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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

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ABSTRACT

Population increase has led to increased pressures on many socioeconomically and ecologically important tree species including *Vitellaria paradoxa* C.F.Gaertn.and *Parkia biglobosa* (Jacq.) R.Br.ex G.Don. This portends great threats to the continued existence of such species including the myriads of goods and services they provide. There is need to put on record, scientific evidence of the current status of these species in order to draw attention to the pressures on their populations and the need for deliberate actions for their conservation and sustainable management. We assessed densities and distribution of *Vitellaria paradoxa* and *Parkia biglobosa* in some agro ecosystems in Oyo State, Nigeria with a view to generating information on the current stocking of the species in the various ecosystems and provide base line data for subsequent resource monitoring and sustainable management planning. Oyo State was stratified into three agro-ecological zones viz: dry-woodland/Southern Guinea savanna, moist-woodland/derived savanna and rainforest. A multistage sampling procedure was used in collecting data on densities and distribution of *Vitellaria paradoxa* and *Parkia biglobosa* in the agro ecosystems through field survey. Descriptive statistics, cross tabulation, simple t-test and analysis of variance (ANOVA) were used to analyze the data. Student's t-test and analysis of variance indicate that there was no significant difference at 5% level of probability in the densities of *V. paradoxa* and *P. biglobosa* in the cultivated and fallow land. Potential mother trees for regeneration were found mainly on crop farms while younger trees dominate the fallow plots. This is an indication of extraction of older trees on fallow plots apparently for domestic energy supplies. It is recommended that the management of *V. paradoxa* and *P. biglobosa* should be intensified through enrichment planting and deliberate cultivation in plantations in order to meet the high demand pressures on their populations.

Key words: Demand Pressures, Ecological status, Enrichment planting*;* Sustainability

INTRODUCTION

Traditional farming systems in the tropics are known to rely on trees and shrubs for soil fertility maintenance (FAO, 2004). The importance of trees in agro-ecosystems has long been realised by farmers, and this is evident in the deliberate incorporation of trees in crop production systems (Sène, 1985 and Hopkins, 1985). Inquiry into current and past farming practices has clearly shown that rural communities have a wealth of knowledge as to which trees improve agronomic crops' growth, provide fodder during dry seasons and help maintain soil structure for successful farming on sloppy terrain (Bayala, 2006). Traditionally, farmers in Africa preserve these valuable resources by nurturing them in agroecosystems. In fallow, the incidence of protected trees of varied species and sizes indicates a strong correlation between conservation and the productive values of trees (Bonkoungou, 2002).

Many rural households in Nigeria depend on forest resources to meet their subsistence needs for staple and supplementary foods, construction materials, fuel, medicine, cash, local ecosystem services and farm inputs, such as animal feed and nutrients for crops (Raintree, 1999). In rural areas, the contribution of indigenous agroforestry fruit trees such as *Vitellaria paradoxa* and *Parkia biglobosa* to food supply is essential for food security as they provide an alternative source of food, when stored food supplies are dwindling and the agronomic crops are not yet ready for harvests.

Vitellaria paradoxa and *Parkia biglobosa* have been widely recognised as important indigenous fruit tree species throughout their range of distribution (Bonkoungou, 2002; Oni, 2006). They are highly valued by farmers for their economic potentials. *Vitellaria paradoxa's* fatty kernels are sold both in local and international markets, thereby contributing considerably to wealth creation. *Parkia biglobosa* seeds (used as condiments) play significant roles in the nutritional requirements and primary health care status of the people of Nigeria (Oni, 2006). Furthermore, both species are known to contribute significantly to farmers' income, particularly in the savanna region of Oyo State, Nigeria (Jimoh and Adedokun, 2005; Jimoh and Haruna, 2007).

Unfortunately, many stands of these species are being destroyed either for agricultural purposes or for charcoal production for the supply of domestic cooking energy. There is need to draw the attention of various stakeholders to the reduction in the wild populations of these valuable species in order to trigger off necessary actions for their conservation, enrichment planting and possibly deliberate plantation establishment. Therefore, this study aims at providing basic information on the current status of these species in three agro ecosystems in Oyo State, Nigeria.

