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Population and natural regeneration pattern in Vitellaria paradoxa (C.F Gaertn) in a Derived savanna ecosystem of Nigeria

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Abstract:- Using one hectare plot each in two contrasting locations (Eruwa), Oyo state Nigeria the impact of land use systems on *Vitellaria paradoxa* mother trees population and natural regeneration were investigated. Complete enumeration approach was adopted while morphological parameters were assessed for the mother trees. Findings indicated that despite various anthropogenic pressures, a relatively high number of mother trees were encountered (16 and 17 stems hectare^{-1}) at both bush fallow and actively cultivated land use types respectively. Medium size mother tree total height class of (10-15m) was the most dominant irrespective of land use types. Stem diameter class (40-50cm) accounted for more than 50% while there was no individual in the (10-20cm) size class. Main number of branches mother tree^{-1} ranged between 2.18 and 2.24 for bush fallow and cultivated land use respectively. Correlation relationship between total tree height and diameter at breast height was more positive in the cultivated land use (R^2= 0.56) compared with the bush fallow (R^2= 0.32). Natural regeneration pattern ranged between 28 and 25 individuals hectare^{-1} in the bush fallow and cultivated plot respectively with a ratio of 1:75 and 1:47 stands mother tree^{-1} for bush fallow and cultivated respectively. Regeneration by coppice shoots re-growth was the most dominant. It was evident that the current succession pattern by juvenile trees is unsustainable, hence proactive measures including; enrichment plantings, wildlings protection and seasonal fires control are implicated. Community wood-lots establishment and development of alternative energy sources to reduce pressures on forests are also advocated.

Keywords:- *Vitellaria paradoxa*, morphological characters, natural regeneration, sustainability.

I. INTRODUCTION

The natural forest resources constitute an integral part of the rural economy providing food, income, medicinal materials as well as services to the rural and peri-urban population (Okafor, 1980). In contrast to considerable attention already received by the timber sector of the economy serious research attention is recent for most non-timber forest products (NTPs) following the recognition of their economic importance after the 4th meeting of the Panel of FAO Experts on Forest Genetic Resources Priority List (FAO, 1988a). *Vitellaria paradoxa* C.F *Gaertn* an important indigenous multipurpose fruit tree in the savanna parklands of West Africa has been exploited for its various economic uses; including food, oil, fuel energy and livestock feed (Campbell-Platt, 1980; Soladoye *et al*; 1989). According to FAO (1988a) the demand for the seed merits the establishment of plantation in a significant proportion of the species range.

The wide recognition accorded the species throughout its range, made the species to acquired protective status in most part of its range like *Parkia biglobosa* (Oni, 2001). Ethnobotanical survey (Soladoye *et al*; 1989) and socio-economic studies indicated that the species is among the edible forest product locally sold in the market in most parts of Northern Nigeria (Popoola and Maishanu, 1995). The species adaptation to its natural environment make it more drought tolerant than many of the exotics grown as alternative resources (Oladele *et al*,1995). Despite these benefits, conscious efforts towards an organized population ecology and regeneration management of the wild population in Nigeria across the different agro-ecological zones remain very low compared to what had been reported in Ghana (Osei-Amaning, 1996) and for *P. biglobosa* (Jacq Benth.*)* in Nigeria (Oni, 1997; 2001). Greig-Smith (1991) investigated population and natural regeneration dynamics in the species involving 5.7 hectares at Olokemeji, Nigeria, most subsequent reports thereafter were on less than 1 hectare (Hall *et al;* 1996). Degradation of farmed parkland is on the increase in Nigeria in terms of both the mother trees and as well as protection of regenerated stands (Oni, 2010). Various forms of threats on the remaining gene-pool had been attributed to demographic pressure, illegal felling, deforestation due to mechanized farming, annual bush fires, slow and poor natural regeneration and increasing desertification (Kessler, 1994, Kessler and Boni, 1996; Hall *et al;* 1996). In the species, mother trees are constantly cut down for fuel wood and charcoal making while seedlings remains the principal pattern of natural succession which are rarely under formal management (Hall *et al*; 1996). Deliberate planting is generally negligible at both farmer's farm as well as in protected parklands (Kessler, 1992; Boffa, 1999). The regeneration problem is further aggravated by the fact that *V. paradoxa* fruits hardly stored for more than few days (1-2weeks) before losing viability (Booth and Wickens, 1988; Osei-Amaning, 1996) while intensive nuts collection also limits fruits

