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Adoption Level of Agroforestry Practices in Katsina State, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author JIA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Also, Author JIA managed the analyses of the study. Author SOB managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Unsustainable forest land use practices have resulted in land degradation in Nigeria leading to low crop yield. Agroforestry is a viable option for reversing dwindling crop yields through proper soil management practices. There is notably no sufficient published information on agroforestry practices (AP) in Katsina State. The aim of this study was to assess AP for sustainable land use in the study area. Multistage stratified sampling design was used to select respondents from the study. Three Local Government Areas (LGAs) were randomly selected from each of the agro-ecological zones (Sahel, Sudan and Guinea) of Katsina State. Within each of the selected LGAs, one community was randomly selected and forty respondents were randomly sampled from each community. Using structured questionnaire, information was sought on socio-economic and AP. Data were analysed using descriptive statistics. Based on the results, multipurpose trees on farmland (79%), windbreaks (50%), woodlots (49.7%), improved fallow in shifting cultivation (32%) and home gardens (24.7%) were the common AP in the study area. Benefits of AP in the area included preservation of the environment (98.5%), provision of fruits and leaves (98%), and improvement of soil fertility (98%), erosion control (98%) and improvement of farmers' income

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(96%). Agroforestry practices enrich the soil with important nutrients and prevent soil erosion. The adoption of multipurpose trees on farmland in the study area will help in preventing environmental degradation, desertification and enhance food crop production.

Keywords: Degradation; forest; nutrients; savanna; sustainable; soil.

1. INTRODUCTION

Cropping system and anthropogenic activities are the major factors affecting sustainable land use in Nigeria. The result is continuous stress on the natural resources base with the conversion of forested areas into croplands; the cropping of marginal lands and the use of adverse agricultural methods including inappropriate and excessive application of agro-chemicals. The need for more food has led to increased deforestation, shortened fallow periods in shifting cultivation cycles, and set in motion a degradation spiral, leading to reduced productive capacity of the land and decreased crop yields. In addition, indiscriminate fire wood gathering, timber harvesting and grazing have aggravated land degradation in many parts of Nigeria. Adoption of agroforestry practices is low despite the recognized potential of sustainable agroforestry to contribute to more resilient farming systems, food security and poverty reduction [1].

A best and easy method for replenishing soil nutrients would be use of inorganic fertilizers; these are beyond most of the rural farmers' budgets. Thus agroforestry practices offer an alternative solution to resource-constrained smallholder farmers, who in the absence of inorganic fertilizers would otherwise grow crops without addressing nutrient requirements and harvest little or nothing for storage [2]. The presence of woody perennials in agroforestry systems may affect several bio physical and bio-chemical processes that determine the health of the soil substrate [3].

In Katsina state, in the Sudan savanna ecological zone of Nigeria, adoption level of agroforestry practices is low despite the recognized potential of sustainable agroforestry to contribute to more resilient farming systems, food security and poverty reduction. Although factors affecting adoption of agroforestry have been carried out in different part of Nigeria [4], there is dearth information on the adoption level of Agroforestry in the study area. Socio-economic study of farmers and their relationship to the agroforestry would help to ascertain the opportunities for the development of agroforestry systems in Katsina, Nigeria [1]. Studies have revealed that growing of trees is a function of socio-economic characteristics of the farming community [5].

Population pressure today precludes practices that would enable the environment to recover from extensive cropping systems or anthropogenic activities. It is expected that this study will assist agricultural planners and policy makers to properly address the problem of environmental and soil degradation. This paper is aim at identifying the various agroforestry practices adopted by farmers; and evaluate farmers' use of agroforestry practices in the study area with a view to ascertaining the benefits derived from planting trees along with food crops in the study area.

