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ASSESSMENT OF AGROFORESTRY PRACTICES ON SMALLHOLDER FARMS IN SEMI-ARID REGIONS OF KATSINA STATE, NIGERIA

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ABSTRACT

This study assessed agroforestry practices among 250 smallholder farmers in semi-arid Katsina State using multi-stage sampling and structured questionnaires. Data were analyzed using descriptive statistics. Four main agroforestry systems identified were agro-silvicultural (60%), agro-silvo-pastoral (19.6%), silvo-pastoral (12.4%), and agro-silvicultural/silvo (8%). Five types of agroforestry technologies practiced included alley cropping (14%), tree on farmland (12.8%), scattered trees (16%), natural tree regeneration (50%), and windbreaks (7.2%). Farm sizes ranged from 1-2 hectares (60%) up to over 7 hectares (4.4%). Seedlings were mainly self-supplied (54%), with others sourced from state forestry and agricultural agencies. Extension services were mostly seasonal (60.4%). Logistic regression showed medium-sized farms (3-4 hectares) significantly increased agroforestry adoption (p=0.0016), while monthly extension services were positive but not significant (p=0.1057). Farmers using self-supplied seeds (p=0.0087) or receiving only seasonal extension (p=0.0043) were less likely to adopt agroforestry. Constraints included drought, long tree gestation, lack of seedlings, and land tenure issues. Reported benefits included reduced soil erosion, improved soil fertility, climate mitigation, and enhanced carbon sequestration. The study recommends consistent institutional support and education programs via mass media and ICT to promote agroforestry adoption.

***K*eywords:** Agroforestry, Agro-silviculture, Agro-silvo pastoral, Silvo-pastoral, Alley cropping, Wind break

INTRODUCTION

Agroforestry has been practiced for several decades across various regions of the world. Agroforestry systems differ greatly across landscapes, countries, and regions, influenced by human needs, available resources, and prevailing environmental, cultural, and socioeconomic factors. Globally, common agroforestry practices include improved fallows, taungya systems, home gardens, alley cropping, the integration of multipurpose trees and shrubs into farmland, boundary plantings, farm woodlots, orchards and tree gardens, tree plantations, shelterbelts, windbreaks, conservation hedges, fodder banks, live fences, silvopastoral systems, and the combination of beekeeping with tree cultivation (Alao & Shuaibu, 2013; Akinnifesi et al., 2017).

Agroforestry system is an ancient form of sustainable land use systems that combine tree with crop or animal husbandry simultaneously and sequentially (FAO, 2013). It has been established that approximately 1.2 billion people worldwide, particularly impoverished rural households, rely on agroforestry practices and services for their livelihoods (Garrity, 2012). Agroforestry is recognized as a land use system in which trees provide both economically valuable products and critical environmental services. The integration of trees into agricultural lands across regions enhances vegetation cover and contributes to ecological conservation (FAO, 2021). Agroforestry systems are particularly beneficial for smallholder farmers, as they provide a wide range of products and services within limited land areas. Agroforestry improves soil fertility, protects crops and livestock, restores degraded lands, conserves water, controls pests, and prevents soil erosion. When properly managed, these systems support biodiversity and contribute to climate change adaptation and mitigation, but poor design can cause competition between trees and crops, reducing yields (Mbow et al., 2014). Rural communities are increasingly affected by the tremendous pressures on their local forest. Widespread poverty in developing countries, driven by sluggish economic growth, has led to deforestation and biodiversity loss resulting from overexploitation of natural resources, land conversion for agriculture, slash-and-burn farming, charcoal production, bushfires, and excessive wood harvesting (Kalaba et al., 2010). Agroforestry, as a sustainable land-use strategy, addresses critical global challenges including deforestation, unsustainable agricultural practices, biodiversity loss, climate change, and issues related to hunger, poverty, and malnutritionall of which align with the United Nations Sustainable Development Goals (SDGs) (FAO, 2021).