availability in the forest floors (Hall *et al*; 1996). The limited data on enumeration study, morphological attributes and regeneration pattern constitute a gap in knowledge for future management of the species. For resource management in an *in-situ* context, targeting well developed stands is necessary in order to focus on populations which are relatively dense and hence likely to prove productive per unit land area (Oni, 1997). In the light of the foregoing, investigation was carried out to assess the current mother trees population and pattern of natural regeneration on succession rates under two land use types in a derived savanna ecosystem (Eruwa) in Oyo North area of Oyo State, Nigeria.

II. MATERIALS AND METHOD

Site description: The field study was carried out in Eruwa, (Latitude 8^0 40'N and Longitude 30° 0'E), Ibarapa East Local Government area of Oyo State. It lies East of Oyo State and approximately 57 km from Ibadan (7˚ 26';N 3˚ 54'E) the state capital. The study site is bordered in the North by Oke-ogun Local Government, South by Ibadan Central, West by Benin Republic and East by Ibarapa Local government. It lies within the derived savanna ecozone of White (1983) with most of the original vegetation already replaced by shrubby woody tree species and giant grasses due to farming activities, urbanization and fuel-wood collection. The vegetation is mostly dominated by savanna tree species including *Daniellia olivei* (Rolfe Hutch & Dalz) *Lophira lanceolata* Keay and *Parkia biglobosa* (Jacq) Benth (Hall *et al*; 1996, Oni 2003). Mean annual rainfall is between 400mm–1800mm while the annual temperature range is between 24˚– 32^0C (Oni and Ladipo, 1997). Due to high human disturbances only preferred economic trees such as *Parkia biglobosa, Vitellaria paradoxa and Adansonia digitat*a are selectively protected.

Study sites selection criteria: At the onset of the study an initial reconnaissance survey was carried out in conjunction with the Oyo state Forestry sub-station office in the town to assess distribution pattern in the species. After series of survey the bush fallow site (L_1) was selected on the basis of more than (>50%) of the area under fallow and *V.paradoxa* as dominant tree species. The same approach was adopted for the cultivated land use (>50% under active cultivation and *Vitellaria* being dominant species. After the two sites selection, a hectare plot each was determined. The bush fallow land use type was located to the east of the town along Lanlate–Alapa Village, about 15 km from Eruwa town ship while the cultivated land use type plot lied north of the town also approximately 25km from the first site. At the onset of the enumeration two additional field staff assistance were engaged. Each hectare was sub-divided into 100m x 25m sub-plots given a total of 4 sub-plots for each hectare. Sequentially all the mother trees (≥10cm dbh) encountered per sub-plot were recorded and assessed for morphological parameters and the process was continued for all the subplots in both hectares in the two contrasting locations. Each mother tree encountered was assessed for total tree height (m) using Haga altirmeter while the stem diameter was measured at breast height (1.3m) and the number of main branches per stem recorded per mother tree. After the mother trees enumeration, each subplot was again assessed for regeneration pattern (seedlings and coppice shoots individuals). Total number of natural regeneration (seedlings and coppice shoots) were classified as indicated; seedlings (1-2cm) saplings (>2cm–5cm) and poles (>5- 9.5 cm) all at soil mark. Data collected were subsequently subjected to analysis of variance and regression while other findings were depicted by graphs.

