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FACTORS AFFECTING SUBSISTENCE FARMERS' ADOPTION OF SUSTAINABLE LAND MANAGEMENT PRACTICES IN OSHIKOTO REGION, NAMIBIA

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ABSTRACT

In Namibia, agriculture employs 30% of the labour force and contributes 7.5% to GDP. More than 60% of the farming is done by subsistence farmers. The sector is facing challenges such as low soil fertility and water shortage. To counter these challenges, sustainable land management practices are needed, but subsistence farmers face constraints in adopting these practices. Hence, this study was conducted to identify what practices the farmers are currently using and what constraints they are facing in adopting sustainable land management practices. Semi-structured interviews were carried out with 15 farmers in the Oshikoto Region. The interviews were recorded, transcribed word for word and thematic analysis applied to the answers. The study showed that the farmers were using some sustainable practices such as manure and mould from termite hills as fertilizer. However, unsustainable practices such as tractor-drawn disk harrows and inorganic fertilizer were also used. The constraints that affect farmers' adoption of sustainable land management practices include climate characteristics, especially low and unpredictable rainfall; limited farmland size; lack of extension services and institutional support; labour shortages; and lack of finances and other resources. Based on these findings it is recommended that extension delivery to farmers in the study area must be strengthened, that projects combating climate change must be down streamed to subsistence farmers, and that farmers should be encouraged and supported to use 'easy to adopt' sustainable practices, e.g. crop rotation and ripping. It is also suggested that long-term weather forecasts should be made available to the farmers through the radio. This could have

a significantly positive impact on the environment as well as on subsistence farmers' situation and household food security.

Key words: sustainable land management practices, Namibia, subsistence farmers, extension services

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1. INTRODUCTION

Land degradation is a major problem facing most African countries' agricultural sectors with over 60% of the arable land, 30% of grazing land and 20% of forests already affected (Glatzel 2014). Glazel (2014) estimated that over 180 million people in Sub-Saharan Africa are affected and that land degradation causes US\$68 billion in economic losses per year. Human activities such as unsustainable agricultural land use, poor soil and water management practices, deforestation, removal of natural vegetation, frequent use of heavy machinery, overgrazing, improper crop rotation and poor irrigation practices, as well as natural disasters such as drought, floods and landslides, are the factors that cause land degradation (Konac 2004). In Namibia land degradation has been recognised as a serious problem which needs immediate counteractive actions to address its primary causes.

Namibian agriculture is characterized by scarcity of fertile land, coupled with erratic rainfall (MARD [Ministry of Agriculture, Rural and development] 1995). In 2012, agricultural land occupied 47% of the total land (World Bank 2015). Over 70% of the country's population is directly or indirectly supported by the agricultural sector; it contributes 6.1% to the GDP and employs 27.4% of the labour force (World Bank 2015). The sector is divided into two different sub-sectors: the capital intensive, relatively well developed and export oriented commercial sub-sector in the south of the country; and the subsistence-based, labour intensive, and low-technology communal sub-sector in the north (MARD 1995; Sweet & Burke 2006).

The communal areas occupy 48% of the agricultural land (Sweet & Burke 2006). Pearl millet, predominantly known as mahangu, is the main staple crop. The food security of the communal areas' population depends on this crop but yields are very low, i.e. between 0.15-0.20 t/ha (Matanyaire 1996). These areas are the most vulnerable to land degradation. Low soil fertility, low water retention and unreliable rainfall are the common problems that accelerate land degradation in these areas (Rigourd & Sappe 1999). These problems are worsened by the land management practices the farmers are using. For instance, tractors with disc harrows are commonly used to plough land at the onset of rainfall. This land management practice helps to bury weeds and crop residues, eases incorporation of kraal manure, loosens the soil surface and breaks compacted layers with crusts to allow water infiltration. However, it also has its negative environmental consequences. Disc harrow ploughing at the same depth every year creates a hard pan. This prevents water infiltration, leading to water accumulation on the surface. Another problem is that it prevents roots from penetrating into the soil for water and nutrient absorption, leading to low yields. Misika & Mwenya (1999) reported that farmers observed accelerated decline in the soil fertility on a portion of the land where tractor disc ploughs were used compared to a site where hand hoes were used. This phenomenon contributes to making Namibia one of the countries in Sub-Saharan Africa most severely affected by land degradation.

One project addressing land degradation in Namibia is the Country Pilot Partnership (CPP) for Integrated Sustainable Land Management (ISLM) programme. The project was devised in 2004 and implemented in 2008 as a way to reach the UN Millennium Goal #7, calling for environmental sustainability (Seely & Montgomery 2009). The project goal was to reduce and reverse the process of land degradation in the country, thus delivering significant benefits to local communities. One of the objectives was to identify and test for methods, models and best practices for integrated sustainable land management. The practices best suitable to local

conditions were then shared with communal farmers for their adoption. Reduction in the vulnerability of farmers to climate change was one of the achievements of the project.

For sustainable land management programmes to be effective, base-line information on their potential users is crucial. Such information can contribute to sound decision-making about what land management practices should be promoted or discouraged, and how it should be done. However, there is little information documented on factors affecting subsistence farmers' adoption of sustainable land management practices in Namibia. Therefore, this study was undertaken with the aim to fill this gap. The objectives of the study were:

- To identify what land management practices – sustainable and unsustainable – subsistence farmers are using.
- To identify what constrains and supports these farmers' adoption of sustainable land management practices.

