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Agricultural Intensification and Implications on Bamboo Vegetation: Dynamics in Narok North Constituency, Kenya

¹ Joseph S. Kopejo, ²Dr. Frida M. Nyiva, ³Dr. Edwin B. A. Juma
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[Email: johnakopejo@gmail.com](mailto:johnakopejo@gmail.com)

Abstract

Bamboo is a plant that has numerous socio-economic as well as ecological benefits. However, the plant faces an uncertain future mainly due to human activities and climate change. This study thus sought to study agricultural intensification and its implications on bamboo vegetation with focus on the dynamics in Narok North constituency in Narok county, Kenya. Guided by a descriptive survey research design, the study collected primary data from 155 household heads and 13 key informants in the study area. Data from sampled household heads was collected using a questionnaire while data from the key informants was collected using a key informant interview guide. Quantitative data from sampled respondents was analysed using descriptive statistics (percentages, mean and standard deviation) as well as inferential statistics (correlation analysis). The study established that majority of the respondents practiced mixed farming in a bid to utilize the limited land while other farming activities included shifting cultivation, commercial farming, sedentary farming among others. The study also established that the slash and burn agricultural activity posed the greatest risk to bamboo vegetation. Finally, the study concluded that agricultural activities were generally threatening the sustainability of bamboo vegetation in the study area ($r=0.534$, $p<0.05$). The study therefore concludes that concerted efforts should be put in place by all stakeholders to ensure that agricultural activities are not expanding at the detriment of bamboo vegetation.

Key words: *Bamboo, agriculture, sustainability, Narok, Kenya*



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Introduction

Bamboo is a perennial grass known for its fast-growing tendency. There are around 1600 species of bamboo growing globally and more so in the tropical and sub-tropical regions. The plant is often referred to as a 'a plant of a thousand uses' due to its varied applications. Its ecological benefits range from controlling soil erosion, increasing ground water recharge, soil stabilization, to being an effective carbon sink (Paud et al., 2019; Phimmachanh et al., 2015; Yoshimura, 2017). Additionally, bamboo has numerous socio-economic benefits for humans. For instance, it serves as a resource to support construction, food, and medicine but also contributes to the economic activity in the form of handicrafts, furniture, and pulp manufacturing (Wakweya, 2023; Nath et al., 2015). As a result, it has the potential to alleviate poverty and support livelihoods for millions of people especially in rural areas (Kuehl et al., 2024).

Despite its importance, the sustainability of bamboo is under serious threat from expanding agricultural activities, compounded by the pressures of climate change. Agriculture has often been cited as a key contributor of environmental degradation. This is through activities such as the clearing of land, the use of pesticides, and bush burning to clear land for agriculture which directly bamboo forests. Aside from these direct impacts of agriculture on bamboo vegetation, agricultural activities also bring other broader effects on the environment, which include climate change, deforestation, loss of biodiversity, dead zones, concerns of

genetic modification, irrigation problems, pollution, poor soil quality, and wastes which all have devastating impacts on bamboo vegetation (Morton et al., 2017). Therefore, as the world struggles to attain Sustainable Development Goal 2 (SDG 2), reducing hunger, food security, improving nutrition, and promoting sustainable agriculture, the expansion and intensification of agricultural activities is having detrimental impacts on the environment in general and bamboo in particular (UNEP 2021).

In the Americas for instance, the Andean and Neotropical regions where *Guadua* and other native bamboos occur, agricultural expansion driven by coffee, cattle ranching and smallholder cropping has been a primary cause of bamboo habitat loss and fragmentation. This is aggravated by the lack of formal bamboo-resource mapping and weak land-use safeguards in several Latin American countries (FAO, 2021; Muñoz-López et al., 2021). The situation is no better in Asia where agricultural practices such as expansion of monocultures, irrigation conversion, and frequent use of agrochemicals have altered hydrology and soil properties in many bamboo-growing areas, especially in China and South/Southeast Asia. The result has been suppressed bamboo regeneration by changing soil moisture regimes, compacting soils, and killing shoot buds with herbicides and increase the likelihood of stand collapse following disturbance (Li et al., 2022).