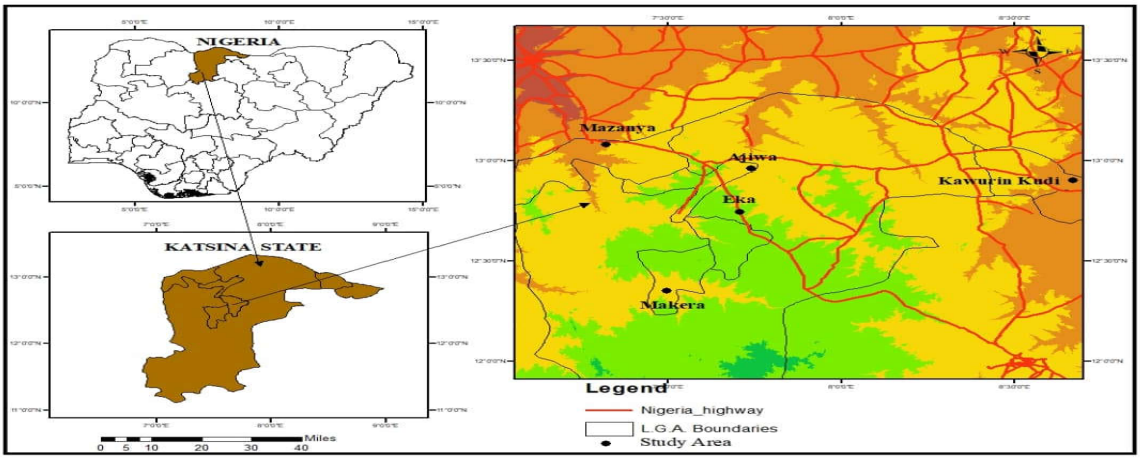
Deforestation is a major challenge in Nigeria and the Sudano-Sahelian regions, driven by rapid population growth leading to excessive tree felling for timber, fuelwood, charcoal, and land clearing for agriculture and industry. This has caused forest depletion, soil degradation, increased erosion, desertification, and the loss of valuable tree species, threatening sustainable agriculture (Adedire, 2007). In response, smallholder farmers in semi-arid Katsina State adopt agroforestry, integrating trees, crops, and sometimes livestock to improve productivity, soil fertility, and resilience to environmental stresses (Mbow et al., 2014; Ndaeyo,

2020). Common systems include alley cropping, parkland with Faidherbia albida, and home gardens, which help retain soil moisture, enhance climate resilience, and diversify livelihoods (Iiyama et al., 2017; Ibrahim et al., 2021). Despite these benefits, adoption is limited by land tenure issues, insufficient technical support, inadequate knowledge, and climate variability (Ajayi et al., 2011; FAO, 2020). Agroforestry is thus a sustainable land-use practice aligned with environmental and socio-economic goals in northern Nigeria, and assessing farmers' perspectives is vital to harness its full potential. Therefore, this study aims to assess agroforestry practices among smallholder farmers in the semi-arid region of Katsina State and was guided by the following specific objectives: i. identify the types and forms of agroforestry practices among smallholder farms in semi-arid area of Katsina State. ii. identify the factors influencing the adoption and non-adoptions of agroforestry practices among smallholder farmers in the Study Area. iii. identify the factors affecting agroforestry practice on smallholder farms in the study area. iv. examine the effects of agoforestry practice for environmental sustainability in the study area.

MATERIALS AND METHODS

Study Area

Katsina State (as illustrated in Figure 1) falls within three distinct agro-ecological zones: the Sahel, the Sudan Savanna, and the Northern Guinea Savanna (Oladipo et al., 2018; Abaje et al., 2014). Katsina State is geographically positioned between latitudes 11°08′N and 13°22′N, and longitudes 6°52′E and 9°20′E. It shares boundaries with Kano State to the east, Zamfara State to the west, Kaduna State to the south, and the Republic of Niger to the north. It has a tropical wet and dry climate, with rainfall from May to September, peaking in August and averaging 700 mm annually (Abaje, 2012). Rainfall is highly variable, often leading to severe droughts that impose socio-economic challenges. The state lies within Nigeria's inselberg region, characterized by undulating terrain, domed hills, and flat-topped ridges, with elevations ranging from 305 to 610 meters above sea level. The soil is primarily ferruginous tropical red and brown, found in areas underlain by basement complex rocks (Ibrahim et al., 2014). The state's vegetation consists of Sudan savannah grasslands with scattered shrubs, although human activities like farming, bush burning, and grazing have significantly altered the natural landscape. Katsina State is an agricultural region that supported the all kind of crops including agroforestry practices.



Source: Analysed from Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model
Figure 1: Map of the Study Area

Sampling techniques and Sample Size

This study adopted a multi-stage sampling technique to select respondents from the semi-arid regions of Katsina State. The first stage involved the use of stratified sampling to select five (5) local government areas from the northern part of the state, which is characterized by semi-arid climatic conditions and is known for active agroforestry practices.

In the second stage, purposive sampling was employed to select five (5) villages namely Ajiwa, Eka, Mazanya, Makera, and Kawurin Kudi from the chosen local government areas. These villages were selected based on their predominance in agroforestry activities, availability of smallholder farms, and accessibility for data collection. The third stage involved also the use of stratified random sampling to select respondents within each village. A total of fifty (50) agroforestry farmers were selected from each village, making up a total sample size of two hundred and fifty (250) respondents. The stratification ensured that farmers with different agroforestry systems and varying farm sizes were represented in the study. This multi-stage sampling technique was designed to ensure both

geographical coverage and diversity of agroforestry practices among smallholder farmers in the semi-arid zone of Katsina State.