The findings could provide a better understanding of the current use of sustainable land management practices by farmers, and thus provide information and recommendations to policy makers and others involved in promoting sustainable land management. Another significance of the study is that it could be used as a reference for other researchers intending to study sustainable land management.

2. ADOPTION AND PROMOTION OF SUSTAINABLE LAND MANAGEMENT PRACTICES

2.1 Factors that affect adoption of land management practices

Numerous studies have investigated the factors that affect the adoption of sustainable land management practices in developing countries (Regassa 2001; Koirala 2015; Hockett 2010; Koirala et al. 2015). Land tenure security is perceived as a strong factor for farmers' willingness to adopt soil conservation practices. Hockett (2010) found out that land tenure is a constraining factor that influences smallholder farmers' decisions to adopt soil and water conservation practices in Kenya. Hockett indicated that farmers with secured land ownership tend to increase manure application. Kassie et al. (2012) found that farmers in rural Tanzania prefer to use long term soil fertility enhancements on their own land and short-term soil fertility management on rented land. Farmers tend to invest towards soil and water conservation practices when they have secured land tenure because they themselves derive the benefits in the long run.

Level of education and awareness has been closely associated with adoption of sustainable land management practices. Among small scale farmers in Kwara State in Nigeria, the educational level of the farmers was found to positively influence the use of fertilizer (Muhammad-Lawal et al 2014). The more educated the farmer, the higher the likelihood of using fertilizer. Kassie et al. (2012) noted that educated farmers tend to be aware of the benefits of land management practices. Adoption of sustainable land management practices in maize and cassava production in Nigeria is greatly influenced by farmers' participation in programmes that teach land management practices, as participation greatly increases the farmers' awareness of these practices (Babalola & Olayemi 2013).

Chomba (2004) observed that contact between extension services and farmers can increase the adoption of soil and water conservation practices, as farmers tend to adopt land management practices that have been communicated to them by extension agents. Chomba (2004) further stated that a farmer receiving agricultural support services was more likely to use intercropping than a farmer without any contact with agricultural support services. Muhammad-Lawal et al. (2014) highlighted that low levels of extension contact negatively affected farmers' adoption of sustainable practices due to the lack of information from extension agents. Rezvanfar et al. (2009) found that adequate extension services could increase awareness about the effects and consequences of sustainable soil conservation practices among wheat growers in Iran.

Farm size also seems to affect adoption of land management practices. According to Alemitu (2011) farmers with large farms have a higher probability of using mulching than those with smaller farms. This is because, when farmers have larger farms, they can plan different management practices (Heyi & Mberengwa 2012). Whilst Chomba (2004) indicated that large farm sizes can significantly increase farmers' prospect of implementing crop rotation. Insufficient land area may therefore play a role in farmers' adoption of such practices.

2.2 Land management in Namibia

Over the centuries, Namibian farmers have been using traditional land management practices for pearl millet production that have been passed on to them by their ancestors (Matanyaire 1996; Misika & Mwenya 1999). These practices are still an integral part of their farming systems and include kraal manure, fallowing, use of household residue, intercropping, crop rotation, hand hoeing, animal-drawn ploughs and tractor-drawn disc harrowing. In addition, some land management practices have been introduced to the farmers by public agencies to enhance their production (UNDP 2015). These practices include conservation agriculture and the use of fertilizers.

In 1970, Namibia, formerly known as South West Africa, adopted the Soil Conservation Act (FAO 1969). The act was implemented to combat and prevent soil erosion, conserve the soil, and improve the manner of soil and vegetation use. Soil fertility management, rangeland management strategies, and water and soil conservation are some of the sustainable land management practices that were introduced (Vigne & Whiteside 1997). Despite, this effort, land degradation remains a threat to agricultural productivity, especially in the rural areas.

In Northern Central Namibia, soil conservation methods were introduced in 2005 by the Country Pilot Partnership (CPP) programme to combat land degradation (UNDP 2015). This project was supported by the Global Environmental Facility (GEF). The main activities under this project were intended to enhance dryland cropping practices by using cultivation methods which prevent soil erosion and reduce losses of soil fertility. Furthermore, the activities were fully integrated into the government programmes and central funding was earmarked for financial funding. The major accomplishment in soil conservation under this programme was conservation agriculture involving ripper furrower tillage and a range of soil fertility management practices (African Climate 2014).

2.3 A brief overview of extension services in Namibia

Prior to Namibia's independence, extension services were mostly provided to commercial farmers (Vigne & Whiteside 1997). Furthermore, financial institutions provided marketing

and financial services only to the commercial sector. Subsistence farmers were not receiving any farming assistance from the government. After independence, there was a radical policy shift for extension services to be mainly focused on the previously disadvantaged subsistence farmers. Extension services are being provided mainly by the state through the Ministry of Agriculture, Water and Forestry (Kumba 2003). A few NGOs and agricultural training institutions also provide extension services to farmers, but they are extremely limited.