2. MATERIALS AND METHODS

2.1 The Study Area

Katsina State lies between latitude 12° N and longitude 8° E. The state is located in the upper Sudan and lower Sahel regions of Nigeria. The entire landmass of Katsina State is composed of basement complex of pre- Cambrian era, which consists of meta-sediments that have been transformed into anatecticmigmatites and granites. The hot, dry and dust laden North East Trade wind predominates in this area for as long as 7 months of the year. Rainfall is experienced in the state from June to September; with mean annual rainfall from 1016 mm to 1143 mm in the south and less than 635 mm in the Northern part of the state. The state on the whole has a mean annual rainfall of about 840 mm. Mean relative humidity is lower than 50% in January and February and could be as high as 80% in June and July. Temperature range is often from 38° to 41°C.

2.2 Data Collection and Analysis

Multi-stage and stratified random sampling techniques were used for the study. Nine Local Government Areas (LGAs) (three per each agro-ecological zone) were randomly selected out of the 34 LGAs in Katsina state. Accurate data on

the actual population of the rural farmers in Katsina state were not readily available; equal number of farmers (120 farmers) was randomly sampled from each of the agro-ecological zones through the use of random numbers. This gave a sample size of 360. Questionnaire was used to collect information on the study objectives. The questionnaire was sub-divided into: source of farm land, farm location and size; other agricultural activities, types of crops and trees planted and estimated farm yield, estimated agricultural income, source of information and the perceived benefits of AP. Information was also obtained through personal observation.

The data obtained from the study were collated and analysed. Descriptive statistic (frequencies and percentages) was used to describe the variables; and inferential statistic (ANOVA, chi-square and correlation analysis) was also used to test for significant variation within the study area.

3. RESULTS

3.1 Demographic Attributes of the Respondents in the Study Area

The demographic characteristics of the respondents in the study area showed the males were more involved in agroforestry practices than the females. Most of the respondents in the Sahel and Sudan Savanna were between 30 and 49 years; while in the Guinea savanna, majority of the respondents age ranged from 60 years and above. The age distribution is an important factor in farming activities because it affects the work force and decision-making in farming activities. The dominant age bracket among rural dwellers (30 – 49 years) in Sahel and Sudan and $\geq$ 60 years in Guinea savanna was indication that this was the age bracket that was actively involved in agroforestry practices.

Majority of the respondents in the three agro-ecological zones were married men and women. Most marriages were polygamous and had an average of more than five children that provided labour force for farming. The result showed that 93.3% of the respondents were married, 4.2% were single, 0.8% divorced and 1.7% widowed. About 92% of the respondents were Muslims, 4.6% were mixture of Islam and Traditional religion, 2.6% and 0.9% Christians and traditional worshippers, respectively.

Based on these findings, majority of the respondents acquired Islamic education as their highest educational attainment. On average, it represented 41.0% across the three zones. This was followed by primary education with 17.9%.

Farming was the major occupation in the three agro-ecological zones of the study area. The study revealed that an average of 66.1% of the respondents as farmers. Other occupation in the study area included trading, civil service, fishing and cattle rearing among others.

3.2 Involvement of Respondents in the Use of Agro-forestry Practices (AP)

Based on the list of agro-forestry practices identified by ICRAF, some agro-forestry practices that were adopted in the study area were selected and the respondents were made to react to the practices, that is, their involvement in the use of any of the practices. The responses were classified into five: do not practise, practised but stopped, practise occasionally, practised but do not intend to continue, and practise regularly (Tables 1 to 2).

Multipurpose trees Agroforestry system on farmland was mostly adopted in the study area (Table 1). The highest was in Sahel savanna with 91.7%, followed by Guinea savanna (83.3%) while Sudan had 62.5% adoption. Farmers who had never practised at all, practised but stopped, practised occasionally or practised but did not intend to continue were negligible.
Also, Table 1 shows majority of the respondents in Sahel and Guinea savanna had never practised home gardens, with 54.2% each. Those farmers had adopted the system were relatively few, (Sahel 35.0%, Sudan savanna 20.8%, Guinea savanna 18.3%), while those who had practised but stopped, practiced occasionally or practised but did not intend to continue recorded very low scores.

