Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 8, No. 2, p. 275-282, 2016
http://www.innspub.net

INNSPUB

RESEARCH PAPER

OPEN ACCESS

Population structure and threats to sustainable management of woody plant species in a Semi-Arid Agro-Ecosystem in Nigeria

T.H. Dauda[1*], S.O. Jimoh[2], I.O. Azeez[2]

[1]*Department of Forestry and Wildlife Management, Federal University of Dutsin-Ma, Nigeria*

[2]*Department of Forest Resources Management, University of Ibadan, Nigeria*

Article published on February 28, 2016

Key words: Woody species, Population, Agro-ecosytems, Threats, Sustainability.

Abstract

This study was conducted to assess population structure and threat to the sustainable management of woody species in the various ago-ecosystems in Dutsin-Ma Local Government Area (LGA) Katsina State, Nigeria. Purposive and stratified random sampling techniques were used to collect data from 21 randomly demarcated 100m × 100m sample plots. All woody plant species found in the sample plots with stem diameter ≥2 cm at 20cm above ground, were recorded. Population structure was summarized by diameter classes. For the identification of threats, field and questionnaire surveys were used. A total of 50 questionnaires were distributed at ten questionnaires per ward in five out of the 11 wards in the LGA. The highest numbers (350) of small diameter trees (0.1-1.0cm) were recorded in the agrosilvopastoral system. This was followed by silvopastoral and agrisilviculture systems with 89 and 85, respectively. However, the highest number of large diameter woody tree species was recorded in the silvopastoral system followed by agrosilvopastoral and agrisilviculture systems. The regular reverse J-shaped and fairly regular reverse J-shaped size class distribution observed for agrosilvopastoral and silvopastoral respectively, suggest a recuperating population. Over exploitation, debarking, de-branching, root-digging, leaf harvesting, seed harvesting, poor regeneration, slow rate of growth, wind effect and bush burning were the major threats to sustainable management of woody plant species in the study area. The implications of our findings for sustainable management of woody plant species in the study area are discussed and recommendations made.

***Corresponding Author:** S.O. Jimoh ✉ jimohsaka@yahoo.com

Introduction

In most semi-arid regions of West Africa, land use is predominantly traditional (non-intensive). Woody plant species have been observed to play numerous

ecological and economic roles on farmlands (Sadio and Negreros-Castillo, 2003; Jimoh and Asinwa, 2012). They also control soil erosion, stabilize regional and global climates, provide carbon sinks and act in pollution control (Adamu, 2006). Woody species are valuable resources for rural people; and their sustainable management on farmland and in the natural vegetation has become an important issue in rural development programmes (Nikiema, 2005).

Indigenous woody plant species are important natural resources in West African savanna and are of high value among rural dwellers of Dutsin-Ma LGA (Tukur *et al.*, 2013). Although, Dutsin-Ma LGA is not well vegetated due to its savanna nature, there are a variety of plant species that play significant roles as food, fuel wood, timber, conservation of land and soil fertility, medicines and so on (Tukur *et al.,* 2013). Agroforestry is the predominant system of land use in the LGA with variants of *agrisilviculture, agrosilvopastoral, silvopastoral* and *apisilvicultural* systems in which woody species are well represented. However, farmers alter this woody vegetation composition and structure in order to facilitate its use (Simon *et al.,* 2004). Majority of the inhabitants of Dutsin-Ma LGA are poor, living below the US$1 per person per day threshold (Terdo and Adekola, 2014). Hence, poverty in Dutsin-Ma LGA makes rate of exploitation of woody species in and out of the forest very frequent as the livelihood of most of these rural dwellers depend on the use of woody species. This has a great consequence on the sustainability of these woody species. At current rate of disappearance, the woody species in the area face the danger of local extinction, and a great ecological and economic challenge may arise for the poor rural dwellers in the LGA. A need therefore arises to determine the population structure as well as identify the threats to such species to be able to prescribe sustainable management options for them in the various agroecosystems of Dutsin-Ma LGA.

Materials and methods

Study area

The study was conducted in Dutsin-Ma LGA, Katsina State, Nigeria. The LGA is located within the Sudan savanna agroecological zone of the central part of Katsina State, Nigeria on latitude 12° 27' 18" N and longitude 7° 29' 29" E and has its headquarters in Dutsin-Ma town (Fig. 1).

