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FEASIBILITY OF LAND RESTORATION USING FODDER TREES AND SHRUBS IN SMALLHOLDER FARMING SYSTEMS IN SEMBABULE DISTRICT OF UGANDA

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ABSTRACT

Fodder trees and shrubs play a vital role in the diet of browsers. Once integrated in agropastoral land use systems, they can improve the soil, vegetation, environment, and livestock production as well as peoples' livelihoods. For this reason, they have been advocated for by many extension workers and are considered an important area of research. This study, carried out in the Sembabule District of Uganda aimed to assess the feasibility of land restoration using fodder trees and shrubs. Data was collected through focus group discussions with farmers and semi-structured interviews with a technical staff member and a local leader. Results indicated that subsistence livestock rearing, and crop growing are major livelihood activities in the area in addition to charcoal production and trade in agricultural products. Land degradation, drought, overgrazing, termite infestation, emergence of plant species unpalatable to livestock, and reduced area available for grazing are the main challenges facing farmers in the area. The most common fodder tree species used by farmers was *Calliandra calothyrsus*, which can encourage the establishment of many other plant species, remains green all year round, increases milk production and income, and improves livelihoods. Women seemed to be more active in fodder tree establishment compared to their male counterparts. Their participation was constrained, however, by land ownership as all male respondents owned land compared to only one of all the women participants. Other constraints to adoption of fodder trees and shrubs were lack of access to planting materials and skills in raising seedlings in nursery beds, drought, not enough awareness of the availability of different fodder tree and shrub species, lack of sensitisation on land rights, and termite infestation. Creating awareness of appropriate fodder tree and shrub species adaptable to the climate in the area, raising their seedlings, and sensitising both genders on land rights and the environment could enhance adoption of fodder trees and shrubs in smallholder farming systems.

Key words: land restoration, fodder trees, fodder shrubs, smallholder farming systems

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1. INTRODUCTION

Livestock production is a fundamental element of smallholder farming systems in most parts of the world. It is seen as an important component of African farming where livestock are a way of making a living for rural households and to escape poverty (Kiptot et al. 2014). In Uganda, cattle, sheep and goats are the most common livestock types kept and based on rangeland grazing.

The nutritive value of the rangelands is generally low depending on vegetation type and season. In Uganda, rangelands cover 44% of the country's total land area (Byakagaba et al. 2018). These rangelands are spread over numerous districts and their vegetation cover ranges from very low levels in Kabarole and Mbale to over 60% in Kiboga, Mubende, Nakasongola, Sembabule, Mbarara and Ntungamo and to 100% coverage as is the case in Moroto, Kotido, and Soroti (MoWE 2007).

The term rangeland is used as a denominator for natural grassland, bush land and wood landform in what has been called the "cattle corridor" of Uganda. Geographically, the cattle corridor forms a continuous stretch of land that splits the other two areas of the country where the main farming activity is crop production (Mugerwa 1992).

The cattle corridor has traditionally been known for livestock grazing but the land use is rapidly changing as land is increasingly being used for crop production. The region has a bi-modal rainfall pattern with the first rainy season extending from March to June and the second from August to December. The daily minimum and annual maximum temperatures range from 18°C-25°C and 25°C -35°C, respectively (Nimusiima et al. 2018).

These rangelands sustain about 80% of the entire national livestock and 90% of the countrywide cattle population (Government of Uganda 2014). The majority of these are kept by pastoral and agropastoral societies surviving on natural rangeland pastures. Because pastoralism is the main economic activity on these rangelands, pastoralists practice migrant herding and keep livestock types that can tolerate relocation stress, drought and intermittent food and dietary deficiencies (Buono et al. 2017). However, with increasing human population in addition to the rising necessity to produce food on a sustainable basis, the area available for grazing has been reduced. In addition, these rangelands get depleted of vegetation cover, particularly grasses in the dry season, and this results in nutritional and fodder shortages (Shenkute et al. 2012).

FAO (1992) and Haussmann et al. (2016) estimate that 75% of the world's grazing land has been degraded. Uganda is not exceptional with approximately 43% of the grazing land area degraded (Kisamba 2001). This is a result of unsustainable land management practices such as overgrazing and charcoal production which lead to low quality and quantity of feed supply and consequently reduce livestock productivity among smallholder farmers (Berc 2004). Sustainable management of grazing land thus remains one of the most important tasks land users, scientists and policymakers in Uganda must accomplish.

Among possible interventions to restore degraded rangeland areas in Uganda and to sustain their productivity is the use of fodder trees and shrubs. This approach has been used in some areas to combat desertification and rehabilitate degraded rangelands (Zucca et al. 2011). Some fodder trees and shrub species are deep rooted, perennial, well adapted to arid conditions, tolerant to aridity and direct grazing, palatable for livestock and produce fodder all year round (Shenkute et al. 2012). Fodder trees and shrubs also have higher biomass yields, resistance to

mismanagement, and an ability to retain higher foliage under stress conditions than herbaceous pastures. They grow fast, produce high quality forage for livestock and can produce nitrogen rich mulch. Integrating them into crop pasture production systems could improve the quality and quantity of fodder and carrying capacity of rangelands in dry areas (Otsyina & Norton 1995).

Despite the numerous qualities and the importance attached to these fodder species by farmers, most of the existing research and extension has largely been focused on the use of these species for fodder production. The potential of using these fodder species for restoring degraded grazing lands and improving livelihoods in smallholder farming systems in Uganda remains to be assessed.

This study sought to explore the feasibility of land restoration using fodder trees and shrubs in smallholder farming systems within the Sembabule district that lies in the central cattle corridor of Uganda. The specific objectives were to:
Identify the livelihood strategies of smallholder farmers in Sembabule, assets they used to meet those livelihood objectives and the environmental impacts of livelihood activities.
Identify fodder tree and shrub species used by farmers for fodder production and soil conservation, the qualities of these fodder trees and shrubs, benefits and challenges to their establishment.
Ascertain the role of women and men in decision making regarding the adoption of fodder trees and shrubs.

1.1 The sustainable livelihood framework and livelihood analysis of farmers

In this sub-section, the sustainable livelihood framework developed by the Department for International Development (DFID 1999) is presented as well as how it can be used to determine the livelihoods of farmers.

A livelihood comprises the abilities, assets (including both material and social resources) and activities required for an individual to earn a living. It is considered sustainable if it can recover from pressures and its abilities and resources can be improved both now and in the future without causing a decline in its natural resource base (DFID 1999).The framework offers a simplified way of conceptualising the complexity of livelihoods and the different variables that shape its activities, objectives, and outcomes. A graphical representation of the sustainable livelihood framework is presented in Figure 1.

In the livelihood framework, people are viewed as operating in a vulnerability setting within which they access assets. Vulnerability represents a complex of influences which may directly or indirectly be responsible for the numerous difficulties people face in pursuing their livelihood objectives (Tumusiime et al. 2018). It is within this setting that people have access to assets and organise them through the prevailing social, institutional and organizational environment to meet livelihood objectives.

