Sokoine University of Agriculture

MSc Dissertation

Wood Volume and Profitability Analysis of Small-Scale Tree Growers' Woodlots with a Gender Perspective in Mufindi District, Iringa Region, Tanzania

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WOOD VOLUME AND PROFITABILITY ANALYSIS OF SMALL-SCALE TREE GROWERS' WOODLOTS WITH A GENDER PERSPECTIVE IN MUFINDI DISTRICT, TANZANIA

Dissertation Submitted to Sokoine University of Agriculture in Partial Fulfilment of the Requirements for the Degree of Master of Science in Environmental and Natural Resources Economics

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EXTENDED ABSTRACT

The majority of tree plantations in Tanzania consist of softwood species, primarily pines, and cypress, along with preferred hardwood species such as teak and eucalyptus. Small-scale forestry has emerged as a significant and potentially productive segment. Empirical evidence suggests that small-scale forestry constitutes the majority of the total plantation area in the country. While government forests employ a standard practice of selling trees by volume, small-scale growers often opt to sell standing trees without prior measurement. Therefore, it is important to assess this selling practices in order to determine if investments made by small-scale tree growers are profitable. The study aimed to assess the profitability of small-scale tree growers' woodlots, considering gender disparities in the sector, and exploring the economic implications of different selling methods and challenges facing small-scale tree growers. Cross-sectional data were collected through semi-structured interviews. Random sampling was used to select small-scale tree growers' households for data collection. Data analysis involved descriptive statistics and cost-benefit analysis by using Stata software. The woodlot assessment included inventory work of measuring tree parameters of diameters (Dbh) and heights. Forest inventory data was analyzed by using yield table models in Microsoft Excel. The results of the household survey revealed that investments by small-scale tree growers are profitable. Profitability indicators for those selling standing trees and processing trees for lumber are presented, showing higher values for the later. Gender differences in revenue and profitability indices are observed, with males earning more than females. Moreover, results indicated that small-scale tree growers are potentially experiencing a substantial loss in revenue, profit, and gross profit margin due to the selling method used. When small-scale tree growers sell by observational estimation, they can generate TZS 1.9 million per acre at the age of 11 years. In contrast, selling by volume yields an average of TZS 2.7 million per acre at the age of 11 years. Likewise on the Profit,

through selling by volume there is a mean increase in profit of TZS 61155 per acre, and by observational estimation, there is a mean decrease of TZS 42063 per acre. Results also revealed that the key challenges facing small-scale tree growers include fire occurrences and low market prices of trees. About 73% of the respondents reported that fire occurrence is the main challenge in the management of woodlots while 34% reported low prices as a main challenge, followed by 26.30% on marketing. Therefore, processing and adding value to the produced woods tend to significantly increase revenue and profitability. This implies that, small-scale tree growers should prioritize in value addition through processing for increased profitability. In addition, mechanisms for a market shift towards valuing good quality products and promoting sales at longer rotation age should be developed. Small-scale tree growers, with the assistance of the government, should be advised to adopt a standardized method of selling trees based on volume which will allow them to maximize their profit. Further, waiting for the recommended rotation age will ensure a good price and diversification of income sources for small-scale tree growers in Mufindi District. This is crucial because it will reduce the pressure of selling immature stands and accepting low prices. Furthermore, providing continuous education on best management practices, particularly regarding fire safety, is essential.

Keywords: Profit margins, Marketing strategies, Selling methods, Volume, Observational estimation, Profitability and challenges.

IKISIRI KUU

Sehemu kubwa ya mashamba ya miti ya kupandwa nchini Tanzania yana aina za miti laini, hasa misindano na mierezi, pamoja na miti migumu inayopendelewa kama vile misaji na mikaratusi. Misitu midogo imeibuka kama sehemu muhimu na inayoweza kuzaa matunda. Ushahidi wa kitaalamu unaonyesha kuwa misitu midogo inachangia sehemu kubwa ya eneo la mashamba yote nchini. Wakati misitu ya serikali inatumia utaratibu wa kawaida wa kuuza miti kwa viwangona vipimo maalum, wakulima wadogo mara nyingi huamua kuuza miti iliyosimama bila kipimo cha awali. Kwa hiyo, ni muhimu kutathmini mbinu hizi za uuzaji ili kubaini kama uwekezaji unaofanywa na wakulima wadogo wa miti una faida. Utafiti huu ulilenga kutathmini faida ya mashamba ya wakulima wadogo wa miti, kwa kuzingatia tofauti za kijinsia katika sekta hiyo, na kuchunguza athari za kiuchumi za mbinu tofauti za uuzaji na changamoto zinazowakabili wakulima wadogo wa miti. Data za sehemu mbalimbali zilikusanywa kupitia usaili wa muundo nusu. Sampuli nasibu ilitumika kuchagua kaya za wakulima wadogo wa miti kwa ajili ya kukusanya data. Uchambuzi wa data ulihusisha takwimu za maelezo na uchanganuzi wa faida za gharama kwa kutumia programu ya Stata. Tathmini ya sehemu ya mbao ilijumuisha kazi ya hesabu ya kupima miti ikiwemo kipenyo (Dbh) na urefu. Data ya hesabu ya misitu ilichanganuliwa kwa kutumia mifano ya jedwali la mavuno katika Microsoft Excel. Matokeo ya utafiti wa kaya yalibaini kuwa uwekezaji wa wakulima wadogo wa miti una faida. Viashiria vya faida kwa wale wanaouza miti iliyosimama na miti ya kuchakata mbao imewasilishwa, kuonyesha thamani ya juu zaidi kwa wale wanaouza mbao baada ya kuchakata kuliko wale wanaouza miti bila kuchakata. Tofauti za kijinsia katika fahirisi za mapato na faida zimeonekana, huku wanaume

wakipata zaidi ya wanawake. Zaidi ya hayo, matokeo yalionyesha kuwa wakulima wadogo wa miti wana uwezekano wa kupata hasara kubwa katika mapato, faida, na kiasi cha faida ya jumla kutokana na njia ya kuuza wanyotumia. Wakulima wadogo wa miti wanapouza kwa makadirio ya macho bila kupima, wanaweza kuzalisha TZS 1.9 milioni kwa ekari wakiwa na umri wa miaka 11. Kinyume chake, kuuza kwa ujazo hutoa wastani wa TZS 2.7 milioni kwa ekari katika umri wa miaka 11. Kadhalika kwenye Faida, kupitia kuuza kwa ujazo kuna ongezeko la wastani la faida la TZS 61155 kwa ekari, na kwa makadirio ya macho, kuna upungufu wa wastani wa TZS 42063 kwa ekari. Matokeo pia yalifichua kuwa changamoto kuu zinazowakabili wakulima wadogo wa miti ni pamoja na matukio ya moto na bei ya chini ya soko la miti. Takriban 73% ya wahojiwa waliripoti kuwa kutokea kwa moto ndio changamoto kuu katika usimamizi wa maeneo ya miti huku 34% wakiripoti bei ya chini kama changamoto kuu, ikifuatiwa na 26.30% kwenye uuzaji. Kwa hiyo, kuchakata na kuongeza thamani kunaongeza kwa kiasi kikubwa mapato na faida. Hii ina maana kwamba, wakulima wadogo wa miti wanapaswa kuweka kipaumbele katika uongezaji thamani kupitia uchakataji ili kupata faida. Aidha, taratibu za mabadiliko ya soko kuelekea kuthamini bidhaa bora na kukuza mauzo katika umri mrefu wa mzunguko zinapaswa kutengenezwa. Wakulima wadogo wa miti, kwa usaidizi wa serikali, wanapaswa kushauriwa kufuata njia sanifu ya kuuza miti kwa kuzingatia ujazo ambao utawawezesha kuongeza faida yao. Zaidi ya hayo, kusubiri umri wa mzunguko unaopendekezwa kutahakikisha bei nzuri na mseto wa vyanzo vya mapato kwa wakulima wadogo wa miti katika Wilaya ya Mufindi. Hii ni muhimu kwa sababu itapunguza shinikizo la kuuza miti ambayo haijakomaa na kukubali bei ya chini. Zaidi ya hayo,

kutoa elimu endelevu juu ya mbinu bora za usimamizi, hasa kuhusu usalama wa moto, ni muhimu.

Maneno muhimu: Mipaka ya faida, Mikakati ya masoko, Mbinu za Uuzaji, Kiasi, Makadirio ya Uchunguzi, Faida na changamoto

DECLARATION

I, **Irene Emmanuel Palangyo**, do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my original work done within the period of registration and that it has neither been submitted nor is concurrently submitted in any other institution.

_____ _____

Irene Emmanuel Palangyo Date
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The above declaration is confirmed by:

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Prof. Yonika M. Ngaga Date
(Supervisor)

_____ _____

Dr. Greyson Z. Nyamoga Date
(Supervisor)

LIST OF MANUSCRIPTS

Manuscript 1: Profitability of Small-Scale Tree Growers with Gender Perspectives in Mufindi District

Manuscript 2: The Impact of Methods used in Selling Trees on Profitability and Challenges faced by Small-Scale Tree Growers in Mufindi District

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DEDICATION

I dedicate this thesis to my loving Father Mr. Emmanuel Makoninde for being the greatest inspiration to me, providing unwavering support, encouragement, and love. I also extend my dedication to my dear Mom Mrs. Maryline Emmanuel for nurturing me, praying for me, and uplifting my spirits. May God bless them both.

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CHAPTER ONE

1.0 General Introduction

1.1 Background Information

The establishment of forest plantations in Tanzania started in the early 1930's to meet the increasing demand for wood products which cannot be met by indigenous tree species that are superior in quality but slow growing. Currently, the area covered by public sector forest plantations is 117,864 ha; the area owned by private companies is 50,827 ha while that owned by individual woodlots (small-scale tree growers) is 415,000 ha making a total area of forest plantations in Tanzania to be 583,691 ha (TFS 2021).

Small-scale tree growing is undertaken by individual farmers, local business people, or urban-based investors. Unlike industrial plantations, most small-scale tree growers do not operate wood processing plants (Lusambo *et al.,* 2021). Small-scale tree growing is becoming important in Tanzania not for supply in the domestic market and conservation only but as a purely business by small-scale tree growers (Lusambo *et al.,* 2021). Factors that make small-scale tree growing an attractive option include rapid population growth, a decline in natural forests, low levels of economic development, land shortages, social risks associated with the expansion of large-scale plantations and climate change pressure (Arvola *et al.,* 2019; Held *et al.,* 2017; Kisegu *et al.,* 2019a; Malkamäki *et al.,* 2018);

Small-scale forestry contributes to poverty reduction through income generation and plays an important role in fighting deforestation and forest degradation as well as sustainable management of the forests (Mwambusi, 2019). They further contribute to animal and plant species preservation and hence reduce human pressure on threatened natural forests (Mwambusi, 2019). According to Singunda (2010), small-scale forestry generates employment in reforestation, silviculture operations, harvesting activities, and small-

scale timber processing. On the other hand, there is a market opportunity for small-scale tree growers due to the high demand for wood for construction, paper manufacturing, electric transmission poles, and furniture. Plywood and veneer also offer new markets for small-scale tree growers as it utilize short-diameter eucalyptus logs and an alternative use of woodlots planned for poles (Held *et al.,* 2017).

To have accurate and profitable sales in forests, there must be a standard method of measuring trees to set the price. In the government forests, the selling of trees by volume has been established as a standard practice, facilitating transparency, accuracy, and fair pricing. This approach ensures a standardized measurement of the resource and contributes to efficient resource allocation and management (Ayoola & Silas, 2023). Forest volume estimation is important for effective and sustainable forest management as well as a prediction of yield and future market but it also points out the maximum harvestable volume and efficient regulations that sustain wood production, incomes, and forest functioning (De Lima *et al.,* 2021; Kearsley *et al.,* 2017) Gschwantner *et al.,* 2019). Volume estimation also serves information needs at country and international levels including the availability and use of wood resources (gives insight on how much stock is available). It also serves as a decision tool for exploiting timber resources (Malata *et al.,* 2017). However, methods employed by small-scale tree growers to sell their trees often differ from those adopted by the government forest, where trees are sold based on volume. Small-scale tree growers, driven by practical considerations and possibly limited resources, have often opted for an alternative method, which involves selling standing trees without prior measurement of their volume (Irawanti *et al.,* 2017).

Moreover, in the small-scale forestry sector, the market system is inadequately developed, and small-scale tree growers heavily depend on local and chance interactions within the market. There is

a significant deficiency in the flow of market-related information to tree growers, resulting in their disadvantaged negotiation position (Arvola *et al.,* 2019). The most successful smallholder tree-growing schemes have involved producing short-rotation wood for example for pulp and paper industries or other industries where timber quality and large diameters are not crucial (Arvola *et al.,* 2019). Harvesting trees before rotation is common among small-scale tree growers in developing countries including Tanzania. This leads to quality problems which might later limit access to the market for small-scale-tree growers when the market is likely to become more selective and substitutes may replace (poor quality) timber (Arvola *et al.,* 2019).

Due to its importance in the economy, it is important to determine the profitability of small-scale tree growing. Profit is the excess of revenue above the cost/expenses incurred in the process of generating income/revenue. It is an absolute measure of the positive gain from an investment or business operation after subtracting all expenses (Stierwald, 2010). Profit often acts as the entrepreneur's reward for his/her investment. Profit is the main motivator of an entrepreneur to do business. Profit is also used as an index for performance measuring of a business (Ogbadu, 2009). Profitability is the size of the profit relative to the size of the business; it measures how efficiently the business is using its resources (capital and employees) as factors of production. Profitability involves the capacity to benefit from all business operations of an organization, firm, or company. Profitability portrays the efficiency of the management in converting a firm's resources into profits ((Muya & Gathogo, 2016; Niresh & Velnampy, 2014). Profit and profitability are closely related and have a distinct role in a business. Profitability attracts investors and the firm is likely to survive for a longer time depending on the profits generated ((Kiganda, 2014; Margaretha & Supartika, 2016).

1.1.2 Forest volume estimation and factors affecting volume production

In plantations or natural forests, volume estimation is done by using allometric models through direct measurement of the stem which is important for yield estimation, projection, and regulation of harvests (Kearsley *et al.,* 2017; Malata *et al.,* 2017)**.** There are several models to predict height diameter relationship, which are species-specific in different regions and whose effectiveness depends on variables used as predictors.(Ayoola & Silas, 2023).

Height diameter models are important for predicting forest growth and yield because these models play an important role in describing forest stocking by using tree variables, height, and diameter, as independent variables (Ayoola & Silas, 2023). Forest volume estimation is important for effective and sustainable forest management, and prediction in yield and future market (De Lima *et al.,* 2021; Gschwantner *et al.,* 2019). It provides a rapid and easy way to estimate the monetary value of trees or forest stands, often referred to as commercial timber stock (De Lima *et al.,* 2021; Gschwantner *et al.,* 2019). It also points out the maximum harvestable volume and efficient regulations that sustain wood production, incomes, and forest functioning (De Lima *et al.,* 2021; Gschwantner *et al.,* 2019).

Management practices have been proven to improve the growth and yield of *Pinus patula*. For instance, thinning increases good stem quality by 9% resulting in a higher growth rate and higher volume than unthinned stands (Mugasha *et al.,* 2022).

Slash management, site preparation, and vegetation management have been proven to influence productivity significantly. According to Ndlovu *et al.*(2019), site preparation has a significant influence on basal area (BA) and volume (Vol), and vegetation management has a significant influence on all the measured growth variables (diameter at breast height, Basal area, and Volume). In addition,

there is a significant interaction between the site preparation and vegetation management for BA and Vol therefore site preparation and vegetation management impact the growth and yield of *Pinus patula* (Ndlovu *et al.,* 2019).

Pinus patula has been reported to be the most commonly affected Pine tree species by F. circinatum which affects productivity as it causes serious root diseases and significant mortality in plantation establishment (Fru *et al.,* 2019).

1.1.3 Growth and productivity of *Pinus patula* in the context of small scale tree growers

In Tanzania, Small-scale tree growers constitute a large area and hence they have a strong potential in supplying wood. Key species planted in their woodlots/ plantation are *Pinus patula* 65% and Eucalyptus 20% followed by Teak and black wattle (Held *et al.,* 2017). The high percentage of *Pinus patula* and *Eucalyptus species* is driven by the high market demand for timber (Mwambusi, 2019). Great enthusiasm for the growth of small-scale woodlots and medium plantations owned by smallholders, cooperative groups, schools, and religious organizations is driven by the high demand for wood, But this growth is hindered by various challenges such as severe uncontrolled fire events, poor tree survival and retarded growth (Mwambusi, 2019).

Moreover, small-scale tree growers tend to plant poor-quality seedlings, perform inadequate management practices, and sell below rotation age(Arvola *et al.,* 2019; Held *et al.,* 2017). This results in woodlots with poor quality, low diameter trees that have lower productivity than public and private large plantations (Held *et al.,* 2017). Moreover, small-scale tree growers are scattered and disaggregated in such a way that it is difficult to reach all of them cost-effectively to offer them processing solutions that maintain quality (Held *et al.,* 2017).

Processing units are owned by small-scale entrepreneurs who can reach dispersed woodlots of small-scale tree growers but tend to produce poor-quality sawn timber, This is because only these processors can utilize small log volumes from poorly accessible woodlots profitably (Held *et al.,* 2017)

1.1.4 Market mechanisms and practices of small-scale tree growers

In Tanzania, Harvesting trees before rotation age which maximizes returns and potential returns is common among small-scale tree growers in developing countries including Tanzania (Arvola *et al.,* 2019). Woodlot owners sell their trees to saw-millers who own portable sawmills (Held *et al.,* 2017; Scudder *et al.,* 2019a). After processing, saw millers sell sawn timber to manufacturing businesses and these processors process lumber according to the market demand in terms of species and dimension required (Scudder *et al.,* 2019b).

Transaction arrangement is based on counting the number of trees if the owner is not selling by volume and the payment is done on the agreement between seller and buyer(Scudder *et al.,* 2019b). Small-scale tree growers decide to sell timber to obtain cash to be used for different purposes such as school fees; store-bought goods; and ceremonies; to build a home(Scudder *et al.,* 2019b).

The drive to enhance plantation management techniques and wood quality loses its effectiveness due to excessive demand in the wood market. This results in a scenario where significant discrepancies in price based on quality are absent from the market. Instead, only the wood's(diameter) dictates the price, diminishing the focus on quality improvement (Arvola *et al.,* 2019). Moreover, the timber market is insensitive to timber quality which proves a weak relationship between the timber market and management practices by small-scale tree growers and even in government plantations (Mwambusi, 2019). The timber market is unclear about the criteria used for

timber grading and prices based on various timber qualities as a result of silvicultural treatment (Mwambusi, 2019).

1.1.5 Gender dynamics in forestry

A combination of factors defines a person or social group's roles, opportunities, expectations by society, and limitations. One of these factors is gender (Ota *et al.,* 2024). Gender defines roles and responsibilities ascribed between males and females at household and community levels in different parts of the world (Ota *et al.,* 2024; Sunderland *et al.,* 2014a). These roles, knowledge, and division of economic resources ascribed to men and women result from cultural norms (Kiptot & Franzel, 2011; Ota *et al.,* 2024). In rural areas men and women have inequality in terms of production resources like land and earning opportunities (Kiptot & Franzel, 2011; Ota *et al.,* 2024; Tyagi & Das, 2017) In forestry, men are involved in higher-value economic activities such as timber production while women are involved in lower-value activities like collection of non-timber forest products and production of agroforestry products (Ota *et al.,* 2024; Stoian *et al.,* 2017; Sunderland *et al.,* 2014a). Sometimes women are excluded from development activities and they dedicate most of their time to domestic chores, unlike men who are more exposed to the forces of globalization and less dedicated to domestic chores (Ota *et al.,* 2024).

Knowledge of forest ecology, management, conservation, and use is gendered whereas forestry is regarded as a masculine socio-technical system since most of the forest activities like harvesting are conducted by men (Follo *et al.,* 2017; Ota *et al.,* 2024). Inequitable access to property rights such as the right to land ownership affects the outcome of forest resources in terms of efficiency, sustainability, and equity (Sunderland *et al.,* 2014a; Tyagi & Das, 2017). In many parts of the world, patrilineal society is dominant where women are unlikely to inherit or own land, and even if they do they fail to exercise full decision-making because managerial control vests with male vests (Tyagi & Das, 2017)**.** In

marketing forest products women are confined to small retail trade while men dominate wholesale trade because they have more access to capital than women (Kiptot & Franzel, 2011)**.**

1.2 Problem Statement

The growth of small-scale forestry in Mufindi is due to favorable climatic conditions and forest institutions which contribute significantly to the livelihoods and national economy (Singunda, 2010) Despite its importance to the national economy, small-scale farmers and woodlot owners face challenges in tree planting, harvesting, and marketing. Lack of investment capital, unavailability of profitability calculations per se for timber growing, lack of adequate knowledge for tree growing and harvesting, poor extension services, informal knowledge gained from experience, lack of inputs, lack of market information, marketing and bargaining power, poor infrastructure, and modern technologies (Ngaga, 2011). These factors result in a smaller profit for small-scale tree growers because the price for standing woodlots is dictated by traders and middlemen failing to account for all the costs necessary for tree growing. Lack of information leads to market imbalance which introduces higher transaction costs to tree growers (Mwakasungula, 2020) Studies show that many small-scale tree growers sell standing trees to middlemen and small-scale saw millers without measuring the volume so they are not aware of the volume contained in the standing trees. Failure to estimate wood volume for small-scale tree growers may overestimate or underestimate capital stock which in turn may affect the profitability of these small-scale tree growers' projects. Also, another study indicates that small-scale tree growers lack the advice and proper plantation management tools which lead to low-quality wood as well as volume (Arvola *et al.,* 2019). Moreover, Gender relations have been studied in small-scale and community forestry under different approaches and with different levels of depth (Ota *et al.,* 2024). However, this study is focused on gender in terms of economic inequality between men and women.

