Journal of Agroforestry and Environment

Volume 18, Issue 1, 2025

Journal DOI: https://doi.org/10.55706/jae

Journal homepage: www.jagroforenviron.com

Documenting the Key Challenges Facing Agroforestry Technologies in Vihiga County, Kenya

Reinhard Endeki[1*], Stanley M. Makindi[2] and Shadrack K. Inoti [3]

[1]Department of Environmental Science, Egerton University, Kenya, Email: reinhardendeki@gmail.com
[2]Department of Environmental Sciences, Machakos University, Kenya, Email: mankindsm@gmail.com
[3]Department of Natural Resources, Egerton University, Kenya, Email: inotikinyua@yahoo.com
*Correspondence: reinhardendeki@gmail.com , Tel: +254 700 811408

Received: 20/10/2024

Accepted: 29/01/2024

Available online: 18/02/2025

Abstract: Agroforestry technologies have been proposed among development practitioners, policymakers, and social scientists as one of the critical strategies for strengthening agricultural production, ameliorating environmental degradation, increasing farmers' resilience against climate change, and promoting livelihoods among rural communities. However, despite this wide recognition, the adoption rate and use of agroforestry technologies remains low in Vihiga County, Kenya, owing to various challenges farmers face. Therefore, the overarching goal of this study was to synthesize and document the various socioeconomic, institutional, ecological, and policy-related challenges facing agroforestry technology farmers in Vihiga County, Kenya. The study assumed a descriptive study design based on primary and secondary data. The sources for primary data for this study were key informants' interviews, questionnaires, and observation. The results indicated that the main challenges facing agroforestry farmers in the study areas are land shortage (60%), lack of capital (15%), lack of seeds/seedlings (8%), competing land use (8%), lack of extension services (6%) and inadequacy of the technologies to sustain livelihoods (3%). Marketing constraints were also evaluated separately, and the results indicated that the key challenges limiting the sale of agroforestry products include poor prices (49%), high transport costs (19%), and competition from similar producers (12%), inadequate market information (13%), and exploitative middlemen (7%). Farmers' recommendations in resolving these challenges include improving farmers' access to agroforestry inputs (35%), provision of credit incentives (28%), and harmonization of land tenure policies (37%). In consonance with these findings, the study recommends a multifaceted approach involving various stakeholders both from the private sector in assessing the barriers to agroforestry development and designing strategies to streamline the identified challenges.

Keywords: Agriculture; Agroforestry technologies; Sustainable livelihoods; Kenya.

INTRODUCTION

One of the most significant challenges encountered by development practitioner and policymakers is meeting the rural developmental needs while ensuring environmental sustainability ensuring environmental sustainability for positive socioeconomic and ecological outcomes. According to Singh and Singh (2023), in most cases, conventional development approaches have often emphasized economic development with little attention given to ecological perspective, which is a critical component of sustainable development. Consequently, this has often led to unsustainable livelihoods and increased poverty, especially among the rural communities dependent on natural resources (Endeki *et al.* 2023; Jebiwott *et al.* 2016; Wei *et al.* 2023). According to a report by the World Bank, poverty in developing countries is concentrated in rural areas, with 75% of the moderate poor and 80% of the extreme poor living in rural areas (Castaneda *et al.* 2016). This calls for programmatic initiatives to offer sustainable livelihoods for rural communities. Based on this background, sustainable agriculture has been acclaimed as one of the most positive approaches to meeting rural development needs, significantly alleviating poverty. The Sustainable Livelihood Framework (SLF) supports the underlying goal of sustainable agriculture through identifying various resources that rural communities can harness to maximize productivity while ensuring sustainability (Mbatha *et al.* 2021). As part of sustainable agriculture, agroforestry technologies have been endorsed as a critical approach to addressing rural poverty since they support the core pillars of sustainability: environmental, social, and economic sustainability which promotes ecological conservation, livelihood resilience and equitable growth (Makindi 2024; Singh and Singh 2023).

Different studies conducted globally over the years have provided empirical evidence and consolidated comprehensive literature on the impact and contribution of agroforestry technologies in supporting the livelihoods of farmers in rural areas (Awano 2012; Endeki *et al.* 2023; Hanif *et al*. 2018; Muthee *et al*. 2022; Ndalama *et al.* 2015; Quinion *et al.* 2010). For example, in emphasizing the significance of agroforestry technologies, Atangana *et al.* (2013) and Makindi (2024) point out that agroforestry supports agricultural livelihood outcomes through soil conservation and water management. Similarly, Abbas *et al.* 2017, Jebiwott *et al.* 2016, and Wanjira and Muriuki 2020 highlight that agroforestry technologies are crucial in climate change mitigation, primarily through carbon sequestration.

From a broader perspective, agroforestry technologies aim to boost land productivity and diversify production, thus promoting reliability in revenue streams that farmers accrue from the sale of various products while ensuring environmental sustainability. Aside from the specific benefits, agroforestry technologies support SDGs 1,2,12, and 15, which aim to eradicate poverty, achieve zero hunger, ensure responsible consumption and production, and promote life on land, respectively (Octavia *et al.* 2022). According to Nair *et al.* (2021), the commonly adopted agroforestry technologies include woodlots, home gardens alley farming, *taungya system*, boundary tree planting, hedgerow intercropping, fodder banks, and improved fallows, among others. Farmers globally have introduced and adopted these technologies because of their diverse benefits.

