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Natural regeneration, population structure and traditional management of V*itellaria paradoxa* subspecies *nilotica* in the shea parklands of northern and eastern Uganda

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Abstract The shea (*Butyrospermum*) parklands of northern and eastern Uganda are a representation of agroforestry farming system in East Africa. Destruction of the parklands by seasonal fires, grazing and cultivation have affected the natural regeneration and population structure of *Vitellaria paradoxa* subspecies *nilotica* (Shea tree) in the natural range. A study was undertaken in Abarilela and Adwari sub-counties in Katakwi and Lira Districts respectively. The objectives were to (1) assess the natural regeneration and population structure of *Vitellaria paradoxa* and (2) assess the socio-economic importance and traditional management of the Shea tree by local communities. Data were collected from sample plots measuring 500 m x 400 m laid in fields of annual and perennial crops growing together with *Vitellaria paradoxa.* Semi-structured questionnaires were administered to farmers to collect information on the traditional management of the Shea tree. Data were analysed using SPSS. One-way ANOVA was conducted to show variations in the regeneration capacity and population structure of the trees. It was found that there were no significant variations in the natural regeneration (F = 0.0017, P = 0.971) and population structure (F= 0.011, P = 0.916) of *Vitellaria paradoxa* in Abarilela and Adwari sub-counties. Farmers lacked basic knowledge of establishment of the Shea tree. Farmers protect the Shea trees because they provide fruits and oil, which are eaten locally and also sold for cash, improve soil fertility, and have medicinal values. The traditional management practices are weeding, pruning, thinning, protection of seedlings/saplings during land clearance and controlled burning and grazing.

Key words: *Vitellaria paradoxa,* natural regeneration, population structure, parkland agroforestry

Résumé Les terres de réserves de shea (*Butyrospermun*) du Nord et de l'Est de l'Ouganda sont une représentation de système d'agroforesterie en Afrique de l'Est. La destruction de ces réserves par des feux de brousse, par le bétail en pâturage et les cultures a affecté la régénération naturelle de *Vitellaria sparadoxa,* sous-espèce *nilotica* (Arbre Shea) dans le spectre naturel. Une étude a été entreprise dans les sous-entités de Abarilela et Adwari, respectivement situés dans les Districts de Katakwi et Lira. Les objectifs étaient (1) évaluer la structure naturelle de régénération et de population de *Vitellaria sparadoxa* et (2) évaluer l'importance socio-économique et la gestion traditionnelle de l'arbre Shea par les communautés locales. Les données étaient analysées en utilisant SPSS. ANOVA à sens unique était effectué pour monter la variation dans la capacité de régénération et la structure de population des arbres. Il a été révélé qu'il n'y avait pas de variation significative en termes de régénération naturelle (F=0.0017, P=0.971) et la structure de la population (F=0.011, P=0.916) de *Vitellaria sparadoxa* dans les sous-entités de Abarilela et Adwari. Les cultivateurs maquaient de connaissances élémentaires de l'établissement de l'arbre Shea. Les cultivateurs protègent l'arbre Shea parce qu'il produit de l'huile et de fruits ; qui sont consommés localement mais aussi vendus pour de l'argent et il améliore la fertilité du sol tout en présentant des vertus médicinales. Les pratiques de gestion traditionnelles sont le désherbage, le sarclage, l'amaigrissement, la protection de plantules/pousses pendant l'éclaircissement des terres et le brûlis et broutage par bétail contrôlés.