The same global scenario manifests itself in Africa where studies assert that bamboo vegetation is increasingly threatened by expansion and intensification of



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agricultural activities. Cases in Ethiopia for instance show that while highland bamboo (*Yushania alpina*) and lowland bamboo (*Oxytenanthera abyssinica*) were dominant, extensive clearing for maize, teff, and coffee cultivation has fragmented bamboo stands and reduced their natural regeneration capacity (Embaye, 2003). Similarly, in Uganda, shifting cultivation and bush burning to prepare land for crops and grazing have degraded bamboo catchments, particularly in the Mount Elgon, and Rwenzori regions. Additionally, while some smallholder farmers adopt sustainable practices that minimize environmental damage, the growing prevalence of mechanized cultivation, high pesticide use, and overgrazing accelerates soil erosion, alters hydrology, and diminishes bamboo viability. Pastoralism, although argued to have limited ecological impact, expansion of modern livestock systems characterized by overstocking and uncontrolled browsing has proven more destructive to bamboo ecosystems than plant-based agricultural systems (KEFRI, 2019).

Locally in Kenya, bamboo has been an integral part of Kenya's indigenous montane forests for a long time in areas such as Aberdare Ranges, Mount Kenya, Mau Escarpment, Cherangany Hills, and Mount Elgon, typically between approximately 2,300 m and 3,200 m above sea level (INBAR, 2005; Muchiri & Muga, 2017). However, research has shown that bamboo vegetation has reduced by nearly half from an estimated 30,000 to 150,000 hectares largely attributed to clearing of forests for agriculture and timber (Katumbi et al., 2017; KEFRI,

2019; Muchiri & Muga, 2017). The same scenario is replicated in Narok North Constituency which was mainly dominated by highland bamboo. However, in the 1970s and 80s, the situation changed following the introduction of individual land ownership that led to and fragmentation and consequent systematic clearance of bamboo. This was followed by in-migration of people following tribal clashes in the neighboring areas. The migration of new population led to a rise in demand of farmlands, where local land owners leased some part of the land to be worked by others, a practice that though played out economically accelerated bamboo depletion. The magnitude of destruction had surpassed red lines and led to soil erosion, changing hydro-systems, and decreasing forest cover by mid-2010s (Ngugi et al., 2015).

This study also highlights significant gaps in the existing literature. Despite bamboo's ecological and economic value, there is a notable lack of empirical, location-specific studies examining how different agricultural practices are impacting bamboo ecosystems in Kenya. Most available research focuses on general forest cover change or biodiversity loss, without isolating bamboo as a unique and vulnerable vegetation type. Moreover, there is limited data on long-term monitoring of bamboo regeneration rates after agricultural encroachment or on the socio-economic trade-offs faced by smallholder farmers who depend on both bamboo and agriculture for their livelihoods. This study contributes to filling these gaps by providing primary evidence from Narok North Constituency but



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also calls for further longitudinal and experimental research to inform adaptive management strategies.

Theoretical and Conceptual Frameworks

Theoretical Framework

The study draws on two complementary theories, Sustainable Development Theory and Social-Ecological Systems (SES) Theory, to examine the interactions between agricultural activities and bamboo ecosystems in Narok North. Sustainable Development Theory originated with the Brundtland Report (WCED, 1987), which defined sustainable development as meeting present needs without compromising future generations' capacity to meet theirs. Its intellectual roots, however, go back to Malthus' warnings on population pressure (1798), Carson's critique of industrial pollution (1962), and the Club of Rome's *Limits to Growth* (1972). Later contributions, such as Schumacher's call for localized economies (1973), Daly's steady-state economics (1990), and Ostrom's work on collective resource management (1990), enriched the framework. Institutionalization of the concept occurred through global processes such as the UN's Sustainable Development Goals (2015). Despite critiques of its anthropocentrism, alternative models like degrowth (Latouche, 2009) and doughnut economics (Raworth, 2017) offer expanded perspectives. In this study, sustainable development theory guides the evaluation of how agricultural expansion impacts bamboo conservation, focusing on intergenerational equity, balanced land-use, and links to SDG 15.

