultural research, under the Ministry of Agriculture and Water Development, initiated the use of agroforestry technology in Malawi in 1984 (Makumba 2003). The World Agroforestry Centre also introduced a programme on Agroforestry Food Security (AFSP) in Malawi, in 2007. The objective of the programme was to offer agroforestry opportunities to farmers. The intention was to enable them to combat food insecurity by improving soil fertility, enhancing nutritional security and income

diversification through fruit production (Coulibaly 2016). Some of the Agroforestry technologies being promoted to enhance soil fertility are intercropping of maize with *Gliricidia sepium, Faidherbia albida, Sesbanian sesban* and annual relay cropping. The research done by the Makoka research station in Zomba district shows that intercropping maize with *Gliricidia sepium* increases soil fertility in comparison to planting only maize in the field (ICRAF 2006). Mwase et al. (2015) found that apart from increasing the soil fertility and improving soil structure, agroforestry practices also have other benefits. These are suppressing weeds, improving the hydrological cycle, increasing the amount of carbon in the soil, and provision of non-timber forest products such as fodder and fruits. According to Thangata et al. (2002), fruit trees may produce various sources of farm income, thereby reducing food insecurity if the income obtained is used to purchase food. Fleming et al. (2019) stated that agroforestry trees are very beneficial as they aid in improving the farm through restoring soil fertility and also help the environment by absorbing pollutants

Meijer et al. (2015) reported that farmers' perception affects the adoption of agroforestry technology in sub–Saharan Africa, thus there is need for better understanding of the intrinsic factors. According to Mwase et al. (2015), the major factors affecting the adoption rate of agroforestry technology by farmers in southern Africa are mostly physical and socio-economic, which include: drought; flooding; small size of land; lack of seed, nursery equipment, land rights, knowledge, and awareness; and inadequate extension support. Coulibaly (2016) suggested that agroforestry is highly adopted when farmers have access to training on management of agroforestry trees and if they have the opportunity to acquire seed and farm assets, which help in the establishment of agroforestry nursery and trees. Chitakira and Torquebiaub (2010) stated that in smallholder farming, to upscale adoption of agroforestry technology, factors like provision of farm equipment, such as wheelbarrows and shovels, are essential. These materials are used for carrying manure and should be considered because lack of such equipment creates challenges in adopting the technology. Insufficient availability of either seed or seedlings is one of the hinderances to adoption of agroforestry technology. Most smallholder farmers in Malawi obtain seed locally or from NGOs, but neither the government nor NGOs have the capacity to meet the high demand for seed by farmers (Phombeya, 2012).

Farm size plays a crucial part in adopting any new technology such as agroforestry. Many studies have found that farm size is one of the most important elements of technology adoption (Lavison 2013). According to Asfaw and Neka (2017), nearly all the introduced agricultural technologies, such as agroforestry, are less adopted by farmers who cultivate on a small scale due to limited cultivable land. Mwase et al. (2015) also found that inadequate availability of land restricts the type of technology that farmers can adopt, thus negatively altering the adoption of agroforestry technology. Other authors claim that mixed tree and crop intercropping technologies are flexible and appropriate to small farm areas (Kwesiga et al. 2003). This agrees with Thangata et al. (2007), who reported that smallholder farmers in Malawi with limited land adopt the intercropping of maize with agroforestry trees because it does not take up so much space. The following are examples of agroforestry tree species that are mainly intercropped with maize crops, *Gliricidia sepium, Sesbania sesban, Leucaena* species and *pigeon peas.* It was also noted that land tenure is important because farmers are keener to plant agroforestry trees in an area where they have access to land rights than on rented land where there is no security (Thangata et al. 2007). Farmers feel that if they do not own the land, they also cannot own the trees planted on that land. Livestock browsing on agroforestry trees during the dry season is another challenge affecting adoption of agroforestry technology. Livestock, particularly goats, destroy trees soon after planting

through browsing on the leaves and eradicating the biomass or by trampling over the agroforestry tree plants (Phiri et al. 2004). This corresponded with the study conducted by Mlamba (2018) who found that, in part of Lilongw, 55% of farmers complained about animals destroying the agroforestry trees after planting. Mlamba (2018) further wrote that other problems faced by smallholder farmers in implementing agroforestry technology were termites, shortage of water and burning of seedlings. Chitakira and Torquebiaub (2010) also reported that water provision is one of the major challenges, especially in the summer season and during periods of drought when the water-table drastically declines and other local water bodies such as streams and wells dry up.

3. METHOD OF STUDY

3.1 Study area

The study was carried out in Nsanje District (Fig. 1) in the southern part of Malawi, which is under the Shire Valley Agricultural Development Division (SVADD). The district had a population of 299 thousand, of which 48% were men and 52% women (NSO 2018). Nsanje district has a total area of 193 thousand hectares, of which 93 thousand hectares are arable and 100 thousand hectares are non-arable. The common soil types of the district are cambisols, luvisols and fluvisols (Vargas & Omuto 2019). These are deep, well drained soils that are good for agriculture due to good soil structure but susceptible to erosion (Government of Malawi 2002). The district has one District Agricultural Office (DAO), which is further divided into five Extension Planning Areas (EPAs). One of the EPAs is Mpatsa which is the study site. Mpatsa EPA is under Traditional Authority (T/A) Tengani with a total population of 41 thousand and a total area of 36 thousand hectares. The area is divided into lowland, and upland. These areas are differentiated by altitude; the lowland is 34 meters above sea level while the upland is 604 m above sea level (Omuto &Vargas 2019). The lowland area is near Shire River, which is the largest river in Malawi. The people in this area fish as an income generating activity. The upland area is near Matandwe Forest reserve. According to the researcher communication with the District Forestry Officer of the Nsanje district, the community around the reserve cut down trees illegally from the forest reserve. Once caught they are punished. Farmers in Mpatsa area mostly cultivate sorghum and millet as the major staple food crops, cotton and sweet potatoes are cultivated as cash crops, and they also keep livestock, particularly goats and cows, for income and consumption

3.2 Data collection

Data was collected at Mpatsa EPA in Nsanje district using qualitative research methods through both focus group discussions and interviews with key informants. Purposeful sampling was used to identify and select informants with rich information connected to the research topic.

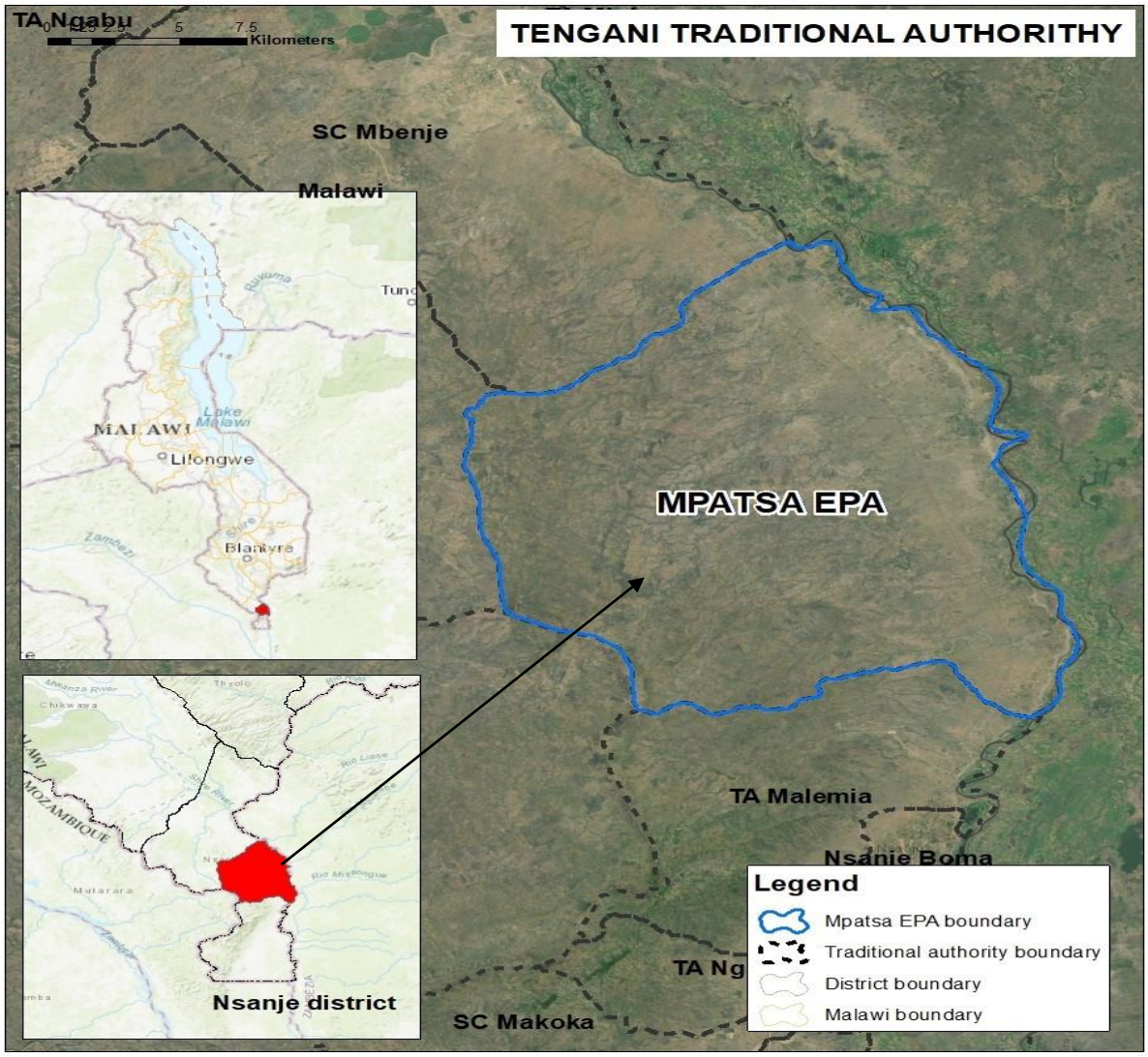

Figure 1. Location of Nsanje District and Mpatsa EPA. (Source: Google earth and NSO 2018).