The sample size of this study is (**s = 250**) and it was determined based on Krejcie and Morgan (1970) formula for calculating sample size of the study area.

To determine the sample size for the purpose of the study, (Krejcie and Morgan's 1970) for sample size was used.

$$S=\frac{X^2\times N\times P\times(1-P)}{d^2\times(N-1)+X^2\times P\times(1-P)} \quad \text{.....(i)}$$

Where;

S = required sample size (household)

X^2 = chi-square value for 1 degree of freedom at the desire confidence level (0.05 = 3.841)

N = total number of respondents

P = population proportion assumed to be 0.50

d = degree of accuracy or level of precision 0.05

Thus, s = 3.841 (75000 to 1000000) 0.50(1 – 0.50)

0.052 (75000 to 1000000 – 1) + 3.841 x 0.50(1 – 0.50)

s = 250

This formula was chosen because of its ability to capture large number of population as it contains many statistical variables such as chi-square table value, population proportion, degree of accuracy and confidence level.

Data Collection

Primary data for this study were collected through the administration of a structured questionnaire designed to capture key information on agroforestry practices. The questionnaire was developed based on the study objectives and covered aspects as: i. Identify the types and forms of agroforestry practices among smallholder farms in semi-arid area of Katsina State. ii. Identify the factors influencing the adoption of agroforestry Practices among smallholder farmers in the Study Area. iii. Identify the factors affecting agroforestry practice on smallholder farms in the study area. iv. examine the effects of agroforestry practice for environmental sustainability in the study area. Prior to the main data collection, the questionnaire was pre-tested in a nearby village not included in the sample to ensure clarity, relevance, and reliability of the instrument. Data collection was conducted through face-to-face using structured questionnaire with the selected respondents, facilitated by trained field assistants who were familiar with the local communities and farming context. This approach enhanced response accuracy and minimized non-response bias.

Data Analysis

Data analysis involved both descriptive and inferential statistical methods. The collected data were first validated, coded, and then analyzed using descriptive statistics including means, frequencies, percentages, tables, and figures to summarize the information. Additionally, logistic regression analysis was employed to identify the factors influencing agroforestry adoption among smallholder farmers. The results were presented through tables, figures, and graphs generated using the Statistical Package for Social Sciences (SPSS).

RESULTS AND DISCUSSION

This section contains the summary of data collected during investigations and analysis.

Socioeconomic Characteristics of the Respondents

Table 1 was the summary of socio-economic characteristics of the respondents as gender, marital status, age, major occupation, educational qualifications as well as years of experiences of the respondents on agroforestry farming.

Table 1: Demographic characteristics of the Respondents

Socioeconomic Characteristics	Frequency	Percentage (%)
Gender		
Male	224	89.9
Female	26	10.4
Marital Status		
Single	25	10
Married	218	87.2
Widow	7	2.8
Age		
20-29	51	20.4
30-40	60	24
41-50	68	27.2
50-60	42	16.8
60 and above	29	11.6
Major Occupation		
Farming	170	68

Fishing	21	8.4
Civil Servants/Farming	24	9.6
Trading/Farming	35	14
Educational Qualifications		
Non-formal Education	150	60
Adult Education	15	6
Primary Education	40	16
Secondary Education	34	13.6
Tertiary Education	11	4.4
Experiences (Year)		
1-5	25	10
6-10	30	12
11-15	70	28
16-20	100	40
21- Above	25	10
Total	**250**	**100**

Source: Author's Computation, 2025

Table 1 provides a summary of the socio-economic characteristics of the respondents within the study area. Results reveal that 89.9% of smallholder farmers were male, while only 10.4% were female, indicating a strong male dominance in agroforestry activities. This supports Ballama (2015), who attributed limited female participation to religious constraints among predominantly Muslim communities. This finding is consistent with the observations of Adereti and Fasina (2017), who reported higher male participation in agroforestry practices. This trend may be attributed to gender disparities in access to agricultural technologies, particularly land tenure systems, which often limit women's involvement in agricultureespecially in agroforestry farmingin Northern Nigeria.

The analysis of respondents' marital status revealed that 87.2% were married, 10% were single, and 2.8% were widowed. This suggests that the majority of agroforestry practitioners in the study area are mature individuals with family obligations. Such demographic traits are important, as being married is often associated with greater responsibility and a stronger commitment to long-term, land-based livelihood strategies. Similar findings were reported by Ogunleye et al. (2016) in a study on agroforestry adoption in southwestern Nigeria, where married individuals constituted over 80% of respondents. Likewise, Akinyemi et al. (2019) observed that marital status played a critical role in the decision-making process regarding sustainable agricultural practices, as married farmers are more likely to adopt innovations that ensure family welfare and food security.