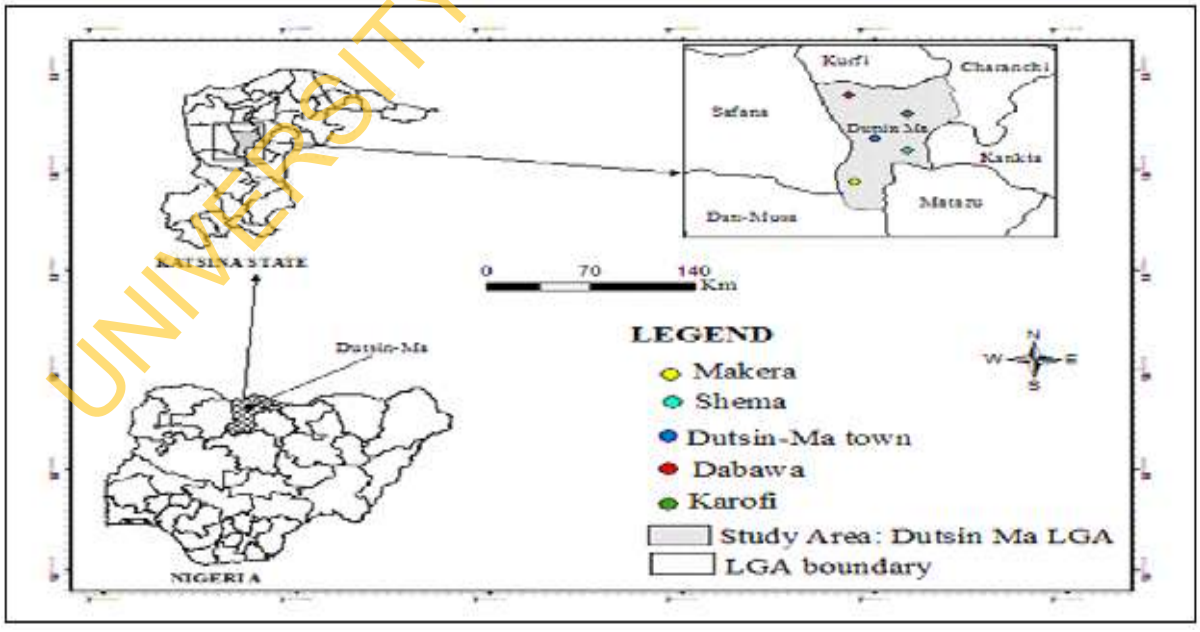

Fig. 1. Map of Dutsin-Ma local government area showing the study locations.

The climate is semi arid tropical wet and dry climate (Tukur *et al.*, 2013). Maximum day temperature reaches about 38°C in the month of March, April and May while minimum temperature is about 22°C in December and January (Tukur *et al.*, 2013). Majority of the inhabitants are poor, living below the US$1 per person per day threshold. The population is about 169,829 within about 18,800 households living on an annual average household income of N18, 989 (US$122) and a land area of about 527km² (Terdo and Adekola, 2014). The inhabitants are predominantly *Hausa* and *Fulani* by tribe and their main occupation is arable and livestock farming. Woody perennials are a common component of the farm ecosystem. Three agroforestry systems (*Agrosilvopastoral, Agrisilviculture* and *Silvopastoral*) are discernible within the farming landscapes. Dauda *et al.* (2013) attributed a recent increase in population and socioeconomic activities in the LGA between 2011 and 2013 mostly to the establishment of a Federal University at Dutsin-Ma. This has exacerbated the anthropogenic pressures on the inherently fragile savanna ecosystem of the LGA.

Study design

Purposive and Stratified random sampling techniques were used for the inventory. Five of the eleven wards that make up Dutsin-Ma LGA were purposively selected based on the agroforestry practices. Information on threat to sustainable management of woody species in the faming landscapes was collected with the aid of semi-structured questionnaire and field observations in each of the selected wards. Also, seven 100m × 100m sample plots were randomly demarcated in each agro ecosystem (*Agrosilvopastoral, Agrisilviculture and Silvopastoral*) and tree inventory data was collected from each sample plot.

Data collection

Tree species inventory

All woody plant species found in the demarcated sample plots with stem diameter ≥2 cm at 20cm above ground, were identified and recorded. Instead of DBH (1.3m above ground), stem diameters at 20 cm above ground were measured, to guard against the exclusion of many useful woody species in the savanna vegetation. Diameter classes were constructed and then used to prepare a bar chart. Population structure was summarized in diameter classes. Recordings of threats to trees' health such as debarking, fruit and leaf removals, root digging, fire; and animal grazing were made.