Table 1 indicates that majority of the respondents across the zones had not adopted *Taungya* system of agro-forestry (Sahel savanna 91.7%, Sudan savanna 87.5% and Guinea savanna 81.7%). Only very few of the respondents had adopted the *Taungya* system of agro-forestry (Sahel 5.0, Sudan savanna 8.3 and Guinea Savanna 15.0%). No farmer had adopted the system but stopped practising it across the zones.

The Table also shows 55.0% of the respondents in Sahel savanna had adopted woodlot system which was the highest across the zones, thus

was followed by Sudan savanna with 50.0%, and Guinea savanna with 44.2%. Those that had never adopted the system were 37.5% in Guinea savanna, 35.0% in Sahel savanna, and 26.7% in Sudan savanna.

3.3 Adoption of Border Planting, Windbreaks/Shelterbelt, Alley Cropping System and Woody Perennial for Sustainable Soil Management

A distribution of the respondents according to adoption of border planting as shown in Table 2, the Table indicates majority of the respondents had never adopted the system across the zones (Sahel savanna 81.7%, Sudan savanna 74.2% and Guinea savanna 91.7%). No respondent adopted the system but stopped practising it. Sudan savanna recorded the highest number of adopters with 18.3%, followed by Sahel savanna (10.0%), while Guinea savanna recorded only one adopter (0.8%). Majority of the respondents across the Sahel and Sudan savanna zones had adopted the windbreaks system of agro-forestry. The respondents from the Sahel savanna, however, recorded the highest number of adopters with 65.0%, followed by Sudan savanna with 55.0%, while Guinea savanna recorded only 30.0%. Conversely, for the respondents that had never adopted the system, Guinea savanna recorded the highest number with 52.5% (Table 2).

Table 2 indicates that majority of the respondents across the entire zones had never adopted the alley cropping system (Sahel savanna 95%, Sudan savanna 80% and Guinea savanna 97.5%). Very few of the respondents had adopted the system (Sahel savanna 3.3%, Sudan savanna 7.5% and Guinea savanna 1.7%). No farmer from Sahel and Guinea savanna had adopted the system and stopped, but in the Sudan savanna 6.7% had. Similarly, for those that practised the system occasionally, the Sahel and Guinea savanna also recorded zero %, while Sudan had 2.5%.

Table 1. Adoption of multipurpose trees, home-gardens, *Taungya* system and woodlots on farmland in *Katsina* State

Variables	Sahel		Sudan		Guinea	
Multipurpose Trees	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**
Do not Practise	4	(3.3)	15	(12.5)	7	(5.8)
Practised but Stopped	0	(0)	10	(8.3)	3	(2.5)
Practise Occasionally	6	(5.0)	8	(6.7)	5	(4.2)
Practised but do not Intend to Continue	0	(0)	12	(10)	5	(4.2)
Practise Regularly	110	(91.7)	75	(62.5)	100	(83.3)
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**
Home-gardens						
Do not Practise	65	(54.2)	48	(40)	65	(54.2)
Practised but Stopped	0	(0)	32	(26.7)	0	(0)
Practise Occasionally	13	(10.8)	10	(8.3)	33	(27.5)
Practised but do not Intend to Continue	0	(0)	5	(4.2)	0	(0)
Practise Regularly	42	(35.0)	25	(20.8)	22	(18.3)
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**
***Taungya* system**						
Do not Practise	110	(91.7)	105	(87.5)	98	(81.7)
Practised but Stopped	0	(0)	0	(0)	0	(0)
Practise Occasionally	4	(3.3)	0	(0)	0	(0)
Practised but do not Intend to Continue	0	(0)	5	(4.2)	4	(3.3)
Practise Regularly	6	(5.0)	10	(8.3)	18	(15.0)
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**
Woodlots						
Do not Practice	42	(35)	32	(26.7)	45	(37.5)
Practised but Stopped	0	(0)	18	(15.0)	7	(5.8)
Practise Occasionally	0	(0)	10	(8.3)	15	(12.5)
Practised but do not Intend to Continue	12	(10.0)	0	(0)	0	(0)
Practise Regularly	66	(55.0)	60	(50)	53	(44.2)
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**

The Table also shows that respondents that had not adopted the system were highest in Guinea savanna with 87.5%. This was followed by Sahel savanna with 81.7, while Sudan savanna recorded only 31.7%. On the other hand, the Sudan savanna recorded the highest number of adopters for this system, with 53.3%; while Sahel and Guinea savanna had very low scores. No respondents had adopted the system but stopped practising it or did not intend to continue to do so across the zones.

