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# FACTORS INFLUENCING ADOPTION OF AGROFORESTRY FARMING SYSTEM AS A MEANS FOR SUSTAINABLE ENVIRONMENTAL CONSERVATION METHOD IN JERE LGA, BORNO STATE, NIGERIA

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## ABSTRACT
Farmers were exposed to agroforestry but did not adopt the system due to some perceived factors. However, unless they adopt agroforestry farming system, the potential benefits of the technology for livelihood improvement and sustainable environmental management will not be realized. Thus, this study was carried out to assess the factors influencing adoption of agroforestry farming systems as a means for sustainable environmental conservation method in Jere L.G.A of Borno State. A multistage sampling procedure was used to select the respondents for this study. A total of one hundred and twenty (120) respondents interviewed for the study. Data were collected using structured questionnaires. Data obtained were analyzed using descriptive statistics which include frequency distributions, means, and percentages. The ordered logistic regression was used to estimate the factors influencing the adoption of agroforestry as a means of sustainable conservation practices by farmers in the study area. The result revealed that majority of the farmers were aware of agroforestry mostly through their farmers' association. The major factors that positively influenced adoption of agroforestry include gender, household size, extension services and farming experience. Despite the numerous benefits of agroforestry to environmental conservation, farmers were constrained by land fragmentation possibly due to inheritance, inadequate nurseries where seeds/seedlings can be accessed, inadequate incentives and poor government policies, poor access to extension services, inadequate capital, long gestation period of trees, damage caused by animals/humans, limited use of machineries and unavailability of labour. It was recommended that land fragmentation should be discouraged, extension services, seedlings and incentives should also be provided to farmers in the study area to encourage and motivate them to go into agroforestry farming to sustain environmental conservation in the area.

**Keywords:** Agroforestry, Conservation, Farming System, Adoption, Jere, Borno.

## INTRODUCTION
Forests are an integral part of daily lives of the rural population in Nigeria. According to Atolagbe (2002) a man's life is unimaginable without the natural environment to supply him with his basic needs such as air, water, food, solid minerals as well as plants and animals. Man-made changes to the world's climate, which create a steady increase in the earth's temperature, commonly referred to as global warming, are the most insidious and significant environmental risks to human well-being and survival (Adekunle, 2009). The growing global population has resulted in a massive increase in the need for living space, food, and energy. As a result, more forestland is being converted to cropland and other purposes than at any other time in history. Furthermore, in emerging nations like Nigeria, the current significant reliance on fuel wood by rural people and the urban poor has resulted in increased deforestation.

Climate change, desert encroachment, soil erosion, sand dune formation, landslides, flooding, and biodiversity loss are all serious consequences of deforestation, as are unemployment, habitat destruction, land scarcity, overexploitation of forest resources, change in land use, pollution, and a lack of emphasis on forest conservation (McNally *et al*., 2002; Adekunle *et al*., 2005). According to Siddiq (2008), desertification has very significant social and environmental repercussions, including food insecurity and the development of survival mechanisms that reinforce and perpetuate desertification and obstruct development. On the other hand, it has been found that desertification-induced survival attitudes have aided the growth of local people's environmental awareness and conservation (FAO, 2007). As a result, a growing number of rural residents are realizing that the fragile ecosystem on which they rely for survival is being over-exploited, and that it is vital to repair and manage it in a sustainable manner. Because of the increasing degradation and loss of agricultural lands caused by the loss of forests and tress, as well as perceived threats to agriculture, agroforestry has received a lot of attention as a way to rehabilitate the damaged agriculture-forest interface and prevent further agricultural lands degradation (Clarke and Thaman, 2006).

Agroforestry is a dynamic, ecologically oriented natural resource management system that diversifies and sustains output for improved social, economic, and environmental advantages by integrating trees on farms and in the landscape (Mukadasi and Nbalegwa, 2008). Agroforestry according to Ibrahim *et al*. (2019) is a land management system combining forest trees and food crops production with or without livestock in such a way that they are technically and financially feasible and will enable the small holder farmer to obtain high income and living standards while ensuring improvement of soil and the environment. It has been recognized as one of the strategies to introduce indigenous and exotic trees into cropping systems and impact on livelihoods of small-holder farmers in Sub-Saharan Africa (Kwesiga *et al*., 2003). Agroforestry is therefore seen as one of the options for reversing the prevalent land degradation.