The results of age of the respondent revealed that 35% of the respondents were within the age range of 30-40 years, 21% were within the age range of 20-29 years, 20% were within the age of 41-50 years, 16% were within the age of 51-60 years while 7.6% were within the ages of 60 above years. This indicates that the majority of respondents were within their economically active age group and are thus more likely to actively engage in agroforestry practices. Similar observations have been reported in recent studies, which found that younger and middle-aged farmers are more receptive to adopting sustainable agricultural innovations due to their physical capacity and willingness to embrace new practices (Ibrahim et al., 2019; Adeola & Adebayo, 2020; Umar et al., 2021; Okafor & Onyegbule, 2022). They are more probably to practice new technological advancement of climate smart agriculture than older farmers. It's important to note that consideration of different age groups particularly youth are needed when promoting any new innovations.

The results on respondents' major occupations revealed that 68% were primarily engaged in farming, 8.4% in fishing, 9.6% in civil service/farming, and 14% in trading/farming. This indicates that the majority of the respondents consider farming as their principal occupation. These findings are consistent with previous studies in northern Nigeria, which reported that smallholder farmers in rural communities predominantly rely on agriculture as their main source of livelihood, often supplemented by secondary activities such as trading or public service (Ibrahim et al., 2019; Adepoju & Oyewole, 2020; Yusuf & Haruna, 2021).

The findings also indicated that 60% of respondents had no formal education, 6% had adult education, 16% attained primary education, 6% had secondary education, and 4.4% completed tertiary education. This suggests that a majority of the respondents possessed some level of formal or informal education. These results are consistent with the study by Jamala et al. (2013), which found a significant relationship between educational attainment and awareness of agroforestry practices.

Regarding farming experience, the data showed that 10% of respondents had 1–5 years of agroforestry experience, 12% had 6–10 years, 28% had 11–15 years, 40% had 16–20 years, and another 10% had over 21 years of experience. This indicates that most agroforestry farmers in the study area possess considerable experience in the practice.

Types of Agroforestry Practice on Smallholder Farms in the Study Area

Table 2: Types of Agroforestry Practice on Smallholder Farms in the Study Area

Types of Agroforestry Practice	**Study Villages**					**T**	**P (%)**
	Ajiwa	**Eka**	**Mazanya**	**Makera**	**Kawurin Kudi**		
	F	**F**	**F**	**F**	**F**		
Agro-silviculture	30	29	30	30	31	**150**	**60**
Agro-silvo pastoral	10	9	10	10	10	**49**	**19.6**
Silvo-pastoral	6	7	6	6	6	**31**	**12.4**
Agro-silviculture/Silvo-pastoral	4	5	4	4	3	**20**	**8**
Total	**50**	**50**	**50**	**50**	**50**	**250**	**100**

Source: Author's Computation, 2025

Where; **F**= frequency, **T**= total no. of the Respondents, **P**= percentage.

Table 2 presents the distribution of agroforestry practices among respondents (smallholder farmers) in the study area. The results indicate that 60% of the respondents engage in the agro-silvicultural system, 19.6% of agroforestry farmers practice agro-silvo pastoral system (i.e. growing agricultural crops, forest crops and livestock together), 12.4% of the agroforestry farmers practice Silvo-pastoral system, while only 8% of the agroforestry farmers practice Agro-silvicultural/silvo-pastoral (i.e. growing agricultural crops and forest trees/livestock on the similar farmland) which involves the cultivation of agricultural crops alongside forest trees. This suggests that the majority of agroforestry farmers in the study area adopt the agro-silvicultural system, which integrates trees and crops on the same plot of land. This observation aligns with recent studies indicating that mixed farming systems in Nigeria's semi-arid regions often mirror traditional agroforestry practices adapted to local ecological and socio-economic contexts (Ibrahim et al., 2020; Olaleye et al., 2021; Okonkwo & Musa, 2022). These systems are particularly prevalent in areas where farmers seek to enhance soil fertility, diversify income, and build resilience against climate variability.