Social-Ecological Systems (SES) Theory, pioneered by Ostrom (1990, 2009), provides a framework for understanding human-environment interactions. It challenges Hardin's "tragedy of the commons" by demonstrating how communities self-organize to sustainably manage shared resources through norms, rules, and collective action. Later contributions, such as Berkes et al. (2003) on indigenous ecological knowledge and Folke et al. (2010) on resilience, broadened SES into an interdisciplinary approach connecting ecology, economics, and governance. Critiques, however, highlight its complexity, limited engagement with globalized forces, and insufficient treatment of power dynamics (Cumming et al., 2006; Liu et al., 2007). In this study, SES theory is applied to analyze the role of local institutions, resilience of bamboo regrowth, adaptive community strategies, and integration of indigenous knowledge in mediating the balance between livelihoods and ecological sustainability. Together, these theories provide a robust lens for analysing the interplay of farming practices and bamboo ecosystems, emphasizing intergenerational sustainability, resilience, and community-based management as key to sustainable land-use strategies.

Conceptual Framework

The conceptual framework for this study illustrates the relationship between four independent variables namely: awareness of bamboo's importance, impacts of agricultural activities, effective management strategies, and conservation challenges and the



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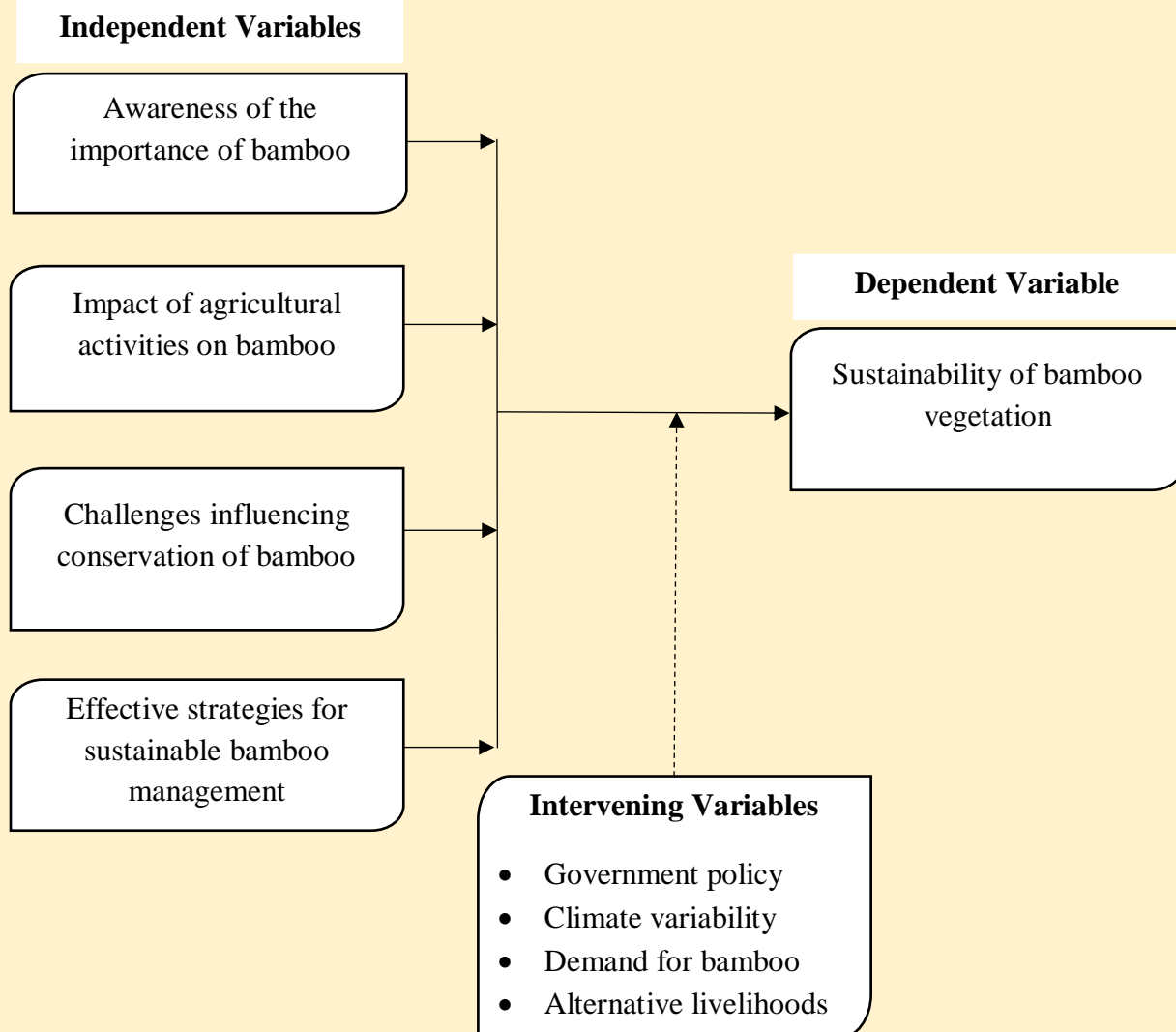
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dependent variable, sustainability of bamboo vegetation in Narok North. It is premised on the idea that high awareness, minimal negative agricultural impacts, effective strategies, and reduced challenges promote long-term bamboo sustainability, while their absence undermines it. Intervening variables such as government policy, market demand, climatic variability, and alternative livelihoods may indirectly influence these