Although there are many studies on small-scale tree growers in the Southern Highlands, there are limited studies that show the link between wood volume and profitability of woodlots from a gender perspective. There is therefore a need for estimates of wood volume and profitability analysis for small-scale forestry in Tanzania with a gender perspective. Small-scale tree growers with little disposable income must know whether forestry is financially feasible and viable or not because they need to balance between diverting labor hours and other resources from food production to forestry. Therefore, there is a need to examine all the costs associated with investments of small-scale tree growers including non-monetary costs incurred such as time, physical efforts, and risks, to get a return on shillings per tree.

Therefore, understanding the cash flow patterns, time to harvest, and solving the problem of price are critical issues for small-scale tree growers in the country (Harrison *et al.,* 2005). This study therefore aims to fill such a knowledge gap to assist the government and the private sector in promoting small-scale tree growing in Tanzania.

1.3 Study Justification

Due to the challenges small-scale tree growers experience and how they undertake tree growing, processing, and marketing activities, it is important to conduct a profitability analysis. Profitability analysis is important for generating information that can be useful to farmers in making informed marketing decisions as well as investments in better processing options. A study on profitability will come up with suggestions for possible interventions in the timber value chain as well as attracting investors in the sector (Lusambo *et al.,* 2021). Profitability analysis will help to determine if the investment in small-scale tree growing is profitable and to what extent. Also, knowing stock volume will help the farmers on how to interact with market demand and supply. Likewise, by incorporating a gender analysis, this study will contribute to the development of gender-inclusive and

responsive policies or interventions that can effectively support small-scale tree growers.

Small-scale tree growers' financial information will be useful to extension agents in promoting tree planting in Tanzania. Such information will allow a comparison to be made of the likely returns from annual food crops and forestry. The availability of site-specific profitability analysis information for pine species would assist the government in planning forestry development. The availability of profitability analysis estimates is also relevant for industrial foresters and other stakeholders, although their cost structures are likely to differ (Lusambo *et al.,* 2021).

1.4 Objectives

1.4.1 Overall objective

The overall objective of the study is to conduct wood volume estimation and profitability analysis of woodlots by small-scale tree growers with a gender perspective in Mufindi district, Tanzania.

1.4.2 Specific objectives

Specific objectives of the study are:

i. To estimate the volume of woodlots at different selling ages by small-scale tree growers in the study area.
ii. To examine input and output costs (monetary and non-monetary) obtained from woodlots in the study area.
iii. To conduct profitability analysis for small-scale tree growers and to assess economic inequality between male and female growers
iv. To examine the challenges experienced by small-scale tree growers and to identify strategies that small-scale tree growers use to overcome the challenges

1.4.3 Research questions

i. What are the input costs that a tree grower incurs in different activities of small-scale forestry?

ii. What is the revenue obtained from selling standing trees/timber?
iii. What are the challenges facing small-scale tree growers in the establishment, management, and harvesting of woodlots?

1.4.4 Conceptual framework

This study aims to analyze the wood volume and profitability of woodlots managed by small-scale tree growers in Mufindi District focusing also on gender disparities. Understanding these factors is crucial for improving the economic outcomes for all small and large tree growers not only in Mufindi District but also in other Regions. The aim is to promote equitable and sustainable forestry practices and management. The expected outcome are quantification of the relationship between wood volume and profitability, insights into how market conditions affect the profitability of woodlots, identification of gender disparities in the forestry sector based income generating activities and their impact on wood volume and profitability. Recommendations from the findings in this study will assist small-scale tree growers to improve their profitability through effective management practices, market strategies and policy recommendations to address gender disparities and promote equitable access to resources and opportunities (Figure 1.1).

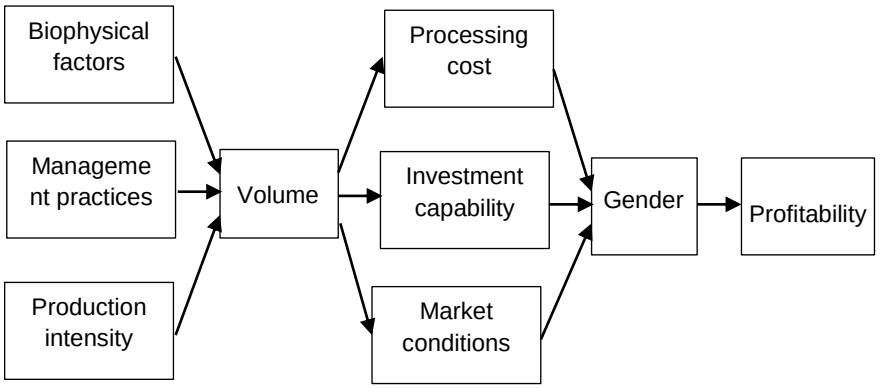

Figure 1.1: Conceptual framework

Biophysical factors such as climate, soil and topography, Management practices like pruning, thinning, spacing, weeding, establishment of fire lines, availability of resources such as land, capital and labor influences volume negatively or positively. On the other hand, these factors influence the quality of woodlots which in turn affects the profitability of the woodlots. Moreover, factors like market conditions, challenges, processing costs, investment capabilities and gender disparities influence profitability of woodlots for small-scale tree growers.

REFERENCES

Arvola, A., Malkamäki, A., Penttilä, J., & Toppinen, A. (2019). Mapping the Future Market Potential of Timber from Small-Scale Tree Farmers: Perspectives from the Southern Highlands in Tanzania. *Small-Scale Forestry*, *18*(2), 189–212. https://doi.org/10.1007/s11842-019-09414-8

Ayoola, J. O., & Silas, A. E. (2023). *Height diameter model for selected trees within university of Ibadan, Oyo State, Nigeria*.

Baynes, J., Herbohn, J., Smith, C., Fisher, R., & Bray, D. (2015). Key factors which influence the success of community forestry in developing countries. *Global Environmental Change*, *35*, 226–238. https://doi.org/10.1016/j.gloenvcha.2015.09.011

BOT. (2023). *Monthly Economic Review, May-2023* [Monthly report]. Bank of Tanzania.

De Lima, R. B., Rutishauser, E., Da Silva, J. A. A., Guedes, M. C., Herault, B., De Oliveira, C. P., Da Silva Aparício, P., Sotta, E. D., Da Silva, D. A. S., & Ferreira, R. L. C. (2021). Accurate Estimation of Commercial Volume in Tropical Forests. *Forest Science*, *67*(1), 14–21. https://doi.org/10.1093/forsci/fxaa032

Duguma, L. A., Nzyoka, J., Obwocha, E., Minang, P., Wainaina, P., & Muthee, K. (2022). The forgotten half? Women in the forest management and development discourse in Africa: A review. *Frontiers in Forests and Global Change*, *5*, 948618. https://doi.org/10.3389/ffgc.2022.948618

Elias, M., Hummel, S. S., Basnett, B. S., & Colfer, C. J. P. (2017). Gender Bias Affects Forests Worldwide. *Ethnobiology Letters*, *8*(1). https://doi.org/10.14237/ebl.8.1.2017.834

Follo, G., Lidestav, G., Ludvig, A., Vilkriste, L., Hujala, T., Karppinen, H., Didolot, F., & Mizaraite, D. (2017). Gender in European forest ownership and management: Reflections on women as “New forest owners.” *Scandinavian Journal of Forest Research*, *32*(2), 174–184. https://doi.org/10.1080/02827581.2016.1195866

Frija, A., Chebil, A., Mottaleb, K. A., Mason-D'Croz, D., & Dhehibi, B. (2020). Agricultural growth and sex-disaggregated employment in Africa: Future perspectives under different investment scenarios. *Global Food Security*, *24*, 100353. https://doi.org/10.1016/j.gfs.2020.100353

Fru, F. F., Steenkamp, E. T., Wingfield, M. J., & Roux, J. (2019). High genetic diversity of *Fusarium circinatum* associated with the first outbreak of pitch canker on *Pinus patula* in South Africa. *Southern Forests: A Journal of Forest Science*, *81*(1), 69–78. https://doi.org/10.2989/20702620.2018.1496312

Ghanem, R. (2017). *Handbook of uncertainty quantification*. Springer Berlin Heidelberg.

Gschwantner, T., Alberdi, I., Balázs, A., Bauwens, S., Bender, S., Borota, D., Bosela, M., Bouriaud, O., Cañellas, I., Donis, J., Freudenschuß, A., Hervé, J.-C., Hladnik, D., Jansons, J., Kolozs, L., Korhonen, K. T., Kucera, M., Kulbokas, G., Kuliešis, A., … Zell, J. (2019). Harmonisation of stem volume estimates in European National Forest Inventories. *Annals of Forest Science*, *76*(1), 24. https://doi.org/10.1007/s13595-019-0800-8

Harrison, S., Herbohn, J., & Niskanen, A. (2002). Non-industrial, smallholder, small-scale and family forestry: What's in a name? *Small-Scale Forest Economics, Management and Policy*, *1*(1), 1–11. https://doi.org/10.1007/s11842-002-0001-3

Harrison, Venn, T. J., Sales, R., & Herbohn, J. F. (2005). *Estimated financial performance of exotic and indigenous tree species in smallholder plantations in Leyte Province*.

Held, C., Jacovelli, P., Techel, G., Nutto, L., Wathum, G., & Wittmann, N. (2017). *2017_UNIQUE-Tanzania-Wood-Market-Study_ES (1).pdf*.

Herawati, T., Rohadi, D., Rahmat, M., & Winarno, B. (2019). An exploration of gender equity in household: A case from a peatland-based community in Riau, Indonesia. *Biodiversitas*

Journal of Biological Diversity, *20*(3), 853–861. https://doi.org/10.13057/biodiv/d200332

Herbohn, J. (2006). *Small-scale Forestry – Is it simply a smaller version of Industrial (Large-scale) Multiple Use Foresty?*

Hingi, O. S. (2018). *Organization of Smallholder Tree Growers, Support Organizations, Linkages and Implications for Woodlots Performance The Case of Mufindi District, Tanzania*.

Indufor. (2011). *Timber Market Dynamics in Tanzania and in Key Export Markets*. Ministry of Natural Resources and Tourism, Forestry and Beekeping division.

Irawanti, S., Ginoga, K. L., Prawestisuka, A., & Race, D. (2014). Commercialising Community Forestry in Indonesia: Lessons About the Barriers and Opportunities in Central Java. *Small-Scale Forestry*, *13*(4), 515–526. https://doi.org/10.1007/s11842-014-9268-4

Irawanti, S., Race, D., Stewart, H., Parlinah, N., & Suka, A. P. (2017). Understanding the timber value chain in community-based forestry in Indonesia: Analysis of sengon in central Java. *Journal of Sustainable Forestry*, *36*(8), 847–862. https://doi.org/10.1080/10549811.2017.1381029

Kearsley, E., Moonen, P. C., Hufkens, K., Doetterl, S., Lisingo, J., Boyemba Bosela, F., Boeckx, P., Beeckman, H., & Verbeeck, H. (2017). Model performance of tree height-diameter relationships in the central Congo Basin. *Annals of Forest Science*, *74*(1), 7. https://doi.org/10.1007/s13595-016-0611-0

Kiganda, E. O. (2014). *Effect of Macroeconomic Factors on Commercial Banks Profitability in Kenya: Case of Equity Bank Limited*.

Kiptot, E., & Franzel, S. (2011). *Gender and Agroforestry in Africa: Are women participating*. World Agroforestry Centre (ICRAF). https://doi.org/10.5716/OP16988

Kisegu, D., Kagaha, D., Whitney, C., & Tabuti, J. R. S. (2019a). Contribution of Smallholder Tree Growers to Increasing Tree

Cover in Kaliro District. In Y. Bamutaze, S. Kyamanywa, B. R. Singh, G. Nabanoga, & R. Lal (Eds.), *Agriculture and Ecosystem Resilience in Sub Saharan Africa* (pp. 417–433). Springer International Publishing. https://doi.org/10.1007/978-3-030-12974-3_19

Kisegu, D., Kagaha, D., Whitney, C., & Tabuti, J. R. S. (2019b). Contribution of Smallholder Tree Growers to Increasing Tree Cover in Kaliro District. In Y. Bamutaze, S. Kyamanywa, B. R. Singh, G. Nabanoga, & R. Lal (Eds.), *Agriculture and Ecosystem Resilience in Sub Saharan Africa* (pp. 417–433). Springer International Publishing. https://doi.org/10.1007/978-3-030-12974-3_19

Kongela, S. M. (2020). Gender Equality in Ownership of Agricultural Land in Rural Tanzania: Does Matrilineal Tenure System Matter? *African Journal on Land Policy and Geospatial Sciences*, *Vol 3*, 13-27 Pages. https://doi.org/10.48346/IMIST.PRSM/AJLP-GS.V3I3.21356

Laswai, F., Malimbwi, R. E., Chamshama, S. A. O., Abdallah, J. M., Balama, C., 1Pima, N. E., Mugasha, W. A., & Mauya, E. (2018). *Rotation age and Fibre length of Pinus Patula at Sao Hill Forest Plantation, Tanzania*.

Levin, K. A. (2016). *Study design III: Cross-sectional studies*.

Lopez, J. L., Abt, R. C., Dvorak, W. S., Hodge, G. R., & Phillips, R. (2018). Tree breeding model to assess financial performance of pine hybrids and pure species: Deterministic and stochastic approaches for South Africa. *New Forests*, *49*(1), 123–142. https://doi.org/10.1007/s11056-017-9609-1

Lusambo, L. P., Nyanda, S. S., & Mhando, D. G. (2021). Profitability Analysis of Tree Growing in the Southern Highlands of Tanzania. *International Journal of Forestry Research*, *2021*, 1–10. https://doi.org/10.1155/2021/8872211

Malata, H., Ngulube, E. S., & Missanjo, E. (2017). Site Specific Stem Volume Models for *Pinus patula* and *Pinus oocarpa*. *International Journal of Forestry Research*, *2017*, 1–6. https://doi.org/10.1155/2017/3981647

Malkamäki, A., D'Amato, D., Hogarth, N. J., Kanninen, M., Pirard, R., Toppinen, A., & Zhou, W. (2018). A systematic review of the socio-economic impacts of large-scale tree plantations, worldwide. *Global Environmental Change*, *53*, 90–103. https://doi.org/10.1016/j.gloenvcha.2018.09.001

Mann, C. J. (2003). *Observational research methods. Research design II: cohort, cross sectional, and case-control studies*.

Margaretha, F., & Supartika, N. (2016). Factors Affecting Profitability of Small Medium Enterprises (SMEs) Firm Listed in Indonesia Stock Exchange. *Journal of Economics, Business and Management*, *4*(2), 132–137. https://doi.org/10.7763/JOEBM.2016.V4.379

Mathayo, N. J. (2019a). *Production efficiency of small scale tree growers in Mufindi district, Tanzania*.

Mathayo, N. J. (2019b). *Production Efficiency of Small-Scale Tree Growers in Mufindi District, Tanzania*.

Mishra, A. K., Khanal, A. R., & Mohanty, S. (2017). Gender differentials in farming efficiency and profits: The case of rice production in the Philippines. *Land Use Policy*, *63*, 461–469. https://doi.org/10.1016/j.landusepol.2017.01.033

Mugasha, W. A., Chamshama, S. A. O., & Nguyeje, P. C. (2022). *Effects of Thinning on Growth, Yield and Stem Quality of Pinus patula at Sao Hill Forest Plantation, Mufindi District, Tanzania*. Tanzania Journal of Forestry and Nature Conservation,.

Muya, T. W., & Gathogo, G. (2016). *Effect of working capital management on the profitability of manufacturing firms in Nakuru town, Kenya*.

Mwakasungula, K. R. (2020). *Costs and thier financial implication for smallholder tree growres in Mufindi district Tanzania*.

Mwambusi. (2019). *Ilvicultural Treatments of Woodlots of Smallholder Forest Producers and their Relation to the Timber Market in Mufindi District, Tanzania*.

Ndlovu, N., Little, K., Titshall, L., & Rolando, C. A. (2019). Site preparation and vegetation management impacts on *Pinus*

patula growth and rotation end productivity in South Africa. *Australian Forestry*, *82*(2), 107–115. https://doi.org/10.1080/00049158.2019.1605753

Ngaga, Y. M. (2011). *Forest plantations and woodlots in Tanzania*.

Nhem, S., & Lee, Y. J. (2019). Women's participation and the gender perspective in sustainable forestry in Cambodia: Local perceptions and the context of forestry research. *Forest Science and Technology*, *15*(3), 93–110. https://doi.org/10.1080/21580103.2019.1595174

Niresh, J. A., & Velnampy, T. (2014). Firm Size and Profitability: A Study of Listed Manufacturing Firms ed Manufacturing Firms in Sri Lanka. *International Journal of Business and Management*, *9*(4), p57. https://doi.org/10.5539/ijbm.v9n4p57

Obayelu, A. E., Ogbe, A. O., & Edewor, S. E. (2019). Gender gaps and female labour participation in agriculture in Nigeria. *African Journal of Economic and Management Studies*, *11*(2), 285–300. https://doi.org/10.1108/AJEMS-03-2019-0128

Ogbadu, E. E. (2009). *Profitability through effective management of materials*.

Oke, R. A. (2019). *Challenges facing forest production value addition and implication on economic development*.

Ota, L., Lidestav, G., Andersson, E., Page, T., Curnow, J., Nunes, L., Goltiano, H., Gregorio, N., Dos Santos, N. F., & Herbohn, J. (2024). Reviewing gender roles, relations, and perspectives in small-scale and community forestry – implications for policy and practice. *Forest Policy and Economics*, *161*, 103167. https://doi.org/10.1016/j.forpol.2024.103167

Perdue, J. H., Stanturf, J. A., Young, T. M., Huang, X., Dougherty, D., Pigott, M., & Guo, Z. (2017). Profitability potential for Pinus taeda L. (loblolly pine) short-rotation bioenergy plantings in the southern USA. *Forest Policy and Economics*, *83*, 146–155. https://doi.org/10.1016/j.forpol.2017.08.006

Rahman, S. A., Sunderland, T., Roshetko, J. M., & Healey, J. R. (2017). Facilitating smallholder tree farming in fragmented tropical landscapes: Challenges and potentials for sustainable land management. *Journal of Environmental Management*, *198*, 110–121. https://doi.org/10.1016/j.jenvman.2017.04.047

Scudder, M. G., Baynes, J., Applegate, G., & Herbohn, J. (2019a). Addressing small-scale forestry informal markets through forest policy revision: A case study in Papua New Guinea. *Land Use Policy*, *88*, 104109. https://doi.org/10.1016/j.landusepol.2019.104109

Scudder, M. G., Baynes, J., Applegate, G., & Herbohn, J. (2019b). Addressing small-scale forestry informal markets through forest policy revision: A case study in Papua New Guinea. *Land Use Policy*, *88*, 104109. https://doi.org/10.1016/j.landusepol.2019.104109

Sete, Y., Alemu, A., & Dagnew, A. (2023). *Analysis of the Profitability of Smallholder Farmers' Eucalyptus Woodlot Production System in Wogera District, North Gondar, Ethiopia* [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-2399249/v1

Sherman, John E. (2022). *The Understanding and Measurement of Profitability in Multi-Subsidiary Companies*.

Singunda, W. T. (2010). *Economic contribution of private woodlots to the economy of Mufindi District – Tanzania*.

Spector, P. E. (2019). Do Not Cross Me: Optimizing the Use of Cross-Sectional Designs. *J Bus Psychol*.

Stierwald, A. (2010). Determinants of Profitability: An Analysis of Large Australian Firms. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1632749

Stoian, D., Elias, M., & Rodas, A. (2017). *Land, Livelihoods and Gender: Dynamics of Community Forestry in Petén, Guatemala*.

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V., & Shively, G.

(2014a). Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. *World Development*, *64*, S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V., & Shively, G. (2014b). Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. *World Development*, *64*, S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Tulsian, Dr. M. (2014). Profitability Analysis (A comparative study of SAIL & TATA Steel). *IOSR Journal of Economics and Finance*, *3*(2), 19–22. https://doi.org/10.9790/5933-03211922

Tyagi, N., & Das, S. (2017). Gender mainstreaming in forest governance: Analysing 25 years of research and policy in South Asia Partage du rôle des sexes dans la gestion forestière: une analyse de 25 ans de recherche et de politique en Asie du sud Transversalización del género en la gobernanza forestal: análisis de 25 años de investigación y políticas en Asia del Sur. *International Forestry Review*, *19*(2), 234–244. https://doi.org/10.1505/146554817821255132

Wagle, R., Pillay, S., & Wright, W. (2017). Examining Nepalese Forestry Governance from Gender Perspectives. *International Journal of Public Administration*, *40*(3), 205–225. https://doi.org/10.1080/01900692.2015.1091015

CHAPTER TWO

2.0 Profitability of Small-Scale Tree Growers with Gender Perspectives in Mufindi District

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ABSTRACT

Small-scale forestry has emerged as a significant component in Tanzania's forestry sector, showing considerable potential in terms of productivity and land area. Empirical evidence indicates that small-scale forestry constitutes the majority of the total plantation area in the country. Therefore, it is important to determine if investments made by small-scale tree growers are profitable and to what extent along with gender disparities that exist in the sector. This study aimed at determining the viability of small-scale tree growers' woodlots by performing profitability analysis and taking into account gender disparities that exist in this sector as well as taking into account the time value of money in measuring profitability. Cross-sectional data was collected through semi-structured interviews. Random sampling was used to select households for data collection. Data analysis involved descriptive statistics and cost-benefit analysis by using Stata software. The results of the household survey revealed that investments in small-scale tree growing are profitable. For tree growers who sell standing trees profitability indicators such as ROI, GPM, and BCR were 79.13, 28.9, and 1.179 respectively. For tree growers who process trees to obtain lumber showed higher values of profitability indicators such as ROI, GPM and BCR with value of 257.80, 70.11 and 3.58

respectively. Results also revealed that there is a significant difference between males and females in terms of revenue, profits earned, and profitability indices (ROI, GPM, and BCR) whereby males earned more than females. Processing and adding value to the produced wood tend to significantly increase revenue and profitability. The study highlights that there are economic disparities between genders in Mufindi District. It was also surprising that the age of the trees or standing trees had a negative correlation with profitability. Small-scale tree growers should prioritize value addition through processing for increased profitability and a market shift towards valuing quality to promote sales at rotation age should be developed. Study also recommends on training programs for women to motivate them engage and actively participate in small-tree growing sector.