Despite the well-established and documented environmental and economic benefits of agroforestry technologies, situational analysis of trends of agroforestry technologies adoption indicate that the uptake of agroforestry continues to be low owing to various constraints (Kpoviwanou *et al.* 2024; Mercer 2004). Most research works over the years have comprehensively investigated the influence of socioeconomic factors on the adoption of agroforestry technologies, such as age, gender, level of education, marital status, income, land size, and the adoption of agroforestry technologies among farmers (Kabwe *et al.* 2009; Magugu *et al.* 2018; Nkamleu and Manyong 2005). However, there is skewed and inadequate information on site-specific factors impeding the use and adoption of agroforestry technologies. Moreover, Kiptot (2007) highlights that most studies on agroforestry technologies have concentrated on quantitative methods and outcomes, and therefore, they have failed to link their findings to socioeconomic, institutional, and political factors and explain how these factors affect farmers who have embraced or are in the process of adopting agroforestry technologies. In addressing this gap, Prabawani *et al.* (2024) suggest that it is vital to investigate and consider the various social, economic, environmental, policy, and institutional constraints that impact farmers. Moreover, depending on geographical locations and population dynamics, the challenges encountered by agroforestry technologies farmers may be unique (Kiyani *et al.* 2017). Therefore, the scientific community need to conduct impartial and site-specific studies to identify the various problems that agroforestry farmers face. Moreover, to arrive at the sustainable solutions to identified problems, there is a need for concerted efforts among the relevant institutions and farmers.

In Vihiga County, Kenya, the agroforestry outcomes reflect the global scenarios and trends, as impacted by various socioeconomic, political, institutional, and environmental constraints. Vihiga is one of the Counties in Kenya with a high population density recorded as 1,047 persons per square kilometer KNBS (2019). According to KNBS (2023), in 2021 the poverty rate in Vihiga stood at 48.8%, higher than the national poverty rate of 38.6%. High population density and high poverty levels have mounted pressure on land and forest resources essential to supporting livelihoods. This has led to land fragmentation and destruction of forests, consequently presenting negative impacts on the environment and agricultural production (RoK 2013). Declining soil fertility, land degradation, land fragmentation, climate variability, and low adoption of new farming technologies contribute to low agricultural production, hence high poverty in the Count. Studies also reveal that despite having favorable climatic conditions and other ecological factors that support agroforestry technologies, agroforestry technologies are inadequately adopted by households in Vihiga County (RoK 2013). Further, foregrounding this low agroforestry technologies adoption outcome, Kiptot *et al.* (2007) highlight that in an experimental study that aimed to introduce improved fallows agroforestry technology among farmers in Vihiga and Siaya counties, fewer farmers in Vihiga County compared to Siaya County embraced the technology.

In an effort to appraise agroforestry technologies among resource-constrained farmers in the study area, there is a need to identify and address the shared obstacles that face agriculture production. Currently, agricultural production, in its complexity, is affected by climate change, soil degradation, limited access to markets, infrastructure deficiencies, poor land tenure systems, and wide adoption of unsustainable agricultural production practices (Singh and Singh 2023; Murken and Gornott 2022; Usman and Haile 2022; Gomiero 2016). These challenges unequivocally affect agroforestry production in the study area. However, empirical evidence suggests that agroforestry technologies can significantly lessen some common challenges agricultural production faces, especially the challenges of

DOI: https://doi.org/10.55706/jae1801

land degradation and unsustainable land use systems (Ollinaho and Kröger 2021).

In view of the provided background, this paper investigates and documents the challenges facing agroforestry technologies farmers in Vihiga County Kenya using the sustainable Livelihoods Framework. In the context of this study, the fundamental aim of SLF is to identify challenges that hinder people from utilizing livelihood assets across natural, social, financial, and physical capital domains (Chambers and Conway 1992). For example, the physical capital challenges impeding the widescale adoption and use of agroforestry in supporting livelihoods include poor infrastructure, limited access to seedling and weak market linkages. Similarly, natural capital challenges include land scarcity and soil degradation while human capital challenges include limited technical knowledge and skills on optimal use of agroforestry technologies and inadequate access extension services (Tranchina *et al.* 2024). All the identified challenges limit the efficiency in the use of livelihood capital proposed by the SLF and therefore need to be identified and addressed.

The information harmonized through this undertaking is critical in providing invaluable insights regarding study site barriers to the widescale adoption of agroforestry technologies including socioeconomic, technological, and knowledge gaps in agroforestry technologies adoption. Such discovery will be critical in inform the approaches that can be used to encourage farmers to adopt agroforestry technologies for positive and sustainable livelihood outcomes. Additionally, the study contributes to Kenya National Agroforestry Strategy 2021-2030 which aims to identify the policy and institutional, socioeconomic and market challenges as well as climate and land use pressures that agroforestry technology farmers face. Most importantly, study provides farmer-centered solutions and recommendation to address the challenges associated with the uptake of agroforestry technologies. Such information can be used as reference point for agroforestry technology development in other areas with similar characteristics.

MATERIALS AND METHODS

Location and Geography of the Study Area

Vihiga County is found in the Western part of Kenya. It covers an area of approximately 531 square kilometers. The County lies on latitude 0°, and 0°, 15°' North and longitude 34°, 30° and 35°, 0° East (Figure 1). It is bordered to the East by Nandi County, Kakamega to the North, Siaya to the West and Kisumu to the South. The landscape of Vihiga County mainly comprises of hills and valleys with an altitude range of 1300 to 1800 meters above sea level. The County consists of four sub counties namely Luanda, Emuhaya, Hamisi, Vihiga and Sabatia sub counties. Statistics from the 2019 census indicate that population of Vihiga county is estimated to be 590,013 people. Conversely, the County has a population density of 1,110 people per square kilometer (KNBS 2019).