relationships. To minimize their confounding effects, the study controlled for ecological and socio-economic conditions across sites, ensured measurement consistency through pilot testing, synchronized data collection to one season, and carefully designed instruments to isolate the effects of the key independent variables. The diagrammatic representation is shown in Figure 1.





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Figure 1.1: The conceptual Framework

Methodology

The study employed a descriptive survey design with a mixed-methods approach in Narok North Constituency, Narok County, targeting 11,800 households engaged in agricultural activities. Key informants included agricultural officers, NGO representatives, community leaders, administrative officials, and forestry/environmental officers. A sample of 200 households was determined using Yamane’s (1967) formula with a 7% margin of error, a decision informed by time, financial, and logistical constraints as well as the relatively homogeneous nature of the population (Israel, 1992; Krejcie & Morgan, 1970; Taherdoost, 2017). Households were selected through simple random sampling to ensure representativeness and minimize selection bias, while 16 key informants were purposively sampled for their expertise. Data from households was gathered using questionnaires, while interviews captured insights from key informants. Quantitative data were analysed through descriptive and inferential statistics and presented in tables and charts, whereas qualitative data underwent thematic analysis.

To enhance the robustness of findings, the study implemented randomization in household selection by

assigning unique identifiers to the population list and drawing samples through a computerized random number generator. Despite these precautions, potential limitations remain. These include recall bias in household responses regarding past agricultural practices, social desirability bias that may have influenced participants to provide more environmentally favourable answers, and the possibility of non-response bias from households or informants who declined participation. Acknowledging these limitations provides context for interpreting the results while maintaining confidence in the study’s validity.

Findings and Discussions

Response Rate

The objective of the study was to establish the existing agricultural activities and their impact on bamboo vegetation in Narok North Constituency, Kenya. As previously indicated, the study distributed questionnaires to 200 household heads and also aimed to conduct 16 key informants’ interviews. However, 155 questionnaires were satisfactorily filled and returned for analysis while the researcher was also able to conduct 12 key informant interviews. A summary of the response rate is provided in Table 1.1.

Table 1.1: Study Response Rate

Respondent Category	Research Instrument	Target No.	Actual Response	Percentage Response
Household Heads	Questionnaire	200	155	77.5%
Key Informants	KII Guide	16	13	81.3%



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Table one indicates that out of the 200 issued household questionnaires, 155 were satisfactorily filled representing a 77.5% response rate. Conversely, 13 interviews were also successfully conducted representing 81.3% success rate. The success rate was deemed satisfactory based on Nixon (2019) who argues that a response rate of 70% is acceptable. With the response rate being deemed acceptable, the researcher went ahead to conduct the analysis that is presented and discussed in the subsequent sections.

Prevalent Agricultural Activities

Firstly, the study sought to gain information from the respondents on which agricultural activities were prevalent in the study area. Data collected from the 155 respondents was analysed and the results are presented in Figure 1.1. The study findings in Figure 1 on the agricultural activities practiced in the region showed that the majority of the residents (28.4%) practiced

mixed farming, 25.8% practice extensive and intensive farming, 18.1% practice sedentary farming, 14.8% practice arable farming, 10.3% commercial farming and lastly 2.6% of the residents practice shifting cultivation. The results here show that indeed, most of the respondents were actively involved in agriculture and therefore natural bamboo vegetation could be easily cleared for agricultural activities to be carried out. This information was further reinforced by most of the interviewees who also attributed their agricultural activities to depletion of bamboo but insisted that they had no access to other forms of livelihood except farming. As one of the key informants asserted:

In the course of my many years of living here, I can confirm that agriculture has been on a steady increase over the years. As agricultural activities intensify, I can also affirm that bamboo vegetation has been on the decline and not only bamboo but vegetation in general.



