Restoring Connections: Tree Planting, Local Ecological Knowledge, and Inclusive Development in the Face of Deforestation at Mt. Elgon

A Case Study on Agroforestry, Gendered Security, and Local Ecological Knowledge in Uganda

Female farmer at Mt. Elgon balancing coffee berries in a bucket on her head. The picture was taken with accept from the farmer and she agreed that it could be used in the thesis. The picture is taken by Josephine Fogt Andersen during fieldwork at Mt. Elgon, Uganda.

Josephine Fogt Andersen *Student nr.:* 201808540

Exam nr.: 144614 *AU-ID.:* 601328

Master thesis in Human Security - 30 ECTS

Josephine Fogt Andersen

Student number: 201808540

Exam number: 144614

AU-ID.: 601328

Contact: 201808540@ecos.au.dk or josephinefogtandersen@gmail.com

Aarhus University

MSc Human Security

Department of Anthropology

Supervisor: Anne Mette Lykke and Katrine Gro Friborg

June 2025

Acknowledgements

I would like to thank my supervisors, Anne Mette Lykke (Aarhus Univeristy) and Katrine Gro Friborg (Copenhagen University) for their support and guidance during the fieldwork and in the process of writing of the thesis.

I would like to thank all the participants in this project, especially the host families in Uganda and the translators that made the fieldwork possible.

I would also like to thank the two students, who I shared the fieldwork experience with, Emilie Ellesøe and Mathilde Willemoes, you have been a great support.

Lastly, I would like to thank my friends and family for their support throughout the entire process. A special thanks to my mother, Helle Fogt Andersen, for final proofreading of the thesis.

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Characters, including space:
Summary: 3700 characters
Full thesis, excluding summary: 157.420 characters

Summary

This thesis investigates how deforestation has affected the relationship between coffee farmers and nature in the Mt. Elgon region of Uganda, and how it has influenced their local ecological knowledge (LEK). The study was conducted in partnership with the AfPEC project and is based on three months of ethnobotanical fieldwork with farmers in Bududa, Sipi, and Bufumbo. It explores LEK, species preferences, gendered security concerns, and the potential for agroforestry and tree planting to address environmental and socio-economic challenges.

Deforestation in Uganda is driven by colonial legacies, political instability, population growth, and dependence on forest resources. These pressures have alienated communities from forests, disrupted knowledge transmission, and reduced the availability of native species. As a result, LEK in Mt. Elgon is weakening. Farmers demonstrated limited knowledge of native plants and their relationship with nature was shaped by agricultural needs rather than cultural or spiritual values. This erosion of knowledge is influenced by factors such as landscape simplification, isolation, and shifting baseline syndrome, where each generation accepts degraded environmental conditions as normal.

The methodology combined qualitative and quantitative approaches, including nine semi-structured interviews with female farmers across three age groups, six focus group discussions with 30 participants, transect walks, and garden mapping to understand species availability and use. Participant observation throughout the fieldwork period provided additional insight into everyday practices, social dynamics, and informal knowledge sharing.

Findings show that species preferences were guided by availability and multifunctionality. Farmers prioritized trees and crops that contribute to income, food security, and climate resilience. Eucalyptus, avocado, and cordia were the most valued species for their roles in firewood, timber, food, and ecological functions. Women emphasized food and income-related species, reflecting their household roles and lack of access to income from coffee, while men focused more on species linked to environmental management. Older women were more concerned with environmental changes, possibly due to their longer-term perspective.

The study identified major security challenges for female farmers, especially economic, food, and environmental insecurity. These issues were amplified by gender inequalities in land access,

education, and decision-making power. Women expressed interest in tree species that could support food and income generation during the dry season, such as fruit trees and species used for firewood and timber. However, barriers such as limited access to seedlings, tools, and financial resources were common.

Agroforestry and tree-planting initiatives were seen as promising strategies, particularly when adapted to local conditions and demographic needs. While exotic species like eucalyptus are favored for their fast returns, this preference has environmental drawbacks and contributes little to LEK. Reintroducing native, multifunctional species could support biodiversity, restore ecological knowledge, and meet farmers' livelihood needs. Cordia, ficus, albizia, markhamia, and elgon teak were identified as native species with high potential.

This thesis concludes that sustainable development efforts in Mt. Elgon should integrate education, gender equity, and context-specific species selection. Addressing the erosion of LEK, prioritizing women's participation, and matching tree-planting efforts to farmers' practical and cultural needs are key to creating resilient and inclusive agroforestry systems.

Preface

This thesis is made in collaboration with the sustainable development project Agroforestry for People, Ecosystems and Climate (AfPEC) (https://afpec.info) at Mount Elgon, Uganda. AfPEC aims to address the challenges of agroforestry and tree planting initiatives and investigate the potential of agroforestry to fight climate change and biodiversity loss, and at the same time sustain local communities. The project is based around four case communities who practice traditional arabica coffee agroforestry situated in the Mount Elgon highlands of Uganda, specifically Bududa (Bududa District), Sipi (Kapchorwa District), Bufumbo (Mbale District) and Buginyanya (Bulamnuli District). Data was collected in collaboration with farmers in three of these communities Bududa, Sipi and Bufumbo. The data collection process lasted three months, where ten days was spent in each community with a host family, all fieldwork was done in close collaboration with farmers.

Background

Worldwide deforestation events are threatening people depending on the forest for natural resources (Turreira-García et al., 2017), and it is becoming an increasing problem in Africa (Hansen et al., 2013; Kyarikunda et al., 2017). Deforestation poses a threat to livelihoods dependent on the forest resources, as trees play a crucial role in sustaining human needs and providing ecosystem goods and services (Kyarikunda et al., 2017). Furthermore, deforestation is a great threat to biodiversity; tropical forests support at least 2/3 of the world's biodiversity while only covering 7% of the Earth's land surface (Bradshaw et al., 2009). Uganda is located in the Sub-Saharan Africa, it has a tropical climate which has enabled the growth of tropical rain forests that are spread around different regions of the country (National Forest Authority, 2025). Mount Elgon's montane forest ecosystem is characterized by diverse plant communities and provides crucial ecological services, e.g. as a watershed for big parts of East Africa (Muhweezi et al., 2007). The biodiversity of Sub-Saharan forests are connected to the availability of various forest resources which is used by the surrounding communities (Alule et al., 2023). Conserving and managing the forest resources is therefore of importance for both livelihoods and biodiversity conservation. To address the challenges of deforestation, there is a need to increase tree planting rates, with a focus on smallholder farmers who own most of the land in Uganda (Kyarikunda et al., 2017; Obua et al., 2010). For this thesis, the focus will be specifically on the Mt. Elgon region of Uganda, an area with widespread Highland farming systems. These areas are especially prone to landslides and water stresses which have the potential to ruin farmers' livelihoods, especially because efforts to address these issues have often been insufficient or ineffective (Galabuzi et al., 2021). This contributes to create panic and confusion amongst people living in these areas (Galabuzi et al., 2021). Agroforestry trees around Mt Elgon have often been abandoned shortly after implementation or farmers have failed to adopt the trees (Kiptot et al., 2007), this is especially true for women and youths (Galabuzi et al., 2021). Environmental degradation and loss of natural forest in these highland systems create firewood scarcity, a decline of soil productivity, landslides and food insecurity leading to neglection of farming efforts and livelihood (Galabuzi et al., 2021). A focus on indigenous knowledge systems has been suggested to reveal unrecognized human-nature relationships (Cocks et al., 2016; Díaz et al., 2015; Reed et al., 2024) and improve agroforestry systems in Uganda (Okullo et al., 2003), however this knowledge is in risk of disappearing due to various factors such as socio-economic, political, and environmental conditions and lack of documentation (Case et al., 2005; Turreira-García et al., 2017, 2015; Waiswa et al., 2015).

With this knowledge, this thesis wishes to explore how deforestation has affected farmers' relationship with nature on Mt. Elgon, Uganda, and whether it has influenced their local ecological knowledge. The study is based on existing literature and fieldwork conducted with coffee farmers from three communities involved in an agroforestry project in the highlands of Mt. Elgon. For a more applied approach, it investigates which native species are currently available to farmers and identifies which species are considered most important for different aspects of life, such as food production, income generation, environmental management, and cultural practices, while also assessing whether these species are primarily native or exotic. As women are disproportionately affected by deforestation and climate change due to systematic inequalities in workforce, land rights, education, access to resources, and decision-making power (Galabuzi et al., 2021; Guloba, 2014; Vincent, 2022), the research examines the importance of women inclusion in agroforestry projects, and the major security concerns faced by female farmers in the region. Finally, the study explores the potential for agroforestry- and tree planting initiatives to address contemporary issues for farmers at Mt. Elgon using the information gained through fieldwork and literature. Demographic factors such as gender, age, and community will be considered to identify potential patterns or differences in local ecological knowledge, security issues, plant availability etc., this will be done by asking the questions:

1. *How has deforestation influenced farmers' relationship with nature on Mt. Elgon, and to what extent has it affected their local ecological knowledge?*
2. *Which factors, influence how farmers select and value plant and tree species? Which species are considered most important within these categories? Do these perceptions vary across different communities, age-groups and between genders?*
3. *What are the primary security concerns among female farmers in the region? Do these vary between communities and age-groups?*
4. *Is there potential for agroforestry and tree-planting initiatives to address contemporary issues for the farmers at Mt. Elgon?*

To understand this, the events leading to widespread deforestation in Uganda will also be addressed through existing literature. The concept of Local Ecological Knowledge (Berkes, 2017) will be explained and its potential as a management tool explained through existing literature. Furthermore, the concept of Human Security will be introduced as an approach to understand the complexities of issues the farmers face at Mt. Elgon. Combined with data on key species identified by farmers, this knowledge can serve as a practical tool to address security-related challenges by highlighting species with the potential to contribute to solutions. By combining an understanding of farmers' needs, local

ecological knowledge, and security concerns, particularly among women, this thesis seeks to assess whether tree planting and agroforestry initiatives, can serve as practical and inclusive responses to environmental degradation and livelihood insecurity at Mt. Elgon.

Drivers of deforestation in Uganda

Deforestation in Uganda is driven by complex interactions of demographic, political and socio-economic factors. In the following paragraph the most relevant drivers of deforestation in Uganda will be explained with a specific focus on the Mt. Elgon region.

Colonial and political impacts on forest management in Uganda

Colonial rule and political shifts have been the cause of difference in forest management politics in Uganda. During the British colonial rule, 1894-1962, forest management was highly connected to resource extraction and control (Turyahabwe, 2010). The British used the forests for logging but they also introduced major cash crops such as coffee, tea, sugarcane and cotton (Turyahabwe, 2010). To create space for plantations with cash crops, massive areas of forest had to be cut down (Turyahabwe, 2010). In 1898 forest resources fell under colonial control as the colonial powers realized that the resources of the forest needed protection as to not run out (Turyahabwe, 2010). The colonial concerns for over-exploitation created the groundwork for what can be explained as “fortress” conservation, where protected forest areas, forest reserves, would restrict people from access to the forests and forest resources (Petursson et al., 2013). Forest reserves were created with the objective of governing natural resources and provide timber for the colonial interests, this meant that local community settlements, cultivation and hunting was banned while some extraction of non-timber forest products was allowed (Petursson et al., 2013). After gaining independence in 1962, there was a shift in forest management from local to centralized state control, a transition that weakened local management practices and contributed to a disconnect between the users of the forest and the official conservation policies (Petursson et al., 2013).

When Idi Amin became president of Uganda in 1971, a new rhetoric was ignited on returning land to the people that had been stolen by the British (Petursson et al., 2013). Land within forest reserves was granted to local people, politically loyal groups, and veterans. The president hereby facilitated agricultural expansion in the forest reserves, leading to encroachment of protected forests, including Mt. Elgon (Petursson et al., 2013). This period was characterized by widespread forest degradation due to illegal settlements, logging and agricultural conversion. In Mt. Elgon alone, during

the period of 1973-1988, 15.500 ha of native forest was lost and significant parts of the forest was degraded (Petursson et al., 2013).

The period after Idi Amins presidency was characterized by instability and unclear land rights. After Idi Amin was overthrown in 1979, the country went through multiple political transitions, having many presidents with very short terms, this led to further destabilization of forest protection (Petursson et al., 2013). In 1986 a National Resistance Movement was established (Petursson et al., 2013). Even though they restored some order, land rights and conflicts still remained unresolved (Petursson et al., 2013). Examples of this from Mt. Elgon was seen in conflicts between the two ethnic groups, Sabei and Bagisu, and a resettlement case of the Benet people, both leading to further displacement of people, giving them nowhere else to go than the forest, causing further deforestation (Petursson et al., 2013; von Kocemba et al., 2025). By evicting or relocating communities, intergenerational knowledge transmission is interrupted. Elders cannot teach sustainable practices like wild plant harvesting or rotational grazing in landscapes they no longer access (von Kocemba et al., 2025; Waiswa et al., 2015).

As Museveni gained power in 1987, foreign donors, especially from Europe and the United States of America supported the rehabilitation of the protected area network (Ditiro et al., 2008; Petursson et al., 2013; von Kocemba et al., 2025). The Mount Elgon forest reserve was converted into a national park in 1993, enforcing access restrictions and strict regulations (Petursson et al., 2011). The Ugandan Wildlife Authority was established in 1996 to maintain the management of all protected areas in Uganda, including the Mount Elgon National Park (Uganda Wildlife Authority, 2022). As a consequence of the establishment of national parks, local communities lost access to forest resources (Petursson et al., 2011; Waiswa et al., 2015). This created conflicts between the local communities and national park authorities on land rights and access to resources (Petursson et al., 2013; von Kocemba et al., 2025). Collaborative resource agreements, allowing local communities some access to surrounding national parks and their resources, were established as a measure to stop these conflicts (Petursson et al., 2011). In the 2022 Mount Elgon National Park General Management Plan, it is stated that communities neighboring the Mount Elgon National Park will be allowed to harvest resources within a resource use zone, marked as a 1-kilometre-wide strip along the boundary (UWA, 2022, p. 26). In this zone, communities may collect firewood, medicinal plants and other approved resources (UWA, 2022, p. 26), what these approved resources consist of is not further described, however grazing with domesticated animals, poaching and overharvesting is described as illegal activities leading to prosecution (UWA, 2022, p. 24-25). Conflicts between local communities

and the National Park administration is an ongoing issue in communities surrounding the Mt. Elgon National Park (von Kocemba et al., 2025). Despite the initiatives to protect the forests in Uganda, the area of natural forest is still decreasing. In the period between 1990 and 2020, a decrease of 45%, from 3.4 to 1.9 million ha, was seen (Odeke and Senyonjo 2020).

Population growth, agricultural expansion and biomass fuel dependence

Since the 1960's the population of Uganda has increased from an estimated 7 million people to 51 million people in 2025 (United Nations, 2025), this is a population increase of 628% in just 65 years. Compared to Denmark the population increase in the same period was around 28%. In the same time period, the life expectancy at birth in Uganda has changed from 45.6 years in 1960 to 68.7 years old in 2025 (United Nations, 2025). At the current moment the median-age of population is 16.9 years old (United Nations, 2025). This means that people live much longer than they used to, furthermore most of the population in Uganda are young people. This generation is expected to live for at least 50 years more, creating a prospect of an old generation in Uganda, much bigger than it has previously been. The population in Uganda is currently increasing at a rate of 2.7% per year (United Nations, 2025). This percentage reflects how much the total population increases annually due to births, deaths, and net migration. A 2.7% annual growth rate is considered high, indicating rapid population increase.

Deforestation due to population growth has become a huge threat in Uganda (Kyarikunda et al., 2017). Smallholder farmers own approximately 70% of the land in Uganda (Kyarikunda et al., 2017; Obua et al., 2010), leading to a huge demand for forest resources such as firewood, timber, and poles for construction (Drigo, 2005; Kyarikunda et al., 2017). Over 90% of Ugandans rely on firewood and charcoal for cooking and heating (Jagger and Kittner, 2017). Furthermore, there is an increasing need for land to accommodate crops and livestock leading to extended land use changes (Kyarikunda et al., 2017). In densely populated areas deforestation has been a greater issue due to a higher demand for forest resources and land (Sassen et al., 2013; von Kocemba et al., 2025). Mt. Elgon has for a long time been a highly populated and cultivated region, known for its coffee production (Sassen et al., 2013). Deforestation on Mt. Elgon has been revealed to be linked to population density and agricultural wealth, especially from coffee farming, as this creates strong incentives to clear forest (Sassen et al., 2013). The most significant forest loss on Mt. Elgon has occurred in densely populated zones, where land scarcity and livelihood needs have driven agricultural expansion into protected forests (von Kocemba et al., 2025). This underscores how population density, especially when combined with limited land access and economic vulnerability, is a critical driver of deforestation in

Uganda's highland regions. Environmentally, the degradation of natural ecosystems due to increasing population pressure, deforestation, and climate variability, diminishes the ecological context in which local ecological knowledge can be practiced and passed on for farmers at Mt. Elgon.

In an article by Waiswa et al., 2015 where proximate and underlying drivers of deforestation in the Lake Victoria Crescent area of Uganda are investigated. They conclude proximate causes to be linked to agricultural expansion and unsustainable use of forest resources, however they focus on how underlying factors such as policy and institutional factors, economic factors, population growth, technological changes, and changes in culture have resulted in alienation of local people from forest resources and that this alienation is the most important underlying driver of deforestation. Alienation is in the article described as "*a psychological dispossession of responsibility for forest resources"* (Waiswa et al., 2015, p. 259) this underlines the feeling local people experienced as they were restricted access from forest and had a feeling of losing ownership of forest resources (Waiswa et al., 2015). This resulted in people losing interest in maintaining forests and subsequent intensification of illegal use of forest resources, which therefore increased deforestation (Waiswa et al., 2015).

Local Ecological Knowledge

Local Ecological Knowledge as a management tool

Local ecological knowledge is being recognized as a valuable tool for conservation efforts (Gadgil et al., 1993; Turreira-García et al., 2017), and might be able to enhance biodiversity at landscape level (Gadgil et al., 1993). As Berkes et al., 1998 describes it, traditional knowledge has the opportunity of complimenting scientific knowledge by providing practical knowledge of living in ecosystems and responding to changes in these ecosystems. The knowledge held of plants that are useful for medicinal purposes, food, and construction can help build resilience in the face of adversity (Turreira-García et al., 2017). Indigenous Peoples and people dependent on the forest for resources are known to hold important and unique knowledge on natural resources and the environment they live in (Martin, 2004). However, factors such as deforestation, acculturation and alienation threaten local ecological knowledge (Case et al., 2005; Waiswa et al., 2015) and that cultural loss can occur within just one generation under rapidly changing socio-economic, political, and environmental conditions (Reyes-García et al., 2013). Ethnobotanical knowledge is especially at risk of disappearing with deforestation and loss of biodiversity. Ethnobotanical knowledge is dependent on the availability of a species, meaning that if a specific plant species is not available, it cannot be used and therefore knowledge of this plant could disappear (Gadgil et al., 1993; Turreira-García et al., 2017). Additionally,

ethnobotanical knowledge is primarily transmitted orally and is rarely documented, which contributes to its vulnerability of disappearing (Case et al., 2005; Turreira-García et al., 2017, 2015). Ethnobotanical knowledge can however be important for scientific purposes as it might be used to investigate biodiversity (Salick et al., 1999) and to clarify to what degree a community is dependent on plant resources, leading to an understanding of the consequences of resource use in this area (Araújo and Lopes, 2012). Understanding the importance of local ecological knowledge, Indigenous Knowledge and ethnobotanical knowledge held by communities dependent on natural resources is therefore being acknowledged as an important factor in conservation efforts (Alule et al., 2023; Egeru et al., 2019; Ssenku et al., 2022).

The literature refers to different concepts when describing knowledge systems rooted in long-standing relationships between people and their environments. The terms *Local Ecological Knowledge (LEK)*, *Traditional Knowledge (TK), Traditional Ecological Knowledge (TEK), Indigenous Knowledge (IK)*, and *Ethnobotanical Knowledge* are often used interchangeably. While some differences do appear between these concepts, they share the intent of understanding a knowledge people hold, often with a focus on their relation to nature. Ethnobotanical knowledge focuses more narrowly on plant use and related practices (Martin, 2004), which is often integrated in the other concepts. LEK, TK, TEK and IK could be seen as more broad concepts and are harder to separate. All the concepts would be relevant to describe the data collected for this thesis, however, as LEK refers to knowledge held by people whether or not they identify as Indigenous (Berkes, 2017), and as to create least confusion, the concept of Local Ecological Knowledge will primarily be used throughout this thesis.

Local Ecological Knowledge and Shifting Baseline syndrome

The concept of Shifting Baseline Syndrome was first introduced by Daniel Pauly (1995) in a context of fisheries. The concept was referred to the way individuals would perceive environmental conditions they encounter in the early stages of their life, as the baseline for what is normal, rather than using historical information (Pauly, 1995). This would lead to a normalization of an already degraded ecosystem, as each generation would have a new baseline and a lack of recognition of ongoing degradation (Soga and Gaston, 2018). Causes for shifting baseline syndrome is by Soga and Gaston, 2018 claimed as being related to the three causes: 1) lack of data on the natural environment, especially with the focus that most scientific material on the natural environment is made recently (Soga and Gaston, 2018), 2) loss of interaction with the natural environment, here they focus on the physical removal from nature due to urbanization, the loss of opportunity to interact with nature as it

is not available and the lost interest in interacting with nature (Soga and Gaston, 2018), and 3) loss of familiarity with the natural environment, this is argued to be caused by a lack of knowledge of natural history as this is less available, both from informal and formal sectors (Soga and Gaston, 2018). These causes all enable the Shifting Baseline Syndrome, which then leads to consequences that lead to a decline in the state of the natural environment (Soga and Gaston, 2018). These consequences are explained to be; An increased societal tolerance for gradual environmental degradation, shifting public expectations of what constitutes a desirable state of the natural environment that is worth protecting, and the establishment of inappropriate targets for conservation, restoration, and management by policymakers and resource managers (Soga and Gaston, 2018). Hanazaki et al., 2013 connects the loss of Local Ecological Knowledge to be related to a changing baseline in the perception of nature.

Local Ecological Knowledge and Agroforestry- and tree planting initiatives

Agroforestry and tree planting initiatives are being acknowledged to present a versatile solution to contemporary challenges. The management method is centered around integrating trees into agricultural systems (Elevitch et al., 2018). By doing so, it can help mitigate climate change through carbon sequestration and temperature regulation, furthermore it conserves soil health, contributes to water management, and supports the local biodiversity (Abbas et al., 2017; Elevitch et al., 2018; Toensmeier, 2016). Agroforestry also has the potential of diversifying income sources for farmers such as timber and fruits (Galabuzi et al., 2021). It may also help to tackle issues linked to land scarcity and the lack of preferred tree products within households led by women and youth in the Mount Elgon region (Galabuzi et al., 2021). Failures of sustainable development projects is however not uncommon, and these can often be linked to external constraints specific to the social context (Chambers et al., 2020; Ika, 2012). Some suggest that these constraints are linked to unrealistic assumptions about participation (Kumar et al. 2002) or by self-selection biases causing broader economic drivers to be overlooked (Chambers et al., 2020). Jacobi et al., (2017) explains that even though agroforestry projects do aim to integrate local knowledge, external expertise is still prioritized and valued greater than local knowledge. He argues that there is a lack of dialogue, collaborative learning and an undervaluation of local knowledge. These factors are claimed to be crucial for projects and policies to "*contribute to a culturally, socially, and environmentally acceptable understanding of development."* (Jacobi et al., 2017, p. 474).

Agroforestry has the potential of being a multi-purpose-solution to challenges of deforestation and livelihood, however it seems important to put a greater focus on the inclusion of Local Ecological Knowledge in sustainable development projects.