The extension services are provided in the form of training, advice, information and credit schemes. These services are mainly provided in subsidized form. The Ministry of Agriculture, Water and Forestry have decentralized extension services to farmers (Thomas 2012). However, this has been a challenge as extension offices and farmers are in remote areas, away from Agriculture Development Centres (ADCs). The training on improved farming technologies is only being undertaken at these ADCs, of which there is only one per region. Extension officials' and farmers' capacity to travel to them is limited by transport unavailability or unreliability (Thomas, 2012). Furthermore, the ratio of extension staff to farmers is very low in Namibia (Owos-Oab 2014).

3. RESEARCH DESIGN AND METHODS

3.1 Study area

The study was conducted in one constituency in Oshikoto region (Fig. 1). The Oshikoto region is located 800 km north of the capital city Windhoek. It has 26,183 inhabitants based on the latest population census (NSA [Namibia Statistic Agency] 2011).

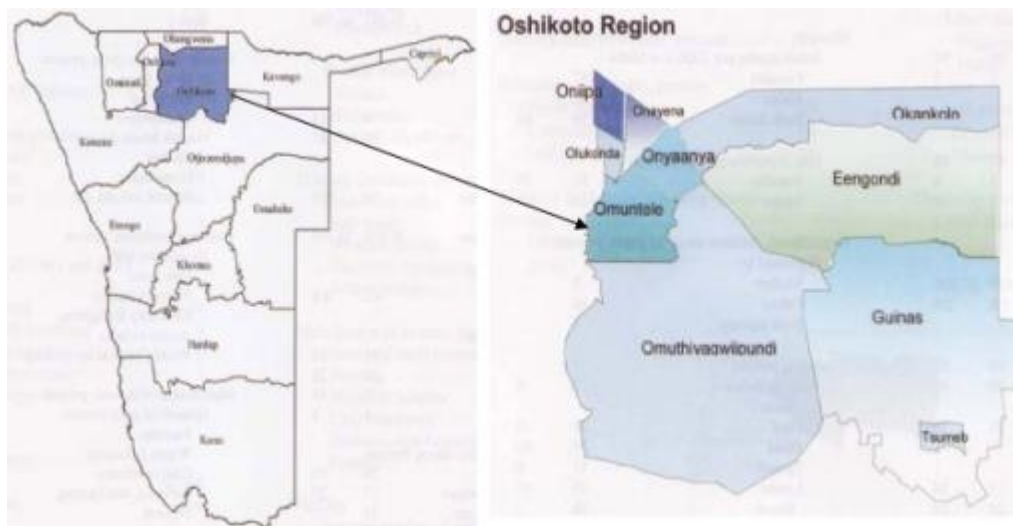


Figure 1. Map of the study area showing Namibia and Oshikoto Region.

The average annual rainfall for Oshikoto region is 460.8 mm (INEE [Inter-Agency Network for Education in Emergencies] 2015). The rainy months extend from October to the end of May. Most of the rainfall is received during the months of December and February. The soil in the area is predominantly aeolian sands and solonchaks (INEE 2015).

3.1.1 Farming systems

According to Sweet & Burke (2006), two main farming systems are found in Oshikoto Region. The first is subsistence farming that is practiced in the north of the region. Here the farming is rain fed, and pearl millet is the staple crop. Other crops are cowpea, sorghum, groundnuts, watermelon and maize. The cropping areas are normally distributed to individual households by traditional authority and the grazing areas are shared by members of a community. The farming system is labour intensive, with limited use of external inputs and technology. Subsistence production contributes 7% to the total agricultural output in Namibia (MAWF [Ministry of Agriculture, Water & Forestry] 2009).

The second farming system is commercial farming in the south. In this system farmers have title deeds to the land. The farming is well developed, capital-intensive and export oriented. The commercial sector accounts for over 90% of the total agricultural output in Namibia (MAWF 2009).

3.2 Research design and data collection

This study was a qualitative research seeking to understand and interpret meaning using semi-structured interviews. In semi-structured interviews the researcher asks the interviewee a series of mostly open-ended questions (Braun & Clarke 2013). The strengths of semi-structured interviews are that the researcher can get rich detailed data about individual experiences and perspectives and only a small number of interviews are required to generate adequate data. An interview guide was prepared before the interviews.

This study was built on interviews with 15 farmers from 3 different communities/villages. A purposive sampling technique was used to select the farmers. Purposive sampling is a deliberate selection of informants due to qualities they possess (Tongco 2007). From each village, 2 households that have married couples, both engaged in farming tasks, and 1 household that is headed by a female were selected. This selection was used only to mirror the gender composition of farmers in the area, and gender differences in responses will not be investigated in the study. In the married couple households the male and the female were interviewed separately.

The farmers were contacted in advance to schedule a convenient time for the interviews. They were also informed that the information presented in the report cannot be traced back to them, and that the names of the villages where they are from would not appear in the report. They were further informed that they could refuse to participate or to answer certain questions.

The interviews were conducted over a period of five days by a Chief Agricultural Technician and a Senior Agricultural Technician in the Ministry of Agriculture, Water and Forestry. I, the researcher, was in Iceland and could not conduct the interviews myself. The interviewers were given a briefing on the objectives and contents of the interview schedule. The farmers were interviewed in the local Oshiwambo language and the interview quotations used in the findings were translated by me. The interviews were recorded with a voice recorder and the sound files were sent to me. The average interview length was 27 minutes.