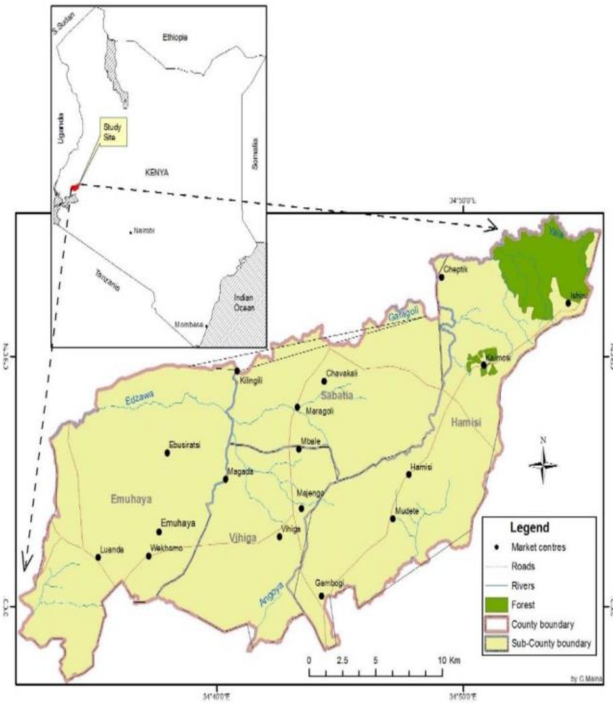

Figure 1. Map of Vihiga County (Source: www.diva-gis.org)

Vihiga county rainfall pattern is bimodal. The study area therefore receives long rains between March and May and short rains between October and December. The average annual rainfall received is 1800-2000mm. The economic activities undertaken in the county include small scale trading, artisan work and handicrafts, mining and quarrying, agro-processing and agriculture. Agricultural production is the main economic activity of Vihiga County. The region cultivates crops like maize, beans, millet, sweet potatoes, cassava, and sorghum and horticultural crops. Cash crop production is also predominant with tea being the main cash crop. Other agricultural activities include dairy and poultry farming.

Sampling Procedure

A multi-stage sampling design was adopted for this study. Hamisi and Sabatia sub counties were selected because of their agroecological zones and good topography. Additionally, the two sub counties proximity to Kakamega and Kibiri forests guarantees support and transmission of ecological knowledge that encourages agroforestry practices among farmers. Two villages from each of the selected sub counties were randomly chosen for the study. Households were then randomly selected in the four villages. The study mainly used household heads as respondents.

Sample Size

The study used a sample size of 110 households which was arrived at using the formulae;

$n = NC^2/C^2 + (N-1)\,e^2$

Where,

n is the required sample size

N is the population size in study area

DOI: https://doi.org/10.55706/jae1801

C is the coefficient of variation, ranging between 20 and 30%
e is the error margin (ranging between 0.02-0.05)

A coefficient of variation of 21% and a standard error of 2% was used for this study (Nassiuma 2000). The total number of households (N) in Vihiga County 123,347, C =21% and e =2%. Therefore, the total number of households (n) 110 (Table 1).

Table 1. Households sampled in each Sub County

Sub location	Population	Number household	Sample size
Hamisi	148,259	32,096	59
Sabatia	129,678	27,742	41
Total	277,937	59,838	110

Data Collection

Primary data was collected through personal observations and administration of a semi-structured, pre-tested questionnaire to household heads. Key Informant Interviews (KII) were used to complement the data gathered from the questionnaire survey. The key informants included two (2) extension officers from Nongovernmental organizations (NGOs); Sustainable Organic farming Initiative (SOFDI) and One Acre Fund Organizations (OAFO) and Five (5) personnel from the government sector including Forestry officer from Kenya Forest Service (KFS), Kibiri, Sabatia Sub County Crops Development officer from the Ministry of Agriculture (MoA), Ecosystem Conservator and Kenya Forestry Research Institute (KEFRI) extension officer. Data was collected on the general constraints to agroforestry technologies by asking respondents to highlight the key challenges that limit their adoption and use of agroforestry technologies to sustain their livelihoods. Similarly, data on market constraints was collected separately. The key market information gathered included where farmers sold their products, which channels they used and the challenges they encountered while selling their products

Data Analysis

Data was analyzed using Statistical Package for the Social Sciences software (SPSS) through descriptive statistics. Descriptive analysis was used to investigate the various constraints encountered by agroforestry farmers. The findings of the study were presented through frequency distribution tables and a text box.

RESULTS AND DISCUSSION

Constraints to Agroforestry Technologies

The majority of the respondents, 60% of the responses, articulated that land shortage was a significant hindrance to adopting agroforestry technologies (Table 2). On the other hand, 15% of farmers expressed that the lack of capital to purchase farm inputs and sustain these technologies was a limitation. Only 7% of farmers pointed to the lack of extension service as a significant challenge, whereas 9% of the responses indicated that the lack of seedlings/seeds and competing land use systems proportionately affected their agroforestry technologies production activities. An insignificant number of the farmers (3%) stated that they could not fully exploit these technologies because they believed the technologies could not meet their needs.

Table 2. Constraints to agroforestry technologies

Agroforestry technologies challenges	Frequency (n)	Percentage (%)
Land shortage	65	60
Lack of capital	16	15
Limited access to extension services	7	6
Limited access to seeds/seedlings	9	8
Competing land use system	9	8
Inadequate to sustain livelihoods	3	3

Land Shortage

The average land size was 1.4 ha (table 3), which is relatively small considering the household sizes and the competing land use systems such as crop production. These findings agree with the government's report (RoK 2013), which identified land shortage and fragmentation as one of the major limitations to the adoption of agricultural technologies in the study area. Lambert and Ozioma (2011), Kabwe (2010), and Zeleka (2009) agree with these findings, stating that farmers with small pieces of land tend to choose activities that will yield benefits within a short period, such as food crop production to get maximum utility from the small pieces of land they own.