Human security

Introduction to the concept

To use the theoretical framework of Human Security, a short historical and theoretical assessment of the concept's existence will be made. The Human security concept is relatively new, but the concept of security has been used and discussed for a long time by many different scholars. It has ranged from a more traditional state centric approach to a broader more individual focused approach. Due to its vagueness and subjectivity the concept was criticized by Baldwin (1997) as he claims that security is a concept that is neither defined nor discussed enough by scholars who uses the concept (Baldwin, 1997). Baldwin underlines that a broad and multidimensional way of thinking of security is necessary, security is not limited to military threats but encompasses a wide range of issues, including political, economic, societal, and environmental dimensions (Baldwin, 1997). He thereby argues that security is a dynamic and evolving concept that will change over time, e.g. in response to changes in the nature of threats, the technological advancements etc. Baldwin (1997) hereby contributes to the understanding that security is not a fixed concept, it is influenced by different factors and perspectives. The emphasis on a multidimensional and subjective understanding of security aligns with broader trends in security studies that recognize the complex and interconnected nature of contemporary security challenges (United Nations, 1994). The field of security studies emerged in the aftermath of World War II, during a period marked by significant international transformations and the rise of bipolar global politics, which strained inter-state relations and exposed new types of threats (Tadjbakhsh and Chenoy, 2006). These developments highlighted the need to address the increasing complexity of threats in a globalized world. Such a multidimensional perspective aligns closely with the extensions proposed in the Human Security Framework.

The Human Security framework was introduced as extensions to the concept of security. Before the extensions security was a concept that was discussed and criticized for its vagueness and subjectivity (Baldwin, 1997) with some scholars arguing it to be an essentially contested concept (Buzan and Waever, 2007). A contested concept is the definition of a concept where its meaning and implication is continuously debated, without scholars being able to reach agreement (Gallie, 1955). However, the security concept was state-centric, focusing on military threats. Baldwin, 1997 argued that this state-centric approach to security should be replaced by a multidimensional way of thinking

of security. This should include a wide range of issues, including political, economic, societal, and environmental dimensions (Baldwin, 1997).

The extensions were presented in the UNDP framework from the *Human Development Report* and shifted the focus from security of states to the security of people, emphasizing freedom from fear, freedom from need and a life with dignity (United Nations, 1994). The framework encompasses the seven pillars: personal-, political-, community-, economic-, food- health- and environmental security (United Nations, 1994), hereby introducing a holistic approach to security, with all dimensions being equally important. These aspects entail, in the given order, freedom from violence, human rights, collective identity, economic stability, access to food, being healthy and living in a healthy environment (United Nations, 1994). With these extensions, the responsibility of ensuring security not only included national states, but also international institutions, regional and local government etc. (Rothschild, 1995).

Security related issues due to deforestation and unequal gendered impact

As the following investigation of literature demonstrates, women experience heightened insecurity in the face of deforestation and climate change. This is especially explained by issues such as unequal workforce with women and children carrying over 70% of labor in agricultural production (Guloba, 2014), unequal access to education due to early marriage and unequal land rights (Galabuzi et al., 2021). The insecurities women face are especially connected to problematics of income-, food-, environmental-, health-, and personal security. To better understand the specific vulnerabilities of female farmers in rural areas of Sub-Saharan Africa, the factors leading to a disproportionate effect on female farmers in each of the mentioned security pillars will be elaborated on (Akampumuza et al., 2020; Atukunda et al., 2020; Balikoowa et al., 2019; Denton, 2002; Galabuzi et al., 2021; Gorettie et al., 2019; Guloba, 2014; Kawuki et al., 2021; Rutakumwa and Krogman, 2007; Vincent, 2022).

Income security: The eastern part of Uganda, where Mt. Elgon is situated, is among the most densely populated and agriculturally productive regions in the country. The majority of the population are poor subsistence farmers relying on rain-fed agriculture (Balikoowa et al., 2019). Research shows, that of the relative income of African farmers, crops account for around 32%, furthermore they are highly reliant on natural resources as this contributes up to 20.5% of the household income (Angelsen et al., 2014). In a study by Galabuzi et al., (2021) on the participation of women and youths in agroforestry at Mt Elgon, Uganda, it was shown that around 70% of women and youths rely on crop farming as a central source of income. Many of the women involved in farming activities were

generally poor, illiterate and faced issues related to land security (Galabuzi et al., 2021). Often the reason for this would be, that the women had engaged in marriage at an early age, forcing them to stop their education (Galabuzi et al., 2021). It is also seen that formal employment sectors of Uganda is dominated by men while informal are dominated by women (Guloba, 2014). As women account for much of the agricultural workload and as household work is largely the domain of women in Africa, e.g. collection of water and firewood, another economic issue arise as women simply have less time for moneymaking activities than men (Denton, 2002; Guloba, 2014).

Environmental security: Climate change impacts have an unequal impact on women. Research reveals that farmers have noticed changes in weather patterns with rain starting later and ceasing earlier than usual, these observed changes could especially affect farmers who lack the ability to adjust to them (Balikoowa et al., 2019). The Mt. Elgon region has been severely affected by climate change impacts, with some of the most devastating events being the Bududa landslides, which occurred repeatedly between 1997 and 2010 (Balikoowa et al., 2019). These landslides happen often, some more severe than others. In 2010 a huge landslide in the Bududa district killed around 300 people (The Independent, 2021) and in 2022 landslides damaged more than 50 households and affected up to 300 people (The Independent, 2022). Especially women seem vulnerable in the effects of climate change, partially explained by women having a lower adaptive capacity as they do not have the same access to resources, they have a low decision making power (Balikoowa et al., 2019; Gorettie et al., 2019; Vincent, 2022), and are less likely to adopt new crops, technologies and farming practices (Vincent, 2022). The consequence of this being a lower agricultural productivity and a need to use social networks to access resources that are not easily available (Vincent, 2022). Furthermore women have limited mobility in events of extreme climate events, and their core activities are highly dependent on natural resources, like access to food, water and energy (Balikoowa et al., 2019). Access to credit and hereby the opportunity of buying farming inputs, was seen to positively influence the decision of female farmers to adopt to climate change (Nabikolo et al., 2012).

Food security: Gender is a determinant for food security, male-headed households have a consumption advantage, while female-headed households are more than twice as likely to rely on borrowing food (Vincent, 2022). Female-headed households of Uganda have also experienced higher post-harvest losses of bananas than male-headed ones (Vincent, 2022). Empowering women in coffee agriculture in Uganda, through control of coffee production and income, has been suggested to not only foster equality but also contribute to better nutrition uptake (Chiputwa and and Qaim, 2016).

Female-headed households also suffer from a larger consumption decline in the face of extreme climatic events, due to their lower adaptative capability (Akampumuza et al., 2020).

Health security: Health and nutrition status is often linked with gender and household headship (Vincent, 2022). Since gender influenced household consumption patterns, there is an inequality to nutrient access between men and women, which can lead to health issues, especially for women. Furthermore, issues of sexual transmitted diseases are reported to be a significant health problem amongst men and women, for women this can be linked to lack of education (Rutakumwa and Krogman, 2007). The mortality rate during birth in Uganda is also one of the highest in the world, and only around 70% of women deliver in a health facility (Atukunda et al., 2020).

Personal Security: Personal security for female farmers is at risk due to their limited mobility during climatic events, however they also suffer from other security issues. Women are e.g. more exposed to gender-based violence (Vincent, 2022), and women living in rural areas of Uganda are more likely to experience sexual violence than women living in the urban areas (Kawuki et al., 2021). Furthermore, a study reveals that beating of a female partner was considered justifiable in some cases by 70% of men and 90% of women, indicating a cultural accept of this (Koenig et al., 2003).

Agroforestry as a tool to mitigate security issues and inequality

Agroforestry and tree-planting initiatives can be a way to address some of these challenges (Galabuzi et al., 2021). The inclusion of women who often stay close to home and cultivates small agricultural plots fits well with these initiatives. Within agroforestry, there is a wide range of products that specifically appeal to women and can be used for both self-sufficiency and local marketing. Planting of trees has the potential to contribute with valuables such as fruits, firewood, medicine and clothing, all benefits that can help address hunger and poverty (Galabuzi et al., 2021). The incentive for women to participate in tree planting has been shown to be related to access to free seedlings, availability to good soil conditions and participation in training programs to build their capacity (Galabuzi et al., 2021). It seems that the women in these areas have the wish to get education on the matter to increase their ability to face the challenges that they are currently up against.

Methodology

Fieldwork was conducted in the time frame from September 21st to December 21st, 2024. The fieldwork built on a mix of quantitative and qualitative research methods with an overall

ethnobotanical approach, allowing the research to investigate the relationship between people and nature.

The following methods, i-iv, were based on the Participatory Rural Appraisal approach, enabling the local people to share, analyze, and enhance their knowledge of their own condition (Chambers, 1994). These methods include i) Semi structured interviews, ii) transect walks and garden mapping, iii) focus group discussions and iv) participatory observations. To ensure triangulation of the data, a quantitative survey estimating the importance of specific crop- and tree species was also included.

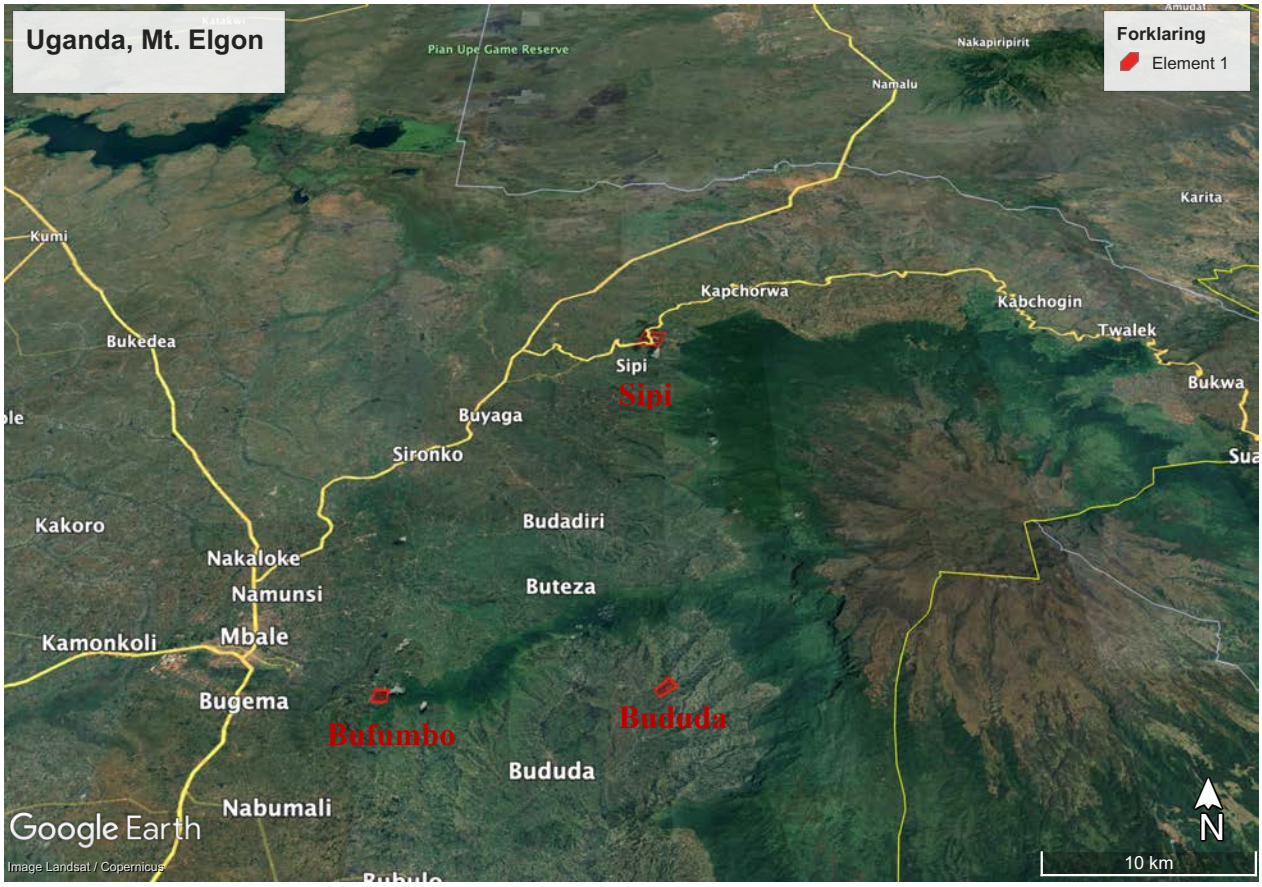
In each community a local person was selected to help translate during interviews. For each interview, the informant chose whether translation was needed, to understand the questions or to communicate their answers. The study focused on farmers who were members of coffee cooperatives in their community. These cooperatives varied in number of members between the communities, with Sipi having most members and Bududa having least, but shared that the members of these had agreed to participate in the AfPEC project. Female farmers that participated in the semi-structured interviews were all interviewed in their home. The focus group discussions were held in community buildings or buildings owned by the cooperative.

Prior, informed consent with the locals, especially the informants, was important. Before arriving at the communities all members of the cooperatives were informed about the research. Furthermore, participation in a kick-off meeting, to commence the beginning of the AfPEC project, allowed for representants of each community to gain insight in the research topic of this project and share this with their respective cooperatives. Before commencing the fieldwork, a visit to all communities also allowed for members in the cooperative to gain knowledge and build trust towards the research. In each community ten days were spent with the voluntary host family. Staying with a host family allowed to build trust with the locals, gain a better insight in the day-today lives in the communities and a larger timeframe for the fieldwork to be conducted. All informants were informed that participation in the research was voluntary, all informants decided to participate in the study.

Research area

The research took place in eastern Uganda on Mt. Elgon, an extinct volcano. This area is characterized by its rich biodiversity, fertile volcanic soils, and variation of gentle and steep slopes (Sassen et al., 2013), the annual rainfall ranges from approximately 1.200 mm and 2000 mm, however with variation depending on the slope (Balikoowa et al., 2019; Sassen et al., 2013). There are two dry

seasons, the first between July and August and the second between December and February, however rain falls all year around (Sassen et al., 2013). Mt. Elgon serves as an important water catchment area for the Turkwell and Lake Turkana systems, the Lake Victoria Basin, Lake Kyoga and the Nile Basin (IUCN, 2005). The vegetation is an afromontane forest belt with a great biodiversity, including 39 endemic species of vascular plants and many species with limited distributions (Sassen et al., 2013). It serves as a vital ecological zone and is home to numerous communities who depend heavily on agriculture for their livelihoods. The research specifically took place in the three communities Bududa, Sipi, and Bufumbo. These are each situated on different slopes of the mountain, the slopes of Bududa, are steep and prone to landslides. These communities are primarily inhabited by two ethnic groups, the Bagisu, who occupy most of the western and southern areas, including Bududa and Bufumbo, and the Sabei, found predominantly in the northern parts around Sipi (Sassen et al., 2013). The Bagisu are traditionally agriculturalists, culturally tied to coffee cultivation, while the Sabei have historically practiced pastoralism but have increasingly adopted farming under the influence of land scarcity and migration, in the 1980s they also turned to agriculture for cash (Sassen et al., 2013). Socio-economically, the introduction of coffee was a significant turning point for local communities at Mt. Elgon, reportedly giving the area the second highest per capita income in Uganda in the 1950s, especially the agriculturalist Bagisu gained power from this (Sassen et al., 2013). In the early to mid-20th century, since the introduction of coffee, the livelihoods of the Bagisu and Sabei shifted to relying on coffee as the main income source. Climate change is significantly impacting the Mt. Elgon region, affecting agriculture, soil erosion, and livelihoods. Studies report changes in rainfall patterns, temperatures, and fog, leading to increased pests, diseases, and reduced crop yields (Aggrey et al., 2024; Kagezi et al., 2018). Local communities' perceptions of these changes align with meteorological data (Bomuhangi et al., 2016). Infrastructure in the Mt. Elgon region has developed in recent years. Historically, the Sabei have been behind in terms transport and access to agricultural support (Kasfir, 1976, referenced in Sassen et al., 2013). In 2003 a road from Mbale to Kapchorwa was constructed (Sassen et al., 2013) with the construction of a road this was no longer the case. The roads leading to Sipi were far better than the roads to Bududa and Bufumbo. Furthermore, Sipi is a tourist area known for the Sipi Falls, which means that investments are prioritized in the infrastructure to this area, a new road was e.g. constructed in April 2025 (Samuel, 2025).



Research area: The picture depicts Mt. Elgon, with the three communities, Sipi, Bududa and Bufumbo, marked with red. The map is constructed using Google Earth Pro (Google Earth Pro, 2023).

Methods

The study is an ethnobotanical study (Martin, 2004), investigating how people at Mt. Elgon use and manage the plants- and trees they have available to them. Ethnobotany is known for including different disciplines as social sciences and natural sciences. This study seeks to include a mix of qualitative and quantitative methods, including both social- and natural science approaches. By doing so, it seeks to ensure triangulation of the data. The Human Security Framework will be applied to examine the security challenges faced by female farmers and to evaluate whether the ethnobotanical data can offer insights or solutions to these issues.

Sampling method of informants

Informants were selected from lists of cooperative members in each community. Firstly, three women were selected for the semi structured interviews. The selection process was done by dividing all women into three age groups of 18-35, 36-50 and 50+, then one woman was randomly selected in

each age group. Secondly respondents for the focus group discussion were chosen. Five men and five women were randomly chosen from the list, excluding the three women who were chosen for the semi structured interview to avoid duplication bias. The participants for focus group discussions were not divided into age groups prior to selection.

Semi structured interviews (See Appendix 1)

Semi structured interviews were carried out with the selected female informants in each community, adding up to nine interviews in total. The interviews were loosely structured with a somewhat set framework and headlines, but allowing to follow up on information and delve into other relevant subjects brought up by the informant. The main headlines for these interviews were 'Nature-Relation and Plant Knowledge', 'Security and Nature's Role' and 'Cooperative Membership and Engagement'. The interviews were held at the informants' house, in as private a setting as possible as this could reduce anxiety amongst the informants (Longhurst, 1996). It was recommended that no one else should be in the room, but in some cases, this was not a possibility. Transect walk and garden mapping of the nearest coffee garden with the farmers took place before or after the interviews.

Transect walks and garden mapping (See Appendix 1)

Transect walks can be a useful method to get an overview of research locations and enable participatory learning (Okoko and Prempeh, 2023). To get a better understanding of the trees and plants available to the informants they were asked to show their coffee garden, explain which plants and trees they had in their garden, besides coffee, and explain the use of these plants. To remember the layout and species grown in the garden it was sketched by the interviewer or the translator in collaboration with the farmer. The sketch was a rough outline of the garden including all trees, except for coffee trees, and all crops or other plants grown in the garden. This allowed for an informal setting where the informants had an extra opportunity to explain which plants and trees were important to them in their day-to-day lives and their use.

Focus group discussion with ranking exercise (Cleaver, 2018) *(See Appendix 2)*

Focus group discussion were conducted with the selected informants in each community, with a total of six interviews and thirty respondents. Focus group discussions were used to ensure triangulation of information, create a space for the participants to discuss and engage with each other, and observe group dynamics. The discussions were loosely structured with the headlines; 'Nature relation/

understanding of nature', 'Basic understanding of cooperative and farmers', 'Knowledge sharing amongst farmers', 'Roles in the cooperative', 'Training possibilities and barriers', 'Plant use, importance, availability and potentials', 'Complications for farmers' and 'Potential for innovation'. During the discussion the participants were asked to rank the three most important plants or trees for the categories: medicine, firewood, timber, income, food, fodder, resilience and spiritual/ religious purposes. Soft drinks and snacks were provided during the discussion and participants were refunded if they had travel costs. The refund led to some complications which will be addressed in the discussion.

Participant observations

Participant observations were used to gain insight into how farmers interact with nature, apply their local ecological knowledge in agroforestry coffee farming, and engage in tree-planting initiatives. It allowed for the documentation of knowledge and practices that were not explicitly mentioned in interviews, while also providing a deeper understanding of daily routines, power dynamics, and gender roles within the community. These observations helped reveal how women's knowledge is integrated or overlooked in decision-making processes and agricultural practices. These observations took place during the entire period of fieldwork in each community. Staying in the village and living with a member of the cooperative allowed for firsthand insight and opened opportunities of participation in savings meetings, church services, festive arrangements and other activities in the cooperative and community. Data was collected whenever possible and noted in a book. These observations will be used in addition to and when interpretating the interview data.

Data processing

All interviews were transcribed using Otter.ai, ensuring responses being documented accurately (Otter.ai, 2025). To maintain participant anonymity each respondent was given a pseudonym. The interview transcripts where then uploaded to Nvivo15, a qualitative data analysis software, to facilitate systematic coding and thematic analysis (QSR International, 2020).

Before coding, each interview was assigned to relevant case attributes such as gender, community, interview type and age group. This allowed for relevant comparative analysis to ensure that different themes could be analyzed across groups. A coding framework was created based on the thematic of the interview guides and the research question. The coding framework was designed to capture relevant information on; 1. Farmers' relation to nature and their Local Ecological Knowledge, 2. Important plant- and tree species and the use of these, 3. Primary security concerns amongst female

farmers (food-, health-, environmental-, economic- and personal security), 4. Challenges and innovation potential for agroforestry farmers. The structure was divided into the following themes with sub nodes.

Theme	**Subnodes**	**Details**
1. Local Ecological Knowledge	Cultural/ Spiritual Medicinal Ecological/ Agronomic	
2. Nature Relation	Definition of nature Nature's role in daily life Interactions with nature Spiritual connection to nature	
3. Important plant- and tree species for farmers at Mt. Elgon	Plant- and tree uses	Environmental management, firewood, fodder, food, income, medicine, religious/spiritual use, timber
	Species Selection	Available species, important species, lost/unavailable species, species farmers want to introduce
4. Security issues for farmers at Mt. Elgon	Economic Security	Gendered differences, agroforestry income, market access, seasonal struggles
	Environmental Security	Agroforestry in climate adaptation, risk perceptions
	Food Security	Preservation, seasonal scarcity, perceptions

	Health Security	Access to and use of medicinal plants
	Personal Security	
5. Challenges in Agroforestry		Access/structural, economic, environmental, gender-specific, knowledge gaps, safety, vandalism/theft
6. Innovation and Solutions in Agroforestry		Business ideas, farming development, inputs

To establish a good workflow during coding a two-stage coding approach was used. First stage was coding relevant text fragments to the bigger themes or parent nodes (1-6), second stage was coding the text fragments into smaller fragments and assign them to sub-nodes (QSR International, 2020). The text fragments were both assigned to the relevant thematic node and simultaneously to a case node to ensure a connection with the correct interview. This dual coding structure enabled gender-based and location-based comparisons using Matrix Coding Queries in NVivo. After coding all interviews, different Nvivo queries and visualizations (QSR International, 2020) were used to interpret the data and look for trends and patterns.

Nature relation

Word Frequency Queries (QSR International, 2020) were used to investigate the four sub-nodes of the node 'Nature relation'. Words shorter than four letters were found to be not relevant. The minimum word length was set to 4 letters and stemmed words were included. Words that did not provide a descriptive or emotional explanation for the farmers' nature relation were added to the 'Stop Words List'. This created a Word Cloud illustrating a weighted ranking of words mentioned by the farmers in the different categories. To give a deeper understanding of the farmers' relation to nature, relevant quotes from individual- and group interviews were selected and collected in a textbox.

Local ecological knowledge

Whenever farmers mentioned uses of specific plant- or tree species, with a cultural, spiritual, medicinal or ecological meaning, this would be coded together and collected under Local Ecological Knowledge. The information given was then used to create a table showing the Local Ecological

Knowledge farmers had presented during interviews. Information was excluded if it was not considered local ecological knowledge. This distinction was made, based on if the farmers expressed any cultural or spiritual connection to the species, or if the species was used in traditional ways. The origin of each plant- and tree species was then investigated and added to the table either as native or exotic (see description beneath). Relevant quotes are included in the appendix (Appendix 3) and may be referenced in the results to support interpretation.

Introduction of the terms native and exotic:

Throughout this thesis *native species* refers to plants that are native to the Mt. Elgon area. *Exotic species* are defined as those introduced from outside the region, including both domesticated species from other parts of Uganda and exotic species from different continents.