3.2.1 Focus group discussion

The use of focus group discussion provides people studying social processes with the opportunity to gain insight into a variety of views from participants, and the nature of their interaction and dialogue over the issues discussed (Flowerdew & Martin 2005). This type of method makes it possible to collect data from multiple participants at the same time. Focus group discussion can also offer a comfortable environment where it is possible for participants to talk in-depth (Braune & Clarke 2014). The data was collected from six groups of respondents sampled purposively and conveniently, with the help of extension workers and local leaders. Three focus groups were held at each study site, one in the lowland and another in the upland areas. Two groups at each site were comprised of non-adopters, divided into a group of women and a group of men. The third group consisted of both men and women who have adopted agroforestry technology. Each focus group had eight respondents of mixed age and household headship. The discussion in each group lasted

for almost two hours and the farmers were very interested in participating in the discussion on the subject. Collection of data was aided by audio recording to avoid losing important aspects of the discussions (Flowerdew & Martin 2005). Four extension workers (research assistants) helped with data collection and worked together two and two in each focus group, facilitating the discussion. The discussion was aided by a question guide (appendix 1 and 2) provided to the research assistants. They were trained by the researcher in using the question guide before conducting the data collection. Table 1 shows the types of focus groups in the two study sites.

Table 1. Type and location of focus groups.

Area	**Focus Discussion Groups**		
	Women (Non-adopters)	**Men (Non-adopters)**	**Both men and women (adopters)**
Lowland	1	1	1
Upland	1	1	1
Total	2	2	2

3.2.2 Key informant interviews

Interview guides (see appendix 3 and 4) were used to collect information from five key informants. The key informants interviewed were two local leaders from the same area where focus group discussions were conducted, two project officers from non-government organisations (NGO) working in an area on agroforestry technologies and the Principal Agriculture officer from the District Agriculture Office. These key informants were chosen based on expertise and knowledge of the area. Information from farmer focus group discussions and interviews with two local leaders was collected by four extension workers (research assistants) from the EPA, who have previous experience of the area. The interviews with the Principal Agriculture Officer, project officers from CARE Malawi and CARD NGOs were conducted by the researcher (Land Resources Conservation Officer) from Reykjavik in Iceland.

3.3 Data analysis

The data was analysed using a thematic analysis approach by the researcher assisted by the research assistant to transfer the recorded material. According to Braune and Clarke (2014), the thematic analysis approach is a method of determining themes and patterns of meaning across a data set in relation to objectives. All recorded data from the focus group discussions and key informant interviews from local leaders was transcribed in the local languages, which are Chisena and Chichewa. The researcher listened through the recordings, to transcribe and translate them to English, which took three days. All transcripts were coded and organised into themes. Complete coding was used for all data, to identify all that was of interest to the objectives of the study.

3.4 Ethical considerations

In general, researchers are supposed to comply to ethical norms and standards to safeguard the participants involved in the research study (deJong et al. 2016). In this study, it was ensured that ethical considerations were met by asking for consent from the sampled farmers

to record the interviews. When going into the field for the collection of data, the study was explained to the participants, and they were assured of confidentiality.

4. RESULTS

This section presents results from the key informant interviews and focus group discussions. Direct quotes taken from key informant interviews and focus group discussions are presented in italics to clarify the perspectives of respondents. In the findings, KI stands for key informants while FG stands for focus group discussion. U stands for upland, L is lowland. NA is non-adopter farmers of agroforestry technology and A means adopter farmers of agroforestry technology. K/NGO 1 stands for key informant CARE Malawi, K/NGO 2 refers to key informant CARD. K/L is key informant local leaders in both upland and lowland areas, and K/PAO refers to key informant PAO.

The first part of the research findings is based on responses from non-adopters of agroforestry technology. Responses from adopters of agroforestry technology follows. In both sections, responses from key informants are included.

4.1 Non-adopters' awareness of agroforestry technology

Focus group discussions established that there is a difference in awareness and benefits acquired from agroforestry technologies between farmers in lowland and upland areas.

4.1.1 Lowland and upland non-adopter farmers

Both men and women who participated in focus group discussions of non-adopters in the upland area said they are not aware of agroforestry technology. They further complained that they do not have access to extension services that can introduce this technology to them. One man from an upland area thought farmers in lowland areas planted trees for shading and not for soil fertility:

> *I have never heard of this technology, I just see certain trees in the fields of lowland area farmers, when I'm going to the district to sell charcoal. I did not know that they are agroforestry trees, I thought my fellow farmers just planted the trees to provide shade when they are resting after getting tired with farming. If farmers are practising this technology in the upland area, I am sure they copied it somewhere else through their own initiative, here we do not have an extension worker to teach us about the technology. (FG/U/Men/NA)*

The respondents from lowland areas reported that they are aware of the agroforestry technologies and that it was introduced to them by the government extension worker of the area from Mpatsa EPA. A lowland man said that, in addition to the government, there are many NGOs that provide extension services in this area:

> *I do not practice the technology, but I heard about it from the extension worker of this area from Mpatsa EPA. Apart from the government extension worker, there are also several non-governmental organisations in this area which promote agroforestry technology. (FG/L/Men/NA)*

The responses from upland farmers show that most of them were unaware of the technology due to lack of extension advices. This contributed to non-adoption of agroforestry technology. However, the lowland non-adopters of the technology were aware of the technology, and it was introduced to many of them by the government and NGOs.

4.1.2 Understanding the importance of agroforestry technology

Most of the upland farmers did not know about the importance of the technology. The research assistant explained to them the meaning of agroforestry, that it is the practice of deliberately planting trees with agricultural crops or grazing animals to provide significant ecological and economic benefits. A woman from the upland area thought it was an interesting technology and that, if adopted, it could benefit more farmers:

> *By the way the assistants have explained of this technology I think it is very interesting. If we adopt the technology, I am sure we can benefit a lot through harvesting abundant yields since the soil fertility will be restored. (FG/U/Women/NA)*

Respondents from the lowland groups said that there are a lot of benefits that they see from other farmers who adopted this technology. A woman from a lowland area believed that if she could adopt the agroforestry technology, she could benefit from increased yields:

> *If I can adopt the agroforestry technology. I am sure it can benefit me because I see my fellow farmers who adopted the technology experience a lot of benefits, such as improved livelihood due to increase in yields. Pods are used as livestock fodder and the soil structure is also improved hence increase in yields. (FG/L/Women/NA)*

Responses from non-adopter upland farmers show that they did not have knowledge of the benefits of agroforestry technology, but they were interested in adopting them if there would be provision of resources. Likewise, the lowland farmers also showed interest in adopting the technology since they already know the benefits.

4.2 Factors affecting non-adoption of agroforestry

All key informants and farmers from both upland and lowland non adopters of agroforestry technology mentioned several challenges that hinder farmers from adopting the technology. The challenges can be divided into socioeconomic, physical, and institutional factors.

4.2.1 Socio-economic factors

Several challenges mentioned by most farmers in both areas from focus group discussions fall under socio-economic factors. The farmers mentioned land rights, size of arable land, inadequate income to purchase seeds, lack of nursery equipment, lack of interest and educational level as the main socio-economic factors affecting the adoption rate of agroforestry technology.

Land rights and gender variations

Land rights in both upland and lowland areas were reported to be ruled by tradition and acquired through family inheritance. Farmers in the different groups complained that the fragmentation of inherited land is one of the hindrances faced in adopting agroforestry technology. One man described that the division of land into smaller areas makes the land inadequate for incorporating technologies like agroforestry:

> *Most of the land is inherited from our parents, for example in our family we were born eight and the land was divided into eight portions according to the size of the household each child had. So, some of us had a very small land since by the time they were dividing the land my household was very small. I ended up having a small land hence adopting agroforestry technology is not possible due to the size of land.* (*FG/U/Men/NA)*

The lowland farmers similarly responded that land is usually acquired through family inheritance. They further said that some of the farmers cultivate on family land most of the time, so it is very difficult to plant agroforestry trees since the land is not permanently theirs, it belongs to the family. One male respondent complained that land allocation changes almost every year:

> *Parents may give us the land today for cultivation, next season may allocate us another land. The one we cultivated last time may be given to the brother, so this makes difficult for us to make developments, hence unable to adopt the technology due to migration each year. (FG/L/Men/NA)*

The women's groups in both areas reported that men do not pay much attention to farming. They said most of the farm work is done by women despite their not being the head of the family. Men usually prefer doing temporary work to earn money every day. However, they are the ones who makes decisions on whatever should be done on the farm due to the patriarchal culture**.** One woman said most women farm and the problem is that they cannot make any decisions regarding the planting of agroforestry trees on the land:

> *As you know, in Nsanje district, culture plays a big role as you are aware it is a patriarch type of regime so when it comes to the issue of land rights, men have more power than women because they are head of the families. Men rarely do farm however advise women what should be planted. They became responsible for all the yields, and sometimes sell all of it and use money on other women. Worse still, if we decide to plant agroforestry trees on our own, we can face serious problems. Sometimes they can even divorce us. (FG/U/Women/NA)*

According to K/PAO, culturally the land is inherited by the son, who is the one who controls this resource. This gives very little room for women, who are mostly involved in agricultural activities to make decisions on what to be done in their gardens. Similarly, K/ NGO 1 testified that the area is a patrilineal society which also gives men power to practice polygamy. Most men who practice polygamy spend the time doing temporary work to bring extra food for two or three households instead of participating in the farm work. Regarding agroforestry technology, the wives cannot plant trees because the land belongs to their husband.