3.4 Tree Species Combined with Agricultural Crops among the Respondents in the Study Area

Table 3 shows some of the commonest trees used in combination with agricultural crops among the respondents in the study area. In the Sahel savanna zone, those tree species with high scores include: *Azadirachta indica* with 25.8% *Parkia biglobosa* with 14.2% and *Adansonia digitata* having 13.3%. In Guinea savanna, those species recorded in decreasing number include: *Adansonia digitata*, with 9.2%, *Parkia biglobosa*, with 6.7% and *Azadirachta indica* having 5.8%. Across the three zones, the highest score is recorded by *Azadirachta indica,* having 13.3%, while *Adansonia digitata* and *Parkia biglobosa* recording 9.7% respectively. Other tree species recorded include: *Borassus aethiopum, Anacardium occidentale* and *Tamarindus indica.*

3.5 Constraints to Adoption of Agro-forestry Practices in the Study Area

Table 4 reveals some of the problems militating against the adoption of agroforestry practices in the study area. The most serious problem preventing adoption of AP in Sahel savanna zone was scanty rainfall, which accounted for (30.8%) of the problems. This was followed by lack of land (6.7%) and inadequate labour (5.0%). In the Guinea savanna zone, the most serious problem was high labour demand (8.3%), followed by lack of land (6.7%). Lack of required seedlings and scanty rainfall had 5.0%

Table 2. Adoption of border planting, windbreaks/shelterbelt, alley cropping system and woody perennial in the study area

Border planting	Sahel		Sudan		Guinea	
	Freq.	%	Freq.	%	Freq.	%
Do not Practise	98	(81.7)	89	(74.2)	110	(91.7)
Practised but Stopped	0	(0)	0	(0)	0	(0)
Practise Occasionally	0	(0)	5.0	(4.2)	9	(7.5)
Practised but do not Intend to Continue	10	(8.3)	4	(3.3)	0	(0.0)
Practise Regularly	12	(10.0)	22	(18.3)	1	(0.8)
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**
windbreaks/shelterbelt						
Do not Practise	39	(32.5)	24	(20)	63	(52.5)
Practised but Stopped	0	(0)	10	(8.3)	8	(6.7)
Practise Occasionally	3	(2.5)	6	(5.0)	3	(2.5)
Practised but do not Intend to Continue	0	(0)	14	(11.7)	10	(8.3)
Practise Regularly	78	(65.0)	66	(55.0)	36	(30.0)
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**
Alley Cropping System						
Do not Practice	114	(95)	96	(80.0)	117	(97.5)
Practised but Stopped	0	(0)	8	(6.7)	0	(0)
Practise Occasionally	0	(0)	3	(2.5)	0	(0)
Practised but do not Intend to Continue	2	(1.7)	4	(3.3)	1	(0.8)
Practise Regularly	4	(3.3)	9	(7.5)	2	(1.7)
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**
Woody Perennial						
Do not Practised	98	(81.7)	38	(31.7)	105	(87.5)
Practised but Stopped	0	(0)	0	(0)	0	(0)
Practised Occasionally	9	(7.5)	18	(15.0)	5	(4.2)
Practised but do not Intend to Continue	0	(0)	0	(0)	0	(0)
Practised Regularly	13	(10.8)	64	(53.3)	10	(8.3)
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**

Table 3. Identified tree species combined with agricultural crops among the respondents