Forms of Agroforestry Practice on Smallholder Farms in the Study Area

Table 3: Forms of Agroforestry Practice on Smallholder Farms in the Study Area

Form of Agroforestry Practices	**Study villages**					**T**	**P (%)**
	Ajiwa	**Eka**	**Mazanya**	**Makera**	**Kawurin Kudi**		
	F	**F**	**F**	**F**	**F**		
Alley Cropping	6	7	8	7	7	**35**	**14**
Tree on Farmland	7	6	7	7	5	**33**	**12.8**
Scattered Tree on Farmlands	8	9	7	6	10	**40**	**16**
Natural Tree Regeneration	25	24	25	26	25	**125**	**50**
Wind Break	4	4	3	4	3	**18**	**7.2**
Total	**50**	**50**	**50**	**50**	**50**	**250**	**100**

Source: Author's Computation, 2025

Where**; F**= frequency, **T**= total no. of the Respondents, **P**= percentage.

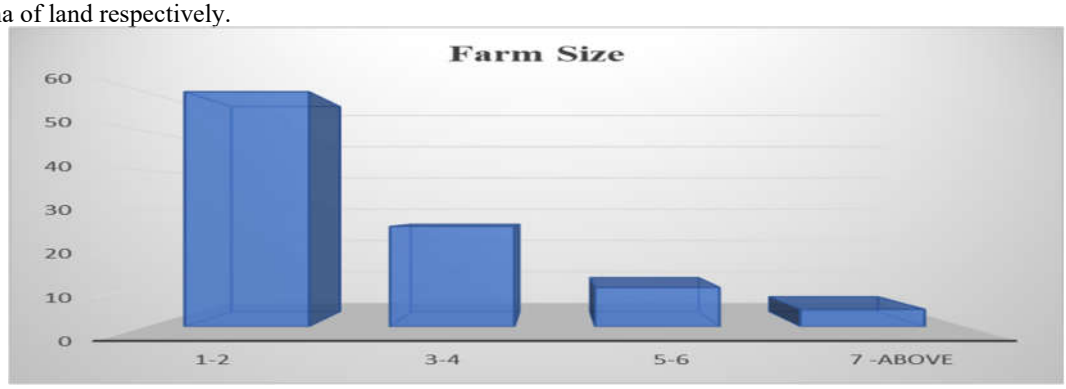
Table 3 shows the different form of agroforestry practice on smallholder farms in the study area. The result revealed that 14% of the agroforestry farms are Alley cropping, 12.8% of the agroforestry farms are Tree on farmland, 16% of the agroforestry farms are scattered tree on farmlands, 50% of the agroforestry farms are Natural tree regeneration, while only 7.2% of the agroforestry farms are wind break in form respectively. This indicated that natural tree regeneration form of agroforestry is usually found in most of the agroforestry farms in the study areas. Alley cropping is an agroforestry technique where annual crops are grown in strips between rows of trees or shrubs. This system enables farmers to cultivate trees that generate food and income while simultaneously enhancing soil fertility, improving environmental conditions, and providing shade during periods of extreme weather (Iiyama et al., 2017; Nair, 2021). In many farming systems, scattered

trees are commonly retained on both cultivated and fallowed lands, often spaced to minimize competition with crops and neighboring trees (FAO, 2020; Place et al., 2022). In scattered tree planting, trees are spaced widely to minimize competition among them. This method represents one of the oldest forms of agroforestry, where trees are preserved based on their economic, medicinal, social, or cultural significance. It typically involves indigenous species such as Parkia biglobosa, Vitellaria paradoxa, Tamarindus indica, and Azadirachta indica (Tukur et al., 2014). These species are known for their deep root systems, nitrogen-fixing ability, and production of litter that decomposes efficiently, thereby enriching the soil with organic matter.

3.4 Factors influencing the Adoption and Non-adoption of Agroforestry Practice among Smallholder Farms in study area

3.4.1 Size of the Farm

The results of agroforestry farm size cultivated by the smallholder farmers (Figure 2) reveals that 60% had a farm size range between 1-2 ha of land used for agroforestry, 25.6% had 3-4 ha of land 10% had 5-6 ha of land, and 4.4% had 6-Above ha of land respectively.



Source: Author's Computation, 2025
Figure 2: Farm Size of the Respondents

This implies that majority of the respondents owned only 1-2 ha of land for agroforestry farming because they are smallholder farmers. This may also be as a result of the poverty of various cycles in the rural area of Nigeria. This agrees with the assertion of Izekor and Oumese (2010) who reported that small-scale farmers are characterized as those farmers who cultivate land size between 0.1 and 5.99 hectares and produce on a subsistence level.