MATERIALS AND METHODS

Oyo State is located in South-western part of Nigeria. It lies between latitudes 7^0N and 9^0N and longitudes 2.5^0E and 5^0E. It has a total land area of 28,454 square kilometres. The vegetation pattern of the State is that of rain forest in the South and Guinea savanna in the North (Fig. 1).

The study area was stratified into three, based on ecological zones i.e. dry-woodland/Southern Guinea savanna, moist-woodland/derived savanna and rainforest (Odebiyi *et.al.*, 2004). Two Local Government Areas (LGAs) were randomly selected from each ecological zone (18% sampling intensity) using the table of random numbers. They include: Atisbo LGA and Olorunsogo LGA from dry-woodland savanna; Orire LGA and Ibarapa East LGA from moist-woodland, Iddo LGA and Akinyele LGA from rainforest zone (Fig. 1). Stratified sampling technique was used to select four study sites in each of these LGAs. This was achieved by partitioning each LGA into four geographical zones i.e. North, South, East and West, based on the information obtained from each LGA headquarters. A village/community was randomly selected to represent each zone in each LGA. Thus, a total of 24 villages/communities were selected and two land use types (crop farm and fallow land) were studied in each village.

Two 1-hectare plots were marked out for each land use type (crop farm and fallow) and then, within each plot, two 50m x 50m sub-plots were randomly selected for sampling. The numbers of trees of the two species (5cm and above) found on the selected sub-plots were counted to determine their density, frequency and relative abundance. The trees were assessed for height using Hagar altimeter and diameter at breast height (dbh) using diameter tape. The measured trees were classified based on diameter, as saplings (5cm- 9.9cm), poles (10cm-20cm) and adult trees (above 20cm). Each tree of the two species found on the selected plots was counted to determine the density and relative abundance of the different tree sizes.

Relative abundance was calculated using Eqn. 1:

$$\text{Relative abundance } (\%) = \frac{\text{Number of trees in the size class}}{\text{Total number of trees}} \times 100 \quad \text{... Eqn. 1}$$

Simple t-test was used to test for significant difference between densities of each of *Vitellaria paradoxa* and *Parkia biglobosa* in the two land use types

The simple t-test was estimated using Eqn. 2:

$$t = \frac{\overline{X}_T - \overline{X}_C}{\sqrt{\frac{var_T}{n_T} + \frac{var_C}{n_C}}}$$

Where:

$\overline{X}_T$ = Means of densities of each species in crop farm

$\overline{X}_C$ = Means of densities of each species in fallow land

Var_T = Variance of each species in crop farm

Var_C = Variance of each species in fallow land

n_T = Number of each species in crop farm

n_C = Number of each species in fallow land

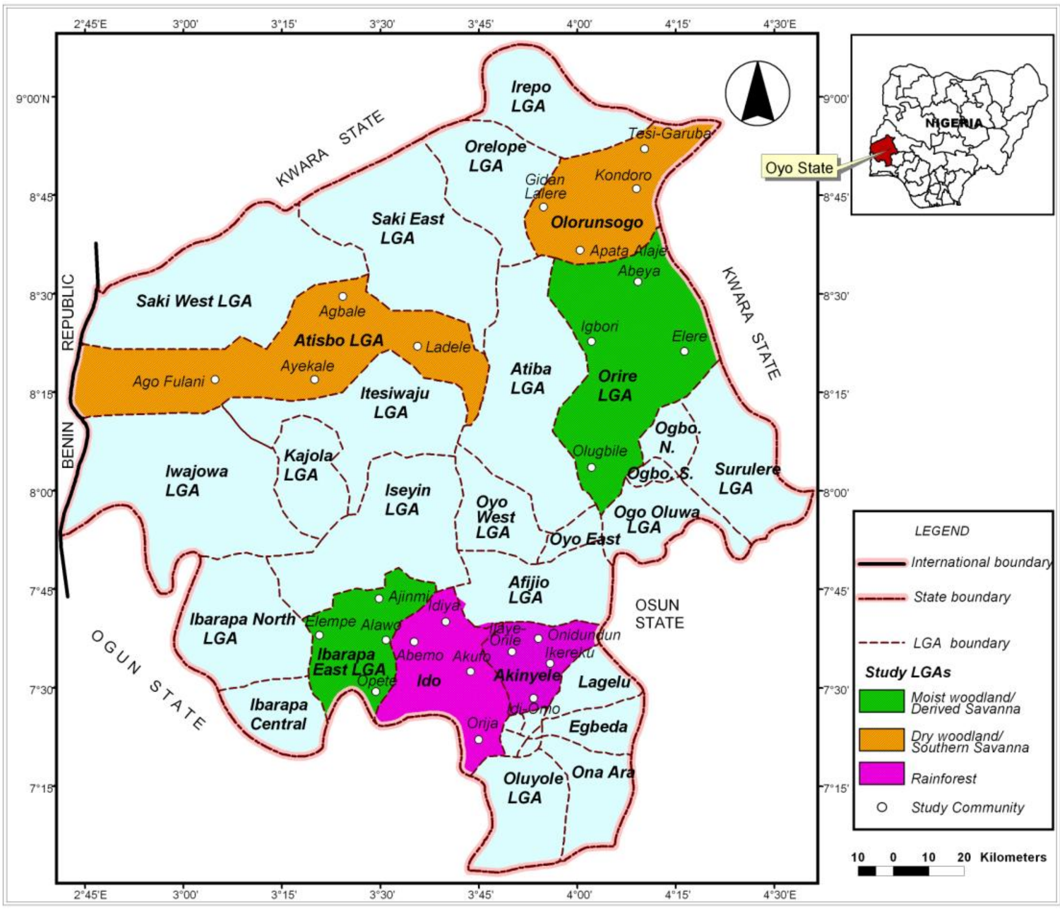

Fig. 1: Map of Oyo State Showing selected LGAs used in the study (inset: Map of Nigeria showing Oyo State)

RESULTS AND DISCUSSION

Species Densities and Distribution

The highest mean density of *V. paradoxa* was recorded in the fallow land of the dry wood land ecological zone (24.88 trees/ha) followed by 24 trees/ha in the fallow land of the moist wood land (Table 1). There were more saplings and pole size trees in the fallow land than in crop farms (Table 2) probably due to extensive removal of trees during land preparation and frequent removals during weeding of crop farms. This reduces the population that grows to mature trees which may eventually threaten the germplasm of the species, as mature trees which would produce seeds would not be available. The lowest mean density of *V. paradoxa* was recorded in the crop farm of rainforest ecological zone. This may be expected since the species is peculiar to savanna ecosystems. In relation to size classes, mature trees of *V. paradoxa* of dbh >20cm at average height of 18.2m had the highest mean densities in the crop farm probably as a result of the fact that most of the seedlings and saplings might have been cleared off during land preparation while mature trees were given management preference. On the other hand, the dominance of the saplings of *V. paradoxa* in the fallow land may be attributed to the intensive exploitation of the adult trees for charcoal -making and effect of uncontrolled bush burning that might retard the growth of the young shoots of the species. It is shown in Tables 4 and 5 that densities of *V. paradoxa* among the three ecological zones were significantly different.

Table 1: Mean densities of *V. paradoxa* and *P . biglobosa* in agro-ecosystems of different ecological zones of Oyo State, Nigeria

Ecological zones	Land uses	Density (No. of Plants/ha)	
		V. paradoxa	*P.biglobosa*
Dry woodland	Cultivated land	20.60	23.25
	Fallow land	24.88	25.00
Moist wood land	Cultivated land	17.50	24.28
	Fallow land	24.00	20.63
Rainforest	Cultivated land	3.75	5.38
	Fallow land	3.38	5.00

Table 2: Relative abundance (%) of *V. paradoxa* and *P. biglobosa* among ecological zones and between land use types in Oyo State, Nigeria

Ecological zones	Land use	Relative abundance (%)					
		V. paradoxa			*P. biglobosa*		
		5.0-9.9 (cm)	**10.0-20.0 (cm)**	**>20 (cm)**	**5.0-10.0 (cm)**	**10.0-20.0 (cm)**	**>20.0 (cm)**
Dry wood land	Cultivated land	20.06	29.73	50.21	9.52	30.72	74.16
	Fallow land	49.23	27.73	23.05	21.10	27.62	65.24
Moist wood land	Cultivated land	20.50	28.56	50.96	5.52	20.31	65.17
	Fallow land	58.36	31.09	50.56	12.96	16.27	58.36
Rainforest	Cultivated land	18.60	14.07	18.00	7.15	20.78	21.08
	Fallow land	14.67	16.67	17.67	10.02	15.81	19.16