Apart from providing wood, food and/or animal products, the integration of trees in the farming system could go a long way to help ameliorate environmental problems: specifically by creating microclimates favourable for crop growing, and enhancing the recycling of minerals to provide a more complete ground cover which could help to protect the soil from erosion and moderate extreme temperatures (Adedire, 2004). The goal of sustainable food production and environmental conservation could be achieved with more widespread adoption of agroforestry (Adekunle, 2009).

Agroforestry techniques are increasingly promoted as potential treatments. Due to the fact that it is a land use system that has the ability to enhance agricultural land usage while delivering long-term advantages and reducing negative environmental effects on a local and global scale. Sobola *et al*., (2015) stated that agroforestry has the potential to lower emissions caused by deforestation and forest degradation, and it supports sustainable forest management as well as environmental sustainability and conservation. Therefore, it is essential to apply agroforestry, a strategy of land use that promotes increased productivity and environmental stability. Windbreaks have long been a necessary component of agricultural landscapes. Among their many functions are wind protection for crops, biodiversity habitats, erosion protection for the soil, and the creation of microclimates that lessen the frequency of extreme weather events that are a result of ongoing climate change (Pantera *et al*., 2021).

Almost half of the world’s agricultural lands have at least 10 percent tree cover, suggesting that agroforestry, an integrated system of trees, crops and/or livestock within a managed farm or agricultural landscape, is widespread and critical to the livelihood of millions of people (Ibrahim *et al*., 2019). The impact of agroforestry on sustainability arises primarily

through the trees and their regenerative effect on soil fertility, shelter and fodder they provide for livestock and the range of tree products directly useful to people (Eneji *et al*., 2004).Studies in several parts of Africa, including Nigeria have demonstrated the economic and agronomic returns of agroforestry practices (Franzel *et al*., 2001) and structures to retard the process of deforestation and environmental degradation have been adopted reluctantly and, even when adopted, the management and maintenance have been less than desirable. According to Lisa *et al*. (2020), the benefits of tree–crop interactions on increased productivity, improved soil fertility and microclimate, nutrient cycling and soil conservation, and benefits of weed and pest control, demonstrating the multifunctional role of agroforestry. Potential advantages include reducing financial and biophysical risks, improving crop yields or quality, reducing fertilizer or other chemical inputs, improving livestock health, adapting to climate change through more resilient production systems, retaining more land at least partially forested, reducing soil erosion and increasing biodiversity (Mercer *et al*., 2014).

The goal of sustainable food production and environmental conservation could be achieved with more widespread adoption of agroforestry. Nigeria is blessed with a large area of land and vegetations, but the use of this important resource has been abused, not sustainably used or managed. Ladipo (2010) pointed out that the forest has been treated in the past by many rural dwellers as inexhaustible. Recently everyone now realize that forest is at the verge of going to extinction if nothing is done to reverse the unsustainable use (Sobola *et al*., 2015).

Farmers in the study area were exposed to agroforestry but did not adopt the system due to some perceived factors. However, unless they adopt agroforestry farming system, the potential benefits of the technology for livelihood improvement and sustainable environmental management will not be realized in the area. To breach this gap, this study was carried out to investigate the factors affecting the adoption of agroforestry farming system as a means for sustainable environmental conservation.