Questionnaire survey

An open and close -ended questionnaire was used for face-to-face interviews. A total of 50 sets of the questionnaire were distributed at ten questionnaires per selected ward. This was complimented with oral interviews of target informants and focus group discussions. The information obtained from the interviews and discussions include: plant species found in agro-ecosystems and the various threats to the conservation and sustainable management of the tree species on the farms.

Data analysis

The data generated were subjected to descriptive statistics using histograms and pie-charts. The analysis was done using IBM SPSS version 21.

Results

Population structure of woody tree species

A total of 1,038 tree species were identified in the study area. These include: 284 in agrisilviculture, 209 in silvopastoral and 583 in agrisilvopastoral ecosystems. Generally, agrisilviculture ecosystem was dominated by smaller diameter trees (Fig. 2). This ecosystem housed the highest number of species that fell within the 1.1 to 2.0 m diameter class and the lowest number of those that were between the 6.1 and 7.0 m diameter class. *Silvopastoral* ecosystem has a wider range of tree diameters (0.1-8.0 m) than *agrisilviculture* (Fig. 2).

The highest number of species in this ecosystem was in the smallest diameter class (0.1-1.0 m), while the lowest number was in the diameter classes 4.1-5.0 m

and 5.1-6.0 m. In the *Agrisilvopastoral* ecosystem; diameter class distribution of trees was between 0.1 and 8.0m There are higher number of trees in the smaller diameter class 0.1-1.0 m but fewer number of trees in the large diameter classes, especially in 5.1-6.0 as is the case with *Silvo-pastoral* ecosystem.

Generally, *Agrisilvopastoral* ecosystem has the highest number of small diameter trees (0.1-1.0 m) while *Silvopastoral* has the least (1.1-2.0 m). On the other hand, *Silvopastoral* and *Agrisilvopastoral* ecosystems have the highest number of big diameter trees, falling in the 6.1-7.0 m and 4.1-5.0 m diameter classes, respectively (Fig. 2).

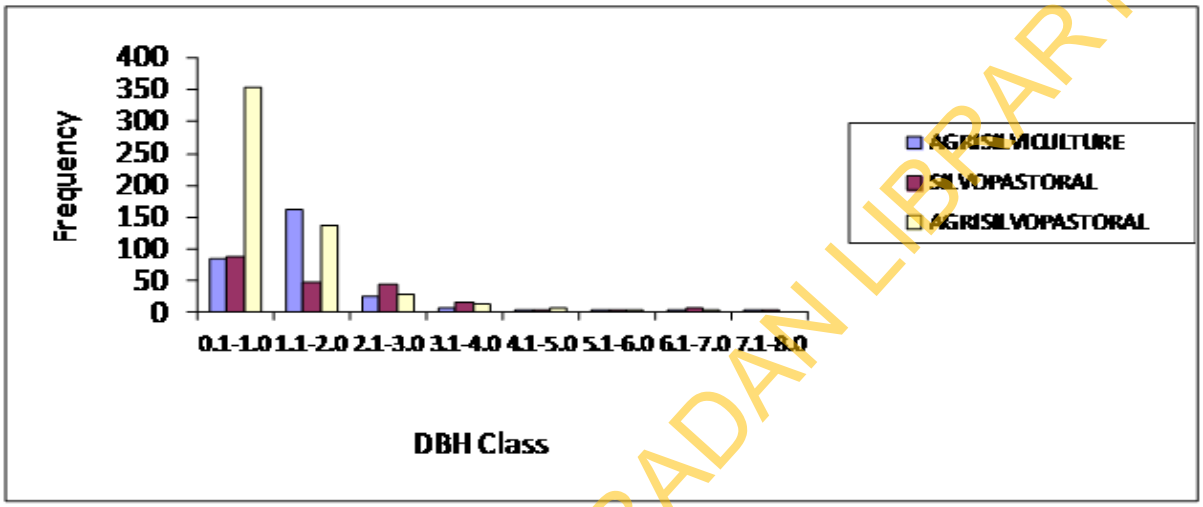

Fig. 2. Population Structure of Woody Species in the Agro ecosystems of Dutsin-Ma LGA.

Threats to sustainable management of woody species

Fig. 3 shows the factors threatening the sustainable management of woody species in agro-ecosystems of Dutsin-Ma LGA as perceived by residents in the area. Over-exploitation (60.0%), debarking (14.0%), biological factors such as slow rate of growth and wind effect (17.0%), uncontrolled felling (7.0%) and bush burning (2.0%) are the major threats to sustainable management of woody species in the study area.