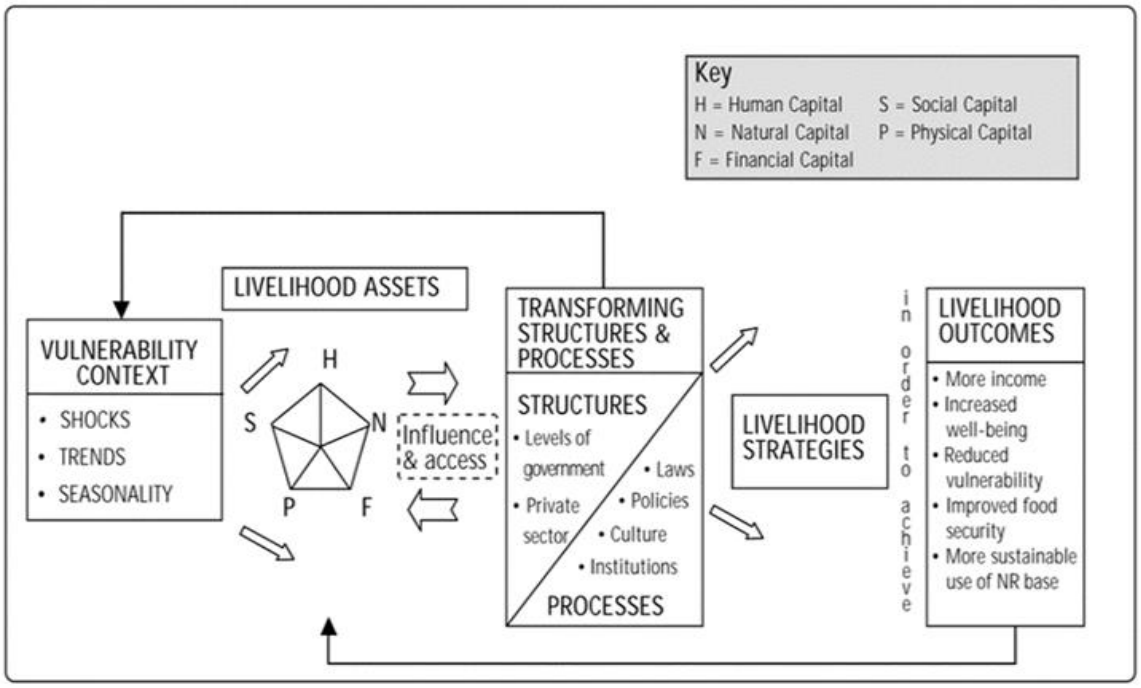

Figure 1. Sustainable livelihood framework. (Source: DFID 1999).

Reducing vulnerability among individuals and households is dependent on the availability, accessibility, and utilization of livelihood assets (Ibrahim et al. 2017). Therefore, households and individuals are seen to scuffle to make livelihood assets available to enable them to constantly achieve their livelihood objectives, persist against shocks and strains (Westley & Mikhalev 2002) and to maintain their livelihood security.

Designing their livelihood strategies in a way that can reduce possible fluctuations impacting their income is important, especially in situations where there is vulnerability such as seasonality in weather and environment. According to the DFID (1999) sustainable livelihood framework, livelihood assets (also called capital) are grouped into human, social, physical, financial, and natural capital.

Organising assets into livelihood outcomes is influenced by transforming structures and processes such as institutions, policies, culture, laws, and level of government intervention. These are seen to operate at all levels, from households to the global scale and determine access to different types of capital, livelihood strategies, terms of exchange among types of capital and earnings to livelihood strategies (Levine 2014). These transforming structures and processes can influence people's access to assets, decision-making thus can impact on their efforts in achieving their livelihood objectives. Once assets are available, individuals choose activities that enable them to meet their livelihood goals. These activities are therefore dependent on assets, institutions, policies, and processes. The more assets one has, the greater the chance of meeting livelihood objectives. Therefore, it is more likely that poor people must compete for assets to be able to meet their needs. Meeting livelihood objectives is measured by the livelihood outcomes. This covers all achievements and outputs of a given livelihood strategy such as increased income, improved food security, reduced vulnerability, increased well-being and more sustainable use of resources (Yang et al. 2018).

1.2 Fodder trees and shrubs: Their effect on livelihoods and environment

This subsection gives a brief overview of the available literature on fodder trees and shrubs, how their use can affect livelihoods and enhance environmental resilience is presented (see also Fig. 2).

Jamala (2013) defines fodder trees and shrubs as "…plants (shoots or sprouts, especially tender twigs and stems of woody plants with their leaves, flowers, fruits or pods) that are raised, used and managed to feed livestock" (p.1). They are an example of cultivated feed resources that can complement natural forage on natural grazing lands and have been used for decades as multipurpose resources to supply food, fibre, fodder, wood and as live fences in different agro-ecological zones of Africa (Devendra 1992). Thus, they play an important role in feeding ruminants, especially in areas where there are few or no alternative plants to cater to the nutritional needs of animals (Chekredza et al. 2007).

Fodder trees have been significantly used in the highlands of Eastern Africa, where over 200,000 smallholder farmers plant them majorly to feed dairy animals and to meet livestock production scarcities in times of extreme weather conditions such as drought (DFID 2010). In Uganda, fodder trees and shrubs have been adopted in the cut-and-carry feeding systems where they are freshly cut, carried and fed to animals kept indoors as protein complements to poor quality grasses and cereal by-products. This is due to their hardiness and favourable chemical composition with crude protein contents of 18 to 30% of the dry matter of edible leaves and stems (Murgueitio et al. 2011). Fodder trees and shrubs are also easy to grow, need little land, labour or capital, have several by-products and can start to supply feed in a year's time after establishment (Zucca et al. 2011).

Shelton (2000) states that besides fodder supply, the fodder trees also play significant roles in landscape and environmental modification. For example, tree legumes are a source of nitrogen-rich mulch for cropping systems and because of their longevity and improvement of soil fertility, they can increase the sustainability of farming systems. They can also act as support for climbing crops and provide other species with shade. For the environment, they stabilize sloping lands and sand dunes against erosion because of their deep roots. They provide a habitat for wildlife, and as woody perennials they act as a sink for carbon dioxide, with positive effects on climate modification.

In the Masaka district of Uganda that was subdivided into other districts including Sembabule, farmers incorporate fast growing leguminous tree shrubs in the crop livestock production systems. This is aimed at improving soil conditions by restoring the land that is highly degraded due to erosion and to meet the demands for woody products such as timber, fuelwood, medicine, shade, services and livestock fodder (Sebukyu & Mosango 2012, Katende et al. 1995). Agroforestry in the Masaka district is also seen to improve food security and the farmers' livelihood. Leguminous tree species are considered most important because of their monetary benefits and ecological adaptability. In addition, because of the ability of these trees to fix nitrogen, farmers replace the less productive woody species with fast growing nitrogen fixating species such as *Leucaena diversifolia, Calliandra calothyrsus*, *Sesbania sesban, Gliricidia sepium*, *Erythrina* species (Sebukyu & Mosango 2012).

Feeding livestock on fodder trees and shrubs can increase milk production for these animals which in turn adds to farmers' income. In their study, Frenzel et al. (2014) indicated that on-

farm feeding trials for a dairy cow in the Masaka district of Uganda with 2 kg of dried calliandra increased milk production by 0.6-0.75kg milk^{-1} dry calliandra.