According to many responses, women have no power over land and cannot make any decision due to the patrilineal structure of society. The woman has no say and agrees to everything the husband says since men are the head of the family. However, despite men being the head of family they do not engage in farming hence making the adoption of agroforestry technology very difficult since they are the decision makers. The responses further showed that most of the land is inherited from their parents, making adoption of the technology impossible since the land is small.

Land size

The upland farmers lamented that they have small sized land, less than 0.4 hectares, and most of the time they rent some piece of land to increase their operational land. The land is rented annually, therefore farmers prefer to use alternative technologies. These technologies are like manure and conservation agriculture which produce instant results on rented land to increase high yields and profitability. A woman from the upland area reported that inadequate land due to increase in population limits them from adopting the technology:

> *Increase in population has limited the size of land for cultivation. Most of us rent the land in order to increase the harvested yields. Therefore, we prefer use of manure and conservation agriculture technologies because the results are seen faster than planting trees, which take time to grow, thus cannot be planted on a rented land. (FG/U/Women/NA)*

Respondents from the lowland area also stated that small size of the land is a big hindrance to agroforestry technology. They said some farmers own a very small piece of land, at a maximum 0.2 hectares, so they fear adopting the technology because they think it will consume land which could be used for crop production. One of the respondents reported that agroforestry is a good technology. However, the small land holding size is a limiting factor:

> *I know that agroforestry technology is very good because I see the benefits acquired by other farmers who adopted the technology through field days conducted by either Government or Non-governmental organisations. However, my fear is that I own a very small piece of land where I plant the crops and in case if the technology is adopted may limit the space for crop production. (FG/L/Men/NA)*

The K/PAO also reported that small land holding is barring many farmers from practicing agroforestry technologies that require vast land for it to be effective.

The K/L from the upland area also stated that small size of the plots is a very big problem in the upland area since it is mountainous and on steep slopes. As a result, many farmers rent more land. He further said that unfortunately, on rented land, people are not allowed to plant either agroforestry trees or other types of trees. This hinders farmers from adopting agroforestry technology.

According to all respondents, size of land holding plays a very big role in adopting agroforestry technology. Most of the farmers have small pieces of land either due to the landscape or population increase leading to fragmentation of land. A farmer is more likely to adopt agroforestry technology if he/she owns or has secure access to a large piece of land.

Inadequate income to purchase seed

The upland farmers mentioned that they do not have access to agroforestry seed which contributes to low adoption of the technology. They further said that apart from farming they also do temporary work (ganyu) and some burn charcoal as a common measure to earn money due to poverty. However, despite doing temporary work, they cannot manage to buy agroforestry seed which are very expensive. The research assistant told them that *Grilicidia sepium* is sold at 4,100 kwacha per kg. One of the farmers said that they prefer to buy food for the little money they get from selling charcoal, rather than buying expensive agroforestry seed:

> *Most of us are very poor. We cut down trees in Matandwe forest reserve and make charcoal which we sell at the district to buy relish, soap, salt, and other necessity things to earn a living. So, we do not have enough money to buy agroforestry seed since NGOs or governmental extension workers are not present to give us free agroforestry seed. (FG/U/Men/NA)*

Some of the lowland farmers indicated that they were very interested in agroforestry technology because they see the benefits other farmers get, but the main challenge is lack of seed. They are too poor to purchase seed. One of them mentioned that sometimes farmers receive seed from NGOs but not all farmers have access to this:

> *We lack seeds to adopt this good technology. The government and NGOs sometimes distribute free seed, but it does not reach out to many farmers since this area has a lot of smallholder farmers. We prefer to buy food instead of buying agroforestry seed because of poverty. (FG/L/Men/NA)*

The K/NGO 2 also talked about lack of seed as one of the hindrances contributing to low adoption of the technology. He similarly said that the seeds are very expensive, close to 4,100 kwacha which is equivalent to 25 kg of maize, so farmers prefer to buy food rather than buying agroforestry seed.

The respondents from the women upland group also complained that they do not have enough money to buy seed. Most of the women in this area look after their families because either they are widows or their husbands went abroad to seek for better opportunities. One of them stated that any money found is used to take care of the family hence they cannot manage to buy agroforestry seed:

> *To plant agroforestry trees, we are supposed to buy either seeds or seedlings, but we don't have money. Some of us, we are the household heads since our husband went to either Mozambique or South Africa, looking for "green pastures" and they got married again there. They do not care for the family anymore, so any money we make we take care of the children. There is no money to buy agroforestry seeds. (FG/U/Women/NA)*

The K/NGO 1 likewise said that most of the farmers in this area were women because most men migrate a lot, either going to Mozambique or marrying other women. They do not care about their families hence the woman alone takes care of the family.

All respondents consistently indicated that lack of seed is one of the challenges barring farmers from adopting agroforestry technology. The responses suggested that if there was provision of seed, most of the farmers could adopt agroforestry technology.

Lack of nursery equipment

Both lowland non-adopter groups reported that sometimes NGOs and government organisations distribute seed without providing equipment to be used in nurseries, such as polythene tubes, wheelbarrows, shovels, and watering canes. One of them said he is demotivated to adopt the technology due to lack of nursery establishment materials:

> *Most of the things that demotivate us from adopting agroforestry technology is that most of the times the NGOs provides seed without polythene tubes and other necessary nursery materials. Since we cannot manage to buy polythene tubes, we decided not to use the seed which they distribute to us. (FG/L/Men/NA)*

Similarly, respondents from K/PAO, K/NGO 1, and K/NGO 2 mentioned that lack of incentives such as polythene tubes, wheelbarrows, and watering canes for nursery establishment were some of the factors affecting the adoption rate of agroforestry technology. One respondent from K/NGO1 believed that most farmers do not adopt the technology due to lack of incentives:

> *Farmers are not willing to participate in implementing agroforestry technology if they are not given incentives. This is because most of the nursery establishment materials are supposed to be bought. Most smallholder farmers are very poor and cannot afford to buy the materials hence not adopting the technology. (K/NGO 1)*

The K/PAO also said that lack of incentives has resulted in some farmers not trying land restoration technologies like agroforestry, despite seeing the benefits from other farmers.

The responses disclosed that lack of incentives such as necessary equipment contributed to low adoption of agroforestry technology by farmers. Most farmers emphasized that provision of nursery equipment is important in motivating most farmers to adopt the technology. The key informants and non-agroforestry adopters in lowland areas all agreed that this was a hindrance.

Education level

Farmers in the lowland area reported that adoption of agroforestry technology is also affected by the high illiteracy level in the area. One of the respondents stated that they did not go far in school hence it is very difficult to easily understand the importance of adopting agroforestry trees:

> *Most of us here we did not go to school. We drop out of school in standard two and start fishing since the Shire River is very close by. If we are told of the benefits of agroforestry technology even if we see from our fellow farmers, we rarely believe them because we think they used African medicine called juju to harvest abundant yields. (FG/L/Men/NA)*

The findings indicated that lack of education is one of the contributing factors to low adoption of agroforestry technology. Some farmers who did not adopt the technology in lowland areas emphasized that they believe that other farmers produce abundant yields due to juju and not because of the agroforestry trees. Despite seeing the agroforestry trees in their fellow farmers' fields, they still do not believe that agroforestry trees are the reasons for harvesting abundant yields.

Lack of interest

Some of the lowland respondents from both men and women groups reported that the communities are aware of the technology. They have three NGOs working in the area promoting agroforestry technology. They also have government extension workers from the Ministry of Agriculture and Water Development. The problem is, however, that some of them lost interest because they think it is a tedious job taking care of the trees starting from the nursery up to the field.

One of the key informants from the Ministry of agriculture also stated that one of the reasons for low adoption of agroforestry technology in the area was the perception among farmers that millet and sorghum, which are dominant crops in the EPA, do not need fertilizer or manure. Farmers thus do not see any reason for adopting agroforestry technologies.

4.2.2 Physical factors

The farmers and key informants reported that there are several physical factors that hinder farmers from adopting the agroforestry technology. Landscape, floods, drought, and livestock damage are the main challenges farmers are facing.