Mots clés: *Vitellaria sparadoxa* régénération naturelle structure de population, agroforesterie de réserves

Introduction

Vitellaria paradoxa C.F. GAERTNER, also known as the shea nut tree, is a major component of parkland agroforestry in Uganda. The species forms an almost unbroken belt approximately 5,000 kilometres wide from Senegal to Uganda (Bonkoungou, 1987). In northern and eastern Uganda, the Shea parklands are a representation of the former *Butyrospermum* parklands dominated mainly by grassland and wooded savanna vegetation types. They represent one of the most widely spread traditional farming systems in Sub-Saharan Africa, termed the " Agroforestry parklands " by Bognounou and Guira (1994). The parkland is defined as a land use system in which woody perennials are deliberately preserved in association with crops and or animals in a spatially dispersed arrangement and where there is both ecological and economic interaction between trees and other components of the system. It is characterised by a three to four year cultivation period followed by relatively long periods of fallow between 10-20 years to allow restoration of soil fertility before re-cultivation.

In the last few decades, it has been suggested that the parklands of northern and eastern Uganda have been degraded by the short fallow periods and changing farming methods, thus affecting the regeneration and population structure of the Shea tree. Many immature Shea trees are cut for building poles because of their ability to

resist termite attack. Moreover, coppicing and pollarding have a limited ability to produce epicormic shoots that usually grow and sustain the wild population. As a result, the natural regeneration has declined and the population structure altered. In order to sustain the Shea trees in the savanna woodlands, there is a need to understand the natural regeneration and traditional management by the local people. Such information is needed for development of management and conservation strategies for the parklands to sustain the wild populations of the Shea tree. In view of the above, a study was undertaken in Adwari and Abarilela sub-counties of Lira and Katakwi districts to assess the population structure and regeneration capacity of *Vitellaria paradoxa* subspecies *nilotica* in the shea parklands. The study sought answers to the following questions: what is the mode of regeneration and population structure of the Shea tree in the parklands? How do farmers establish the Shea tree? What problems do they encounter when establishing the tree and how do they overcome them? How are the Shea trees protected and managed?

Materials and methods

With the help of the Global Positioning System (GPS), measuring tape and a compass, inventories were carried out within plots established away from the farmers' residential area to minimise the effect of edge. One hundred-meter wide sample plots were established along the 500 m block-line demarcated with a flagging tape. Each sample plot was further divided at 10 strip plots. Shea trees with diameter at breast height (dbh) >7 cm encountered within the plots were recorded and their positions on the ground fixed with the GPS. Regeneration was assessed by recording the number and position of the seedlings (young Shea trees below 30 cm height and having a single shoot) and coppices (young Shea trees below 2 m height and having multiple shoots) found along the tie line. The different land use types were also recorded. Semi-structured questionnaires were administered to a total of 120 farmers, 60 each from Adwari and Abarilela. The purpose was to obtain information on Shea tree establishment and management, the importance of the Shea tree and its products, and the agricultural crops affected and unaffected by the Shea tree. Data were entered in MS Excel to create a data file and then transferred to SPSS for a more elaborate analysis. One-way analysis of variance (ANOVA) was used to show the variations in the natural regeneration and population structure of the Shea tree. Responses from the questionnaires were edited, coded and analysed using descriptive statistic.

Results and discussion

Natural regeneration and population structure. *Vitellaria paradoxa* subspecies *nilotica* naturally regenerated from seedlings and coppices. Each mode of regeneration contributed differently to the total natural regeneration in the two study sites (Adwari and Abarilela). It was found that the Shea tree regenerated more through coppices than seedlings in the parklands (Figs. 1a and b). One way ANOVA showed that there was no significant variation in the regeneration capacity in both Abarilela and Adwari sub-counties (F =0.0017, P= 0.97) on both farmland and fallow. This finding is however, contradictory to those of Abbiw (1990) and Hall *et al*. (1996), who indicated that *Vitellaria paradoxa* regenerated more in the fallow than in areas under cultivation.