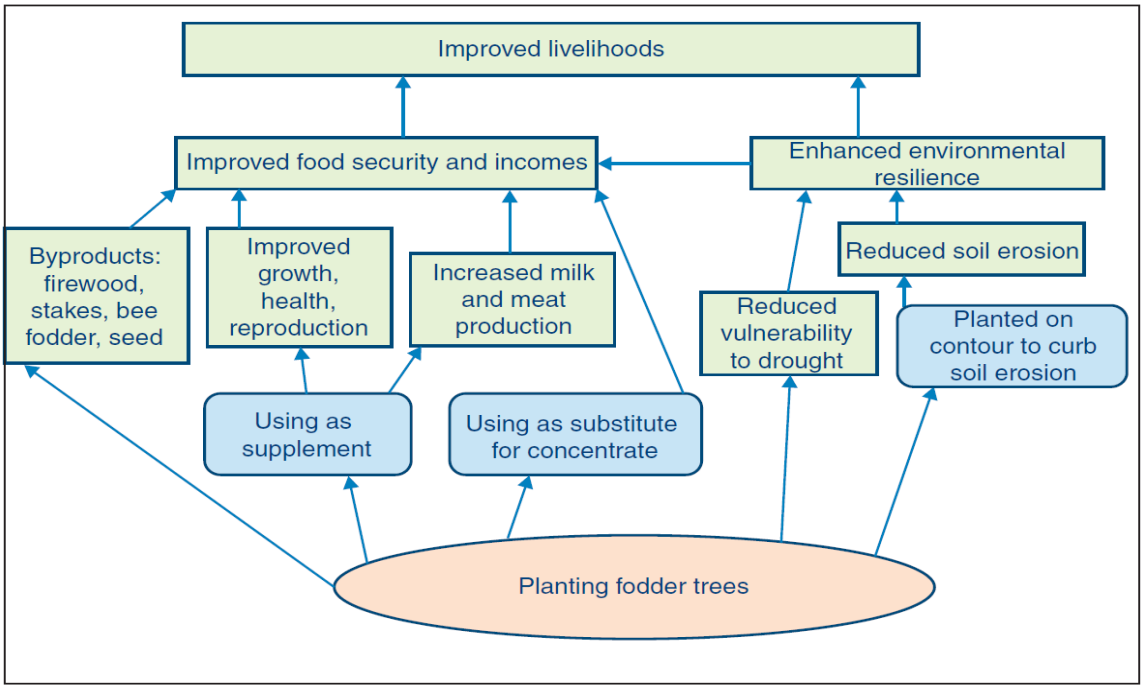

Figure 2. Fodder trees and livelihood improvement. (Frenzel et al. 2014).

However, fodder tree and shrubs require considerable skills in growing them that most farmers do not have, such as raising seedlings in nurseries, pruning and preservation methods before they are fed to livestock (Roothaert & Franzel 2001). In addition, numerous pests attack different trees and shrubs in both natural and introduced systems. Common pests include grasshoppers, aphids, bacteria, viruses, and termites. According to Otsyina et al. (1995), termites are the most overwhelming pests restraining trees and shrub establishment in semi-arid and arid lands in Africa.

1.3 Fodder tree and shrub establishment: A gender perspective

Women farmers play a significant role in agroforestry farming systems as they provide 50% of the agricultural labour force in sub-Saharan Africa (Kiptot et al. 2014). They are often responsible for managing trees in the early stages of establishment. In their study on gender, agroforestry and food security in Africa, Kiptot et al. (2014) estimated from surveys on the dissemination and adoption of fodder shrubs in the East African region that approximately 205,000 smallholder farmers had planted 82,000 fodder shrubs each in Kenya and Uganda, 28,000 in northern Tanzania and 14,000 in Rwanda. Out of these planters, about 47% were women. This high participation of women was enabled by extension staff targeting women organised in groups. However, while women are as actively involved as men, their level of participation and benefits are often constrained by cultural norms and lack of resources. As an example, a report on women and natural resources (UNEP et al. 2013) indicated that despite being responsible for growing 80% of all the food crops, only 7% of women in Uganda own land because of traditional customs and practices. Sweetman and Ezpeleta (2017) stated that there is need for implementation of various policies, technological and institutional interventions to deal with inequalities existing between men and women in order to enable

women to benefit fully from agroforestry and to contribute to environmental sustainability, food security and improved livelihoods.

2. METHODS

2.1 Study area

The study was conducted in Lugusulu subcounty, Sembabule district. Sembabule is located between 0.08160S and 31.45990E, is at an elevation of 12,000 m and covers an area of 2470.5 km^2 (UBOS 2017). It lies within the stretch of land that forms the cattle corridor of Uganda which is currently experiencing extensive land degradation including prolonged drought and biodiversity loss (Nimusiima et al. 2016). Figure 3 below shows the location of the study area.

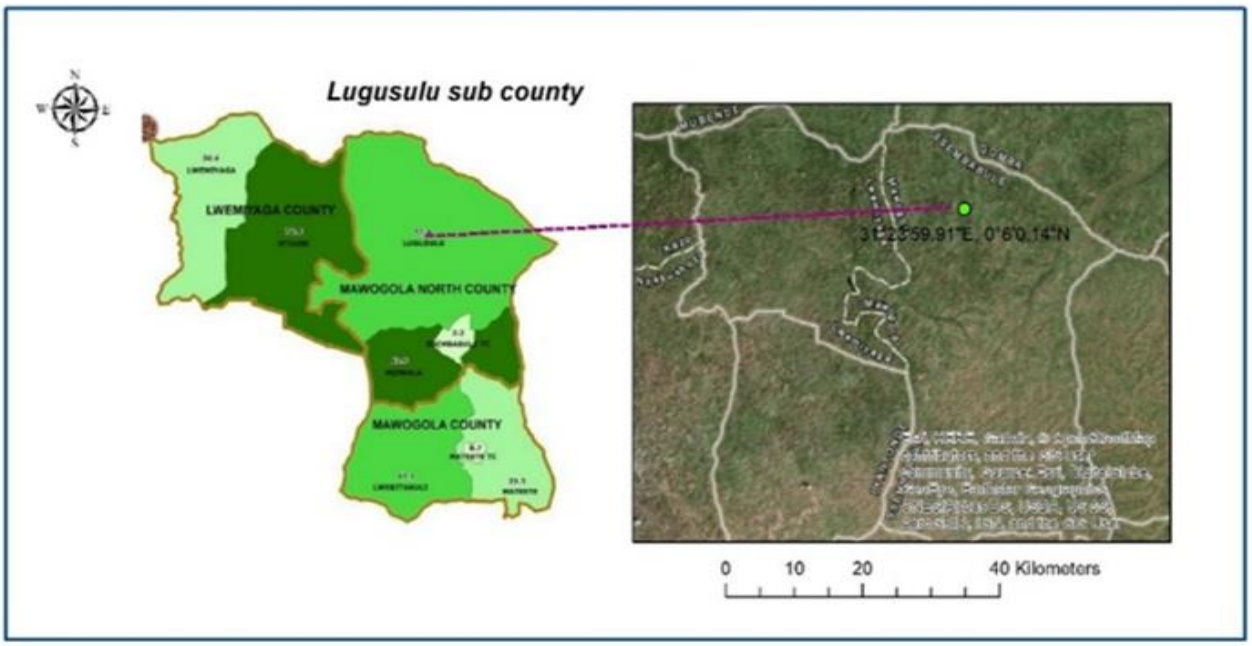

Figure 3. Location of Lugusulu subcounty in Sembabule district, Uganda. (Source: UBOS 2017).