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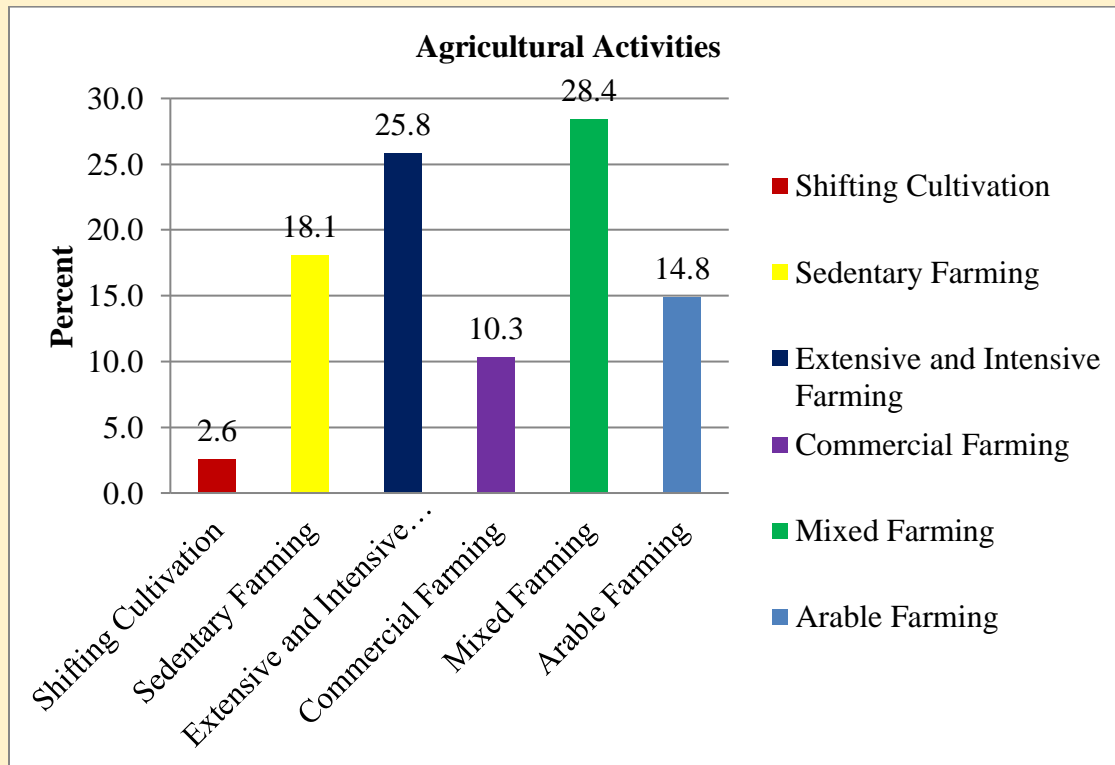


Figure 1.2: Dominant Agricultural Activities

From the interviews conducted with the key informants, it appeared that mixed farming was the most preferred agricultural activity in the study area, taking over from shifting cultivation. The key informants attributed this trend to the fact that land in the study area was diminishing and there was need for the local farmers to maximise the use of the little land that is left. As a result, most farmers had moved to this agricultural activity that entails intercropping of various types of crops and also keeping of animals in the same piece of land. With these findings, the study then embarked on establishing how different agricultural activities practiced in this area affected the

sustainability of bamboo vegetation. The findings are presented in the subsequent section.

Agricultural Activities' Impact on Bamboo Vegetation

After establishing the dominant agricultural activities in the study area, the study sought to find out the impact the same was having on the sustainability of bamboo vegetation in Narok North Constituency. Data obtained from the household heads was analysed and is presented in Table 1.2.