Important plant- and tree species for farmers at mt. Elgon

Species availability, importance and desires

Word Frequency Queries (QSR International, 2020) were used to investigate the sub-node 'Species selection'. Words shorter than four letters were found to be not relevant. The minimum word length was set to four letters and stemmed words were included. Words not related to plant or tree species were added to the 'Stop Words List', keeping only plant and tree-species mentioned. This created a Word Cloud illustrating a weighted ranking of the species mentioned by the farmers in the different categories, available species, important species, lost/unavailable species, species farmers want to introduce. Relevant quotes are included in the appendix (Appendix 3) and may be referenced in the results to support interpretation.

Species use

To understand patterns of species use across different social and demographic categories, data were analyzed and compared based on age, gender, interview type, and community. Matrix coding (QSR International, 2020) was used to investigate the sub-node 'Plant- and tree uses'. The rows were selected as the attributes; community, gender, age and interview type and the columns were selected as the items in the investigated nodes. The items of 'Plant- and tree uses' were environmental management, firewood, fodder, food, income, medicine, religious and spiritual use and timber. For the row 'gender', only the data from the focus group discussions was used, as the semi structured interviews were only done with women, and therefor left out of the gender comparison. For the row 'age' only semi-structured interviews were included, these were only done with women. Age data

was not collected in focus group discussions. Bar plots were created for each attribute for easier analysis and comparison. For a full data table see Appendix 7.

Investigation of species importance using quantitative data **(Appendix 4)**

The data collected in the ranking exercise was transferred to excel with the variables; Category (food, fodder, income, medicinal, timber, firewood, resilience, spiritual), Community (Bududa, Bufumbo, Sipi), Gender (M, F), Species (Name of plant or tree species), Importance (ranked from 1-3, 3 being highest importance). Analysis of the data was conducted in RStudio (Version 2024.09.1+394). The data was imported to RStudio. For proper analysis the libraries *dplyr, ggplot2, ggrepel, tidyr* and *tidyrverse* were loaded. Before analysis the categorical variables were converted into appropriate data types, particularly factors using the *as.factor()* function to enable grouping and summarization of the data. Four analyses were conducted to investigate 1. Species importance across categories, 2. Overall importance ranking of species, 3. Species importance by community, 4. Species importance by gender.

1. To illustrate the species importance across use categories (e.g., food, firewood, medicine), a *faceted horizontal bar chart* was created. Data were grouped by Category and Species using *group_by(Category, Species)*, and the mean importance score was calculated. The resulting plot used *geom_col()* and *coord_flip()* to generate horizontal bars, and *facet_wrap(~ Category, scales = "free_y")* was applied to create a separate subplot for each category. Colors were assigned using *scale_fill_brewer()*with a distinct palette to differentiate categories.
2. To illustrate the overall importance ranking of species, a *bubble plot* was created showing both the average importance score and the frequency of mentions for each species across all interviews. Data were grouped by species using *group_by(Species)* from the *dplyr* package, and summary statistics were calculated with *summarise()*, including the mean importance score and the number of mentions *(n()).* The *ggplot2* and *ggrepel* packages were used to visualize the results. The number of mentions was plotted on the x-axis and the average importance score on the y-axis. Each species was represented as a bubble using *geom point()*, with bubble size and color scaled by mention frequency using the size and fill aesthetics. Labels were added using *geom_text_repel(),* and *subset()* was used to exclude species names that were mentioned less than three times, to avoid text overlap. A gradient color palette was applied using *scale_fill_gradient()* to clearly differentiate between low- and high-frequency species. This bubble plot hereby highlights both how important a species was perceived to be and how often it was mentioned across interviews.

3. To compare the perceived importance of species across communities a *heat map* was made. Data were grouped by species and community using *group_by(Species, Community)* from the *dplyr* package and summarized using *summarise()* to calculate average importance scores. A *heatmap* was constructed using *geom_tile()* from the *ggplot2* package, with community on the x-axis and species on the y-axis. Color intensity, controlled with *scale_fill_gradient(),* reflected the average importance ranking of each species in each community.
4. To compare how species were valued by male and female respondents, a *diverging bar chart* was created using the *ggplot2* and *tidyverse* packages. The data were first grouped by species and gender using *group_by(Species, Gender)* and summarized using *summarise()* to calculate the average importance score for each group. The dataset was then reshaped using *pivot_wider()* from the *tidyr* package to produce a table with separate columns for male and female average importance scores. A new variable, *Diff*, was calculated as the difference between these values *(Diff = MeanImportance_M - MeanImportance_F),* indicating how much more or less important a species was to men compared to women. The diverging bar chart was created with species on the y-axis and the difference score *(Diff)* on the x-axis. Bars to the right of zero indicated species more valued by men, while bars to the left of zero indicated species more valued by women. A vertical reference line at zero was added using *geom_vline()* to clearly separate male and female preferences. To enhance interpretability, bars were color-coded using *scale_fill_manual()* based on the direction of the difference: blue for species rated more important by men, and orange for species rated more important by women. The fill aesthetic was driven by a logical condition *(Diff > 0)*, this means that if the average importance was higher among men, the bar was filled with blue, if higher among women, it was filled with orange.

Security issues for female farmers at Mt. Elgon

Matrix coding (QSR International, 2020) was used to investigate the sub-nodes of 'Security issues for farmers at Mt. Elgon'. The rows were selected as the attributes; community and age and the columns were selected as the items in the investigated nodes. The items of 'Security issues for farmers at Mt. Elgon' matched the subnodes; economic security, environmental security, food security, health security and personal security. Only the data from the semi structured interviews were used, these were only done with women. The security items were not incorporated in the focus group discussion. A pie chart was created showing the percentage of security concerns amongst all female farmers in the five investigated security categories. This was calculated as the percentage of coded text

fragments assigned to a specific security category out of the total number of coded fragments across all security categories. Bar plots were created to investigate potential differences in security concerns amongst the female farmers in different communities and different age groups. Relevant quotes are included in the appendix (Appendix 3) and may be referenced in the results to support interpretation. For a full data table see Appendix 7.

Challenges and innovation potential in Agroforestry

Matrix coding was used to investigate the sub-nodes of 'Challenges in Agroforestry' and 'Innovation and solutions in agroforestry'. The rows were selected as the attributes; community, gender, age and interview type and the columns were selected as the items in the investigated nodes. The items of 'Challenges in Agroforestry' were access and structural challenges, economic challenges, environmental challenges, gender-specific challenges, lack of knowledge and access to knowledge, safety challenges and vandalism/theft. The items of 'Innovation and solutions in agroforestry' were business ideas, farming development and inputs. As explained earlier, the row 'gender', only included data from the focus group discussions and the row 'age' only included data from semi-structured interviews. Bar plots were created for each attribute for easier analysis and comparison. Relevant quotes are included in the appendix (Appendix 3) and may be referenced in the results to support interpretation. For a full data table see Appendix 7.

Species names and descriptions

Species names used in the thesis will be referred as the farmers have named them during interviews. The first time a species is mentioned the scientific name will be included. This will help create an easier link between the text and the figures. Some species will be written in latin, if this is the name that farmers used, often due to the species being exotic. Some species will be used by their common names. For a full list of species including common names, latin names, author names and short descriptions there will be referred to Appendix 5.

Ethical considerations

During the fieldwork, guidelines outlined in the EU General Data Protection Regulation (Data Protection (GDPR) 2016) and the ethical research conduct standards of Aarhus University were followed. Collaboration with Ugandan colleagues ensured a culturally appropriate and respectful approach to engagement with local communities at Mount Elgon. The conduct of the research was continuously re-evaluated to maintain agreement among all participants and to address potential conflicts of interest and methodological concerns.

Informed consent was obtained from all participants, with careful attention given to respect and consideration during interviews. Emphasis was placed on honesty, transparency, and responsibility throughout the research process. Measures were taken to ensure that participants were not placed at any disadvantage as a result of their involvement. A specific measure was taken to ensure safety of female participants, based on the knowledge that research on women rights can lead to an increase in domestic violence (Mark and Winniefridah, 2010). As the research was based in communities with a patriarchal structure, this consideration was acknowledged by including men in the research, specifically by doing group interviews with men in all communities. In the process of the fieldwork, some encounters and comments made it clear that including men was important to gain trust and goodwill in the communities.

Participants were fully informed about the aims and direction of the research, and clarity was provided regarding how their data would be used. Data privacy was prioritized by secure storage of interview data and creating pseudonyms for all participants. The expected time and effort required for participation were communicated clearly, and participants were assured of their right to withdraw at any stage without consequence. Attention was also given to the potential impact of the researcher's presence, with efforts made to avoid causing discomfort or distress for participants.

Results

Local ecological knowledge (LEK)

Farmers at Mt. Elgon were able to present ethnobotanical knowledge of some of the species that they had available to them in their community. Overall, the ethnobotanical knowledge was however very limited. When collecting the data from all interviews, knowledge fell into three categories; species

that have cultural or spiritual meaning, species with medicinal purposes and species used for ecological or agronomic purposes (Table 1).

Circumcision of men is a part of the culture in Uganda, especially amongst the Bagisu and Sabei people (Sabet Sarvestani et al., 2012), therefor some plants- or trees had cultural significance in this ritual. Specifically, amatuggunda, wild custard apple, and ficus were related to circumcision. Some trees would be used to mark the circumcision location, meaning that the ritual would be performed where this tree was growing. Other cultural plant uses were seen as taboos and superstitions, e.g. if a tree was struck by a lightening it was believed to be bad luck to use any parts of the tree (Table 1).

Farmers were able to identify multiple species that they valued for medicinal purposes, they were able to explain what the species could cure and how it should be prepared and used. For many of the farmers, the use of traditional medicine was not preferred. Some expressed that they used plant medicines less, and if they did, it would only as an addition to the medication prescribed by a doctor (Appendix 3, Q1-Q2). This could be explained by an increased access to formal healthcare, however factors such as erosion of knowledge, acculturation and loss of biodiversity could also be related to this. Though farmers were able to express ethnobotanical knowledge, it will be discussed, whether parts of this knowledge can be acknowledged as local ecological knowledge. Many of the species farmers identified were not local to the Mt. Elgon region. For local ecological knowledge to be used as a management tool, this is important to consider.

Table 1: Local Ecological Knowledge

Plant Name	**Scientific name**	**Use Category**	**Specific Use**	**Preparation/How It's Used**	**Origin**
Tree struck by lightning	Not able to identify	Cultural/Spiritual	Taboo, superstition	Believed to bring bad luck if used after the lightning strike	NA.
Amatuggunda (in Lugiso)	Not able to identify	Cultural/Spiritual	Present at circumcision sites	Associated with spiritual places	NA. (Likely native)
Night Rose tree	Not able to identify	Cultural/Spiritual	Fragrant, ceremonial use	Used for its sweet scent at night	NA. (Likely native)
Unknown climbing plant	Not able to identify	Cultural/Spiritual	Spirit possession rituals	Burned and smoked to identify spirit	NA. (Likely native)

Wild custard apple	*Annona senegalensis*	Cultural/Spiritual	Circumcision ritual and spiritual uses	Used in water to call spirits of ancestors	Native
Cactus	*Opuntia* sp.	Cultural/Spiritual	Lightning protection	Planted to attract or trap lightning	NA. (likely exotic)
Ficus	*Ficus* spp., *Ficus natalensis*	Cultural/Spiritual	Circumcision ritual, boundaries	Used during circumcision, marks boundaries	Native
Markhamia	*Markhamia lutea*	Cultural/Spiritual Medicinal	Burial and circumcision rites. Mosquito repellent	Stem used in burials and ceremonies Leaves rubbed on skin or placed at windows	Native
Albizia	*Albizia* sp.	Cultural/Spiritual Medicinal	Drives away demons Fever	Charcoal of tree bits burned to repel spirits Bark and leaves used	Native
Orange	*Citrus sp.*	Medicinal	Cough, yellow fever	Leaves and bark boiled and drunk as soup	Exotic
Wild olive	*Ximenia americana*	Medicinal	Diabetes, ulcers	Leaves and bark boiled and consumed	Native
Aloe vera	*Aloe* sp.	Medicinal	Skin treatment, infections, constipation	Juice applied to skin or drunk	Exotic
Guava	*Psidium* sp.	Medicinal	Skin rashes	Leaves boiled for bathing and drinking	Exotic
Mango	*Mangifera* sp.	Medicinal	Cough	Leaves boiled and water drunk	Exotic
Neem	*Azadirachta indica*	Medicinal	Fever, malaria, cough, skin rashes	Leaves and bark boiled; steam inhaled	Exotic
Lemon	*Citrus limon*	Medicinal	Skin rashes, cough	Juice mixed with oil for skin; juice or leaves for cough	Exotic
Coffee	*Coffea arabica*	Medicinal	Brain illness, diarrhea	Roots boiled and consumed	Exotic
Passion fruit	*Passiflora* spp.	Medicinal	Malaria, cough	Juice squeezed and drunk	Exotic
Gufungu (in Lugiso)	Not able to identify	Medicinal	Ulcers, blood pressure, impotence,	Boiled as herbal remedy	NA. (likely native)

			poultry diseases		
Eucalyptus	*Eucalyptus* spp.	Medicinal	Cough, flu	Leaves chewed or boiled and drunk; roots also used	Exotic
Avocado	*Persea* spp.	Medicinal	Back pain, infections	Leaves and bark boiled and drunk as tea	Exotic
Kamahuyu (in Lugiso)	Not able to identify	Ecological/Agronomic	Natural fertilizer	Fruits fall and fertilize soil	NA. (Likely native)
Grevillea	*Grevillea robusta*	Ecological/Agronomic	Shade, soil improvement	Planted near coffee	Exotic
Bamboo	*Bambusa* sp.	Ecological/Agronomic	Erosion control	Planted along waterways	Exotic or native
Cordia	*Cordia africana*	Ecological/Agronomic	Improves coffee yield, provides shade	Planted near coffee, leaves drop and fertilize	Native
Elephant grass	*Cenchrus purpureus*	Ecological/Agronomic	Soil protection, fodder	Planted to reduce erosion and feed livestock	Native

Nature relation

The relation to nature for coffee farmers at Mt. Elgon was highly related to their farming practices. They expressed feeling very connected to nature as farmers (Fig. 1). When thinking of nature and trying to describe it the farmers had few words and struggled with descriptive explanations, however *trees, nature* and *water* seemed to be what most farmers would think of. They would also relate their description of nature to their farming practice, which was seen as many of them used the words *plants, crops* and *farmer.* Some farmers would explain that nature is a place to gain knowledge, specifically by going to other communities and observing their farming practices, emphasizing that their view of nature is connected to their farming practice (Textbox 1, quote 10-11). The words *connected, environment* and *related* gave an impression of how the farmers felt connected to and a part of the environment (Fig. 1A). When asked to describe the role that nature played in their daily life, they would especially use words as *nature, garden, trees, feel* and *coffee* emphasizing how their garden, the trees and their coffee was strongly connected to how they use nature day-to-day (Fig. 1B, and textbox 1, quote 2, 5 and 9). This was also supported when asked how they interacted with nature where they used words as *nature, garden, trees, feel* and *coffee.* Again, garden and coffee appear, which underlined that the interactions they have with, what they believe nature to be, was strongly

related to their coffee garden. A few times the words *relax, working, hills, work, picnic, farmer, trees, relaxation* were also mentioned, expressing that nature was both a space used for work and relaxation, however these words were used few times (Fig. 1C and Textbox 1, quote 1-5). In general, most farmers expressed being connected to nature, however not in a spiritual way. When asked to define their spiritual connection to nature they expressed to feel connected to nature in the way that nature provides them with daily necessities and was a place they spent most of their time. This was seen in the use of words as the most mentioned words were *nature, farmer, different, relates, relation, related, farmers* and *feel* (Fig. 1D). Spirituality was not a big part of their relation to nature. Some farmers described that they saw nature and man as two separate things and that nature and animals were created for them to use (Textbox 1, quote 6 and 7). This gave a good indication of how the farmers at Mt. Elgon view nature as something separate to them, however with a connection in the sense that people use nature and spent much time in nature as farmers.

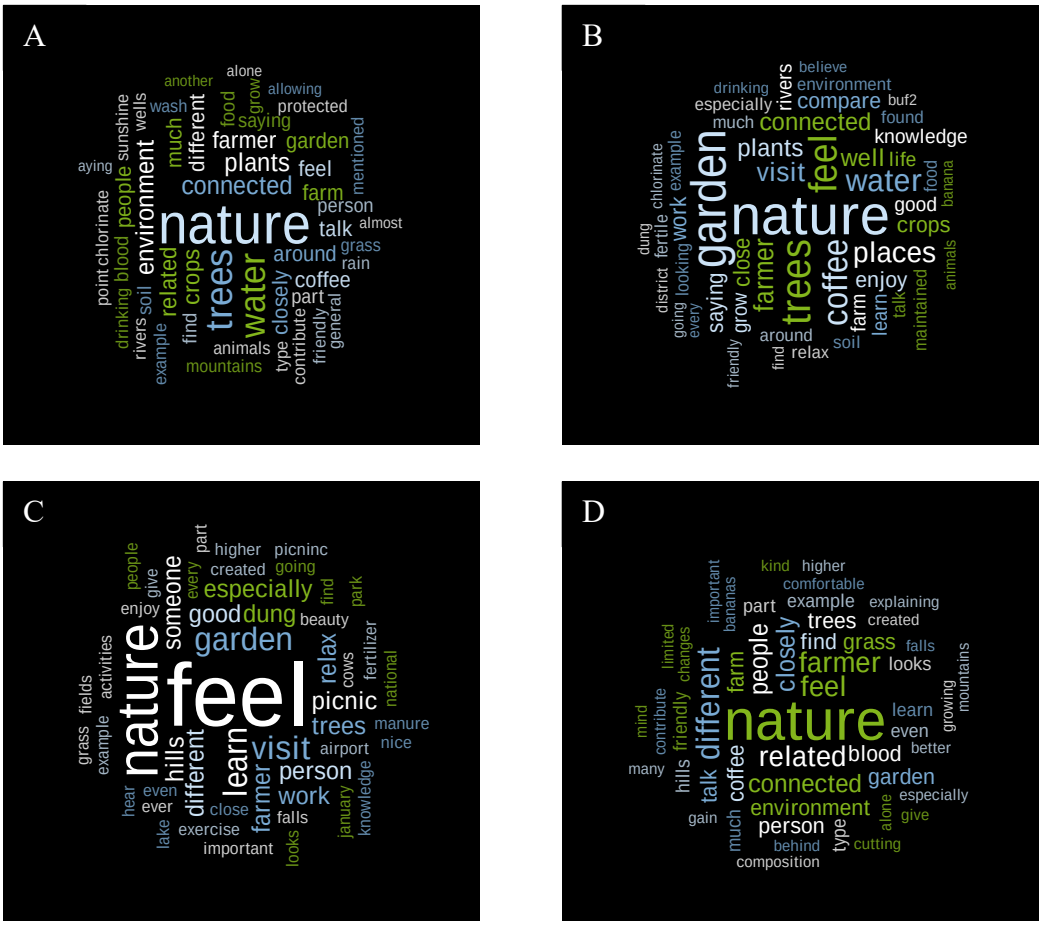


Figure 1: Word clouds of most mentioned words by farmers to get insight into A: their definition of nature, B: the part nature plays in their daily lives, C: the interactions they have with nature and D: their spiritual connection to nature.

Textbox 1: Quotes - nature relation

Bufumbo, female farmer, individual interview:

1. *"what comes in my mind when I talk of nature. I know that now talking about environment and it is a composition is like the trees, bananas and even the coffee, it is there in the garden."*
2. *"that we are connected, connected to nature as farmers*"

Bufumbo, male farmer, group interview:

3. "*I think of air. Then there is soil where we plant our food crops. From that soil is where we get almost everything. I also think of crops which grow in the soil, using water, which makes our livelihood possible. I also think of the sunshine and the rain, both of which contribute to the growth of our crops.*"
4. "*it is not limited in farming only. I am referring to those Mountains behind us. When you go nearer there, you find different types of grass. There's a type of grass you find it is very smooth, if you sit there, and the way it looks the scenery alone, very comfortable."*
5. *"that for us it relates very much with our farming, the relation to nature."*

Bufumbo, female farmer, groups interview:

6. *"For me those two things are different, because man has blood, a person has blood. those things, plants do not have blood. A persons reasons by the environment, is you just to contribute to it to be better or bad."*
7. *"for me I use what God has put on place to gain from."*

Bududa, female farmer, individual interview:

8. *"I go and see different types of trees and rivers, animals" "To get knowledge" "it is very important, cause when I also plant mine it will help with the air around my home."*

Sipi, female farmer, individual interview:

9. *"Providing timber for building, and then also firewood for sale, also to generate income."*

Bufumbo, female farmer, group interview:

10. *"Sometimes we like to visit places, to visit new places so that we can compare with their place and enjoy the scenery. That for example, when we go to a place like Kapchorwa, there are farmers there who grow things like maize extensively, cowpeas, and as we can learn from those and also come and improve on our garden"*
11. *"I moved out of Mbale district and went to Sironko district. And I remembers that I found a banana plantation which was very well maintained, and coffee garden is very well maintained. So with that knowledge I can come and also improve mine. After learning from, from that In Sironko I went to that mountain up there that they grow. I found things like Carrots, passion fruit, Irish potatoes, onions, and the coffee is very, very fertile. The soils are Fertile, And the coffee is very good. Up there. That's what I found out."*

Important plant and tree species for farmers at mt. Elgon

Farmer perspectives on species availability, importance and desires

The species mentioned as available by farmers were a mix of trees and crops, the most mentioned species were avocado (*Persea* spp.), coffee (*Coffea arabica*), and jackfruit (*Artocarpus heterophyllus*), species that served as food and/ or cash crops. Species such as eucalyptus (*Eucalyptus spp.*) mango (*Mangifera* sp*.)*, and yams (*Dioscorea* spp.) were mentioned slightly less, these species also served as food and/ or cash crops (Fig. 2A).

Among the species that farmers identified as most important, food and cash crops were mentioned, e.g. orange (*Citrus* sp.), ficus (*Ficus* spp.) and banana (*Musa* sp.), along with trees with environmental and ecological benefits and trees used for firewood and timber, these were albizia *(Albizia* sp.) and markhamia (*Markhamia lutea*). Bamboo (*Bambusa* sp.) was also mentioned as an important species, this was primarily planted to create resilience and avoid soil erosion (Fig. 2B). When asked which tree-, crop- and plant species were unavailable to the farmers they struggled. Few

species were mentioned. Millet (*Pennisetum glaucum*) was emphasized by one farmer (Fig. 2C). Some farmers explained that there used to be more trees available in their community, but that these had disappeared due to deforestation (Appendix 3, Q3-Q4)

When asked what species the farmers wanted to introduce, they mainly mentioned species that could contribute as food for the household and to give an income, the most mentioned species were maize (*Zea mays*), oranges, millet, onions (*Allium cepa*), and tomatoes (*Solanum lycopersicum*), with orange being the only tree mentioned, and the rest being food crops. When looking into less mentioned species two other trees showed up, cocoa (*Theobroma cacao*) and cordia (*Cordia africana*). Cocoa which could be an additional cash-crop and cordia which had ecological benefits for the soil and surrounding crops and provides timber and firewood (Fig 2D). Cordia was also mentioned as a species available to the farmers (Fig. 2A, phrased as '*africana*') and as an important species (Fig. 2B, phrased as '*africana*'). The orange tree was the only species mentioned in all categories, it specifically stood out as an important species to the farmers and as a species the farmers wanted to introduce (Fig. 2B and 2D), it was already available to some farmers (Fig. 2A).

Figure 2: Word clouds of crops, herbs and tree species mentioned by the coffee farmers to be A: available to them, B: important to them, C: unavailable to them and D: wants to introduce them. As the species names have been taken directly from the transcripts some appear slightly misspelled, in plural and not with their full species name, e.g. irish = irish potatoes, climbing and creeping = plants described by their characteristics, night and black = black nightshade, albezia = albizia, Kusola = Markhamia lutea, Mekengeret = Cordia africana,.

Species use related to community, gender, age and interview type

Species use varied between the three communities. Overall, the primary purposes for which species were used were environmental management, food, income and medicine. Species used for environmental management were mentioned most frequently in Bududa. In contrast, Bufumbo had very few mentions of environmental management. Species used for food and income generation were most frequently mentioned by interviewees from Sipi. Medicinal species use importance did not vary significantly across the communities (Fig. 3A). No mentions were recorded for species used in religious or spiritual practices in the interviews (Fig. 3A-D).