The broad objective of the study was to investigate the factors influencing agroforestry farming system as a means for sustainable environmental conservation in Jere L.G.A of Borno state, Nigeria. While the specific objectives are to;

i. describe the socio-economic characteristics of respondents in the study area
ii. identify the level of awareness of Agroforestry farming system the respondents in the study area
iii. identify the factors affecting adoption of agroforestry as a means of conservation practice

## MATERIALS AND METHODS

### The Study Area

The study was carried out at Jere L. G. A. of Borno State. It lies within latitudes $11^{o}40^{'}$ and $12^{0}05^{'}$N and longitudes $13°50^{'}$ and $12^{0}20'$E, it occupies a total landmass of 160 $km^2$ (Ministry of Land and Survey, 2008). Within the state, it shares boundaries with Mafa L. G. A. to the east, Maiduguri Metropolitan Council to the north and Konduga L. G. A. to the south. The climate of the area is characterized by dry and hot seasons, minimum temperature ranging from 15-20°C, while the maximum temperature ranges from 37-45°C. The annual rainfall ranges from 500mm to 700mm per annum (Nigerian Metrological Agency, 2008). The rainy season is usually from May to October with low relative humidity and short wet seasons. The topography is generally low land plain, and the soil is generally sandy with scanty trees, short grasses and thorny shrubs. Jere Local Government Area has a projected population of 211,204 persons with annual growth rate of 2.8% (NPC, 2006). Majority of the inhabitants are farmers, traders and civil servants (Borno State Agricultural Development Programme, 2008).

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**Sample and Sampling Technique**

Six wards were purposively selected out of 12 wards in the study area. The selection was based on the fragile nature of the area due to insecurity and insurgency. These wards were selected as a result of their accessibility and relatively secured. They include, Dusuman, Alau, Zabbarmari, Dala - Lawanti, Jere and Gongolon wards. Farmers were selected for their exposure in one way or the other to agroforestry based on a list of contact farmers held by the farmers' associations in the study area. A Multistage sampling technique was used to select 2 villages randomly in each ward. Ten farmers were randomly selected from each village making a total of 120 respondents for the study area. Data for this study were obtained from both primary and secondary sources. The primary data were obtained with the aid of a well-structured questionnaire and personal interview conducted for farmers who cannot read nor write and the results of the interview interpreted in the questionnaire.

**Method of Data Collection**

Data were collected using questionnaires administered by trained enumerators. The questionnaire was developed through a consultative process keeping in view the objectives of the study. The questionnaire developed was pre-tested to avoid the chances of duplication and biasness, keeping in view the available financial resources, heterogeneity of the target villages, allotted time and security situation of the area. Data were collected on socio-economic variables of the respondents such as gender, age, educational level, household size, farming experience, source of farmland and farm size of respondents. Data were also collected on the contributions of agroforestry to environmental conservation and the factors of agroforestry farming and environmental conservation among others. All questionnaires were completed and retrieved on the spot.

**Method of Data Analysis**

Data obtained were analyzed using descriptive statistics which include the use of frequency distributions, means, percentages and charts. These were used to analysed objectives i and ii. The ordered logistic regression was used to achieve the objective on factors influencing the adoption of agroforestry as a means of sustainable conservation practices by farmers in the study area. If the coefficient of a particular variable is positive, it means that higher values of that variable result in a higher probability of adoption, while a lower value of a particular variable implies a lower probability of adoption (Sarap and Vahist, 1994 in Alkali *et al*., 2021). An adoption score from 0 – 4 was used. The model is expressed as:

$Y = (X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, \ldots U)$ …(1)

where;

Y = Adoption score for Agroforestry.
$X_1$ = Age of farmers (years)
$X_2$ = Household Size
$X_3$ = Farm Experience (years)
$X_4$ = Farm size (Hectares)
$X_5$ = Sex
$X_6$ = Education Level
$X_7$ = Land Fragmentation
$X_8$ = Extension services

## RESULTS AND DISCUSSION

**Socio-economic Characteristics of Respondents**

The result of the socio – economic characteristics of the respondents is presented in Table 1. The result shows that about 39.17% (47) of the respondents falls within the age

brackets of 31 – 40 years of age, 29.17% (35) are between the ages of 41 – 50 years, 21.66% (26) are between the ages of 21 – 30 years while 7.50% (9) and 2.50% (3) were between the ages of 51 – 60 and above 60 years, respectively. The mean age of the respondents was 38.5 years. This implies that majority of the respondents are young and in their productive ages. This finding is in line with that of Abdulmumini *et al*. (2019) who stated that the age population of the respondents in a similar study in Jigawa State was young and energetic that can affect the adoption of technologies. The result also agrees with the findings of Adamu *et al.* (2021) who reported that young farmers in the productive age have the capacity of carrying out agricultural production.