Tree Species	Sahel		Sudan		Guinea		Mean
	Freq.	%	Freq.	%	Freq.	%	%
Adansoniadigitata	16	(13.3)	8	(6.7)	11	(9.2)	9.7
Azadirachtaindica	31	(25.8)	10	(8.3)	7	(5.8)	13.3
Anacardiumoccidentale	2	(1.7)	-	-	3	(2.5)	1.4
Borassusaethiopum	2	(1.7)	-	-	01	(0.8)	0.8
Parkiabiglobosa	17	(14.2)	6	(5.0)	8	(6.7)	8.6
Tamarindusindica	-	-	-	-	6	(5.0)	1.7
Combination/others	52	(43.3)	96	(80)	84	(70)	64.4
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**	**(100)**

Table 4. Identified constraints to adoption of agro-forestry practices in the study area

Identified problems	Sahel		Sudan		Guinea		Mean
	Freq.	%	Freq.	%	Freq.	%	%
High Labour Demand	6	(5.0)	-	-	10	(8.3)	4.4
Lack of Required Tree Seedlings	3	(2.5)	-	-	1	(0.3)	1.1
Inadequate Extension Personnel	2	(1.7)	-	-	4	(3.3)	2.5
Lack of Land	8	(6.7)	1	(0.8)	8	(6.7)	4.73
Scanty Rainfall	37	(30.8)	3	(2.5)	6	(5.0)	12.8
Lack of Transportation	4	(3.3)	1	(0.8)	4	(3.3)	2.5
Lack of Incentive	2	(1.7)	-	-	2	(1.7)	1.1
Combination	58	(48.3)	115	(95.8)	80	(66.7)	70.3
Total	**120**	**(100)**	**120**	**(100)**	**120**	**(100)**	**(100)**

respectively. The problems, in decreasing order of severity across the three zones were: scanty rainfall, lack of land, high labour demand, inadequate extension personnel and lack of transportation recording the same percentage, lack of required seedlings and lack of incentives recorded the same percentage.

4. DISCUSSION

4.1 Socio-economic Attributes of the Respondents in the Study Area

Respondents' gender showed that there were more male than female farmers across the zones. This implies that the male gender is more involved in agroforestry practices as compared to their female counterparts. Farming generally, is almost an exclusive business for the male in the study area. This may be as a result of the strenuous nature of most farming activities in general and agroforestry practices in particular. These activities are not attractive to women who often engage in household activities. The paucity of women in agroforestry practices might also be attributed to culture and religion which made access to women by male extension agents difficult since there were very few women extension agents.

In Sahel and Sudan savanna zones, majority of the respondents fell between 30 and 49 years. Except in Guinea savanna, where majority of the respondents fell from ≤ 60 years. This dominant age bracket among the rural dwellers implied that this is the age bracket that is actively involved in agroforestry practices. This also meant that, the farming population is mainly made up of both the old and the middle-aged people. The young ones might have migrated to urban areas in search of white collar jobs while others might have been in school or too young to have farms. This has an adverse effect on the economy of the rural people because at old age, farmers cannot have optimum productivity.

Also, majority of the respondents across the three zones were married men and women. Most marriages were polygamous and have an average of more than five children that provided labour force for farming. This is because agroforestry practices are not only capital intensive but also labour intensive. This means that there is a good source of labour. An

explanation to this is that more adult members in a household means that more quality labour would be available for carrying out farming activities and the practice of agroforestry would not pose any problem. This agreed with the findings of [6].

As revealed in the study, educational level of the rural dwellers was low. However, on average, Islamic education recorded the highest percent, which was followed by primary education. The study also revealed that inspite of the low level of western education; they had indigenous/traditional knowledge and high level of awareness about farming systems, tree species, shrubs, herbs and other agroforestry practices. This indigenous knowledge affects their perception and willingness to participate in agroforestry practices. However, they still needed more enlightenment and training on modern agroforestry techniques as a means of sustainable land management. Farmers who acquire some level of education are more likely to perceive new technologies than the ones who have no any form of education. According to Amaza and Tashikalma [7], the literacy level of farmers is important as it determines the rate of adoption of improved technology for increased productivity. Also, Adekunle [8] pointed out that the level of education of farmers will directly affects their ability to adapt to change and to accept new ideas.