In this study, both qualitative and descriptive research designs were used. Qualitative methods were used to explore participant's experiences and perceptions on land restoration using fodder trees and shrubs. Qualitative methods were also preferred because of flexibility as they allowed for further probing during interviews (see e.g. Nassaji 2015). Descriptive research, which is a theory-based research design, was also used and proved helpful in describing the situation surrounding the study population (see e.g. Seixas et al. 2017).

To gain an insight into the environmental impact of farmers' living strategies within the study area, their livelihood activities were identified. For this purpose, the sustainable livelihood framework developed by DFID (1999) was used. The hardships farmers must go through to secure their livelihoods, perceptions on ownership and access to assets by men and women and how these influence use of fodder trees and shrubs in the area were also analysed.

2.2 Selection of participants

The study involved 16 farmers in total; 8 men and 8 women above 18 years of age from Lugusuulu subcounty and two key informants, i.e. one local leader and a technical staff member of Lugusuulu subcounty that regularly interacts with farmers in this area. Purposeful sampling was used to include two categories of farmers, both those who had experience in using fodder trees and shrubs and those who had not. To get a holistic picture of the trends on how land degradation and restoration activities were perceived in the area, a prerequisite of the study was that participating farmers had lived in the area for more than five years.

2.3 Data collection and analysis

Data was collected through in-depth interviews and focus group discussions. Two focus group discussions were held, the first one with 8 male farmers and the second with 8 female farmers in the two villages of Kagango and Lwentale, respectively. Focus groups were used because they can provide an open supportive environment in which participants are able to discuss in-depth often quite sensitive issues (see e.g. Braun & Clarke 2014).

In addition to the focus group discussions, two in-depth interviews were carried out, one with a local leader in Lugusuulu subcounty and one with a technical officer (staff member of the same subcounty) that interacts regularly with farmers. Interviews were used because they are suitable for exploring participants' perceptions on issues in which they may have a personal stake (see e.g. Easwaramoorthy & Zarinpoush 2011).

In both interviews and focus group discussions, interview guides with semi-structured open-ended questions were used (see e.g. Braun & Clarke 2014). Semi-structured interviews were conducted where sets of predetermined questions set in English were interpreted to the farmers and local leader. These responded in Runyankole and Luganda, their local languages, whereas the technical officer responded in English. Both interviews and focus group discussions were recorded.

Social background information on participants was also collected to aid in data interpretation and to get an insight into their thoughts and experiences regarding land restoration using fodder trees and shrubs.

Data was collected on my behalf by the assistant veterinary officer and assistant production officer, who are both employees of the Sembabule district local government. Both were familiar with the study area and the local languages of Luganda and Runyankole used in the region. They were assisted by two local council leaders during the initial stage to establish contact with the farmers, introduce the study, explain the study objectives, and make appointments for the two focus group discussions.

Like in any other qualitative research, certain ethical considerations were adhered to throughout the entire research process. These included getting informed consent of the participants, informing them of the overall objective of the study, their rights to withdraw from the study at any time and assurance to the participants that all data would be treated as confidential information and anonymity ensured.

Data recordings were transcribed and then organised thematically in accordance with the research objectives. The data was then coded and categorised into concepts for a more effective data analysis as described by Dey (2003) and Easwaramoorthy and Zarinpoush (2011).

2.3.1 Livelihood analysis

The livelihood analysis for farmers was conducted with the help of the sustainable livelihood framework of human, social, natural, physical and financial capital as developed by the Department for International Development (DFID 1999). The livelihoods were analysed in regard to farmers' vulnerability, the assets as well as the structures and processes that transform these assets into livelihood strategies for a desired livelihood outcome (see e.g. Levine 2014). Direct interview and focus group quotations are presented in italics in the next section on results.

3. RESULTS

In this section, results are presented on the livelihood activities of farmers, the fodder trees and shrubs used in fodder production and soil conservation, other benefits of these trees and shrubs, constraints to their establishment, and the role of men and women in decision-making on adoption of these fodder trees and shrubs. Results are presented based on the study objectives.

3.1 Social background of participants

A majority of the 18 participants engaged in the focus group discussions and key informant interviews had attained the primary level of education, a few had advanced to tertiary level, while others only had informal education. Interaction with farmers indicated that, despite most of them having attained formal education, they still lacked training and knowledge on several aspects of ecosystem functioning, environmental impacts of livelihood activities and the interdependence of different ecosystem components.

As an example, study results indicated that it was not clear to farmers as to why soil erosion and termite infestation had intensified in the area. They confessed that these problems were always heard of in Nakasongola district and couldn't ascertain the cause of the same problems in Lugusuulu subcounty. In the words of one participant:

> *I cannot understand what has caused this problem of termites that eat every plant whether dry or fresh. I used to hear on the radio that people of Nakasongola have no pastures for their animals because animals compete with termites on pastures, but now for us we have termites, a lot of prolonged dry season and all soils are taken away by wind.*

3.1.1 Farmers' livelihood strategies and activities

Results of this study revealed that most of the respondents were engaged in livestock rearing and crop growing. According to the participants, most of the livestock kept and crops grown were for private consumption and that only the surplus was sold to meet other family needs. This means that production was at subsistence level.

Besides livestock rearing and crop growing, other livelihood activities were reported. This included charcoal production, trade in agricultural produce and general merchandise and crafts like carpentry, broom and basket weaving from papyrus, and hair styling by women. These were reported as activities that give the farmers supplementary income. Unreliable rainfall patterns and drought were reported as the major driving forces of diversification of livelihood activities. Charcoal was produced to supplement income from crop growing for those farmers who did not own livestock, but to those with livestock, the intention was to eliminate plant species unpalatable to livestock.

> *I do many activities to earn a living. If one of the activities fails, my family survives on income from others.*

It was also reported that making crafts was becoming a highly paying activity as the number of tourists visiting the Bigobyamugyenyi cultural site in Ntuusi a neighbouring subcounty, had increased. This was creating a market for crafts such as baskets, mats, brooms and hats made from papyrus harvested from the R. Katonga wetland. One of the women participants stated:

> *All the maize and beans I grew this season were caught by drought and very little harvest was realised. My family now is depending on money from selling charcoal and crafts like mats, hats, and baskets to people who pass by as they go to visit Bigobyamugyenyi tourist site.*

The study also revealed that besides unreliable rainfall patterns and drought, farmers are experiencing other sudden events and shocks in livestock and crop farming and that these events affect their livelihood security. The mentioned shocks were land degradation, termite infestation, livestock and plant pests and diseases, soil infertility and fluctuating prices for agricultural products. During a focus group discussion, one participant stated that:

> *This area is experiencing termite infestation, soil erosion and strange crop pests and ticks. These reduce output from crop and animal production activities.*

In the same discussion, it was reported that a lot of animal deaths are experienced during the dry seasons and farmers end up selling the animals they recognise to be in a bad state at very low prices, as described by one participant.

> *I must sell many cows to be able to raise school fees for my children because in the dry season, cows are malnourished and bony. Traders give me little money per cow I sell.*

In meeting their livelihood objectives, the study revealed that several assets/resources were being owned and accessed by farmers. These included natural, human, financial, and social capital. In addition, physical assets are owned by the government, but farmers access them. Farmers transform these assets/resources into their livelihood outcomes. Figure 4 shows assets that farmers in the study area used to meet their livelihood objectives.