However, even with the small land sizes, it is still feasible for small-scale farmers to integrate agroforestry technologies on their land. Supporting such outcomes, Mugure *et al.* (2013) posit that, in a study conducted in the neighboring Kakamega County, approximately 80% of farmers have planted trees on 25% of their lands despite owning small land sizes. In situations where land size is a significant challenge, farmers can use agroforestry technologies to complement food crop production rather than replacing their already established crop-planted acreage (Persha *et al.* 2015). Complementary approaches can include adopting nitrogen-fixing tree species and using to them to enrich the soils. For the effective implementation of such strategies, there is a need to intensify extension service delivery to facilitate knowledge dissemination on agroforestry technologies, product diversification, and land use systems for optimum utility.

Land Tenure

The findings of the study shows that most common method of land acquisition was through inheritance, accounting for 75% of the responses (Table 3). The results also indicate that 22% of the respondents reported that they bought their land, while 3% lived on leased land. Concerning land entitlement and ownership, only 39% of the respondents

DOI: https://doi.org/10.55706/jae1801

had title deeds, while the majority (61%) did not have title deeds. Regarding land size, the results show that 32% of the respondents had less than 1 acres of land, while 50% had a land size of 1-2 acres. Only 18% of the sampled population had more than 2 acres of land.

Table 3. Land Tenure and Land Size

Variable	Frequency (n)	Percentage (%)
Land acquisition		
Purchased	24	20
Inherited	83	78
Rented	3	2
Title deeds ownership		
Yes	42	38
No	68	62
Size of land (acres)		
0.1-1	35	39
1.1-2	55	43
2.1-3	14	10
>3	6	8

The negative implications of land shortage, primarily through land fragmentation, have a cross-cutting effect on land tenure systems. The study indicated that most respondents did not have secure land tenure since most of the land they used for agricultural production was inherited. The land acquisition method, mainly patrilineal inheritance systems, validates the fewer responses for title deed possession. Such land use rights limited their capacity to invest and partake in projects such as agroforestry practices. Norton (2004) established that land tenure limits farmers from investing in agroforestry technologies because of the lengthy testing periods, adoption, and eventual reaping of the benefits. This is further supported by Chitakira and Torquebiau (2010) and Kabwe (2010), who revealed that most farmers are only willing to invest in land that they feel has security regarding ownership and freedom of use. The rationale is that farmers fear losing land use rights before they can reap benefits. Instead, they focus on short-term land-use projects like food crop production.

In a study evaluating land ownership and its impacts on adopting agroforestry technologies, Mugure *et al.* (2013) assert that if farmers do not have security over land, adopting sustainable technologies such as agroforestry becomes out of the question. This study also indicates that most farmers had acquired land through inheritance and were not given title deeds. Maguire *et al.* (2013) highlight that when farmers do not have land title deeds, they shy away from investing in long-term agricultural practices. Retrospectively, secure land tenure is crucial for broad adoption of agroforestry technologies. Therefore, solutions aiming to streamline land tenure systems in Vihiga County, characterized by the complexity of land fragmentation owing to high population density, should revolve around land reforms, redefining legal rights for land use and incentivizing the long-term sustainable use of land for small-scale farmers.

Extension Services

The results show that only 19% of the sampled farmers were aware of the existence of agroforestry extension centers or were able to access extension services while 81% stated that they were not aware of extension services in the study area (Table 4). In addition, majority of the respondents (76%) indicated that they got extension services from NGOs while only 24% received extension services from the government. This included KFS and County government. This implies that access to extension services from the government is low and extension service delivery is not regular; therefore, most farmers preferred NGOs and other private sources that were readily available.

Table 4. Extension services

Characteristics	Variable	n	%
Presence of extension services	Yes	21	19
	No	89	81
Extension service provider	Government	3	24
	NGOs	9	76

Both agricultural officers and extension officers from the NGOs pointed out that they were limited in terms of workforce and that they could not pay regular visits to the farmers. This is in line with the findings by Scherr and Franzel (2002), who identified inadequate training among extension workers, limited extension resources, particularly human resources to reach out to farmers, and unclear responsibilities for agroforestry extension service officers, particularly between agriculture and forestry extension departments as the significant challenges limiting efficient delivery of the extension services. Such inadequacies in the extension service provision have impacted the capacity of farmers in the study area to gain the technical know-how on properly implementing agroforestry practices such as tree species selection and diversification of agroforestry production. As a result, farmers have failed to achieve optimal utility from agroforestry technologies.

However, it was worth noting that farmers could identify SOFDI and One Acre Fund, which work in collaboration with World agroforestry Center (WAC) as leading NGOs that have spearheaded agroforestry projects in the study area by offering agroforestry extension services. The two organizations have conducted extensive research and advised farmers on lucrative tree species based on farmers' needs and resources. However, there is a need to encourage collective action to ensure comprehensive extension service delivery. Basamba *et al.* (2016) highlighted that refining the quality of extension service delivery should be directed towards coverage and regularity of delivery of these services. This should consider the socioeconomic status of farmers and their needs as well as the biophysical aspects of the technologies. Similarly, Matata *et al.* (2010) state that regular extension contact with farmers significantly instills a positive attitude towards adopting new technologies.

DOI: https://doi.org/10.55706/jae1801

Seeds and Seedlings

The result (Table 5) show that a half of the respondents own tree nurseries where they get their seedlings while 36% of the respondents reported that they purchase their seedlings from either other farmers or private entities. Only 8% of the sampled population was able to get seedlings from Kenya forestry service and KEFRI at Maseno. Another 5% get donated seedlings from NGOs such as SOFDI and One Acre Fund as well as from other farmers.