3.3 Data analysis

As the sound files were received, I familiarized myself with the data by playing the sound clips over many times. The aim of this phase was to become familiar with the dataset contents and to begin to find things that were relevant to the research questions. The recordings were transcribed word by word. Thematic analysis (Braun & Clarke 2013) was used to identify themes and patterns of meaning across the dataset in relation to the research questions. The data were then categorized into meaningful codes. Different themes were developed by merging similar codes.

3.4 Socio-economic description of the interviewed farmers

The socioeconomic characteristics of the participants are presented in Table 1.

Table 1. The socio-economic information about the interviewed farmers.

Variables	Frequency
Average ages	
< 59	1
> 59	14
Marital status	
Married	12
Single	3
Education level	
Tertiary	1
Primary	11
No Education	3
Farm size	
> 4	6 households
< 5	3 households
Off-farm income	
Pension	14
Employed	1
Labour hire	
Yes	8 households
No	1 house hold

The farmers were mainly growing pearl millet as a staple crop. Other crops grown were maize, sorghum, cowpea, groundnuts, melon, watermelon and pumpkin.

The average household size was 10 persons. However, the young people are living in cities and towns, attending schools or jobs, and only the old people are working on the farms. The household members living in the city depend on the farm produce for food. The old farmers send the food produce to them in the city.

4. FINDINGS

4.1 Land management practices farmers are using

The majority of the farmers said that soil fertility decline is a major problem and they mentioned that conservation practices are necessary. Only one farmer had not experienced soil fertility decline, as he said, because his soil is clay. The type of land management practices the farmers are using were soil fertility enhancements and tillage for land preparation (Fig. 2). The practices they are currently using are manure, inorganic fertilizers, crop rotation, mould from termite moulds for fertilizer, tractor-drawn disc harrows and animal-drawn ploughs.

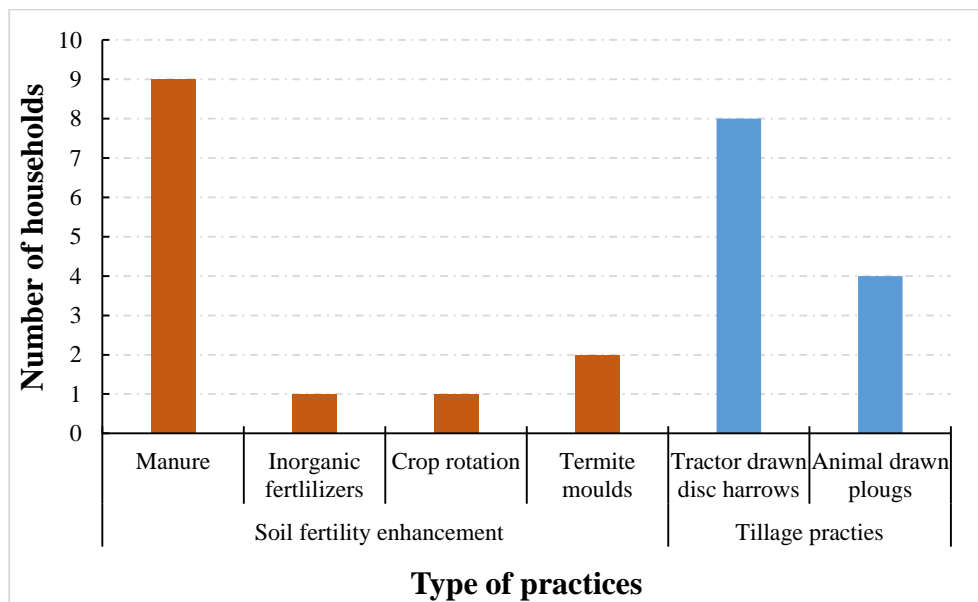


Figure 2. Land management practices currently used by interviewed farmers.

All the farmers responded that they use manure on their farm land. They use it to enhance soil fertility on portions of the land that have low yield, as one farmer stated:

I apply manure at portions that have very low soil fertility, and if you apply you can get a little bit of yield.

Manure is applied at the beginning of the new growing season from animal kraals. Some farmers detailed that there has been a decrease in manure quantities from the animal kraals. They mentioned two main causes. Firstly, droughts have affected animal grazing areas and reduced the number of animals the farmers can keep. Secondly, farmers had moved their animals to other places due to the proclamation of their land for use as urban residential.

Only a few farmers use inorganic fertilizer for soil fertility enhancement. The commonly used types of fertilizers are urea and NPK. The reason for the low use of chemical fertilizer is that, even though subsidized by the government, farmers still think it's very expensive to buy as most of them rely on pension funds as their main source of income and farming is mostly carried out for home consumption. Another reason the farmers stated is that the place where they buy inorganic fertilizer is very far away. The farmers who used inorganic fertilizer applied it together with manure. This gives them the best possible yield, as one of the interviewees declared:

I use manure and inorganic fertilizer, it doesn't matter that that the place have manure already. I will still apply inorganic fertilizer and it gives me the best yield ever.

However, the farmers do not always know what type of fertilizer they are using, as an interview revealed:

Like the fertilizers I used this year, white in colour, I do not know its name and the problem with us old people, we do not read.

Crop rotation for disease and pest management was only practised by one farmer while other farmers did not indicate using this strategy. That farmer illustrated:

There are pests which are underground, so I rotate my crops so that the pests do not build up for that particular crop. I plant always millet at a place where there was cowpea the previous year to minimize pest's intensity.