III. RESULTS AND DISCUSSION

Mother trees stand character

Result of the field enumeration study indicated that the total number of mother trees encountered per land use type in the species were quite similar despite differences in land use intensity (Table 1). This could possibly be due to similar form of protection accorded the tree species in this zone irrespective of land use systems. A high to moderate density for mother trees with 16 and 17 stems for bush fallow and cultivated lands respectively were observed. A slightly higher number of mother trees were observed in the cultivated land use type compared with the bush fallow, although not significant (Table1). Physical observations showed that the level of resource utilization in the species was relatively low compared with the findings of Fatoba (2003) in Saki (8° 40'N, 30° 0'E) also in Oyo state as evident from the large number of uncollected fruits in the forest floor. However this finding compared favorably with the result of a similar study carried out in Republic of Benin (Kessler and Boni, 1996). The present study tends to suggest high level of protection for the species despite the existence of a charcoal cottage industry in the area, perhaps the species is not among the priority woody species used utilized in this region for the fuel wood energy. In a socio-economic survey carried out in Kaduna State (10˚ 36'N; 7˚ 27'E) where the species is also abundant it was not included in the list of seven most preferred fuel wood tree species (Sodimu *et al*; 2004).

Table1. Stocking density for *V. paradoxa* mother trees under the two land use types

Location	Land use types	Stocking density (Ha^{-1})
Eruwa	Bush fallow (L_1)	16
	Cultivated (L_2)	17

Source: Field work 2010

Mother trees total height class distribution (m)

Mother tree total height class distribution in the species indicated that the medium height class (10m-15m) accounted for the highest population (Figure 1). Hall *et al*. (1996) reported that the species is normally a small to medium sized tree. On land use basis, trees with shorter heights (5-10m) were more frequently encountered in the actively cultivated land use type compared with the bush fallow. For the medium height class (10-15m) more stands were observed under the bush fallow land use compared with the actively cultivated land. However for the upper tree height class (15-20m) more were recorded in the bush fallow compared with cultivated plot. This perhaps might be due to more inter-tree competitions. According to Kessler (1994) only preferred trees are selectively protected in actively cultivated farmlands leading to larger inter-tree distances resulting in less inter-tree competitions. Hall *et al*. (1996) reported that the species rarely exceeds 10-15m as a result of regular seasonal fires. Trees above 15m were less represented under both land use types (Figure 1).

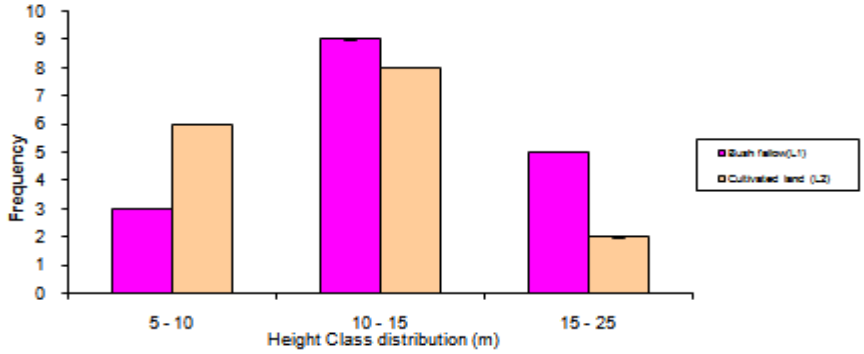

Fig 1. Total tree height (m) class distribution in Eruwa

Mother trees diameter class distribution (cm)

Diameter class distribution (cm) in the species indicated that all the stems encountered were adults (>10cm dbh) as there was no mother tree below (10–20cm) diameter class (Figure 2). The absence of lower diameter class in the present investigation tend to suggest poor rate of natural succession as many of the seedlings rarely develop to pole sizes or allowed to mature to adult size trees. Stems in the diameter class (20-30cm) were also less represented irrespective of land use types. However within the diameter class (30-40cm) more mother trees were observed in the cultivated land use type compared with bush fallow (Figure 2). The largest diameter classes (40-50cm) were more in the bush fallow compared with the actively cultivated land use type. The absence of the lower diameter classes in several parklands in West African countries were indicated to be due to decreasing annual rainfall, desert encroachment and poor natural regeneration (Baumer, 1990, Kessler and Boni, 1994).

