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Original Article

Assessment of the Sustainability of Forest Certification in Village Land Forest Reserves in Southern Tanzania

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Forest Certification, Community-Based Forest Management, Sustainability, Tanzania.

ABSTRACT

Certification aims to improve the environmental, economic, and governance by ensuring market access for certified forest products, improving control of logging operations, reducing illegal harvesting, and increasing the transfer of funds to forest management, which consequently ensures sustainability. This study conducted an assessment in selected Village Land Forest Reserves (VLFR) in Pwani, Lindi, and Ruvuma regions in southern Tanzania to examine the sustainability of the Forest Certification Scheme (FSC). Data were collected through a review of reports, management plans, and harvesting plans. Other methods included household surveys, key informant interviews, and focus group discussions. Qualitative data were analyzed using content analysis, while quantitative data were analyzed descriptively and using NPV and sensitivity to estimate the economic profitability and viability of certified VLFR. Results indicate that the certification scheme has enhanced the management practices of VLFRs and some revenue generation. Even though harvesting in the forests in all the villages was far below allowable cut, the sustainability of the certification scheme was found to be questionable in terms of the costs of management, since, without the support of other stakeholders at present could not work out. We concluded that FSC certification under CBFM can only be sustainable if there is an increase in the harvesting levels by 100% and effective marketing strategies of the products from certified forests, which fetch a good competitive price to offset the forest management and the costs for implementing the FSC certification protocols.

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INTRODUCTION

Tanzania stands a good chance to benefit from Forest Stewardship Council (FSC) certification schemes due to its vast land dedicated to forest conservation compared to many African countries. As of 2021, about 48.1 million (mil) hectares (ha), which is equivalent to 55% of the total surface land area of Tanzania's mainland, was covered by forests (URT, 2021). Of the total forest land, 44.7 million hectares (93%) are woodlands, and the remaining 3.4 million hectares (7%) are catchment forests, mangroves, coastal forests, and forest plantations. In terms of management regimes, 21.97 million hectares (45.7%) are managed under Village Governments, 16.6 million hectares (34.5%) by the Central Government, 3.10 million hectares (6.5%) by Local Government Authorities, and 3.50 million hectares (7.3%) are under the private sector. The total area under Participatory Forest Management arrangement in Tanzania is 5.1 million ha, while Community-based forest management areas with Village land Forest reserves cover about 2.2 million ha (URT, 2022). Thus, a large percentage of the forest resources in Tanzania lie within the communities, and therefore it is imperative that conservation efforts be strengthened towards supporting villages in the management of the forest resources. A recent Participatory Forest Management (PFM) Facts and Figures of 2022, shows that already 752 forests "Village Land Forest Reserves (VLFR)" have been registered under Community Based Forests Management (CBFM), with a total area cover of about 2.7 million ha in 1,225 villages across the country (URT, 2022). Of these, 15 VLFR obtained FSC group certification, and all these forests are located in the southern part of the country, specifically in Lindi and Ruvuma regions (Charnley *et al.,* 2022). The southern part of the country has a relatively higher contribution in terms of the size of forests under CBFM in Tanzania.

The establishment of CBFM and, consequently, certification is growing in the tropics (Burivalova *et al*., 2017), mostly under substantial support from external donors (Molnar, 2004). In Tanzania, VLFRs certification has been supported by the Mpingo Conservation Development Initiative (MCDI), a conservation NGO that aims to advance forest conservation and community development by facilitating sustainable and socially equitable utilization of forest resources. Under the coordination of MCDI, the communities have since 2012 continued to implement FSC standards to reduce illegal harvesting pressure, to enhance management of the resources and sustainable harvesting through selective logging or timber production, and from the benefits accrued create alternative livelihoods, including investment in different business ventures and community services (URT, 2015).

This paper echoes the concept of environmental sustainability by development and resources utilization theory informed by several authors including Thomas Mathus et al. 1989; Hicks 1946, Ruttan, 1991; Goodland, 1995; Basiago, 1999 and the influential report by Brutland (1980) our common future. To address sustainability in the case of the CBFM it is important to examine the achievement of the PFM goals and objectives, which include improved forest resource condition, improved livelihood in terms of income and well-being, and improved resource governance. Likewise, in terms of resource governance, forest certification protocols strive to improve the forest condition and resource standards concerning conservation and sustainable management efforts and investment. Then it is expected that community livelihood will consequently improve with improvement in the forest condition, as it will

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be possible to pay for forest management costs. In general, economic sustainability implies a system of production that satisfies the present consumption levels without compromising future needs. Forest resource sustainability has a linkage to social sustainability, where the community strives to improve their livelihood and well-being while relying on natural resource exploitation (in this case, forest resources) for poverty reduction. On the other hand, environmental sustainability theory refers to the maintenance of the natural capital (the forest resources) as a provider of both sources (inputs) and sinks (outputs) whereby the harvest rates must be kept within the regeneration rates.