Sources of Tree Seedling

Figure 3 illustrates the various sources of tree seedlings among agroforestry farmers in the study area. The findings reveal that 54% of the farmers obtained their seedlings through self-raising, 19.6% sourced them from the State Forestry Department, 12.8% acquired seedlings from the Katsina State Agricultural and Rural Development Authority (KTARDA), while 13.6% relied on other sources. This indicates that self-raising is the primary method by which agroforestry farmers in the area acquire tree seedlings. This signifies the commitment of agroforestry farmers to appreciating the value of the trees and crops they cultivate, reflecting a strong sense of ownership and purpose in their farming practices. Similar findings have been reported in recent studies, which highlight that while farmers recognize the benefits of agroforestry, challenges such as limited access to quality planting materials particularly seeds and seedlings continue to hinder the widespread establishment and sustainability of such systems (Akinyemi et al., 2019; Ajewole & Olorunfemi, 2020; Eze et al., 2021)

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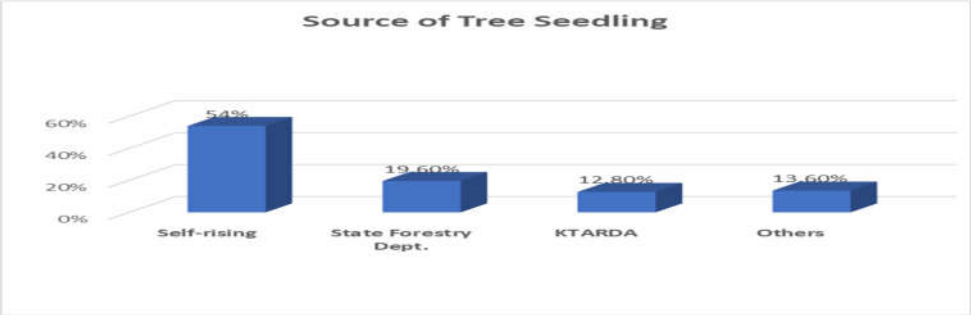
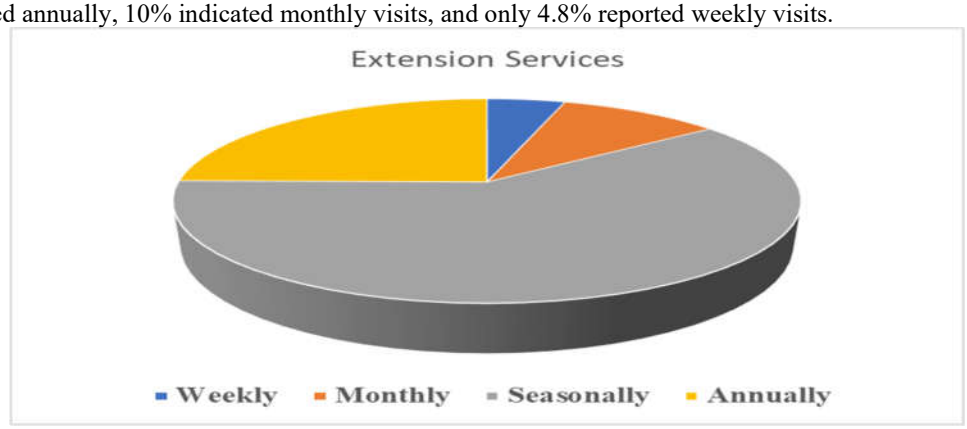


Source: Author's Computation, 2025
Figure 3: Source of Tree Seedling

Extension Services
Figure 4 illustrates the frequency of extension services provided to agroforestry farmers in the study area. The results show that 60.4% of respondents reported that agricultural extension workers visited their farms seasonally, 24.8% said visits occurred annually, 10% indicated monthly visits, and only 4.8% reported weekly visits.



Source: Author's Computation, 2025
Figure 4: Farm Extension Services
This suggests that the majority of farmers received seasonal visits from agricultural experts, including agronomists, agro-climatologists, and development agents, all of whom are relevant professionals in the agricultural sector. These seasonal interactions enhance farmers' awareness and encourage the adoption of improved and sustainable land management practices, leading to increased productivity. This finding aligns with Charles (2013), who identified farmers' awareness and access to extension services as key factors influencing the adoption of agroforestry in Kasulu District, Tanzania. Similarly, Saliu (2015) found that both age and frequency of extension visits positively affected the adoption of agroforestry practices.

Factor Influencing Agroforestry Practices Adoption and Non-Adoption among Smallholder Farmers in the Study Area
The results of a binary logistic regression analysis conducted to determine factors influencing the adoption of agroforestry practices among smallholder farmers.