Keywords: Small-Scale tree growers, Gender disparity, Profitability, Opportunity cost, and woodlot

2.1 Introduction

Small-scale forestry has emerged as a significant component in Tanzania's forestry sector, showing considerable potential in terms of productivity and land area. Small-scale forestry constitutes about 71% of the total plantation area in the country.

In the small-scale forestry sector, the market system is inadequately developed, and small-scale tree growers heavily depend on local and chance interactions within the market. There is a significant deficiency in the flow of market-related information to tree growers, resulting in their disadvantaged negotiation position (Arvola *et al.,* 2019). The most successful smallholder tree-growing schemes have involved producing short-rotation wood for example for pulp and paper industries or other industries where timber quality and large diameters are not crucial (Arvola *et al.,* 2019). Harvesting trees before rotation age which maximizes returns and potential returns is common among small-scale tree growers in developing countries including Tanzania. This leads to quality problems which might later limit access to the market for small-scale tree growers when the market is likely to become more selective and substitutes may replace (poor quality) timber (Arvola *et al.,* 2019).

Many social factors defines a person and one of those factors is gender (Sunderland et al., 2014). Gender relations play a key role in shaping the use of natural resources, management, and prospects for economic development. Gender roles, interests, knowledge, and skills between males and females differ concerning forest use and management, goods and services, and marketing of forest products (Duguma *et al.,* 2022; Elias *et al.,* 2017; Sunderland *et al.,* 2014b). Women have limited access to land, and are often excluded from decision-making about sustainable forest and environmental protection due to the heavy competing demand of their time, limited knowledge of forest management, low level of education in rural contexts, rules of entry, social norms, perception, rules of practice, personal endowment and other organization cultures (Duguma *et al.,*

2022; Elias *et al.,* 2017; Nhem and Lee, 2019). Moreover, in this sector, women often lack recognition due to the traditionally predominant focus on active management and self-employment in forestry which is regarded as a masculine socio-technical system, and paramount activities in forest such as harvesting are mostly conducted by men (Follo *et al.,* 2017).

It is important to look into the potential of this sector due to its importance in the economy by conducting a profitability analysis analyze how gender relates to profitability of these growers. Profitability can be defined as either accounting profits or economic profits which take into account the opportunity cost for a business's expenses (Sherman, 2022). Profitability can also be defined as the ability or power of a given investment to make a profit, It denotes its earning power or operating performance (Tulsian, 2014).

Information on profitability will be important to policymakers who wish to promote the development of the small-scale tree grower's sector. Previous studies that have been done to study small scale tree growers have explored aspects of the production efficiency of small scale tree growers (Mathayo, 2019a), the contribution of this sector to the economy (Singunda, 2010), and profitability analysis of woodlots (Lusambo *et al.,* 2021). However, there is limited research available regarding the profitability of small-scale farmers specifically. For instance, the profitability analysis conducted by (Lusambo *et al.,* 2021) did not adequately consider the opportunity costs associated with investing in tree-growing projects for farmers. It is crucial to consider the time value of money given the lengthy time frame required for tree investments and management before harvesting. Neglecting to account for this period undervalues the costs and overestimates the benefits of trees, thus impacting the profitability of tree growers.

Furthermore, previous studies have also neglected to incorporate gender analysis when examining the profitability of small-scale tree

growers. Studies within the agricultural sector have consistently revealed gender disparities among men and women in various aspects of production, post-harvesting, and marketing in Sub-Saharan Africa, including Tanzania (Frija *et al.,* 2020; Herawati *et al.,* 2019; Kongela, 2020; Obayelu *et al.,* 2019). Consequently, investigating gender disparities among tree growers is essential to gain insights into the opportunities and challenges faced by both male and female small-scale growers within this subsector. Since gender can be a broader concept, the Gender perspective that was captured in this study was information between males and females in terms of economic inequalities. This information will be important to policy makers to design targeted intervention and ensuring sustainability of the sector by addressing both needs and perspectives of men and women by using gender sensitive approach.

Therefore, the primary objective of this study is to contribute to the existing body of knowledge by comprehensively assessing the profitability of small-scale tree growers by gender. This will be achieved by considering the time value of money and evaluating gender disparities prevalent among small-scale tree growers. By accounting for the time value of money, which encompasses the concept that money, holds different worth over time due to inflation and the opportunity cost of investing the same capital elsewhere, this study aims to provide accurate and comprehensive insights into the profitability of woodlots for small-scale tree growers. Likewise, by incorporating a gender analysis, this study seeks to contribute to the development of gender-inclusive and responsive policies or interventions that can effectively support small-scale tree growers. Profitability analysis will provide improved knowledge on how small scale tree growers integrate tree growing in their livelihood, how efficient are they in making profit , how they access the markets and what are the prices paid to smallholder tree growers compared to the prices paid for timber from industrial plantations (Arvola et al., 2019). Profitability analysis will help to determine if the investment in

small-scale tree growing is profitable and to what extent (Lusambo et al., 2021)

2.2 Methodology

2.2.1 Study area and study design

This study was conducted in the Mufindi district within three wards which are Ihalimba, Mninga, and Igowole. The study considered analysis for pine since the majority of the growers plant pine trees compared to other species. Mufindi district was purposively chosen for this study due to its potentiality in tree growing and as a leading district in woodlot production due to a large number of small-scale tree growers (Mathayo, 2019a; Singunda, 2010).

2.2.2 Study design

The study adopted a cross-sectional research design which allows a researcher to analyze data of variables collected at one given point in time across a sample population or pre-defined subset. Cross-sectional research design was also chosen because it is economical in terms of funds and time (Mwakasungula, 2020).

To ensure for validity and reliability of data pre testing was done to 20 tree growers prior to the main household survey and then tool for data collection was modified accordingly to ensure collection of reliable and valid data.

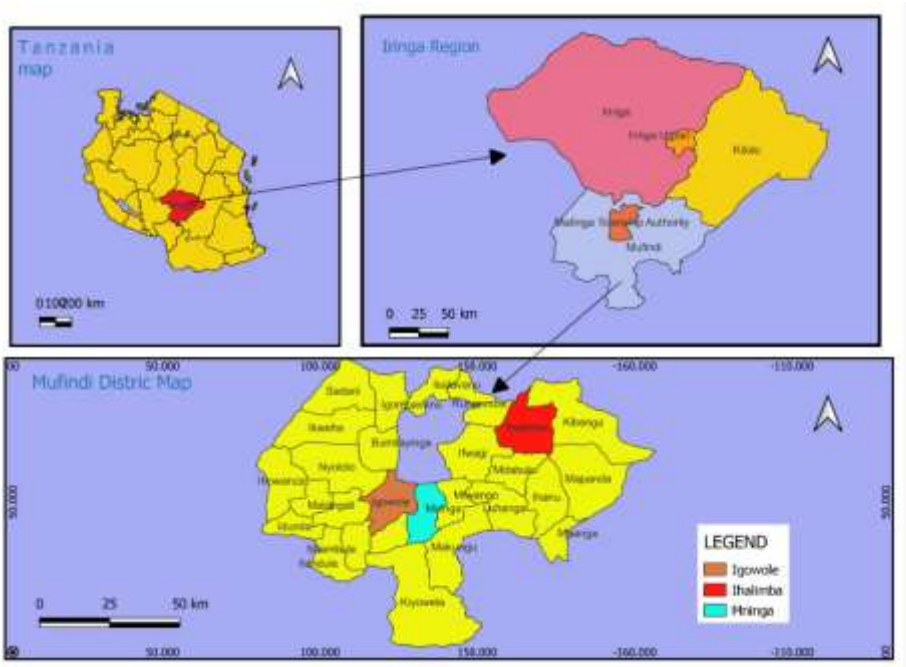

Figure 2.1: A Map Showing the Selected study Villages

2.2.3 Sampling procedure, sample size and Selection

Purposive sampling was used to select small-scale tree growers who plant trees for different purposes and then a simple random sampling technique was used to select households for the survey to ensure that all members of the population had an equal chance of being selected. The sample size for this study was guided by Bailey (1994) Saunders *et al*. (2007); Mbeyale (2009) and Mtongani *et al.* (2014) who posed that 30 respondents per case is a minimum number recommended to represent a population being studied irrespective of the population size. The targeted population for sampling was households in the study wards. Three wards were sampled out of 30 wards which represent 10% and these wards are Mninga, Igowole, and Ihalimba. Therefore, in each ward, a total of 30 households were randomly selected from 9 different villages which are Ugesa, Vikula, Nundwe, Kihanga, Mkalala, Mninga, Igowole, Pasodzi, and Muhamati. In each village, 10 respondents

were sampled making a total of 91 respondents. Therefore, a total of 91 respondents were interviewed using a household questionnaire survey and the researcher's direct observation.

2.2.4 Data collection

Quantitative data were collected by using semi structured interview and the main tool for these data was semi structured questionnaire. Information like household revenue, costs, and areas harvested for tree selling was collected to be used in the computation of profitability. This information is based on the pine tree species because the majority of small scale trees growers more than (50%) plant pine species due to the demand and selling price of pine (Lusambo *et al.,* 2021; Mwakasungula, 2020; Mwambusi, 2019).

2.2.5 Data analysis

Analysis for quantitative data was performed by using Stata software. Gross profit margin, return on investment, and benefit-cost ratio were used to calculate the woodlots' profitability of small-scale tree growers in Mufindi. The costs involved in tree growing were analyzed using a discount rate of 8%. The 8% discount rate was chosen based on the 12-month bank deposit rate as of the year 2023 provided by (BOT, 2023). The discounted costs save as opportunity cost of investment by taking into account that trees take an extended period to harvest (minimum 6 years) hence it is important to consider the value for money invested versus the benefit accrued after this period. Lastly, sensitivity analysis was performed using discount rates of 6% and 12% to account for uncertainties in the model due to changes in interest rates. This provides a deeper understanding of the model to reduce uncertainties most effectively (Bertrand and Ghanem, 2017). The main assumptions and limitations considered in the analysis are presented in Table 2.1.

Table 2.1: General Assumptions Guiding Profitability Analysis

No	Assumptions
1.	Current prices and costs (survey year) were used in the analysis and were considered to remain constant over the time period, this is not always the case since prices and costs may vary depending on demand and supply and other factors.
2.	A discount rate of 8% for analysis was used based on the 12 month-deposit rate as cited from (BOT, 2023). This is used as an opportunity cost for investment. The assumption is that what if the amount used in tree production would have been fixed and deposited on banks and earned an interest?
3.	The analysis considers only direct benefits. That is revenue after harvesting and does not account for other benefits (both tangible and intangible) for example revenue from beekeeping, firewood, charcoal, and sawdust, thinning, and pruning can be used for house repairing or organic fertilizer which is in cost saving for a grower. But also forest provides regulating services like control of soil erosion, carbon storage, and flood control.
4.	The study uses land rent as an opportunity cost for land. For farmers who did not rent land, the median rent cost in their respective villages or wards was used.
5.	The potential taxation implications have not been taken into account but in most cases, small scale tree growers would pay little or no income tax.

2.3 Results and Discussion

2.3.1 Socio-economic characteristics of the respondents

Results in Table 2.2 show that, the majority of the interviewed respondents were males (81.3%) while females were only 18.7%. Approximately 47% of the respondents fall within the age range of 18-35 years, followed by 36.5% in the age range of 36-60 years and 16.2% had the age above 60 years. These findings indicate that the majority of individuals engaged in tree-growing activities belong to the working-age group. It is this group that is expected to have the

ability to actively participate in tree production and marketing to generate income for their households. Moreover, the significant representation of young people in this sector reflects a positive trend and sustainability in terms of awareness and interest in tree planting and its potential for development.

Findings show that 50% of the respondents have attained primary education while 20.3% had secondary education. On the other hand, 16.2% reported to have not been in any formal education system and 13.5% reported to possess higher education qualifications. These findings align with the prevailing trend observed in the agriculture sector in Tanzania where the majority have lower education levels and have consequently chosen self-employment in the sector, possibly due to limited opportunities in other sectors that require specialized skills (Mathayo, 2019b; Mwakasungula, 2020; Mwambusi, 2019). In this study, about 14% of the respondents hold higher education qualifications. This is a very good indication of the potential of the sub-sector in attracting educated individuals which means that it is a viable business capable of contributing to economic growth and social welfare within the forest sector, in Mufindi District and Tanzania as a Country.

Regarding experience in tree growing activities, findings reveal that about 39% of respondents have an experience of 0-10 years while about 34% had an experience of 21-30 years, and 27% with 11-20 years of experience. It is evident from these findings that considerable proportions of tree growers are relatively young in the sector and have not been engaged in tree growing for an extended period indicating an evolving nature of the sector. These individuals may therefore need some incubation period, training, and capacity building in various issues related to the forest products business to grow and contribute more to the sector.

Land size, management, and ownership are among the important aspects when discussing about tree growing activities. Results show

that the average total area owned by individuals was found to be about 6.7 acres. Specifically, the average area cultivated by female respondents was 3.3 acres, while that cultivated by males was 7.4 acres. The mean difference in land cultivated between males and females was 4.1 acres, and this difference was found to be statistically significant at a p-value of 0.01. Similarly, the average pine area harvested was 1.6 acres, with males harvesting an average of 1.6 acres and females harvesting an average of 1.2 acres. The mean difference in harvested area between males and females was 0.48 acres and statistically significant at a p-value of 0.01.

These findings indicate a significant disparity between males and females in terms of both land ownership and harvested area. One possible explanation for this disparity could be the limited access to land resources faced by females compared to males. Gender roles and responsibilities within society can have implications for households' ability to generate income, and this may contribute to the observed differences. According to Mishra *et al*. (2017), women tend to have limited access to land although they significantly contribute to the agriculture sector and rural economies in developing countries. The descriptive statistics in this study are consistent with other research findings, indicating that the majority of respondents belong to the working-age group, are married, and have an average of 0 to 21 years of experience in tree growing. Most of the respondents have primary education, with only a few having higher education. Additionally, the data reveals that respondents own less than 2 acres of land, and the activity is predominantly led by men rather than women (Mathayo, 2019.; Mwakasungula, 2020; Mwambusi, 2019).

Table 2.2: Household characteristics

	Male (74)		Female (17)		Total (91)		Tests
	Freq./Mean	Percent/ SD	Freq./ Mean	Percent/ SD	Freq./Mean	Percent/ SD	Chi2/t-test
Age of the respondent							
18-35 years	35	(47.3%)	12	(70.6%)	47	(51.6%)	Ns
36-60 years	27	(36.5%)	4	(23.5%)	31	(34.1%)	
Above 60 years	12	(16.2%)	1	(5.9%)	13	(14.3%)	
Education level							
No formal education	12	(16.2%)	2	(11.8%)	14	(15.4%)	1.393
Primary education	37	(50.0%)	9	(52.9%)	46	(50.5%)	Ns
Secondary education	15	(20.3%)	5	(29.4%)	20	(22.0%)	
Higher education	10	(13.5%)	1	(5.9%)	11	(12.1%)	
Experience							
0-10 years	29	(39.2%)	10	(58.8%)	39	(42.9%)	3.531
11-20 years	20	(27.0%)	5	(29.4%)	25	(27.5%)	Ns
21-30 years	25	(33.8%)	2	(11.8%)	27	(29.7%)	
TAG membership							
No	61	(82.4%)	16	(94.1%)	77	(84.6%)	1.450
Yes	13	(17.6%)	1	(5.9%)	14	(15.4%)	Ns
Total area under trees (Acres)	7.42	(7.88)	3.29	(2.47)	6.65	(7.35)	***
Pine harvested area(acres)	1.64	(1.13)	1.16	(0.47)	1.55	(1.06)	***

2.3.2 Analysis by wards (Average woodlot area and renting cost per acre)

Figure 2.2 is showing an average area owned by small scale tree growers by wards. Growers in Igowole ward have smallest woodlot area compared to other wards because this ward is beginning to grow into small town and most of its area is occupied by settlement and other human activities other than tree growing. An average

woodlot area in Igowole is 3.3 acres, while in Mninga and Ihalimba is 8.3 and 5.3 acres respectively. The same applies to renting cost (figure3), is showing that the value of land in Igowole ward is higher than in other two wards. Renting cost in Igowole per acre is TZS 492 500, followed by TZS 488 000 in Mninga and TZS 381 200 in Ihalimba. This phenomenon can have implications for the expansion of tree-growing operations and the overall sustainability of the forestry sector in Igowole ward. Moreover Larger woodlot areas in Mninga and Ihalimba wards may allow growers to achieve economies of scale, potentially leading to higher production efficiency and lower production costs per unit of output compared to growers in Igowole ward. The combination of smaller woodlot areas and higher land rent costs in Igowole ward may result in lower profitability for instance in profitability indices like ROI and BCR (Appendix 2) and competitiveness for small-scale tree growers compared to growers in Mninga and Ihalimba wards. Higher production costs and limited land availability could constrain their ability to expand production. These results highlight the importance of land use policies such as land tenure issues and land use planning and interventions aimed at promoting small-scale tree growers**.** According to (Vitriana, 2017) rural regions that were formerly peri-urban increasingly transform into conventional urban settlement areas. Following this change, the economic worth of the land increases, which is reflected in a rise in land price.

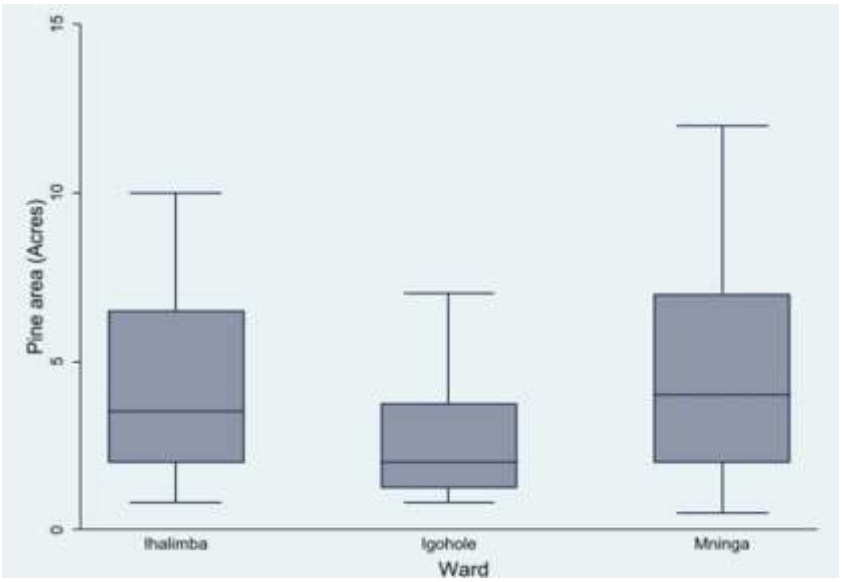

Figure 2.2: Showing average woodlot area by wards

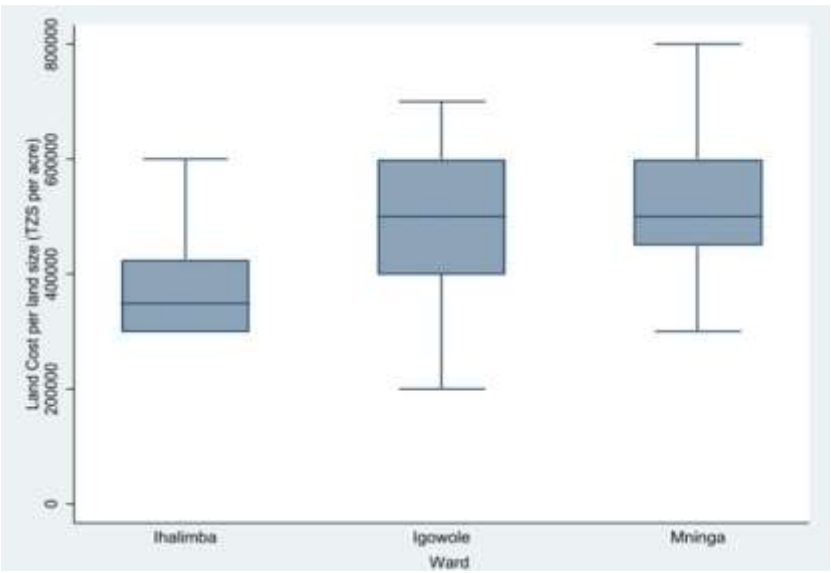

Figure 2.3: Showing land rent cost per acre by wards

2.3.3 Pine production costs

Table 2.3 shows the costs associated with tree pine growing activities. The mean establishment cost is about TZS 191 632 per acre per year. Establishment cost is mostly driven by pitting and planting followed by the cost of seedlings, land clearing, land rent, and transportation costs. It was observed that tree growers incur most of the cost to purchase seedlings. The management cost per acre per year was found to be about TZS 96 471. These management costs included pruning, fire protection, weeding, forest patrols, and beating up. The high costs of pruning and fire protection show that there is awareness among tree growers on the importance of pruning in the quality of the stands but also indicates that growers are cautious about fire risks in such a way they dedicate such an amount of money per year to manage their woodlots. The findings in this study are different from those reported by Mwakasungula (2020) which identified that the primary drivers of establishment costs are seedling expenses, land preparation, and planting. Conversely, the management aspect is predominantly influenced by fire line costs, pruning, and ultimately, wedding expenses. A study by Lusambo *et al.* (2021) reported similar findings to this study where the management costs are primarily driven by factors such as fire protection and nursery management. Another study by Sete *et al*. (2023) found that establishment cost is driven by land opportunity cost (rent), seedling cost, followed by planting and replanting while management cost is driven by weeding, fire protection and lastly pruning. This might be due to differences in location and type of the species planted. Timber processing cost per acre per year was found to be about TZS 674 865. This cost is mostly driven by payment of machine operators TZS 273,563, payment of casual laborers TZS 221 447; transportation costs TZS 114 198, Chainsaw operators TZS 114 198, and fuel purchases TZS 16 890. Machine operators seem to be highly paid due to high demand because there are only a few of them and tend to be mobile to be able to access tree growers, and utilize small log diameters also some woodlots are remote and inaccessible making processing difficult. A study by Sete

et al. (2023) found that harvesting costs are covered by traders but traders reduce the purchasing price to compensate for their cost. Therefore, these costs have been considered on the farmers' side. On the other hand, if farmers covered those costs by themselves, then their sales prices increase.