The benefits of forest certification do not come cost-free, as certification adds some costs and the standard requirements can lead to forgo some opportunities for forest owners. Of particular concern have been management costs and limited market share, resulting in reduced efforts to certify more forests. Because of poverty, a community's decision to certify the forest will only become attractive if the benefits outweigh the costs (Scudder *et al*., 2018), unless somebody else is paying the cost (Rametsteiner, & Simula, 2003). The costs may also increase with increasing requirements as a signal for decreasing investment in the sector. There is thus a risk that the certification instrument may become an obstacle for the promotion of forest-based products, as similar demands for environmental performance are not put on substitutes. The substitute here may be a non-wood product, but can also be wood products in a non-certified forest, where deforestation is likely to be redirected, causing a "leakage effect", and thus leading to absolute or overall limited impact of sustainable forest management efforts (Yamamoto, & Matsumoto, 2022). Moreover, forest certification is a market tool and is thus driven by market forces, including specified demand for certified forest products by consumers (Fujiwara *et al*., 2015). Thus, global market risks and uncertainty, limited experience and market-negotiation capacity of the forest owners, and tiny access or exposure to the market may risk the economic viability of the FSC for community-based forest management initiatives.

Kalonga *et al.* (2016) and Kalonga, & Kulindwa (2017) are the first scholars to ascertain the impact of forest certifications on forest conservation and livelihoods in our study sites, respectively. These studies found a positive relationship between forest certification and forest conservation for certified forests compared to non-certified forests. Accordingly, households in the villages with certified forests appeared to earn significant income from the forest compared to households in villages with non-certified forests. These two studies, however, did not look at the sustainability of certification intervention and partly what was addressed by Yamamoto, & Matsumoto (2022) as the leakage effect of certification. Charnley *et al*. (2022) identified and examined the roles of actors that support forest certifications in Tanzania, along with two other tropical countries of Brazil and Mexico. We are aware of the two studies (Frey *et al*., 2021;2022) which were conducted in southeastern Tanzania and appeared to be closely similar to ours. While the former assessed the economic viability of 14 certified VLFR forests, using the dataset from 2013/2014 to 2017/2018, the latter explored the monetary and non-monetary social costs and benefits of FSC. Here we are complementing these two previous studies by adding a larger dataset of two years from 2019/2020 and discussing sustainability in its holistic form by considering the environmental, economic, and governance domains simultaneously. We argue that a separate discussion may not be informative enough to judge sustainability, since all three aspects are intertwined. An economically viable scheme can likely motivate environmental sustainability, but also be contrary if communities are driven by rational motives rather than pro-conservation behaviour, and when the governance structure is weak in integrating economic and environmental sustainability. There is also a possibility that the original governance system set by CBFM was distorted by the introduction of the forest certification system thereby resulting in governance confusion and ultimately forest

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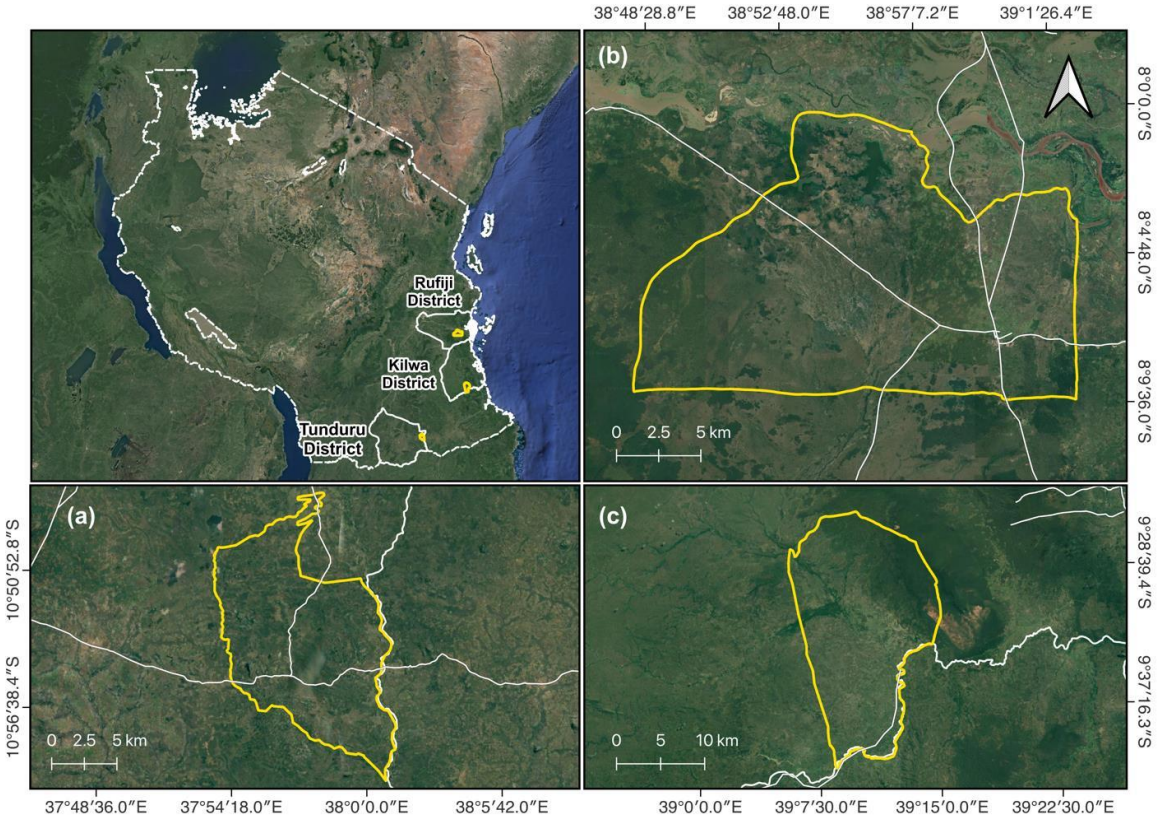
destruction. Therefore, we are specifically interested in responding to three sustainability questions based on forest resource utilizations, economic viability, and forest governance feasibility. Therefore, the specific objectives for the study were to assess the environmental/forest sustainability of the certified VLFRs, to estimate the economic sustainability of the certified VLFRs, and finally to examine the forest governance of the VLFRs under the certification scheme.