Fertilizing with termite mounds is another practice a few farmers are using to enhance soil fertility, but only in one of the communities. The farmers said they transport material from termite mounds with a wheel barrow or animal cart to the field. They then incorporate the termite material into the topsoil as a way to increase the fertility on the farm land, as the interviewee quote stated: "You dig termite mounds [From the termite hills] and apply it where there is low soil fertility". The farmers said the main advantage of using termite mound is the immediate increase in yield, as this interviewee described:

One portion of my land it was low fertile, then I applied termite mound, it's only when I got better yields I realized that termite mound is very good.

Termite mound hills depletion and transport are the problems the farmers mentioned they are facing in using termite mound.

The farmers use tillage for land preparation and soil fertility preservation. They use either tractor-drawn disc harrows or animal-drawn ploughs. Many farmers indicated that they try to prevent the decline of soil fertility by changing the ploughing direction from the previous year. As one farmer stated:

If last year, I ploughed from south to north than next year I will plough from west to east.

Farmers stated that changing the ploughing direction is more effective than always doing it in the same direction. Tractors are hired and farmers indicated that the tractor owners are

reluctant to change the ploughing orientation because they say their tractors will encounter mechanical breakdown as they move up and down the rows in executing that strategy. The farmers specified various fertility problems they have encountered in using a tractor disc harrow. For example, the use of a tractor for consecutive years lowers the soil fertility, as this farmer said:

If you plough using a tractor this year and again using it next year, the crop yield will drastically be reduced...if you see that then the soil fertility is declining.

The farmers mentioned that tractors plough deep, bringing poor soils from the depths to the soil surface. Many farmers said that animal ploughing is the best tillage option for preserving the soil because it only ploughs the soil surface without bringing infertile subsoil to the top. The farmers also expressed that due to the rampant drought over the past few years, the animals now struggle to plough.

4.2 Abandoned practices and reasons for abandoning them

The farmers explained that they had used some enhancement practices but later abandoned them. They gave several reasons for why they stopped using some of the practices. Most farmers stated that they stopped using inorganic fertilizer because of the cost and labour to apply the fertilizer. Several farmers insisted that the 50 kg bags of fertilizer that they buy are too expensive. However, other farmers who managed to buy the fertilizer said they do not have the labour to apply it, as one interviewee stated:

I bought my two bags last year. When the rain started, the kids were at school and I did not manage to apply it anymore. Maybe next year.

One farmer that stopped using fertilizer because of the cost said:

I did not use fertilizer this year because my pension money is not enough to buy the bags. As I have to buy food and pay school fees for the kids.

Fallowing is another practice a few farmers stopped using. The farmers indicated that due to the increase in number of household members over the years, they need all the land to grow crops every year. This limits them to letting some of the land rest. These farmers had been consecutively cultivating the same land for more than 15 years.

Leaving crop residue on the field after harvest is another practice all the farmers had abandoned. Persistent land degradation over the last decade had limited the grazing areas. Therefore, some farmers cut the stalks from the field to feed as fodder to the animals. In addition, fences around their fields are poor, allowing free range animals to destroy crop residue. As this interview revealed:

Immediately after harvesting I let the livestock to feed the stalk from the field before neighbour cattle invade in my field.

Other farmers gave another reason why they had stopped leaving crop residue on the field. They stated the stalks hinder cultivation and can cause injury. This led farmers to burn the stalks in the field, as this interview quote reveals:

I burn them, because when you cultivate during the rainy season it can injure you.

4.3 Land management practices the farmers know about but have not used

There are two land management practices the farmers are not using but they know about, namely, conservation tillage and composting. The majority of the farmers said that they had heard about conservation tillage and the positive yield one can get even during poor rainfall seasons. They had heard it from fellow farmers from other regions, as one farmer said: *“One of my friends from Omusati told me that they rip their field in the dry season”*. Some farmers said the reason they are not using ripping is because they did not receive extension advice, as this interview quote revealed:

I want to start the ripping exercise but I do not know how to start....if you officers [Extension officials] can help me on how to go about it.

A few farmers said that they are not using compost. However, their neighbours are using it. The farmers mentioned that lack of material and labour to dig a pit for making compost are the challenges that stopped them from using it.

4.4 Constraints that affect adoption and use of land management practices

4.4.1 Climate characteristics

The majority of the interviewees stated that rainfall patterns have changed. This has affected their land management practices, as this farmer said:

Rainfall comes very late in January and this gives me limited time to prepare the field with animals... because nowadays rainfall just come once and after two days the land is dry and you have to wait again...when it returns it is too late to plough.

These farmers indicated that manure application depends on the rainfall. Poor rainfall at the beginning of the season tends to cause manure to scorch the crops. This is because of the already high soil temperatures, as this farmer recounted:

If I apply manure and as this year there is poor rainfall, and there is too much heat, we won't get any yield, because the soil temperature is high and the temperature of manure will also get high. This will cause all our plants to be scorched and lose our entire yield.

A few farmers pinpointed that due to the poor rainfall at the beginning of the season, they only got yields from the portions of their fields that no manure was applied to, as one farmer pointed out:

Like our fields that have manure this year we didn't get yield, the yield which we have gotten it was from portions where there was no manure applied.... manure works with rainfall.