Species used for firewood, fodder and timber had the same frequency of mentions between men and women. Species used for food and income were only mentioned by women, but few times. Species used for environmental management had the highest frequency of mentions and was only mentioned by men, there could potentially be a gender role perspective in this (Fig. 3B). There was a clear pattern when comparing the interview types, in the individual interviews the participants had more mentions of species use than in the group interviews. The pattern of environmental management, food, income and medicine being the most mentioned categories was confirmed (Fig 3C). Women in different age groups, young (18-35 y), middle-aged (36-50 y) and old (50+ y), had some differences in their mentions of species use. Again, the categories environmental management, food, income and medicine were the categories with most mentions for all age groups. The old farmers had more mentions of species used for environmental management compared to the middle-aged and young. The young female farmers had the least focus on species used for food. For the categories firewood, fodder for animals and timber there did not seem to be an age-related difference in species use (Fig. 3D).

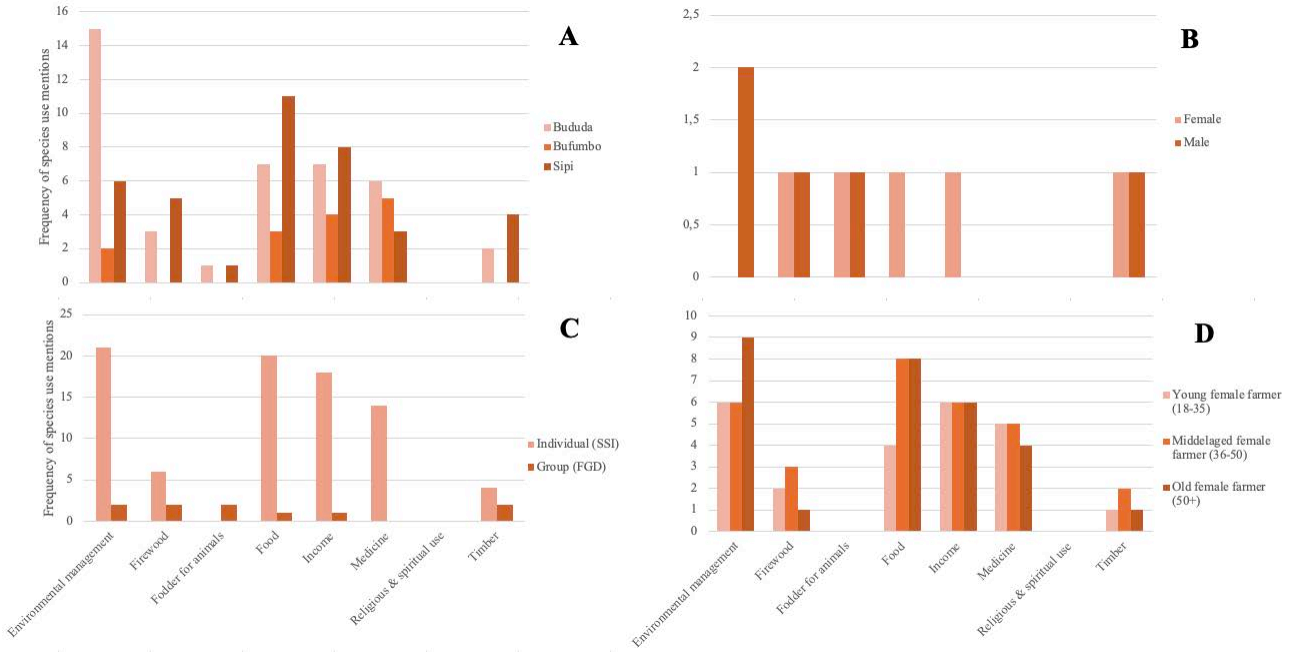


Figure 3: Species use patterns illustrated by the number of coded text fragments of each species use category (x-axis) related to community, gender, interview type and age. The y-axis shows the number of text fragments coded to a specific category. Categories are presented on the x-axis. A: Species use in the communities. The bars are colored according to the community. B: Species use by female and male farmers. The bars are colored according to the gender. Data is only included from Focus group discussions. C: Species use mentions in semi-structured interviews and focus group discussions. The bars are colored according to the interview type. D: Species use by young, middle-aged and old female farmers. The bars are colored according to the age group. Data is only included from semi-structured interviews where all participants were female.

Species importance related to its use

Farmers ranked the three most important species in eight different categories, this gave an average importance ranking of the species, connected to the specific category the species was mentioned in (Fig. 4). This revealed some species to have multifunctional purposes for the farmers, while some species only have a few or one purpose (Fig. 4). This could help to understand why some species are more important to the farmers than others. Species like grevellia (*Grevillea robusta*), albizia and eucalyptus were mentioned in multiple categories, and received relatively high importance rankings in the categories they were mentioned in (Fig. 4). There could be a connection between the importance of the species and its multifunctionality. Some species were only mentioned in one category and in one interview, e.g. hibiscus and iroko, however they were valued as very important in this specific interview (Fig. 4).

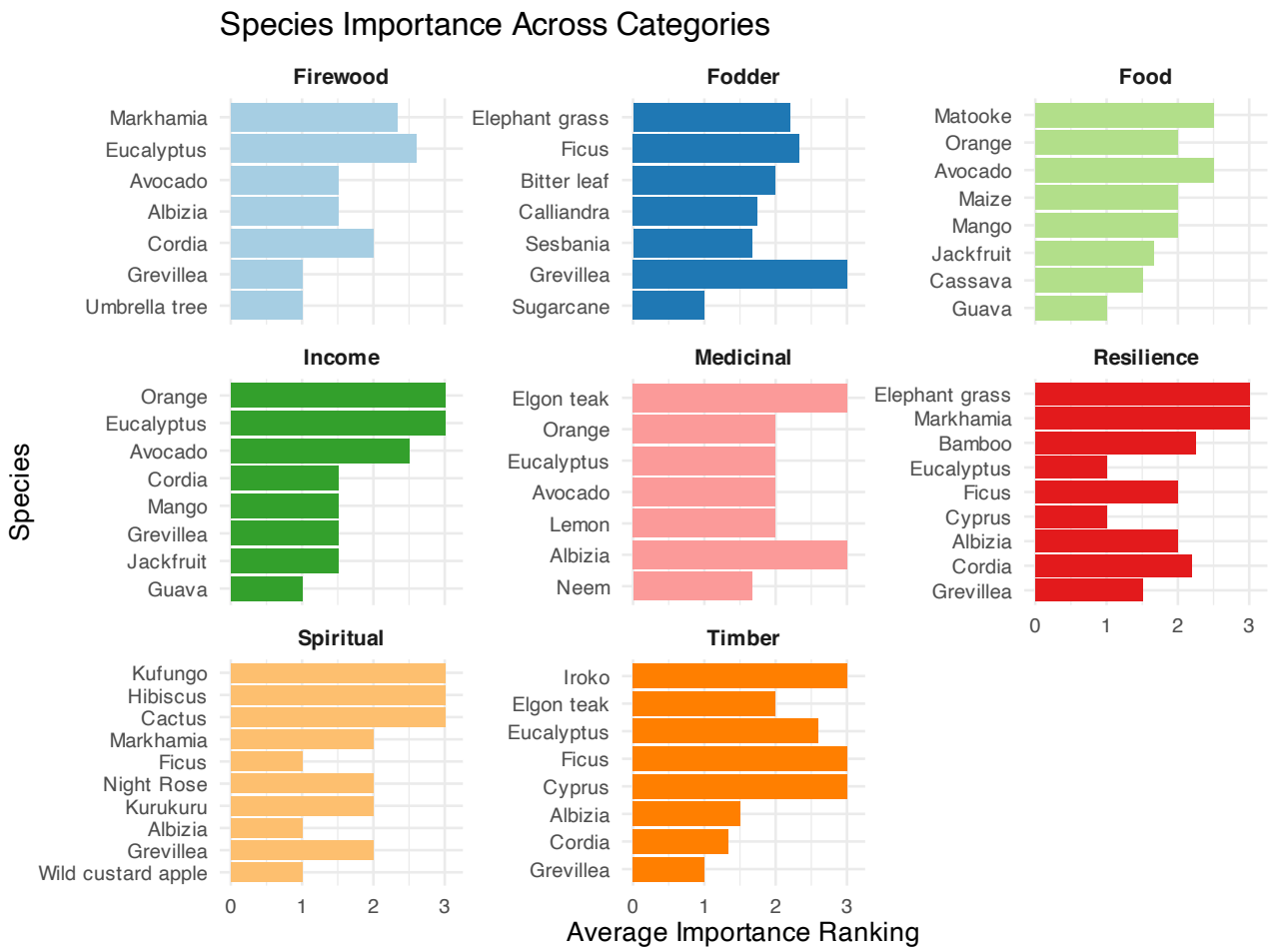


Figure 4: Species importance across use categories. Presenting how the farmers have ranked tree- and plant species that are important to them in the different categories; Firewood, fodder for their animals, food for the household, income, medicinal plant species, resilience against climate change and natural disasters, spiritual and/or religious uses and for timber. The species that have been mentioned in the different categories are listed on the y-axis and the importance is seen on the x-axis (3=most important). The importance is an average measure of all the farmers' statements.

Several species were mentioned in more than one category. These species were identified by the farmers as important species for multiple purposes, indicating that these species had a high and diversified value to the farmers (Table 2).

Table 2: Multipurpose species. Based on data shown in Figure 4. Species that appeared in more than one use category were identified. The count revealed the number of use categories it was mentioned in, and the use categories were listed.

Species	Count	Categories
Grevillea	6	Firewood, fodder, income, resilience, spiritual, timber
Albizia	5	Firewood, medicinal, resilience, spiritual, timber
Eucalyptus	5	Firewood, income, medicinal, resilience, timber
Cordia	4	Firewood, income, resilience, timber
Avocado	4	Firewood, food, income, medicinal
Ficus	4	Fodder, resilience, timber, spiritual
Orange	3	Food, income, medicinal
Markhamia	3	Firewood, resilience, spiritual
Guava	2	Food, income
Jackfruit	2	Food, income
Mango	2	Food, income
Cyprus	2	Resilience, timber
Elgon teak	2	Medicinal, timber
Elephant grass	2	Fodder, resilience

Several species stood out as particularly important to the farmers in the ranking exercise. Eucalyptus, avocado and cordia were the most frequently mentioned, each cited 12-16 times and receiving average importance rankings above 1.5. Other important species included elephant grass (*Cenchrus purpureus*), markhamia, albizia and grevillea which were mentioned 8-12 times and had an average importance ranking above 1, reflecting that the interviewed farmers perceived them as important (Fig. 5). Many of these species were valued useful to the farmers in several ways, e.g. grevillea which the farmers mentioned to be valuable for both firewood, fodder, income, resilience against climatic variability, spiritual uses and timber (Fig 4 & Table 2).

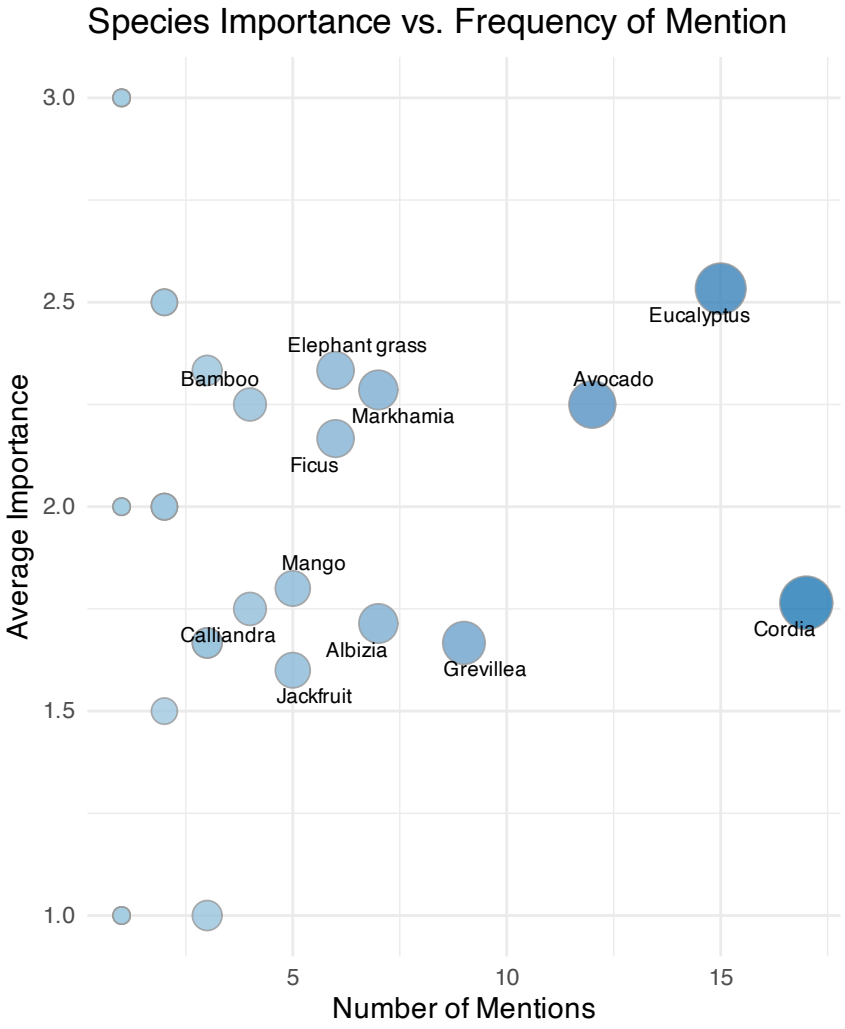


Figure 5: Overall importance ranking of species by female and male farmers illustrated by a bubble plot. With average importance ranking on the y-axis (1-3, 3=most important) and the number of mentions on the x-axis. The size and color of each bubble helps visualize the importance of a species by illustrating how many times a species has been mentioned (many mentions = big and dark blue).

Species importance across the communities, related to its use

Across the three communities, a handful of species emerged as consistently important to farmers (Fig. 6). These species were valued by the farmers for food, e.g. mango, avocado, orange, jackfruit and resilience against climatic variability such as elephant grass, eucalyptus, markhamia and cordia. Most

of these species were also valued highly as income sources and sources of firewood (Fig 4 & Table 2).

Avocado, eucalyptus, orange and elephant grass were valued as highly important species across all communities (Fig. 6). These species were all valued important for multiple categories of use (Table 2). Eucalyptus and orange were valued as the most important species for income. Eucalyptus was moreover the most important species for firewood and valued highly for its timber (Fig. 4). Orange was additionally very important for its food and medicinal purposes (Fig. 4). Avocado was especially important as a food and income source and for its medicinal purposes (Fig. 4). Elephant grass was, along with markhamia, valued as the most important species for its use as resilience against climatic variability, furthermore it was an important species for its use as fodder for animals (Fig. 4).

Markhamia was also a species that stood out as important in all communities (Fig. 6), besides its value for resilience against climatic variability, it was also valued highly for firewood and spiritual uses (Fig. 4). Ficus was valued as important in all communities, though less in Bududa (Fig. 6). It was valued important for multiple categories (Table 2), though especially for timber (Fig. 4). Cordia was likewise important in all communities (Fig. 6) and was especially valued for firewood and resilience against climatic variability, though also for income and timber (Fig. 4).

Bududa and Bufumbo respectively valued maize and matooke very highly (Fig. 6), these species were valued as key food crops (Fig. 4). Sipi did not have a food crop amongst their highest valued species (Fig. 6), however the trees avocado, mango and orange, which were valued highly as food sources (Fig. 4), were important species in all three communities (Fig. 6). Elgon teak (*Olea capensis*) was valued highly in Sipi and Bududa but received no mentions in Bufumbo (Fig. 6). Elgon teak was especially valued for its medicinal purposes (Fig. 4). Though cactus (*Opuntia* sp.) and iroko (*Milicia excelsa*) in Bufumbo and hibiscus (*Hibiscus* sp.) in Sipi stood out as highly important (Fig. 6), these species were only mentioned one time and in one use category (Appendix 6). More data would need to be collected to investigate their importance. As their validity is difficult to ensure with this data, they will be seen as random outliers.

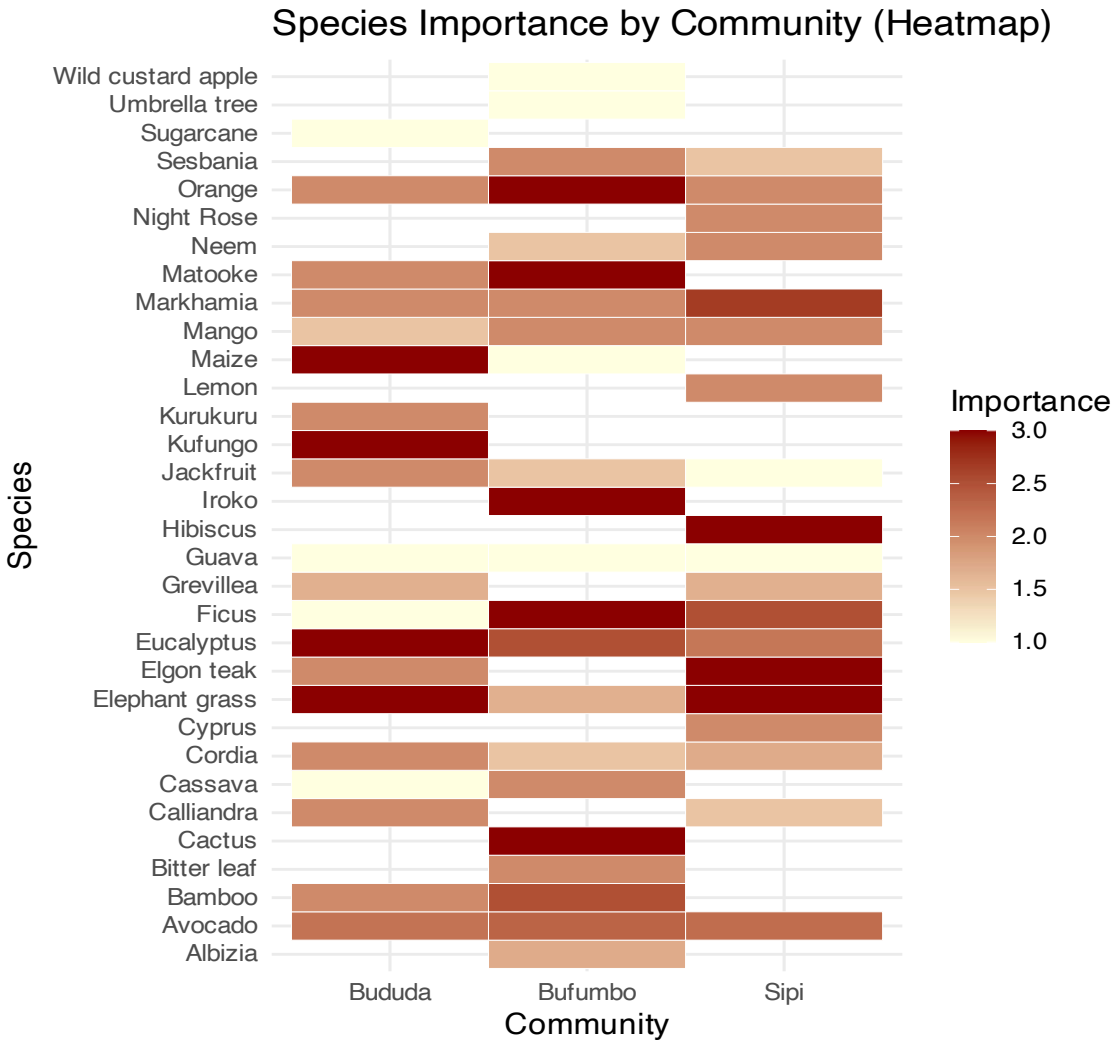


Figure 6: Species importance by community illustrated in a Heatmap. With species on the y-axis and community on the x-axis. Bars are colored to illustrate their importance ranking in each community with a graduate color scale from 1-3 (3= most important), with lighter colors being less important species and darker colors being more important species. No color shading means that the species has not been mentioned in the community.

Species importance across genders, related to its use

Men and women valued elephant grass, albizia, avocado, cordia, eucalyptus and mango of almost equal importance (Fig. 7). Among both men and women, several of the species they agreed were important overlapped with those associated with resilience to climatic variability (Fig. 4). These included ficus, eucalyptus, elephant grass, bamboo, and markhamia (Fig. 7). While avocado was valued slightly higher by women and orange slightly higher for men both genders agreed that these species were important (Fig. 7). Avocado and orange were especially valued for their medicinal

properties and as food- and income sources (Fig. 4). Almost all the species had been ranked valuable in more than one use category (Table 2). Species where men and women disagreed the most on their importance were cactus, hibiscus, iroko and kufungu (Fig. 7), looking into the data these species were only mentioned one time (Appendix 6). As these results are difficult to confirm, due to a small sample size, they will be seen as random outliers. Women in general valued food-relevant species higher than men with the species avocado, mango, jackfruit, guava, ficus, cassava, maize, lemon (*Citrus limon*) and matooke all having received a higher average importance by women (Fig. 7). Many of these species were valued of high importance for food (Fig. 4). Orange was the only highly ranked food species (Fig. 4) that received the highest average importance ranking by men (Fig. 7). Some women explained, that coffee is for the man, while they gain income from fruit trees and other crops like matooke, which could explain their focus on food-relevant species (Appendix 3, Q5-Q6)

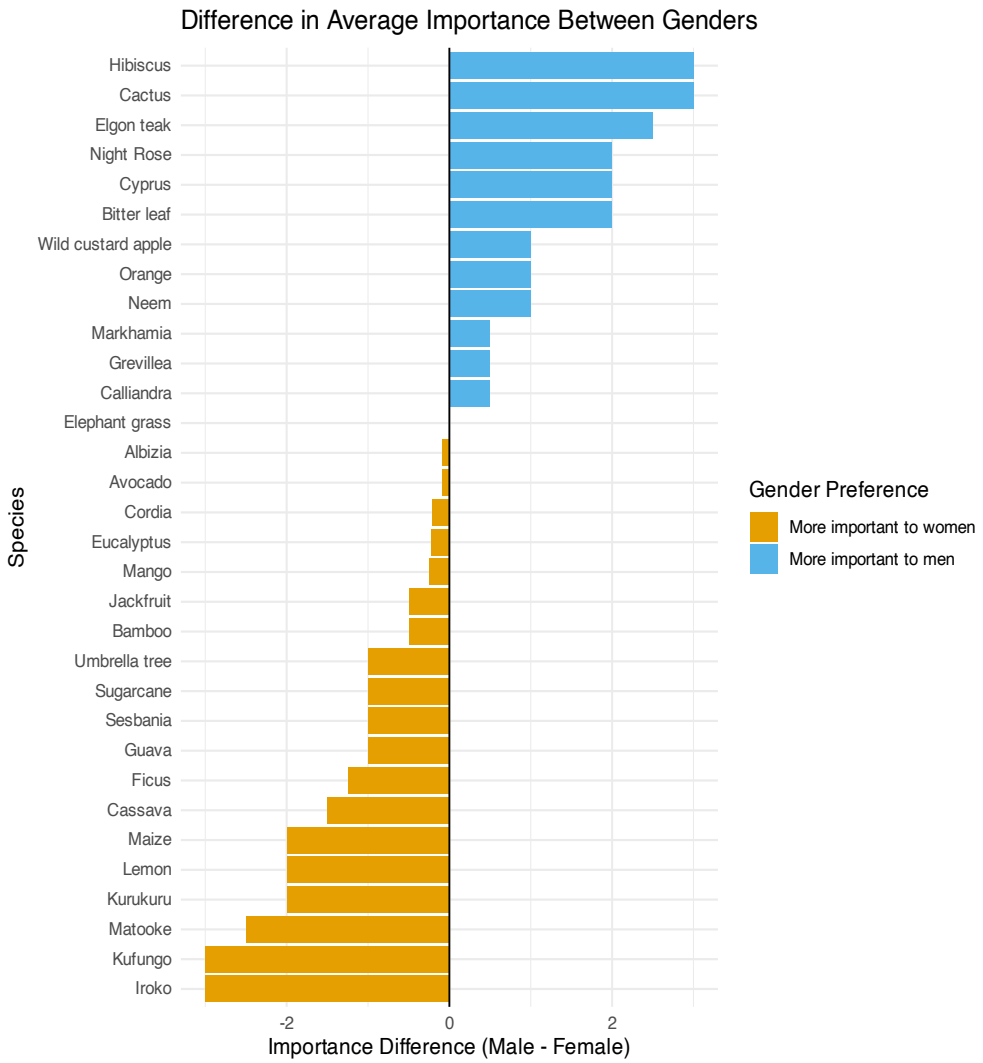


Figure 7: Difference in species importance by male- and female farmers illustrated by a diverging bar chart showing the species importance by gender. With species names listed on the y-axis and importance difference rating on the x-axis, negative values reveal a preference for the species by women and positive values a preference for the species by men. Values close to or equal zero reveal a similar preference for the species. Bars are colored to illustrate which gender values the species the highest (orange=female, blue=male).