Table 4: Regression Summary

Variable	Coeff.	Std. Error	Z	P>|z|	95% CI
Const	0.3317	0.6140	0.5402	0.5891	[-0.8717, 1.5350]
Farm Size_3-4	1.9852	0.6289	3.1566	0.0016	[0.7525, 3.2178]
Farm Size_5-6	1.8157	1.0549	1.7212	0.0852	[-0.2519, 3.8832]
Farm Size_>6	1.2399	1.2031	1.0305	0.3028	[-1.1182, 3.5979]
Seed Source_KTARDA	-0.2885	0.9703	-0.2973	0.7662	[-2.1902, 1.6132]
Seed Source_Other	-0.4092	0.7976	-0.5130	0.6079	[-1.9724, 1.1540]
Seed Source_Self	-1.7157	0.6544	-2.6220	0.0087	[-2.9983, -0.4332]
Extension Freq_Monthly	1.4365	0.8879	1.6179	0.1057	[-0.3037, 3.1768]
Extension Freq_Seasonal	-1.8988	0.6649	-2.8560	0.0043	[-3.2019, -0.5957]
Extension Freq_Weekly	0.0580	1.0505	0.0553	0.9559	[-2.0009, 2.1170]

Source: Author's Computation, 2025

The table above shows the regression coefficients, standard errors, z-values, p-values, and 95% confidence intervals.

Factor of Adoption of Agroforestry Practice among smallholder Farmers in Study area

1. Farm Size (3-4 hectares)
The positive and statistically significant coefficient for medium-sized farms (1.9852, p = 0.0016) suggests that farmers owning 3–4 hectares are more likely to adopt agroforestry. This is consistent with recent findings in Ethiopia, where farmers with moderate land sizes adopted agroforestry more frequently due to sufficient space for experimentation and tree integration (Alemie & Mezgebu, 2023; Amare & Shiferaw, 2025).

2. Extension Services Frequency
Monthly extension visits show a positive influence (1.4365), though marginally insignificant (p = 0.1057). This aligns with studies in Ghana and Rwanda where regular, timely extension support improved the likelihood of adoption (Asare-Nuamah et al., 2025). Conversely, seasonal visits have a significantly negative coefficient (-1.8988, p = 0.0043), implying that infrequent or poorly timed visits hinder adoption trend also observed in Pakistan (Sarfraz et al., 2025). Weekly visits were not statistically significant, suggesting that the quality and relevance of advice matter more than frequency alone (Alemie & Mezgebu, 2023).

Factors Associated with Non-Adoption of Agroforestry Practices among smallholder Farmers in Study area

1. Seed Source – Self-Provision
Farmers sourcing seeds themselves had a significantly lower probability of adoption (-1.7157, p = 0.0087). This trend has been observed in recent studies across Ghana and Ethiopia, where self-provision is often linked to poor seed quality and limited input support (Asare-Nuamah et al., 2025; Alemie & Mezgebu, 2023).

2. Other Seed Sources
Negative but non-significant coefficients for other seed sources also suggest challenges with seed availability and quality. This corroborates findings in Burkina Faso where institutional seed access was a key driver of agroforestry uptake (Ouedraogo et al., 2025).

3. Smaller and Larger Farm Sizes
Both very small and very large farms showed low or non-significant coefficients. Small farms may lack the land flexibility for tree planting, while large farm owners might prioritize commercial or monoculture uses (Amare & Shiferaw, 2025; Sarfraz et al., 2025).

Factors Affecting Agroforestry Practice on smallholder farms in the study area
Table 5: Factors Affecting the Agroforestry Practice in the Study Area

Problems	Frequency	Percentage (%)
Drought	50	20
Flood	25	10
Long time gestation period of indigenous species	101	40.4
Lack of viable seed	37	14.8
Land tenure issue	10	4
Pest and disease	20	8
Technical Know-how (Knowledge)	7	2.8
Total	**250**	**100**

Source: Author's Computation, 2025

Table 5 shows the results of factors that hinders the scaling up of agroforestry practice in the study area. Drought was indicated by 20% while 10% of the respondents indicated the flood problems. 40.4% of the respondents indicated long time gestation period of indigenous species, 14.8% of the respondents indicated lack of viable tree seed, 4% of the respondents indicated land tenure issue, 8% of the respondent's indicated pest and disease are seriously affected their output and only 2.8% 4% of the respondents indicated lack of knowledge respectively are the factors hindrance the development of agroforestry practice on smallholder farms in the study area. This indicates that the prolonged gestation period of indigenous tree species (40.4%) and drought conditions (20%) are the primary constraints limiting agroforestry practices among smallholder farmers in the study area. These findings are consistent with Ado (2012), who noted that delayed returns due to long maturation periods of trees hinder broader adoption of agroforestry in Kano. Similarly, the results align with those of Kiptop and Franzel (2012), who found that factors such as uncontrolled livestock grazing, insect