Landscape

The upland area has a very steep slope with an average altitude of 612 meters above sea level. Usually the slope is almost 25%. The respondents from upland groups complained that the slope makes cultivation difficult, and the area has a lot of rocks making the arable land very limited and fragmented. A woman from the group mentioned that landscape is a big challenge to farmers because it limits arable land:

> *There is no adequate land to cultivate for some of us due to the landscape of the area. The arable land is very limited since the area is very mountainous with a lot of rock. Therefore, we prefer to cultivate only crops because if we mix with trees the yields will not be enough, since trees will take up the spaces where crops are supposed to be grown.* (*FG/U/Women/NA).*

The respondents from the lowland area also complained about the Shire River changing its course each year, thus limiting the land to cultivate. One man reported that the Shire River is the hydrological boundary between Mozambique and Malawi and changes in the river course often move land used for cultivation to the Mozambique side:

> *Most of our land is taken up by the people from Mozambique when the Shire River changes the boundary. Each year the river changes the direction. Instead of going to Mozambique side, usually it comes to our side hence losing land almost each year. People from Mozambique are so heartless. They take*

> *advantage of the river to grab our land. As a result, the arable land is reduced, barring us to adopt the agroforestry technology. (FG/L/M/NA)*

The K/L from the lowland area agreed with the farmers on how landscape affects adoption of agroforestry due to the lack of cultivable land. He said that people in Mozambique do not allow them to cultivate their land whenever the boundary changes due to changes in the course of the Shire River.

According to all respondents, landscape factors such as mountains, topography and the ever-changing course of the Shire River limit the farmland, barring farmers from adopting agroforestry technology.

Floods and Drought

The lowland groups reported that flooding is one of the major challenges that is influencing adoption of agroforestry technology. Most of the fields are in a flat area with an altitude of almost 32 meters above sea level and near the Shire River which causes floods each year. One of the women said that they do not plant agroforestry trees because they fear that they will be washed away by floods:

> *Flooding is a very big challenge here because we fail to make good sustainable land management practices, such as planting agroforestry trees, in fear that all will be washed away by water. Usually, heavy floods come around February to March which is also the same time trees are planted. (FG/L/Women/NA).*

The K/NGO1 also mentioned that some farmers in the lowland area do not adopt agroforestry technology because there is a common understanding that flood water brings with it fertile soils and so there is no need of either planting agroforestry trees or applying fertilizer in their fields.

Farmers in both upland and lowland areas said that variability in rainfall affects tree growth. They heard from Nyanthepa community radio that in Nsanje district the average rainfall per year was 1,200 mm, but due to climate change the average rainfall per year is now only 500 mm. One of them reported that, apart from flooding, dry spells also hinder farmers in adopting the technology because it affects the survival rate of the trees:

> *Apart from floods which wash away our crops each year, we experience either dry spells or drought. The rain may fall in December and fall again either in February or March. This affects establishment and growth of agroforestry trees which usually are planted in January. This is one of the reasons that demotivates us from adopting the agroforestry technology. (FG/L/Men//NA)*

The representative from K/NGO 2 disclosed that harsh weather conditions is another challenge that farmers in Nsanje district are facing, not sparing farmers from Mpatsa EPA. Most places in Nsanje district are prone to dry spells and drought. This discourages farmers in planting agroforestry trees since dry spells affect survival rates.

Key informants and participants in the non-adopter focus groups from both upland and low land areas attributed low adoption of agroforestry technology to flooding, drought, and dry spells.

Livestock damage

All the respondents from the low land focus group discussion said that the area has a lot of livestock which feeds on agroforestry trees like *Gliricidia sepium*. Once the trees are planted in the field, it invites livestock which end up feeding on crops as well. One man from the group reported that they fear to adopt the technology because of livestock:

> *I know that agroforestry technology is very beneficial. However, my fear is that I own a very small piece of land where I plant the crop. In case of adopting the technology, I may invite the livestock, especially goats, which like* Gliricidia sepium *type of agroforestry trees. In the process, the livestock will feed on my crops as well. (FG/L/Men/NA)*

The representative from K/NGO 1 revealed that Nsanje is the district with the largest number of livestock in the whole of Malawi. Farmers fail to adopt the agroforestry technology because livestock feed on these trees if they are not protected.

The responses from both farmers and key informants show that livestock damaging agroforestry trees is a very big challenge in this area.

4.2.3 Institutional factors

The farmers from both areas mentioned lack of access to extension advice and poor timing as the main institutional factors affecting the adoption rate of agroforestry technology.

Lack of extension advice

Farmers get access to new technologies in agriculture from NGOs, government extension staff, agricultural research, and local leading farmers. The respondents in the upland area complained of being side-lined by the government due to topography. They reported that the main challenge in the upland areas is the lack of both NGOs and government extension staff who are the source of extension advice. One farmer said that they do not have an extension worker so whatever they are farming, they are only using local knowledge. He further said farmers do not know where to get knowledge about new technologies despite being interested in adopting agroforestry technology. As described in section 4.1.1, non-adopters just heard of the technology from the research assistant.

> *In this area we do not have either NGOs or Government extension workers to help us in agricultural activities. We just cultivate anyhow without any extension advice. We heard that there is one Government extension worker who comes here once in a month, but we have never set our eyes on him. Whatever we are farming we use the knowledge taught by our parents. This technology is very new to us. We are very ready to adopt the technology if the government consider us by giving the required resources, like our own extension worker. (FG/U/Women/NA).*

Similarly, the lowland respondents reported that, despite being aware of the technology, there was inadequate capacity building offered to them. Farmers are not taught how to take care of the trees hence the tree survival rate was very low in cases where the technology was adopted. One respondent stated that they lack knowledge on management of trees and selecting the right tree species for the area:

> *We do not have knowledge on management of trees and on the right agroforestry tree species to plant. The government extension workers are there from Mpatsa EPA but do not put much emphasis on agroforestry technology. (FG/L/Women/NA)*

The K/NGO 2 representative also indicated that one of the reasons hindering adoption of agroforestry technology is inadequate service from both NGOs and Government extension workers who cannot manage to reach out to all farmers and advise them on new technologies due to either inadequate staff or resources.

Key informant interviews with local leaders in both the upland and lowland areas also established that inadequate knowledge and skills regarding agroforestry technology is one of the major problems contributing to the low adoption rate of agroforestry technology.

The respondents in all groups believed that the extension system can help to improve productivity, through provision of technical advice and timely transfer of agriculture information. Their responses show that inadequate access to technical advice hinders farmers from adopting agroforestry technology in both upland and lowland areas.

Poor timing

The farmers in the lowland area reported that seed distribution to the farmers by either the Government or NGOs was done very late. One of them said he is demotivated to adopt the technology due to the late distribution of seed because the survival rate of the seedlings is affected once planted late:

> *The Government and NGOs distribute agroforestry seeds to farmers very late. The seeds are supposed to be established on a nursery for almost three months. The right time in Nsanje to establish a tree nursery is in July but most of the times free seed is distributed in October, which is very late. The seedlings become ready for transplanting in February, making survival rate very low after planting since it's the end of the rainy season. (FG/L/Men/NA)*

The responses disclosed that late delivery of inputs such as agroforestry seeds is one of the challenges hindering most of the farmers in adopting agroforestry technology. Most farmers emphasized that timely sowing is a strategy to reduce the risk of low survival rate for agroforestry trees. The key informants and non-agroforestry adopters in lowland areas all agreed that this was a hindrance.

4.3 Adoption and benefits of agroforestry technology among adopters

The adopters in both upland and lowland areas reported on how they adopted the technology. They also described the benefits which they receive from practising agroforestry technology.

4.3.1 Adoption

The adopters of agroforestry technology from the lowland area focus group discussion said that agroforestry technology was introduced by extension staff from the government of Malawi and several NGOs such as CARE Malawi, Goal Malawi, CADECOM and CARD

which are working in the area. Farmers in the lowland area have been practising the technology from 2002. They further said that a lot of agroforestry tree species were introduced to them, such as *Gliricidia sepium*, *Faidherbia albida*, *Acacia Spectabilis* and *Acacia galpini*. One of them stated that all the household members take part in agroforestry farming. They used a lot of agroforestry tree species but the good ones which fix nitrogen and other nutrients fast are *Gliricidia sepium* and *Faidherbia albida*:

> *When agroforestry technology was introduced by both government and NGOs, all members of the family participated in implementing and taking care of the agroforestry technology except young children under the age of sixteen. Several species were introduced but we mainly use* Gliricidia sepium *and* Faidherbia albida, *since most of the time seeds of these two species are distributed to us from NGOs and these species easily fix nutrients in the soil. (FG/L/A).*

The upland farmer adopters of agroforestry mentioned that agroforestry technology was introduced to them in 2008. They said the agroforestry technology was introduced by extension workers from the Mpatsa EPA (Government). The type of Agroforestry trees used were *Bridelia micrantha, Gliricidia sepium* and *Albizia lebbeck*. They added that the whole household takes part in caring for the agroforestry trees. One farmer lamented that the government extension workers, who had introduced the technology, only visited them once a month:

> *The agroforestry trees were introduced by extension workers from government side since there are no non-governmental organisations in this area. The government side-lined us so much that even the extension workers from Mpatsa EPA comes occasionally, just once in a month. We mainly use* Grilicidia sepium *and* Albizia lebbeck *because sometimes we receive the seed from the government. (FG/U/A)*

The K/PAO also stated that the district has been implementing soil fertility improvement campaign launches almost every year as a means of calling for more farmers to join the movement of restoring degraded soils. He further said Agroforestry technology is among the many technologies that are showcased in such functions in addition to on-farm demonstrations that are mounted across the district. Farmers are invited to attend such functions to appreciate what fellow farmers are doing to restore soil fertility in order to help convince them to adopt the technology. The agroforestry technology is mostly adopted by crop growing farmers who are cultivating on their own lands and not rented land. It is adopted by both the upland and lowland farmers.