Security issues for female farmers at Mt. Elgon related to community and age

Female farmers at Mt. Elgon were mostly concerned of economic security, however environmental, food, and health security were of almost equal concern. Personal security was a minor concern to the female farmers (Fig. 8). Differences in security concerns was seen amongst the different communities and age groups. Female farmers in Bududa expressed slightly greater concern for economic security and significantly higher concern for environmental security compared to the female farmers in Sipi

and Bufumbo. Comparably, the female farmers in Bufumbo, expressed a slightly higher concern for health security and a significantly higher concern for food security than the other communities. Noteworthy, the Bududa female farmers expressed very little concern for health security compared to the others. The female farmers of Sipi were the only ones to have a mention of personal security (Fig. 9A). Across different age-groups of female farmers security concerns were high in all categories, except personal security. The security concerns between age-groups of female farmers were very similar across the categories, except for food security where the middle-aged female farmers expressed a much bigger concern than the young and old female farmers (Fig. 9B). Food and income security was explained to be season-dependent, with the dry season being less food and income secure as most food crops and food trees produce outcome in the rainy season. They had observed changes in weather patterns causing extreme drought and heavy rains (Appendix 3, Q12-Q13 and Q29).

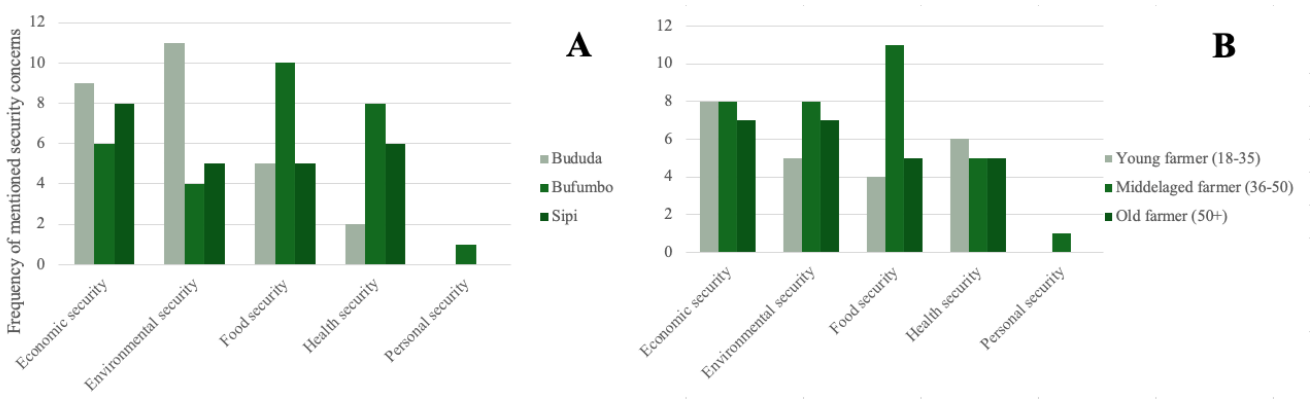


Figure 9: Security concerns amongst female farmers related to their community and their age, illustrated by the number of coded text fragments to each security category (economic security, environmental security, food security, health security and personal security). The y-axis shows the number of text fragments coded to a specific category. Categories are presented on the x-axis. A: Security concerns related to community. The bars are colored according to the community. B: Security concerns by young, middle-aged and old female farmers. The bars are colored according to the age group. Data is only included from semi-structured interviews where all participants were female.

Challenges and innovation potential in Agroforestry related to community, gender, age and interview type

Across all communities, interview types, genders, and age groups, three types of challenges consistently stood out as the most pressing: access and structural barriers, economic barriers, and environmental challenges. These categories were the most frequently mentioned across all demographic and social groups (Fig. 10A–D).

At the community level, Bududa reported the highest overall number of challenges, with economic and environmental issues being particularly prominent. Gender-specific challenges were also most frequently raised in Bududa. In contrast, knowledge barriers and safety concerns were rarely mentioned across any of the communities, however Sipi had some mentions of issues of theft and vandalism (Fig. 10A). Gender also played a clear role in how challenges were experienced. Women more frequently reported barriers related to access and structure e.g. in access to knowledge, economy, especially related to inputs for farming, and gender-specific concerns. They specifically mentioned that as they have less access to land, they could not access the income from coffee. As the land is owned by the man he decides how income from crops can be distributed, he takes the income from coffee and women can get income from other crops (Appendix 3, Q5-Q6). Furthermore, time constraints due to much time spent on labor in the garden, unequal access to knowledge from men and lack of input, especially monetary, was major challenges for the women (Appendix 3, Q7-Q9). Lack of access to seedlings, fertilizer and gardening tools was also a barrier to the women (Appendix 3, Q21-Q23). The women explained that goat keeping, and food crops were beneficial to them, because they are not able to move far away from their home, and these income sources could be managed close to their house (Appendix 3, Q10-Q11).

Men highlighted environmental challenges and concerns about theft and vandalism. Neither men nor women identified knowledge barriers as a major issue (Fig. 10B). When comparing interview types, individual interviews generally yielded a higher number of reported challenges than group interviews. However, mentions of knowledge barriers, gender-specific issues, safety concerns, and vandalism remained low across both formats (Fig. 10C). Age also influenced which challenges were emphasized among female farmers. Older women reported access and structural barriers at more than double the rate of middle-aged and younger women and noted slightly more environmental challenges. In contrast, younger women more frequently mentioned economic barriers as a challenge. Other types of challenges were mentioned infrequently or not at all by the different age groups (Fig. 10D)

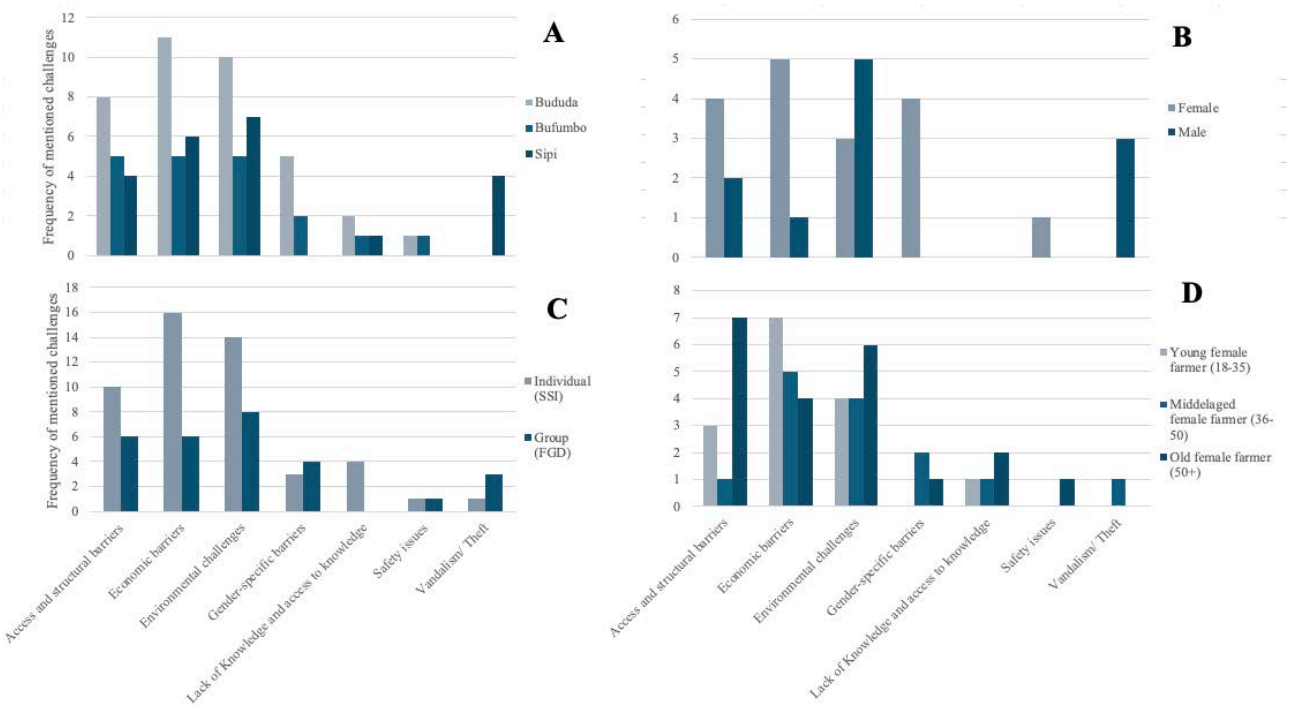


Figure 10: Challenge patterns illustrated by the number of coded text fragments to each challenge category related to community, gender, interview type and age. The y-axis shows the number of text fragments coded to a specific category. Categories are presented on the x-axis. A: Challenges in the communities. The bars are colored according to the community. B: Challenges mentioned by males and females. The bars are colored according to the gender. Data is only included from Focus group discussions. C: Challenges mentioned in semi-structured interviews and focus group discussions. The bars are colored according to the interview type. D: Challenges of young, middle-aged and old female farmers. The bars are colored according to the age group. Data is only included from semi-structured interviews where all participants were female.

Across all communities, interview types, genders, and age groups the innovation potential amongst farmers was highest in ideas related to farming development. In contrast, farmers across all demographic and social groups had few mentions of ideas for businesses and need for monetary or agricultural inputs (Fig 11A-D).

At community level Bududa had approximately half as many mentions of farming development ideas as Bufumbo and Sipi (Fig. 11A). During the group interviews men had more mentions of farming development ideas than women (Fig. 11B). During individual interviews women however had many mentions of farming development ideas. A need for monetary or agricultural inputs was also expressed in the individual interviews (Fig. 11C). Comparing the different age groups of women, the number of ideas was highest amongst old farmers, then middle-aged then young (Fig. 11D).

Women also explained that members of the cooperatives had organized themselves in Village Savings and Loans Associations (VSLA), where they could save up money and take loans. The female farmers had a very positive attitude towards this (Appendix 3, Q14-Q20). Though farmers generally had a positive attitude towards agroforestry they explained that extreme weather events could cause trees to fall and destroy houses and crops (Appendix 3, Q24). Furthermore, rainfall and soil erosion were becoming a bigger issue, that trees could not solve as they were also being taken by the landslides (Appendix 3, Q26, Q28 and Q31-Q32). Trees could also reduce the outcome from crops as they compete for light and could bring in pests that destroy crops (Appendix 3, Q25 and Q30).

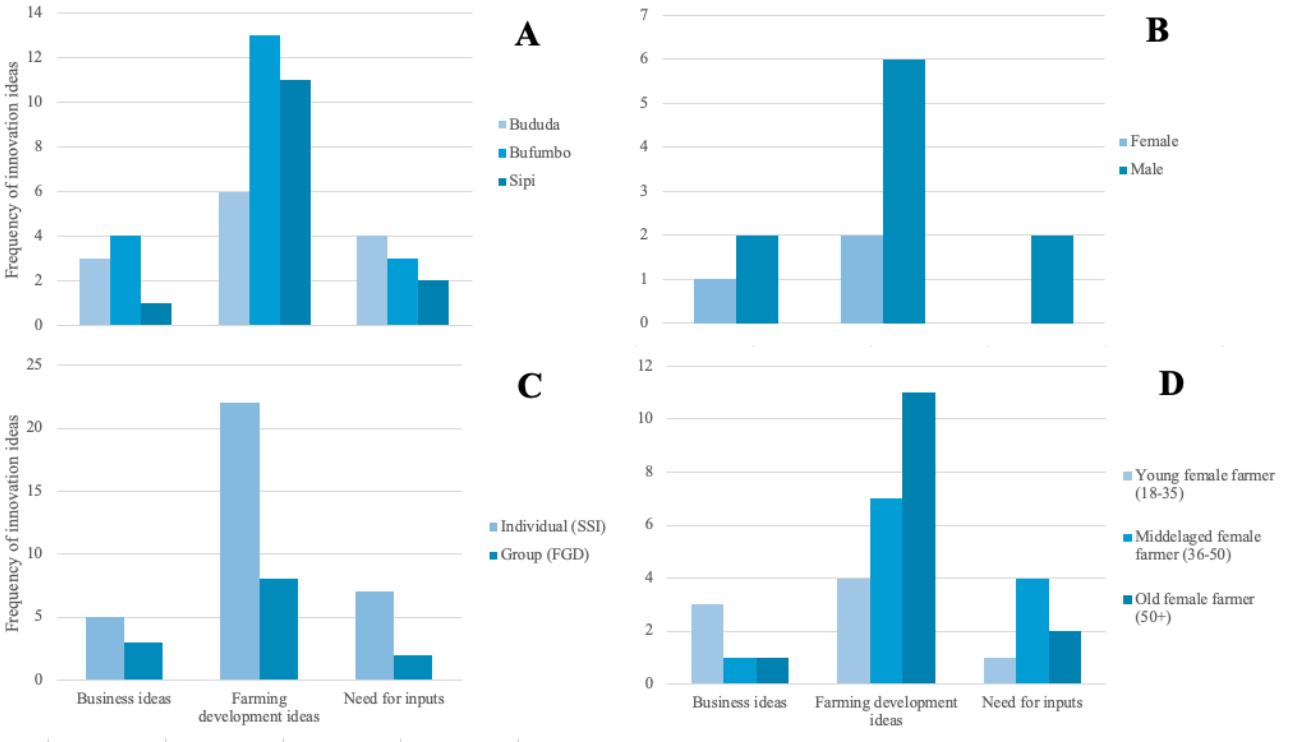


Figure 11: Innovation potential pattern illustrated by the number of coded text fragments to each innovation category related to community, gender, interview type and age. The y-axis shows the number of text fragments coded to a specific category. Categories are presented on the x-axis. A: Innovation ideas in the communities. The bars are colored according to the community. B: Innovation ideas by males and females. The bars are colored according to the gender. Data is only included from Focus group discussions. C: Innovation ideas mentioned in semi-structured interviews and focus group discussions. The bars are colored according to the interview type. D: Innovation ideas by young, middle-aged and old female farmers. The bars are colored according to the age group. Data is only included from semi-structured interviews where all participants were female.

Discussion

Absence of Local Ecological Knowledge amongst farmers at Mt. Elgon is connected to their nature relation and historical events

Through observations in the communities, and talking to the farmers, it was evident that few native species were available, which could explain that their ethnobotanical knowledge on native species was limited. Other studies has revealed a connection between the availability of plants- and trees and the ethnobotanical knowledge (Gadgil et al., 1993; Turreira-García et al., 2017). The lack of availability of the species was however not the only factor that could have influenced the lack of local ecological knowledge amongst farmers at Mt. Elgon. As Reyes-García et al., 2013 argued, changing socio-economic, political, and environmental conditions are drivers of rapid cultural loss. These conditions could therefor help to discover the erosion of local ecological knowledge at Mt. Elgon.

By shifting to monoculture and market-driven agriculture the knowledge transmission of traditional practices weakens, as these practices were no longer the ones used in the day-today lives of farmers at Mt. Elgon. Politically, displacements from ancestral lands, boundary demarcations, and conversion of forests into protected areas where people are not allowed to use traditional forest practices, could have further disrupted the relationship between communities and their environment at Mt. Elgon (Sassen et al., 2013; von Kocemba et al., 2025). Socio-economic transformations, political exclusions, and ecological changes have enabled a cultural loss at Mt. Elgon. This cultural loss has also allowed for a new mindset to thrive at Mt. Elgon, that nature is a resource to be exploited (Turyahabwe, 2010).

The farmers expressed to feel connected to nature by being farmers, and that nature is a resource for them to use. In this sense, they viewed nature as a functional space, essential for their livelihoods. They distanced themselves from nature and were very clear that they viewed nature and people as two separate entities, with nature being a resource created for people. The mindset of nature being something that should be controlled by people, could be explained by various factors. A possible explanation could be that their view on nature is connected to monotheistic religious traditions (Berkes, 2024). In Bududa and Sipi most farmers were Christian and in Bufumbo they were either Christian or Muslim. White (1967, cited in Berkes, 2024) argues that Christianity is the most Anthropocentric religion and largely responsible for the environmental crisis. One farmer directly expressed that she was using "*what God has put on place to gain from*". This anthropocentric mindset creates no incentive for the farmers to value nature for anything besides its use. This human exceptionalist thinking, where humans exist independently of the ecosystems, has negative impacts

on sustainability and environmental conservation (Kim et al., 2023). Another factor that could enable people feeling distanced to nature can be found in the introduced concept of alienation (Waiswa et al., 2015). Farmers at Mt. Elgon have been and are undergoing many changes that can lead to alienation, amongst others economical and technological changes (Waiswa et al., 2015). The technological changes in the communities was not yet that progressed, many did not have electricity in their houses, however tv, internet access and access to smartphones seemed to be relatively normal, at least amongst the more wealthy (own observations). Another factor that can drive alienation is population growth, as it is a driver of agricultural expansion and deforestation (Waiswa et al., 2015), which is also a very present factor at Mt. Elgon. The explained political changes and disturbance in access to forest resources could also have intensified this feeling of alienation amongst the farmers. A research project from Germany found that landscape simplification, explained as the loss of multifunctional, cultural agroecosystems and the expansion of monofunctional, intensive croplands, can lead to a loss of human-nature connectedness (Riechers et al., 2022). Though farmers at Mt. Elgon practice small-scale farming, not comparable to the scale of farming in Germany, the farms had simplified due to coffee becoming a main cash crop. All farmers were growing coffee, and most farmers had very few trees (own observations). In the article they find that a rapid landscape simplification can decrease and change human–nature connectedness which will lead to a contrast in value preferences, and erosion of relational values, such as cultural identity and social relations (Riechers et al., 2022), for the farmers at Mt. Elgon, this could explain their lack of spiritual connection to nature and viewing nature as a resource.

Another aspect important to address is the shifting baseline syndrome. In the context of Mt. Elgon, deforestation, population pressure, and restricted access to forests create a foundation of the shifting baseline syndrome to have been going on for a long time. This could contribute to an erosion of local ecological knowledge, as communities become increasingly disconnected from practices and understandings once passed down by elders. The three causes of shifting baseline syndrome, lack of data, loss of interaction and loss of familiarity with the natural environment (Soga and Gaston, 2018) were all present for the farmers at Mt. Elgon. Firstly, due to knowledge barriers, mainly isolation, they were not able to gain insight into how the ecosystem would look like if it was not degraded. Secondly, though the farmers did spend much time in their gardens, these interactions were not with a natural environment. Natural environments were not available to the farmers as all land within their reach was used for farming. Thirdly, farmers seemed to have very little familiarity with the natural environment. Furthermore, factors present at Mt. Elgon such as religion, a huge generation of young

people, quick generation changes, modernization and isolation, might have the potential to rapidly induce the shifting baseline syndrome. As most people in Uganda are young, the biggest part of the population will grow up with a natural environment that is already degraded, potentially lowering their expectations for what a desirable natural environment is, this can have consequences for restoration programs (Soga and Gaston, 2018).

The farmers at Mt. Elgon were found to possess relatively limited local ecological knowledge, which was initially surprising. However, considering that deforestation, acculturation, alienation etc., which are all identified as key threats to local ecological knowledge (Case et al., 2005; Waiswa et al., 2015), are strongly present in the Mt. Elgon region, this erosion of knowledge becomes more understandable. Furthermore, forest management in Uganda, and particularly in Mt. Elgon, has been affected by colonial exclusion (Turyahabwe, 2010), instability in political powers (Petursson et al., 2013), and external interference (von Kocemba et al., 2025). Along with a population that is still under rapid growth (United Nations, 2025), there is a potential for people to lose connection to nature, and conflicts over land to sustain livelihoods to increase (Petursson et al., 2013; von Kocemba et al., 2025). The events causing deforestation in Uganda are with no doubt strongly impacted by the country's history and the intense population increase. It is however also important to consider the effects of these events, and how they have influenced local people's perception of forest management and their motivation to protect forest. Understanding and emphasizing the importance of underlying factors, such as people's relationship with nature, might be an important factor to decrease deforestation events in the future. Furthermore, another important aspect to consider is that the factors contributing to the erosion of local ecological knowledge interact in complex, multi-directional ways. These are not linear or isolated processes. For instance, alienation can drive deforestation, and deforestation can also deepen feelings of alienation by severing communities from the environments they once actively managed and understood (Waiswa et al., 2015). Similarly, acculturation may reduce the transmission of ecological knowledge, but it can also be intensified by environmental degradation and the loss of traditional livelihoods. Degradation of nature can also lead to people gaining a new baseline for what nature is, this could lead to a loss of connection to and knowledge of a not degraded ecosystem which could lead to further degradation and so on. Recognizing such reciprocal and reinforcing relationships is essential to fully understand how local ecological knowledge is lost, and how efforts to protect or restore it must address these interdependencies.

Factors influencing species selection and importance for agroforestry coffee farmers at Mt. Elgon

To understand how farmers at Mt. Elgon select and value plant- and tree species for their agroforestry systems, this study investigated which aspects the farmers mentioned to be important for the plants and trees to fulfill. This highlighted several key factors: the availability of species, the high value placed on species with multiple uses and species that support key livelihood aspects, especially food, income and environmental resilience, are the most important. It was also found that the preferences varied across communities, genders, and age groups. These findings will be explained and discussed in the following paragraph. Furthermore, the specific plant- or tree species' that farmers have emphasized as key to address specific livelihood aspects will be included.

Preference for plant- and tree species is influenced by both accessibility and the range of uses

In the assessment of farmers' local ecological knowledge, only limited information from the interviews was presented. Knowledge on species that did not live up to the criteria of cultural, spiritual or traditional uses of was not considered local ecological knowledge. Though this knowledge is not considered local ecological knowledge, it is useful to assess the livelihood needs and plant- and tree species preferences amongst farmers at Mt. Elgon. Throughout the interviews and the ranking exercise, farmers were encouraged to emphasize for which livelihood aspects trees- and plants benefited them the most. Farmers at Mt. Elgon expressed a general focus on species valuable for income- and food purposes, however species valuable for medicine and resilience against climatic variability was also important to the farmers. This focus was both seen when farmers had the opportunity to answer more freely during interviews and from their answers in the structured ranking exercise. In general farmers valued species that had multiple uses, meaning that even though a species was especially valued for food- or income purposes, it would often have other uses as well.