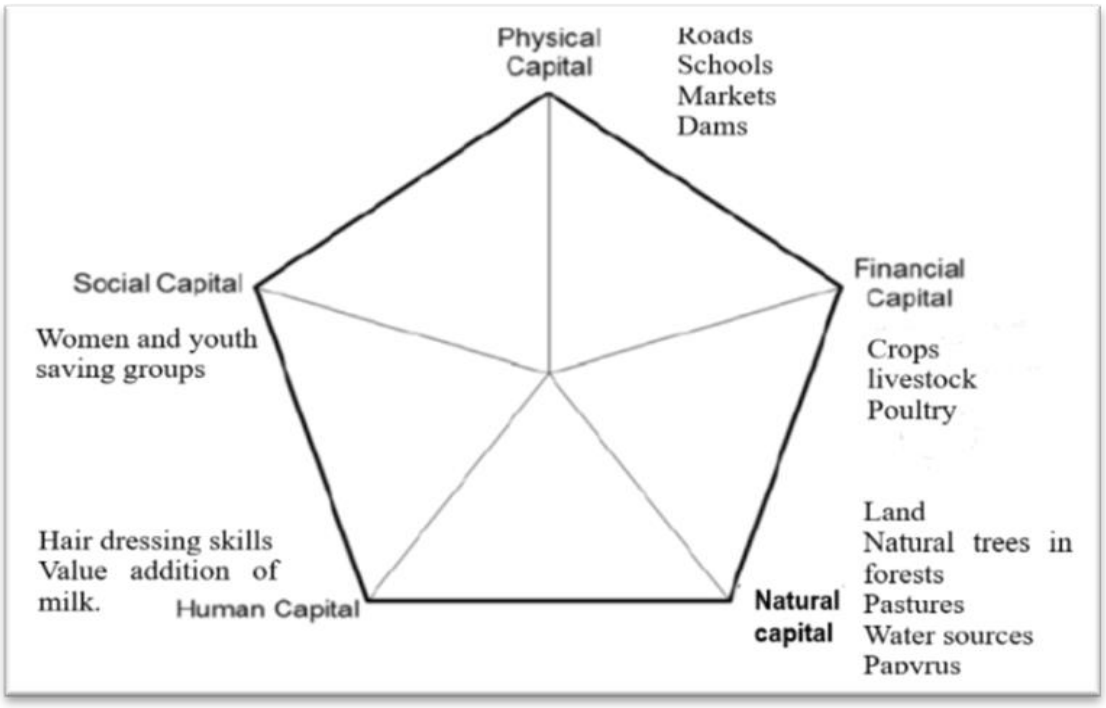

Figure 4. Livelihood assets used by farmers to meet livelihood objectives. (Based on model by DFID 1999).

Much as several resources were reportedly owned and used by farmers, differences existed between men and women regarding control and access to these resources. All men participating in the focus group discussion had ownership and access to land while only one of all the women respondents owned land. However, all the women interviewed claimed to have access to land via their marital rights. Figures 5 and 6 show the differences between men and women regarding access to and ownership of resources.

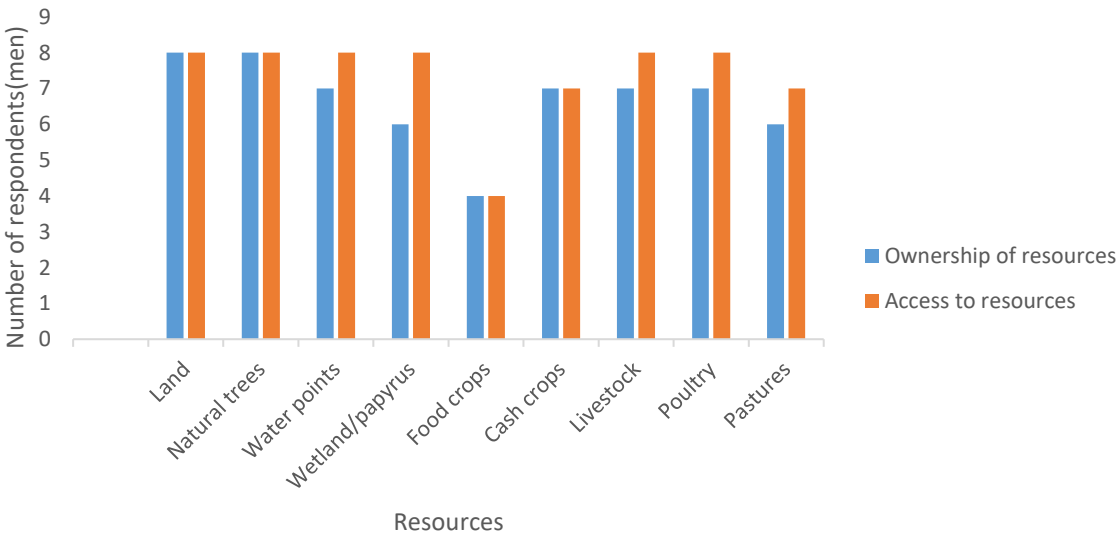

Figure 5. Differences between ownership and access to resources (male respondents).

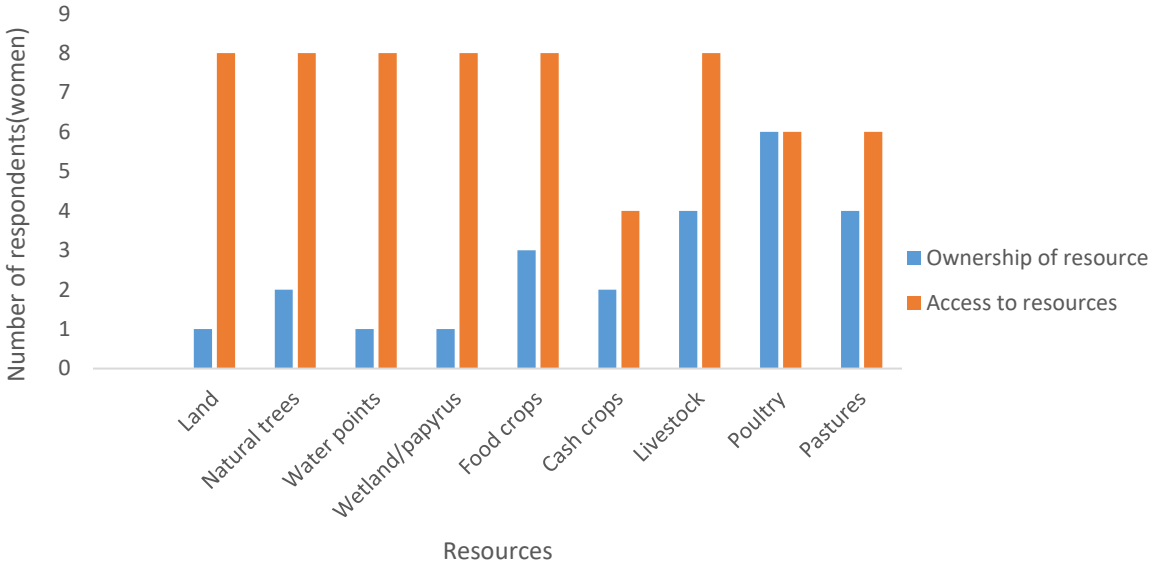

Figure 6. Differences between ownership and access to resources (female respondents).