Table 2.3: Costs Associated with Pine Tree Growing Activities (per acre per year)

Variable	Valid sample	Mean	Std. Dev.	Min	Max
Establishment costs	**87**	**191 632**	**77 614**	**108 000**	**628 000**
1. Land cost(rent per year)	87	23 759	9 463	10 000	50 000
2. Land Clearing	79	39 165	31 638	10 000	140 000
3. Pitting and planting	87	51 734	11 674	40 000	96 000
4. Seedlings	87	41 871	12 105	20 000	72 000
5. Other costs(transportation)	82	14 598	8 948	5 000	40 000
Management costs(per year)	**87**	**96 471**	**29 231**	**55 000**	**185,000**
1. Beating up costs	80	5 538	2 181	3 000	20 000
2. Weeding costs	7	27 143	8 092	20 000	40 000
3. Pruning costs	87	48 161	12 609	40 000	100 000
4. Forest patrols	81	16 975	5 179	10 000	30 000
5. Fire protection	62	35 484	11 512	20 000	50 000
Standing trees total cost	**87**	**288 103**	**86 467**	**168,000**	**688 000**
Timber process costs	**19**	**674 865**	**307 478**	**174 000**	**1 338 000**
1. Chainsaw operator- pines	19	108 880	38 784	50 000	180 000
2. casual laborer – pines	19	221 447	94 258	90 000	400 000
3. Fuel- pines	5	16 890	13 899	6 000	41 250
4. Machine operator	16	273 563	92 733	100 000	400 000
5. What are transportation cost	19	114 198	65 547	50 000	300 000

2.3.4 Profitability of Pine Trees

Table 2.4 presents the results of economic indicators for pine trees disaggregated between standing trees and processed timber. Results show that processors have higher investment costs than growers who sell standing trees but this additional cost results in additional revenue by processors. Processors receive TZS 6 153 083 per acre compared to growers who sell standing trees receiving revenue of TZS 2 052 844 per acre. It is therefore evident that there is a statistically significant difference between revenues obtained by processors and tree growers. Growers who sell standing trees sell at a mean price of TZS 5 062 per individual tree making a profit of TZS 1 331 549 per acre. This is less profitable than processors who sell at a mean price of TZS 15 324 per tree and make a profit of TZS 3 459 360 per acre.

Further results indicate that the ROI for tree growers who sell standing trees is 79.13 while that of the processors is 257.80. The GPM for growers who sell standing trees is 28.9 while that of processors is 70.11**.** On the other hand, the BCR for growers who sell standing trees is 1.79 while that of processors is 3.58. The difference between these economic indicators among the two groups was found to be statistically significant at a p-value of 0.01. These results indicate that value addition through processing trees to obtain timber is more profitable and economically viable than selling standing trees (Table 2.4). However, these findings on economic indicators are different from those reported by Lusambo *et al*. (2021) in the same study area which revealed that woodlots of small-scale tree growers are profitable by GPM of 21% and ROI of 26%. The differences in the findings reported by these two studies could be due to different attempts to conduct profitability assessments.

A study on profitability potential for pine species found out that these investments are profitable with IRR ranging from -0.3% to 14.2% on uplands and -2.9% to 10.4% on lowlands in the USA (Perdue *et al.,*

2017). However (Lopez *et al.,* 2018) found out that pine species are profitable with NPV of 223.6 USD and IRR of 10.4 USD at a discount rate of 6% in USA.

Table 2.4: Economic indicators for pine tree growing projects (per acre) by standing trees and processed timber.

	(A)Standing trees	(B)Timber	Difference (B-A)
Total Cost	1 250 061	1 834 765	583,597***
	(522 834)	(594 806)	[147,152]
Total Revenue	2 052 844	6 153 083	4100238***
	(920 017)	(933 001)	[238958]
Profit	802 783	4 318 318	3515535***
	(856 123)	(900 411)	[229005]
Selling price per tree	5 062	15 324	10262***
	(2 237)	(2 644)	[659]
Cost per tree	3 115	4 475	1376***
	(1 393)	(1 045)	[279]
ROI	79.13	257.80	178.66***
	(82.30)	(86.26)	[21.95]
GPM	28.90	70.11	41.21***
	(40.95)	(8.84)	[5.15]
BCR	1.79	3.58	1.79***
	(0.82)	(0.86)	[0.22]

Note: Mean; SD in parenthesis; SE in brackets; *** p<.01, ** p<.05, * p<.1

2.3.5 Profitability analysis by gender

Table 2.5 presents economic indicators for pine tree growing projects per acre by gender. Results show that there is a significant statistical difference between males and females on all other profitability indicators except the costs incurred. It was observed that, in the same one acre of production, females generate revenue of TZS 1 490 000 and a profit of TZS 823 633 while males get revenue of TZS 2 193 556 and a profit of TZS 1 458 528. Further, females had ROI of 50.07, GPM of 17.05, and BCR of 1.50 while males had ROI of 86.40, GPM of 31.87, and BCR of 1.86. The differences in all economic indicators among males and females were found to be statistically significant at p-values of 0.01. It is

evident from these results that females are underpaid and disadvantaged compared to males. This could be due to low market bargaining power and/or limited access to production resources leading to low-quality products that tend to fetch lower prices. Likewise, females might be dedicating their time to other activities such as household chores and taking care of the family while male can invest their time in tree-growing activities hence becoming better off economically. These findings are consistent with the study conducted by Duguma *et al.* (2022) who revealed that women disproportionately bear the costs of tree and forest management but realize only a part of the benefits and are typically enlisted in decision-making as far as forest and tree resources are concerned which affects their profitability. According to Elias *et al*. (2017), women are susceptible to temporary and low-wage employment in the forest sector.

Table 2.5: Economic indicators for pine tree growing projects (per acre) by gender.

	(A)Male	(B)Female	Difference(A-B)
Total Cost	1 278 864	1 134 851	39 331
	(524 448)	(517 669)	[161 832]
Total Revenue	2 193 556	1 490 000	703 556***
	(957 531)	(431 029)	[166,333]
Profit	914 692	355 149	559 543**
	(865 155)	(671 881)	[206 325]
Selling price per tree	5 406	3 682	1,724***
	(2 302)	(1 248)	[438]
Cost per tree	3 189	2 819	243
	(1 400)	(1 367)	[375]
ROI	86.40	50.07	36.32*
	(86.19)	(57.96)	[18.65]
GPM	31.87	17.05	14.81
	(37.29)	(53.09)	[14.53]
BCR	1.86	1.50	0.36*
	(0.86)	(0.58)	[0.19]

Note: Mean; SD in parenthesis; SE in brackets; *** p<.01, ** p<.05, * p<.1

2.3.6 Profitability by age of the trees

Findings demonstrate a negative correlation between the profitability of tree growing and the age at which the trees are sold. Figure 2.4 displays the benefit-cost ratio (BCR) for both males and females. There is a negative relationship between selling age and BCR (Benefit-Cost Ratio) as profits increase at a decreasing rate. This negative relationship between age and the benefits-cost ratio could be due to the narrowing or decreasing of the profit margin as the selling age increases. One could expect that as the age of the trees increases, the management costs should decrease but the mean annual increment (MAI) and the current annual increment (CAI) should increase up to a certain age and later stagnate. This could therefore cause an increase in profit as the age increases. Unfortunately, this is not what we observe in this study probably due to market insensitivity in terms of wood quality based on age. The market's insensitivity to quality forces the tree growers to prefer selling trees at around 10 years of age or even below instead of waiting for the rotation age of around 15 to 18 years. It means that farmers receive lower benefits relative to costs as the age of the trees increases. This suggests that selling prices increase at a decreasing rate with age. This could be potentially influenced by market conditions in the study area. Possibly, the price differences for trees aged 10 years and those aged 18 years do not vary much hence lacking motivation for a tree grower to keep a tree for an additional year because it does not receive the right proportion of price and does not add any value. As a result, if farmers choose to retain trees on their farms beyond the rotation age of 10 years, they are unlikely to achieve significant revenue gains although it does not mean profit decreases with age. In addition, findings reveal that female growers experience lower benefits compared to their male counterparts. On average about 20 % of the surveyed farmers make a loss, and it was found out, all female growers encounter losses when selling trees aged over 12 years. This phenomenon could be influenced by the fact that men have dedicated most of their time to tree production hence they have more time to bargain and search for

a better customer who can offer good prices and thereby becoming profitable than females.

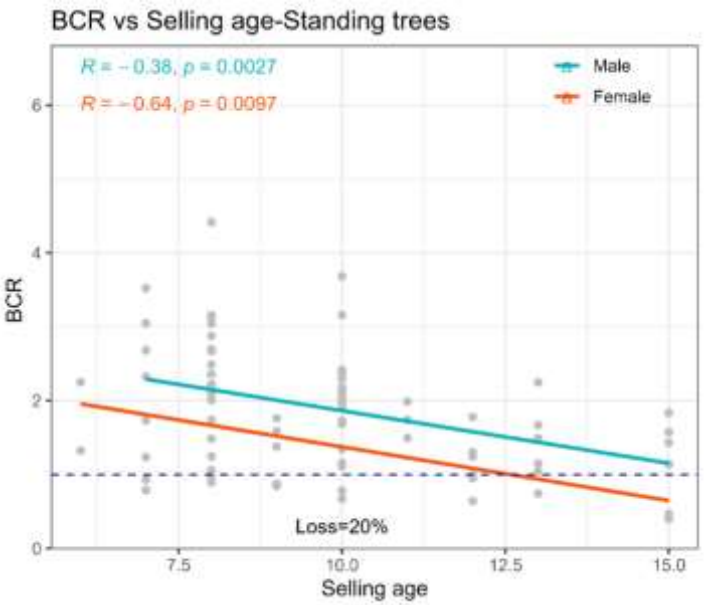

Figure 2.4: Benefit-cost ratio by gender

2.3.7Sensitivity analysis

Sensitivity analysis results are presented in Table 2.6. In the last 10 years, the deposit rate fluctuated between 6% and 12% and these served as the basis for the analysis. Findings indicate that the tree production business remains profitable across the range of discount rates, from 6% to 12%. For instance, when the discount rate increased from 8% to 12%, the estimated return on investment (ROI) became 37% for standing trees and an impressive 223% for timber. The sensitivity analysis included a scenario with a 0% discount rate to demonstrate how profitability might be overestimated if opportunity costs are not taken into account. For instance, the ROI for standing trees at a 0% discount rate was found to be 180% and reduced to 79% when the discount rate was set at 8%. Using a naïve approach, the analysis would overstate the profitability by a factor of more than 2.

Table 2.6: Sensitivity analysis at different discount rates

	Discount rate	ROI	GMP	BCR
Standing trees	0%	180.29	56.41	2.80
	6%	99.02	36.85	1.99
	8%	79.13	28.90	1.79
	12%	36.88	4.52	1.37
Timber	0%	384.60	78.32	4.85
	6%	305.35	73.66	4.05
	8%	257.80	70.11	3.58
	12%	222.95	65.96	3.23

2.4 Conclusions and Recommendations

The small-scale tree growing sector is predominantly male-dominated with 81% males and females only 19% highlighting a clear gender disparity. Despite the gender disparities, there is a positive trend in terms of age distribution among tree growers, with a substantial representation of young individuals. This suggests a promising outlook for the sector's future development and sustainability, as younger generations show awareness and interest in tree planting. However, a gender disparity is observed beyond participation, as men have greater access to resources and decision-making power, leading to unequal opportunities for women. This is evidenced through economic inequality, with males earning more revenue, profits, and profitability indices per acre compared to females. This disparity is attributed to women's limited access to resources, weaker market bargaining power, and competing demands on their time. Furthermore, the profitability analysis demonstrates that investments in tree growing, particularly those involving processing trees into lumber, are generally profitable. The profitability measures, such as ROI, GPM, and BCR, indicate positive outcomes for both growers who sell standing trees and processors. Particularly, those who process trees for lumber exhibit significantly higher revenue, profit, and profitability indices, emphasizing the importance of value addition through processing. A negative correlation between the profitability of tree growing and the

age at which the trees are sold has been observed in the sector. This negative relationship between age and the benefits-cost ratio could be due to the narrowing or decreasing of the profit margin as selling age increases as a result of the market insensitivity in terms of wood quality based on age.

To increase the profitability of small-scale tree growers, they should consider processing their trees into lumber, potentially earning TZS 3515535 more per acre if they process, compared to TZS 802783 from selling standing trees alone. Value addition through processing can significantly increase their income. Furthermore, if the timber market starts valuing older trees for their quality, it could motivate small-scale tree growers to sell their trees at rotation age rather than prematurely. Proper marketing mechanisms developed to their needs could further enhance their profitability in this scenario. Addressing gender disparities within the sector is crucial for fostering equitable and sustainable growth in forestry. Encouraging women to actively participate in forestry activities can contribute to their economic development.

REFERENCES

Arvola, A., Malkamäki, A., Penttilä, J., & Toppinen, A. (2019). Mapping the Future Market Potential of Timber from Small-Scale Tree Farmers: Perspectives from the Southern Highlands in Tanzania. *Small-Scale Forestry*, *18*(2), 189–212. https://doi.org/10.1007/s11842-019-09414-8

Ayoola, J. O., & Silas, A. E. (2023). *Height diameter model for selected trees within university of Ibadan, Oyo State, Nigeria*.

Baynes, J., Herbohn, J., Smith, C., Fisher, R., & Bray, D. (2015). Key factors which influence the success of community forestry in developing countries. *Global Environmental Change*, *35*, 226–238. https://doi.org/10.1016/j.gloenvcha.2015.09.011

BOT. (2023). *Monthly Economic Review, May-2023* [Monthly report]. BANK OF TANZANIA.

De Lima, R. B., Rutishauser, E., Da Silva, J. A. A., Guedes, M. C., Herault, B., De Oliveira, C. P., Da Silva Aparício, P., Sotta, E. D., Da Silva, D. A. S., & Ferreira, R. L. C. (2021). Accurate Estimation of Commercial Volume in Tropical Forests. *Forest Science*, *67*(1), 14–21. https://doi.org/10.1093/forsci/fxaa032

Duguma, L. A., Nzyoka, J., Obwocha, E., Minang, P., Wainaina, P., & Muthee, K. (2022). The forgotten half? Women in the forest management and development discourse in Africa: A review. *Frontiers in Forests and Global Change*, *5*, 948618. https://doi.org/10.3389/ffgc.2022.948618

Elias, M., Hummel, S. S., Basnett, B. S., & Colfer, C. J. P. (2017). Gender Bias Affects Forests Worldwide. *Ethnobiology Letters*, *8*(1). https://doi.org/10.14237/ebl.8.1.2017.834

Follo, G., Lidestav, G., Ludvig, A., Vilkriste, L., Hujala, T., Karppinen, H., Didolot, F., & Mizaraite, D. (2017). Gender in European forest ownership and management: Reflections on women as “New forest owners.” *Scandinavian Journal of Forest Research*, *32*(2), 174–184. https://doi.org/10.1080/02827581.2016.1195866

Frija, A., Chebil, A., Mottaleb, K. A., Mason-D'Croz, D., & Dhehibi, B. (2020). Agricultural growth and sex-disaggregated employment in Africa: Future perspectives under different investment scenarios. *Global Food Security*, *24*, 100353. https://doi.org/10.1016/j.gfs.2020.100353

Fru, F. F., Steenkamp, E. T., Wingfield, M. J., & Roux, J. (2019). High genetic diversity of *Fusarium circinatum* associated with the first outbreak of pitch canker on *Pinus patula* in South Africa. *Southern Forests: A Journal of Forest Science*, *81*(1), 69–78. https://doi.org/10.2989/20702620.2018.1496312

Ghanem, R. (2017). *Handbook of uncertainty quantification*. Springer Berlin Heidelberg.

Gschwantner, T., Alberdi, I., Balázs, A., Bauwens, S., Bender, S., Borota, D., Bosela, M., Bouriaud, O., Cañellas, I., Donis, J., Freudenschuß, A., Hervé, J.-C., Hladnik, D., Jansons, J., Kolozs, L., Korhonen, K. T., Kucera, M., Kulbokas, G., Kuliešis, A., … Zell, J. (2019). Harmonisation of stem volume estimates in European National Forest Inventories. *Annals of Forest Science*, *76*(1), 24. https://doi.org/10.1007/s13595-019-0800-8

Harrison, S., Herbohn, J., & Niskanen, A. (2002). Non-industrial, smallholder, small-scale and family forestry: What's in a name? *Small-Scale Forest Economics, Management and Policy*, *1*(1), 1–11. https://doi.org/10.1007/s11842-002-0001-3

Harrison, Venn, T. J., Sales, R., & Herbohn, J. F. (2005). *Estimated financial performance of exotic and indigenous tree species in smallholder plantations in Leyte Province*.

Held, C., Jacovelli, P., Techel, G., Nutto, L., Wathum, G., & Wittmann, N. (2017). *2017_UNIQUE-Tanzania-Wood-Market-Study_ES (1).pdf*.

Herawati, T., Rohadi, D., Rahmat, M., & Winarno, B. (2019). An exploration of gender equity in household: A case from a peatland-based community in Riau, Indonesia. *Biodiversitas*

Journal of Biological Diversity, *20*(3), 853–861. https://doi.org/10.13057/biodiv/d200332

Herbohn, J. (2006). *Small-scale Forestry – Is it simply a smaller version of Industrial (Large-scale) Multiple Use Foresty?*

Hingi, O. S. (2018). *Organization of Smallholder Tree Growers, Support Organizations, Linkages and Implications for Woodlots Performance The Case of Mufindi District, Tanzania*.

Indufor. (2011). *Timber Market Dynamics in Tanzania and in Key Export Markets*. Ministry of Natural Resources and Tourism, Forestry and Beekeping division.

Irawanti, S., Ginoga, K. L., Prawestisuka, A., & Race, D. (2014). Commercialising Community Forestry in Indonesia: Lessons About the Barriers and Opportunities in Central Java. *Small-Scale Forestry*, *13*(4), 515–526. https://doi.org/10.1007/s11842-014-9268-4

Irawanti, S., Race, D., Stewart, H., Parlinah, N., & Suka, A. P. (2017). Understanding the timber value chain in community-based forestry in Indonesia: Analysis of sengon in central Java. *Journal of Sustainable Forestry*, *36*(8), 847–862. https://doi.org/10.1080/10549811.2017.1381029

Kearsley, E., Moonen, P. C., Hufkens, K., Doetterl, S., Lisingo, J., Boyemba Bosela, F., Boeckx, P., Beeckman, H., & Verbeeck, H. (2017). Model performance of tree height-diameter relationships in the central Congo Basin. *Annals of Forest Science*, *74*(1), 7. https://doi.org/10.1007/s13595-016-0611-0

Kiganda, E. O. (2014). *Effect of Macroeconomic Factors on Commercial Banks Profitability in Kenya: Case of Equity Bank Limited*.

Kiptot, E., & Franzel, S. (2011). *Gender and Agroforestry in Africa: Are women participating*. World Agroforestry Centre (ICRAF). https://doi.org/10.5716/OP16988

Kisegu, D., Kagaha, D., Whitney, C., & Tabuti, J. R. S. (2019a). Contribution of Smallholder Tree Growers to Increasing Tree

Cover in Kaliro District. In Y. Bamutaze, S. Kyamanywa, B. R. Singh, G. Nabanoga, & R. Lal (Eds.), *Agriculture and Ecosystem Resilience in Sub Saharan Africa* (pp. 417–433). Springer International Publishing. https://doi.org/10.1007/978-3-030-12974-3_19

Kisegu, D., Kagaha, D., Whitney, C., & Tabuti, J. R. S. (2019b). Contribution of Smallholder Tree Growers to Increasing Tree Cover in Kaliro District. In Y. Bamutaze, S. Kyamanywa, B. R. Singh, G. Nabanoga, & R. Lal (Eds.), *Agriculture and Ecosystem Resilience in Sub Saharan Africa* (pp. 417–433). Springer International Publishing. https://doi.org/10.1007/978-3-030-12974-3_19

Kongela, S. M. (2020). Gender Equality in Ownership of Agricultural Land in Rural Tanzania: Does Matrilineal Tenure System Matter? *African Journal on Land Policy and Geospatial Sciences*, *Vol 3*, 13-27 Pages. https://doi.org/10.48346/IMIST.PRSM/AJLP-GS.V3I3.21356

Laswai, F., Malimbwi, R. E., Chamshama, S. A. O., Abdallah, J. M., Balama, C., 1Pima, N. E., Mugasha, W. A., & Mauya, E. (2018). *Rotation age and Fibre length of Pinus Patula at Sao Hill Forest Plantation, Tanzania*.