METHODOLOGY

Study Area

The study was conducted in southeastern Tanzania. The area is characterized by strong rainy/dry seasons, frequent fires, charismatic wildlife, and several high-value tropical hardwood species, including East African blackwood (Dalbergia melanoxylon, ‘‘mpingo” in Swahili), bloodwood (*Pterocarpus spp.*, ‘‘mninga”), pod mahogany (*Afzelia quanzensis*, ‘‘mkongo”), and a few other commercial species. Mpingo, in particular, is one of the highest-value timbers per cubic meter (m^3) in the world and is prized for its black heartwood that is used for woodwind instruments (e.g., clarinets, oboes, and bagpipes), fine arts, and other specialized purposes. This study was carried out in three districts, namely Rufiji (Pwani Region), Kilwa (Lindi Region) and Tunduru (Ruvuma Region) in villages with Community-Based Forest Management (CBFM) forests supported by MCDI and other partners. Figure 1 is the map of the study areas.

Figure 1: Study Area Map Showing (a) Sauti Moja, (b) Nyamwage, and (c) Nanjilinji A Villages Selected from Tunduru, Rufiji, and Kilwa Districts Respectively



Sampling and Sample Size

We collected our data in three out of 15 villages with the VLFRs in the study districts. Selection of these villages and subsequent VLFRs were purposive, using three criteria: the diversity of the economic activities in the village, the age of the CBFM forest, and forest size. In this regard, the village with more diverse economic activities, long experience in CBFM (with all necessary documents such as management plans, harvesting

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and reports, bylaws plans, and other reports), and relatively large CBFM forest size was most preferred and sampled. We adopted the minimum sample size of at least 30 households from each village for the household survey. The number and names of villages, VLFRs, and the number of households selected and corresponding sample size are presented in Table 1.

Table 1: Sampled Villages, VLFRs and Households in the Study Area

Variable	Rufiji District	Kilwa District	Tunduru District
Village selection			
Number of wards with VLFRs	3	6	6
Randomly selected ward	1	1	1
Number of villages in selected ward	3	3	2
Selected villages	Nyamwage	Nanjilinji A	Sauti moja
Certified VLFRs selection			
Number of VLFRs (Total)	5	15	7
Number of Certified VLFRs	1	5	2
Number of Non-Certified VLFRs	4	10	5
Selected Certified VLFRs	**Nyankongo**	**Mbumbila A and Mbumbila B**	**Chihuluka**
Household selection			
Total households in selected village	267	230	323
Selected households	31	31	31

Data Collection

We used both quantitative and qualitative methods for data collection and analysis. The data were obtained from document review, socioeconomic survey for sampled households, key informants' interviews, and focus group discussions. We started by reviewing various project documents, including the forest management plan, forest harvesting plans, forest patrol report, VLFRs financial/accounts reports, FSC Group Certification Scheme technical reports, and evaluation. These documents were obtained from different sources, including WWF, MCDI, the respective Villages and District offices. Other information was collated from published reports and articles. Relevant information collated included forest size, harvested volumes of timber, forest stock, established forest-based enterprises, and costs and revenues of forest conservation.

The household survey involved a representative of a household (mostly the head or spouse). Households were identified randomly from the village register, and a representative of the household was notified by the respective village leader a day before the interview. The survey took place in the respondents' houses and few cases in the village office. The survey aimed to elicit socio-economic and demographic characteristics of the household, costs and benefits derived from forest certification, awareness and perception about the certification scheme, and their participation in forest conservation. The household survey was supplemented by Key informant interviews and Focus Group Discussions. The key informants included village government leaders (village chairperson and chairperson of VNRC), the coordinator of MCDI, and the district forest officer. From key informants, we were interested in understanding their views and opinions on the operation and sustainability of certification, including challenges (policy and technical) and potential opportunities. Finally, we used FGD to triangulate the information from the household survey and Key informants' interviews. The focus group included 12 villagers of different age categories, gender, and localities within the village.

Data Analysis

Quantitative and qualitative methods were used to analyze our data. Specifically, we used descriptive analysis to ascertain the forest resource utilizations against forest management and harvesting plans. Using management plans,

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harvesting plans and reports of the annual implementation concerning the amount harvested (removals) as sales to different business persons or companies were collected and Computation of the data from forest resources assessment, calculated as removals based on the allowable cut to establish amount harvested per ha as compared with the harvesting plan.

To estimate the economic viability, we used Net present value (NPV). NPV is the most appropriate compared to the Benefit-Cost Ratio and Internal Rate of Return because it intuitively reflects societal behaviour where decisions about future flows of costs and benefits are considered (Mburu, & Birner, 2002). The decision criterion is that positive NPV is considered economically viable, and otherwise when negative. However, the determination of NPV requires the correct identification and quantification of costs and benefits, choosing the appropriate discounting rate, and time horizon.