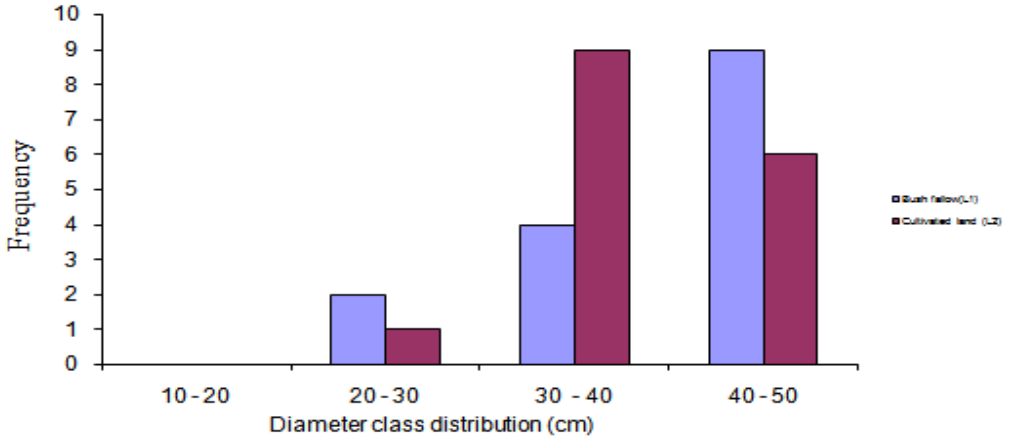

Figure 2 .Mother trees diameter class (cm) in *V.paradoxa* in Eruwa

Regression relationships

Regression relationship between total tree height and diameter was significant and highly correlated (R^2 =0.56) in cultivated plot (Figure 3). However in the bush fallow the regression relationship between these variables was not significant (R^2= 0.32) hence not closely associated compared with the cultivated plot (Figure 3).

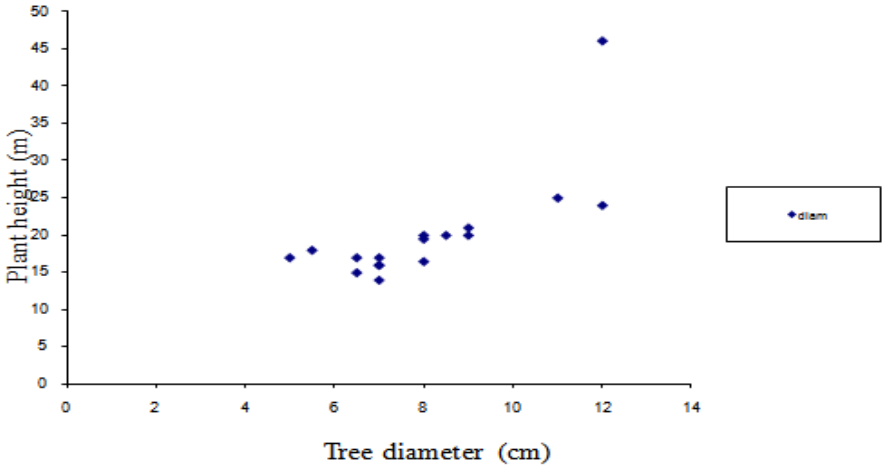

Figure 3 Regression relationships between the total tree heights and stem diameter

Number of main branches per mother tree

Irrespective of land use types, two main branches mother tree^{-1} was the most common in the study. However trees with three main branches per mother tree were more commonly encountered in the actively cultivated land use type compared with the bush fallow. This was responsible for the higher mean number of branches observed under the cultivated compared with the bush fallow (Table 2). There was however no consistency in the observed height at branching in the species under both land use types. The observed branching habit in the species was similar to what was reported for *Parkia biglobosa* (2 branches stem^{-1}) in Nigeria (Oni, 2004).