Levin, K. A. (2016). *Study design III: Cross-sectional studies*.

Lopez, J. L., Abt, R. C., Dvorak, W. S., Hodge, G. R., & Phillips, R. (2018). Tree breeding model to assess financial performance of pine hybrids and pure species: Deterministic and stochastic approaches for South Africa. *New Forests*, *49*(1), 123–142. https://doi.org/10.1007/s11056-017-9609-1

Lusambo, L. P., Nyanda, S. S., & Mhando, D. G. (2021). Profitability Analysis of Tree Growing in the Southern Highlands of Tanzania. *International Journal of Forestry Research*, *2021*, 1–10. https://doi.org/10.1155/2021/8872211

Malata, H., Ngulube, E. S., & Missanjo, E. (2017). Site Specific Stem Volume Models for *Pinus patula* and *Pinus oocarpa*. *International Journal of Forestry Research*, *2017*, 1–6. https://doi.org/10.1155/2017/3981647

Malkamäki, A., D'Amato, D., Hogarth, N. J., Kanninen, M., Pirard, R., Toppinen, A., & Zhou, W. (2018). A systematic review of the socio-economic impacts of large-scale tree plantations, worldwide. *Global Environmental Change*, *53*, 90–103. https://doi.org/10.1016/j.gloenvcha.2018.09.001

Mann, C. J. (2003). *Observational research methods. Research design II: cohort, cross sectional, and case-control studies*.

Margaretha, F., & Supartika, N. (2016). Factors Affecting Profitability of Small Medium Enterprises (SMEs) Firm Listed in Indonesia Stock Exchange. *Journal of Economics, Business and Management*, *4*(2), 132–137. https://doi.org/10.7763/JOEBM.2016.V4.379

Mathayo, N. J. (2019a). *Production efficiency of small scale tree growers in Mufindi district, Tanzania*.

Mathayo, N. J. (2019b). *Production Efficiency of Small-Scale Tree Growers in Mufindi District, Tanzania*.

Mishra, A. K., Khanal, A. R., & Mohanty, S. (2017). Gender differentials in farming efficiency and profits: The case of rice production in the Philippines. *Land Use Policy*, *63*, 461–469. https://doi.org/10.1016/j.landusepol.2017.01.033

Mugasha, W. A., Chamshama, S. A. O., & Nguyeje, P. C. (2022). *Effects of Thinning on Growth, Yield and Stem Quality of Pinus patula at Sao Hill Forest Plantation, Mufindi District, Tanzania*. Tanzania Journal of Forestry and Nature Conservation,.

Muya, T. W., & Gathogo, G. (2016). *Effect of working capital management on the profitability of manufacturing firms in Nakuru town, Kenya*.

Mwakasungula, K. R. (2020). *Costs and thier financial implication for smallholder tree growres in Mufindi district Tanzania*.

Mwambusi. (2019). *Ilvicultural Treatments of Woodlots of Smallholder Forest Producers and their Relation to the Timber Market in Mufindi District, Tanzania*.

Ndlovu, N., Little, K., Titshall, L., & Rolando, C. A. (2019). Site preparation and vegetation management impacts on *Pinus*

patula growth and rotation end productivity in South Africa. *Australian Forestry*, *82*(2), 107–115. https://doi.org/10.1080/00049158.2019.1605753

Ngaga, Y. M. (2011). *Forest plantations and woodlots in Tanzania*.

Nhem, S., & Lee, Y. J. (2019). Women's participation and the gender perspective in sustainable forestry in Cambodia: Local perceptions and the context of forestry research. *Forest Science and Technology*, *15*(3), 93–110. https://doi.org/10.1080/21580103.2019.1595174

Niresh, J. A., & Velnampy, T. (2014). Firm Size and Profitability: A Study of Listed Manufacturing Firms ed Manufacturing Firms in Sri Lanka. *International Journal of Business and Management*, *9*(4), p57. https://doi.org/10.5539/ijbm.v9n4p57

Obayelu, A. E., Ogbe, A. O., & Edewor, S. E. (2019). Gender gaps and female labour participation in agriculture in Nigeria. *African Journal of Economic and Management Studies*, *11*(2), 285–300. https://doi.org/10.1108/AJEMS-03-2019-0128

Ogbadu, E. E. (2009). *Profitability through effective management of materials*.

Oke, R. A. (2019). *Challenges facing forest production value addition and implication on economic development*.

Ota, L., Lidestav, G., Andersson, E., Page, T., Curnow, J., Nunes, L., Goltiano, H., Gregorio, N., Dos Santos, N. F., & Herbohn, J. (2024). Reviewing gender roles, relations, and perspectives in small-scale and community forestry – implications for policy and practice. *Forest Policy and Economics*, *161*, 103167. https://doi.org/10.1016/j.forpol.2024.103167

Perdue, J. H., Stanturf, J. A., Young, T. M., Huang, X., Dougherty, D., Pigott, M., & Guo, Z. (2017). Profitability potential for Pinus taeda L. (loblolly pine) short-rotation bioenergy plantings in the southern USA. *Forest Policy and Economics*, *83*, 146–155. https://doi.org/10.1016/j.forpol.2017.08.006

Rahman, S. A., Sunderland, T., Roshetko, J. M., & Healey, J. R. (2017). Facilitating smallholder tree farming in fragmented tropical landscapes: Challenges and potentials for sustainable land management. *Journal of Environmental Management*, *198*, 110–121. https://doi.org/10.1016/j.jenvman.2017.04.047

Scudder, M. G., Baynes, J., Applegate, G., & Herbohn, J. (2019a). Addressing small-scale forestry informal markets through forest policy revision: A case study in Papua New Guinea. *Land Use Policy*, *88*, 104109. https://doi.org/10.1016/j.landusepol.2019.104109

Scudder, M. G., Baynes, J., Applegate, G., & Herbohn, J. (2019b). Addressing small-scale forestry informal markets through forest policy revision: A case study in Papua New Guinea. *Land Use Policy*, *88*, 104109. https://doi.org/10.1016/j.landusepol.2019.104109

Sete, Y., Alemu, A., & Dagnew, A. (2023). *Analysis of the Profitability of Smallholder Farmers' Eucalyptus Woodlot Production System in Wogera District, North Gondar, Ethiopia* [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-2399249/v1

Sherman, John E. (2022). *The Understanding and Measurement of Profitability in Multi-Subsidiary Companies*.

Singunda, W. T. (2010). *Economic contribution of private woodlots to the economy of Mufindi District – Tanzania*.

Spector, P. E. (2019). Do Not Cross Me: Optimizing the Use of Cross-Sectional Designs. *J Bus Psychol*.

Stierwald, A. (2010). Determinants of Profitability: An Analysis of Large Australian Firms. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1632749

Stoian, D., Elias, M., & Rodas, A. (2017). *Land, Livelihoods and Gender: Dynamics of Community Forestry in Petén, Guatemala*.

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V., & Shively, G.

(2014a). Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. *World Development*, *64*, S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V., & Shively, G. (2014b). Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. *World Development*, *64*, S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Tulsian, Dr. M. (2014). Profitability Analysis (A comparative study of SAIL & TATA Steel). *IOSR Journal of Economics and Finance*, *3*(2), 19–22. https://doi.org/10.9790/5933-03211922

Tyagi, N., & Das, S. (2017). Gender mainstreaming in forest governance: Analysing 25 years of research and policy in South Asia Partage du rôle des sexes dans la gestion forestière: une analyse de 25 ans de recherche et de politique en Asie du sud Transversalización del género en la gobernanza forestal: análisis de 25 años de investigación y políticas en Asia del Sur. *International Forestry Review*, *19*(2), 234–244. https://doi.org/10.1505/146554817821255132

Wagle, R., Pillay, S., & Wright, W. (2017). Examining Nepalese Forestry Governance from Gender Perspectives. *International Journal of Public Administration*, *40*(3), 205–225. https://doi.org/10.1080/01900692.2015.1091015

CHAPTER THREE

3.0 The Impact and Challenges of Methods Used in Selling Trees on Profitability by Small-Scale Tree Growers in Mufindi District

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Abstract

In the Tanzanian government-owned forests, the selling of trees by volume is a standard practice contributing to efficient resource allocation and management. However small-scale tree growers have chosen to adopt selling standing trees without prior measurement of their volumes. Therefore, this study aimed to investigate the implications of these different selling methods, in terms of economic viability together with challenges facing small-scale tree growers. A cross-sectional research design was used where data was collected through semi-structured interviews and field observations. Purposive sampling was used to select tree growers for different purposes and then random sampling was used to select small-scale tree grower's households for (91 households) data collection. Data analysis involved descriptive statistics and cost-benefit analysis by using Stata software and SPSS. The woodlots assessment included inventory work of measuring tree parameters including diameters at breast height (DbH) and heights. Forest inventory data was analyzed by using yield table models. Results indicated that small-scale tree growers are potentially experiencing a substantial loss in revenue, profit, and gross profit margin due to the selling method used. When small-scale tree growers sell by observational estimation, they can generate TZS 1.9 million per acre at the age of

11 years. In contrast, selling by volume yields an average of TZS 2.7 million per acre at the age of 11 years. Likewise, on the profit, through selling by volume there is a mean increase in profit of TZS 61,155 per acre, and by observational estimation, there is a mean decrease of TZS 42 063 per acre. On the other hand, gross profit margin decreases for both selling by volume and by observational estimation as rotational age increases. For instance, selling by volume at the age of 12 years, GPM is 48.44 and at the age of 13 GPM is 47.17. The key challenges facing small-scale tree growers include fire occurrences, poor marketing conditions or strategies, and low market prices of trees. Small-scale tree growers, with the assistance of the government, can adopt a standardized method of selling trees based on volume which will allow them to maximize profit from their woodlots. Waiting for the rotation age will ensure a good price and diversification of income sources which is crucial as it will reduce the pressure of selling immature stands and accepting low prices. The provision of extension services such as continuous education on best forest plantation management practices, particularly regarding fire safety is essential.

Keywords: Marketing strategies, Woodlot, Volume, Observational estimation, Profit and challenges

3.1 Introduction

Small-scale forestry refers to privately owned forest land, where management goals and motives for production extend beyond timber production. These forests are predominantly owned by individuals like farmers, local entrepreneurs, or investors based in urban areas (Harrison *et al.,* 2002; Lusambo *et al.*, 2021)**.** But Herbohn (2006) states that there is no universal definition of small-scale forest and this term means different levels in different countries. In the Southern highlands, various studies show varying average woodlot sizes. Mwambusi (2019) found 0.8 hectares, Singunda (2010) reported 2.6 hectares, Mwakasungula (2020)) noted 0.2 to 1 hectare, and Arvola *et al*. (2019) found 5.05 hectares. In this study, a small-scale woodlot adopted will be growers owning less than 10 hectares.

Rapid population growth, the decline in natural forests, the decline in timber supply from public forests, low levels of economic development, land shortages, social risks associated with the expansion of large-scale plantations, and climate change pressure have made small-scale tree growing an attractive livelihood or income generating option (Arvola *et al.,* 2019; Kisegu *et al.,* 2019b; Lusambo *et al.,* 2021). The small-scale tree growers market is informal with different actors which are tree growers, wood processors, middlemen, village traders, NGOs, tree growers associations/ groups, and timber depots (Irawanti *et al.,* 2017). Village traders play an important role in connecting small-scale tree growers to commercial markets (Irawanti *et al.,* 2017).

Forest volume estimation is important for effective and sustainable forest management as well as prediction in yield and future markets. It provides a rapid and easy way to estimate the monetary value of trees or forest stands, often referred to as commercial timber stock (De Lima *et al.,* 2021; Kearsley *et al.,* 2017; Gschwantner *et al.,* 2019). In government-owned forest plantations, the selling of trees by volume has been established as a standard practice, facilitating

transparency, accuracy, and fair pricing. This approach ensures a standardized measurement of the resource and therefore contributes to efficient resource allocation and management (Ayoola & Silas, 2023)

Methods employed by small-scale tree growers to sell their trees often differ from those adopted by the government forest plantations, where trees are sold based on the estimated volumes. Small-scale tree growers, driven by practical considerations and possibly limited resources, have often opted for an alternative method, which involves selling standing trees without prior measurement of their volume (Irawanti *et al.,* 2017)

Due to financial hardship and poverty, small-scale tree growers sell standing trees, and the major transaction is done through village traders and middlemen, who dictate the price. Additionally, because of the high discount rate experienced by small-scale tree growers, only those with strong economies manage to wait until the optimal rotation age to harvest the trees (Irawanti *et al.,* 2017; Mwambusi, 2019; Singunda, 2010). Small-scale tree growers sell their produce to sustain themselves and meet various family needs, such as school fees, store-bought goods, ceremonies, health care, home construction, and Christmas celebrations. Among these, paying for school fees is typically the most crucial reason (Irawanti *et al.,* 2017; Scudder *et al.,* 2019a). Small-scale tree growers are often enticed to sell their trees before reaching the optimal rotation age, primarily due to the presence of plywood and veneer industries (Irawanti *et al.,* 2017).

The pricing of trees is determined by assessing the quantity of trees particularly sizable ones that hold market value and subsequently calculating an average price for the entire woodlot (Irawanti *et al.,* 2017; Mwambusi, 2019). The buyer is exclusively remunerating for the larger, marketable trees; the smaller ones are considered supplementary and do not factor significantly into the overall costs.

Saw millers process timber dimensions according to the current market demand or specific orders from clients, who may belong to the manufacturing or construction industries (Scudder *et al.,* 2019a)

In the small-scale forestry sector, the market system is inadequately developed, and small-scale tree growers heavily depend on local and chance interactions within the market. There is a significant deficiency in the flow of market-related information to tree growers, resulting in their disadvantaged negotiation position (Arvola *et al.,* 2019; Irawanti *et al.,* 2017). Harvesting trees before rotation age is common among small-scale tree growers in developing countries including Tanzania (Arvola *et al.,* 2019). This leads to quality problems which might later limit access to the market for small-scale tree growers when the market is likely to become more selective and substitutes may replace (poor quality) timber (Arvola *et al.,* 2019; Mwambusi, 2019)

The lack of a standardized approach to selling standing trees raises concerns about the fairness, accuracy, and long-term sustainability of their practices. The absence of a clear understanding of the implications of these diverse methods, in terms of economic viability hinders the advancement of informed policy decisions and sustainable forest management strategies. Additionally, the challenges faced by small-scale tree growers, such as pricing disparities and market access limitations, remain inadequately addressed.

Addressing this knowledge gap is important as small-scale tree growers constitute a significant share of the forestry sector, and their practices influence the overall supply of timber and quality wood products. Understanding the implications of their selling methods can give valuable insights into far-reaching effects on market dynamics and economic sustainability. This study gives valuable insights into the optimal practices for maximizing profitability and sustainable resource management. Examination of the challenges of

small-scale tree growers can assist policymakers and industry stakeholders in developing targeted interventions to support these growers, enhance market access, and contribute to the overall advancement of the forestry sector. Therefore, this study compares the profitability resulting from two different selling methods between small-scale tree growers and the government sector and examines the challenges facing small-scale tree growers.

3.2 Methodology

3.2.1 Description of the study area

Mufindi district is one of the four districts of the Iringa region. It is bordered to the North by the Kilolo district and Iringa urban district, to the South by the Njombe region, to the East by the Morogoro region, and the West by the Singida region. Mufindi is mountainous, with one of the coolest and rainiest climates in Tanzania. Mufindi district lies between latitudes 8^0 and 9^0 South and between Longitudes 30^0 and 36^0 East (URT, 2019). The district is located at an altitude ranging from 800 to 2200 meters above sea level. The average annual temperature is 17.1^0C, whereby temperatures vary from 13.2^0C in July to the maximum monthly mean of 18.4^0C in November. Rainfall ranges from 950 to 1,600 mm per year and is well distributed. The long rainy season is from November to April and the dry season is from May to October. Among many, the district is known for its tea and timber industries as commercial products (Singunda, 2010).

The district covers an area of 7 122 square kilometers which is equivalent to 712200 hectares. About 64 100 hectares are forest reserves and catchment forests. Plantation forests cover 62 748 hectares, 169 150 hectares are under cultivation, 38 910 hectares are not suitable for anything, and the remaining 376 286 hectares are used as residential, grazing land, open space, and leased land (URT, 2015).

Mufindi district was purposively chosen for this study due to its potentiality in tree growing and as a leading district in woodlot production due to a large number of small-scale tree growers (Mathayo, 2019a; Singunda, 2010). Mufindi district is known for its wood production and there is a presence of many wood-related manufacturing industries like Mufindi paper mills, Sao Hill Industries, Mufindi wood pole plant, and timber, Duville wood works, and over 500 small processing units (Singunda, 2010). Mufindi district has a large forest area both forest reserve and forest plantations. Forest reserve covers approximately 64106 hectares (Singunda, 2010) and total plantation forests cover an area of 207 000 ha in the Southern highland (Lusambo *et al.,* 2021).

The largest plantation in the country Sao Hill is found in the Mufindi district as well as other large commercial private plantations owned by Green Resources Ltd., TANWAT Ltd., Mufindi Paper Mills Ltd., and New Forests Co. Ltd. About 174 000 hectares (54% of the total area) are owned by small and medium-scale tree growers signifying the potential of small-scale tree growers, while TFS owns 100 000 hectares (31%) and 51,000 hectares (15%) owned by large private plantations(Lusambo *et al.,* 2021). In the Mufindi district, forest activities rank as the second economic activity after agriculture (Mathayo, 2019a)

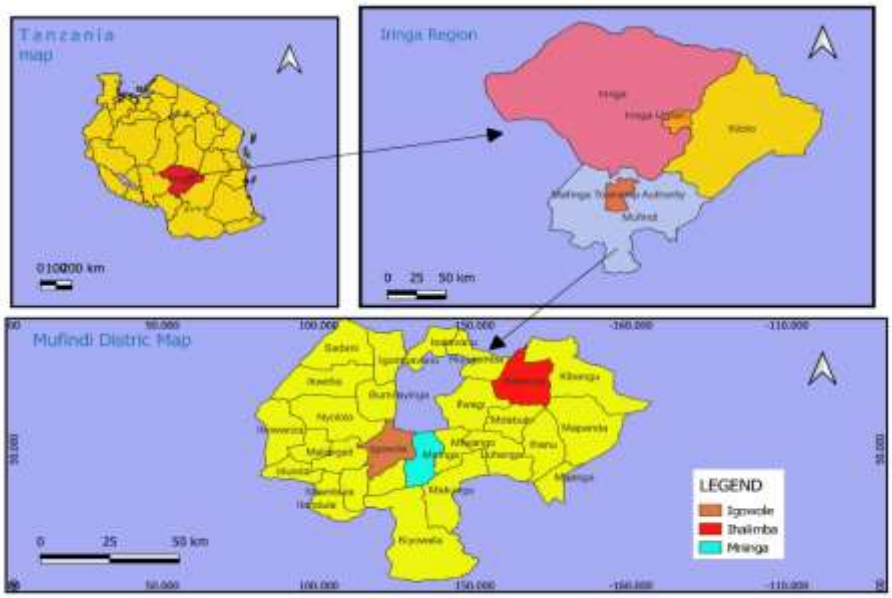

Figure 3.1: Map of the study Sites (Mufindi district and Wards)

3.2.2 Research design

The study was conducted in the Mufindi district where Ihalimba, Mninga, and Igowole wards were selected. The study employed a cross-sectional research design because it allows a researcher to collect the necessary data at one given point in time across a sample population or pre-defined subsets. Cross-sectional research design was also chosen because it is economical in terms of funds and time (Mwakasungula, 2020). Cross-sectional designs can be used to provide a wide range of possible alternative explanations for correlations between variables and can also give evidence for such associations (Levin, 2016; Mann, 2003; Spector, 2019). Cross-sectional research design provides sampling group descriptive statistics that, if the sample cohort is sufficiently representative of a larger population, may be generalizable (Spector, 2019).

To ensure for validity and reliability of data pre testing was done to 20 tree growers prior to the main household survey and then tool for

data collection was modified accordingly to ensure collection of reliable and valid data.

3.2.3 Sampling procedures and sample size

Purposive sampling was used to select small-scale tree growers who plant trees for different purposes and then a simple random sampling technique was used to select households for the survey to ensure that all members of the population had an equal chance of being selected.

The sample size for this study was guided by Bailey (1994) Saunders *et al*. (2007); Mbeyale (2009) and Mtongani *et al.* (2014) who posed that 30 respondents per case is a minimum number recommended to represent a population being studied irrespective of the population size. The targeted population for sampling was households in the study wards. Three wards were sampled out of 30 wards which represent 10% and these wards are Mninga, Igowole, and Ihalimba. Therefore, in each ward, a total of 30 households were randomly selected from 9 different villages which are Ugesa, Vikula, Nundwe, Kihanga, Mkalala, Mninga, Igowole, Pasodzi, and Muhamati. In each village, 10 respondents were sampled making a total of 91 respondents. Therefore, a total of 91 respondents were interviewed using a household questionnaire survey and the researcher's direct observation.

For volume estimation, systematic sampling was then used to establish sample plots. Established plots were square plots with a side length of 20 m making an area of 400 m^2 (0.04ha) and located at the possible center of the woodlot. A total of 53 temporary sample plots were established within 50 woodlots in which tree parameters of Dbh and height were measured and recorded.

3.3 Data collection

3.3.1 Small-scale tree growers' interview

Through small-scale tree growers' interviews, qualitative and quantitative data were collected from small-scale tree growers. Information on the challenge facing small-scale tree growers, revenues, and costs related to tree planting, management, and harvesting were recorded.

Quantitative data were collected by using semi structured interview and the main tool for this data was semi structured questionnaire. Qualitative data was collected by using unstructured interview and the main tool for qualitative data collection was open ended questionnaire.