The analysis in Table 1.2 show respondents' views on how different agricultural practices influenced bamboo vegetation in the selected study area. The study findings revealed that majority 134 (86.5%) of the respondents



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agreed that agricultural expansion is a significant factor contributing to bamboo depletion, while 9 (5.8%) were neutral on the statement and 12(7.7%) disagreed with the same statement. The strong consensus that

agricultural expansion is a key factor in bamboo depletion highlights the need to balance agricultural development with conservation efforts.

Table 1.2: Agricultural Activities’ Impact on Bamboo Vegetation

Statement	SD	D	UD	A	SA	Mean	SD
Agricultural expansion is significant contributing to bamboo depletion	3 (1.9)	9 (5.8)	9 (5.8)	97 (62.6)	37 (23.9)	4.01	.84
Increased grazing livestock have a negative impact on bamboo forests	0 (0.0)	10 (6.5)	29 (18.7)	101 (65.2)	15 (9.7)	3.78	.70
Commercial farming is negatively affecting bamboo vegetation	2 (1.3)	14 (9.0)	11 (7.1)	58 (37.4)	70 (45.2)	4.16	.99
Slash and burning is posing a significant risk to bamboo vegetation	4 (2.6)	4 (2.6)	6 (3.9)	105 (67.7)	36 (23.2)	4.06	.78
Intensive farming activities are having a significant impact on bamboo vegetation	3 (1.9)	21 (13.5)	13 (8.4)	85 (54.8)	33 (21.3)	3.80	.99
Mixed farming activities are having an impact on bamboo vegetation	0 (0.0)	5 (3.2)	12 (7.7)	80 (51.6)	58 (37.4)	4.23	.73

Source: Field Data (2024). (Note that numbers appearing in parentheses are in percentage)

Key: F-Frequency, P-Percentage, SD-Strongly Disagree, D-Disagree, N-neither agree or disagree, A-Agree, SA-Strongly Agree & Std Dev-Std. Deviation.

Findings from this study were in agreement with Li et al. (2016) who affirmed that agricultural expansion significantly reduced bamboo forest cover, leading to habitat loss and decreased biodiversity. The findings here were also supported by field

observations as shown in Figure 2 which shows some newly encroached piece of land that was initially under bamboo but was encroached to extend potatoes and other crops farming for the farm in the foreground



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Figure 1.3: Newly Encroached Land

Moreover, 116 (74.9%) of the respondents agreed that increased grazing livestock have a negative impact on bamboo forests, while 29 (18.7%) were neutral on the statement and 10 (6.5%) disagreed with the same statement that increased grazing livestock have a negative impact on bamboo forests in Narok North Constituency. The high agreement indicates a recognized issue of livestock grazing impacting bamboo forests. The recognition of illegal harvesting

as a major threat underscores the need for stronger enforcement and alternative solutions. Findings concur with Alemayehu (2019) who highlights that unmanaged livestock grazing leads to significant degradation of bamboo forests, reducing regeneration rates and overall forest health. This is reinforced by field observations where livestock grazing was clearly evident as shown in Figure 3.



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Figure1. 4: Livestock Grazing on Land Previously Under Bamboo

In addition, 37.4% of respondents agreed and another 45.2% strongly agreed that commercial farming posed a serious threat to the environment, while 7.1% remained neutral and 10.3% disagreed with the statement. These results indicate a strong perception by the community members that commercial farming is one of the sources of environmental degradation, perhaps through deforestation, over utilization of water sources, and excessive exploitation of agrochemicals. Concerns relating to these issues have also been reported in Kenya and other regions of sub-Saharan Africa where massive commercial agriculture ventures have been the cause of land degradation, a decline in biodiversity, and a decreased supply of ecosystem services (Kogo et al., 2020; Njeru et al., 2021). In that regard, Kogo et al. (2020) mention that the rate of soil

erosion and loss of soil fertility has been increasing in Kenya due to unsustainable land use emerging as a factor that has contributed to the growth of commercial farming in highlands. Similarly, Njeru et al. (2021) note that the use of natural lands to create monoculture farms destroys the livelihoods and ecological stability in the region, which confirms the value of sustainable agriculture. The substantial agreement shows that residents have the perceptions on these environmental risks and probably stand to benefit in interventions that seek to establish climate-smart and conservation-oriented farming systems.