In the opinion of the technical officer interviewed, women do not have equal opportunities in decision-making regarding access and control of most resources. He reported that:

> *Men and women have no equal opportunities in control of resources. In African settings men have an upper hand in decision making on use of resources and women have small opportunities to some resources like poultry.*

3.1.2 Impact of livelihood activities on the environment and fodder tree and shrub establishment

When analysing the environmental effect of livelihood activities, farmers reported that charcoal production greatly seemed to affect the land's vegetation cover. The activity led to disappearance of natural pastures and more colonization of the areas by non-palatable shrubs. To allow regrowth of natural pastures, farmers are forced to clear land of these shrubs that are then used for firewood and for charcoal production. Examples of those shrubs mentioned here included tick berry, phytolacca species and sodom apple. This practice according to participants can leave land bare. One of the participants stated that:

> *A lot of shrubs that animals don't eat are growing up on my farm and that is why I get workers to remove them so that good pastures can grow, and when these shrubs are removed, I tell my workers to burn them into charcoal and I sell it to get money but this practice sometimes leaves land bare.*

Besides leaving land bare, the use of the available natural trees and shrubs for charcoal production was reported to have other environmental problems. According to participants, these included soil erosion, high temperatures, extended drought, termite infestation and emergence of pests and parasites resistant to chemicals. These are threats to the farming community that make it more difficult to establish fodder trees and shrubs in the area. One woman stated that:

> *As farmers, we are confronted by many challenges including many types of pests that are resistant to chemicals, termites and infertile soils that no longer support crops and pasture growth. The good black soils are washed away by running water*

> *when it rains, making it hard for us to grow calliandra. The situation is worsened by termites that eat up every calliandra seedling you plant.*

The technical officer interviewed revealed that in the past years the area had been communally grazed but because of population increase, land fragmentation had emerged. He added that there is reduction in the area available for grazing and that farming was shifting more from livestock keeping to crop growing. He stated, however, that those farmers that still relied more on livestock production were keeping large numbers of animals, thus resulting in overstocking and subsequently overgrazing.

3.2 Use of fodder trees and shrubs in soil conservation and fodder production

In the focus group discussions and key informant interviews, it was revealed that fodder trees for goats and cattle were being established to conserve soil and to supplement natural pastures in degraded grazing lands. However, out of 16 farmers engaged in the study, only three had adopted the use of such fodder trees and shrubs at their farms. *Calliandra calothyrsus* (calliandra) and *Tithonia diversifolia* (Mexican sunflower) were reportedly the shrub species used by farmers. In a discussion with women participants, one of the women revealed that she had heard that there were many fodder tree species, but she and her partner had only adopted *Calliandra calothyrsus* because the Sembabule district farmers association (SEDFA) extension staff provided it to them at no cost. In a similar discussion with men participants, the farmers who had adopted the use of fodder trees and shrubs also stated that *Calliandra calothyrsus* was the commonly used species to supplement naturally growing Acacia species.

According to the technical officer interviewed, sensitisation and training on use of fodder trees and shrubs had been done by key stakeholders led by SEDFA, Minnesota, and the Lutheran federation. He reported that farmers had begun adopting fodder trees and shrubs, especially *Calliandra calothyrsus.* He added that a few farmers had an opportunity to attend sensitisation meetings and trainings on establishment of these fodder trees and shrubs.

Several reasons were given as to why certain fodder tree and shrub species were used by farmers and others not. Those farmers who had used fodder trees and shrubs shared success stories and revealed that use of such trees and shrubs enhanced growth of other plant species and increased milk production. As stated by one farmer:

> *Calliandra is a good tree because it provides good shade for animals, has no thorns to injure animals, many other grasses grow and spread quickly where it is planted, and milk production increases in animals that are fed on it.*

In addition, farmers claimed that *Calliandra calothyrsus* was palatable to livestock, especially goats, was drought tolerant, fast growing and was easily accessible from the Sembabule District Farmers Association. One respondent added that this species remains green and can feed animals all year round, including during the dry seasons.

> *I can harvest leaves and branches from Calliandra calothyrsus for the whole year*.

Ability to recover quickly from pruning, cutting, and grazing was also mentioned as a good quality of *Calliandra calothyrsus.* One respondent reported that:

> *Calliandra takes a few weeks to grow other leaves and branches after a harvest, and leaves grow in a short period of time.*

The technical officer also reported that besides being palatable to animals, fodder trees and shrubs are highly nutritious, survive in extreme conditions, have long taproots and can adapt to the climate of Sembabule.

One of the farmers also claimed that the Calliandra he grew on his farm was not only used for animal feed but also for firewood.

> *When the whole Calliandra plant dries up, it can be used as firewood, and if it's cut and carried to animals, the leftover branches are used as firewood when dry.*

Results of the study show, however, that several challenges existed in adopting fodder trees and shrubs. Whereas SEDFA sometimes gave farmers seedlings, termites and drought were identified as major challenges to establishment of fodder trees and shrubs seedlings in the area. One of the farmers made a comment on this:

> *I received free Calliandra calothyrsus seedlings from SEDFA and I planted them so they can spread on the whole farm, but termites destroyed many of them and a few that survived later dried up due to lack of rain.*

Those farmers who had adopted fodder trees and shrubs mentioned that certain skills are required in raising seedlings. These farmers shared their view that lack of skills in raising fodder tree and shrub seedlings is a challenge they were facing as there were no nursery beds established in the area for them to get such seedlings.

> *Raising the fodder tree seedlings requires you to have some skills on nursery bed preparation and yet some of us don't have them.*

The technical officer on the same issue also reported that:

> *There are no nursery beds established at farm level to supply other farmers with seedlings, and most farmers are unable to raise seedlings themselves due to lack of skills and thus unable to access planting materials.*

3.3 Role of men and women in decision-making on use of fodder trees and shrubs

The results indicate that the use of fodder species is perceived differently by men and women. Women seemed to be taking a lead in adopting use of fodder trees and shrubs compared to their male counterparts. This, according to one women participant, was due to distinguished roles and responsibilities. Women seemed to be more active in caring for animals while men are away for trade in agricultural products. One of the woman participants stated that:

> *Most of the time it's me who take care of animals and suffer moving a lot with them on the farm when my husband has taken milk to the dairy. Because of little pastures during the dry period, animals move a lot and I too move with them, so if I can get fodder trees to plant for them, I can do it wholeheartedly so that the problem I face is solved.*

While results indicated that women seemed to have more interest in establishing fodder trees, they reported that denial of the rights to make decisions concerning the use of land resources affected their participation in establishment of fodder trees and shrubs. During the focus group discussion, one female participant also stated that*:*

> *If I want to use land for any purpose, I must first seek permission from my husband since he is the owner of the land and is the one to plan on how the family members utilise it. As a woman, I can't decide on how to use land that my husband inherited from his father.*

Men on the other hand showed a lot of interest in growing other tree varieties like eucalyptus that can earn them direct income from sales and construction materials. Also, growing of fruit trees such as mangoes and oranges that are provided to them by the government through the Operation Wealth Creation Programme was a common practice for men. One of the male participants requested from the research assistant during a discussion:

> *Since you can talk to the big officers that are managing the government's Operation Wealth Creation Programme, I request that you tell them to give us eucalyptus seedlings to plant so that we improve on our environment and our income.*

4. DISCUSSION

Below, the study results are discussed in relation to the study objectives.