3.3.2 Woodlots' tree inventories

The forest inventory was conducted on *Pinus patula* woodlots ranging from 6 to 18 years of age. This age range coincides with the period when small-scale tree growers typically harvest their trees**.** The woodlots assessment involved inventory work of measuring tree parameters which are diameters (Dbh) and heights. Dbh of all trees falling within the sample plot was measured by using a caliper and the height of 5 sample trees (smallest, medium, and largest) was measured by using a Suunto hypsometer and these were used to compute the volume of woodlots.

3.4 Data analysis

3.4.1 Volume estimation

Different models and formulas as suggested by the yield tables for Pinus patula for Sao Hill Forest Plantation as developed by Malimbwi (2016) were employed to analyze inventory data for the estimation of the volume of trees in the woodlots. Models adopted from yield tables were models for the estimation of heights for unmeasured trees developed from the Naslund equation and model for volume estimation developed by Huber's formula which is used to estimate the volume of individual trees by using Dbh and height

as independent variables. The calculated tree volumes were further analyzed to estimate the performance within one ha of the woodlot by dividing it by the area of sample plots (0.04 ha). Lastly, all individual data were aggregated by using pivot in Microsoft Excel to define the performance of forest trees in one ha of every woodlot. Results obtained were volume in m^3ha^{-1}. Equation 2 represents models for the estimation of height and volume respectively.

$$\text{Height}=1.3+\frac{Dbh^2}{13.63898+0.026482*Dbh^2} \dots\dots\dots\dots\dots\dots\dots\dots\dots equation\ 1$$

$$\text{Volume} = exp(-9.04925 + 1.14781 * ln(Height) + 1.5496 * ln(Dbh) \dots\dots\dots equation\ 2$$

3.4.2 Small-scale tree growers' interview

Quantitative data from household surveys were analyzed by using STATA and Microsoft Excel software to give inferential statistics for the objective of wood volume estimation. Gross profit margin was used to calculate the economic viability of the two selling methods which are selling by volume and selling at stumpage price. Qualitative data was analyzed by using content analysis for the objective of challenges facing small scale tree growers.

3.5 Results and discussions

3.5.1 Economic viability of small-scale tree grower's methods

Results in Figure 3.2 are showing a comparative analysis of the profitability obtained by selling trees using volume as a unit of measurement as applied by the government sector (price/m^3) for *Pinus patula* and selling by observation estimation. Selling by volume technique is published in the government notice (GN) of 2022. In this analysis, it is assumed that what if small-scale tree growers could be selling trees by measuring volumes. The second method is selling standing trees without measuring volume but rather relying on observational estimation. The graph indicates that both production cost and revenues demonstrate an upward trajectory as the age of trees increases but selling trees based on volume shows more returns than selling without measuring volume.

This method indicates that small-scale tree growers are potentially experiencing a substantial loss in revenue. In essence, the data suggests that these tree growers are not optimizing their revenue potential due to the selling method used. However, according to Indufor (2011), log prices for small-scale tree growers are naturally low due to the absence of value-added tax (VAT) and Logging and Miscellaneous Development Account (LMDA) also trees are sold at younger ages and hence the price comparison with the government is not possible. Price ranges from 5 000 TZS to 9 000 TZS per tree which is very low and small-scale tree growers have limited room for price negotiation. Through value chain analysis, it becomes evident that woodlot owners sell their trees to traders and saw millers, who purchase at an average price of 12 000 TZS per m^3. This equates to approximately 6 000 TZS per tree. This pricing is notably low, implying that growers do not receive a fair return on their investment, especially after dedicating 15 years or more to cultivation (Indufor, 2011).

In developed countries like Australia, small-scale tree growers have adopted the method of selling trees by volume through informal market arrangement between woodlot owners and portable mill owners (Scudder *et al.,* 2019a). About two-thirds of the growers have adopted this method and there are price rates per volume that are set for specific species although there are still transactions by selling in terms of counting the number of trees (Scudder *et al.,* 2019b). This proves that selling trees by volume for small-scale tree growers is more profitable than selling through estimation by observation

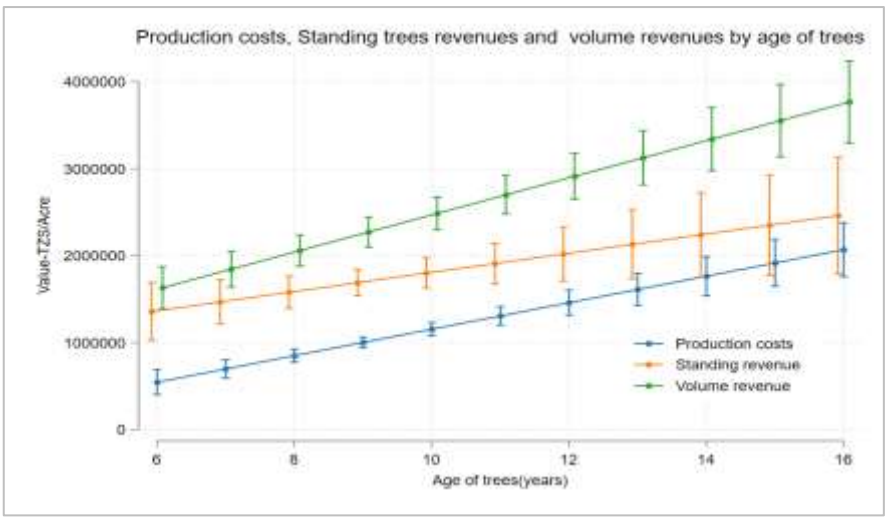

Figure 3.2: Production costs and revenue based on volume and standing trees

3.5.2 Revenue based on standing trees and volume sales

Results in Figure 3.3 reveal a consistent increase in revenue as the trees age, regardless of the method of sale, whether through observational estimation or by measuring volume. However, selling by volume consistently demonstrates higher returns. When a tree grower employs observational estimation, the average revenue is TZS 1.9 million per acre. In contrast, selling by volume yields an average of TZS 2.7 million per acre, marking a notable difference of TZS 788 000 per acre which means those who sell by volume earn 41.4% more than those who sell by observation estimation. This disparity in revenue strongly suggests that small-scale tree growers are potentially losing significant earnings by selling standing trees without measuring their volume. It underscores the critical importance of implementing a precise measurement system, particularly one that accounts for volume, to optimize revenue for these growers. This method holds the promise of substantially improving profitability and sustainability in their operations. However, in their study, Baynes *et al*. (2015) suggested that other factors such as property rights, socio-economic status, and gender-based

inequality, government support, and material benefits to small-scale tree growers can significantly influence the success and sustainability of small-scale tree growers.

The amount of revenue obtained will depend on the age and volume of trees in a particular woodlot. A study conducted at Sao Hill forest plantation from the volume of standing trees and thinnings revealed that *Pinus Patula* aged 5 years generated an average revenue of TZS 216 794/m^3 while at 16 years rotation age generated an average revenue of 1 Million/m^3 *(*Laswai *et al.,* 2018). Revenue also is affected by the price which is guided by demand and supply forces and negotiation (Mwambusi, 2019) lack of accurate information to smallholders on the timber prices in the market weakens their negotiation ability thereby affecting the revenue they obtain (Mwambusi, 2019).

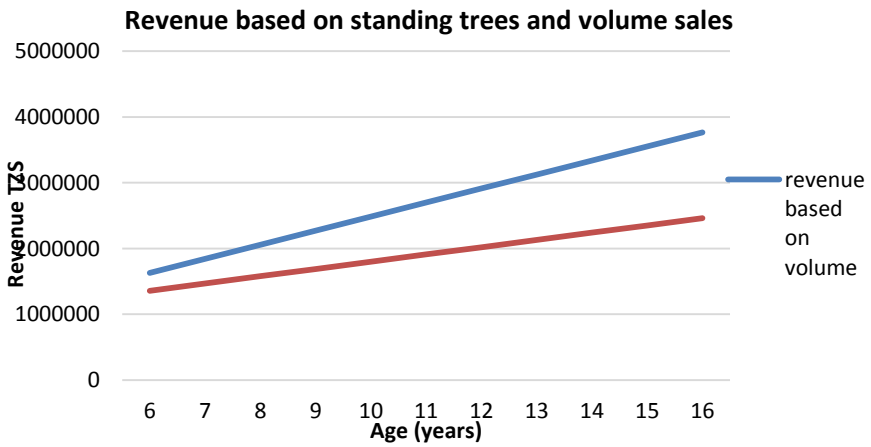

Figure 3.3: Revenue based on standing trees and volume sales

3.5.3 Profit based on standing trees and volume sales

Results in Figure 3.4 show profit based on selling standing trees through observational estimation and by volume. Profit based on selling by volume increases with age while profit based on selling by observational estimation decreases with age. For instance, at the rotation age of 12 years selling by volume generates a profit of TZS

1452 659 per acre and at the rotation age of 13 years, the profit is TZS 1513 814 per acre. While selling by observational estimation generates a profit of TZS 560 504 per acre at the rotation age of 12 years and the rotation age of 13 years the profit is TZS 518 440 per acre. Through selling by volume there is a mean increase in profit of TZS 61 155 per acre and by observational estimation there is a mean decrease of TZS 42063 per acre. This phenomenon is due to the nature of the method employed by small-scale tree growers to sell their trees. Observational estimation does not reflect the accurate growth rates or change in volume as rotation age increases. When growers sell by observational estimation, their pricing is based on subjective judgments rather than actual measurements. Therefore, this method could be less accurate as tree rotation age increases. The estimations the tree growers make might not account for the actual increase in volume with increasing rotation age, leading to lower perceived value and profits. The cumulative effects of consistently undervaluing trees through observational estimation as they age could lead to a compounding decrease in profits over the years, while volume-based selling benefits from the accurate measurement of increased tree volume.

On the other hand, this phenomenon is amplified by increasing costs of production and market insensitivity to quality. The cumulative cost of management like silviculture and protection increases with the age of trees but annual costs decrease by 0.05% (Laswai *et al.,* 2018). The market price is determined by the size (diameter) and not the quality (Arvola *et al.,* 2019; Mwambusi, 2019) which affects the profit generated by tree growers. A grower continues to incur the cost of management and later on, sells the tree based on observation estimation which underestimates the price per tree, offers small revenue, and hence little profit.

A study by Scudder *et al*. (2019a) shows that the comparative analysis between the price paid to small-scale tree growers and their production costs reveals a notable disparity. While at the initial

stages, the prices are relatively low in comparison to the costs incurred, there is a substantial increase in prices as the product moves up the value chain. Unlike tree growers in Mufindi, who are selling their trees by observation estimation, the profits are decreasing with age due to underestimation of price based on subjective judgment.

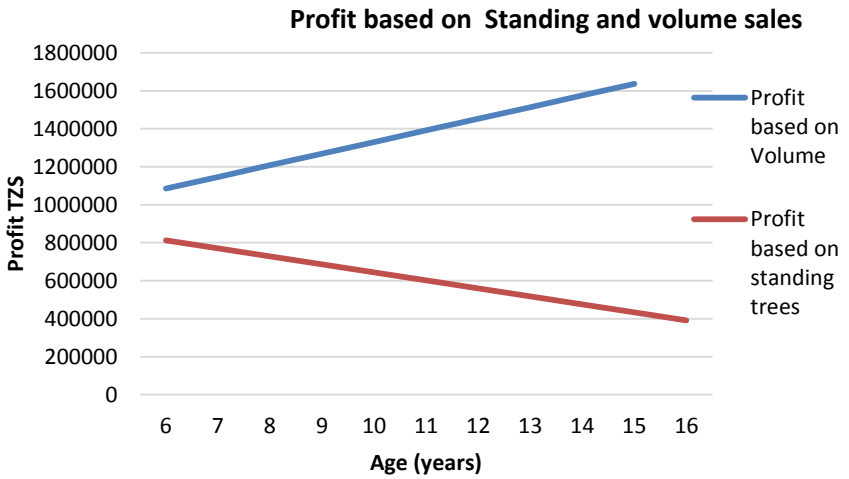

Figure 3.4: Profit based on Standing trees and Volume sales

3.4 Gross Profit Margin Based on Standing Trees and Volume Sales

Results in Figure 3.5 is showing the gross profit margin for sales based on observational estimation and by volume. The gross profit margin is decreasing for both methods. This is due to rising costs of production and low selling prices. Gross profit margin tells how efficient an investment or a company is in generating profits. I n this scenario, it means if the costs of production are not altered both methods will be inefficient in generating profits. The observed phenomenon may be attributed to the compounded costs associated with tree management and immature stands in the woodlots of small-scale tree growers. Small-scale tree growers often sell their trees before they reach the optimal age for harvest. Trees below

rotation age normally have lower volume compared to trees at rotation age resulting in them being sold at prices below what would generate a profitable return. Even when selling by volume, this approach does not lead to efficient profit generation, as immature trees fetch lower prices. Therefore, for these tree growers to generate profit more effectively, they must be patient and wait until the trees reach the optimal rotation age. A study conducted at Sao Hill forest plantation on economic analysis of rotation age, it was revealed that the optimal rotation age for *Pinus patula* is between 15 and 16 years (Laswai *et al.,* 2018). Therefore, it is economically viable and profitable to start harvesting trees at the age of 16 years.

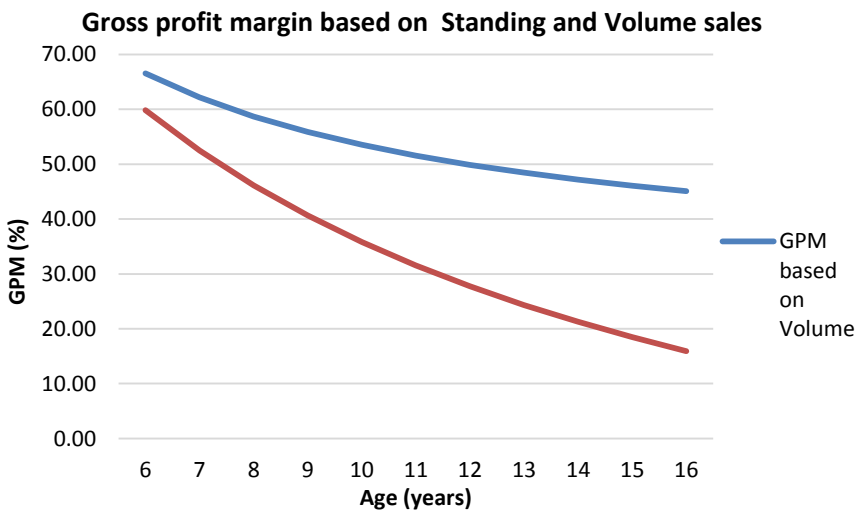

Figure 3.5: Gross profit margin based on standing trees and volume sales

3.5 Challenges Facing Small-scale Tree Growers

3.5.1 Market challenges

Small-scale tree growers seem to be facing several challenges in the tree-planting stage. The key challenge mentioned by growers in the marketing area is the low price offered by middlemen. About 34% of the respondents reported being offered low prices to their

expectations on the value of their investment. Also, 26% reported that the price of trees is determined by middlemen. About 24% reported on the unreliability of the market indicating that there is price fluctuation in the market, and the market price is not consistent. In addition, 14% reported on the inaccessibility to external market.

The low prices offered to small-scale tree growers are attributed to the presence of middlemen who come to the farmer and propose low prices so that they can also make a profit out of the business. Additionally, small-scale tree growers often accept lower prices due to the life challenges they face and low-quality stands due to poor management of woodlots.

These findings are consistent with others (Arvola *et al.,* 2019; Irawanti *et al.,* 2014; Scudder *et al.,* 2019a) who found out that the most common selling plan used by small-scale tree growers is to sell to village traders, middlemen, and saw millers who dictate the price. Moreover, small-scale tree growers are losing significant revenue since they are selling immature stands due to financial stress (Irawanti *et al.,* 2014). The low market price is due to the poor market mechanism, weak bargaining powers, and choice of the selling method where small-scale tree growers sell their timber on a tree basis or by area of land (Arvola *et al.,* 2019; Irawanti *et al.,* 2014). Other studies mentioned that small-scale tree growers have limited capital to add value to their products and inability to access good markets (Irawanti *et al.,* 2017). For instance, in Mufindi, only 2% of the growers can transport and market their products outside the district (Mwambusi, 2019).

3.5.2 Woodlot Establishment Challenges

Results regarding the challenges faced by small-scale tree growers on woodlot establishment indicate that poor quality seedlings (28.7%), inadequate knowledge of tree planting (24.9%), low capital investment (23%), difficulties in obtaining seedlings (14.8%), and

poor soils and climatic conditions (9%) are the key challenges. Small-scale tree growers said that they buy seedlings from nurseries in the villages whereby the seeds planted in these nurseries are randomly collected in the forest from poorly selected stands. This is linked to the fact that small-scale tree growers have limited knowledge of trees that can give the best seeds and hence good quality seedlings and sawn woods. Small-scale tree growers also reported low capital investment as good quality seeds are relatively expensive. In addition, also mentioned management practices narrating that it costs them a lot of money which is why they choose not to observe all the required silvicultural practices. Although the government provides seedlings for planting to small-scale tree growers, not all growers can receive these free seedlings. In studies conducted by Held *et al.* (2017) and Irawanti *et al*. (2014), they also mentioned similar challenges. Farmers reported that they don't have the knowledge of choosing the superior seeds or seedlings and they have a poor understanding of how management practices like silviculture relate to timber quality and product specification in the commercial wood markets. They tend to buy seedlings from locally raised nurseries and poor genetic sources (Mwambusi, 2019). Small-scale tree growers still lack sufficient knowledge about some aspects of tree planting, such as site preparation, spacing, woodlot maintenance, fertilization, as well as pit preparation and filling. Hingi, (2018) reported that small-scale tree growers lack practical knowledge of tree planting space and do not use proper measurement tools. Due to neglecting these essential practices, the performance of their woodlots is adversely affected (Mwambusi, 2019). Moreover, small-scale tree growers have limited capital to purchase inputs such as seeds, polythene bags, fertilizer, and other technical materials for nursery establishment (Mathayo, 2019a; Mwakasungula, 2020).

3.5.3 Management challenges

Regarding management challenges, fire occurrence (72.8%) was among the most problematic issues in the area (Table 3.1). Farmers

reported uncontrolled fire that occurs during the dry season due to farm preparation from September to January. About seven respondents reported that their woodlots were burned completely causing an extreme loss to them in the year 2022. The main source of this fire was farm preparation particularly inadequate precautions during farm preparation, charcoal burning, and carelessness in starting the fire. The severity of this fire is also influenced by the fact that many woodlots are highly stocked and poorly designed and managed. People cram their farms together because they don't want to create large firebreaks, arguing that it reduces space for planting trees. So even if one person decides to create a firebreak, if their neighbors don't do the same, they are still prone to a very high risk for fire.

Fire occurrences is the biggest challenge facing not only small-scale tree growers but also big plantations in Mufindi. Fire causes damage every dry season and much effect is seen in small woodlots and main reason for this fire has been due to uncontrolled fire from farm preparation and charcoal burning (Hingi, 2018; Mathayo, 2019a; Mwakasungula, 2020; Mwambusi, 2019). However, there are strict by-laws imposing fines on those who do not adhere to the regulations for starting fires without a special permit. Permits are issued by the village governments, and when a person is burning the field, they are not allowed to have fewer than five to ten people to help control the fire in case it escapes and spreads into other places. It was observed that there is a very strong cooperation between farmers and the government when it comes to firefighting and suppression. Whenever a fire occurs, everyone is obligated to respond and help fight and suppress it. Besides, the village government conducts educational seminars on fire suppression in collaboration with the management of the Sao Hill Plantation. As a result, one of the villages i.e. Nundwe, reported that they did not experience any fire incidents in the year 2022 because tree growers and other villagers are very responsible and everyone takes responsibility for fire prevention. Nevertheless, the management of

Sao Hill plantations is instrumental in firefighting efforts when a fire occurs and helps to repair and construct some of the roads. This is very positive as among the extension services provided to local communities adjacent to Sao Hill Plantation.

Other challenges included theft of trees (14.6%), diseases (6.8%), and browsing animals (5.8%) (Table 3.1). Some farmers reported that their trees were attacked by fungi, causing the trees to wither, and they did not know how to fight against these disease challenges. Mwambusi (2019) and Irawanti *et al.* (2014) revealed that small-scale tree growers face some issues related to fungal diseases, particularly on younger trees in their woodlots but they have very limited knowledge of pests, insects, and pathogens. Assistance from the Government in cases like these is therefore inevitable.

3.5.4 Challenges in the tree processing industry

It was evident that equipment damage and high maintenance costs (24.6%), poor infrastructure (41%), and high running costs (34.4%) were the main challenges affecting the processing industries (Table 3.1). Processors reported that some woodlots are remotely located with bad landscapes (hills and valleys), so the work of cutting and loading logs becomes difficult, and they incur high costs in paying laborers. The entire process of obtaining wood requires both laborers and machines, all of which require a substantial amount of investment capital. One farmer mentioned that since they buy trees based on estimation without measuring the exact volumes, sometimes when they go to process them, they end up operating just at a break-even point. Another thing that makes the small-scale tree growers' operation costs high is the scarcity of proper wood-cutting machines (technologies). Due to a shortage of proper technologies for cutting wood, they pay an average of 900 shillings per cubic meter cut which is relatively high. Laborers are also costly because they collect and load at TZS 400 to 600 per log. Wood processors who are also traders reported that government tariffs are too high, forcing them to purchase trees from small-scale tree

growers at lower prices to cover all costs including tariffs so that they can also make a profit. Further, there is no reliable market for the sale of timber, and there is no access to the international market to absorb excess supply, resulting in a flooded local market.