The highest proportion of respondents (37.50%) have a family size ranging from 6 - 10 members followed by 3.33% response with 1 – 5 household members with 16.67% and 12.50% of the respondents were having 11 – 15 and above 16 household members. The average household size of respondents in the study area was 8 persons. This implies that the household size was fairly large and may affect adoption of agroforestry in the area. According to Yusuf *et al*. (2021) it is expected that farmers with larger family are more likely to engage in other schemes because of the labour-intensive nature of agricultural enterprise. Larger family size is important in subsistent agricultural production especially within the rural setting (Odoemenem and Obinne, 2015).

According to the result in Table 1, the respondents had a mean farming experience of 14.33 years in the study area. This indicates that agroforestry had been accepted and practiced among farmers. The result agrees with the observation of Ndanitsa (2008) where experienced farmers facilitate the easy detection of any change brought into their business in order to enhance their participation. The findings presented in Table 1 also reveal that some (54.16%) proportion of the respondents used 1-2 hectares of land for agroforestry, while 26.67% used between 2.1 and 3 hectares. Also, 12.5% used between 3.1 - 4 hectares, and only 6.67% used more than 6 hectares of land. This implies that there was a limited land for agroforestry in the study area. The results align with the findings of Oriole (2009) who reported that most farmers in Nigeria were small-scale who cultivated less than 3 hectares of land. The average farm size of the respondents is found to be 2.24 hectares. This finding differs from the findings of a study carried out in southeastern Nigeria (Tafida and Sani, 2020) were the average number of hectares cultivated per farmer was found to be about 1.5 hectares. This implies that farmers in the study area cultivate relatively larger hectares than their counterparts in southeastern Nigeria.

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**Table 1:** Quantitative Data on Socio-economic Characteristics of Respondents (n =120)

| Variable | Frequency | Percentage | Mean |
|---|---|---|---|
| Age (Years) | | | |
| 21 – 30 | 26 | 21.66 | |
| 31 – 40 | 47 | 39.17 | |
| 41 – 50 | 35 | 29.17 | 38.5 |
| 51 – 60 | 9 | 7.50 | |
| Above 60 | 3 | 2.50 | |
| Household size | | | |
| 1 – 5 | 40 | 33.33 | |
| 6 – 10 | 45 | 37.50 | 8.42 |
| 11 – 15 | 20 | 16.67 | |
| Above 16 | 15 | 12.50 | |
| Farming experience (Years) | | | |
| 1 – 10 | 45 | 37.50 | |
| 11 – 20 | 53 | 44.17 | 14.33 |
| 21 – 30 | 13 | 10.83 | |
| Above 31 | 9 | 7.50 | |
| Farm size (ha) | | | |
| 1 – 2 | 65 | 54.16 | |
| 2.1 – 3 | 32 | 26.67 | 2.24 |
| 3.1 – 4 | 15 | 12.50 | |
| Above 4 | 8 | 6.67 | |

The result in Table 2 shows that 75.00% of the respondents were males while 25.00% were females suggesting agrofeorestry in the study area is practiced by both genders. Majority of the respondents 45.84% (55) did not attend any form of formal education, 33.33% (40) attended primary school while 15.83% (19) and 5.00% (6) attended secondary school or tertiary institution, respectively. This suggest that agroforestry in the study area is beset by farmers who had no formal education. Most (44.17%) of the land used by farmers in the area got their land through inheritance indicating small farm holding as a result of fragmentation.