All farmers in both upland and lowland area adopters groups have access to the agroforestry technology which was introduced by either non-governmental organisations or government extension workers. They also grow several species of agroforestry trees. However, they mostly like *Gliricidia sepium* and *Faidherbia albida* agroforestry tree species because they grow fast in both nurseries and the fields.

4.3.2 Benefits

Both upland and lowland adopters as well as local leaders said there were many benefits from agroforestry technology. The benefits reported are improvement of soil structure and fertility, hence increased yields, and that trees act as a barrier to wind, protecting the crops

from falling down. They further said that some trees are used as fodder for livestock, to provide fuelwood and building materials, and for medicinal benefit. They recommended other farmers to adopt the technology in order to utilise all these benefits

The interviews conducted with the key informants similarly revealed that agroforestry trees improved soil structure, and also improved water holding capacity in some soils which were likely to leach nutrients. Trees were also used as fodder for livestock. It is relatively cheaper to use agroforestry trees for soil fertility enhancement compared to the use of chemical fertilizers which are very expensive for subsistence farmers. The K/PAO emphasized that agroforestry trees have proven a sustainable way to improve soil fertility:

> *Use of agroforestry technologies is the most sustainable way of improving soil fertility in the district other than use of inorganic fertilizers, which are not only expensive but also contaminate the environment. Agroforestry technologies do enhance biodiversity and farmers' resilience to climate change*. (K/PAO)

All respondents expressed satisfaction with the agroforestry technology, because they see a lot of benefits in practising the technology. They, however, also faced challenges in upscaling the technology.

4.4 Challenges faced by adopter farmers in upscaling the technology

Farmers who have adopted agroforestry technology in both upland and lowland areas reported that they face a lot of problems which hinder them from upscaling the technology.

4.4.1 Livestock and theft

The lowland adopter respondents stated that some of the challenges they face are livestock damaging the trees and people stealing trees to use as fuelwood. One of them complained that livestock damage the trees once planted, and some people cut down grown trees for firewood:

> *Once the trees are planted, we are supposed to make a fence in order to protect them from livestock, such as goats, which feed on either the leaves or bark of the tree. This makes the survival of the tree very impossible. People from the community steal our trees and use them either as firewood or poles for building the house. (FG/L/Men/NA)*

Livestock damage and theft of agroforestry trees hinder the adoption of the technology according to the responses of adopters of agroforestry technology in the lowland area.

4.4.2 Floods and erratic rainfall

The lowland adopter farmers also mentioned floods and drought as other challenges which affected them much. One respondent from the lowland area mentioned that flooding in irrigation schemes is a very big problem because trees are washed away. He further said that abnormal rainfall distribution also affects the survival rate of the trees:

> *In addition to the challenges already mentioned, we also face flooding in irrigation schemes which wash away the planted agroforestry trees as well as*

> *crops. Erratic rainfall is another problem we mainly face. We rarely have normal rainfall distribution. This affects growth of trees leading to low survival rate. These challenges are affecting us in scaling up the technology. (FG/L/A).*

According to the respondents, it shows that floods and drought affect adoption of agroforestry technology in the Mpatsa area.

4.4.3 Inadequate technical information

Upland adopter farmers reported that, in case of challenges which require technical support, nothing is done. No one addresses their problems since they do not have an extension worker who stays there. They said that there is only one extension worker who provides extension services in the area occasionally. There are no NGOs working in this area as well. One respondent said that it is difficult to upscale the technology because there is inadequate knowledge about the technology due to limited extension services:

> *We have one extension worker who stays in the lowland area at the EPA. He comes here in the upland area once a month. This makes difficult for us to receive the required extension service". (FG/U/A).*

The representatives from both NGOs also said that shortage of extension workers who can provide guidance to farmers is another hindering factor to upscaling of agroforestry technology:

> *There are few extension workers to guide farmers in various technical know-how, such as tree planting and management as well as the right agroforestry tree species to be grown. (K/NGO 2).*

Both farmer groups in the upland area said that lack of extension workers in this area affects them significantly in adopting the agroforestry technology. Similarly, the key informants' interview revealed that shortage of extension workers hinders the farmers from adopting the technology.

4.4.4 Long term benefits

The K/PAO and the NGOs' key informants said that both upland and lowland farmers fail to upscale the technology because agroforestry trees take a long time before yielding the much-needed benefits to the farmer. In the words of one NGO:

> *Agroforestry benefits cannot be achieved in the short term. As a result, the adoption rate is low because farmers want immediate benefits right in the first season". (K/NGO 1).*

The upland farmers similarly said that most of the agroforestry trees take time to grow, trees like *Faidherbia albida.* The farmers also believed that because poor people do not live long, there was no need to adopt the technology*:*

> *Most of the agroforestry trees take time to grow and start showing benefits. As a result, most farmers become reluctant to grow trees. Farmers in this area also*

believe that poor people have a short life span so there is no need to plant trees which take a long time to grow. (FG/U/A).

Both farmers and key informants reported that agroforestry trees take time to show a positive impact. As a result, farmers become reluctant to adopt the technology.

4.1.5 Inadequate seed

The upland farmers' adopter group said that sometimes they receive the seed and training from government extension workers, however the support is not enough because there are a lot of farmers in this area. Lowland adopter farmers similarly said that they get support of agroforestry seed/seedlings from non-governmental organisations. Government extension officers provide capacity building, however, the support is not enough.

Local leaders from both lowland and upland areas reported that sometimes either the government or NGOs support them with seeds, however they targeted only a few households, leaving many households without seed. In addition, they also complained that the seed distributed to the few households does not come in time. This leads to farmers not using the seeds given.

The responders showed that there are a lot of challenges farmers are facing in implementing agroforestry technology. The main problems are lack of seed, inadequate extension workers to reach out to many farmers, livestock and thieves damaging agroforestry trees, agroforestry trees taking considerable time to give benefit and floods which wash away the trees once grown.

4.5 Measurers to address challenges in adoption and upscaling of agroforestry

Apart from identifying challenges faced by smallholder farmers in adopting and upscaling agroforestry technology, the study also investigated possible measurers to address them. The purpose was to come up with viable and socially acceptable strategies appropriate to both upland and lowland farming communities. In this sub-chapter, suggestions from non-adopters and adopters, as well as key informants, are combined.

4.5.1 Access to technical advice

All upland and lowland non-adopter farmers said they were sure that if the Ministry of Agriculture and Water Development would address their challenges, they would be able to adopt the agroforestry technologies. They proposed some measures, such as making extension services available by building their capacity through demonstration plots, field days and door to door extension advice. They further said that employing more extension workers and training more lead farmers would help them access technical advice because they would be able to reach out to many more people. A man from an upland group emphasized that for farmers to adopt agroforestry technology, the government should consider their problems:

The government should provide extension workers and NGOs in this area in order to have access to technical advice, which will help us to gain knowledge and skills on adoption of the agroforestry technology. In addition, training of the lead farmers is required to reach out to more farmers. (FG/U/Men/NA)

The upland adopter respondents also argued that to improve implementation of agroforestry technology, the Ministry of Agriculture and Water Development should offer training on how to manage agroforestry technology and provide an extension worker who would be staying in the area. They said that if the extension worker would be staying in the upland area, they would be able to visit him/her any time they encounter a problem and gain knowledge, thus leading to more adoption.

Lowland farmers said that training would help them to acquire knowledge. Hence there is need for farmer training on agroforestry technology:

> *There is need for farmer training on Agroforestry technology so that we can be convinced of the importance of adopting the technology. In addition, extension advice is needed on nursery establishment and tree management. These are some of the things which demotivate us to adopt the technology. (FG/L/Men/NA)*

The K/PAO similarly emphasized the activities required to address adoption challenges. These are conducting sensitization meetings on the importance of adopting agroforestry technology and capacity building initiatives. In addition, mounting of on-farm demonstrations, conducting field days and raising many agroforestry seedlings for farmers to plant out in their gardens and various designated areas like stream banks.

The representative from K/NGO 2 also indicated that recruiting more government extension staff will help to address the problem, since NGO projects do not last long. They also depend on government staff to carry out most of the field activities. If there is adequate capacity building for the farmers, the adoption rate of agroforestry technology will increase.

The K/NGO 1 representative suggested that the government should also recruit more extension workers in order to reach out to more farmers and upscale agroforestry technology. The NGOs assist the government in promoting various technologies including agroforestry. The government, on the other hand, should help NGOs in ensuring sustainability when a NGO project is phased out.

4.5.2 *Formation of by-laws*

The adopter farmers in both upland and lowland areas, as well as both local leaders, suggested that the challenges of livestock damaging trees can be addressed by live fencing of the farm to protect trees from livestock. Local leaders should take a leading role in protecting the trees from theft and livestock through the formation of by-laws.

The key informant interviews with the PAO and the two NGO representatives revealed that they support the farmers with mostly *Acacia galpinni* seed. *Acacia galpinni* is mainly used for live fencing to avoid livestock damaging crops. They said the farmers should also take the initiative to buy *Acacia galpini* because the Government has limited resources to provide seed and reach out to all farmers.

4.5.3 Provision of seed and nursery equipment

The K/NGO 1 respondent similarly stated that there is need to assist farmers with agroforestry seed or readily available trees in order to upscale agroforestry technology, since most small holder farmers are poor and cannot afford to buy agroforestry seeds themselves.