Four categories of costs were considered in the economic analysis: forest management and development, administration costs, harvesting costs, and certification costs. Forest management and development category included forest patrols, boundary clearance, early burning, maintenance of road infrastructure in the forest, purchasing of field patrol gear, and tree nursery preparation and development. Administration costs included the salary of the guard, meeting allowances, office management costs, training, education, and other administrative costs such as stationery and transportation (Anup *et al.,* 2015). Harvesting costs included harvesting supervision, tree selection and marking for harvest, log hammering, felling, skidding, loading and offloading of logs, and logs collection. Certification costs included annual auditing costs, bird monitoring, and payment of health insurance to VNRC members. Monetary benefits included sales of timber and other sources, which include penalties from forest perpetrators, timber harvest application fees and sales from confiscated illegal timber, logs, and equipment used from illegal logging.

Estimating NPV requires an appropriate choice of discount rate. However, this is often difficult and sometimes the decision may rest on the discretion of a researcher, guided by the discount rates applied for government and international agencies (Lockwood *et al.*, 1993), the length of the project time considered (Kniivila *et al.*, 2002), or opportunity cost of capital in the country or area of study (Mburu, & Birner, 2002). This study used the discounting rate of 12% based on the two main justifications. First is the adoption of discounting rate from other similar studies; for example, the study of Anup *et al.* (2015) used in the Community Forest in Nepal was also used by Lescuyer *et al.* (2019) to assess the economic viability of community forests in Congo.

Limitations

The estimation of economic viability in this study considered only financial flows; neither non-observed costs, such as psychological costs, nor non-marketed benefits, such as ecosystem services (e.g., regulating services, pollination, climate regulations, etc.) were measured. While we are aware of the relevance of forest actors beyond the local levels for the sustainability of certifications, our scope ended at the district level key stakeholders. We believe that these lower-tier stakeholders are relatively fundamental for the sustainability of certifications. Future research may extend to traders, buyers of the certified timbers, regional and national stakeholders, and FSC representatives.

RESULTS

Environmental Sustainability

Table 2 shows forest size, harvested volumes, forest stocks, and other important statistics for four sampled certified VLFRs (Nyankongo VLFR, Mbumbila A, Mbumbila B VLFRs, and Chihuruka VLFR). The VLFR share of the total village land appeared to be notable. In every sampled VLFR, about 10% of the total forest area was set aside for total protection (no harvesting was allowed), leaving 90% for production. All sampled VLFRs had forest management and harvesting plans that were prepared between 2016

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and 2019. The plans showed the number and quantity of harvestable tree species as indicated in Table 2.

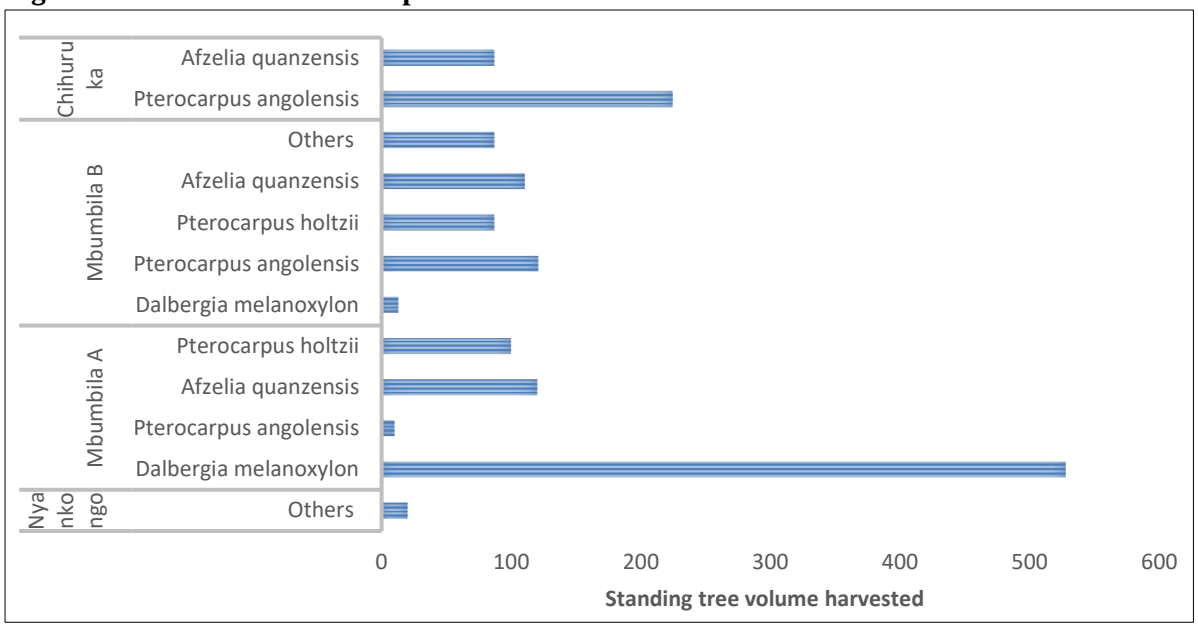
Table 2: Forest Stock in Volume (m^3) for the Sampled Certified VLFRs

Forest parameters	Village Name	Nyamwage	Nanjirinji A		Sautimoja
	Forest Name	Nyankongo	Mbumbila A	Mbumbila B	Chihuruka
Forest Area (ha)		1,644	57,641	18,987	21,966
Productive forest area (ha)		1,480	51,179	17,054	19,769
Year of the last inventory		2016	2018	2016	2019
Number of harvestable tree species		11	21	13	37
Standing volume (m^3)		157,924.9	535073.5	697862.4	382731.7
Harvestable volume (m^3)		101,606.0	371597.3	392428.6	163217.2
VLFR 5 Year AC (m^3)		6,072.6	17839.4	25560.9	9170.4
VLFR Annual AC (m^3)		1,214.5	3567.9	5112.2	1834.1
Volume lost from illegal logging (m^3)		-	124.1	81.1	0
*Harvested volume (m^3)		*20.1(0.3)	757.9(4.2)	418.7(1.6)	311.9(3.4)
Forest stock (remaining harvestable volume in m^3)		6052.5	16957.4	25061.2	8858.5
Stock per hector of productive forest area (m^3/ha)		4.1	0.3	18,987	21,966