Frequency analysis of the respondents' occupation revealed that farming is the major occupation in the three agro-ecological zones of the study area. The study reveals on average, a high % of the respondents as farmers. Other occupation in the study area includes: trading, civil servants, fishing and cattle rearing among others.

4.2 Adoption of Agro-forestry by the Respondents in the study Area

The difference on agroforestry practices among the three zones (Sahel, Sudan and Guinea savanna) in the study area was examined using analysis of variance (ANOVA). The test shows that there was a significant difference in the use of agroforestry practices among the three zones ($F = 63.29$, $P < 0.05$). The differences in adoption might be due to differences in soil types, rainfall patterns, socio-economic reasons and readiness or the people to accept innovations.

Adoption occurs when one has decided to make full use of the new technology as a best course of action for addressing a need [9]. The results of this finding showed majority of the respondents were involved in food crop-production, while others were involve in rearing of animals, and planting of tree crops such as *Azadirachta indica, Parkia biglobosa, Adansonia digitata* among others. Tree species such as *Sesbania sesban* (L.) Merr, *Tephrosia vogelii* Hook .f., *Cajanus cajan*, *Gliricidia sepium* (Jacq.) Walp. *Leuceana leucocephala* (Lam.) De Wit., *Acacia angustissima* and *Tephrosia candida* (Madagascar) are suitable for agroforestry [10,11]. Puri and Bangarawa [12] pointed out that the choice of tree species is the most important factor to be considered in agroforestry practices. Also, Foroughbackhch [13] stated that the choice of tree species be made after careful consideration of their adaptability for growth and benefit for rural populace. Leguminous species such as *Faidherbia albida* and *Leucaena leucocephala* cause a considerable improvement on crop yields. Okali and Nwoboshi [14] recorded poor performance of crops on apparently rich *Tectona grandis* and *Eucalyptus camadulensis* oil. The farmer's preference of forest trees would definitely be due to their potentials and adaptability to the land area.

Respondents' involvement in AP varied from zone to zone. The differences in adoption could be that an innovation which was appropriate for a given zone might not necessarily be accepted in another zone. It might also be due to socio-economic reasons, complexity and incompatibility of the innovation with the existing practices. Thus, majority of respondents across the zones could not adopt *Taungya*, border planting and alley cropping. Very few respondents across the zones adopted these systems of agro-forestry. Conversely, multipurpose trees on farmland, improved fallow in shifting cultivation, home-garden, woodlots and windbreaks or shelterbelt were much more adopted by farmers. The reason for low adoption of *Taungya* system of agroforestry might be that food crop might compete with tree crop. Sahel and Sudan zones adopted woodlots practices more than Guinea savanna.

Majority of the respondents adopted multipurpose trees on farmland across the zones. The findings therefore reveal that this agroforestry system was popular among the farmers across the zones hence the massive adoption. This might be due to the blend of the system with indigenous or traditional farming practice across the zones.

The study also revealed that majority of the respondents in the study area had not practiced home-gardens. Those farmers that had adopted the system were relatively few. While those that had practiced but stopped, practice occasionally or practiced but do not intend to continue recorded very low scores.

The reason for their adoption might be to stem the environmental degradation in the Sahel and Sudan savanna zones. Farmers could only take fuel-wood from these plantations and no other place. Indiscriminate felling of trees for timber, fuel-wood and other domestic uses and clearing of land for agricultural purposes and industrial development help to remove the forest cover; thereby exposing the soil to wind erosion. Adeola [15] observed that the system is used for various purposes such as provision of wood, fodder, electric-poles, fencing poles, roofing poles, soil protection, soil reclamation etc.