Farmers were overall able to mention many species when asked which species they had available, which species were important to them and which species they would like to introduce to their farms, however when asked which species were no longer available to them, they struggled. Farmers at Mt. Elgon are not able to think of species that they are not already familiar with in their local environment, the species farmers know, are the species available to them. The species that the farmers wanted to introduce were also species already existing in the communities, these were especially food crops. These species were available in the communities, however some farmers wanted more of them and some farmers were only growing a few of them but wanted to have more. Often, the reason they did not have these species was explained by a lack of input to buy seeds or

seedlings. This emphasizes that the farmers focused on the species that they already know and have available and that they do not have knowledge of species that they are not surrounded by. This lack of knowledge of other species could be explained by different factors. The deforestation events at Mt. Elgon have led to a decrease in the diversity and availability of species (Giam, 2017). Many farmers expressed that there used to be more trees available in their community, but that these had disappeared due to deforestation. They were not able to identify these species. Even though some of these species might be found in the Mt. Elgon national park the physical limitations of movement, as most of the farmers were only able to get around by foot, made it very difficult for farmers to get to the forest without having to pay for transportation. This limits the possibility of farmers to regain knowledge on species lost in their nearby community. Though efforts have been initiated to create collaborations between local communities and Mount Elgon National Park to decrease conflicts between forest management and local communities, none of the interviewed farmers expressed that they benefit from forest resources. Another explanation for the lack of knowledge on other species could be that farmers at Mt. Elgon are very isolated. Most of the farmers were not able to transport themselves around longer than they could go by foot, if they were to go further, they needed to pay for transportation (own observations). Most of the farmers had never visited other regions, some expressed that they had visited other farms in the nearby communities, but not further than that. Furthermore, most of the farmers did not have access to electricity or owned a smartphone. Access to information outside their community was therefore very limited.

There seem to be a connection between the fact that most farmers in Bududa, Bufumbo and Sipi are isolated to new knowledge, and the fact that they are not able to identify species that are missing in their communities. For farmers to gain knowledge on species that used to be available in their communities, would require that they have access to natural forests where they could gain knowledge on other species and access to knowledge in form of formal education and training.

Demographic patterns in plant and tree use and species importance

Exploring species use across demographic variables can help reveal which functions farmers at Mt. Elgon mainly rely on plants and trees to fulfill. For an easier understanding, ‘key functions’ will refer to the species use categories, e.g. food, income, environmental management etc. To understand how these needs vary, this section will examine how and why different groups of farmers value certain species. The discussion will include the specific species identified as most important, assessing whether they possess characteristics aligned with the key functions of use. Data from both the species

use patterns and the ranking exercise will be used, allowing for a direct connection between key functions and the species most frequently prioritized by farmers.

Eucalyptus, avocado and cordia are of significant importance to farmers at Mt. Elgon

There was a correlation between species that farmers mentioned to be important in the ranking exercise and species that were available to them. The availability was confirmed by observations throughout the fieldwork in the communities, and by comparing the data to the interview responses where farmers identified species available to them. In general farmers revealed to have a preference of species, especially trees, with multiple uses. This means, that trees that can benefit the farmers in more than one way, has a higher value to the farmers. Three species will be highlighted: eucalyptus, cordia and avocado. These species were the overall most important to the farmers in the ranking exercise, furthermore they were available to the farmers, and they all had multiple uses. This means, that across all farmers at Mt. Elgon, regardless of gender, age and community, these were the three species that were most important to them. Farmers mentioned that eucalyptus was an important tree because it was fast growing and the timber could be sold at a relatively high prize, it was a fast way of earning money. In a study from Kenya, eucalyptus was found to be the most preferred species by farmers, due to its diversity of products (Rotich et al., 2017). Though farmers at Mt. Elgon mainly benefited from the income, eucalyptus also served other purposes as firewood, medicine and resilience. Farmers were however aware that eucalyptus uses a lot of water and explained that it reduces the coffee yield if planted in the coffee gardens, therefore most farmers would plant it at the edge of the gardens and along riverbanks (own observations). Negative effects of eucalyptus in agroforestry systems has been seen in other studies, one suggests that proper management such as placement of eucalyptus and proper care of the tree is necessary to reduce its negative impacts (Raj et al., 2016). Farmers valued cordia for its agroecological benefits, by providing shade for the coffee and the leaves acting as natural fertilizer when they decompose. Many farmers explained that the coffee growing near the cordia would give a better yield. Besides its agroecological benefits it was valued for firewood, income, resilience and timber. Studies from Ethiopia, reveal that farmers value cordia for its multipurpose uses (Lelamo, 2021) and that it has positive impact on maize yield (Ibrahim et al., 2025). Avocado was valued very highly as a food source, many farmers had multiple avocado trees in their gardens (own observations). Though the main purposes of the avocado tree were eating the fruits and providing income from selling the fruits, it was also used for firewood and medicinal purposes. A study from Ethiopia also suggests that avocado has beneficial impacts on soil composition and chemical properties in the soil (Kindie et al., 2023).

Community variabilities and challenges affected the farmers' perception of species use and importance

In Bududa farmers were more focused on the category environmental management, suggesting a greater interest in, or need for, species that can be beneficial for this purpose. Bududa is one of the areas in Uganda known to be prone to landslides, occasionally they are big and have devastating effects, however these landslides happen often in smaller scale for the farmers in Bududa. During the fieldwork, instances of fields being covered and houses suffering from damages due to landslides, were observed (own observations). Though initiatives to plant species such as bamboo to reduce the risk of landslides are made (The Independent, 2023), landslides were too severe for bamboo or trees to stop them. Many farmers showed how their trees and bamboo had been taken by landslides (own observations). This could explain why farmers of Bududa were more prone to have mentions of species used for environmental management than farmers in Sipi and Bufumbo.

Farmers in Sipi had a slightly bigger focus on species with food and income purposes. This could suggest that the farmers in Sipi have a focus on edible and marketable species. An explanation for this could be found in the infrastructure. Better infrastructure could have enabled the farmers in Sipi to be better off in terms of buying and selling products. In a research project in South-Western Kenya it was found that improved road infrastructure led to an increase in agricultural productivity and market access by smallholder farmers, leading to economic growth and beneficial livelihood impacts (Philemon and Matsumoto, 2018). This could potentially explain the focus on edible and marketable species in Sipi.

A spiritual or religious connection to nature did not appear to play a significant role in any of the communities. Farmers only mentioned spiritual or religious uses of plant species when encouraged directly during the ranking exercise, and even then, they found it difficult to name examples. In the interviews, where farmers were encouraged to speak freely about how they use plants and trees, spiritual and religious uses were rarely mentioned, suggesting these are not important aspects of native plant use amongst farmers at Mt. Elgon. As forest dependent communities are known to hold this kind of knowledge on nature (Martin, 2004), it was surprising that the farmers shared so little information of this, and that they struggled to name species in the ranking exercise. However, this type of knowledge is closely tied to local ecological knowledge and is shaped by the cultural and historical events that have occurred at Mt. Elgon. The low emphasis on spiritual connections to nature may reflect broader shifts in cultural practices over time.

Connecting species use and community patterns to highest valued species

Four species stood out as consistently important in all communities, avocado, eucalyptus, orange and elephant grass. The species use discussion revealed farmers to be focused on species with key functions related to food, income and environmental management. Looking into how these four species were ranked in these categories, revealed a great overlap. In the category food, avocado and orange were very important, for income eucalyptus, orange, and avocado were the most important and for resilience against climatic instability elephant grass were one of the most important species. There seem to be a big overlap with the key functions, and how specific species are valued in the communities. The functions that farmers mention in the interviews align with the use of the species that they value as most important. This indicates that farmers at Mt. Elgon have a very big focus on species that can provide food, income and can act as resilience against climatic instabilities.

Though the community patterns in the interviews revealed farmers in Bududa to be more focused on species with key functions of environmental management it did not seem that Bududa farmers valued species in the resilience category, e.g. elephant grass and markhamia, higher than the other communities. This could be an indication that, though Bududa are especially vulnerable to landslides, climatic instability is a concern in all three communities. Though the community patterns in the interviews revealed Sipi farmers to be more focused on species connected to food- and income sources, they were the only community to not have a food crop as one of their most important species. Bududa and Bufumbo farmers mentioned respectively maize and matooke. This could potentially reveal that the focus of farmers in Sipi is more on food sources that also provide an income, making trees more relevant. It could however also be, that farmers in Sipi did not understand that the assignment should include both crops and trees. Such misunderstandings would affect the results, as the sample size of each community is small.

Gender-based variabilities and challenges affected the farmers' perception of species use and importance

Gender-based differences were observed in how women and men prioritized key functions of plants and trees. Women focused on species in the categories food and income and men focused on species in the category environmental management. A possible explanation for this is that the women in these communities were the main food providers in their household. The women explained that they spent

the mornings working in the garden, often with the help of the husband. As the work was done, the woman would return to the house where she would take care of all the household chores. At this point the men would often have the day off. This pattern was explained and observed in many of the families and across all communities and is also backed by literature, e.g. Guloba, 2014. During the group meeting in Bududa, the women also explained that the coffee is for the man. They explained, that due to men often owning the land, women had no rights over the crops growing on it. Often the man would get the money from selling coffee, and the woman would sell matooke or other food crops. This pattern could explain why women were more focused on income generating crops, as these are their main income sources and as they do not necessarily benefit from the coffee production. This could also explain why studies have found women to be more prone to abandon agroforestry trees after implementation (Galabuzi et al., 2021, Kiptot et al., 2007), as their interest is higher for fast growing crops. Furthermore, the focus on species used for food, could be explained by women overseeing cooking for the household.

That men had a specific focus on species used for environmental management is probably an expression of them having more knowledge on agricultural systems and climate adaption. This knowledge would be gained from school or workshops. Due to women often ending their education early (Galabuzi et al., 2021), men have a better foundation for knowledge on these species. This is also very well connected with women having a worse adaptive capacity than men (Balikoowa et al., 2019; Gorettie et al., 2019; Vincent, 2022), as they do not have the necessary foundation to discuss species used for environmental management. During individual interviews with women, it was however revealed, that especially elder women in the age group 50+, mentioned species used for environmental management. Talking to the farmers it was clear that they had seen great changes in the environment during their lifetime. For the older women they had a longer time frame of comparison, this could be an explanation for them being more conscious of adapting to changes in the environement. Another possible explanation is that older women may be physically less able to carry out demanding agricultural tasks, such as digging trenches to prevent soil erosion, which could heighten their concern as they are less capable of mitigating the impacts of extreme weather. Many of the interviewed old women were physically limited (own observations). Looking at existing literature, different patterns of environemntal concern related to age has been found, some reveals that environemntal concerns to be highest amongst the young and well-educated (Klineberg et al., 1998), while others reveal it to be highest amongst the elder (Liu et al., 2014) and some find no link between age and environmental concern (Gray et al., 2019). Age-related concerns of the environment

seem to vary, therefore specific circumstances should be investigated to understand the circumstances of why older female farmers at Mt. Elgon are more conserned with the environment than other age-groups.

That young women had less mentions of species used for food compared to middle-aged and elder women could be signal that young women are less concerned with food crops than middle-aged and older women. Though it was not possible to find literature to explain this specific pattern, different observations were made during the fieldwork, that could explain this pattern. Though this is contradictorary to the finding of women being tha main food providers, a potential explanation for this might be that the interviewed young women were not the head of the household (own observations), therefore their focus is not related to factors such as food crops or other agricultural concerns. It could be an indicator for young women having less power in the household. Research reveals that young people have less interest in agriculture and that, especially young women, will move away from rural communities (Rietveld et al., 2020). This could explain the lack of mentions of species used for food purposes, as young women simply have less interest in agriculture.

Connecting species use and gender patterns to highest valued species

A higher focus on species used for food amongst women was confirmed when comparing it to which species were important to men and women. Species that were important for food were more important to women. These were a mix of food crops such as matooke, cassava and maize and trees such as avocado, mango, jackfruit, guava and lemon. As discussed, household and cooking are mainly overseen by women. Their focus on species that can be used for food, confirms that this is mainly a female concern. Amongst the species that men and women valued of equal importance many species had multiple uses, however they were especially valued for their resilience against climatic variability, income and medicinal uses. This pattern did therefore not confirm that women are more focused on species used for income purposes or that men are more focused on species used for environmental management. It seems that farmers of both genders value species in these categories very highly. Looking into species specifically important to men was however species only valued for their religious and spiritual uses, hibiscus and cactus. This could indicate that species used for these purposes are more important to men. Although these species seemed to be important to men, they were only mentioned in one interview. To confirm if men in general value species in this category more important than women, more data would need to be collected. A study from Eastern Uganda contrastingly found local knowledge to be gender blind and observed no difference in the ranking of

species between men and women (Gram et al., 2018). They however observed a difference in preferences between altitudes (Gram et al., 2018), a parameter that could have been interesting to include in this study.

Farmers at Mt. Elgon value species for availability, multifunctionality and livelihood support

To sum up these finding, farmers at Mt. Elgon select and value plant and tree species based primarily on availability and multifunctionality. Species used for livelihood aspects as food, income, and resilience to climate change are especially valued. Preferences are affected by local environmental challenges, such as landslides in Bududa, and by infrastructure differences across communities. Gender also plays a role as women prioritize food-related species due to their roles in household food provision, while men more often focus on environmental management. The most valued species across all communities were avocado, eucalyptus, orange, cordia, and elephant grass, which align with these key livelihood needs. Out of these species, only cordia and elephant grass are native to the Mt. Elgon region.

Security issues of female farmers at Mt. Elgon were multifaceted and varied between communities and age-groups

The human security framework allows for a holistic approach to understand the complexity of security challenges female farmers in coffee agroforestry face. Especially health, economic, food, environmental and personal security are security aspects that impact women disproportionately. Understanding how local circumstances, such as location and age, influence the security of female farmers at Mt. Elgon can provide valuable insight into how their needs can be better prioritized and how gender equality can be more effectively addressed in agroforestry and tree-planting initiatives.

Economic security was the overall primary concern among female farmers at Mt. Elgon, with similar levels of concern across communities and age groups, indicating it is a universal issue for women in the region. The interviewed female farmers were all doing coffee agroforestry. Coffee is grown for the purpose of creating income, however this is not necessarily an income resource available for the women. Land ownership inequality did affect the income security of the women at Mt. Elgon. The women expressed, coffee is for the man, while they gain income from fruit trees and other crops like matooke. Hereby the main income source is not available to the women. Focusing on plant and tree species that create an income for women, is important. As orange, eucalyptus and avocado were the highest valued species for income, these species could be important to focus on for the female farmers. During the interviews they expressed that food- and income insecurity is

dependent on the season. During the dry seasons they would experience most economic insecurity as they did not have any fruits to sell. However, products such as firewood, charcoal and timber could benefit them in these periods. To create more economic security for the female farmers, a focus on trees that can provide these products could be beneficial. Specifically, a focus on eucalyptus, markhamia and cordia for firewood and ficus and cyprus for timber could be beneficial for the female farmers, as these trees were valued as the most important in these categories. These are very applicable, fast solutions to accommodate the income security issues of women, however, a focus should also be put on equality in education. As women are more likely to not finish school (Galabuzi et al., 2021), this creates a gendered imbalance. To ensure equality is addressed in agroforestry and tree planting initiatives, the focus should not only be on income generating solutions, but also solutions creating the groundwork for women having the same opportunities as men.

Environmental security was a general big concern amongst female farmers. This could be explained by women being disproportionately affected by climate change due to their lower adaptive capacity (Balikoowa et al., 2019; Gorettie et al., 2019; Vincent, 2022). Due to this, female farmers will also have a lower agricultural productivity, which will affect their income and food security. Environmental security could be an important focus when addressing equality, as adaptive capacity will not only influence their resilience against climatic instabilities, but also ensure that their agricultural productivity is more stable. Women expressed a lack of economic input to be a big challenge for them. A focus on female farmers gaining access to economic input could positively benefit female farmers in adopting to climate change (Nabikolo et al., 2012). Female farmers in Bududa were a lot more concerned with environmental security than in Sipi and Bufumbo. These concerns were highly linked to landslides and soil erosion, and they expressed that planting bamboo and trees did not help. A specific focus on how environmental security can be addressed is necessary to create security for the female farmers, especially in Bududa. Improving the environmental security could also improve, food, income and even personal security. The focus should specifically be on prevention of landslides, for this tree planting can have positive effects. Currently, the steep slopes surrounding the community in Bududa, are covered in fields with very few trees incorporated (own observations). Research from Indonesia suggests that a mixture of tree species with deep roots and grasses with intense fine roots provides the highest hillslope and riverbank stability (Hairiah et al., 2020). The species most important to farmers at Mt. Elgon for resilience against climatic instabilities, are elephant grass, markhamia, bamboo, cordia, albizia and ficus. These species include both grasses and trees, making them suitable to focus on for environmental management.

Food security was a general big concern for female farmers, however especially in Bufumbo and amongst middle-aged female farmers. This could suggest that there are differences amongst the communities and age-groups. Potentially, middle-aged female farmers are more likely to have many children living at home. Eventhough women in the rural communities have children at an early age, the middle-aged female farmers could be likely to have children that are quite big, and need more energy. The young female farmers might have many kids as well, however younger kids. The older female farmers might have grown children or grand children helping in the garden. Furthermore, the interviewed young women had less repsonsibility of the households, whereas the middle-aged and older were more likely to have more responsibility of the household (own observations). The older women could potentially be less worried about food security because their kids were grown up and able to fend for themselves, this was however not expressed by the farmers but based on observations. Most of the interviewed women were living in a male-headed household, which could mean that these women had a consumption advantage to other female-headed households (Vincent, 2022), it could have been interesting to compare the difference between male- and female headed household at Mt. Elgon. For women at Mt. Elgon to gain more food security, a focus could be put on ensuring they have matooke, avocado, orange, maize and mango available to them, as these are the most important food species for farmers at Mt. Elgon. Another suggested solution to create higher food security for the female farmers at Mt. Elgon, would be to introduce voluntary sustainability standards, as certified farmers have been seen to have a higher nutrient uptake (Chiputwa and and Qaim, 2016).

Health security was also a big concern amongst women, however much less of a concern amongst female farmers in Bududa. This demographic pattern was not able to be explained by the data. It could be interesting to investigate if this pattern would repeat itself if more data was collected. As the farmers must pay for medical treatment, it could be that income and health security were related to each other. However, women in Bududa were not economically more secure. A focus on species with medicinal purposes could help women gain access to medicine without spending money. Trees like elgon teak, albizia, orange, eucalyptus, avocado, lemon and neem are mentioned as the most important species for medicine. A focus on educating women to reduce the health risk of sexual transmitted diseases and birth delivery outside hospital facilities is also important.

Personal security: Personal security did not seem to be a big concern amongst the female farmers at Mt. Elgon. As research indicates that women in rural areas of Uganda suffer from gender-based violence (Kawuki et al., 2021, Vincent, 2022), it would be expected that this is an insecurity amongst the female farmers at Mt. Elgon. However, the sensitivity of this subject could make it hard

for women to speak up about this during interviews, furthermore, cultural accept of this (Koenig et al., 2003) could lead to the women not seeing it as a security concern. This highlights a problematic mentality in terms of changing this pattern.

Female farmers at Mt. Elgon face insecurities that are disproportionately big due to their gender. Especially economic, food, environmental and health security were of high concern amongst the women. These insecurities did vary between the three communities and the three age-groups. The insecurities of the women are highly connected to each other, meaning that contributing to one insecurity could also influence the others. During the fieldwork, farmers had organized in Village Savings and Loans Associations (VSLA), where they could save up money and take loans. The female farmers had a very positive attitude towards this. Another study from Uganda reveals that cooperatives can help create more gender equality by allowing women to develop organizational relationships they did not have access to before and giving them access to financial resources (Theeuwen et al., 2021). Women organizing in groups could be a potential way of addressing economic insecurity, however as the insecurities are highly interlinked with each other this would also be beneficial for other security aspects. A heightened economic security could enable a heightened food security as women could spent money on food and seedlings of food crops. Furthermore, environmental security could be heightened by gaining monetary access to tree seedlings that could address issues of soil erosion, which simultaneously would have positive effects on their personal security, if landslides became less of an issue. Furthermore, it could address their health security as they could gain access to a more varied diet and be able to pay for medical care. By addressing the security issues of women through the human security framework, revealed which issues are the most pressing for the female farmers at Mt. Elgon, this further create the grounds for finding a solution that can positively impact these security issues, e.g. that women organize in groups. Being aware of differences between communities and age-groups is necessary, e.g. age-specific needs of women should be considered, as younger women may benefit more from training and information access, while middle-aged women may prioritize food and income-generating crops.

The potential of Agroforestry and tree planting initiatives to address contemporary challenges and security issues at Mt. Elgon

Though agroforestry and tree planting have many benefits, a focus on the specific context and local needs of farmers at Mt. Elgon is crucial to ensure the success of the project (Chambers et al., 2020;

Ika, 2012, Jacobi et al., 2017). The challenges of farmers at Mt. Elgon were therefore investigated and their potential for innovation was examined in order to avoid having unrealistic assumptions about participation (Kumar et al. 2002). Though demographic challenge patterns were observed, farmers across communities consistently identified 1) access and structural barriers, 2) economic barriers, and 3) environmental challenges, as the most pressing challenges. As such, this discussion will focus on these three challenge areas. Farmers in Bududa were generally more outspoken about these challenges, and men and women did not agree upon which challenges were most pressing. Despite these variations, focusing on how agroforestry can address these core issues offers a pathway towards holistic and inclusive solutions that transcend community and gender boundaries. For an inclusive approach to solve these aspects, an emphasis should be put on the innovation potential amongst the farmers. Notably, farmers across all groups expressed many ideas in innovation related to farming development to address their challenges. For agroforestry and tree planting initiatives to be inclusive and realistic, this should be of focus.

The first challenge of access and structural barriers farmers especially reported not having is access to seeds, seedlings, fertilizer and garden tools. As a part of the project, it could be beneficial in aiding farmers to get access to tools. In Sipi, one cooperative organized to buy shared tools that all members could use. This could be a potential way of solving this challenge. Agroforestry tree species can help limit the need for fertilizer, as incorporating trees into agricultural systems can reduce soil erosion, maintain soil organic matter levels, and increase the abundance and activity of beneficial soil organisms, subsequently improving soil productivity (Barrios et al. 2012, Bronick and Lal, 2005). A study revealed neem leaves to have positive effects on height, root length, greater biomass, flowering and fruit yield (Gajalakshmi and Abbasi, 2004), however neem is not native to Mt. Elgon. A species such as cordia, which is native to Mt. Elgon, was seen to have positive effects on maize yield in Ethiopia (Ibrahim et al., 2025). Agroforestry tree planting could offer a great way of accommodating this challenge.

The second challenge of economic barriers was related to the first challenge, as lack of capital was the reason farmers did not have access to e.g. seeds and fertilizer. For this challenge agroforestry can be beneficial as it can help diversifying income sources for farmers (Galabuzi et al., 2021). Increased biodiversity in agroforestry gardens has been linked to greater income in agroforestry systems (Cardozo et al., 2015), indicating that helping farmers gain a greater diversity in trees, could help solve the challenge of economic barriers.

The third challenge of environmental challenges was especially focused on seasonal variabilities in weather. In the dry season drought affected the crop yield and caused food scarcity. In the wet season soil erosion and extreme weather would cause destruction of the crops. As explained, agroforestry trees could help reduce soil erosion, furthermore they could reduce crop destruction, by shielding crops against heavy rain (Chambers and Longhurst, 1986), however, as some farmers explained, if a tree falls it can be very destructive to the other crops. In a study from Kenya, agroforestry was found to have positive impacts on the resilience of farmers to floods and droughts (Quandt et al., 2017).

Looking into the ideas farmers posed in the innovation category of farming development ideas, these align very well with the challenges. Farmers expressed a wish to plant more bamboo to stop soil erosion and a hope to gain more knowledge on how to do agroforestry with specific mentions of knowledge on how to retain soil fertility. Other mentions were a wish to gain knowledge of pest control and post-harvest management.

Interdependence of agroforestry and local ecological knowledge

Farmers had a positive attitude towards developing their agroforestry systems and agroforestry trees could present a versatile solution to the challenges mentioned by the farmers. However, these challenges are not the only challenges farmers at Mt. Elgon have. The discussion raised many challenges for farmers at Mt. Elgon, which have not been addressed here. These challenges are linked to loss of local ecological knowledge, deforestation, shifting baseline syndrome, demographic variabilities etc. How agroforestry and tree planting initiatives could affect these aspects should also be considered.