**Numbers in bracket are in percentage*

Estimated Total Allowable Cut (TAC) for 5 years and Annual Allowable Cut (AAC), showed that since the harvesting plan was approved, villages managed to market relatively small quantities of standing tree volume. Results indicate that Mbumbila A and Mbumbila B VLFRs were able to harvest only 4.2% and 1.6% of the TAC. Nyamwage and Chihuruka harvested 0.3% and 3.4% of the TAC respectively). Tree species frequently harvested, were *Dalbergia melanoxylon* (Mpingo), *Afzelia quanzensis* (Mkongo) and *Pterocarpus spp* (Mninga) Figure 2.

Figure 2: Distribution of Tree Species Harvested from Certified VLFRs



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Illegal logging was also reported to contribute to the removals. In most cases, these removals were considered selective of high-quality and market-demanded tree species, for example, Mbumbila A and Mbumbila B (Table 2). Moreover, Table 2 shows an unharvested stock in all the VLFRs until July 2020. The finding shows all VLFRs have relatively large total harvestable stock remaining in the forest. These estimates represent more than 95% of the TAC for five years that were not harvested, over 80% of these being lesser-known species.

In estimating sustainable harvesting quotas in VLFRs, villages have been adopting low-intensity logging, which is timber extraction that does not exceed 20% of the mean annual increment of wood volume in the forest, with a maximum of 5,000 m^3 per year. It should be noted that the mean annual increment is the average volume of wood that is expected to be added each year and is calculated across all species.

Economic Sustainability

Costs of Forest Management

The costs of forest management were estimated by considering both variable and fixed costs and presented on an annual basis and per hectare of VLFR conserved. The costs were grouped into forest management and development costs, administration costs, harvesting costs and certification costs. All costs are presented in TZS. Therefore, the costs considered in this study are fixed costs precisely borne by the respective villages. Table 3 shows the total costs of VLFR management for sampled certified VLFRs for the past five years.

Administration costs (which include allowances, office supplies and stationery, transport and transportation and social costs such as various contributions to the village development) were the costliest expenditure.

Table 3: Total Costs of Forest Management for the Past Five Years 2015/2016 - 2019/2020

Name of the VLFRs	Costs variables				TOTAL
	Forest Management and development	Administration Costs	Forest harvesting	Certification	
Nyankongo	7,369,306 (23.6)	23,823,696 (76.4)			31,250,132
Mbumbila A	57,785,900 (27.7)	115,111,692 (55.1)	6,045,000 (2.9)	29,737,592 (14.3)	208,737,592
Mbumbila B	15,240,000 (11.7)	115,111,692 (88.3)			130,351,692
Chihuruka	7,189,100 (12.1)	49,046,861 (82.6)	2,350,000 (4)	810,000 (1.4)	59,396,861

Note: In brackets are percentages

Forest management and development were the second most expensive operations. The activities included forest patrols, boundary clearance, early burning, maintenance of infrastructure in the forest, purchasing of field patrol gear, and tree nursery preparation and development. Forest harvesting operations and activities under the former include harvesting supervision, tree selection and marking for harvest, log hammering, loading and offloading of logs, and logs collection and certifications were the least costly items. This includes annual auditing costs, bird monitoring, and payment of health insurance to VNRC members. Forest harvesting operations and certifications are currently financed predominantly by MCDI.

Revenues Accrued from the Forests in VLFR

Figure 3 shows the revenue trends in the study villages. Two sources of revenue were sales of timber (tree standing volume) and others. Other sources included fines or penalties from forest perpetrators, timber harvest application fees, sales from confiscated illegal timber, and equipment