One farmer suggested that climate prediction information for the following season must be available to them for better planning:

If we had known the climate for the next season, then we know when to apply or not to apply manure, to avoid our crops being scorched.

4.4.2 Farm size

Participants frequently stated that the limited land for cropping at their disposal had affected adoption of land management practices. A couple of farmers indicated that due to limited farm size they cannot implement fallowing. This had led them to cultivate on the same land every single year, as this farmer quote revealed:

The land is losing fertility because I am growing on the same land every year and I do not have enough land to rest this one....if you let the land to rest, what you are going to feed your family? You keep ploughing to get something.

A few farmers indicated that due to limited farm land they cannot rotate land, as this farmer explained:

The problem we are having is that we are having small fields..... when you see the rainfall is not good that year, and then you should work where there is no fertilizer. When you see that there is rainfall that year then you should work where there is fertilizer. But because the field is small, you just plough the whole field, and then you get yield at one side and the other side is wasted money.

4.4.3 Access to extension services and institutional support

The majority of the farmers said they do not receive extension services and there is no extension agent in contact with them, as one farmer stated:

No [don't receive extension agents], they don't come to advise us on land management issues, unless only when I attend community meetings on agriculture.

Another farmer was of the same sentiment about not receiving extension services and explained that they only rely on indigenous knowledge, neighbours, other farmers and their own experience for agricultural information: *I don't get any advisor. I only use my indigenous knowledge.* A majority of the farmers indicated that even though they are not receiving extension services they are in need of extension agents to advise them on how to improve their soil management, as one farmer stated:

No [don't receive extension agents], but I want them to come and give me advices on new farming practice, for instance, how can I improve my soil, rather than just using manure which have also become scarce due to the drought that has taken place the past years.

Only three farmers responded that they received extension services in the form of subsidized ploughing services and seeds.

A few farmers said that the agricultural information they get from the radio is announcements for places where to buy seeds and register for ploughing services. The farmers mentioned that manuals, leaflets and pamphlets about new farming practices are also not available to them.

4.4.4 Labour shortages

Most of the respondents shared the view that labour shortage is the main challenge they are facing in implementing land management practices. These farmers indicated that manure application is labour intensive, for example this farmer:

It takes me a lot of months to finish applying the whole field. Like nowadays people are at school and work. I do not even finish manuring the field.

Even though the households have an average of ten members, shortage of labour is due to household members migrating to urban areas for work or youthful members pursuing education away from home. This has led the farmers to abandon some land management practices, as this farmer revealed:

All my kids are at school in the capital, now I'm faced to do all the work by myself, which limit me, because I'm also getting old.

This had led them to hire labour, which they find expensive as one farmer described:

I am forced to hire small boys to help me, but not all the time because it's too expensive as I rely on my pension money.

Some farmers said that animal-drawn ploughs need to be operated by two people, so due to labour shortage they tend to use a tractor instead.

4.4.5 Lack of finances and other resources

A majority of the farmers stated that financial limitations are one of the major factors restraining their adoption of land management practices. Fertilizer was perceived by the farmers as expensive, as one interview emphasized: *"With increased school fees, I won't be able to buy those fertilizer bags"*. A majority of the farmers stated that they rely on pension funds for their living which limits their possibilities to hire labour for manuring. As one farmer stressed: *"For me to give away my pension fund? No ways"*. Some farmers underlined that they lack equipment and machinery to adopt management practices. They wanted small tractors that mimic animal ploughing as this would help them avoid using larger tractors that ruin their land. As one male farmer stated: *"If I have a small tractor, then it will be good, because it will not plough deeper"*.

5. DISCUSSION

5.1 Identified land management practices

Soil fertility decline has been a major problem the interviewed farmers have been facing over the years and they perceived that conservation practices are needed to counter these problems. This study identified that the current land management practices the interviewed farmers are using are manure, inorganic fertilizers, termite mould for fertilizer, animal-drawn ploughs and

tractor-drawn disc harrow. The land management practices abandoned by some of the farmers are fertilizer use, fallowing and leaving crop residue on the field, while some practices the farmers know about but are not using are composting and conservation tillage.

The use of manure was the main practice used by farmers in the study area. This is in line with the results of Matanyaire (1996) who found that over 80% of farmers in communal areas of Namibia regularly use manure. Application of manure is a traditional practice to enhance soil fertility that the farmers have passed on for generations. Manure application is carried out to raise yields when yields have dropped. The use of manure among the farmers could be attributed to farmers' ownership of livestock. Heyi & Mberengwa (2012) stated that livestock holding predicts manure application. However, the availability of manure in the study area has declined. One reason is increased urbanization. This restricts farmers' possibilities to have animals in the proximity of the town. Furthermore, the drought that has been rampant for the past years has limited the number of animals the farmers can keep. However, apart from these challenges, the use of manure to sustain and enhance soil fertility is consistent with sustainable agriculture.