Local knowledge of tree species and their ecosystem services is vital for developing tailored agroforestry recommendations (Gram et al., 2018), nevertheless farmers at Mt. Elgon lack this local ecological knowledge, which could limit the inclusion of native species in agroforestry projects in this area. However, as it was suggested earlier in the discussion, focusing on species with multifunctional uses with an emphasis on food provision, income generation and environmental benefits would incorporate the wishes of farmers at Mt. Elgon, though not relying on their knowledge on specific tree species. Many valuable species to the farmers were exotic. In management projects, specifically agroforestry and tree planting initiatives, the importance of introducing native species is often highlighted. Native species play a crucial role in agroforestry and tree planting initiatives due to their multiple benefits such as diversifying and intensifying farming systems while benefiting

biodiversity and the environment. (Leakey, 1999). Though native trees provide essential ecosystem services, support livelihoods, and help farmers adapt to climate change, many initiatives have promoted exotic species (Buyinza, 2015) and farmers at Mt. Elgon are more likely to plant exotic species (Graham et al., 2022). Overall, incorporating local preferences and knowledge is essential for successful agroforestry initiatives, still farmers at Mt. Elgon show a lack of knowledge on native species, and a preference for exotic species. An example of this could be eucalyptus. All farmers were growing eucalyptus, as it is fast growing and can be sold for timber, it is an important tree for many farmers. However, the tree is exotic and have negative environmental impacts as it takes up a lot of water from the soil and thus negatively affects the environment and surrounding species (Raj et al., 2016). Furthermore, it does not possess the various benefits of native species. Finding native tree species with similar benefits as exotic species, such as eucalyptus, could be beneficial and would simultaneously support the local biodiversity at Mt. Elgon. Introducing farmers to species with native origin, and teaching them the various benefits of native species, could help farmers regain local ecological knowledge, reverse deforestation events and potentially reduce the shifting baseline syndrome by helping the farmers regain a natural environment that is much less degraded than the one they currently live in. Demographic variabilities should be considered when choosing which species should be planted, e.g. a focus could be put on native species with environmental management purposes in Bududa. Agroforestry has the potential to solve gender sensitive problems, especially by diversifying incomes and as it could reduce the workload in the gardens (Duffy et al., 2021), hereby women could have more time for other income generating activities. Some species have already been introduced to help address women's security challenges. However, if the focus is to be on native species, elgon teak, albizia, cordia, ficus, and markhamia could play an important role in addressing gender-specific concerns related to food, income, health, and environmental security.

Agroforestry does have the potential to solve contemporary issues for farmers at Mt. Elgon, but a specific sensitivity for women and demographic variabilities should always be considered to ensure the best possible outcome. A specific focus on hindering further erosion of local ecological knowledge is recommended. Efforts to expand local ecological knowledge as a part of agroforestry initiatives on Mt. Elgon should be included, as this knowledge has multiple benefits for the farmers such as adapting to socioecological changes, improving the longterm sustainability of their livelihood strategies and fostering social-ecological resilience (Haq et al., 2023). If agroforestry initiatives at Mt. Elgon successfully incorporate and build upon farmers' local ecological knowledge, they could

offer a holistic approach, addressing not only livelihood challenges, but also responding to local contexts and promoting gender equality.

Recommendations

Many sustainable development initiatives fail to reach the outcome they wished. As this research has shown, farmers at Mt. Elgon choose to engage in agroforestry and tree planting based on a range of underlying motivations, which inevitably influence their level of participation and, ultimately, the success of such projects in this area. The following recommendations for achieving successful outcomes in sustainable development projects with coffee farmers at Mt. Elgon are based on the findings of this research.

Agroforestry and tree planting projects must address the erosion of local ecological knowledge amongst farmers at Mt. Elgon, to create realistic and inclusive expectations. Recognizing reciprocal and reinforcing relationships of nature degradation and erosion of local ecological knowledge is essential to fully understand how local ecological knowledge is lost, and how efforts to protect or restore it must address these interdependencies.

Agroforestry projects could address issues of access to seeds and seedlings, by helping farmers gain access to tree seedlings, e.g. by establishing community led plant nurseries.

Keeping in mind, that the knowledge farmers at Mt. Elgon hold on species is connected to the availability of species, should be an important consideration in agroforestry and tree planting projects in this area. As farmers struggle to mention species that are not available to them, and the species currently available and important to them are often exotic, this should be a consideration in agroforestry and tree planting projects. Relying solely on farmers' existing knowledge may limit the inclusion of native species.

A focus on plants and trees with multifunctional uses, with an emphasis on food provision, income generation and environmental benefits, could direct projects to focus on introducing native species that have characteristics that could benefit farmers in these livelihood aspects. Hereby, though the farmers cannot identify the specific species, their needs and hopes remain central, supporting a more inclusive and effective approach.

As women are especially vulnerable to deforestation and climate change impacts, agroforestry and tree planting initiatives must aim to understand how women can be included. Though planting of trees with a specific focus on how they could benefit women could reduce some of their insecurities, many of the insecurities faced by women build on cultural and structural barriers. Limited access to land, economic input, education, and decision-making power are factors that tree planting cannot solve. Addressing gender inequality in agroforestry and tree planting initiatives requires a holistic approach, that recognizes the differentiated needs of women across age groups and locations, supports their access to multifunctional tree species, and integrates broader empowerment measures such as education, input access, and organization in cooperatives.

Discussion of methodology

Refund for travel cost

The refund led to some complications which will be addressed here. In coordination with the AfPEC project it was arranged to refund the participants of each interview, in the case that they spent money to attend the interviews, e.g. if they took a Boda Boda (small motorcycles working as private transportation) to get to the interview or to go home after. This was especially relevant for the focus group discussion where the meeting point was not at their own house. These rides would usually cost around 2000 UGX (0.5 EUR) for one trip. At the beginning of each interview, it was explained that participation was voluntary and unpaid, but travel expenses would be compensated. At the end of the interview each participant was asked if they had any travel costs to get to the interview. This created some issues; some participants felt that they should be paid to attend the interview and would therefore say that they had travel costs even if they didn't. At some interviews all participants ended up getting the same amount of money, even though some spent money on transportation and others didn't, creating a situation where some were paid to attend, and others were refunded for their transportation costs. Another issue was participants asking for more money than the transportation would have cost, in one specific interview the participants ended up asking for up to 25.000 UGX (6 EUR), and it seemed that the next would always add 5000 UGX (1.2 EUR) to the previous estimate. These scenarios created a situation where it was clear that they asked for more than they could have spent, and that participants who had walked to the interview were paid to attend. Furthermore, some participants at one interview would leave with more money than participants from another interview, this could create some issues for the members in the cooperative, should it be known. It seemed a difficult situation to confront the participants with this as it could create discussions and mistrust. In

these scenarios it would have been very helpful to have guidelines made beforehand, stating the maximum refund and how to avoid participants asking for money when they did not spend any. A solution could be to give all participants the same amount of money and make it clear that it is for travel costs, however this would then create a situation where some participants were actually paid to attend, and some only refunded. This could affect the validity of the interviews as participants should be voluntarily participating and should not have alternate motives to attend.

In this project the issue was handled by initiating interviews by making it very clear to the farmers, that they could not be paid to participate in the interviews as it was a part of a research project, and this would create a bias for them attending. This was done when the farmers were invited to the interview and in the beginning of the interview. Furthermore, it was explained that participation was voluntary. In the end of the interview, farmers were asked if they had any transportation costs that they needed covered. This created instances where farmers asked for more money than they spent, however as no maximum was set for the travel cost beforehand, farmers ended up getting what they asked for.

Comparison of Individual interviews and Group interviews

Throughout the analysis of the collected data, individual interviews and groups interviews were coded and analyzed together. Although the two interview types shared common themes, the protocols were slightly different. The individual interviews were more structured, and the setting led to less detours from the question than the group interviews. During group interviews the dynamic of having more people participating led to more loose discussions of the questions and a higher tendency to go off track. Using the data from the individual interviews and the group interviews together can have strengths and weaknesses. The strengths of doing this lies in the variety of the data. By using data from different interview methods together, it covers a broader spectrum of data and ensures that the interview type has less influence on the results. A complication however arises in the comparison of the data, where the pattern is often that the frequency of mentions is much higher in the individual interviews compared to the group interviews. This could be because the individual interview had more structure, and the format did not allow for the conversation to side-track as for the group interviews. Another explanation could be that the participants felt more free to answer question and share sensitive information when interviewed alone, this especially applied to women (Kruger et al., 2019). Comparison of the genders only included data from the group discussions. Men tended to have a slightly higher answering frequency than women, however looking at the interview types the highest

answering frequency is found in individual interviews which were only done with women. This could indicate that women felt less comfortable responding in group settings than alone. Another explanation for this dynamic could be that men are more used to meeting settings and knowledge sharing than women, and thus feel more comfortable sharing knowledge in a group setting. A research project from Uganda found a positive correlation between social capital and knowledge sharing and that men often had more social capital than women (Katungi et al., 2008). These observations could be beneficial to include in projects where knowledge and input from all demographic groups should be represented. To ensure obtaining knowledge from women, creating a setting where they feel comfortable sharing information should be considered. Research indicates that female participants share more information during individual interviews (Kruger et al., 2019), which could explain why there was a general pattern of participants being much more responsive in individual interviews than in group interviews.

Potential Bias and Its Implications for Data Quality

Use of Interpreter

Throughout the fieldwork, interpreters were used to facilitate communication between the researcher and respondents. The use of an interpreter presented different issues of bias that could have implications on the results. Factors that could have affected the data was e.g. seen as personal relations between the interpreter and the respondent, social hierarchies affecting the interpreter and/or the respondents' statements, internal bias or own agendas, selective translation or failure to translate correctly, gender dynamics especially when the translator was male and the respondent female and power balances between the researcher and interpreter.

To mitigate some of these issues, the interpreter was explicitly instructed to translate questions as directly as possible, refrain from interpreting or summarizing answers, and avoid answering based on personal knowledge. These expectations were reinforced regularly, but the risk of unconscious bias or subtle rephrasing remains. Overall, the use of interpreters, while unavoidable, posed ethical and methodological challenges. These experiences underline the importance of continuously reflecting on interpreter roles, actively managing translation accuracy, and acknowledging the influence of social context on data integrity.

Time consuming methods

Due to interviews being a time-consuming research method the data represents a relatively small group of farmers. If more data had been available, it could have been beneficial to do statistical analysis and look for significant patterns of the data.

Underlying incentives

An important methodological consideration in this study is the potential influence of underlying incentives on respondents' answers. In several interviews, it appeared that some participants tailored their responses in ways that might position them to benefit from future opportunities. These observations were specifically based on respondents often highlighting needs, vulnerability, or alignment with perceived project goals or directly asking for money (own observations). This was likely influenced by my identity as a researcher from the Global North and my affiliation with the AfPEC project, which may have been perceived as a gateway to external support or funding. In this context, farmers may have seen the interview process not only as a means of sharing information but also as a chance to attract development initiatives or financial assistance. This could mean that the study might not always reflect local realities. This should be kept in mind when interpreting the data.

Cultural and Linguistic Barriers

The research involved working with diverse groups of men and women across three communities, each with distinct cultural norms and social hierarchies. Language barriers and the need for translation posed significant methodological challenges. Engaging with participants through interpreters introduced the possibility of miscommunication or incomplete understanding, particularly in discussions involving sensitive topics such as gender roles, exclusion, or access to resources.

Conclusion

The local ecological knowledge amongst farmers at Mt. Elgon is limited. Due to the high biodiversity of Mt. Elgon and its role as a water catchment area, the area is of important ecological and livelihood significance, especially the forest has a huge historical, cultural and ecological importance. As local ecological knowledge can be an important tool in management projects, the erosion of this knowledge should be taken seriously. The impacts of this erosion can be manyfold and complex, however main concerns of the erosion of local ecological knowledge lies in the loss of human-nature interactions, a view of nature being a resource to be used without consideration of the consequences and the shifting

baseline to an accept of a very degraded ecosystem. A specific emphasis will be put on the relevance of the Shifting Baseline Syndrome at Mt. Elgon. Due to isolation, lack of knowledge transfer, short generation times and a huge population of young people that have grown up in a degraded environment, this syndrome could have a huge impact of the farmers willingness to participate in sustainable development projects and on their ambitions of these projects. Common for these impacts is that they will lead to further degradation and deforestation of the natural environment at Mt. Elgon which can have devastating consequences, reaching a lot further than Mt. Elgon.

Female farmers are disproportionately affected by insecurities and climate change at Mt. Elgon. Though introduction of species specifically beneficial to the female role in the society could be helpful, structural and cultural aspects limit the inclusion of women in sustainable development projects at Mt. Elgon. For women to reach the goals of the UNDP framework, freedom from fear, freedom from need and a life with dignity, not only agricultural changes have to be made. An emphasis on equal inclusion of female knowledge and preferences in sustainable development projects is of high importance. This can be accommodated by creating settings where women feel comfortable sharing their knowledge, challenges and ideas. Individual meetings facilitate deeper and more extensive knowledge sharing than group discussions and are therefore beneficial for female inclusion. For the female farmers at Mt. Elgon, the lack of access to money from the coffee production is an important factor to take into consideration, when introducing new trees. If to increase the economic security of women through tree planting, a focus should not be on a higher coffee yield, but instead a higher yield from other trees with monetary benefits. A simultaneous food production from trees is important for the women.

Deforestation and degradation of natural ecosystems is an ongoing problem at Mt. Elgon, and sustainable development projects should aim to reduce these trends. A solution for this could be to through tree planting. By giving farmers access to more trees locally, the forest would no longer be utilized for resources, this would simultaneously reduce the conflict between forest management and local people. Planting of trees will also be beneficial for the contemporary challenges that farmers face at Mt. Elgon, including soil erosion, declining soil fertility, food and income insecurity, and vulnerability to climate change. To ensure the best outcome, planting of trees should be done in close collaboration with the farmers. However, as farmers at Mt. Elgon lack knowledge, especially of native species, using their knowledge would induce tree planting efforts with low planting of native species.

Agroforestry projects focus on benefiting livelihood, biodiversity and the environment at the same time, however this calls for introduction of native tree species. Therefore, to accommodate the challenges for farmers at Mt. Elgon, a focus should be on the key aspects that the farmers need the tree species to fulfill, food, income and environmental management. This knowledge can then be used to introduce farmers to species, that they no longer have available to them, but are native to the area and benefit them for these purposes. Farmers at mt. Elgon have a high interest in species with multifunctional uses, an important consideration to take into consideration when introducing them to native species. Native species are highly adapted to the local environment and often serve multiple purposes. In addition to them having positive impacts on the local biodiversity and environment, a focus should be put on if they can provide food or income.

Following, multifunctional, native trees are found to be important for coffee farmers at Mt. Elgon; *Cordia africana* due to its agroecological and ecological benefits, and for its production of timber and firewood, which could also have positive impacts on deforestation. *Ficus* spp. due to its ecological benefits in resilience against climatic variabilities, and likewise for timber and firewood which could decrease deforestation. *Albizia* sp. likewise due to ecological benefits and firewood and timber production, and furthermore for its medicinal and spiritual use, making it an important species in maintaining local ecological knowledge. Following, exotic species were of great importance for the farmers; *Eucalyptus* spp. especially due to its rapid growth and subsequent fast income generation and *Grevillea robusta* due to its multifunctionality and agroecological benefits. Alternative native species accommodating their functions should be included in tree planting efforts with coffee farmers in the Mt. Elgon region.

Demographic and social variabilities affect the way farmers interact with nature, prioritize tree species, and experience challenges related to agroforestry and livelihood security. Sustainable development projects, working with coffee farmers at Mt. Elgon, should include considerations for these variabilities into all aspects of their work. This would allow for more targeted and context-specific efforts, increasing the likelihood of long-term inclusion and success in meeting project goals.

This thesis shows that by understanding farmers' livelihood needs, acknowledging the erosion of local ecological knowledge, and addressing the specific insecurities faced by women, tree planting and agroforestry initiatives can indeed serve as a practical and inclusive tool to combat deforestation and environmental degradation and strengthen resilience among smallholder farmers at Mt. Elgon.

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Appendix

Appendix 1: Semi Structured Interview

1:1 interview ow with 3 women from the cooperative, these should ideally not overlap with the 5 women from the FGD. The format will be a transect walk where the women take me to their agroforestry systems and tell me about the plants.

A. INTERVIEW DETAILS

Farmer Group/Cooperative Name	
Date of Interview	
Geographic Location	
Jurisdiction	

Name of Interviewer		
Was an interpreter used? Y/N	**What language was used to complete the interview?**	**Location of interview**
Name of note-taker or translator, if applicable		
Comments/other relevant information		
Informed Consent	Consent to record name? Consent to take photos?	

B RESPONDENT DETAILS

Gender Group	
Age Class (youth/adult/aged)	
Name of interviewees/interlocutors	

Nature-Relation and Plant Knowledge

Nature relation/ understanding of nature

- What do you think of when you hear the word 'nature'?
- What role does nature have in your life?
- Do you, as a farmer, feel closely connected to nature? If yes, in what way?
- Do you ever use nature as a place for relaxation, enjoying the scenery, going for a walk etc.?

I wish to understand the role nature partakes in their day-to-day life (nature-relation) and the knowledge they hold on plants

- How do you use these species in your daily life?
- Can you tell me what the different species are good for?

I wish to understand how they have achieved the knowledge about nature that they hold.

- Where did you gain knowledge on the plants and how to use them? Mom, dad, other family members, others in the household, education, training/courses?

Security and Nature's Role

I will try to get a better idea of their feeling of security in different parameters; health security, food security, environmental security, economic security and how this relates to their relation to nature and their AF practice

Health:

- Do you feel that you have enough access to medicinal plants?
- Are there any plants that you would like to have access to?
- Do you know how/if you could get access to these?

Food:

- Do you feel you have enough access to food?
- Do you feel you get a varied diet?
- Are you always able to get access to food when you need it?
- Are there some foods that you wish you had access to?
- Do you know how/if you could get access to these?
- Are you able to provide food for the entire household every day?
- Are there any times of the year where you have access to less food than others; rain- vs. dry season?
- Do you have any ways of conserving food for these periods; dry, pickle etc?
- Are there some species that would be useful to have to mitigate some of these issues?
- Do you know how/if you could get access to these?

Environmental security:

- Do you feel the environment is secure?

- Do you experience environmental issues that could put your security at risk, e.g. floods, droughts, landslides etc.?
- Do you have any ways of managing these issues?
- Do you have any suggestions/knowledge of how to handle these issues?
- Are there some species that would be useful to have to mitigate some of these issues?
- Do you know how/if you could get access to these?

Economic security:

- Are you able to buy the things you need for you and your household?
- Are there times of the year where you have less economic flexibility than others, e.g. dry- vs rain season because you do not have any plant derives to sell?
- Are there some species that would be useful to have to mitigate some of these issues?
- Do you know how/if you could get access to these?

Cooperative Membership and Engagement
I wish to get a better understanding of their role in the cooperative to understand if their knowledge and ideas are being heard and if they have access to training.
Basic information:

- When did you become a member of the cooperative?
- Why did you join it?
- Has anything changed since you joined?

Training:

- Have you received any training in connection with the cooperative?
- If not, have you been offered training?
- If not, have there been other things you had to attend to that put a barrier to you attending to training?
- Do you have any ideas to how you could be able to attend to training, e.g. if it was at a specific time of the day, close to your house, short hours at a time, receive self-training material etc.?

Decision-making:

- Do you participate in meetings and decision-making processes in the cooperative?
- Are you invited or are they only for specific members/roles in the cooperative?
- Would you like to be more involved in these?
- Could you try to explain the barriers that might be for you to participate?

Voice:

- Are there some things that you would like there to be a bigger focus on in the cooperative?
- Do you have ideas/knowledge that you would like to be shared in the cooperative?

- If yes, what are some of the barriers for this?

Knowledge sharing:

- do you share knowledge and ideas with others from the cooperative?
- If yes, are these mostly other female farmers or also male?
- If no, what are some of the barriers to you sharing knowledge amongst each other, e.g. no place, time or opportunity to do it?
- Have you experienced to learn a lot through knowledge sharing?
- If yes, do you have some examples of knowledge you have learned from another farmer?

Transect walk & Garden Mapping
I wish to get a visual understanding of their agroforestry system and if possible a sketch of the garden was made

- Will you show me your AF system?
- Will you tell me which plants grow in your AF system?
- Why have you decided to use these species?

Appendix 2: FGD: Focus group discussions

In each FGD there should be 5 people, two of them will be with men in the cooperative and two of them will be with women in the cooperative

A. INTERVIEW DETAILS

Farmer Group/Cooperative Name	
Date of Interview	
Geographic Location	
Jurisdiction	

Name of Interviewer		
Was an interpreter used? Y/N	**What language was used to complete the interview?**	**Location of interview**
Name of note-taker or translator, if applicable		

Comments/other relevant information	
Informed Consent	Consent to record name? Consent to take photos?

B RESPONDENT DETAILS

Gender Group	
Age Class (youth/adult/aged)	
Name of interviewees/interlocutors	

C PURPOSE OF INTERVIEW

1 Introduce the project and aims

- Human-nature relations and indigenous knowledge of plant uses.
- Cooperative learning, indigenous knowledge can hold valuable insights and create clearer idees of which species are important to focus on in agroforestry projects
- Knowledge of this could help create more security for farmers => medicinal plants, plants that can provide income, diversification of income, adaption to climate change
- Specific focus is on women-nature relations to ensure that their knowledge is not lost in projects like this
- Alongside with the FGD for men and women I hope to go for walks with some of the female farmers for them to share knowledge and stories with me. I also intend to create a baseline of the plants available in the area to understand if the species important to you are actually available.

2 Purpose of our visit

- To get a better understanding of your relation to nature
- To make sure that your knowledge on plants and trees will be used in the project
- To understand what is important to you now and in the future

3 Explain what an FGD is

- *A conversation where the participants bring in their world views, opinions, experiences, roles, responsibilities and knowledge.*
- *We will ask a set of questions for you to discuss*
- *There are no right or wrong answers*
- *If you do not wish to answer a question it is completely fine*
- *We are here to learn from your lived experience*
- *We are interested in hearing from all of you*

D FOCUS GROUP DISCUSSION

Nature relation/ understanding of nature

- What do you think of when you hear the word 'nature'?
- What role does nature have in your life?
- Do you, as a farmer, feel closely connected to nature? If yes, in what way?
- Do you ever use nature as a place for relaxation, enjoying the scenery, going for a walk etc.?

Basic understanding of cooperative and farmers:

- Tell us about the activities that your cooperative is involved in
- How and why was the cooperative/ community/farmer group created?
- How many members are there? How many women/ men? Ages
- What is the structure of the group? [probe about leadership, chairperson, committees etc.]
- How long time have you each been members of the cooperative
- Why they each joined the cooperative

Knowledge sharing amongst farmers:

- Do you share your knowledge and experiences of AF practices amongst each other?
- If yes, how is this set up? Official meetings, over the 'hedge', on the phone?
- Are all members able to be a part of knowledge-sharing?
- Have you experienced to adapt new species or practices due to input/ideas from others?

Roles in the cooperative, training possibilities and barriers:

- How did you get the knowledge of AF practice that you hold today? School, knowledge sharing, self-taught etc.
- Has the cooperative held training programs you have participated in?
- Do you have access to get knowledge if you wish? E.g. through training programs, internet etc.
- If you do not have access to knowledge, could you explain to me what the barriers to this is?
  - E.g. maybe the women cannot participate due to duties at home, the men cannot participate due to other jobs
- Do you have any ideas to how you could be able to attend to training, e.g. if it was at a specific time of the day, close to your house, short hours at a time, receive self-training material etc.?
- What is your level of (formal) education 1) illiterate 2) read and write and/or a) primary b) secondary c) high school
  - 'is it normal for girls to end their education before high school? Do you know why or do you have examples of why this happens? Is it the same for young boys?

Plant use, importance, availability and potentials:

- Can you tell me which plants you have in your AF systems?
- Could you tell me the 3 most important plants for:
  - medicinal plants
  - important firewood

        - income generating
        - Fodder for animals
        - Food
        - Resilience (Resistance against natural phenomenon; floods, drought, landslides)
        - Spiritual/ religious purposes
        - Timber
    - Do you think it would be beneficial to you to increase the amount of these species?
    - Are there any plants or trees that you would like to have in your AF system?
    - Are there any plants or trees that used to be available to you but you no longer have?
    - PICTURES: Are there any of the plants in the pictures that you have used before, have now or could see a potential in introducing to your AF systems?