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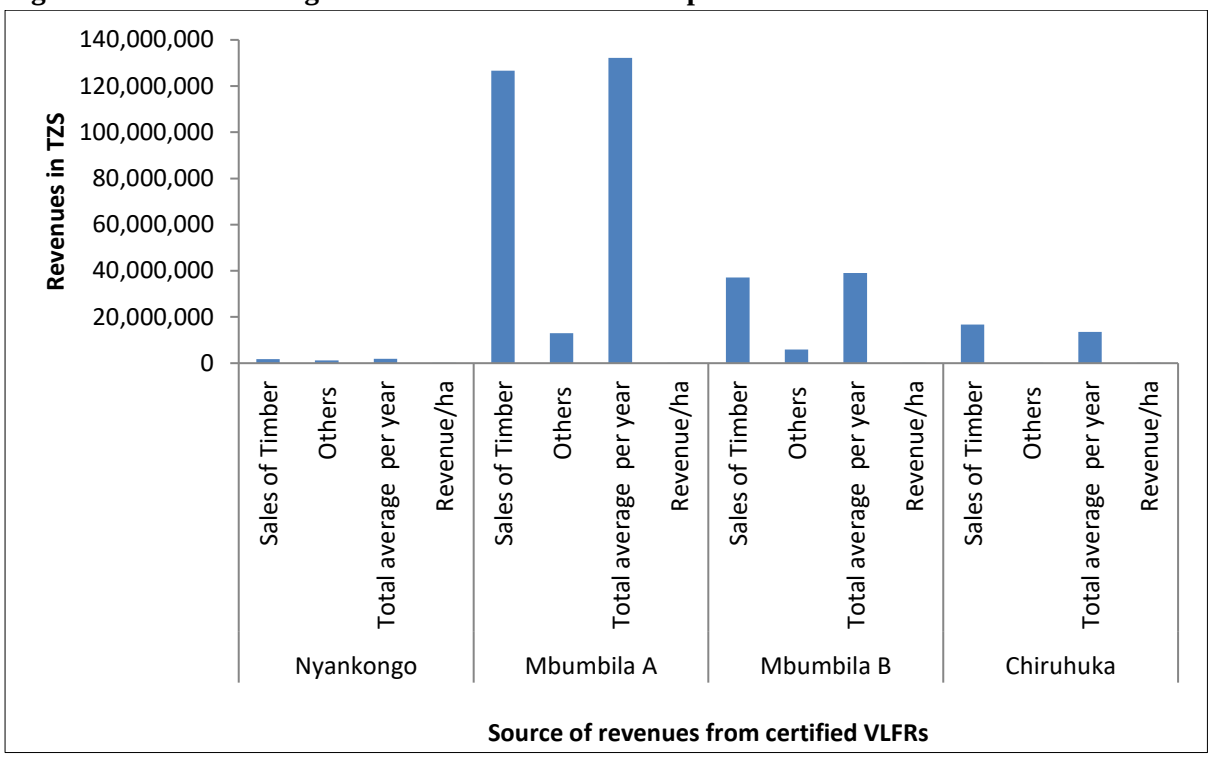
used for illegal logging. The total average revenue per year mainly comes from timber sales. Mbumbila A was leading, followed by Mbumbila B, while Chihuruka and Nyankongo were far behind in terms of revenue collection from timber sales. Timber accounts for over 90% of the total annual revenues in all the sampled VLFRs. Variation in revenue across the villages was attributed to the different magnitudes of timber harvesting efforts, which were also associated with demand and marketing strategies.

Figure 3: Annual Average Total Revenues for the Sampled Certified VLFRs



Cost Benefit Analysis of the Certified Village Land Forest Reserves

We computed a cost-benefit analysis using NPV. We used five years (2015/2016 - 2019/2020) of costs and revenues. Our finding in Table 4 shows that the NPV is positive for two VLFRs: Mbumbila A and Chihuruka. This finding implies that the investments in these VLFRs are economically worthwhile, with more profit noted in Mbumbila A, followed by Chihuruka. Nyankongo and Mbumbila B VLFRs had higher costs than the revenues, and their NPV turned out to be negative. This suggests that Nyankongo and Mbumbila B VLFRs need to better manage the costs of operations while improving the revenues, for conservation to be economically viable.

Table 4: Summary of the NPV for the Certified VLFRs

Name of the VLFR	NPV (TZS)
Nyankongo	-16,004,117.9
Mbumbila A	322,907,222.4
Mbumbila B	-22,269,712.6
Chihuruka	6,145,350.9

Though some efforts were reported to encourage villages to finance their VLFRs management operations to their fullest capacity, still the stake of MCDI was noted to be significant, though the financial contribution could not possibly be quantified. This implies that the inclusion of the MCDI costs could reduce the NPV.

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Sensitivity Analysis

The sensitivity of the CBA model was tested by running possible scenarios by changing two important parameters of the model, i.e., costs and revenue flow from the forest. We take the concern of the insufficient data on costs to make assumptions for the sensitivity analysis. The first assumption was based on the findings of Frey *et al*. (2020), particularly on 80% financial support offered by MCDI to certified VLFRs management. We assumed that about 25% of the expenses incurred by MCDI for VLFRs planning and establishment were considered before 2015 - 2016 and were not applicable to this study data set; therefore, it was deducted from the 80% contribution. The remaining 55% is therefore assumed as the financial support from MCDI to the VLFRs management, which was equally supported, as a rough estimate by MCDI to the studied VLFRs. We therefore added 55% of the costs to our dataset and determined the NPV. Table 5 (column 2) shows that only Mbumbila A remained economically viable. The rest VLFRs are not viable with the critical level for Mbumbila B VLFR.

The second assumption was based on the revenue flow. Since the established harvestable volume is higher than what is harvested by more than 100%, it is reasonable to recommend increasing timber harvesting and therefore revenues. In this regard, we increased the revenues by 100% (approximately 10 times more than the current revenue flow). We maintain our first assumption, discounting rate, and the time horizon of 5 years. Table 5 shows that all the VLFRs are economically viable with positive NPV. This implies that under the prevailing market, the increase in timber harvesting by 10 times from the current level will increase the profitability. Again, profitability could equally be enhanced by value addition to the timber and investing in Non-Timber Forest Products (NTFPs) production and processing.