Table 5: Table source of seedlings for agroforestry technologies

Source of Seedlings	**Frequency**(n)	**Percentage** (%)
Own tree nursery	53	51
Purchase	44	36
Government nursery (KFS, KEFRI)	8	8
Donation	5	5

The study results indicated that many respondents bought seedlings for agroforestry technologies, which were costly. These findings concur with those of Adedayo and Sobolo (2014), who revealed that the availability of seedlings was one of the hindrances to the adoption and upscaling of agroforestry technologies among rural farmers. Interviews with key informants also indicated that tree/shrub production was limited by the few numbers of trees/shrub species available for integration in agroforestry technologies. Supporting these sentiments, the crop development officer pointed out that aside from the fruit trees, *Grevillea robusta* and *Eucalyptus spp* were the study area's only commonly planted tree species. This scenario indicates farmers lack access to quality and diverse seed and seedlings for agroforestry production. This limits farmers' seed accessibility, hindering the adoption of agroforestry technologies. According to Nyoka *et al.* (2011), most resource-constrained farmers rely on government agricultural and forestry extension departments and NGOs to provide seeds and seedlings for agroforestry production. However, such programmes are often inconsistent and inadequate in meeting farmers' demands. Without access to seedlings and seedlings, farmers usually have resolved to adopt unsuitable and low-yielding tree/shrub varieties that fail to meet their agroforestry technologies production needs

Lack of Capital

Lack of capital (15%) was identified as one of the hindrances to the adoption of agroforestry technologies (Table 2). Availability of capital influences acquisition of agroforestry inputs such as Seed/seedlings which are the major input in the establishment of agroforestry technologies. These findings are in line with that of Sunderlin et al., (2008) who identified capital as one of the limitations to the adoption of agroforestry technologies among farmers through hindering investment in essential inputs such as improved seedlings, fertilizer and other. Similarly, Tranchina *et al.* (2024) highlights that most farmers lack upfront financial resources to invest in new agroforestry technologies and this limits farmers uptake of these technologies. There, capital incentives complemented by trainings can be pivotal in encouraging farmers to adopt agroforestry technologies.

Market Constraints

A majority of farmers (49%) identified poor market price for agroforestry products as major marketing challenge followed by high transport costs (19%) (Table 6). Some farmers (12%) pointed out that competition from other producers, inadequate market information (13%) and exploitation from the middle men (7%) were the major inhibitors to the effective sale of agroforestry products and profit realization for livelihood improvement.

Table 6: Constraints in marketing agroforestry technologies

Variable	**Frequency (n)**	**Percentage (%)**
Poor price	37	49
High transport cost	14	19
Competition	9	12
Inadequate market information	10	13
Exploitative middlemen	5	7

The study revealed that most farmers sold agroforestry products, such as fruits, timber, and fuelwood, mainly at the village market. However, the respondents disclosed that challenges of poor prices, high transport costs, competition from other producers, inadequate market information, and exploitation of farmers by intermediaries limit the sale of agroforestry products. The current findings are congruent with the findings of Ibrahim *et al.* (2019), who identified market structure complexities as a significant problem facing agroforestry farmers. A study in Uganda by Agea *et al.* (2005) on marketing of agroforestry products identified various factors to be major hindrances towards efficient marketing of smallholder farmers' agroforestry product. These included; lack of information and linkages among farmers, poor pricing policies, high taxes, high transport costs and poor storage facilities. Earlier studies by IFAD (2001) identified poor road infrastructure, poorly functioning markets for agroforestry commodities, and the lack of post-harvest technologies as significant hindrances to the maximum benefits of agroforestry technologies among farmers.

In support of the outlined findings, an interview with the SOFDI extension officer revealed that getting a ready market for farmers' produce was a significant challenge. Conversely, the Sabatia Sub- County Crop Development Officer stated that farmers faced substantial difficulties caused by exploitative intermediaries and agroforestry products price fluctuation. The officer also pointed out that the farmers lacked formal groups to sell their agroforestry products and this negatively impacted their bargaining power, hence poor product prices. This is supported by Agea

DOI: https://doi.org/10.55706/jae1801

et al. (2005), who pointed out that selling agroforestry products individually does not attract reasonable market prices. A more recent study in Cameroon by Gyau *et al.* (2014) proposes Collective Action as an important strategy that can increase market access for smallholders. According to the study, collective action helps farmers to pool market risks and enable small-scale farmers with little production capacities to gain entry into the markets.

Text box 1: KII information on the constraints to agroforestry technologies

> "Transfer of land ownership rights is a significant problem in this area since land ownership is mainly through inheritance. This significantly hinders the adoption of agroforestry technologies and other sustainable technologies since farmers lack land security. The land cost has also increased over the years, making it difficult for farmers to acquire land for agroforestry technologies. Agroforestry technologies, especially those that use *eucalyptus* species as the main component, have been associated with effects on soil fertility, reducing agricultural production. Eucalyptus species are also associated with the draining of water sources. This has particularly negatively influence farmers' attitudes towards agroforestry technologies. Farmers also face the challenge of accessing tree seeds/seedlings for agroforestry technologies production. This is attributed to the cost of purchasing these planting materials. Marketing agroforestry technologies products is another challenge facing farmers in terms of the lack of formal groups to market their products; hence, farmers are being exploited since individual sales compromise the bargaining power of farmers. For instance, the market cost of *Persea americana* (avocado) could rise to KES 30 per fruit while intermediaries still get the same products from farmers at KES 5 per fruit. Farmers also lack direct access to the market due to a lack of information, poor infrastructure, and high transport costs. There is also problem of inefficient delivery of extension services since the number of extension officers cannot meet the needs of individual farmers."