The various threats observed directly on the field include: root digging (23.0%), leaf harvesting (11.0%), De-branching (46.0%) and seed harvesting for human consumption (10.0%). Sixty percent of the woody tree species encountered on the field suffered one, two or a combination of all the identified threats. In all, over-exploitation of different parts of trees was identified as the greatest threat to woody species populations in the study area.

Discussion

Woody species distribution

There is evidence of woody species regeneration either naturally or through planting in the *Agrisilviculture system*. The fewer number of middle class diameter trees and lower number of large diameter trees give an indication that woody species are not allowed to grow to large stem diameter before they are exploited in the study area.

Many trees must have been exploited at their younger stages for firewood and building poles. This observation is consistent with the report of Gouwakinnou *et al.,* (2009) that most agrisilviculturists aim to optimize profit from their crops and trees through any avenue. This can be achieved by harvesting every useful part of their tree species (leaves, fruits, seed and bark for food and medicine and branches for firewood or other income generation purposes). These may affect the growth process of the woody species resulting in stunting, stagnation or even death of the trees.

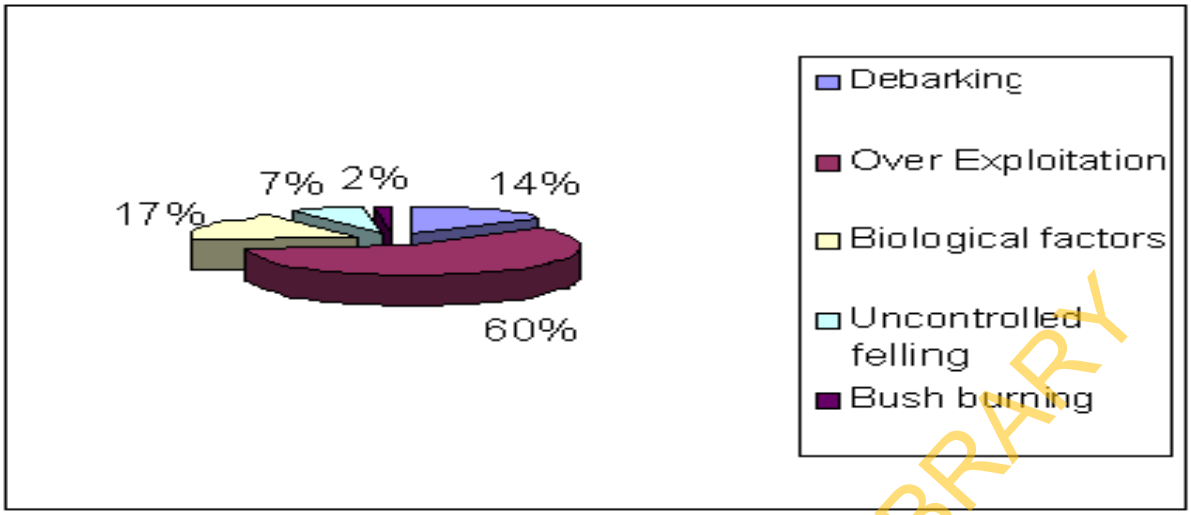

Fig. 3. Respondents' perceived threats to woody species populations in the study area.

Also, the fact that *Silvopastoral* ecosystem has a high number of large stem diameter-woody species may be attributed to the fact that, most of the younger trees, particularly the palatable ones would have been nipped by cattle, sheep and goats or harvested by human, as fodder at their tender ages. Hence, only old, naturally regenerated large diameter trees such as *Adansonia digitata* are dominant because they are not disturbed for fodder production purposes.

The presence of large number of small diameter woody species in the *Agrosilvopastoral* ecosystem may be an indication that this ecosystem is recuperating (Jimoh *et al.,* 2013). It may also indicate the ecological interdependence of the system. The livestock assist in soil replenishment and seed dispersal, the woody trees provide fodder and favourable microclimate for livestock and food crops (Sobola and Amadi, 2014); while arable crops' residues contribute to soil fertility maintenance. This productive interdependence creates favourable environment for tree regeneration.