Complications for farmers:

- What complications do you face doing AF?
    - Floodings, landslides, nutrition depletion, pests, bad harvests, heat, droughts, land access, market access, policies
- What do you see as the most pressing challenges related to farming that your community faces?

Potential for innovation:

- How do you imagine that your community could develop to encounter the challenges that you face now and in the future?
- If the farmers have any hopes of how their own practice could develop in the coming years
    - are there any methods or instruments they would like to adapt in their practice?
    - are there any investments they hope/plan to make?

Appendix 3 - quotes for results section

Preference for medication over plant medicine:
Bufumbo, female farmer, individual interview:
Q1: *"But what I do is, first of all, to take to the doctor. Afterwards I seen the doctors treating and the healing is not so fast, then I can apply my medicine, plant medicine, and see how effective it will be."*

Bududa, female farmer, individual interview:
Q2: *"People use plant medicine, but for me, the way I am served, I don't believe in those trees. I don't believe in using those local medicine. I would go to the health service instead"*

Deforestation:
Bufumbo, female farmer, individual interview:
Q3: "*the environment is not as good as it is as it used to be, because of deforestation, rampant cutting of trees, and the bad farming practices, which has led to a lot of erosion in some areas, which also has led to landslides."*

Bufumbo, female farmer, individual interview:
Q4: *"Our parents used to have a lot of those medicine trees, but according to this generation, some of them are not easily even available. With the deforestation of the forests, because some species were found in the forests, we would go there and Get some medicinal herbs and plants there, but most forests were cleared"*

Gender specific challenges:
Bududa, female farmer, group interview:
Q5: *"That the challenges we have gotten, because we have paid, they have a lot of problems. We struggle to get seedlings and fertilizers. As our coffee, because we don't have manure, it doesn't make well. As mothers, here, the coffee is for the man, not for the woman."*
Q6: *"That because the man says that the coffee is his, because the land is his, it belongs to him. They just gives you ground to plant beans."*

Bududa, female farmer, individual interview:
Q7: *"Most of the day is spent in the garden. that takes all time in my garden, making it. Like weeding those, those trees, weeding the garden"*

Bufumbo, female farmer, individual interview:
Q8: *"mainly the Knowledge I gets is mainly with other ladies. Women mostly, because sometimes men, you may get him thinking these only things. Now, if you want to seek knowledge from him, he may not give the full knowledge you want. So, I feel like sharing with the other ladies, because I always very free with her fellow ladies. That is the reason why I wants to share with ladies, because I feels free when I am with ladies and not with gents"*

Bududa, female farmer, group interview:
Q9: *"we can buy land, but we have nothing to start off, we have our own business, which can make us get enough income for ourselves, not for the two. but just I, as me. So that's the problem. We don't do that. We have little capitals. that is 2000 (ug sch) every week. if we have our own capital we can be able to buy our own land."*
Q10: *"that the good thing, the woman can get income from is Goat keeping. Because most of the time us, we just, we are just around home. So when you think that goat keeping and other things like for you, planting onions, onions, sukuma, cassava. small, small things, that man can like selling product and get this one outside, we get food. So the problem is asking for money "*
Q11: *"that the good thing, the woman can get income from is Goat keeping. Because most of the time us, we just, we are just around home. So when you think that goat keeping and other things like for you, planting onions, onions, sukuma, cassava. small, small things, that man can like selling product and get this one outside, we get food. So the problem is asking for money "*

Season-dependent challenges of food- and income security:
Bududa, female farmer, individual interview:
Q12: *"when the sun is too much, we don't have many food now, like fruits, they are not there now. But when during rainy season can get so, like now they're in a rain season, You see the mangoes are there, but when the sun is there, the leaves are all off. The shed off the leaves, so no way they can bear. But when it rains we get more, and when it rains much, we get less."*
Bufumbo, female farmer, individual interview:
Q13: *"during dry season, when there's a lot of sunshine. Of course, some crops will fail, like you say vegetables, you might have food, but lack vegetables, crops because they they want a lot of water."*

VSLA - Benefits to women:
Bududa, female farmer, individual interview:

Q14: *"It has benefited me to be in the cooperative, I loaned money and bought a cow and paid tuition for the children."*
Q15: *"it helped me to educate the children. It helps me to get money to buy some land, some might get some money to buy a cow. I used to get loans to do my business"*
Q16: "*previously, when I was not in the cooperative, life was not moving well. Right now, I have gained a cooperative at least I seen life is moving, it is a bit okay. Sometimes I may lack some money for the basic needs in the home, like buying sugar, sometimes food stuffs. But when I come to the circle, I borrow some money, I come and buys those items, and then life, life moves Well. I feel now secure when I joined the circle."*

Bufumbo, female farmer, group interview:
Q17: *"joining a group would assist me for getting knowledge, and share experiences among the members."*
Q18: *"being a member of the VSLA, the village savings and loans Association, I can go to my fellow members in a group and ask for a loan. When I access the same it can be used to pay school fees and maybe buy seeds and other necessities."*

Sipi, female farmer, individual interview:
Q19: *"saving group have helped me to construct this house, to pay the fees for the pupils at school, and also trying to buy more food than not run out when I wants to buy other things."*
Q20: *"they were buying our coffee, at better price than the others, that's why I went to there."*

Access- and structural barriers:
Bududa, female farmer, group interview:
Q21: *"We struggle to get seedlings and fertilizers. As our coffee, because we don't have manure, it doesn't make well."*

Bufumbo, female farmer, individual interview:
Q22: "*there are some tools I lack for improvement of the garden. The tool for pruning, then the ones for stumping and for feeding in manure."*
Q23: *"seedlings, seeds, pesticides and also some getting the tools, I cannot be able to get them."*

Agroforestry- and environmental challenges
Bufumbo, male farmer, group interview:
Q24: *"that during heavy rains of these days, if you plant those trees near your home or house, it can be disastrous becomes, because when the winds come and blow, it can cause the accidents. Yeah, yeah. And sometimes, when they if you have winter crops and food crops like Matooke. It can crash the whole garden, those trees that you have got in your garden"*

Sipi, male farmer, group interview:
Q25: "*In addition to the challenges you do have, is the kind of trees you have in our plantations, they compete with our crops, and when they compete with the crops, when the trees grows, the crops will start compete for light. So these crops will not be able to be the to there will not be direct penetration of light, so the crops will not do very well. Then number two on the same note, crop rotation also, agroforestry also has the challenge of, of these trees, like we can plant some trees, that have some pests, putting these pests sometimes ends up destroying our crops."*

Bududa, female farmer, individual interview:
Q26: *"The erosion has taken the bamboo."*
Q27: *"when the sun is too much, we don't have many food now, like fruits, they are not there now. But when during rainy season can get so, like now they're in a rain season, You see the mangoes are there, but when the sun is there, the leaves are all off. The shed off the leaves, so no way they can bear. But when it rains we get more, and when it rains much, we get less. "*

Q28: *"But even if you plant trees, trees cannot control landslides, okay, yeah, only that even floods."*

Bufumbo, female farmer, group interview:
Q29: *"That the environment has sort of changed. That because of these disasters, home steads used to not buy food from the shops. But because these climate, is too much rain, much drought, you found that people go to buy some food, to supplement."*
Q30: "*The biggest challenge is the pests, actually what they are saying is pests. For example, this area has been producing lot of tomatoes. Due to pests people have made great losses."*

Bududa, female farmers, individual interview:
Q31: *"But even if you plant trees, trees cannot control landslides, only that even floods. Trees do not help so much. Mostly soil erosion it helps more. You can find someone planted trees, but still, Landslides can take"*
Q32:*"I felt like planting Eucalyptus, trees, in the sides of the garden, to make the soil, not to go. To control erosion. But nowadays the trees also go."*

Appendix 4 - R Scripts for Species Importance Visualizations

1. Species Importance Across Categories

```
library(ggplot2)
library(dplyr)

category_summary <- data %>%
  group_by(Category, Species) %>%
  summarise(
    MeanImportance = mean(Importance),
    .groups = "drop"
  )

ggplot(category_summary, aes(x = MeanImportance, y = reorder(Species, MeanImportance),
fill = Category)) +
  geom_col(show.legend = FALSE) +
  facet_wrap(~Category, scales = "free_y") +
  scale_fill_brewer(palette = "Paired") +
  labs(
    title = "Species Importance Across Categories",
    x = "Average Importance Ranking",
    y = "Species"
  ) +
  theme_minimal(base_size = 12) +
  theme(
    strip.text = element_text(face = "bold"),
    axis.text.y = element_text(size = 9),
    axis.text.x = element_text(size = 9)
  ) +
  xlim(0, 3.1)
```

2. Bubble Chart – Average Importance Ranking

```
library(ggplot2)
library(dplyr)
library(ggrepel)

overall <- data %>%
  group_by(Species) %>%
  summarise(
```

```
    MeanImportance = mean(Importance),
    Mentions = n(),
    .groups = "drop"
  )

ggplot(overall, aes(x = Mentions, y = MeanImportance, size = Mentions, fill = Mentions))
+
  geom_point(shape = 21, color = "gray60", alpha = 0.8) +
  geom_text_repel(
    data = subset(overall, Mentions > 3),
    aes(label = Species),
    size = 3,
    box.padding = 0.4,
    point.padding = 0.3,
    segment.color = "gray40",
    segment.size = 0.3,
    color = "black"
  ) +
  scale_size_continuous(range = c(3, 10), guide = "none") +
  scale_fill_gradient(low = "#a6cee3", high = "#1f78b4") +
  labs(
    title = "Species Importance vs. Frequency of Mention",
    x = "Number of Mentions",
    y = "Average Importance",
    fill = "Mentions"
  ) +
  theme_minimal(base_size = 12)
```

3. Community Heat Map

```
library(ggplot2)
library(dplyr)

community <- data %>%
  group_by(Community, Species) %>%
  summarise(MeanImportance = mean(Importance), .groups = "drop")

ggplot(community, aes(x = Community, y = Species, fill = MeanImportance)) +
  geom_tile(color = "white") +
  scale_fill_gradient(low = "lightyellow", high = "darkred") +
  labs(title = "Species Importance by Community (Heatmap)",
       x = "Community",
       y = "Species",
       fill = "Importance") +
  theme_minimal(base_size = 12)
```

4. Gender Difference Graph (Diverging Bar Chart)

```
library(tidyverse)

gender_summary <- data %>%
  group_by(Gender, Species) %>%
  summarise(
    MeanImportance = mean(Importance),
    Mentions = n(),
    .groups = "drop"
  )

gender_diff <- gender_summary %>%
  pivot_wider(names_from = Gender, values_from = MeanImportance, values_fill = 0) %>%
  mutate(Diff = M - F)
```

```
ggplot(gender_diff, aes(y = reorder(Species, Diff), x = Diff, fill = Diff > 0)) +
  geom_col() +
  geom_vline(xintercept = 0, color = "black") +
  scale_fill_manual(
    values = c("TRUE" = "#56B4E9", "FALSE" = "#E69F00"),
    labels = c("TRUE" = "More important to men", "FALSE" = "More important to women")
  ) +
  labs(
    title = "Difference in Average Importance Between Genders",
    x = "Importance Difference (Male - Female)",
    y = "Species",
    fill = "Gender Preference"
  ) +
  theme_minimal(base_size = 12)
```

Appendix 5 - Full list of species names

Common Name	**Latin Name**	**Local Name**	**Author**	**Comment**
Millet	*Pennisetum glaucum*		(L.) R.Br.	
Orange	*Citrus sp.*		L.	
Maize	*Zea mays*		L.	
Onion	*Allium cepa*		L.	
Tomato	*Solanum lycopersicum*		L.	
Cocoa	*Theobroma cacao*		L.	
Cordia	*Cordia africana*	Mekengeret	Lam.	
Avocado	*Persea* spp.			The specific species was not clarified; however more than one species was identified in the area
Coffee	*Coffea arabica*		L.	
Jackfruit	*Artocarpus heterophyllus*		Lam.	
Eucalyptus	*Eucalyptus* spp., *E. globulus, E.*		Labill., Dehnh.,	Farmers would often not specify the species;

	camaldulensis, E. grandis		W.Hill ex Maiden	however more than one species of Eucalyptus were identified in the area.
Mango	*Mangifera* sp.			
Yam	*Dioscorea* spp.		L.	Farmers would often not specify the species; however more than one species of yam were identified in the area.
Ficus	*Ficus* spp., *Ficus natalensis*		Hochst.	More species of Ficus was available. F. natalensis was the only one identified to species level. As more species were available in the area it is referred to as Ficus.
Banana (Matooke)	*Musa* spp.		L.	Usually the farmers would refer to Matooke, however sweet bananas were also available.
Albizia	*Albizia* sp.	Namulira	Durazz.	Due to transciption errors it is osmetimes referred to as 'Albezia' in figures.
Markhamia	*Markhamia lutea*	Kusola	Benth. K.Schum	
Bamboo	*Bambusa* sp.		Schreb.	
Elephant grass	*Cenchrus purpureus*		Schumach. Morrone	
Grevillea	*Grevillea robusta*		A.Cunn. ex R.Br.	Due to transciption errors it is osmetimes referred to as 'Gravelia' in figures.

Cyprus	*Cupressus* sp.		L.	
Elgon teak	*Olea capensis or Olea welwitschii*		L., Gilg & G.Schellenb.	
Iroko	*Milicia excelsa*		Welw. C.C.Berg	
Cactus	*Opuntia* sp.		Mill.	It is expected that the farmer was referring to Opuntia as this was the only one observed.
Hibiscus	*Hibiscus* sp.			
Wild custard apple	*Annona senegalensis*	Mposa	Pers.	
Wild olive	*Ximenia americana*	Siruli	L.	
Aloe vera	*Aloe* sp.		L.	The farmer was not able to identify or locate the species. However, the farmer was referring to a specific species of Aloe.
Guava	*Psidium* sp.		L.	
Neem	*Azadirachta indica*		A.Juss.	
Lemon	*Citrus limon*		L.	
Passion fruit	*Passiflora* spp.		L.	More than one species was available. Farmers were not able to identify the specific species they were talking of.
Calliandra	*Calliandra* sp.		Benth.	One species was observed, however not identified to species level
Sesbania	*Sesbania sesban*		(L.) Merr.	

Bitter leaf	*Vernonia amygdalina*		(Delilie) Sch.Bip.	
Sugarcane	*Saccharum officinarum*		L.	
Umbrella tree	*Maesopsis eminii*		Engl.	
		Amatuggunda (Lugiso)		
Night Rose tree	Not identified			
Unknown climbing plant	Not identified			
	Not identified	Gufungu (Lugiso)		
	Not identified	Kamahuyu (Lugiso)		

Author names were found on www.worldagroforestry.org using the Agroforestry Species Switchboard 3.0.

Unidentified species

	Local species name	**Language**
1	Ensali	Lugiso
2	Gufungu	Lugiso
3	Gutugutu	Lugiso
4	Shirukuru	Lugiso
5	Shikuma	Lugiso
6	Shiruruli	Lugiso
7	Kurukuru	Lugiso
8	Amatuggunda	Lugiso
9	Kamahuyu	Lugiso
10	Climbing plant	

Appendix 6 - Data from ranking exercise

Category	Community	Gender	Species	Importance
Food	Sipi	M	Avocado	3
Food	Sipi	M	Mango	2
Food	Sipi	M	Jackfruit	1
Food	Sipi	F	Avocado	3
Food	Sipi	F	Orange	2
Food	Sipi	F	Guava	1
Food	Bufumbo	M	Mango	3
Food	Bufumbo	M	Avocado	2
Food	Bufumbo	M	Jackfruit	1
Food	Bufumbo	F	Matooke	3
Food	Bufumbo	F	Cassava	2
Food	Bufumbo	F	Maize	1
Food	Bududa	M	Jackfruit	3
Food	Bududa	M	Avocado	2
Food	Bududa	M	Mango	1
Food	Bududa	F	Maize	3
Food	Bududa	F	Matooke	2
Food	Bududa	F	Cassava	1
Fodder	Sipi	M	Elephant grass	3
Fodder	Sipi	M	Calliandra	2
Fodder	Sipi	M	Sesbania	1
Fodder	Sipi	F	Elephant grass	3
Fodder	Sipi	F	Sesbania	2
Fodder	Sipi	F	Calliandra	1
Fodder	Bufumbo	M	Ficus	3
Fodder	Bufumbo	M	Bitter leaf	2
Fodder	Bufumbo	M	Elephant grass	1
Fodder	Bufumbo	F	Ficus	3
Fodder	Bufumbo	F	Sesbania	2
Fodder	Bufumbo	F	Elephant grass	1
Fodder	Bududa	M	Grevillea	3
Fodder	Bududa	M	Calliandra	2
Fodder	Bududa	M	Ficus	1
Fodder	Bududa	F	Elephant grass	3
Fodder	Bududa	F	Calliandra	2
Fodder	Bududa	F	Sugarcane	1
Income	Sipi	M	Eucalyptus	3
Income	Sipi	M	Grevillea	2
Income	Sipi	M	Cordia	1
Income	Sipi	F	Eucalyptus	3
Income	Sipi	F	Cordia	2
Income	Sipi	F	Grevillea	1
Income	Bufumbo	M	Orange	3

Income	Bufumbo	M	Avocado	2
Income	Bufumbo	M	Mango	1
Income	Bufumbo	F	Avocado	3
Income	Bufumbo	F	Jackfruit	2
Income	Bufumbo	F	Guava	1
Income	Bududa	M	Eucalyptus	3
Income	Bududa	M	Avocado	2
Income	Bududa	M	Jackfruit	1
Income	Bududa	F	Avocado	3
Income	Bududa	F	Mango	2
Income	Bududa	F	Guava	1
Medicinal	Sipi	M	Elgon teak	3
Medicinal	Sipi	M	Neem	2
Medicinal	Sipi	M	Lemon	1
Medicinal	Sipi	F	Lemon	3
Medicinal	Sipi	F	Eucalyptus	2
Medicinal	Sipi	F	Avocado	1
Medicinal	Bufumbo	M	Albizia	3
Medicinal	Bufumbo	M	Neem	2
Medicinal	Bufumbo	F	Neem	1
Medicinal	Bududa	F	Avocado	3
Medicinal	Bududa	F	Orange	2
Timber	Sipi	M	Cyprus	3
Timber	Sipi	M	Eucalyptus	2
Timber	Sipi	M	Cordia	1
Timber	Sipi	F	Ficus	3
Timber	Sipi	F	Eucalyptus	2
Timber	Sipi	F	Cordia	1
Timber	Bufumbo	M	Eucalyptus	3
Timber	Bufumbo	M	Cordia	2
Timber	Bufumbo	M	Albizia	1
Timber	Bufumbo	F	Iroko	3
Timber	Bufumbo	F	Albizia	2
Timber	Bufumbo	F	Cordia	1
Timber	Bududa	M	Eucalyptus	3
Timber	Bududa	M	Elgon teak	2
Timber	Bududa	M	Cordia	1
Timber	Bududa	F	Eucalyptus	3
Timber	Bududa	F	Cordia	2
Timber	Bududa	F	Grevillea	1
Firewood	Sipi	M	Cordia	3
Firewood	Sipi	M	Markhamia	2
Firewood	Sipi	M	Eucalyptus	1
Firewood	Sipi	F	Markhamia	3

Firewood	Sipi	F	Avocado	2
Firewood	Sipi	F	Grevillea	1
Firewood	Bufumbo	M	Eucalyptus	3
Firewood	Bufumbo	M	Cordia	2
Firewood	Bufumbo	M	Albizia	1
Firewood	Bufumbo	F	Eucalyptus	3
Firewood	Bufumbo	F	Albizia	2
Firewood	Bufumbo	F	Umbrella tree	1
Firewood	Bududa	M	Eucalyptus	3
Firewood	Bududa	M	Markhamia	2
Firewood	Bududa	M	Cordia	1
Firewood	Bududa	F	Eucalyptus	3
Firewood	Bududa	F	Cordia	2
Firewood	Bududa	F	Avocado	1
Resilience	Sipi	M	Markhamia	3
Resilience	Sipi	M	Ficus	2
Resilience	Sipi	M	Cordia	1
Resilience	Sipi	F	Cordia	3
Resilience	Sipi	F	Grevillea	2
Resilience	Sipi	F	Cyprus	1
Resilience	Bufumbo	M	Elephant grass	3
Resilience	Bufumbo	M	Bamboo	2
Resilience	Bufumbo	M	Eucalyptus	1
Resilience	Bufumbo	F	Bamboo	3
Resilience	Bufumbo	F	Albizia	2
Resilience	Bufumbo	F	Cordia	1
Resilience	Bududa	M	Cordia	3
Resilience	Bududa	M	Bamboo	2
Resilience	Bududa	F	Cordia	3
Resilience	Bududa	F	Bamboo	2
Resilience	Bududa	F	Grevillea	1
Spiritual	Sipi	M	Hibiscus	3
Spiritual	Sipi	M	Night Rose	2
Spiritual	Sipi	M	Grevillea	1
Spiritual	Sipi	F	Grevillea	3
Spiritual	Bufumbo	M	Cactus	3
Spiritual	Bufumbo	M	Wild custard apple	1
Spiritual	Bufumbo	F	Markhamia	2
Spiritual	Bufumbo	F	Albizia	1
Spiritual	Bududa	M	Markhamia	3
Spiritual	Bududa	M	Ficus	1
Spiritual	Bududa	F	Kufungo	3
Spiritual	Bududa	F	Kurukuru	2
Spiritual	Bududa	F	Markhamia	1

Appendix 7 - Tables

The matrix coding tables includes the data used to create the bar charts illustrated in the results section.

Species use:

	Environmental management	Firewood	Fodder for animals	Food	Income	Medicine	Religious & spiritual use	Timber
Community								
Bududa	15	3	1	7	7	6	0	2
Bufumbo	2	0	0	3	4	5	0	0
Sipi	6	5	1	11	8	3	0	4
Gender								
Female	0	1	1	1	1	0	0	1
Male	2	1	1	0	0	0	0	1
Age								
Young farmer (18-35)	6	2	0	4	6	5	0	1
Middelaged farmer (36-50)	6	3	0	8	6	5	0	2
Old farmer (50+)	9	1	0	8	6	4	0	1
Interview type								

Group (FGD)	2	2	2	1	1	0	0	2
Individual (SSI)	21	6	0	20	18	14	0	4

***Security issues for female farmers at Mt. Elgon**:*

	Economic security	**Environmental security**	**Food security**	**Health security**	**Personal security**
Bududa	**9**	**11**	**5**	**2**	**0**
Bufumbo	**6**	**4**	**10**	**8**	**1**
Sipi	**8**	**5**	**5**	**6**	**0**
Total for all communities	**23**	**20**	**20**	**16**	**1**
Young farmer (18-35)	**8**	**5**	**4**	**6**	**0**
Middelaged farmer (36-50)	**8**	**8**	**11**	**5**	**1**
Old farmer (50+)	**7**	**7**	**5**	**5**	**0**

Challenges:

	Access and structural barriers	Economic barriers	Environmental challenges	Gender-specific barriers	Lack of Knowledge and access to knowledge	Safety issues	Vandalism / Theft
Bududa	8	11	10	5	2	1	0
Bufumbo	5	5	5	2	1	1	0
Sipi	4	6	7	0	1	0	4
Female	4	5	3	4	0	1	0
Male	2	1	5	0	0	0	3
Young female farmer (18-35)	3	7	4	0	1	0	0
Middelaged female farmer (36-50)	1	5	4	2	1	0	1
Old female farmer (50+)	7	4	6	1	2	1	0
Individual (SSI)	10	16	14	3	4	1	1
Group (FGD)	6	6	8	4	0	1	3

Innovation potential:

	Business ideas	Farming development ideas	Need for inputs
Bududa	3	6	4

Bufumbo	4	13	3
Sipi	1	11	2
Female	1	2	0
Male	2	6	2
Young female farmer (18-35)	3	4	1
Middelaged female farmer (36-50)	1	7	4
Old female farmer (50+)	1	11	2
Individual (SSI)	5	22	7
Group (FGD)	3	8	2