Text box 1 shows a review by the Sabatia Sub County Agricultural Development Officer on the various challenges facing farmers practicing agroforestry technologies. The major challenges discussed included limited number of tree species that are suitable for the study area hence farmers are left with the option of *Eucalyptus spp* which is associated with various biophysical problems such as draining of water sources and deprivation of soil nutrients hence affecting soil fertility. Other challenges pointed out by the Sub County agricultural officer included: limited farmers' access to seedlings, poor strategies for marketing of agroforestry technologies products and inadequate provision of extension services to farmers.

Other Constraints

Other constraints identified include competing land use systems and inadequacy of agroforestry technologies production to sustain livelihoods. These are related to farmers' perceptions and attitudes towards agroforestry technologies. The possible explanation is that most farmers in the study area perceived agroforestry technologies as long-term projects that could not be tuned to meet their immediate needs. Similar findings by Ajayi (2007) show that farmers tend to invest in farming technologies that yield immediate benefits. production. Competing land use systems are evident in the study area in that most farmers practice livestock farming, crop production, and agroforestry technologies on the same piece of land. This, coupled with the land shortage problem in the study area, is a significant disincentive towards agroforestry production.

Farmers' Suggestions for Resolving Constraints to Agroforestry Technologies.

Majority of the respondents (37%) recommended that there is need to promote policies which advocate for agroforestry technologies (Table 7). In close association, 35% of the farmers suggested that there is need for stakeholder to promote incentives that will improve farmers' access to agroforestry technologies inputs. Other recommendations included providing farmers with credit to help them invest in these technologies (28%).

Table 7. Enabling factors for agroforestry technologies

Enabling factor	Frequency (n)	Percentage (%)
Positive policies for agroforestry technologies	12	37
Improving farmers access to agroforestry inputs	38	35
Providing farmers with credit	31	28

Farmers recommendation on the matter of credit provision was cite some stakeholders cited as a disincentive to promoting agroforestry technologies because it promotes laxity among farmers. KEFRI and SOFDI extension officers indicated that using credit and handouts to promote agroforestry technologies among farmers had not yielded positive results from the previous years' experience since farmers only attended the extension meetings when such incentives were guaranteed and they mostly invested in farming technologies that yielded returns in short period. These findings are congruent with Foresta (2013), which revealed that financial incentives do not guarantee the adoption of agroforestry technologies in the long run and, therefore, should be restricted at initial stages of agroforestry

DOI: https://doi.org/10.55706/jae1801

technologies promotion among farmers to create conditions that propel farmers to pursue agroforestry technologies. Mwase *et al.* (2015) also contend that using incentives in the form of cash does not guarantee the uptake of agroforestry technologies because it only stimulates initial engagement, and, in most cases, farmers may abandon the technology when the incentives are withdrawn. Therefore, extension services should direct resources toward promoting profitable agroforestry technologies without focusing on providing subsidies and incentives. In compelling cases, such as when dealing with early adopters of new and unfamiliar technologies, Foresta (2013) proposes using financial handouts to be terminated once farmers get the taste of the benefits that accrue from these technologies.

Other recommendations included developing policies that advocate for agroforestry technologies, improving farmers' access to inputs of agroforestry technologies such as seedlings, and harmonizing land tenure policies. The mentioned recommendations are in line with those of FAO (2013). Similarly, the study by Ajayi *et al.* (2006) revealed that the promotion and eventual development of agroforestry technologies are embedded in the efficiency of legal, institutional arrangements, and policy issues. Therefore, there is a need for a multifaceted approach to mainstream policy issues to provide farmers with the support needed to scale up the uptake of agroforestry technologies.

CONCLUSION

Land shortage was identified as the major constraint to adopting agroforestry technologies in the study area. Additionally, the market structure for agroforestry technologies in the study area is not well defined, which hinders farmers from finding profitable outlets for agroforestry technologies. Correspondingly, extension services delivered by the government are inadequate in reaching out to farmers. However, NGOs in the study area have made great strides in promoting agroforestry technologies among farmers. Farmers get extension services from non-governmental organizations such as SOFDI and One Acre Fund. Formal groups such as community-based Organizations (CBOs), although present, are inactive; hence, their role in the promotion of sustainable agricultural technologies is insignificant.

Consequently, this study recommends key policy reforms related to agroforestry that will rectify extension service delivery and the market structures for agroforestry products. These include budgetary allocation for extension officers, intensification of extension services on agroforestry technologies, product value addition, and knowledge of marketing agroforestry technologies. Other policy reforms include harmonization of land tenure and tree tenure policies and identifying institutions that will help farmers acquire title deed. Similarly, membership of farmers in formal groups such as CBOs and marketing cooperatives can be instrumental in agroforestry technologies knowledge dissemination and will allow farmers to access competitive markets for agroforestry products. The study also endorses a multifaceted approach involving various government and private sector stakeholders. Such collaborations will aid a better understanding of the barriers to agroforestry development and support efforts in designing strategies to mainstream some of the challenges facing farmers in the study area.

Acknowledgement

The authors acknowledge Egerton University, Kenya for supporting this study and all the officers from several institutions like KEFRI, SOFDI, KFS and One Acre Fund, farmers and community members who participated in the interviews, discussions and administration of the questionnaires.

Conflict of Interest

There are no conflicts of interest declared by the authors.

REFERENCES

Abbas, F., Hammad, H.M., Fahad, S., Cerdà, A., Rizwan, M., Farhad, W., Ehsan, S., and Bakhat, H.F. 2017. Agroforestry: a sustainable environmental practice for carbon sequestration under the climate change scenarios-a review. Environmental Science and Pollution Research, 24(12): 11177–11191.