**Table 2:** Qualitative Data on Socio-economic Characteristics of Respondents (n =120)

| Variable | Frequency | Percentage |
|---|---|---|
| **Sex** | | |
| Male | 90 | 75.00 |
| Female | 30 | 25.00 |
| **Educational Level** | | |
| Non-formal | 55 | 45.84 |
| Primary | 40 | 33.33 |
| Secondary | 19 | 15.83 |
| Tertiary | 6 | 5.00 |
| **Source of Farmland** | | |
| Inheritance | 53 | 44.17 |
| Lease | 30 | 25.00 |
| Purchase | 25 | 20.83 |
| Government Land | 12 | 10.00 |

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**Awareness**

The response on the level of awareness of farmers in the study area on agroforestry is shown in Figure 1. The result indicates that 75% of the respondents were aware of one form of agroforestry or the other while 25% are not aware of the system. This indicates that the level of awareness of agroforestry as a means of livelihood and sustainable conservation method is high.

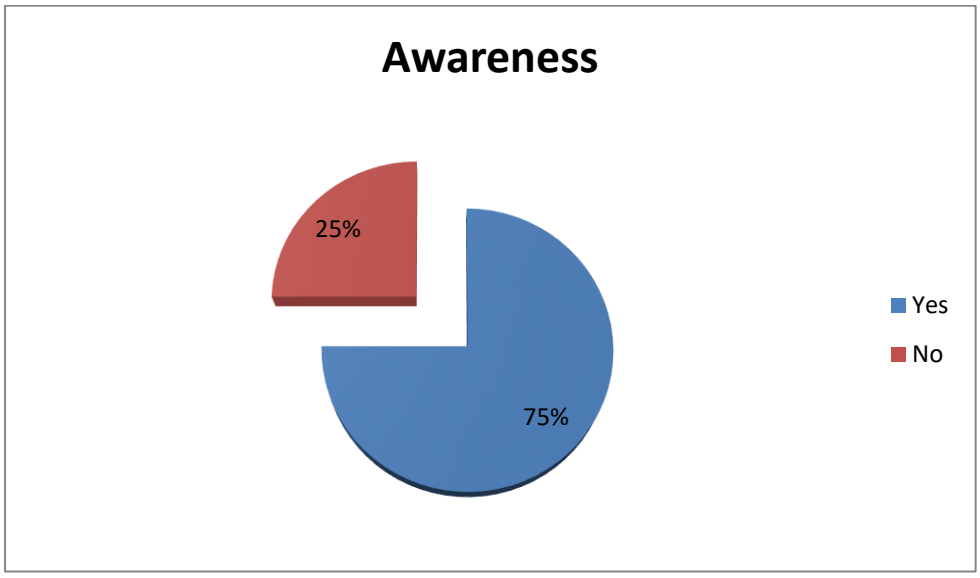


Figure 1: *Level of Awareness of Agroforestry Farming System in Jere LGA*

**Means of Awareness ofAgroforestry**

Figure 2 reveals that majority of the farmers got their information on agroforestry through farmers associations (35%), radio/Television which serves as a means of disseminating information was responded by 24%, the role of extension agents received 20% response as a means by which farmers became aware of agrofroestry and those that were aware of agroforestry through forest guards and village heads were the least with 11% and 10% response respectively. This implies that majority of the farmers in the study area belongs to farmers associations.