The farmers further requested that seed be provided in good time. A respondent from the adopter group emphasized that there is need for capacity building, seed, and nursery materials to upscale the technology:

> *We need intensive capacity building on agroforestry and adequate materials for nursery establishment for agroforestry technology to be scaled up. The government should also help us with more agroforestry seed tree species adapted to this area that can show the good results fast. (FG/L/A).*

An upland respondent similarly mentioned the need to provide them with equipment to be used for nursery establishment:

> *To promote agroforestry technology, there is need to provide enough nursery establishment materials such as seed, hoes, picks, wheelbarrow, and polythene tubes. Most farmers lack these materials to upscale agroforestry technology. (FG/U/A)*

The non-adopter farmers in both upland and lowland areas said that the government should promote communal nursery establishment of different agroforestry tree species in order to multiply the agroforestry tree species which would then be distributed to farmers, since most of the smallholder farmers are very poor and cannot manage to buy agroforestry seed. A woman from the group suggested that assistance is required from the government or NGOs on the establishment of communal nurseries:

> *There is need for either the government or NGOs to help in establishing communal nurseries which will help some of us to have free agroforestry seedlings to adopt the technology. As we have already said, we are very poor. We cannot afford to buy agroforestry seed. (FG/L/Women/NA).*

The interviews with both upland and lowland local leaders similarly disclosed that the establishment of communal nurseries is very important because it will help farmers to have access to agroforestry seedlings, Thus, most of the farmers could adopt agroforestry technology. They further said that agroforestry seeds are very expensive and most farmers cannot afford to buy them.

K/NGO 2 said that to address the challenges there is need for a holistic approach, and government should put in extra effort since the Ministry of Agriculture is a key player in promoting various technologies. He further said that the government was promoting a fertilizer subsidy known as the Affordable Input Programme (AIP) and suggested that the provision of inputs by government should be attached to agroforestry technologies. For example, beneficiaries should be engaged in implementation of the agroforestry programme as a prerequisite of being a beneficiary.

According to all respondents, the challenges could be addressed by the government taking a leading role in promoting the technology, mainly by recruiting more extension workers who would be able to provide capacity building to farmers through training, field days and demonstration plots. Timely distribution of free seed could also help to upscale agroforestry technology. According to all the responses, multiplication of seeds would help in increasing the hectarage of agroforestry trees since farmers would be able to get seedlings from the nurseries and, therefore, increase the adoption rate.

4.5.4 Introduction of fast-growing tree species

Respondents from the women's groups of both upland and lowland non-adopters suggested that, apart from providing an extension worker in the area, the government should also provide either agroforestry seed or seedlings. The fast growing tree species that show early results are the ones needed for more farmers to get motivated to adopt the technology. They further said that one of the tree species they want is *Cajanus cajan*, which grows fast and the pods are used as relish. One of the farmers mentioned that provision of *Acacia galpini* for fencing is also required. She further said pigeon peas are also required because they are so beneficial:

> *We heard that* Cajanus cajan is *very helpful, it fixes nitrogen in the soil and the pods are also used as relish. In additional to* Cajanus cajan, *we also want* Acacia galpinni *type of agroforestry tree species, which is used to fence the fields and protect crops and* Gliricidia sepium *from being destroyed by livestock. (FG/L/Women/NA).*

The respondents, especially women, requested introduction of new species which could provide a variety of benefits. In addition, they also wanted species that bring benefits fast, since most of agroforestry trees takes so many years to start releasing nutrients into the soil.

The K/PAO reported that from the government side, no new agroforestry tree species had been introduced but instead methods for propagation of these trees, such as use of truncheons to shorten the tree establishment period, are encouraged.

5. DISCUSSION

This section discusses the main findings in relation to other studies regarding factors affecting adoption of agroforestry technology in Mpatsa EPA, Malawi. Findings and arguments are structured to answer the research questions.

5.1 Challenges faced in the adoption of agroforestry technology

The findings show that farmers face many challenges in implementing agroforestry technologies. The overall reason for using agroforestry for soil fertility improvement is to improve crop yield. However, the choice of adopting agroforestry technology depends on several factors, including socio-economic, physical, and institutional factors. Thangata and Alavalapati (2003) reported that the adoption of agroforestry technology is determined by socio-economic and biophysical factors that are governed by a set of succeeding variables such as skills and knowledge of agroforestry practice.

5.1.1 Socio-economic factors

Farmers mentioned land tenure and gender variation, size of land, lack of income to purchase seed/seedlings, inadequate nursery equipment, education level and lack of interest as challenges they are facing which hinder them from adopting and upscaling agroforestry technology.

According to the findings in the Mpatsa area, land rights plays a vital role in adopting agroforestry technology. The women farmers in Mpatsa reported that land is owned by the husband and the family of the husband, who have more power over the land than them. Hence, they are unable to make decisions regarding the land. This corresponds with findings by Place et al. (2011), who found that in patrilineal regimes in the southern part of Malawi where the men are in custody of the land, women cannot make any decision regarding tree planting. According to Jha et al. (2021), land rights determine the capability of farmers to use agroforestry technology and thus their motivation to adopt it. A farmer most likely adopts agroforestry technology if the land rights are secure. Thangata et al. (2007) also commented that land tenure is very important for adoption of agroforestry technology, because farmers are more ready to plant trees on land which they have secure custody over. Farmers think that if the land is not in their possession, then trees planted on that land do not belong to them (Kabwe 2010). Lack of land rights has also led to women not being able to plant and own agroforestry trees in cultivated land. The findings showed that adoption of agroforestry technology can also be influenced by gender. The women focus group discussion revealed that women headed households are more likely to adopt agroforestry technology than households headed by men. This is because men who head households do not see agriculture as the primary source of income in the way women do, since men focus their work on other sources of income such as fishing and selling charcoal. Families which are headed by women mostly adopt agroforestry technology when given information on how to manage the technology. In Nigeria, women adopt agroforestry technology more than men (Opaluwa et al. 2011). Women farmers work more at the farm than men who depend on income bringing activities other than agriculture. This is an illustration of labour division within a typical farming household, where women farmers' total labour burden is more than that of men, and the conclusion was that women are the major source of farm labour in Africa (FAO 2011)

Small land size is another socio-economic factor which was found to hinder the adoption of agroforestry technology by farmers around Mpatsa EPA. A modelling study conducted in Kasungu, Malawi by Thangata et al. (2002) envisaged that when there is sufficient land holding size, adoption of fallow agroforestry technology is possible in contrast to when the land size is very small. This agrees with Moronge and Nyamweya (2019) who reported that agroforestry systems may not be effective if the plot size is very limited because it will not be able to support integrated farming. Mwase et al. (2015) also found out that small size of land limits the type of technology that farmers can put into practice, thereby negatively affecting adoption of agroforestry technology. Some agroforestry technologies such as tree crop fallows need larger pieces of land than 0.2 hectares. This creates a barrier for smallholder farmers with limited land. Pello et.al (2021) reported that farm size affects adoption of agroforestry technology. This means there is a positive correlation between agroforestry and farming land size, hence agroforestry adoption increases with increase in size of farmland owned by smallholder farmers. This is because farmers with large farmlands can dedicate part of the land to agroforestry technology which small holder farmers cannot do.

Farmers in Mpatsa also reported that lack of agroforestry seed and seedlings is barring them from adopting the technology. This agrees with Mwase et al. (2015) who found that lack of enough tree seed and seedlings is hindering the adoption of agroforestry technology in Malawi. According to Jha et al. (2021), farmers who have a consistent source of seed and seedlings are more likely to adopt agroforestry than those farmers with no seed source available. Tarefe and Nigussie (2018) also indicated that there is positive association

between the source of seed and adoption of agroforestry technology. It was further said that if primary resources are available, farmers will implement and maintain agroforestry technology. Kyamani (2009) stated that when quality seed/seedlings and other propagation materials are scarce, it hinders adoption of agroforestry technology. .

The study revealed that lack of materials and equipment for nursery establishment was a contributing factor to the low adoption rate of agroforestry technology. The farmers in Mpatsa area lack materials such as polythene tubes, shovels, wheelbarrows, hoes, picks, and watering canes which are essential for effective agroforestry tree nurseries. Coulibaly (2016) also mentioned that access to farming equipment is significantly correlated with adoption of agroforestry trees. He claimed that equipment used at nurserie is a necessary asset to promote adoption of technologies, thus increasing yields and income.

The findings further showed that lack of household income led to low adoption rate of agroforestry technology in Mpatsa area. Farmers in both upland and lowland areas indicated that they are too poor to be able to buy agroforestry seed and other nursery establishment materials which are very expensive. This agrees with Nyaga et al. (2015) and Jha et al. (2021) who said that the resources needed for setting up agroforestry technology are very expensive, therefore only farmers with high level income can adopt agroforestry technologies due to better access to the required inputs. Magugu et al. (2018) also reported that farmers with higher income have more chances of adopting agroforestry technology because they can afford costs such as labour, seeds, and farm equipments. The findings revealed that adoption of the technology was high when farmers had increased income.