Adedayo, A.G and Sobolo, O.O. 2014. Famers' perception of agroforestry practices in Osun State, Nigeria. Forest Research Open Access Journal, 3 (127).

Agea, E. Ssebuliba and Obaa, I. 2005. Marketing of agroforestry products in Nama sub-county Mukono district, Uganda. African Conference Science Proceedings, 7: 537–540.

Ajayi, O.C. 2007. User Acceptability of Sustainable Soil Fertility Technologies: Lessons from Farmers' Knowledge, Attitude and Practice in Southern Africa. Journal of Sustainable Agriculture, 30(3): 21-40.

Ajayi, O.C., Akinnifesi, F.K., Mitti, J.M., DeWolf, J.J., Matakala, P.W. and Kwesiga, F.R. 2006. Adoption of Agroforestry technologies in Zambia: Synthesis of key findings and implications for policy. Proceedings of Agricultural consultative forum policy and stakeholders workshop, Lusaka, Zambia, 7 December 2006. 31pp.

Atangana, A., Khasa, D., Chang, S., and Degrande, A. 2013. Agroforestry for Soil Conservation. Tropical Agroforestry, 203–216.

Basamba A.T, Mayanja, C., Kiiza, B., Nakileza, B., Matsiko, F., Nyende, P., Kukunda, E., Tumushabe,A., and Ssekabira, K. 2016. Enhancing Adoption of Agroforestry in the Eastern Agro-Ecological Zone of Uganda. International Journal of Ecological Science and Environmental Engineering, 3 (1): 20-31.

Chitakira, M., and Torquebiau, E. 2010. Barriers and Coping Mechanisms Relating to Agroforestry Adoption by Smallholder Farmers in Zimbabwe. The Journal of Agricultural Education and Extension, 16(2): 147–160.

Castaneda, R., Doan, D., Newhouse, D.L., Nguyen, M., Uematsu, H. and Azevedo, J.P. 2016. *Who are the Poor in the Developing World?* Social Science Research Network.

DOI: https://doi.org/10.55706/jae1801

Endeki, R., Inoti, S.K. and Makindi, S.M. 2023. Impacts of agroforestry technologies on livelihood improvement in Vihiga County, Kenya. International Journal of Scientific Research Updates, 5(1): 001-011.

FAO. 2013. WFP, the State of Food Insecurity in the World 2013. The multiple dimensions of food security, 214.

FAO. 2009. Criteria and indicators for sustainable woodfuels, 274.

Gomiero, T. 2016. Soil Degradation, Land Scarcity and Food Security: Reviewing a Complex Challenge. Sustainability, 8(3): 281.

Gyau, A., Franzel S., Chiatoh, M., Nimino, G. and Owusu, K. 2014. Collective action to improve market access for smallholder producers of agroforestry products: Key lessons learned with insights from Cameroon's experience. Current Opinion in Environmental Sustainability, 6(1), 68–72

Hanif, A., Roy, R.M., Bari, S., Ray, P.C., Rahman, S. and Hasan, F. 2018. Livelihood Improvements through Agroforestry: Evidence from Northern Bangladesh. Small-Scale Forestry, 17(4): 505–522.

Ibrahim, A.O., Adedeji, A.S., and Meduna, P.N. 2019. Constraints facing agroforestry practices among farmers in New Bussa, Nigeria. Journal of Research in Forestry, Wildlife and Environment, 11(3): 133–141.

Jebiwott, A., Ogendi, G.M., Makindi, S.M., and Esilaba, M.O. 2019. Forest cover change and its impacts on ecosystem services in Katimok forest reserve, Baringo County, Kenya. In W. Leal Filho (Ed.), *Handbook of Climate Change Resilience.* Springer Nature, Switzerland AG 2019.

Kabwe, G. 2010. Uptake of agroforestry technologies among smallholder farmers in Zambia.

Kabwe, G., Bigsby, H.R. and Cullen, R. 2009. Factors influencing adoption of agroforestry among smallholder farmers in Zambia. 2009 New Zealand Agricultural and Resource Economics Society (Inc.) Conference.

Kiptot, E., Hebinck, P., Franzel, S. and Richards, P. 2007. Adopters, testers or pseudo-adopters? Dynamics of the use of improved tree fallows by farmers in western Kenya. Agricultural Systems, 94(2): 509–519.

Kiyani, P., Andoh, J., Lee, Y. and Lee, D.K. 2017. Benefits and challenges of agroforestry adoption: a case of Musebeya sector, Nyamagabe District in southern province of Rwanda. Forest Science and Technology, 13(4): 174–180.

KNBS. 2023. The Kenya Poverty Report: Based on the 2021 Kenya Continuous Household Survey. pp. 27-31.

KNBS. 2019. 2019 Kenya Population and Housing Census: Population by county and subcounty

Kpoviwanou, M.A., Sourou, B.N.K. and Ouinsavi, C.A.I.N. 2024. Challenges in adoption and wide use of agroforestry technologies in Africa and pathways for improvement: A systematic review. Trees Forests and People, 17: 100642–100642.

Kumar Singh, S., and Singh, G. 2023. Agroforestry for Sustainable Development: Assessing Frameworks to Drive Agricultural Sector Growth. Environment, Development and Sustainability.

Lambert, O. and Ozioma, A.F. (Eds.). 2012. Adoption of Improved Agroforestry Technologies among Contact Farmers in Imo State, Nigeria. Asian Journal of Agriculture and Rural Development.

Makindi, S.M. 2024. Community Lessons on Participatory Forest Management Performance within the Mau Forest Complex, Kenya. East African Journal of Forestry and Agroforestry, 7(1), 442-452.