These results are consistent with the findings from Irawanti *et al.* (2017) who found that the woodlots of small-scale tree growers exhibit a diverse range of topographical features and are typically located far from roads. As a consequence, traders incur higher transport and hauling expenses. Moreover, woodlots owned by small-scale tree growers are scattered and poorly accessible which imposes costs to processors and these processors are only able to reach these woodlots for processing through mobile ding dong type sawmills which have low recovery rates ranging between 20-35% at the same time producing low quality sawn wood (Held *et al.,* 2017). Small-scale tree growers face limitations in acquiring machinery because these advanced technology machines are expensive and involve high maintenance costs (Singunda, 2010).

Table 3.1: Challenges facing small scale tree growers

Category	Challenges	Frequency	Percentage
Market challenges	Price domination by buyers	55	26.30%
	Unreliable market	52	24.90%
	Low price	72	34.40%
	In-access to external market	30	14.40%
	Total	**209**	**100.00%**
Tree planting challenges	Poor quality seedlings	35	28.70%
	Low capital investment	28	23.00%
	Difficulties in obtaining seedlings	18	14.80%
	Poor soils and climatic conditions	11	9.0%
	Inadequate knowledge of tree planting	30	24.90%
	Total	**152**	**100.00%**
Management challenges	Fire	75	72.80%
	Browsing animals	6	5.80%
	Theft	15	14.60%
	Diseases	7	6.80%
	Total	**103**	**100.00%**
Processing challenges	Equipment damage and high maintenance cost	15	24.60%
	Poor infrastructure	25	41.00%
	high running cost	21	34.40%
	Total	**61**	**100.00%**

3.5.5 Strategies used by small scale tree growers to address various challenges

Despite the challenges faced by small-scale tree growers but they have their own ways of overcoming them. During interview, it was evident that they accept low prices for their trees due to seasonal financial stresses and low quality of their stands and woodlots. One of these tree farmers said:

> "*You find that I have children who need school fees, I have a sick person in the hospital, and my family still depends on me for other needs, so I am forced to sell the trees at a very low price.*"

Among other strategies, respondents revealed that, being a member in the official tree growers' associations seems to assist in reducing the seasonal financial stresses. This is because being in a group it increases the bargaining power. For example, those who are part of the Tree Growers Association (TGA) sell their trees collectively. A member of the UWAMINU group said,

> *"I sell my trees at a good price because we sell together as a group**."***

On the other hand, fire was among the major challenge reported by small-scale tree growers. The main reason mentioned for causing fires is that the woodlots are very densely packed, and the issue is that they are reluctant to establish fire lines because creating fire lines reduces the area available for trees, thereby lowering their profits. One farmer reported that:

> **"***I can decide to establish a fire line to protect my woodlot, but if my neighbors do not do the same, my woodlot will still be at risk of catching fire."*

Therefore, it is important to create awareness on the importance of constructing fire lines to all small scale tree growers. If all tree growers will be aware and comply to the fire management practices, it will be easy to control of fight against this challenge. One farmer from Nundwe Village confirmed this by stating that:

> "*In our village, we did not experience fire challenges last year because we started taking precautions against fire risks and*

> *we educated each other through village meetings on how to prevent and control wild fires."*

Most of the small-scale tree growers do not perform certain silvicultural management practices that directly affect wood volume, quality and profitability. Silvicultural management practices such as thinning and pruning are rarely undertaken by small-scale tree growers due to lack of knowledge about the importance of these practices as well as the market conditions. Since the market does not recognize or value such practices, farmers also does not see the importance of practicing them. One tree grower said:

> *"I do not see any benefit in doing pruning and thinning when the market does not differentiate in price between someone who practices management and someone who did not perform any of those practices".*

3.6 Conclusions

Small-scale tree growers generally make a profit on their investments, but they often do not receive the full benefits they deserve from their investments due to selling standing volumes by observational techniques instead of measuring the actual volume available in the woodlot. As a result of using such a method, often fail to maximize the full potential of what is available in their woodlots. Small-scale tree growers also sell immature trees causing inefficiency and low profitability of the investments made. Like any other profitable business, small-scale tree growers face several interconnected factors affecting the profitability of their investments. Marketing issues, and financial constraints forcing them to harvest trees at lower rotation age which have implications on the wood quality and profitability are among the challenges that need to be addressed to change the livelihoods of the small-sale tree growers. The complex connection between financial stress and selling practices is intensified by the involvement of middlemen and the absence of a standardized selling method. These factors collectively

contribute to lower returns on the investment made by small-scale tree growers. On the other hand, the influence of middlemen who tend to dictate prices, low prices offered by these middlemen, lack of proper standard methods for selling timber, and uncontrolled fire occurrences also contribute substantially to lowering the profit accrued by small-scale tree growers. The financial stress limits value addition in the small-scale tree grower's industry due to the high operation and maintenance costs required in the value addition process.

The Government needs to assist small-scale tree growers to formulate cooperative unions to make them more powerful and capable in price negotiations to increase the profitability of their woodlots hence improving the welfare of the people in Mufindi district. Provision of extension services to small-scale tree growers by the Central and Local Government Authorities and other stakeholders is crucial because of the low financial capacities and capabilities of these small-scale tree growers.

It's challenging for small-scale tree growers to invest in infrastructure development to improve the accessibility of remotely located woodlots. Accessibility to these woodlots will only be made possible if the Government invests heavily in rural road construction to have better road networks which will in turn reduce transportation costs for processors hence increasing profitability to small-scale tree growers. The cooperative unions will also assist small-scale tree growers to diversify the markets by exploring international markets which are thought to have premium prices hence increasing profitability.

REFERENCES

Arvola, A., Malkamäki, A., Penttilä, J., & Toppinen, A. (2019). Mapping the Future Market Potential of Timber from Small-Scale Tree Farmers: Perspectives from the Southern Highlands in Tanzania. *Small-Scale Forestry*, *18*(2), 189–212. https://doi.org/10.1007/s11842-019-09414-8

Ayoola, J. O., & Silas, A. E. (2023). *Height diameter model for selected trees within university of Ibadan, Oyo State, Nigeria*.

Baynes, J., Herbohn, J., Smith, C., Fisher, R., & Bray, D. (2015). Key factors which influence the success of community forestry in developing countries. *Global Environmental Change*, *35*, 226–238. https://doi.org/10.1016/j.gloenvcha.2015.09.011

BOT. (2023). *Monthly Economic Review, May-2023* [Monthly report]. Bank of Tanzania.

De Lima, R. B., Rutishauser, E., Da Silva, J. A. A., Guedes, M. C., Herault, B., De Oliveira, C. P., Da Silva Aparício, P., Sotta, E. D., Da Silva, D. A. S., & Ferreira, R. L. C. (2021). Accurate Estimation of Commercial Volume in Tropical Forests. *Forest Science*, *67*(1), 14–21. https://doi.org/10.1093/forsci/fxaa032

Duguma, L. A., Nzyoka, J., Obwocha, E., Minang, P., Wainaina, P., & Muthee, K. (2022). The forgotten half? Women in the forest management and development discourse in Africa: A review. *Frontiers in Forests and Global Change*, *5*, 948618. https://doi.org/10.3389/ffgc.2022.948618

Elias, M., Hummel, S. S., Basnett, B. S., & Colfer, C. J. P. (2017). Gender Bias Affects Forests Worldwide. *Ethnobiology Letters*, *8*(1). https://doi.org/10.14237/ebl.8.1.2017.834

Follo, G., Lidestav, G., Ludvig, A., Vilkriste, L., Hujala, T., Karppinen, H., Didolot, F., & Mizaraite, D. (2017). Gender in European forest ownership and management: Reflections on women as “New forest owners.” *Scandinavian Journal of Forest Research*, *32*(2), 174–184. https://doi.org/10.1080/02827581.2016.1195866

Frija, A., Chebil, A., Mottaleb, K. A., Mason-D'Croz, D., & Dhehibi, B. (2020). Agricultural growth and sex-disaggregated employment in Africa: Future perspectives under different investment scenarios. *Global Food Security*, *24*, 100353. https://doi.org/10.1016/j.gfs.2020.100353

Fru, F. F., Steenkamp, E. T., Wingfield, M. J., & Roux, J. (2019). High genetic diversity of *Fusarium circinatum* associated with the first outbreak of pitch canker on *Pinus patula* in South Africa. *Southern Forests: A Journal of Forest Science*, *81*(1), 69–78. https://doi.org/10.2989/20702620.2018.1496312

Ghanem, R. (2017). *Handbook of uncertainty quantification*. Springer Berlin Heidelberg.

Gschwantner, T., Alberdi, I., Balázs, A., Bauwens, S., Bender, S., Borota, D., Bosela, M., Bouriaud, O., Cañellas, I., Donis, J., Freudenschuß, A., Hervé, J.-C., Hladnik, D., Jansons, J., Kolozs, L., Korhonen, K. T., Kucera, M., Kulbokas, G., Kuliešis, A., & Zell, J. (2019). Harmonisation of stem volume estimates in European National Forest Inventories. *Annals of Forest Science*, *76*(1), 24. https://doi.org/10.1007/s13595-019-0800-8

Harrison, S., Herbohn, J., & Niskanen, A. (2002). Non-industrial, smallholder, small-scale and family forestry: What's in a name? *Small-Scale Forest Economics, Management and Policy*, *1*(1), 1–11. https://doi.org/10.1007/s11842-002-0001-3

Harrison, Venn, T. J., Sales, R., & Herbohn, J. F. (2005). *Estimated financial performance of exotic and indigenous tree species in smallholder plantations in Leyte Province*.

Held, C., Jacovelli, P., Techel, G., Nutto, L., Wathum, G., & Wittmann, N. (2017). *2017_UNIQUE-Tanzania-Wood-Market-Study_ES (1).pdf*.

Herawati, T., Rohadi, D., Rahmat, M., & Winarno, B. (2019). An exploration of gender equity in household: A case from a peatland-based community in Riau, Indonesia. *Biodiversitas*

Journal of Biological Diversity, *20*(3), 853–861. https://doi.org/10.13057/biodiv/d200332

Herbohn, J. (2006). *Small-scale Forestry – Is it simply a smaller version of Industrial (Large-scale) Multiple Use Foresty?*

Hingi, O. S. (2018). *Organization of Smallholder Tree Growers, Support Organizations, Linkages and Implications for Woodlots Performance The Case of Mufindi District, Tanzania*.

Indufor. (2011). *Timber Market Dynamics in Tanzania and in Key Export Markets*. Ministry of Natural Resources and Tourism, Forestry and Beekeping division.

Irawanti, S., Ginoga, K. L., Prawestisuka, A., & Race, D. (2014). Commercialising Community Forestry in Indonesia: Lessons About the Barriers and Opportunities in Central Java. *Small-Scale Forestry*, *13*(4), 515–526. https://doi.org/10.1007/s11842-014-9268-4

Irawanti, S., Race, D., Stewart, H., Parlinah, N., & Suka, A. P. (2017). Understanding the timber value chain in community-based forestry in Indonesia: Analysis of sengon in central Java. *Journal of Sustainable Forestry*, *36*(8), 847–862. https://doi.org/10.1080/10549811.2017.1381029

Kearsley, E., Moonen, P. C., Hufkens, K., Doetterl, S., Lisingo, J., Boyemba Bosela, F., Boeckx, P., Beeckman, H., & Verbeeck, H. (2017). Model performance of tree height-diameter relationships in the central Congo Basin. *Annals of Forest Science*, *74*(1), 7. https://doi.org/10.1007/s13595-016-0611-0

Kiganda, E. O. (2014). *Effect of Macroeconomic Factors on Commercial Banks Profitability in Kenya: Case of Equity Bank Limited*.

Kiptot, E., & Franzel, S. (2011). *Gender and Agroforestry in Africa: Are women participating*. World Agroforestry Centre (ICRAF). https://doi.org/10.5716/OP16988

Kisegu, D., Kagaha, D., Whitney, C., & Tabuti, J. R. S. (2019a). Contribution of Smallholder Tree Growers to Increasing Tree

Cover in Kaliro District. In Y. Bamutaze, S. Kyamanywa, B. R. Singh, G. Nabanoga, & R. Lal (Eds.), *Agriculture and Ecosystem Resilience in Sub Saharan Africa* (pp. 417–433). Springer International Publishing. https://doi.org/10.1007/978-3-030-12974-3_19

Kisegu, D., Kagaha, D., Whitney, C., & Tabuti, J. R. S. (2019b). Contribution of Smallholder Tree Growers to Increasing Tree Cover in Kaliro District. In Y. Bamutaze, S. Kyamanywa, B. R. Singh, G. Nabanoga, & R. Lal (Eds.), *Agriculture and Ecosystem Resilience in Sub Saharan Africa* (pp. 417–433). Springer International Publishing. https://doi.org/10.1007/978-3-030-12974-3_19

Kongela, S. M. (2020). Gender Equality in Ownership of Agricultural Land in Rural Tanzania: Does Matrilineal Tenure System Matter? *African Journal on Land Policy and Geospatial Sciences*, *Vol 3*, 13-27 Pages. https://doi.org/10.48346/IMIST.PRSM/AJLP-GS.V3I3.21356

Laswai, F., Malimbwi, R. E., Chamshama, S. A. O., Abdallah, J. M., Balama, C., 1Pima, N. E., Mugasha, W. A., & Mauya, E. (2018). *Rotation age and Fibre length of Pinus Patula at Sao Hill Forest Plantation, Tanzania*.

Levin, K. A. (2016). *Study design III: Cross-sectional studies*.

Lopez, J. L., Abt, R. C., Dvorak, W. S., Hodge, G. R., & Phillips, R. (2018). Tree breeding model to assess financial performance of pine hybrids and pure species: Deterministic and stochastic approaches for South Africa. *New Forests*, *49*(1), 123–142. https://doi.org/10.1007/s11056-017-9609-1

Lusambo, L. P., Nyanda, S. S., & Mhando, D. G. (2021). Profitability Analysis of Tree Growing in the Southern Highlands of Tanzania. *International Journal of Forestry Research*, *2021*, 1–10. https://doi.org/10.1155/2021/8872211

Malata, H., Ngulube, E. S., & Missanjo, E. (2017). Site Specific Stem Volume Models for *Pinus patula* and *Pinus oocarpa*. *International Journal of Forestry Research*, *2017*, 1–6. https://doi.org/10.1155/2017/3981647

Malkamäki, A., D'Amato, D., Hogarth, N. J., Kanninen, M., Pirard, R., Toppinen, A., & Zhou, W. (2018). A systematic review of the socio-economic impacts of large-scale tree plantations, worldwide. *Global Environmental Change*, *53*, 90–103. https://doi.org/10.1016/j.gloenvcha.2018.09.001

Mann, C. J. (2003). *Observational research methods. Research design II: cohort, cross sectional, and case-control studies*.

Margaretha, F., & Supartika, N. (2016). Factors Affecting Profitability of Small Medium Enterprises (SMEs) Firm Listed in Indonesia Stock Exchange. *Journal of Economics, Business and Management*, *4*(2), 132–137. https://doi.org/10.7763/JOEBM.2016.V4.379

Mathayo, N. J. (2019a). *Production efficiency of small scale tree growers in Mufindi district, Tanzania*.

Mathayo, N. J. (2019b). *Production Efficiency of Small-Scale Tree Growers in Mufindi District, Tanzania*.

Mishra, A. K., Khanal, A. R., & Mohanty, S. (2017). Gender differentials in farming efficiency and profits: The case of rice production in the Philippines. *Land Use Policy*, *63*, 461–469. https://doi.org/10.1016/j.landusepol.2017.01.033

Mugasha, W. A., Chamshama, S. A. O., & Nguyeje, P. C. (2022). *Effects of Thinning on Growth, Yield and Stem Quality of Pinus patula at Sao Hill Forest Plantation, Mufindi District, Tanzania*. Tanzania Journal of Forestry and Nature Conservation,.

Muya, T. W., & Gathogo, G. (2016). *Effect of working capital management on the profitability of manufacturing firms in nakuru town, kenya*.

Mwakasungula, K. R. (2020). *Costs and thier financial implication for smallholder tree growres in Mufindi district Tanzania*.

Mwambusi. (2019). *Ilvicultural Treatments of Woodlots of Smallholder Forest Producers and their Relation to the Timber Market in Mufindi District, Tanzania*.

Ndlovu, N., Little, K., Titshall, L., & Rolando, C. A. (2019). Site preparation and vegetation management impacts on *Pinus*

patula growth and rotation end productivity in South Africa. *Australian Forestry*, *82*(2), 107–115. https://doi.org/10.1080/ 00049158.2019.1605753

Ngaga, Y. M. (2011). *Forest plantations and woodlots in Tanzania*.

Nhem, S., & Lee, Y. J. (2019). Women's participation and the gender perspective in sustainable forestry in Cambodia: Local perceptions and the context of forestry research. *Forest Science and Technology*, *15*(3), 93–110. https://doi.org/10.1080/21580103.2019.1595174

Niresh, J. A., & Velnampy, T. (2014). Firm Size and Profitability: A Study of Listed Manufacturing Firms ed Manufacturing Firms in Sri Lanka. *International Journal of Business and Management*, *9*(4), p57. https://doi.org/10.5539/ijbm.v9n4p57

Obayelu, A. E., Ogbe, A. O., & Edewor, S. E. (2019). Gender gaps and female labour participation in agriculture in Nigeria. *African Journal of Economic and Management Studies*, *11*(2), 285–300. https://doi.org/10.1108/AJEMS-03-2019-0128

Ogbadu, E. E. (2009). *Profitability through effective management of materials*.

Oke, R. A. (2019). *Challenges facing forest production value addition and implication on economic development*.

Ota, L., Lidestav, G., Andersson, E., Page, T., Curnow, J., Nunes, L., Goltiano, H., Gregorio, N., Dos Santos, N. F., & Herbohn, J. (2024). Reviewing gender roles, relations, and perspectives in small-scale and community forestry – implications for policy and practice. *Forest Policy and Economics*, *161*, 103167. https://doi.org/10.1016/ j.forpol. 2024.103167

Perdue, J. H., Stanturf, J. A., Young, T. M., Huang, X., Dougherty, D., Pigott, M., & Guo, Z. (2017). Profitability potential for Pinus taeda L. (loblolly pine) short-rotation bioenergy plantings in the southern USA. *Forest Policy and Economics*, *83*, 146–155. https://doi.org/10.1016/j.forpol.2017.08.006

Rahman, S. A., Sunderland, T., Roshetko, J. M., & Healey, J. R. (2017). Facilitating smallholder tree farming in fragmented tropical landscapes: Challenges and potentials for sustainable land management. *Journal of Environmental Management*, *198*, 110–121. https://doi.org/10.1016/j.jenvman.2017.04.047

Scudder, M. G., Baynes, J., Applegate, G., & Herbohn, J. (2019a). Addressing small-scale forestry informal markets through forest policy revision: A case study in Papua New Guinea. *Land Use Policy*, *88*, 104109. https://doi.org/10.1016/j.landusepol.2019.104109

Scudder, M. G., Baynes, J., Applegate, G., & Herbohn, J. (2019b). Addressing small-scale forestry informal markets through forest policy revision: A case study in Papua New Guinea. *Land Use Policy*, *88*, 104109. https://doi.org/10.1016/j.landusepol.2019.104109

Sete, Y., Alemu, A., & Dagnew, A. (2023). *Analysis of the Profitability of Smallholder Farmers' Eucalyptus Woodlot Production System in Wogera District, North Gondar, Ethiopia* [Preprint]. In Review. https://doi.org/10.21203/rs.3.rs-2399249/v1

Sherman, John E. (2022). *The Understanding and Measurement of Profitability in Multi-Subsidiary Companies*.

Singunda, W. T. (2010). *Economic contribution of private woodlots to the economy of Mufindi District – Tanzania*.

Spector, P. E. (2019). Do Not Cross Me: Optimizing the Use of Cross-Sectional Designs. *J Bus Psychol*.

Stierwald, A. (2010). Determinants of Profitability: An Analysis of Large Australian Firms. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1632749

Stoian, D., Elias, M., & Rodas, A. (2017). *Land, Livelihoods and Gender: Dynamics of Community Forestry in Petén, Guatemala*.

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V., & Shively, G.

(2014a). Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. *World Development*, *64*, S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Sunderland, T., Achdiawan, R., Angelsen, A., Babigumira, R., Ickowitz, A., Paumgarten, F., Reyes-García, V., & Shively, G. (2014b). Challenging Perceptions about Men, Women, and Forest Product Use: A Global Comparative Study. *World Development*, *64*, S56–S66. https://doi.org/10.1016/j.worlddev.2014.03.003

Tulsian, Dr. M. (2014). Profitability Analysis (A comparative study of SAIL & TATA Steel). *IOSR Journal of Economics and Finance*, *3*(2), 19–22. https://doi.org/10.9790/5933-03211922

Tyagi, N., & Das, S. (2017). Gender mainstreaming in forest governance: Analysing 25 years of research and policy in South Asia Partage du rôle des sexes dans la gestion forestière: une analyse de 25 ans de recherche et de politique en Asie du sud Transversalización del género en la gobernanza forestal: análisis de 25 años de investigación y políticas en Asia del Sur. *International Forestry Review*, *19*(2), 234–244. https://doi.org/10.1505/146554817821255132

Wagle, R., Pillay, S., & Wright, W. (2017). Examining Nepalese Forestry Governance from Gender Perspectives. *International Journal of Public Administration*, *40*(3), 205–225. https://doi.org/10.1080/01900692.2015.1091015

CHAPTER FOUR

4.0 General Discussion, Conclusion and Recommendations

In this section, the key themes and findings of this dissertation are discussed. This section shows the integration of the results from the two research papers focusing on the profitability of small scale tree growers with a gender perspective, wood volume, and challenges facing small scale tree growers. The findings of both research papers contribute to a comprehensive understanding of the wood volume and profitability analysis of woodlots for small-scale tree growers.