Table 2 Mean numbers of branches in *V.paradoxa* in Eruwa

Land use types	**Mean number of branches**
Bush fallow	2.18
Cultivated	2.24

Source: Field work 2010

Natural regeneration in *V. paradoxa*

The result of the investigation showed that a slightly higher number of natural regeneration per plot were encountered in the bush fallow compared with the cultivated land use type (Table 3). In relating the number of natural regeneration with the observed number of mother trees, an average of 0.56 and 0.68 stems^{-1} mother tree per hectare were observed in both the bush fallow and cultivated land use respectively (Table 3). Despite the high stocking density for mother trees in both land use types, the total number of regenerating stands hectare^{-1} was very low with less than 2 plants mother tree^{-1}. This could probably be attributed to the different land use management associated with regenerating stands compared with mother trees in the species. *V. paradoxa* rarely survive seasonal bush burning and livestock grazing in the first year of emergence. Boffa (1999) indicated that annual bush burning, land clearing for food crops cultivation, fuel wood exploitation for domestic cooking and charcoal production were some of the key ecological factors affecting natural regeneration in most savannah parklands of West Africa. Kessler (1994) also indicated that natural regenerating seedlings stand little chance of survival under active cultivation compared with bush fallow land use due to selective protection. Comparing rates of natural regeneration with mother trees it may be concluded that natural succession was very low at both sites possibly due to the aforementioned reasons.

Table 3: Stocking density for mother trees in relation to natural regeneration in Eruwa.

Location	Land use types	Total number of mother trees	Total number of natural regeneration	Mean number of natural Regeneration mother tree-
Eruwa	Bush fallow (L_1)	16	28	1.75
	Cultivated (L_2)	17	25	1.47

Source: Field work 2010

Types of natural regeneration

Classifying the natural regeneration stands into categories based on their diameter size classes, presented an interesting distribution among the various regeneration categories. None of the regeneration category maintained consistency in either land use type (Table 4). Under the bush fallow land use, the sapling category accounted for the highest number of regeneration, however the seedlings gave superior number of individual in the actively cultivated land use type (Table 4). Observed number of poles category under both land use types were quite similar and not significant. Seedlings category however accounted for the highest number of natural regeneration irrespective of land use types with 21 individual while saplings and poles had 15 individuals each (Table 4).

Table 4 Natural regeneration pattern in *V. paradoxa* in Eruwa

Location	**Land use type**	**Pattern of natural regeneration**		
Eruwa		Seedlings (1-2cm)	Saplings (>2-5cm)	Poles (>5-9.5cm)
	Bush fallow L_1	10	10	8
	Cultivated L_2	13	5	7
	Total	23	15	15

Source: Field work 2010

Forms of natural regeneration

As shown in Table 5 more of the natural regenerating individuals were due to coppice shoots re-growth irrespective of land use with 34 compared with 19 individuals respectively. More natural regeneration stands were observed to be in form of seedlings from the bush fallow compared with cultivated land use whereas coppice shots re-growth accounted more for regeneration in the cultivated compared with the bush fallow (Table 5). Succession maintenance through coppice shoots re-growth had been indicated as means of survival against seasonal annual bush fires for several typical savannah species (Hall *et al*; 1996, Boffa, 1999, Oni, 2004).

Table 5. Effect of land use type on forms of natural regeneration in *V. paradoxa* in Eruwa

Location	**Land use type**	**Forms of natural regeneration**	
		Seedlings	Coppice shoots
Eruwa	Bush fallow (L_1)	12	16
	Cultivated (L_2)	7	18
	Total	19	34

IV. CONCLUSION

Results obtained from the present investigation tend to suggest the need for more proactive interventions in the *situ* conservation strategy in the species. Various silvicultural and ecological activities that can ensure sustainability of the remaining natural population of most economic fruit trees in the savannah parklands of Nigeria should be put in place. Such actions may include increase awareness in the prevention of seasonal fires, alongside assisted tree regeneration program through the supply of seedlings to farmers by appropriate government agencies. The establishment of community wood-lots on degraded lands to meet domestic wood energy requirement may also help reduce pressure on economic and other preferred farm trees. Issues of fuel-wood energy continues to be a major policy issue following the complete deregulation of downstream of the oil sector in Nigeria, thus putting more pressures on several forest genetic resources. The need therefore for the different stakeholders at various levels to come up with more holistic management program that will enhance reduced pressure on various important forest genetic resources is long overdue. In similar vein low technologies using other energy sources such as solar cookers and bio-energy gas stoves and charcoal briquette sawdust and low-density coal are other options (Akande, 2002)

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