Threats to sustainable management

Over-exploitation was found to constitute the highest form of threat to sustainable management of woody species in the study area. Research has shown that there are cases of over harvesting of parts of woody species by people especially in the rural areas whose level of dependency on woody plants are high due to poverty (Tukur *et al.*, 2013). Parts of trees such as leaves, fruits, bark, stem, root, seeds are collected by these rural dwellers to meet their everyday needs. Since the threshold for susnable harvesting of these parts are not known; these parts are invariably over exploited and these may lead to consequent death of the tree (Shamaki *et al.*, 2014). Also, biological factors accounted for 17.0% of the threats to sustainable management of woody species. Factors such as slow rate of growth, poor regeneration, irregular flowering and fruiting patterns are some of the biological factors that threaten sustainable management of woody species in the agro-ecosystems of the study area. Across the globe, research has revealed that sustainable management of woody species in and out of the forest is being challenged with some of these biological factors (Smith, 1986). Other factors such as debarking, uncontrolled felling and bush burning are also important sources of threat to sustainable management of woody species in the area. Bush burning contributed a very small percentage to threat in Dutsin-Ma LGA . This is probably because woody plants are kept within crop fields as an important component (Nikiema, 2005); so even during occasions of burning, the woody tree species are protected. This may also be attributed to the fact that many of the tree species in this ecological region must have developed fire resistance over the years. Similar observations had earlier been made by Tukur *et al.* (2013) and Abaje *et al.* (2014) in the study area.

There is evidence of heavy reliance on edible wood products for livelihood support in the study area. Gideon and Verinumbe (2013) observed that rural people sometimes collect food from the forest or trees e.g. mushrooms obtained from trees on farm land. Boffa (1999), also stated that, trees outside forest represent major food sources for rural populace. Parklands of *Parkia biglobosa* Jacque benth and *Villellaria paradoxa* G. Don are conserved because of the food items they offer. Fruit from woody species such as: *Diospyros mespiliformis Hochst.ex A .DC.*, *Lannea barteri(Oliv.)Engl.*, *Borassus aethiopum Mart.*; leaves from: *Adansonia digitata* Linn, *Tamarindus indica* Linn, *Anogeissus leiocarpa* (Guill. & Perr.) and fodder obtained from these woody species provide rural livelihood supports.

This may have implication on sustainable management of woody species in Dutsin-Ma LGA because, before a farmer may be persuaded to conserve a resource; his food need must first be met. This is more so, when the people of this area are largely poor (Tukur *et al.*, 2013, Terdoo and Adebayo, 2014) and their livelihoods depend so much on products from woody species. These uses constitute threats to sustainable management of woody species if not carefully controlled.

There are cases of root digging (19.0%), de-branching (41.0%) and outright felling of woody species in the study area for the purpose of firewood. Firewood is the major energy source of domestic cooking in the study area (Tukur *et al.*, 2013). This constitutes a major threat to sustainability of woody tree species. Adebayo and Tukur (1999), Tukur *et al.*, (2013), Gideon and Verinumbe (2013) have observed that rural population in Nigeria depends solely on firewood to meet their basic energy needs for cooking and heating.

The community dwellers of Dutsinma also use various parts of woody tree species for medicinal purposes. The rampant debarking observed in the study is largely due to bark harvesting for medicinal purposes. According to Terdoo and Adekola (2014), most of the people here cannot afford orthodox drugs and they also believe in the potency of their herbs. Hence, different parts of woody species are used for different medicinal purposes.

This however constitutes threat to the sustainable management of the woody species population in the area. This is because bark removal may hinder translocation of food materials which may in severe cases, lead to the death of the trees affected. Furthermore fruit and seeds collection for medicinal purposes may reduce drastically, the quantity and quality of seeds available for natural regeneration.

Conclusion

The study shows that, there are generally more of younger trees in the various agro-ecosystems which implies that the larger trees have been harvested for various purposes. This has implication for future tree regeneration since mature mother trees will be required to produce seeds for regeneration. *Agro-silvopastoral* system seems to support better, the conservation of woody tree species. The factors constituting threats to the woody species in the study area include: poor regeneration, slow growth and economic factors such as over harvesting of plants parts for food, fuel, medicine and housing needs.

Recommendation

There should be deliberate efforts to aid natural regeneration of particularly favoured species for food, fuel, medicine and housing needs.

It is advised that priorities be accorded the *agro-silvopastoral* practice in future; as this appears to support woody species regeneration better. Considering the economic status of the people and their energy requirements, fast growing fuel-wood species such as *Eucalyptus spp* and *Gliricidia sepium(Jacq.)Walp*. should be incorporated into the agroforestry landscape. Also, more plantation forests and woodlots need to be developed so that the pressure on agroforestry plots could be reduced.