According to the findings of this study, the illiteracy level also contributes to the low adoption rate of agroforestry technology. Some non-adopter farmers in the lowland area emphasized that they believe that other farmers produce abundant yields due to traditional African medicine (juju) and not because of agroforestry trees. Chinangwa (2016) reported that education level improves farmers' knowledge and skills, helping them to make simple calculations to determine the financial gains of a technology. Therefore, education enhances farmers' coherent decision making on the use of technologies. Rogers (2003) found out that the decision to adopt agroforestry technology is influenced by education level because good management of agroforestry trees requires understanding of information. Okunlola et al. (2011) also conducted a study on the adoption of organic fertilizers, and it was found that level of education had a significant impact on the adoption of agroforestry technology.

5.1.2 Physical factors

Physical factors that affect farmers' adoption of agroforestry technologies are landscape, drought, floods, and livestock damaging trees. According to the findings of this study, landscape plays a very big role in adopting agroforestry technology. Farmers in Mpatsa area were affected by the landscape, either by mountains or the Shire River changing its course regularly which reduced the farming area. When the river changes its course, most of the land along the Shire River is then owned by Mozambique people, thus minimising the arable land for Malawi people in the area. Most farmers had small pieces of land either due to the landscape or an increase in population (Mwase et al. (2015). Pattanayak et al. (2003) reported that higher areas are generally affected by soil erosion due to excessive runoff which carries nutrients down to the lowlands. Agroforestry tree planting is more generally done in steep areas in order to deal with erosion problems. Therefore, farmers having steeper farmland are more likely to adopt agroforestry technologies. However, the arable land for

each farmer is continuously decreasing with increased fragmentation of land making adoption of agroforestry very difficult.

Most places in the Mpatsa area are prone to flooding, dry spells and drought, which discourage farmers in planting agroforestry tree species due to the fact they think the trees cannot survive. For example, Nsanje District experiences very high temperatures, close to 45°C during rainy seasons. If the rains stop for two weeks, planted trees get affected. According to Parwada et al. (2010), drought occurrence discouraged farmers from adopting agroforestry technology because planting agroforestry trees in non-conducive conditions is very challenging. Parwada et al. (20l0) further said that an area that experiences more heat during the year might depend on irrigation for the survival of trees, thereby increasing the demand for labour and water. On the other hand, lowlands are continuously affected by perennial flooding which washes away trees, hence hindering adoption of agroforestry technology (Magugu et al. 2018)

5.1.3 Institutional factors

Institutional factors such as lack of technical advice and poor timing were some of the challenges mentioned that hinder adoption of agroforestry technology in the Mpatsa area. The farmers reported that lack of extension workers, especially in the upland area, contributes to low adoption of agroforestry technology because farmers who did not adopt the technology are unaware of what the technology is all about. In addition, the findings showed that most lowland farmers are aware of the technology, but many lack knowledge on how to establish and take care of the agroforestry trees, hence the low adoption rate of the technology. This agrees with Matata et al. (2010), who said that maintaining extension bond with farmers is important in creating a conducive environment among farmers towards adopting agroforestry technology. Inadequate number of extension visits to farmers contribute to low adoption which indicates that extension workers are of paramount importance in creating awareness and supporting farmers in adopting agroforestry technologies. Masangano and Mthinda (2010) wrote that when extension workers are visiting farmers frequently, their knowledge and skills are increased, through mounting demonstration plots and conducting field days which help in building farmers' capacity and improving adoption of agroforestry technology. Parwada et al. (2010) suggested that agroforestry technology is still a new technology among farmers, so to increase the adoption rate there is need to conduct awareness and capacity building regarding the technologies before introduction. This agrees with Van den Ban and Hawkins (1998), who indicated that the initial stage of the adoption process of any technology is awareness. Govere (2003) also agreed with Van den Ban and Hawkins (1998), writing that there is need to raise farmer awareness about agroforestry technologies through effective communication in order for farmers to be able to adopt agroforestry technology. Receiving information about any new technology influences adoption of that technology. It allows farmers to acquire knowledge and promotes effective use of the technology, hence facilitating adoption. Farmers mostly adopt technologies they are aware of or of which they have heard and seen the benefits (Bonabana & Wabbi 2002).

5.2 Benefits of agroforestry farming practices experienced by adopters

The findings revealed that both upland and lowland adopters reported that agroforestry technology has a lot of benefits. Both groups said that agroforestry improves soil fertility, soil structure, and soil texture thus increasing yields, providing fodder for animals, acting as

a windbreak, and can also be used for firewood and building material. Jose (2009) wrote that there is clear evidence that agroforestry technology is a sustainable land use option that offers a lot of ecosystem services and environmental benefits, such as increase in soil fertility and reducing deforestation by providing more fuelwood. Bugayong (2003) also discusses that agroforestry introduced in Nepal improved soil fertility and controlled land degradation through minimising soil erosion due to the presence of vegetative cover which reduces runoff. Kiyan et al. (2017) conducted a study on the environmental benefits that agroforestry brought to the Musebeya district in Rwanda. The study findings showed that the introduction of agroforestry reduced deforestation of natural forests, improved soil fertility and also reduced erosion. Agroforestry thus provides a lot of benefits, including improved soil fertility hence contributing to food security.

6. CONCLUSIONS

Agroforestry is an agricultural technology that provides numerous environmental benefits. It holds a great deal of promise for addressing problems faced by farmers due to land degradation. Use of agroforestry is being promoted because it promotes soil fertility improvement by fixing nitrogen into the soil, thereby increasing the supply of nutrients, and increasing crop productivity. However, adoption of agroforestry in the Mpatsa area in Malawi faces a lot of barriers due to socioeconomic, institutional, and physical factors. The study findings indicate that unsecure land rights, drought, flooding, poor timing, landscape effects, small land size, lack of extension advice and agroforestry seed are the major challenges farmers in Mpatsa area are facing which hinders them in either adopting or upscaling the technology.

The following lessons and suggested solutions are drawn from the results:

- Availability of agroforestry seed and seedlings helps farmers to adopt agroforestry technology. Most smallholder farmers are poor and cannot afford to buy seeds which are expensive. There should therefore be an effective agroforestry strategy to provide farmers with seed and/or seedlings of agroforestry tree species. The farmers should also be consulted on the favoured tree species they would like to use.

- Extension visits to farmers help them to acquire knowledge and encourage the farmers to adopt agroforestry technology. Extension advice is essential to create awareness and for farmers to learn new things. This would encourage them to upscale the technology. To ensure high adoption and upscaling of agroforestry technology by smallholder farmers, the government should make sure the extension workers visit the farmers to help build their capacity on some of key activities concerning agroforestry.

- Training meetings on agroforestry technology are important for farmers to learn how to plant and manage the trees. There is a need to intensify training and farmer exchange visits to successful agroforestry implementers to boost the morale of farmers and encourage the adoption of agroforestry technology. Such exchange visits are vital as they provide concreate examples of agroforestry technologies that farmers can apply to their own circumstances, promoting change in behaviour and attitudes amongst farmers

- Landscape factors such as topography limit farmers in adopting agroforestry technology. Farmers must be encouraged to plant trees despite limited land due to topography. Upland areas are steep, thus increasing the chances of erosion. Planting of trees could minimise the problem. Trees are also essential in reducing climate change effects, such as drought and floods. Excess runoff causes flooding, therefore trees help to maintain vegetative cover and lessen water runoff.

- Limited land size affects farmers in adopting the technology. However, farmers must be taught appropriate methods of increasing soil fertility also on small pieces of land to achieve high yields and increase food security.

- Secure land rights help in adopting agroforestry technology. Lack of land tenure security hampered women farmers in adopting the technology. Women's rights should be secured in order for them to adopt and upscale agroforestry technology since they are the ones who mostly do the farming.

- Livestock damage and drought after planting trees are some of the challenges farmers are facing. There is a need for formation of effective by-laws to control livestock by local leaders of the area as suggested by the farmers. In order to achieve a high survival rate of trees, early planting of agroforestry trees with the first rains is required to avoid facing dry spells/drought which usually occur around January.

The study was conducted in Nsanje district with a limited sample size due to time and resource constraints. It is recommended to expand the study further to other districts since there is social, cultural and ecological diversity in Malawi. The results from this study might not necessarily reflect hindrances to the adoption of agroforestry by farmers in other parts of Malawi, or globally.

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APPENDICES

Appendix I: FOCUS GROUP DISCUSSION GUIDE FOR NON-ADOPTERS

Filled in by assistants – name of assistants:

_____

Location of focus group:

_____

Date and time of discussion:

_____

Participants: Non-adopters / adopters; men / women / mixed men and women; number of participants: men____ women____ (write over categories that are not relevant)

[The assistants have to say they will begin by reading an introduction letter from the person/researcher doing the research]

Dear Respondent, I am **Jasmine Gello**, an extension worker now on a study leave in Europe (Iceland) learning more about Land Restoration. As part of my studies, I am carrying out research on **Factors affecting the adoption of agroforestry technologies in this area**. You have been chosen to participate in a group discussion for the study. The aim of this group discussion is to know more about the adoption of agroforestry technologies in this area and challenges faced in adoption of the technology. I seek your own opinion on the implementation and possible benefits of agroforestry. The duration of our group discussions will probably be 2 hours. What will be discussed here will be treated with confidentiality. Are you willing to allow recording of the discussion, which will be destroyed after the researcher has worked with the data? (Yes/No)

Background information

- Briefly tell me about yourself (Age, village, marital status, household size, level of education, origin).
- What type of farming are you doing (plants grown and livestock kept)?
- Who in the household is doing most of the farm work?
- Apart from farming what else do you do to provide for the household?
- How do you evaluate the state of soil fertility in your field/farm? (Changes)?