The population structure of *Vitellaria paradoxa* subspecies *nilotica* in the sub-counties is presented in Figure 2. The structure is characteristic of populations that experience sporadic or irregular seedling establishment. The actual level of regeneration may be sufficient to maintain the population, but its infrequency of occurrence causes notable 'peaks' and 'valleys' in the size class distribution as new seedlings grow into larger size classes. This type of distribution is common among late secondary species that depend on canopy gaps for regeneration (Peters, 1994). It also reflects a population whose regeneration has been temporarily interrupted through excessive harvesting of fruits or seeds, direct physical damage to seedlings, for example, trampling by

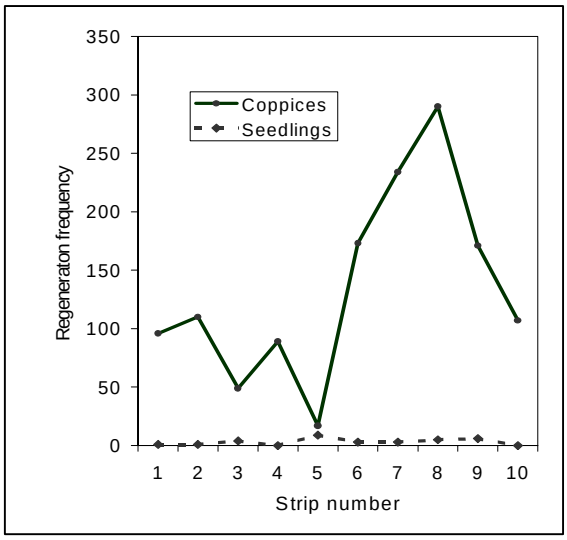

Figure 1a. Regeneration in Abarilela.

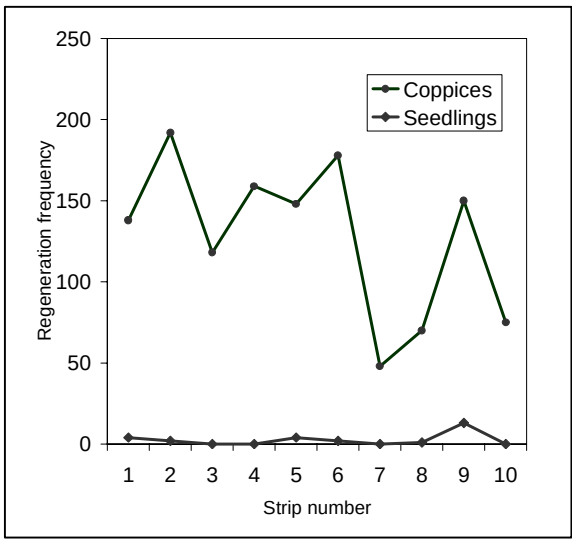

Figure 1b. Regeneration in Adwari.

collectors and grazing livestock or lack of pollinators or dispersal agents. In Abarilela and Adwari, the seeds of *Vitellaria paradoxa* were collected mainly for oil extraction; young trees are cut before they produce regeneration for use in construction and the bigger diameter class used for charcoal production. ANOVA showed that there was no significant variation in the population structure in the two sites (F= 0.011, P= 0.91).

Methods of establishment of *Vitellaria paradoxa.* Seeds were the most common planting materials for establishment of *Vitellaria paradoxa* in the two sub-counties (Table 2). This observation is consistent with that of Nair (1993) who reported that *Vitellaria paradoxa* can be propagated from wildlings, cuttings and direct sowing of seed. It is also clear from this Table that more males planted *Vitellaria paradoxa* than females in Abarilela. Farmers in Abarilela were more knowledgeable about the different methods of tree establishment than in Adwari. Generally, *Vitellaria paradoxa* is known to grow in the wild and this explains why it was growing naturally from seeds in Abarilela and propagated using wildlings in Adwari. Direct discussion with local residents revealed that the farmers considered the Shea tree to be a wild plant that does not need to be planted. A similar perception has been reported in Ghana where the Shea nut tree is rarely planted and the wild populations result from natural regeneration (Adomako, 1985).