4.1 Livelihood strategies/activities for smallholder farmers

Most farmers were engaged in small scale livestock rearing and crop growing as major livelihood activities. Trading in agricultural products and charcoal production offered farmers additional income to farming. These results are in line with the results of UBOS (2017) that found that in the Sembabule district more than 69% of total households derive their livelihood from subsistence farming and that the majority of the working population (65%) are subsistence farmers. Smith et al. (2001) also suggests that subsistence agriculture retains a central role in sustaining livelihoods of the rural population.

Farmers were faced with hardships in meeting their livelihood objectives such as drought, loss of livestock, plant pests and diseases, unreliable rainfall and soil erosion. These have also been mentioned by Kalinda and Langyintuo (2019). However, such events seemed to have a greater effect on the women than the men. This can be attributed to the differences in ownership over productive resources such as land, as most of the women engaged in the study did not own land but could only access it via their marital rights. These results are in line with the study findings by Elmhirst and Resurrection (2008) in their study on gender and natural resource management in Asia.

Charcoal production, one of the livelihood activities in the area, seemed to negatively be impacting the environment and subsequently the efforts on fodder tree and shrub establishment. The activity can leave land devoid of vegetation, accelerate soil erosion, increase temperatures, extend drought, soil infertility, emergence of pests and parasites resistant to chemicals, termite infestation, and colonisation of grazing land with unpalatable plant species. This result is validated by similar findings in other research, with Chidumayo and Gumbo (2013) reporting

that charcoal burning through carbonization can significantly impact soil pH, nutrient amounts, reduce percolation rates and water retention, as well as soil aggregates, thus increasing the risk of soil erosion. They argue that, at the charcoal burning sites, soil significantly loses organic matter due to high temperatures (500-700°C) generated during the carbonization process.

4.2 Use of fodder trees and shrubs in soil conservation and fodder production: Species used, their qualities and challenges to their establishment

Only a few of the farmers participating in this study had integrated fodder trees and shrubs into their farming systems. *Calliandra calothyrsus* (calliandra) and *Tithonia diversifolia* (Mexican Sunflower) were the used fodder shrub species. Previous studies (Chakeredza et al. 2007; Sebukyu & Mosango 2012) identified several tree and fodder species that can be used in agro-pastoral farming systems, including calliandra and Mexican sunflower. Farmers who had adopted *Calliandra calothyrsus* attributed their use to its good qualities of supplying fodder to animals all year round and its ability to improve soil and enhance growth of other plant species in areas where it is grown. These qualities have also been mentioned by Katende et al. (1995) and Sebukyu and Musango (2012). Additional benefits of using fodder trees and shrub species include increasing milk production, manure, medicine and firewood supply. According to the farmers in this study, these additional benefits motivated them to adopt the fodder trees and shrubs. This has also been mentioned by Frenzel et al. (2014).

Adoption of fodder trees and shrubs was on a small scale. This was attributed to several factors. The results showed that extended drought, soil infertility, inadequate training in raising fodder tree and shrub seedlings, and pests like termites were some of the limiting factors to fodder tree and shrub establishment. Other scholars have mentioned similar threats to fodder tree establishment; for example, in a study on fodder trees and shrubs in arid and semi-arid livestock production systems, Otsyina and Norton (1995) mentioned that numerous pests attack different trees and shrubs in both natural and introduced systems. They cite the common pests as grasshoppers, aphids, viruses, bacteria, viruses, and termites but emphasise, however, that termites are the most overwhelming pests restraining tree and shrub establishment in semi-arid and arid lands in Africa. It was also mentioned in this study that termite infestation interfered with fodder tree establishment and hence land restoration using these fodder trees and shrubs.

Inadequate training of farmers on the use of fodder trees and shrubs contributes to the low level of use of these plants. The study revealed that some trainings of the farmers had been done but not all farmers had had an opportunity to attend these trainings. This denied farmers useful information on the use of the fodder trees and shrubs, especially on the appropriate fodder tree and shrub species to use in the area and the role of these shrubs and trees in land restoration. These results are in line with studies by Jeanett and Clouston (2005) that showed that, in order to understand the complexity of farm systems and to find suitable management actions, land administrators needed access to dependable information on both the problem to be addressed as well as the technology and practices to adopt in addressing the problem. This dependable information can be accessed by farmers through education and training. However, this had not been done to achieve 100% coverage in the study area. Similarly, Frenzel et al. (2014) and Kwesiga et al. (2003) highlighted the importance of training on the use of fodder trees and shrubs.

In addition, inadequate training and knowledge on the causes of termite infestation in the area interfered with fodder tree and shrub establishment. Amidst intensified termite infestation, farmers continuously cleared farmlands and produced more charcoal. Increased charcoal

production and land clearing reduces the amount of litter that termites feed on. They then resort to foraging on herbaceous plants including grasses and shrubs, thus making fodder tree and shrub establishment difficult.

Also, drought can have severe impacts on rangeland ecosystems as it increases water shortage, soil erosion, pests, invasive species and reduced vegetation production (Finch et al. 2016). This study discovered that the farmers' efforts to adopt use of fodder trees and shrubs was partly difficult because of water shortages. Due to prolonged dry seasons, the planted seedlings could not survive. This interfered with efforts to restore land using the fodder trees and shrubs.

4.3 Role of men and women in decision-making on use of fodder trees and shrubs

Women and men seemed to use fodder trees and shrubs differently, with women respondents being more interested in establishing these fodder trees and shrubs compared to their male counterparts. This could be influenced by differentiated roles, responsibilities, and knowledge. According to the study results, women mostly take care of the livestock and therefore, availability of fodder for animals, especially during the dry season, made their work easier since moving with animals for long distances in search for pastures could then be avoided. The results are in line with studies of Elmhirst and Resurrection (2008) who indicated that men and women have gender differentiated interests in natural resource management based on roles, responsibilities and knowledge and this influences their intervention in natural resource management.

Participation of women in natural resource use and management is constrained, however, by their lack of power in decision-making and traditional customs (Betty 2007; Sweetman & Ezpeleta 2017). The results indicated that while women played a central role in caring for livestock and ensuring that the animals get fodder, many of them had no power to influence decision-making on the use of land for fodder tree and shrub establishment. As only one of the women participants had control over land, the rest could only access and use it as per their husbands' decisions. The study findings are also in line with a report on gender, natural resource use and justice by UNEP et al. (2013) which revealed that only 7% of women in Uganda owned land because of continued entrenched customs and practices. Limiting women's accessibility to natural resources in turn restrains their efforts in adopting natural resource management interventions.

Similarly, a study by FAO (2012) revealed that whereas women comprise two thirds of livestock keepers worldwide with 53% of them being primary caretakers of poultry and dairy animals, they had little control over land. Since the study concentrated on the feasibility of land restoration using fodder trees and shrubs, lack of land ownership would mean that women's efforts to establish fodder trees and shrubs, and hence their contribution to land restoration through such methods, is constrained.