Magugu, J.W., Feng, S., Huang, Q. and Ototo, G.O. 2018. Socio-economic factors affecting agro-forestry technology adoption in Nyando, Kenya. Journal of Water and Land Development, 39(1): 83–91.

Matata, P., Ajayi, O.C., Oduol, P.A. and Agumya, A. 2010. Socio-economic factors influencing adoption of improved fallow practices among smallholder farmers in western Tanzania. African Journal of Agricultural Research, 5(8): 818–823.

Mbatha, M.W., Mnguni, H., and Mubecua, M.A. 2021. Subsistence Farming as a Sustainable Livelihood Approach for Rural Communities in South Africa. Africanus Journal of Development Studies, 11(3), 55–75.

Mercer, D.E. 2004. Adoption of agroforestry innovations in the tropics: A review. Agroforestry Systems, 61-62(1-3): 311–328.

Mugure, A., Oino, P.G. and Mwori, S. 2013. Land Ownership and its Impact on Adoption of Agroforestry Practices among Rural Households in Kenya: A Case of Busia County. International Journal of Innovation and Applied Studies, 4(3): 552–559.

Murken, L. and Gornott, C. 2022. The importance of different land tenure systems for farmers' response to climate change: a systematic review. Climate Risk Management, 100419.

Muthee, K., Duguma, L.A., Majale, C., Mucheru-Muna, M., Wainaina, P. and Minang, P.A. 2022. A quantitative appraisal of selected agroforestry studies in the Sub-Saharan Africa. Heliyon, 8(9).

Mwase, W., Sefasi, A., Njoloma, J., Nyoka, B.I., Manduwa, D. and Nyaika, J. 2015. Factors Affecting Adoption of Agroforestry and Evergreen Agriculture in Southern Africa. Environment and Natural Resources Research, 5(2).

Nair, P. K. R., Kumar, B. M. and Nair, V. D. 2021. An Introduction to Agroforestry. Springer International Publishing.

Nassiuma, D.K. 2000. Survey sampling. Theory and Methods, 10.

Ndalama, E., Kamanga-Thole, G., and Missanjo, E. 2015. Agroforestry Contribution to the Improvement of Rural Community Livelihoods in Balaka, Malawi. International Journal of Forestry and Horticulture, 1(1): 5–11.

Nkamleu, G.B. and Manyong, V.M. 2005. Factors affecting the adoption of agroforestry practices by farmers in Cameroon. Small-Scale Forest Economics, Management and Policy, 4(2): 135–148.

Norton, R.D. 2024. Agricultural Development Policy: Concepts and experiences. FAO.

Nyoka, B.I., Mng'omba, S.A., Akinnifesi, F.K., Ajayi, O.C., Sileshi, G. W., and Ramni Jamnadass. 2011. Agroforestry Tree Seed Production and Supply Systems in Malawi. Small-Scale Forestry, 10(4): 419–434.

Octavia, D., Suharti, S., Murniati, D.I.W.S., Nugroho, H.Y.S.H., Supriyanto, B., Rohadi, D., Njurumana, G.N., Yeny, I., Hani, A., Mindawati, N., Suratman, A.Y., Prameswari, D., Hadi, E.E. ., and Ekawati, S. 2022. Mainstreaming Smart Agroforestry for Social Forestry Implementation to Support Sustainable Development Goals in Indonesia: A Review. Sustainability, 14(15): 9313.

Pandit, B., Shrestha, K., and Bhattarai, S. 2014. Sustainable Local Livelihoods through Enhancing Agroforestry Systems in Nepal. Journal of Forest and Livelihood, 12(1).

Persha, L., Mercedes, S., M. and Huntington, H. 2015. Does stronger land tenure security incentivize smallholder climate-smart agriculture? Understanding drovers of agricultural investment in Zambia's Eastern Province. Available at https://www.land-links.org/wp-content/uploads/2016/09/Strong_Land_Tenure_Smallholder_Climate-Smart_Agriculture.pdf (accessed on 12 October 2024).

Quinion, A., Chirwa, P.W., Akinnifesi, F.K., and Ajayi, O.C. 2010. Do agroforestry technologies improve the livelihoods of the resource poor farmers? Evidence from Kasungu and Machinga districts of Malawi. Agroforestry Systems, 80(3): 457–465.

Republic of Kenya. 2013. Vihiga District Strategic Plan 2005 - 2010 for Implementation of National Population Policy for Sustainable Development. National Coordinating Agency for Population and Development, Nairobi.

Sunderlin, W.D. 2008. *In* Centre for International Forestry Research, B. Hatcher, J., and Liddle, M. (2008). From exclusion to ownership? Challenges and opportunities in advancing forest tenure reform. In *agris.fao.org*. https://agris.fao.org/search/en/providers/122621/records/6473a5832437ad1e5b922e9a (Accessed on 14 November 2025).

Tranchina, M., Reubens, B., Frey, M., Mele, M., & Mantino, A. (2024). What challenges impede the adoption of agroforestry practices? A global perspective through a systematic literature review. Agroforestry Systems, 98.

Usman, M.A. and Haile, M.G. 2022. Market access, household dietary diversity and food security: Evidence from Eastern Africa. Food Policy, 102374.

Wanjira, E.O. and Muriuki, J. 2020. Review of the Status of Agroforestry Practices in Kenya. Background study for preparation of Kenya National Agroforestry Strategy (2021-2030). https://doi.org/10.13140/RG.2.2.35739.59681 (Accessed on 17 November 2025).

Wei, Y., Zhong, F., Song, X., and Huang, C. 2023. Exploring the impact of poverty on the sustainable development goals: Inhibiting synergies and magnifying trade-offs. Sustainable Cities and Society, 89(89): 104367.

DOI: https://doi.org/10.55706/jae1801