Table 5: Effect of Changing Costs and Revenues Flow on NPV

Name of the VLFR	NPV (TZS) after increasing costs by 55%	NPV (TZS) after increasing the revenues by 100%
Nyankongo	- 45,073,850	24,948,024
Mbumbila A	101,281,604	4,639,417,067
Mbumbila B	- 162,385,589)	760,976,058
Chihuruka	- 46,655,911	397,461,542

Forest Governance

Our measure of forest governance focused on the participation of communities in the planning and management of certified VLFRs, compliance with rules, particularly certification standards, the inclusion of various actors beyond the local level, and opinions of key informants on the sustainability of certification. The results show that only 35% of respondents were aware or had heard about the certification of VLFRs (Figure 4). Most of these were reported to have been heard through village meetings, implying that there is a likelihood of either limited village meetings being held or many villagers appearing not to attend these meetings. Village leaders in the study area, district forest officers, and the MCDI coordinator had some shared negative feelings about the sustainability of the certification scheme. The common concerns put forward included their passive involvement, overdependence on donors for both technical and financial support, limited awareness of communities on certification benefits and costs, and stringent regulations laid down by the FSC. Stakeholders attribute the challenge of higher costs of certification audits to a lack of a local national expert. Certification auditors are usually hired from outside the country. The challenge of higher prices of certified timber compared to non-certified timber in the local market appeared to constrain village leaders from finding reliable markets. Mismanagement of funds at the village levels,

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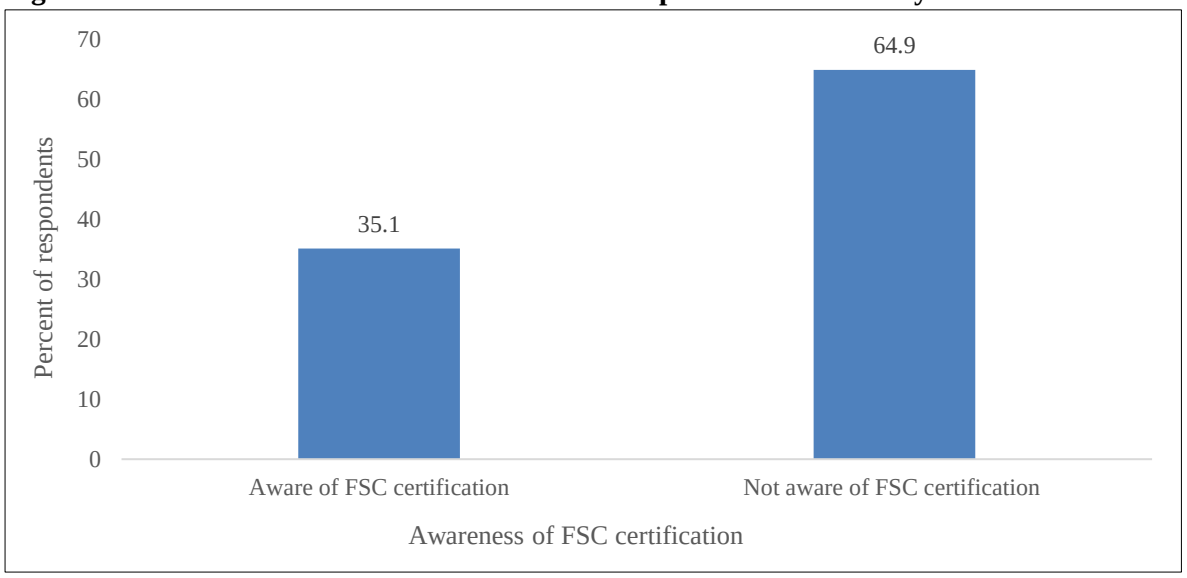
increasingly illegal harvesting, and political interference are reported by some key informants to be other challenges. The latter was also cited by the district forest officer. In some cases, politicians (members of parliament, ward chancellors, and elected village leaders) were claimed to mobilize villagers to dispute against existing forest boundaries, influence change in the composition of the Village Natural Resources Committee (VNRC) to suit their interests and allowing villagers to graze, farm and cut trees in the forest reserves. All these were noted to be motivated in pursuit of political interests and personal gain.

Figure 4: Awareness of FSC Certification and its Importance in the Study Area



Compliance with forest harvesting operations as per the FSC standards seemed to be fairly good. This was revealed during discussions with village leaders, VNRC, and the Harvesting Supervision Committee (HSC). In all villages, VNRC and HSC were consistently able to explain the harvesting procedures they undertake. The supervisor must ensure the harvesting is selective; i.e., harvesting is done to trees with a required diameter as per the harvesting plan and before cutting, a physical assessment of trees is necessary (e.g., curvature, rotten, dead and its branches) to avoid possible wastage of trees and damage to other nearby trees. Despite the existence of these rules and a significant level of compliance, some of the tree species were reported to be harvested but not sold because of various reasons, including defects, particularly heart rot. Local means for testing those defects have never been successful, resulting in unintended losses. This calls for more technical expertise to investigate the problem and recommend scientific strategies to mitigate these losses.

DISCUSSION

This study aimed to assess the sustainability of certifications of VLFRs in some villages in the southern part of Tanzania. Our results show that stand volumes per hectare in the studied VLFRs are comparable but somewhat lower than those observed in miombo woodlands elsewhere in Tanzania. For example, Bakengesa *et al.* (2013) reported a stand volume of 46.67 m^3ha^{-1} for Bukombe-Mbogwe forest, Zahabu (2008) registered between 55.3 and 88.2 m^3ha^{-1} for Kitulang'alo area, while Nuru (2008) reported 57.74 m^3ha^{-1} for Urumwa forest, while the stand volume at studied VLFRs ranged from 9.28 m^3ha^{-1} and 37 $m^3ha^{-1,}$ except Nyankongo VLFR, which had 96.06 m^3ha^{-1}. Moreover, harvesting levels are equivalent to what was observed by Ngaga *et al.* (2013) in some CBFM forests in other parts of Tanzania (for example in Durua-Haitemba was 2.77 m^3 ha-1yr-1, SULEDO 0.240 m^3 ha-1yr-1, Mfundia 0.870 m^3 ha-1yr-1, Kisanga 2.96 m^3 ha-1yr-1, Kindundakiyave 0.004 m^3 ha-1yr-1,

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Ntumbili 1.24 m^3ha-1yr-1 and Gangalamtumba 0.16 m^3 ha-1yr-1).