Problems encountered by farmers in establishing the Shea trees and how they were overcome. Problems encountered by farmers in establishing the Shea trees is presented in Table 3. Majority of farmers reported that domestic animals, termites, wildfires and diseases hindered the establishment of Shea trees. Observations made during the study showed that other factors were also responsible. Mature Shea trees were cut for making charcoal as indicated by the presence of numerous scars of earth kilns. The trees were also cut for timber and making tool handles and utensils. Although grazing resulted in trampling and destruction of seedlings and coppices, controlled grazing and weeding were found to lessen the fire risk through

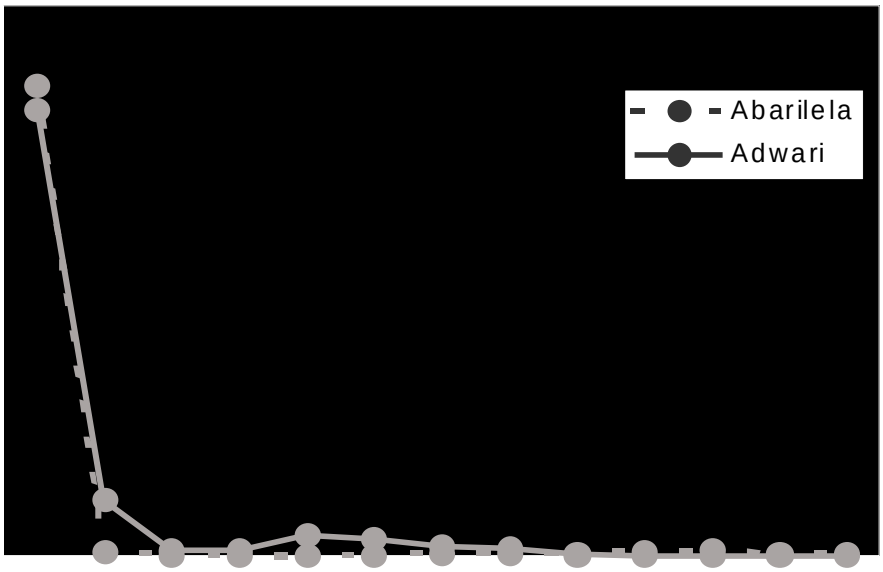

Table 2. Methods of tree establishment in Abarilela and Adwari.

Method of establishment	Abarilela (%)		Adwari (%)	
	M	F	M	F
Seeds	59.0	50.0	7.7	0.0
Seedlings	0.0	12.5	19.2	20.0
Stem cuttings	17.7	12.5	3.9	0.0
Root cuttings	0.0	12.5	0.0	0.0
Wildlings	0.0	12.5	69.2	0.0
Natural	23.5	0.0	0.0	80.0

reduction of the amount of combustible material. Trampling by cattle also compacted the grass layer and reduced fire intensity, thus agreeing with the observations by Adomako (1985) and Masters and Puga (1994). Trampling by domestic animals was minimised by fencing the young trees with the thorny *Zizyphus abyssinica*, and termites controlled by spraying the seedlings with Ambush (an insecticide). Early prescribed-burning helped to overcome the problem of seedling destruction by wild fire.

Location of shea trees on farmers' land and methods for protecting the Shea trees. The shea trees were found in areas with different soil types and terrain ranging from flat areas with loam soils to near swamps with peat soils and dry land (Table 4). In both Abarilela and Adwari, the trees were mainly associated with loam soils on flat terrain, thus indicating that free-draining soils and flat terrain favour the growth of Shea trees.

All the respondents, except one farmer in Abarilela, said that they spared Shea trees on their land when clearing it for cultivation. The farmer in Abarilela said that he did not spare the Shea trees because they shade agricultural crops and reduce the yield. Land clearance, weeding and sparing of seedlings and coppices were the major methods used by farmers to protect the Shea trees (Table 5). Various reasons were also given for the protection of Shea trees

Table 3. Problems encountered by farmers in the establishment of *Vitellaria paradoxa* and the possible solutions.