infestations, fungal attacks, and other forms of damage significantly reduce seedling survival rates and have impeded the success of agroforestry on dispersed farmlands located away from homesteads. This finding also aligns with recent studies that have identified major constraints to agroforestry adoption in rural communities, such as inadequate education on tree tenure, limited availability of seedlings, outbreaks of plant and animal diseases, insufficient knowledge of sustainable harvesting practices, and poor market infrastructure all of which limit the deliberate adoption of agroforestry systems (Mensah et al., 2019; Okon & Effiom, 2020). Furthermore, scholars have emphasized the importance of land and tree tenure systems in influencing farmers' willingness to invest in agroforestry. For instance, tenure security, socio-economic status, demographic characteristics, and cultural norms have been found to significantly affect farmers' decisions to plant and manage trees on their land (Olawuyi et al., 2020; Ayanlade & Olagunju, 2021). Similar to findings by Aturamu, recent evidence also suggests that under private user rights or customary ownership structures, farmers are more inclined to invest in fruit tree cultivation due to the assurance of exclusive rights to long-term benefits (Aliyu & Aremu, 2022). In the context of dryland agroforestry, lack of secure usufruct and land tenure rights continues to pose a significant barrier to adoption across sub-Saharan Africa (Mwangi et al., 2021).

Effects of Agroforestry Practice on Smallholder Farms in the study area

Table 6: The effects of Agroforestry Practice for Environmental Sustainability

Impacts	Frequency	Percentage (%)
Check Soil Erosion	60	24
Wind Break	20	8
Improve Soil Fertility	100	40
Reduce harsh climate	50	20
Reduce Carbon-monoxide	15	6
Others	5	2
Total	**250**	**100**

Source: Author's Computation, 2025

Table 6 presents the respondents' suggestions on how agroforestry practices can contribute to environmental protection in the study area. The results revealed that 24% of the respondents stated that the trees planted on their agroforestry farms help to control soil erosion, 8% of the respondents indicated that planted trees in their farmland through agroforestry practice was established wind break with a view for protecting their farmlands from desiccating wind, 40% of the respondents indicates that the litter obtained from the trees improve soil fertility, 20% of the respondents indicated that reduce harsh climate, 6% of the respondents indicated that planted trees help reduce environmental harshness caused by fossil fuel combustion and air pollution, particularly through the absorption of carbon monoxide. Additionally, 2% identified other ways in which agroforestry contributes to environmental protection. This suggests that many respondents recognize the environmental benefits of certain tree species such as Faidherbia albida (winter thorn) and Parkia species which enhance soil fertility through nitrogen fixation on their farms.

Agroforestry in the study area enhances soil fertility through biological nitrogen fixation, litter fall, and organic matter incorporation, which also help prevent soil erosion. Trees provide fodder and fuelwood, aiding nutrient recycling, and improve soil nutrient levels, particularly nitrogen and phosphorus, often limited in degraded soils (Akinnifesi et al., 2017). Agroforestry modifies the microclimate by offering shade and windbreaks, protecting crops from drought stress, and supports environmental stability, climate resilience, and increased household income. It aligns with nature's regulatory cycles and long-term soil renewal (Aina & Adepoju, 2020), making it suitable for resource-poor farmers (Ajiboye et al., 2021; Yusuf & Ibrahim, 2022). Additionally, agroforestry is an effective carbon sequestration strategy that can mitigate climate change impacts such as deforestation, soil degradation, and erratic weather (Sobola et al., 2015). While other soil fertility practices exist, agroforestry offers more sustainable, long-term benefits.

CONCLUSION AND RECOMMENDATIONS

Agroforestry has the potential to enhance agricultural land use systems by offering long-term benefits and mitigating negative environmental impacts. The finding of the study concludes that agro-silvicultural was identified as main types of agroforestry practice while natural tree regeneration was also the main form of agroforestry practice on smallholder farms in the study area. Farm size, sources of seedling, extension services were the major factors hindering the agroforestry practices in the study area. The regression shows that

adoption of agroforestry among smallholder farmers is positively influenced by medium farm size and regular extension services, while self-sourcing of seeds is a significant barrier. The results revealed that drought, and long tree gestation period of indigenous species were the key factors limiting agroforestry practice on smallholder farms in the study area. The findings were also showed that agroforestry practice reduced soil erosion, desiccating wind, increase soil fertility and add nutrients to the soil through its litters, reduced harsh climatic conditions and carbon monoxide emissions and enhanced carbon sequestration as well as sources of energy (fuelwood) for environmental sustainability in the study area. The study recommends educating agroforestry farmers on adopting new technologies and innovations through mass media and Information Communication Technology (ICT) programs. Farmers should also diversify into different types of agroforestry practices to enhance soil fertility on their farms. Furthermore, improving the quality and frequency of forestry extension services in the study area is essential. Addressing challenges related to seed quality and enhancing extension delivery coverage would help increase adoption rates

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