There were significant differences in the densities of *V. paradoxa* in the two land use types of the three ecological zones (Tables 3 and 7). The higher density of *V. Paradoxa* recorded in the fallow land is in agreement with Popoola and Tee (2001) who reported a density of 23-105 trees/ha of *V. paradoxa* in the savanna ecosystem in Benue State, Nigeria. Conversely, Odebiyi *et al.* (2004) reported 3.8 and 4.3 trees/ha in the fallow land in moist woodland and dry woodland, respectively in Nigeria.

The Highest density of *P. biglobosa* was recorded in the fallow of dry woodland (25.00 trees/ha) followed by the cultivated land of moist woodland (24.28 trees/ha). This is an improvement over the findings of Odebiyi *et al.* (2004) who reported 8.2 and 5.2 trees/ha in cultivated and fallow land respectively. Analysis of Variance and simple t-test show that densities of *P. biglobosa* in the two land use types of the three ecological zones are not significantly different (Tables 4 and 6). This could be an indication that this species enjoys farmer's protection in all the ecological zones probably because of its economic and ecological benefits.

Distributions of *V. paradoxa* and *P. biglobosa* were significantly different in the three ecological zones; but their mean densities do not differ in moist woodland and dry woodland (Tables 4, 5 and 6). This corroborates the findings of Bonkoungou (2005) that *V. paradoxa* and *P. biglobosa* were equally distributed in African parkland and Odebiyi *et al.* (2004) that the species were almost equally dominant at Igangan, Ogbomoso, Saki and Ilorin Moist woodland and Dry woodland ecosystems.

Table 3: Analysis of Variance (ANOVA for Densities of *V. paradoxa* in the two land use types of the three ecological zones

SV	Df	SS	MS	F cal.	F tab.
Ecological zones	2	33450.04	1725.02	236.63*	3.23
Land use types	1	117.18	117.18	16.07*	4.08
Error	42	306.13	7.29		
Total	47	3873.35			

* = Significant at 5% level of probability.

Table 4: T-test for Densities of *V. paradoxa* in the three ecological zones.

Ecological zones	Mean
Dry woodland	22.25 a
Moist woodland	20.75 a
Rainforest	3.57 b

* Means with the same letter are not significantly different (P > 0.05)

Table 5: Analysis of Variance (ANOVA) for Densities of *P. biglobosa* in the two land use types and the three ecological zones

SV	Df	SS	MS	F cal.	F tab.
Ecological zones	2	3498.04	1749.02	291.99*	3.23
Land use types	1	7.52	7.52	1.26ns	4.08
Error	42	251.38	5.99		
Total	47	3756.94			

* = Significant at 5% level of probability. ns = Not significant at 5% level of probability.

Table 6: T-test for Densities of *P.biglobosa* in the three ecological zones.

Ecological zones	Mean
Dry woodland	24.00 a
Moist woodland	22.50 a
Rainforest	5.19 b

* Means with the same letter are not significantly different (P > 0.05)

Table 7: T-test for mean densities/hectare of *V. paradoxa* in the land use types of each ecological zone

Ecological zones	Land uses	Mean	SD	Df	T. cal.	T.tab
Dry wood	CL	6.87	1.14	7	3.27*	2.36
land	FL	2.96	0.58			
Moist	CL	5.83	1.52			
wood land	FL	8.00	0.40			
Rainforest	CL	1.13	0.40	7	3.50*	2.36
	FL	1.67	0.77			

Source: Field survey, 2011

* = Significant at 5% level of probability. ns = Not significant at 5% level of probability.