Only a few farmers used inorganic fertilizer for fertility management. This result is validated by similar findings in other research, with Matanyaire (1996) reporting that only 3% of the communal farmers in Namibia used inorganic fertilizer. In 1999, Rigourd & Sappe (1999), found that in North Central regions in Namibia fertilizers are hardly used by farmers since they are expensive and not available in remote areas. The results of this study indicate that fertilizer use among farmers has not increased for the last two decades. The inability of many farmers to raise the resources needed to purchase inorganic fertilizers is the major constraint that has caused the low use of fertilizer. Inorganic fertilizers have been subsidized by the government in the communal areas in order to increase the usage but this effort has apparently not helped in boosting the use. Coordinated innovations must therefore be put in place to increase fertilizer use in Namibia if the country is to meet its food security targets and poverty reduction goals.

This study found that termite mould is used as a soil enhancing strategy by the farmers interviewed in one community. That the use of termite mould was in only one particular community can be attributed to the abundance in termite hills in that area and a lack of them in other areas. These farmers received higher yields from the portions of the land where they had applied the termite mould soils. This observation is the same as the one echoed by Siame (2005), that many small-scale farmers in Zambia that were using termite mounds as fertilizer had higher maize harvests than they had when using inorganic fertilizers. Seidlheko & Masiane (2013) stated that termite mould use can improve soil fertility in an environmentally friendly and cheap way. Termite mould has been accredited with containing organic matter and nutrients in larger amounts than most soil (Batalha et al. 1995). The termite mounds could be used to improve poor sandy soils in the sandy areas. This practice could be a cheaper alternative to inorganic fertilizer. However, the practice is labour intensive and farmers do not have the implements to transport the termite mould to the field.

A larger number of farmers practiced conventional tillage such as using disk harrows and animal ploughs. This result is validated by similar findings in other studies, with Misika & Mwenya (1999) reporting high rates of adoption of conventional tillage in Namibian communal areas. Typically, the soil is ploughed to produce a fine seedbed and also to bury the plant residue from the previous season. The soil is then left bare, which makes it vulnerable to

wind and water erosion. Animal-drawn ploughs was the preferred tillage method over tractor use among the majority of the farmers in the study area. This is because the farmers perceived that the most damaging effect on the soil is caused by tractor-drawn disk harrows while the problems are less pronounced when working with animal ploughs. The soil productivity drastically reduces each year conventional tillage is used, especially with tractor-drawn harrows. Mathew et al. (2012) stated that conventional tillage practices have a long term negative effect on soil productivity due to erosion and loss of organic matter from soils.

Even though the farmers are changing the ploughing direction to counter soil fertility decline they are still running the risk of the soil forming a hard pan. A study conducted by Tsimba et al. (2007) in smallholder areas in Zimbabwe has even found the occurrence of a hard pan caused by animal-drawn ploughs. This practice is unsustainable in the study area as it influences the chemical and physical properties of the soils and has a negative impact on soil sustainability and productivity. Tjaronda (2015) pointed out that one of the major causes of soil degradation identified in various parts of Namibia is the use of inappropriate methods for land preparation and tillage. More suitable land management practices, such as conservation ripping, which is now being researched in the country, must be down streamed to subsistence farmers to combat soil degradation. Ripping is done with a tractor-drawn ripper to break down the hard pan. This reduces runoff, increases water infiltration and allows deep root development. As a result, it reduces the vulnerability of the soil to water or wind erosion. Tjaronda (2015) reported a 200% yield increase when using ripping tillage in comparison with traditional tillage practices.

Soil fertility can be maintained by rotating cereal crops with a leguminous crop. This is a simple and affordable practice to restore soil nutrients depleted by crops. This study found, however, that crop rotation is not being adopted by farmers as a soil fertility restoration strategy. Crop rotation in the area was mainly used for pest management and cannot be considered as an intended soil fertility enhancement strategy. This result is in line with Shiningayamwe (2012) who reported that the planning of crop sequencing is not commonly practiced in Namibian communal areas. Farmers are using a monoculture system with pearl millet covering most of the land, which is a nutrient demanding crop. However, the interviewed farmers are growing cowpea as a diversification crop. For the farmers in the area, rotating cowpea and millet could therefore be an appropriate and affordable option to enhance soil fertility in a sustainable and environmental friendly manner. A study conducted in Namibia showed that pearl millet yield can be increased when rotated in planned sequences with cowpea (Shiningayamwe 2012).

The use of inorganic fertilizer is a practice some interviewed farmers had abandoned for various reasons. Cost and lack of labour for application were the major reasons for abandoning inorganic fertilizer. Similar studies by Ibrahim (2013) in Uganda have found abandonment of inorganic fertilizer by smallholder farmers. Pender et al. (2001) found out in Ethiopia that low asset and self-sustaining smallholder farmers are also less likely to use inorganic fertilizer. This is attributed to lack of surplus income to commit to buying farm inputs, such as fertilizer.

Leaving crop residue on the field was another practice the farmers had stopped using. This practice has advantages over leaving the soil surface bare, as it reduces erosion from water and wind. Alternative uses of crop residues were the reasons for abandonment, such as providing fodder for animals. A similar study by Shiferaw et al. (2011) in Ethiopia found that

due to increased livestock pressure, stock is allowed to graze on crop residue left over after harvest. This means that the nutrients absorbed by the crops are not replaced, leading to reduction in soil fertility.

This study found that the farmers in the study area have stopped using fallowing. This used to be a traditional practice of conserving the land in the study area. However, due to the increase in household sizes, farmers continuously cultivate the land to meet the increased food demand.