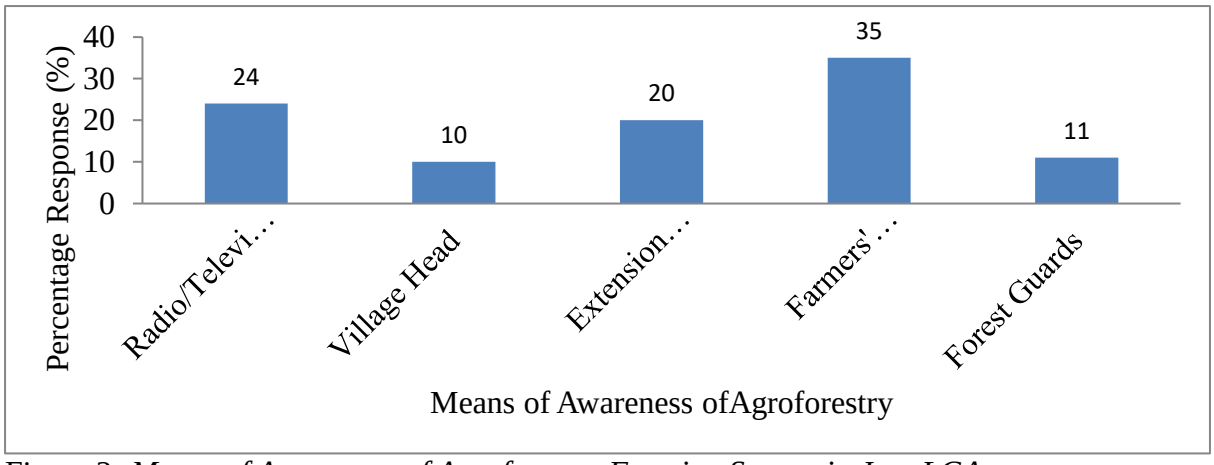


Figure 2*: Means of Awareness of Agroforestry Farming System in Jere LGA*

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**Factors Influencing Adoption of Agroforestry as a Means of Conservation Practices**

Table 3 shows perceived factors affecting adoption of agroforestry as a means of environmental conservation in agriculture. The adoption model explained that 96.0% ($R^2$ = 0.960) of the variables were responsible for the adoption of agroforestry farming practices as a means of environmental conservation. According to Ajayi (2007), agroforestry adoption is a complex phenomenon. Thus, this regression model is considered powerful (F = 354.94, P ≤ 0.000).

Sex was found to be the major determinant factor influencing agroforestry adoption (P≤0.000) in the study area (Table 3). This suggests that male farmers accept the farming practice relatively faster to their female counter parts as farming in the study area is dominated by males. The result agrees with the findings of Onemolease (2001) which states that female farmers are reluctant to adopt improved farming technologies relative to their male counterpart. Similarly, household size (P≤0.023) and contact with extension agents (P≤0.050) were among the determinants of agroforestry adoption with years of farming experience recorded the least influencer (P≤0.099) of agroforestry adoption. Extension services involve contact with farmers either through the extension agents visits to the farmers or the farmers visiting the extension office seeking for advice and information. Faming experience has been reported to influence farmers' decision to adopt innovation. Alkali *et al*. (2021) was of the view that years of experience of farmers in farming to a large extent affects the farmer's managerial ability and decision in many farm operations. Alakpa and Onemolease (2014) reported that farmers with more farming experience tend to appreciate and consequently adopt improved technology. The significant relationship for farm experience could be that farmers with more years of experience are more likely and willing to adopt improved farm practices for their production. Education level, farm size and land fragmentation did not have any significant influence on agroforestry adoption in the study area. This result contradicts Sani *et al.* (2018) that adoption level was very high with the level of education of education and low among those with low level of education.

**Table 3:** Factors Affecting Adoption of Agroforestry as a Means of Conservation Practices

| Variable | Coefficient | Standard Error | Z | P ≥ z |
|---|---|---|---|---|
| Constant | 0.278 | 0.132 | 2.106 | 0.037** |
| Age ($X_1$) | 0.017 | 0.021 | 0.803 | 0.424 |
| Household (X) | -0.068 | 0.030 | -2.305 | 0.023** |
| Farm experience ($X_3$) | 0.051 | 0.030 | 1.664 | 0.099* |
| Farm size ($X_4$) | -0.022 | 0.024 | -0.911 | 0.364 |
| Sex ($X_5$) | 0.875 | 0.045 | 19.506 | 0.000*** |
| Education level ($X_6$) | -0.003 | 0.029 | -0.113 | 0.911 |
| Land fragmentation ($X_7$) | 0.028 | 0.027 | 1.032 | 0.304 |
| Extension services ($X_8$) | -0.060 | 0.030 | -1.985 | 0.050** |
| Adjusted $R^2$ | 0.960 | | | |
| F – value | 354.94 | | | |
| P – value | 0.000 | | | |

Note: *=significant at 10%, **=significant at 5% and ***=significant at 1%

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**Constraints to Adoption of Agroforestry as a Means for Sustainable Environmental Conservation**