The slash and burn practice also reported to have adverse effects to the bamboo vegetation. About 2/3 of the respondents 67.7% agreed with the statement with only a small number of respondents



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1.3% strongly disagreeing with this statement. The fact that the threat of the slash and burn method is overwhelming is indicative of the urgency need to do away with such poor agricultural activities that can easily end up in uncontrolled fires. Our results agree with Nguyen et al. (2020), who showed that wildfires are disastrous to the bamboo forests causing long-term ecological imbalances and destruction of biodiversity. On the other hand, Martin (2020) postulated that bamboo forests could be managed and revitalized under specific fire management practices which in this case is controlled burning of bamboo forests with proper planning and execution.

The result showed that a majority of the respondents, 138 (89.0), agreed that the mixed farming systems were affecting the bamboo vegetation thus clearly indicating the fact that many of the people were aware of this problem. A smaller percentage, 12 respondents (7.7%), were at the middle with some respondents displaying indecisiveness or lack of adequate information to make a firm stand. The small percentage (3.2) in disagreement shows that there is a general

consensus on the perception that crop cultivation coupled with livestock rearing practice leads to the destruction of bamboo vegetation. These findings confirm the existence of high consensus among the weighted respondents on the negative impacts of mixed farming on bamboo vegetation, which means that the agricultural practices should be sustainable so that both the livelihoods and the environment can be balanced.

The standard deviation of this data clearly indicates that there is an agreement among many of the respondents to the questions. (Q1= 0.84 Q2=0 .70 Q3=0 .99 Q4=0.78 Q5=0.99 Q6=0.73) as previously indicated a standard deviation of less than one is an indication that data points in a data set are clustered tightly around the mean, meaning the values are relatively close to the average.

To make a conclusion of the findings, the study conducted a correlation analysis to establish if agricultural activities were having a significant impact on bamboo vegetation sustainability. The results of the statistical test are presented in Table 3.

Table 1. 3: Overall Correlation Analysis Results

Item		Bamboo vegetation sustainability	p-value
Agricultural practices	Pearson Correlation	.534**	.05

** . Correlation is significant at the 0.01 level (2-tailed)



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The statistical test results concerning the influence of agricultural practices on bamboo vegetation sustainability shown in Table 3 indicated that, there was a positive and significant contribution of agriculture activities on sustainability of bamboo vegetation at ($r=0.534$, $p<0.05$). The Pearson correlation coefficient of $r = 0.534$ indicates a moderate positive relationship between agricultural activities and bamboo vegetation depletion. In practical terms, this means that as agricultural activities (such as mixed farming, commercial farming, and grazing) intensify, there is a corresponding and fairly strong tendency for bamboo vegetation to decline. While the relationship is not perfectly linear, it is strong enough to be of ecological and policy significance, suggesting that unchecked agricultural expansion could continue to undermine bamboo sustainability if no mitigating measures are implemented. Consistent with these results, a study conducted by Zhou et al. (2020) reported illegal logging, overgrazing, and agricultural encroachment as important causes of the bamboo loss, which adversely affect the bamboo sustainability. In their study, there is the necessity to point out the urgency of action directed toward these factors in order to improve conservation practices.

The findings of this study resonate strongly with major global and regional policy frameworks designed to balance agricultural development with environmental stewardship. The moderate positive correlation ($r = 0.534$) between agricultural intensification and bamboo depletion underscores a key challenge highlighted in the African Union's Land Policy Initiative (LPI): the need to promote secure, equitable, and sustainable land use that safeguards ecosystems. These results indicate that Narok North's situation is not just a local issue but part of a broader continental trend where agricultural pressures threaten forest resources. The study's outcomes also support the FAO's Sustainable Agriculture Guidelines, which call for climate-smart, conservation-oriented farming practices. Specifically, the evidence that mixed farming, commercial agriculture, and grazing significantly

affect bamboo cover highlights the urgency of adopting sustainable intensification strategies that reduce ecological harm. Integrating bamboo into agroforestry systems and applying land-use zoning principles could help Kenya meet its commitments under the Sustainable Development Goals (SDGs 2, 13, and 15) ending hunger, combating climate change, and protecting terrestrial ecosystems.