Problems	M (%)	F (%)	Solutions	M (%)	F (%)
Domestic animals	8.0	28.6	Fencing seedlings with thorns	14.3	28.6
Wildfire	12.0	0.0	Cleaning and planting around	0.0	0.0
Diseases	16.0	57.1	No measure	14.3	0.0
Termites	16.0	0.0	No measure	0.0	57.1
Termites	0.0	14.3	Spray with ambush	28.6	14.3
Drought	8.0	0.0	No measure	0.0	0.0
Defoliators	8.0	0.0	No measure	28.6	0.0
Thunderstorm, lightening and hail	8.0	0.0	Replanting	14.3	0.0
Cutting for firewood	4.0	0.0	No measure	0.0	0.0
Cutting for charcoal	4.0	0.0	No measure	0.0	0.0
Water logging	4.0	0.0	No measure	0.0	0.0
Low soil fertility	4.0	0.0	No measure	0.0	0.0

Table 4. Location of shea trees on farmers' land in Abarilela and Adwari.

Location/nature of terrain	Abarilela (%)		Adwari (%)	
	M	F	M	F
Loam (flat area)	18.8	85.7	61.9	50.0
Sandy loam	25.0	14.3	0.0	0.0
Sandy	6.3	0.0	0.0	0.0
Clay loam with some sand	6.3	0.0	0.0	0.0
Clay loam	6.3	0.0	0.0	0.0
Near swamps (black peat soil)	18.8	0.0	19.1	18.8
Flat raised ground (reddish sand)	18.8	0.0	9.5	6.3
Swamp (white sand)	0.0	0.0	0.0	12.5
Flat area (white sand)	0.0	0.0	0.0	12.5
Not found in the swam	0.0	0.0	4.8	0.0
Dry land	0.0	0.0	0.0	4.8

Table 5. Methods for protection of Shea trees by farmers in Abarilela and Adwari.

Measures of protection	Abarilela (%)		Adwari (%)	
	M	F	M	F
Land clearance	8.3	0.0	68.4	83.3
Weeding	25.0	0.0	5.3	0.0
Pruning	8.3	0.0	0.0	8.3
Avoiding cutting	33.3	57.1	21.1	0.0
Removing fire hazards	25.0	42.9	0.0	0.0
Early burning	0.0	0.0	5.3	8.3

Table 6. The reasons for protecting Shea trees in Abarilela and Adwari by farmers.

Reasons for protection	Abarilela (%)		Adwari (%)	
	M	F	M	F
Obtain fruits (food)	11.1	22.2	5.3	0.0
Income generating	22.2	0.0	0.0	0.0
Act as wind breaks	11.1	0.0	0.0	0.0
Increase soil fertility	11.1	44.4	5.3	0.0
Allow proper tree growth	0.0	0.0	0.0	9.1
Medicine/termiticide	0.0	0.0	68.4	63.6
Obtain seeds for oil extraction	44.4	33.3	15.8	9.1
Food security	0.0	0.0	5.3	0.0

(Table 6), the major ones being use of the Shea cake as a termiticide, and extraction of butter/oil for domestic consumption and sale for extra income.

Conclusions and recommendations

The following conclusions can be drawn from this study: The low number of medium size and large size diameter trees population structure of Vitellaria *poradoxa* subspecies *nilotica* in both Abarilela and Adwari shows a typical species greatly affected by human interventions through land use. Farmers lacked basic knowledge of establishing Shea trees. Many farmers were reluctant to plant Shea trees because they believed that the Shea tree grows in the wild and even if they were to plant them, the trees would take long to mature. In view of these conclusions drawn, there is need to encouraged farmers to plant fuel woodlots to meet the demand for firewood in order to reduce the pressure on cutting the shea trees. There is need is also need revive the by-law to protect and conserve the shea trees, and reduces the degradation of the parklands.

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