4.1 General Discussion

The first paper gives insight on profitability made by small-scale tree growers considering gender perspective and the impact of value addition through processing. Key findings in this paper show that investments in small-scale tree growers are profitable for both growers who sell standing trees and those who process to obtain timber. However, those who process to obtain timber gain twice more per acre than those who sell standing trees. Value addition helps to improve the livelihood of people both in rural and urban areas and it increases the marketability and trade of the products (Oke, 2019). However, forest processing industry faces main challenges which are inadequacy of technological advancement and the design of government policies to promote value addition (Oke, 2019). On the other hand, males are gaining more than females in terms of revenue, profit, selling price per tree, BCR, GPM, and ROI. Findings also show that males own larger woodlots than women and usually harvest larger areas compared to females. This shows a clear disparity between males and females where men have more marketing bargaining power and access to production resources which makes them advantageous in this sector. Literature suggests that women's limited access to land, financial capital, and extension services often constrain their participation in forestry activities and hinder their ability to achieve economic empowerment (Ota *et al.,*

2024; Stoian *et al.,* 2017; Tyagi & Das, 2017; Wagle *et al.,* 2017). The second paper discusses the comparative analysis of profitability obtained by selling trees based on volume measurement versus observational estimation and the challenges that small-scale tree growers face in selling their trees. It emphasizes that selling by volume yields higher returns, indicating potential revenue loss for growers using observational estimation. Likewise, the paper shows the issue of decreasing profits with age for growers selling standing trees due to market insensitivity to quality.

Therefore, both papers highlight the economic viability of small scale tree growers. For instance, paper 2 emphasizes the importance of an accurate measurement system, volume-based selling, in optimizing revenue for small-scale growers. This resonates with Paper 1's focus on profitability analysis by age of trees, highlighting a negative correlation between profitability and selling age due to market insensitivity (Arvola *et al.,* 2019). In other words, trees are sold in a market that is not competitive and lacks an effective mechanism to enforce standard compliance. This observation challenges conventional assumptions and suggests that an emphasis on the quality and market readiness of trees at rotation age might be more crucial than solely focusing on tree age. It calls for a standard shift towards promoting sales at rotation age by emphasizing quality over quantity. Accurate measurement, as emphasized in Paper 2, could potentially mitigate this negative correlation by ensuring fair pricing based on volume.

On the other hand, the second paper discusses challenges in woodlot establishment, management, and marketing. Challenges like low market prices, price domination by middlemen, limited access to external markets, and fire occurrences. These challenges have a cumulative effect on the profitability of small scale tree growers. For instance, low-quality seedlings and poor management practices could contribute to lower yields and quality, hence lower returns for their produce. Despite these challenges, a small-scale

tree growing is found to be successful from a farmer's perspective, and to address these challenges competent government policies are required (Rahman *et al.*, 2017)

4.2 General Conclusion, Recommendation, Limitations of the Study, and Future Directions

4.2.1 General conclusion

The small-scale tree-growing sector is predominantly male dominated with 81% males and females only 19% highlighting a clear gender disparity. However, a gender disparity is observed beyond participation, as men have greater access to resources and decision-making power, leading to unequal opportunities for women. This is evidenced through economic inequality, with males earning more revenue, profits, and profitability indices per acre compared to females. This disparity is attributed to women's limited access to resources, weaker market bargaining power, and competing demands on their time. Furthermore, the profitability analysis demonstrates that investments in tree growing, particularly those involving processing trees into lumber, are generally profitable. The profitability measures, such as ROI, GPM, and BCR, indicate positive outcomes for both growers who sell standing trees and processors. Particularly, those who process trees for lumber exhibit significantly higher revenue, profit, and profitability indices, emphasizing the importance of value addition through processing. Moreover, regardless of small-scale tree growers generally making a profit on their investments, they often do not receive the full benefit they deserve from their investments due to the selling methods they choose to adopt.

The method they use for selling often prevents them from maximizing the full potential of what is available in their woodlot. Due to selling standing trees without measuring volume, small-scale tree growers end up getting less revenue, profits, and gross profit margin compared to if they would have sold by volume. However, selling immature trees has shown an implication in the efficiency of these

investments in generating profit even though they sell by volume, this is seen in the results where gross profit margin is decreasing with age for both selling methods. On the other hand, challenges faced by small-scale tree growers present a network of interconnected factors that significantly impact the profitability of their investments. Market challenges, in particular, exert a direct and pronounced influence on the earnings of these growers. The financial strain experienced by small-scale tree growers forces them to make decisions that directly affect the profitability of their investments by selling their trees below rotation age. This premature selling results in diminished benefits, as the trees are often immature and of poor quality

4.2.2 General recommendations

Based on results and conclusion of this study, it is recommended that:

i. Small-scale tree growers should be advised to wait for their trees to reach the recommended rotation age and adopt a standardized method of selling (selling by volume) with assistance from the government to increase profitability.
ii. Government and other stakeholders should implement training programs and extension services to train tree growers on measuring tree volume. It may be useful to find simple ways which farmers can use to estimate the volume.
iii. Encouraging women to actively participate in forestry activities can contribute to their economic development in vital. This is because, addressing gender disparities within the sector is crucial for fostering equitable and sustainable growth in forestry.
iv. The use of cost-effective processing technologies and improved infrastructure is important for reducing operation costs to processors. This will enhance value addition through processing which can in turn significantly increase the income of small-scale tree growers.

4.2.3 Limitations of the study and Future directions

i. **Sampling Bias:** One potential limitation could be the sampling method used, which might not fully represent the diversity within small-scale tree growers in the Mufindi District. Addressing this limitation might require broader and more diverse sampling techniques.
ii. **Scope and Generalization:** The study's findings might be specific to the context of Mufindi District and might not be fully generalizable to other regions or countries with differing socio-economic and environmental conditions.
iii. **Variable Consideration:** The studies might have omitted certain influential variables that could impact profitability and challenges faced by small-scale tree growers. Future research should consider a wider range of variables for a more comprehensive analysis. Moreover longitudinal studies can be conducted track households' experiences and outcomes over time in order to reduce reliance on memory.

4.2.4 Future directions

i. Future studies can undertake a more comprehensive gender analysis to investigate deeper into the underlying causes of economic disparities between male and female tree growers.
ii. Moreover, comparative studies across different geographical regions can be done to examine how varying contexts influence the profitability and challenges faced by small-scale tree growers.
iii. Given the current technological changes, further studies could be developed to assess how small-scale tree growers should be capacitated technologically in order to add value into their grown trees.

4.2.5 Scientific Contribution

i. **Impact of Value Addition on Profitability and Livelihoods:** This insight demonstrates that value addition through processing can significantly enhance economic returns. It emphasizes the necessity of promoting technological advancements and supportive government policies to facilitate this value addition.

ii. **Gender Disparities in Forestry Sector Profitability:** The papers provide quantitative evidence that males are generally profitable than females. By identifying these gender-based inequities, the research calls for targeted interventions to address these barriers, promoting more inclusive growth and equitable access to resources and opportunities in the forestry sector.

iii. **Importance of Accurate Measurement and Market Quality Standards:** Another significant contribution is the emphasis on the importance of accurate measurement systems and market quality standards in optimizing profitability for small-scale tree growers. This suggests a need for a shift in market practices to prioritize quality over quantity, particularly by promoting sales at rotation age and ensuring fair pricing based on tree volume and quality.

REFERENCES

Arvola, A., Malkamäki, A., Penttilä, J., & Toppinen, A. (2019). Mapping the Future Market Potential of Timber from Small-Scale Tree Farmers: Perspectives from the Southern Highlands in Tanzania. *Small-Scale Forestry*, *18*(2), 189–212. https://doi.org/10.1007/s11842-019-09414-8

Oke, R. A. (2019). *Challenges facing forest production value addition and implication on economic development*.

Ota, L., Lidestav, G., Andersson, E., Page, T., Curnow, J., Nunes, L., Goltiano, H., Gregorio, N., Dos Santos, N. F., & Herbohn, J. (2024). Reviewing gender roles, relations, and perspectives in small-scale and community forestry – implications for policy and practice. *Forest Policy and Economics*, *161*, 103167. https://doi.org/10.1016/j.forpol.2024.103167

Rahman, S. A., Sunderland, T., Roshetko, J. M., & Healey, J. R. (2017). Facilitating smallholder tree farming in fragmented tropical landscapes: Challenges and potentials for sustainable land management. *Journal of Environmental Management*, *198*, 110–121. https://doi.org/10.1016/j.jenvman.2017.04.047

Stoian, D., Elias, M., & Rodas, A. (2017). *Land, Livelihoods and Gender: Dynamics of Community Forestry in Petén, Guatemala*.

Tyagi, N., & Das, S. (2017). Gender mainstreaming in forest governance: Analysing 25 years of research and policy in South Asia. *International Forestry Review*, *19*(2), 234–244. https://doi.org/10.1505/146554817821255132

Wagle, R., Pillay, S., & Wright, W. (2017). Examining Nepalese Forestry Governance from Gender Perspectives. *International Journal of Public Administration*, *40*(3), 205–225. https://doi.org/10.1080/01900692.2015.1091015

APPENDICES

Appendix 1: Questionnaire

My name is Irene Emmanuel Palangyo. I am a postgraduate student at the Sokoine University of Agriculture pursuing an MSc in environmental and natural resources economics. Currently, I am carrying out my research on Wood volume and profitability analysis of woodlots by small scale tree growers in Mufindi district. Your contribution and opinions to this research are of great importance so please help me by answering the following questions. All the information provided will be treated with confidentiality and used for this research only.

Name of interviewer ……
Date of interview……..
District……..……
Ward……....
Village…….……..

A) Background Information

1) Respondent's Names……..……..
(2) Sex (1) Male (2) Female ……..
3) Marital status (1) Married (2) single (3) Widowed……
4) Age…….. (1) 18-38 (2) 39-59 (3) Above 60
(5) Education level 1) No formal education 2) Primary 3) Secondary 4) Higher education……..
6) Household size ……
7) How long have you been growing trees? 1) 0-10 2)10-20 3) 20-30 4)30-40 5) Above 40
8) Which species do you grow on your farm? 1)……
2) ……3)……
9) Are you a member of any TGA, If yes which one.....

10) What do you consider as your main type of farm production? a. Wood production
b. Mixed production (wood plus other crop) Crop name……..

B) Section B: Establishment and management costs/ Input costs

11. Do you own land? A. Yes B. No
12. Acquisition mode of the cultivated land a. Family b. heritance c. Government c. Association d. Bought/private
13. How many plots do you have?
.....
14. Their total size in ……..ha
15. How many plots are dedicated to wood production?
.....
16. What is the area under wood production?
.....ha
17. If you do not own land what is the rent cost……..and Size…….?
18. If you could sell your land how much could it be per acre?
…….
19. Which tree species do you plant and what size is the area planted?
i. Pine …… ii. Eucalyptus……
iii. Teak…… IV. Other……..
20. How old are your tree stand(s)
……
21. How do you obtain tree seedlings? 1) From government 2) Private organizations 3) Buying
22. If you buy seedlings, how much does it cost per seedling for different species (Shs/seedling), and how much do you use to transport these seedlings?
Capital costs

SN	Item/operation	Cost per unit	Total cost
1	Equipment used in production		
2	Land		
3	Seedlings		
4	Fertilizers		
5	Insecticides		
6	Water charges		
7	Other		
TOTAL			

Labor establishment cost

SN	Item/operation	Family labor					Hired labor				
		Number of people					Number of people				
		Hrs/day	Male	Female	Child	No of days	Hrs/day	male	female	Child	No of days
1	Land Clearing										
2	nursery preparation										
3	Pitting and planting										
4	Weeding										
5	Transplanting /planting										
6	Transportation										
	TOTAL										

Labor management cost

SN	Item/operation	Family labor					Hired labor				
		Number of people					Number of people				
		Hrs/day	Male	Female	Child	No of days	Hrs/day	male	female	Child	No of days
1	Beating up										
2	Weeding										
3	Pruning										
4	Thinning										
5	Forest patrols										
6	Herbicides										
6	Fire protection										
	TOTAL										

C. OUTPUT COSTS AND INCOME FROM OTHER SOURCES

23) How long does it take for you to start harvesting your trees? …….

24) Do/did you sell trees produced on your farm a) Yes ( ) b) No ( )

25) At what ages do you sell/ did you sell your trees for each species?

26) Do you sell/sold standing trees or do you process trees to obtain timber?

27) If you sell/sold standing trees how much do/did you get per acre (Shs/tree)?

28) If you process trees to get timber how much do/did you sell for one piece of timber for each species?

29) With this size of farm and the input incurred what amount of produce are you expecting? ……

30) Do/did you sell your trees for timber, poles, or plywood production?

31) At what price do/did you sell for each category?

32) What else do/did you sell apart from timber 1) firewood 2) Thinnings 3) Sawdust 4) Slabs

33) Who and what determines the price of the timber/products? ……..…… ……

ii. What is your opinion on the price compared to the effort time and resources you have invested?
a). Loss [ ] b). Fair [ ] c). Profitable [ ]

34. Do you see the benefits of woodlots after harvest? If „Yes" state which? a). Yes [ ] Which: ……
b). No [ ] Reason: ……

Season	Harvested area	Quantity harvested m3	Quantity sold	Price/unit shs	Point of sale	Cost of sale(tax transport) TSHS
Last year						
This year						

35) What are the costs associated with processing to obtain timber? 1) Chainsaw operator 2) maintenance costs (vehicle and chainsaw) 3) casual laborer 4) Time used in harvesting

36) What are transportation costs from the harvesting area to the marketplace/sawmill?

OTHER INCOME SOURCES

Income from non-wood production

Non-wood crop product type sold	**Average Quantity produced**	**Average Quantity sold**	**Price per unit**	**Total revenue generated**
a. Maize				
b. Wheat				
c. Paddy				
d. Sorghum				

Income from livestock

Livestock type	**Number sold**	**Price per unit**	**Amount of revenue**
Cattle			
Goats			
Sheep			
Poultry			
Other livestock			
Total revenue from livestock sales			

Income from other sources as business enterprises performed by the farmer (e.g. Employment, Pettit Trade, brewing, food vending, Kiosk, bar, etc)

undertaking other business undertakings that the farmer performs and earn income (at least one)	**Revenue Amount generated per month/year**	**Total annual revenue**
1.		
2.		
3.		
4.		
5.		
6.		

D) Challenges facing small scale tree growers

37) What challenges are associated with tree planting including means of obtaining seeds/seedlings?

……
……
……

38) What are the challenges associated with management practices like fire protection, weeding, thinning, and pruning?

……
……
……

39) What are the challenges associated with harvesting and processing to obtain timber?

……
……
……

40) What are the challenges associated with the selling of timber/standing trees (Market-based challenges)?

…….....
……..

41) Which challenge(s) is more prevailing in the above-mentioned categories (tree planting, management practices, and harvesting/processing?)?
……..
……
42) What do you think causes all these challenges to occur?
……..
43) Are there existing strategies that you use towards alleviating these challenges on your own? If Yes, What are they?
……
……
44) In your opinion what strategies can be adopted to solve these challenges?
……
……..
45) Do you think the government is making a contribution towards the challenges faced by small scale tree growers? 1)YES 2)NO

Resource assessment data in temporary sample plots.

Village…… Inventory date: ……
Surveyor Name: ……
Woodlot Number: …… Plot Number: ……
Plot Coordinates: ……
Plot area: …… Woodlots age: ……
spacing: ……

Tree no	Species	Tree dbh (cm)	Tree height (m)
1			
2			
3			
4			
5			
6			
7			
8			

Appendix 2: A table showing economic indicators by ward

Variable	Ihalimba			Igowole			Mninga			Total		
	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median	Mean	SD	Median
Land cost	381,250.00	119,643.30	350,000.00	492,500.00	123,487.10	500,000.00	488,888.90	112,944.30	500,000.00	450,459.80	128,939.40	450,000.00
Pine area	5.26	5.61	3.50	3.03	2.95	2.00	6.57	8.38	4.00	4.95	6.17	3.00
Selling_age	9.81	2.50	9.00	9.71	2.16	10.00	10.14	2.38	10.00	9.89	2.33	10.00
harvested_area	1.70	1.04	1.50	1.84	1.32	1.25	1.29	1.28	1.00	1.61	1.22	1.00
total costs	1,302,705	541,390	1,278,294	1,125,089	398,440	1,140,263	966,187	467,139	906,450	1,137,237	489,940	1,037,704
Revenue	1,874,872	784,057	1,800,000	1,602,899	672,787	1,500,000	1,842,564	818,145	1,800,000	1,780,267	763,332	1,799,999
Profit	564,061	832,517	557,480	538,883	600,834	484,255	852,234	570,199	913,919	656,240	687,079	713,425
ROI	64.21	88.46	47.85	56.25	64.55	49.82	103.82	76.11	98.98	75.50	79.25	68.27
GPM	17.80	50.94	32.36	24.64	31.03	33.25	40.01	39.15	49.74	27.60	42.09	40.57
BCR	1.64	0.88	1.48	1.56	0.65	1.50	2.04	0.76	1.99	1.75	0.79	1.68
Selling price	4,802.60	1,886.38	4,500.00	3,889.02	1,528.51	4,000.00	4,416.32	2,045.75	4,045.46	4,388.52	1,857.07	4,090.91

Appendix 3: Data collection permit

JAMHURI YA MUUNGANO WA TANZANIA

OFISI YA RAIS
TAWALA ZA MIKOA NA SERIKALI ZA MITAA

Anuani ya Simu "TAMISEMI" DODOMA
Simu Na: +255 26 2321607
Nukushi: +255 26 2322116
Barua pepe:ps@tamisemi.go.tz

Mji wa Serikali – Mtumba,
Mtaa wa TAMISEMI,
S.L.P. 1923,
41185 DODOMA.

Unapojibu tafadhali taja:-

Kumb. Na. AB.307/323/01/197

20 Januari, 2023

Katibu Tawala wa Mkoa,
Ofisi ya Mkuu wa Mkoa,
S.L.P 858,
IRINGA.

Yah: **KIBALI CHA KUFANYA UTAFITI KUHUSU WOOD VOLUME AND PROFITABILITY ANALYSIS OF WOODLOTS BY SMALL SCALE TREE GROWERS IN MUFINDI DISTRICT**

Tafadhali rejea somo tajwa hapo juu.

2. Ofisi ya Rais –TAMISEMI imetoa kibali kwa **Bi. Irene Emmanuel Palangyo, Mwanafunzi** kutoka Chuo Kikuu cha Kilimo Sokoine (SUA) kwa ajili ya kufanya utafiti tajwa katika Halmashauri ya Wilaya ya Mufindi.

3. Muda wa kufanya utafiti huu ni kati ya mwezi Novemba, 2022 na mwezi Machi, 2023. Ofisi ya Rais -TAMISEMI kwa kushirikiana na Taasisi nyingine za Serikali itafanya ukaguzi wakati wowote kujiridhisha na utekelezaji sahihi wa kibali hiki. Takwimu zitakazokusanywa kutokana na utafiti huu ni kwa ajili ya matumizi ya ndani tu na iwapo zitatakiwa kuchapishwa na kusambazwa kibali kutoka Mamlaka husika kitapaswa kuombwa.

4. Kwa barua hii, tafadhali muelekeze Mkurugenzi wa Halmashauri tajwa ili kutoa ushirikiano utakaohitajika na kukamilisha utafiti huu kama uilivyokusudiwa. Kazi hii isimamiwe na Mtakwimu wa Mkoa na Halmashauri husika na kutoa taarifa ya utekelezaji.

Ninakushukuru kwa ushirikiano wako.

Prof. Riziki S. Shemdoe
KATIBU MKUU

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MOROGORO. *(Nakala ya taarifa ya utafiti iwasilishwe Ofisi ya Rais - TAMISEMI na Ofisi husika ya Mkuu wa Mkoa na Halmashauri. Kibali kinaweza kufutwa muda wowote endapo kutakuwa na ukiukwaji wowote au sababu nyingine yoyote)*

JAMHURI YA MUUNGANO WA TANZANIA

OFISI YA RAIS
TAWALA ZA MIKOA NA SERIKALI ZA MITAA

Anuani ya Simu "TAMISEMI" DODOMA
Simu Na: +255 26 2321607
Nukushi: +255 26 2322116
Barua pepe:
Unapojibu tafadhali taja:-

Mji wa Serikali – Mtumba,
Mtaa wa TAMISEMI,
S.L.P. 1923,
41185 DODOMA.

Kumb. Na. AB/307/323/01/33 **19 Januari, 2023**

Katibu Tawala wa Mkoa,
Ofisi ya Mkuu wa Mkoa,
S.L.P. 858,
IRINGA.

Yah: KIBALI CHA KUFANYA UTAFITI

Tafadhali husika na somo tajwa hapo juu.

2. Ofisi ya Rais -TAMISEMI, imepokea barua yenye Kumb.Na. SUA/ADM/R.1/8/28 ya tarehe 09/11/2022 kutoka Chuo Kikuu cha Kilimo Sokoine kuhusu somo tajwa.

3. Barua hiyo imeeleza kuwa Ndugu Irene Emmanuel Palangyo, mwanafunzi wa Shahada ya Uzamili (*Enviromental and Natural Resources Economics*) mwenye Namba ya Udahili MEN/D/2021/0046 ameruhusiwa kufanya utafiti. Utafiti huo unahusu "*Wood volume and profitability analysis of woodlots by small scale tree growers*" katika Wilaya ya Mufindi kuanzia Januari hadi Machi, 2023.

4. Kwa barua hii, tafadhali mwelekeze Mkurugenzi wa Halmashauri ya Wilaya ya Mufindi atoe ushirikiano utakaohitajika ili kufanikisha utafiti huo.

5. Ninashukuru kwa ushirikiano wako.

Rogasian Lukoa
Kny: **KATIBU MKUU**

Nakala: Makamu Mkuu wa Chuo,
Chuo Kikuu cha Kilimo Sokoine,
S.L.P.3000,Chuo Kikuu
MOROGORO