5. CONCLUSIONS AND RECOMMENDATIONS

The main objective of this study was to assess the feasibility of land restoration using fodder trees and shrubs in Lugusuulu, one of the rangeland areas in Sembabule district, Uganda. One of the livelihood activities of farmers within the study area that seemed to have the most negative effect on the environment was charcoal production that uses the cleared unpalatable trees and shrubs as raw materials. This practice is environmentally unsustainable as it can leave

the land bare and thus prone to agents of erosion. The situation has been worsened by termite infestation. These termites destroy any emerging vegetation and have been mentioned as a serious threat to vegetation establishment within agro pastoral land use systems as well as rangeland ecosystems in Lugusuulu. It can therefore be concluded that some livelihood activities of farmers in the study area are contributing to land degradation due to the unsustainable land use practices of land clearing, overgrazing and charcoal production.

Attempts have been made to restore the degraded rangelands and to sustain fodder production in the study area through establishment of fodder trees and shrubs. Species used include *Tithonia diversifolia* (Mexican sunflower) and *Calliandura calothyrsus,* which was the most commonly known species among farmers. However, only a few farmers within the study population had adopted the use of fodder trees and shrubs, with women being the most active and interested despite their participation being constrained by lack of control over use of the land, little awareness of the available fodder tree and shrub species, and lack of skills in raising seedlings and thus a shortage of planting materials.

Where *Calliandura calothyrsus,* the most common species had been used, more plant species including grasses had reportedly emerged, surface runoff was reduced, fodder production sustained, and other benefits of fuelwood and manure supply realised. *Calliandra calothyrsus* is a leguminous shrub that fixates nitrogen. Thus, when successfully established, use of fodder trees and shrub species can aid in restoring ecosystem functions within the area by reducing surface runoff and retaining soil nutrients.

Much as women seemed to be taking more care of livestock than men and grow more of the food crops, they still owned much less land. This can affect their decision making and active participation in natural resource management interventions such as establishment of fodder trees and shrubs. It can also make them more vulnerable when faced with events such as desertification, deforestation and misdirected economic policies. Thus, to enhance the active engagement of women in land restoration interventions such as use of fodder trees and shrubs, sensitisation of both genders on land rights and gradual sensitisation on traditions that constrain women's participation in decision making are needed.

Even though only a few species of fodder trees and shrubs were known to the farmers, available literature shows a variety of possible species. This therefore calls for more experimentation on the available fodder species to come up with those that can survive in the current environmental conditions in the study area. In addition, due to the potential of fodder trees and shrubs from other regions of the world, it is recommended that efforts be made to expand the already adopted fodder species in the area while continuing to experiment with new ones. This expansion can be done through building farmers' skills and knowledge through training and facilitation of exchange visits, direct education of farmer trainers and local change agents, and supporting extension initiatives on sustainable land management. The extension should, however, consider farmers' needs and circumstances.

It is also important to engage in further research on the causes of termite infestation in the area and to disseminate results to create community awareness on how to deal with such an emerging environmental problem as it interferes with tree and shrub establishment.

To safeguard sustainability and protect the fragile ecosystems of dry rangelands, there is a need to develop other livelihood options that are eco-friendly and other appropriate methods of range management in the region.

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APPENDICES

APPENDIX I: Interview guide for key informants

General information

Location of interview…….
Position of participant…….
Gender of the participant…….
How long have you worked in Sembabule district/ Lugusuulu sub-county?
How does your position/work relate you with small holder farmers in Lugusuulu subcounty?

Livelihood strategies of smallholder farmers

Can you please explain some of the livelihood strategies among small holder farmers in Lugusuulu sub county?
To your knowledge, what assets/resources are at disposal for farmers to generate income?
Do you think men and women have equal opportunities in accessing these resources?
Who do you think among men and women takes a lead in deciding on how to access and use the available assets/ resources? In your opinion, what kind of challenges might farmers be facing while using these assets/resources to achieve their livelihood goals?
What strategies have farmers adopted to cope up with the above challenges?
In your view, do you think the activities of the farmers impact the environment and its resources? If yes, how?
To your knowledge, have there been any interventions by any agencies or government institutions in helping the communities in meeting their livelihood objectives? What are they?
How have these interventions helped farmers achieve their livelihood goals and to what extent have they been sustainable?
Are there any other factors that could influence farmers opportunities in achieving their livelihood goals? (ethnicity, age, gender, wealth, education, power, political allegiance) etc.

Use of trees and shrubs in soil conservation and fodder production.
Do you think these farmers face any challenges related to land degradation? How is the situation?
Has there been any attempt to modify the existing natural grazing lands in this area? What interventions have been adopted
To your knowledge, have farmers in Lugusuulu adopted the use of fodder trees and shrubs as one of the interventions to increase and sustain fodder production? If so, which species are they using?
What qualities /characteristics do these species have?
What challenges do farmers face in establishing these fodder trees and shrubs?
Which fodder trees and shrub species would you recommend for farmers to use? Why?
Role of men and women in decision making in adopting use of these fodder trees and shrubs.

In your opinion, are there any differences between men and women in deciding on use of fodder trees and shrubs in this area?
What could be the factors that influence the level of participation among men and women in adopting use of fodder trees and shrubs in this area?

Thanks for your cooperation.

APPENDIX II: Interview guide for farmers

1. General information

- Gender of the respondents
  Male Female
- Age of the respondents

  20-29 years 30-39 years, 40-49 years, 50-59 years, 60-69 years, above 70……

- Position in the household
  Husband Wife child others specify……
- Level of formal education
  Primary secondary Tertiary/university
  Non formal
- For how long have you lived in this area? 1-5 years 5-10 years
  More than 10 years

2. Livelihood strategies of smallholder farmers

- What kind of activities do you do to make a living and to satisfy your needs?
- What are the assets/resources that you use to make a living?
- How do men and women perceive the opportunities in accessing these resources?
- Who takes a lead in deciding on how to access and use the available assets/ resources?
- What challenges do you face while using these assets/resources to achieve your livelihood goals?
- What are the coping mechanisms employed to counteract the above challenges?

- In your view, do you think your activities have an impact on the environment and its resources? If yes, how? To your knowledge, have there been any interventions by any agencies or government institutions in helping the communities in meeting their livelihood objectives? Can you please name them?
- In your opinion, have these interventions shaped you in achieving your goals and to what extent have they been sustainable? (Sustainability in this context refers to the general phenomenon of the continuation of the intervention or of its effects)
- Do you consider these interventions to have an impact on environment?
- If yes, what has been the role of the community in addressing these impacts?
- Are there any other factors that you feel are influencing your opportunities in achieving your livelihood goals? (e.g. ethnicity, age, gender, wealth, education, power, political allegiance etc.)?

3. Use of fodder trees and shrubs for fodder production and soil conservation and why these species are preferred

- Have you experienced any challenges related to land condition during farming? Can you describe these challenges?
- What has been the trends in occurrence of these challenges?
- Do you know of any attempt to modify the existing natural grazing lands in this area? What interventions have been done exactly?

- ❖ Have you adopted the use of fodder trees and shrubs in your operations to increase and sustain fodder production? If so, which species are you using?
- ❖ What qualities /characteristics compel you to use these species /what would you base on to increase the acceptability of fodder trees and shrub establishment?
- ❖ What challenges do you face in establishing these fodder trees and shrubs?

4. Role of men and women in decision making in adopting use of these fodder trees and shrubs.

- ❖ What roles do you think men and women play in adopting use of fodder trees and shrubs?
- ❖ In your opinion, are there any differences between men and women in deciding on use of fodder trees and shrubs in this area?
- ❖ What could be the factors that influence the level of participation among men and women in adopting use of fodder trees and shrubs in this area?

Thank you for your participation.