CL = Cultivated land FL = Fallow land

Table 8: T-test for mean densities of *P. biglobosa* in the land use types of each ecological zone

Ecological zones	Land uses	Mean	SD	Df	T. cal.	T.tab
Dry wood land	CL	7.71	1.07	7	2.32ns	2.36
	FL	8.29	0.42			
				7	0.46ns	2.36
Rainforest						

Source: Field survey, 2011 * = Significant at 5% level of probability.
Ns = Not significant at 5% level of probability.
CL = Cultivated land FL = Fallow land

Population Structure

Generally, all size classes of the two species were not equally distributed in the two land use types. Saplings of *V. paradoxa* were less abundant on crop farm than the fallow land (Figs. 2 and 3) especially in the dry wood land and moist wood land. This is different from Odebiyi *et al.* (2004) who reported that saplings of *V. paradoxa* and *P. biglobosa* were absent in moist and dry woodland agro-ecozones. This might be as a result of seed dispersal through animal or human factors in the study area during the time interval. In the dry and moist wood land ecological zones, mature trees of *P. biglobosa* were more abundant than those of *V. paradoxa* in the two land use types (Figs. 4 & 5). This may be attributed to the exploitation of *V. paradoxa* for charcoal- making of which *P. biglobosa* is spared. Abundance of the two species was low in the rainforest zone of the study area apparently because they are savanna species.

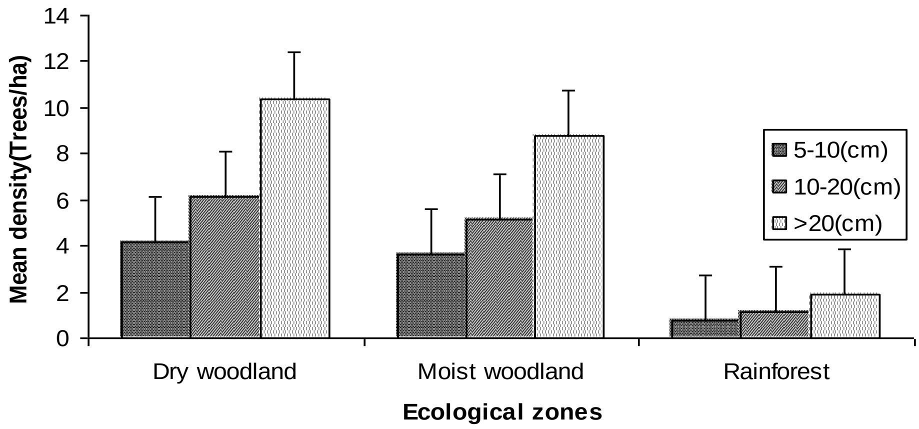

Fig. 2: Size class distribution of *V. paradoxa* on cultivated land in the three ecological zones of Oyo State, Nigeria

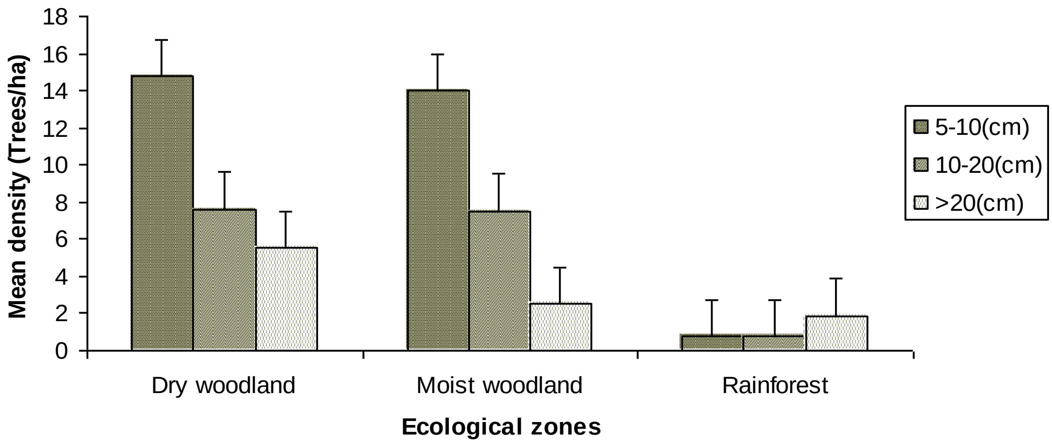

Fig. 3: Size class distribution of *V. paradoxa* on fallow land in the three ecological zones of Oyo State, Nigeria