The constraints faced by respondents in the adoption of agroforestry as a means of conservation are shown in Table 4. These include land fragmentation (75%), inadequate nursery where farmers can have access to good quality seedlings (62.5%), lack of incentives and poor government policy in disbursement of the incentives (70.8%), poor access to extension services (60.8%), inadequate capital (58.3%) to engage in agroforestry. The Table (3) also shows that long gestation period of the seeds (57.5%), damage by animals grazing and humans (53.3%), limited use of modern machines in the farm (52.5%) and unavailability of labour (50.0%) were among the contributing constraints negating the adoption of agroforestry as a means for sustainable conservation mechanisms in the study area. The result suggests that farmers in the study area are faced with several problems which are likely to affect their adoption of agroforestry as a means of sustainable conservation. This result agrees with the findings of Yapi *et al.* (2006) that lack of improved seeds ranked second with 67% in Mali, indicating that improved seeds are not always available when needed and in the required quantity. Ibrahim *et al.* (2016) was of the view that poor extensions services limit the adoption of improve crop production packages. Alkali *et al*. (2021) suggest that capital availability contributes significantly to technology adoption, because credit is necessary for the purchase and use of new technologies by low capital-based farmers.

Singh and Jay (2010) reported high cost of technology, low availability of the required inputs, lack of training and lack of conviction in the technology as the constraints faced by most farmers. Umar *et al.* (2014) observed that inadequacy of seed was the major constraint followed by inadequacy of fertilizer and cost of seed being the third constraint faced by farmers in Kano and Katsina States, Nigeria. Similarly, Ibrahim *et al.* (2016) indicated that majority of the respondents had input constraints, financial constraint and poor storage facilities, lack of implement and poor extension services. Similarly, Abubakar *et al.* (2016) studied the adoption of production technologies by lowland rice farmers of Niger State, and reveals that the adopters were constrained by the high cost of inputs (chemical fertilizers, agro-chemicals and tractor hiring to carry out tillage operations) and ranked first in the order of magnitude. In addition, low availability of inputs was a constraint to the adopters to optimally comply with the recommendations.

**Table 4:** Constraints to Adoption of Agroforestry as a Means for Sustainable Environmental Conservation in the Study Area

| Variable | Frequency | Percentage | Ranking |
|---|---|---|---|
| Land Fragmentation | 90 | 75.0 | 1st |
| Poor Access to Extension Services | 73 | 60.8 | 4th |
| Limited Use of Machinery | 63 | 52.5 | 8th |
| Inadequate Capital | 70 | 58.3 | 5th |
| Unavailability of Labour | 60 | 50.0 | 9th |
| Inadequate Nursery (Seeds/Seedlings) | 75 | 62.5 | 2nd |
| Damage by Animals and Humans | 64 | 53.3 | 7th |
| Long Gestation Period of Seed | 69 | 57.5 | 6th |
| Inadequate Incentive and Poor Government Policies | 85 | 70.8 | 3rd |

## CONCLUSION AND RECOMMENDATIONS

The major findings from this study reveals that majority of the farmers in the study area were aware of agroforestry farming system mostly through their farmers' association. The major factors influencing adoption of agroforestry farming systems in the study area include

gender, household size, extension services and farming experience. Despite the numerous benefits of agroforestry to environmental conservation, farmers were constrained by land fragmentation possibly due to inheritance, lack of nursery where seeds/seedlings can be accessed, lack of incentives and poor government policies, poor access to extension services, inadequate capital, long gestation period of trees, damage caused by animals/humans, limited use of machineries and unavailability of labour. Based on the result of this study, the factors affecting the adoption of agroforestry as a means of sustainable environmental conservation can be overcome through the following recommendations

1. Land fragmentation should be discouraged to make it available to interested and intending farmers to check mate the problem of land fragmentation through inheritance
2. Government and non – governmental organizations should provide seeds/seedlings, credit facilities and incentives to encourage farmers to engage in agroforestry farming
3. Extension agents both from public and non-governmental organizations should work hard in sensitizing farmers on agroforestry farming practices.
4. This study may be replicated in other parts of Borno State to improve agroforestry farming system adoption for sustainable environmental conservation.

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