Sudan Savanna had the highest adoption of woody perennials for soil conservation across the zones. The farmers' interest and adoption of the system could be to check the menace of annual flooding of this zone which leads to soil and gully erosion. Plants help to stabilize the soil and other conservation works thereby fulfilling one of the environmental functions of agroforestry [16].

Majority of the respondents adopted multipurpose trees on farmland across the zones; this could be due to good yield obtained if tree species are combined with agricultural crops in the study area. This implies that native tree species enhance high yield of agricultural crops when combined; agroforestry system was popular among the farmers across the zones hence the massive adoption. This might be due to the blend of the system with indigenous or traditional farming practice across the zones.

On sources of information/awareness on some sustainable land use practices, the study revealed that extension agents recorded high scores for all the land use practices in the study area. This may be due to the availability of the agricultural development programme in the area. This study therefore agreed with the findings of Onumadu [17] who observed that agricultural agents were the most important source of agricultural information to farmers. This view was also supported by Azeez [18].

Majority of the respondent were of the view that they obtained information on sustainable land use practices/agro-forestry practices through radio. This implies that farmers in these zones had several options of other sources of information that could enhance or stimulate their use of AP. Although, radio/mass media and extension agents were the principal means of the awareness, these two sources of information could as well be responsible for the significance of the AP. Mass media plays an important role in the dissemination of information on agricultural activities as it enables even the cattle rearers that roam about in the bush to have access to the information on agricultural activities through their radio. This was also supported by Onumadu [17], who observed that mass media was one of the most important sources of seeking information on agro-forestry practices.

Other sources such as traditional and a combination of one or more of these sources also recorded relatively high scores, whereas sources such as relatives and neighbour recorded very low scores; while some of the respondents reported that they had no information at all. This may be due to lack of adequate publicity or enlightenment. This calls for an increase in agricultural extension agents who should take up the responsibility of educating, training and monitoring of farmers in the areas of food crop production. The relationship between sources of information and use of agroforestry practices. It is observed that, among the three agro-ecological zones, it is only in Guinea savanna that sources of information was not significantly related to use of agroforestry practices by the farmers (χ^2 = 0.32, P > 0.05). Conversely, in Sahel and Sudan savanna zones, source of information was significantly related. In Sahel savanna zone χ^2 = 0.01, P < 0.05 and in Sudan savanna, χ^2 = 0.03, P < 0.05.

Farmers in the study area may have adopted AP because of the various benefits they derive from it. These benefits range from social, economic and environmental benefits. The social benefits in the study area include provision of fruits and leaves, provision of shade, provision of fuel-wood, provision of fodder and medicinal herbs. Correlation result on the relationship between use and benefits of agroforestry practices across the three agro ecological zones of Katsina state showed a significant positive relationship between the use and benefits of agroforestry practices, with a Pearson correlation (r) of 0.160, (P < 0.05). This implies that farmers derived

immense benefits from the use of agroforestry practices; and that farmers who use agroforestry practices more, also benefit more.

5. CONCLUSION

Based on the findings of this study, windbreaks, scattered trees on farmland, woodlots, improved fallow and home-gardens were the various AP that were common in the study area. There was difference in adoption of AP among the three agro-ecological zones. The differences in adoption could be that an innovation in which was appropriate for a given zone might not necessarily be accepted in another zone. This could also be due to soil and climate type and socio-economic reasons. In order to sustain and even increase our agricultural productivity and to reduce, to the barest minimum, the effects of desertification and environmental degradation, the following recommendations are made: Government should encourage the adoption of agroforestry as a system of multiple land use to increase wood and food production thereby ensuring the optimum use of land. Provide incentives such as seedlings, transportation, inorganic fertilizers and tractors to farmers so as to encourage them to participate actively in agroforestry activities. The use of more indigenous tree species that can improve soil fertility and at the same time more adaptable to the environment should be promoted (e.g. *Parkia biglobosa*). Application of organic fertilizers and planting of leguminous trees will help to resuscitate the soil for high productivity. A study to re-examine the factors limiting the adoption of some AP that have low adoption in the study area such as alley cropping and *Taungya*is recommended.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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