5.2 Constraints that affect adoption of land management practices

The findings revealed changing climate characteristics, farm size, limited access to extension and institutional support, labour shortages and financial limitations as constraints farmers are facing.

Climate plays a major role in the type of land management practices a farmer can adopt. Rainfall pattern is the major determinant for land management practice adoption according to Chomba (2004). The timing and amount of rainfall have varied greatly from year to year for the past several years in the study area and the rainfall experienced currently is less than it used to be several years ago. This has affected the use of manure and inorganic fertilizer. In addition, change in rainfall patterns has shortened the time available for land preparation as the fields dry out very quickly. This limited time to prepare fields for growing crops has led to the use of inappropriate tillage practices such as tractor-drawn harrows. Furthermore, as rainfall arrives later than usual, by the time it arrives household members are at school or work away from the farm. This creates a labour shortage which leads to sustainable land management practices not being adopted. It is of great interest for farmers in the study area to be able to adapt their current practices to changing climate conditions. Access to long term weather predictions would help them. They could be provided over the radio as printed material is more problematic for the farmers as the majority are illiterate.

It has been argued that farm size affects adoption decisions (Alemitu 2011). It is often discussed that larger farm holders are more able to adopt certain land management practices than small holders. In this study, the interviewed farmers indicated that limited farm size has restricted them from practicing fallowing. Muhammad-Lawal (2014) found evidence that in Nigeria insufficient land availability limited the use of sustainable practices such as crop rotation and fallowing, as these require large land areas for implementation. Adoption of fallowing in Zambia was also found to depend on farm size (Chomba 2004). In this study the interviewed farmers used to rest portions of their land to restore fertility but this practice has not been practiced in recent years. This had been brought on by reduced land holding capacity due to the pressure from livestock and a growing number of people. Now, the farmers continuously grow on the same field every year to meet household food demands. One way to counteract the fertility loss this causes, and at the same time to meet the food demand, could be to enable the farmers to use the existing land in a more sustainable way.

This study has revealed that extension services are not readily available to subsistence farmers. Extension agents are supposed to be the source of agricultural information and to play a vital role in creating awareness among farmers. Heyi & Mberengwa (2012) stated that adoption of land management practices among farmers in Ethiopia has been facilitated by access to extension services. The farmers in the study area are in need of alternative land

management practices to complement the current practices. Extension services could play a role in making available practices that have been successful in other regions of the country (African Climate 2014). This can be done by organizing demonstration days where farmers can have a first look at the use and benefits of such practices. The farmers in the study area are in the retiring phase and literacy is lacking, but reaching them through the radio is viable. Extension services should provide information to farmers on how to manage their land in a sustainable manner and discourage the use of unsustainable tillage practices that are being widely used in the study area. Educational programmes to understand land management constraints at the grassroots level should be strengthened in the study area.

According to Heyi & Mberengwa (2012), households with larger number of members undertake more diverse land management practices as they are more likely to have the labour required to carry out land management activities. Alemitu (2011) stated that labour availability influences the gross margin for adopting land management practices. This study discovered that the farmers have large households, but that most household members have moved to urban areas for employment opportunities and education away from home. This has caused a labour dilemma that leaves only old farmers to carry out land management on the farms, which in turn limits their possibilities to use sustainable practices. This is in agreement with a study by Regassa (2001), who found that household labour availability was the most important factor determining land management practices, such as soil fertility maintenance techniques in the Northern Highlands of Ethiopia. Commitment in off-farm activities can also reduce the amount of labour that could be used in manure application. In my case study, the collection and application of kraal manure had indeed been affected by the shortage of labour.

The findings of the study revealed that farmers' lack of financial means has also affected the adoption of land management practices. Adimassu & Kessler (2012) found out that "richer" farmers in Ethiopia, with more land and livestock available, invest more in land management, particularly because of having the financial means to purchase inorganic fertilizer. The farmers in this study depend on government pension grants as their main source of income. The purchasing of inorganic fertilizers and tillage implements are expensive for the farmers. Even though fertilizer prices have been subsidized by the government the farmers still found it expensive to buy. This lack of buying power by many potential users of inorganic fertilizer has caused low use. For this reason, current programmes and policies need to be amended to encourage fertilizer use among subsistence farmers in ways that are market friendly and at the same time economically viable to the farmers.

6. CONCLUSION AND RECOMMENDATIONS

The farmers in this study are using many land management practices and have a good knowledge of these practices. Some of them are sustainable, which contributes to improving the physical properties and nutrient level of the soil. However, one of the key problems facing the interviewed farmers is the changing local climate evident in the increasingly unpredictable rainfall patterns and amounts. The farmers have limited resources and try to deal with these changing conditions using their own knowledge, and mainly without support from others. Long-term weather predictions, preferably over the radio, as well as guidance and formal knowledge from extension services could help these farmers adapt to these changes. Policy makers should therefore focus on enhancing extension delivery to subsistence farmers in the study area to disseminate and support practices that are useful and easy for them to adopt, e.g.

crop rotation and ripping. Furthermore, there is a need for the government to add ripping services to the current ploughing services. This could have a significantly positive impact on subsistence farmers' situations and household food security. Subsistence farmers still provide 30% of the food for the country, so helping them adopt more sustainable practices is important, both for the food supply and the environment in Namibia.

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