References

Abaje IB, Sawa BA, Ati OF. 2014. Climate Variability and Change, Impacts and Adaptation Strategies in Dutsin-Ma Local Government Area of Katsina State, Nigeria. Journal of Geography and Geology **6(2),** 103-112.

Adebayo AA, Tukur AL. 1999. Adamawa State in maps. Paraclete publishers, Yola
Nigeria.

Boffa JM. 1999. Agroforestry parklands in Sub-saharan Africa. Food and Agricultural Organisation of the United Nations, Rome. *FAO Conservation Guide 34,* 230 p.

Dauda AB, Yakubu SO, Kabir I. 2013. Determinants of Fish Consumption in Dutsin-Ma LGA, Katsina State. In: Adediran J A, Saka JO, Ibrahim AG, Adeyemi VA, Atere AO, Adenekan MO. (Eds.) Revamping Nigeria Agriculture Through Transformation Agenda: The Way Forward. Proceedings of the 47th Annual Conference of the Agricultural Society of Nigeria held at the Federal College of Animal Health and Production Technology, Moor Plantation, Ibadan, Oyo State, Nigeria 4th – 8th November, 2013. 1106-1109.

Gideon PK, Verinumbe I. 2013. The contribution of agroforestry tree products to rural farmers in Karim–Lamido Local government area of Taraba state. Journal of Research in Forestry, Wildlife and Environment **5(1),** 50-62

Gouwakinnou GN, Kindomihou V, Achille E, Assogbadjo AE, Sinsin B. 2009. Population structure and abundance of *Sclerocarya birrea* (A. Rich) Hochst subsp. *birrea* in two contrasting land-use systems in Benin. International Journal of Biodiversity and Conservation **1(6),** 194-201.

Jimoh SO, Asinwa IO. 2012. Densities and Distribution of *Vitellaria paradoxa* C.F. Gaertn. and *Parkia biglobosa* (Jacq.) R. Br. ex G. Don in Agro-ecosystems in Oyo State, Nigeria. Nigerian Journal of Ecology **12,** 28-36.

Jimoh SO, Amusa TO, Azeez IO. 2013. Population distribution and threats to Sustainable management of selected non-timber forest products in tropical lowland rainforests of south western Nigeria. Journal of Forestry Research **24(1),** 75-82.

Nikiema A. 2005. Agroforestry Parkland Species Diversity: Uses and Management in Semi-arid West Africa (Burkina Faso). PhD thesis Wageningen University,Netherlands. 8-22.

Sadio S, Negreros-Castillo P. 2003. Trees outside forests: Contributing towards sustainable development being a paper submitted to XII World forest Congress 2003, Quebec city Canada. 0866-B5

Shamaki SB, Bello AG, Dikko AA. 2014. Tree Species Density Distribution in Dabagi Forest Reserve in Semi-Arid Region of Nigeria. In: Adekunle *et al.*, Eds. *Forest and Forest Products: Key to Sustainable Livelihood*. Proceedings of the fourth Biennial National Conference of the Forest and Forest Products Society, Federal University of Agriculture, Abeokuta, Nigeria, 23-26 April, 2014. 144-148

Simon B, Mushabe D, Nkuutu D, Pomeroy D, Tushabe H. 2004. Trees, Birds and Agriculture. Biodiversity in Uganda's Farming Systems in Relation to Agricultural Intensification. Strategic Criteria for Rural Investments in Productivity (SCRIP) Program of the USAID Uganda Mission. 12-14.

Smith DM. 1986. The Practice of Silviculture, 8th edition.John Wiley and Sons., New York. 97-102 .

Sobola OO, Amadi DC. 2014. The role of Agroforestry in Environmental Sustainability. In: *Forest and Forest Product: Key to Sustainable Livelihood.* In Adekunle *et al.,* Eds Proceedings of the fourth Biennial National Conference of the Forest and Forest products society, Federal University of

Agriculture, Abeokuta, Nigeria, 23-26 April, 2014. 153-159.

Tukur R, Garba KA, Ibrahim A. 2013. Indigenous Trees Inventory and Their Multipurpose Uses in Dutsin-Ma Area, Katsina State. European Scientific Journal **9(11),** 288-300.

Terdo F, Adekola O. 2014. Assesing the Role of Climate Smart Agriculture in Combating Climate Change, Desertification and Improving Rural Livelihood in Northern Nigeria. African Journal of Agricultural Research **9(15),** 1180-1191