Agroforestry – general views/opinion and knowledge

- Have you heard about agroforestry? If yes, can you explain what it is? [If no, the assistants need to explain what is meant by agroforestry – can also add to information given by some participant, if needed]
- Have you been introduced to agroforestry? If yes, by whom?
- Do you think agroforestry could benefit you/your farming – the area? If yes, in what way - List the benefits starting with the major ones? If no, explain why not?

Factors affecting adoption of Agroforestry technologies.

- What challenges or barriers do you have in adopting agroforestry technology? [assistants need only to ask about the following factors if they are not taken up in the

discussion about the first open question – always ask people to explain more if answers are short or not clear what is meant]

a) Social- and economic factors affecting adoption - explain why/how (i.e. income, wealth, type of tenure (communal, private, rented …), occupation, family size, religion, education level, health, language, time, lack of decision-making power in household).

b) Physical factors affecting adoption – explain why/how (i.e. size of land, location of land (i.e., slope, far away …), soil type and quality, weather, natural threats).

c) Institutional factors influencing adoption – explain why/how (i.e., interest, awareness, knowledge, availability of extension services, no NGO working on this in area) Any other factors? ….

Possible measures to address challenges in the adoption of AF technologies.

- How do you think the challenges or barriers you mentioned can best be addressed? [What do they think is needed for them to take up agroforestry – hear what ideas they have about needed support; type of trees, etc. ….]

Appendix II: FOCUS GROUP DISCUSSION GUIDE FOR ADOPTERS

Filled in by assistants – name of assistants:

_____

Location of focus group:

_____

Date and time of discussion:

_____

Participants: Adopters; men / women / mixed men and women; number of participants: men____ women____ (write over categories that are not relevant)

[The assistants have to say they will begin by reading an introduction letter from the person/researcher doing the research].

Dear Respondent, I am **Jasmine Gello**, an extension worker now on a study leave in Europe (Iceland) learning more about Land Restoration. As part of my studies, I am carrying out research on **Factors affecting the adoption of Agroforestry technologies in this area**. You have been chosen to participate in a group discussion for the study. The aim of this group discussion is to know more about the adoption of agroforestry technologies in this area and challenges faced in adoption of the technology. I seek your own opinion on the implementation and possible benefits of agroforestry. The duration of our group discussions will probably be 2 hours. What will be discussed here will be treated with confidentiality. Are you willing to allow recording of the discussion, which will be destroyed after the researcher has worked with the data? (Yes/No)

Background information

- Briefly tell me about yourself (Age, village, marital status, household size, level of education, origin).
- What type of farming are you doing (plants grown)?
- Who in the household is doing most of the farm work?
  Apart from farming what else do you do to provide for the household?
- How do you evaluate the state of soil fertility in your field/farm? (Changes?)

Adoption and benefits of agroforestry technology

- Who introduced Agroforestry technology to you? When? [Get information on how long practiced agroforestry].
- Who in your household participated when agroforestry was introduced to your household?
- What kind of trees do you use for agroforestry?
- Why do you use these type of agroforestry trees? Who is taking care of agroforestry trees in your household?
- What are the benefits of practising agroforestry technology?

Challenges faced by farmers in adopting agroforestry technology.

- What kind of challenges or barriers have you faced in adopting AF technologies? Name the major challenges faced in successfully adopting agroforestry technology.

- Whom do you approach in case you have a challenge in adopting a specific AF technology?
- Have you received support for agroforestry technology? If yes from whom? And what type of support? Was this enough support, in your opinion?

Possible measures to address the challenges in the adoption of AF technologies.

- Do you think the challenges discussed can be better addressed? If yes, how do you think that the challenges can be addressed? If no, why not?
- What kind of support is needed to promote agroforestry technology more in this area?
- What advice can you give to the Ministry of Agriculture to improve in implementation of the agroforestry program?

Appendix III: KEY INFORMANT INTERVIEW GUIDE FOR PAO AND NGOs

Filled in by interviewer – name: _____
Location of interview: _____
Date and time of interview: _____
Respondent - position: - _____

[The assistants have to say they will begin by reading an introduction letter from the person/researcher doing the research]

Dear Respondent, I am **Jasmine Gello**, an extension worker now on a study leave in Europe (Iceland) learning more about Land Restoration. As part of my studies, I am carrying out research on **Factors affecting the adoption of Agroforestry technologies in this area**. You have been chosen to participate in this interview as one of the key informants working in the area. The aim of this interview is to know more about the adoption of agroforestry technologies in this area and challenges faced in adoption of the technology. I seek your own opinion on the implementation and possible benefits of agroforestry. The duration of our discussions will be 30-40 minutes. What will be discussed here will be treated with confidentiality. Are you willing to allow recording of the discussion, which will be destroyed after the researcher has worked with the data? (Yes/No)

Agroforestry adoption trend

- Briefly tell me about yourself (Name, age, level of education, position).
- May you give a brief background on Agroforestry technologies promoted in Mpatsa EPA.
- What has been the trend in implementation and adoption for the past 5 years? [Approaching farmers; trees introduced ….]
- Which farmers are more likely to adopt the agroforestry technology? (Gender - men/ women; type of household – headship and economic situation; type of farming – crops/animals; upland and lowland areas)
- What explains differences in adoption? [No need to ask if already explained in answer or add "why" in the right place, if for example answer "men" without explanation]

Benefits of adopting agroforestry technology.

- Why is the promotion of agroforestry technology important to this area?
- Highlight the benefits to farmers in the area (if the answer is low fertility, ask what the perception of farmers on soil fertility is?).

Challenges to adoption and measures to address them.

- What kind of challenges or barriers do farmers face in adopting agroforestry technologies in this district? Are there variations by EPAs?
  [you only need to ask about the following factors if they are not taken up in the discussion about the first open question – always ask people to explain more if answers are short or not clear what is meant].

a) **Social-economic factors** affecting adoption - explain why/how (i.e. income, wealth, type of tenure (communal, private, rented …), occupation, family size, religion, education level, health, language, time, lack of decision-making power in household).
b) **Physical factors** affecting adoption – explain why/how (i.e. size of land, location of land (i.e., slope, far away …), soil type and quality, weather, natural threats)
c) **Institutional factors** influencing adoption – explain why/how (i.e., interest, awareness, knowledge, availability of extension services, number of NGO working on this in area). Any other factors?

- ONLY Agricultural officers: What do you think is the reason for low adoption rate of agroforestry technology at Mpatsa EPA compared to the other 4 EPAs?
- ONLY Agricultural officers: Do you think Non-Governmental Organisation in your district are facing similar challenges in promotion of agroforestry technology?
- ONLY NGOs: Do you think the Agricultural Extension Service in the district is facing similar challenges in promotion of agroforestry technology?
- How do you think these challenges can best be addressed?

Upscaling of agroforestry technology

Both Agricultural officers and NGOs:

- What type of support have farmers received from you in practising agroforestry?
- What kind of support is needed to upscale adoption of agroforestry technology? [Social, economic, information support; more staff (NGOs and/or extension workers.

Appendix IV: KEY INFORMANT INTERVIEW GUIDE FOR LOCAL LEADERS

Filled in by interviewer – name: _____
Location of interview: _____
Date and time of interview: _____
Respondent - position: -
_____

[The assistants have to say they will begin by reading an introduction letter from the person/researcher doing the research]

Dear Respondent, I am **Jasmine Gello**, an extension worker now on a study leave in Europe (Iceland) learning more about Land Restoration. As part of my studies, I am carrying out research on **Factors affecting the adoption of Agroforestry technologies in this area**. You have been chosen to participate in this interview as one of the key informants working in the area. The aim of this interview is to know more about the adoption of agroforestry technologies in this area and challenges faced in adoption of the technology. I seek your own opinion on the implementation and possible benefits of agroforestry. The duration of our discussions will be 30-40 minutes. What will be discussed here will be treated with confidentiality. Are you willing to allow recording of the discussion, which will be destroyed after the researcher has worked with the data? (Yes/No)

Background information

- Briefly tell me about yourself (age, village, marital status, household size,)
- What type of farming do farmers practice in your area?
- How is the state of soil fertility in this area?

Adoption of agroforestry technology

- Who introduced Agroforestry technology to the farmers in your area?
- What kind of trees do farmers use for agroforestry?
- Why do they use these types of agroforestry trees?
- How many farmers from your area participate in implementing agroforestry activities?
- Who mainly takes care of agroforestry trees in the farm household?
- What changes have you observed so far due to adoption of agroforestry technology in your area? List the changes.
- Do you think there are benefits of adopting agroforestry acquired by farmers in your area? List the benefits starting with the major ones.

Challenges faced by Farmers in adopting agroforestry technology.

- What kind of challenges or barriers do farmers face in adopting AF technologies?
- Name the major challenges faced in successfully adopting agroforestry technology.
- Whom do farmers approach in case of having challenges in adopting a specific AF technology?
- Have farmers in the area received support for agroforestry technology? If yes from whom? And what type of support? Was this enough support, in your opinion?

Possible measures to address the challenges in the adoption of AF technologies.

- Do you think the challenges discussed can be better addressed? If yes, how do you? think that the challenges can be addressed? If no, why not?
- What measures have been put in place to resolve the challenges faced in your area during implementation of agroforestry?
- What kind of support is needed to promote agroforestry technology more in this area?
- What advice can you give to the Ministry of Agriculture to improve in implementation of the agroforestry program?