All VLFRs in the studied villages have relatively high total harvestable stock, implying a stable utilization of forest resources. On the other hand, limited markets of timber from the VLFR resulted in reduced harvesting levels. One of the reasons for limited marketing of the timber from the certified VLFRs was that traders have little incentives to access timber from these certified forests where the harvesting rules are stringent as compared to forest products available in the general lands (with minimal monitoring and supervision) where one can get timber of similar quality for a relatively cheap price. Consequently, a leakage effect where degradation is shifted to forests with limited restrictions may ultimately lead to a lower overall effect of certification (Yamamoto, & Matsumoto, 2022). Unless the certification efforts cover the entire ecosystem or a similar stringent governance system is considered for non-certified forests, the leakage effect may be unavoidable. Moreover, there were fewer capabilities for the local communities to access potential markets for certified forest products, which are often made up of a tiny segment of consumers. Molnar *et al.* (2008) contend that marketing the products from CBFM enterprises requires a more careful identification of market segments and niches where communities and stakeholders have a competitive advantage. The case in the study area presents a situation where there are active CBFM, but there is a lack of regulatory measures on the ground to support broad community participation in forest products markets, such as forest certification. Scherr *et al.* (2004) and Molnar *et al.* (2008) strongly argue that under most forest arrangements in developing countries, markets have tended to bypass or hurt the poor due to a host of internal and external factors, including politicized rules that favour monopoly sellers and buyers that limit community competitiveness.

We also noted that lesser-known species account for more than 80%. For example, tree volumes of the lesser-known species in the Chihuruka VLFR were 88% of the total harvestable stock and 72% in Mbumbila B VLFR. This means the observed harvestable stock is not that promising in terms of sustainability if we also care about the exhaustion of common and high-value tree species such as *Pterocarpus spp* (Mninga), and *Afzelia quanzensis* (Mkongo). A similar phenomenon has been reported in CBFM elsewhere in Tanzania, where during forest inventory, high stocking levels were recorded for less preferred/known/utilized species (Bakengesa *et al*., 2013). The findings imply that there is a need to advocate more for the marketing and utilization of lesser-known species and start to set a control mechanism for the harvesting of commonly known species for sustainability.

The finding about Cost-Benefit analysis using NPV showed that only investment in Mbumbila A was consistently economically worthwhile. We empirically show the potential to enhance economic profitability from sensitivity analysis. Given the fact that harvesting levels have been falling far short as compared to the TAC (Total Annual Cut volume), recommending an increase in harvesting up to 10 times more than the current level. Assuming a non-volatile market potential, such an increment can result to increase in the profitability of all the studied VLFRs, making the intervention economically rewarding. The profitability can be enhanced by extending utilization to non-timber forest products such as honey production, as has been the case in other CBFM forests (Kessy, & Kingazi, 2009), and value addition for the timber products to access specific markets. This will improve income for the villages, which will be reflected in the improvement of different livelihood aspects and investments. The accrued benefit will also be reflected in the increased capacity for forest management.

CONCLUSIONS AND RECOMMENDATIONS

VLFRs in southern Tanzania, particularly in the study area, have very potential for management under certification as they have a considerable volume with comparable stocking levels to other miombo forests in other parts of the country.

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Results indicate that the villagers are facing difficulties in marketing their products, which is reflected in the harvesting levels, which are less than 10% of the allowable cut for timber, partly attributed to the competitive timber that traders access from general land that is relatively cheaper than timber from certified VLFRs.

However, more marketing opportunities need to be exploited, including using different marketing channels and models such as auctions and links to access specific markets for certified forest products; up to now, little has been done. As long as the harvesting/removal remains below 10% of the allowable cut, the utilization remains highly sustainable, though threats such as illegal harvesting and wildfires remain. The sustainability and threats/risk reduction for these forests will likely improve if harvesting levels increase, with increasing profitability, thereby increasing the economic viability of implementing the CBFM under FSC certification.

Both the cost-benefit analysis using NPV and the sensitivity analysis indicate that CBFM implementation in the study area was economically viable. By increasing harvesting efforts by 10 times the current level of harvesting, the profitability is likely to increase by more than 200%. It is therefore important to consider the following to improve the economic viability in the implementation of CBFM and make FSC certification sustainable in southern Tanzania:

- Increase harvesting level by at least 10 times the existing level, and continue picking up slowly as more customers are engaged.
- Improve the marketing of the products from the VLFRs, more advertising in different media on the availability of FSC-certified forest products from village forests.
- Regulations should be introduced, particularly by the Ministry of Natural Resources and Tourism, to secure a market share in different market niches for FSC-certified timber for communities to benefit.
- Consider embarking on producing Non-Timber Forest Products such as honey to improve the economic viability of the CBFM in the area.

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Authorship Contribution Statement

Gimbage Mbeyale; Conceptualization, methodology, data collection, analysis, and leading the writing process. Nyanghura Qambemeda; conceptualization, methodology, theoretical contribution, data collection, and editing of the manuscript

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

The authors do not have direct permission to share data

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