By aligning the study's findings with these global frameworks, this research not only diagnoses a pressing environmental problem but also offers a roadmap for multi-level interventions. It underscores the importance of linking local conservation actions to national policies and international targets, ensuring that agricultural development and bamboo conservation progress hand-in-hand rather than in conflict.

A critical insight emerging from this study is the tension between the need for food security and the imperative to conserve bamboo ecosystems. On one hand, households in Narok North rely on agriculture for their livelihoods, which drives the clearing of bamboo stands to expand farmland. On the other hand, the loss of bamboo vegetation undermines ecosystem services such as soil stabilization, watershed protection, and carbon sequestration services that are essential for sustaining agricultural productivity in the long term. To address this trade-off, integrative solutions must be pursued. Payment for Ecosystem Services (PES) schemes have proven effective in similar contexts. For example, Kenya's Upper Tana-Nairobi Water Fund compensates farmers for adopting soil conservation practices, resulting in improved water quality and agricultural yields a model that could be adapted to bamboo conservation in Narok North. Similarly, the inclusion of bamboo ecosystems in REDD+ programs (Reducing Emissions from Deforestation and Forest Degradation) is gaining traction; in Ethiopia, pilot projects under REDD+ have demonstrated the viability of mobilizing climate finance to protect bamboo forests while supporting local livelihoods. Agroforestry models incorporating bamboo with food crops can provide both income



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and ecological resilience. In India's Northeast region, bamboo-based agroforestry systems have improved soil fertility, diversified farm incomes, and reduced land degradation. Lessons from these initiatives show that bamboo can be a profitable and sustainable crop when integrated into farming systems rather than cleared. Additionally, community-led land-use planning that incorporates conservation zones and rotational grazing systems can balance food production with ecological integrity. These solutions ensure that the pursuit of food security does not come at the cost of long-term environmental degradation but rather works synergistically to achieve both livelihood improvement and bamboo ecosystem sustainability.

Conclusion

Based on the findings, the study concludes that indeed there has been a steady increase of population in the study area which has resulted in the expansion of agricultural activities. The study established that while the common agricultural activities in the study included extensive and intensive farming, sedentary farming, arable farming, commercial farming and shifting cultivation, mixed farming was the most dominant activity in a bid to leverage on the limited farming space. The study can also conclude that, while most of the farmers had slowly abandoned shifting cultivation (slash and burn), the practice remained the highest risk to bamboo vegetation sustainability in the study area. This is because the practice more often than not results in accidental fires, destroying large tracks of bamboo vegetation. All in all, the study concludes that while different agricultural practices result in different levels of impacts on bamboo vegetation, the fact remains that any expansion in agricultural activities (both farming and livestock keeping) have a negative and significant impact on the sustainability of bamboo vegetation in the study area. There is therefore need for all stakeholders to make deliberate efforts to ensure that any future agricultural activities are done in a sustainable manner if we need to ensure sustainability of bamboo vegetation itself.

Recommendations

This study proposes several strategies to strengthen bamboo sustainability in Narok North. First, integrated land-use planning should be prioritized by the Narok County Government in collaboration with the National Land Commission and the Kenya Forest Service. This would involve establishing bamboo conservation zones and incorporating them into county spatial plans, with zoning maps co-created through stakeholder workshops involving farmers and local leaders. Second, agroforestry and bamboo integration can be promoted by partnering with KEFRI and FAO to train farmers on bamboo-based practices, supported through community nurseries, provision of seedlings, and establishment of demonstration plots to showcase productivity benefits.

Third, controlled grazing programs are essential, including bylaws on rotational grazing schedules, designated communal grazing areas, and the deployment of community rangers to monitor compliance and reduce overstocking. Fourth, fire management and community training should be strengthened through village fire committees, seasonal fire drills, provision of firefighting equipment, and early-warning systems leveraging mobile alerts and community radio.

Fifth, incentivizing conservation through mechanisms such as Payment for Ecosystem Services (PES) and REDD+ could provide farmers with financial compensation for protecting bamboo, supported by donor or private sector funding to pilot these initiatives. Finally, longitudinal research and monitoring are necessary, with a research consortium of universities, NGOs, and local government established to conduct annual bamboo cover mapping using remote sensing, publish biennial ecosystem health reports, and provide a data-sharing platform to guide adaptive policymaking.

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