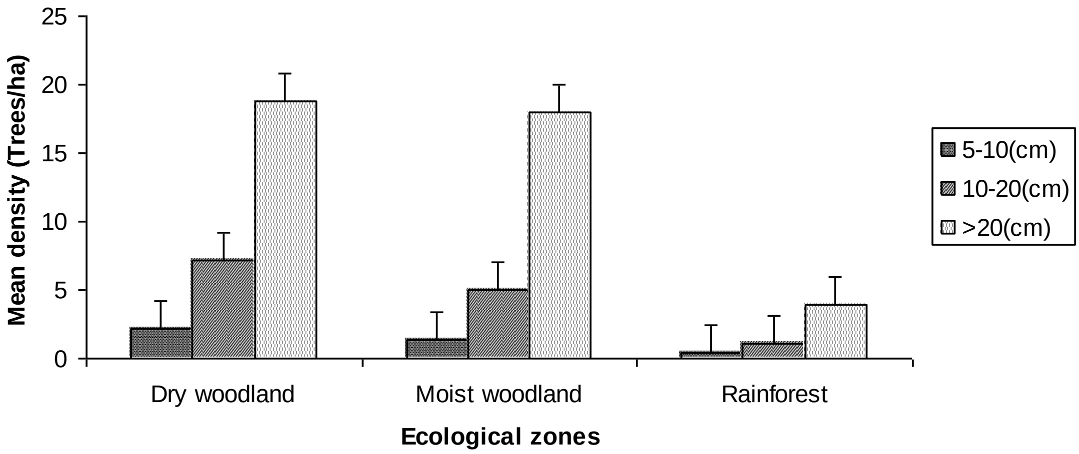

Fig. 4: Size class distribution of *P. biglobosa* on cultivated land in different ecological zones

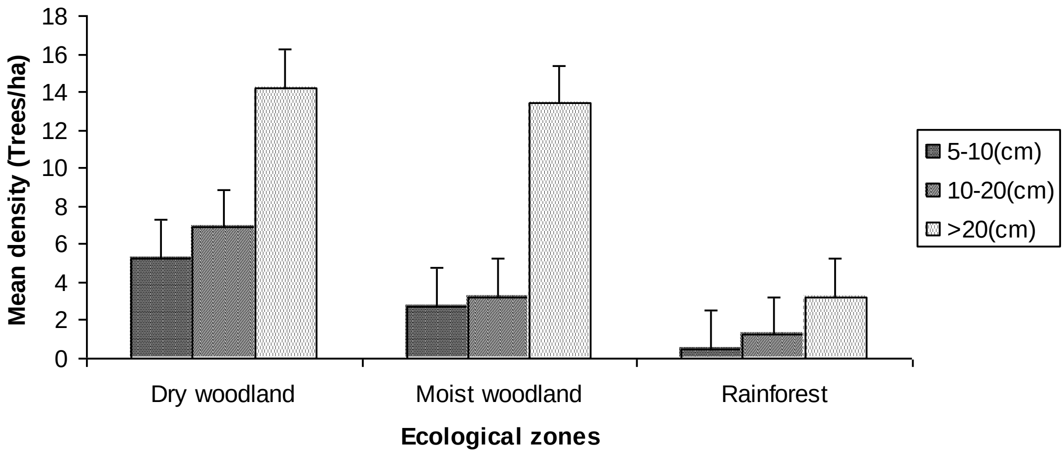

Fig. 5: Size class distribution of *P. biglobosa* on fallow land in the three ecological zones

CONCLUSION

The results of this study have shown that farming activities and wood extraction for domestic energy have marked impacts on the regeneration of the two species in the study area. Although matured trees are retained on crop farms, they do not enjoy similar protection on fallow lands. The species are neither domesticated nor established in plantation like other economic tree species. This portends great danger for the sustainability of these species. Therefore there is need for intensive management of the species most especially the saplings on crop farms as well as the holistic conservation of the mature trees on the fallow land. Synergistic efforts are required on domestication, enrichment planting and plantation establishment of the species for sustainability. Farmers are advised to desist from felling live trees of these species for charcoal and firewood production.

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