International Union of Forest Research Organizations
Union Internationale des Instituts de Recherches Forestières
Internationaler Verband Forstlicher Forschungsanstalten
Unión Internacional de Organizaciones de Investigación Forestal

IUFRO World Series Vol. 15

Meeting the Challenge: Silvicultural Research in a Changing World

Extended abstracts
From the conference held in Montpellier, France,
From 14 to 18 June 2004

Jointly organized by
IUFRO – Division 1 (Silviculture)
USDA Forest Service
CIRAD-Forêt
Institut National de la Recherche Agronomique (INRA)

Editors
John A. Parrotta, Henri-Félix Maître,
Daniel Auclair, Marie-Hélène Lafond

ISBN 3-901347-51-8
ISSN 1016-3263

IUFRO Headquarters
Vienna, 2005

IMPACT OF FARMERS' PRACTICES ON ECOLOGICAL PROCESSES OF *VITELLARIA PARADOXA* (SHEA TREE) IN THE PARKLAND OF SOUTHERN MALI

Bokary Allaye Kelly [1], Nicolas Picard [2], Sylvie Gourlet-Fleury [2] and Jean-Marc Bouvet [2]

[1] Institut d'Economie Rurale, Programme Ressources Forestières Centre Régional de la Recherche Agronomique de Sikasso, BP 178 Sikasso, Mali
[2] Cirad –Forêt, Campus International de Baillarguet, TA 10C, BP 5035, 34035 Montpellier, France,
E-mail: jean-marc.bouvet@cirad.fr,

Introduction

Parklands, defined as a regular, systematic and ordered presence of trees in the fields (Sautter, 1968, cited by Bagnoud *et al*. 1995), are the result of a long evolutionary process during which association between natural elements (trees and shrubs conserved, maintained and enhanced because of their utility) and crops happens within a regularly exploited space (Raison, 1988). *Vitellaria paradoxa* (karité in French or shea butter tree) is an important tree species in sub-saharan parklands. Butter extracted from the kernel of this tree species is used for local consumption and is an important source of income for rural women.

Human practices through the management undertaken according to the type of land use are likely to have an influence on several aspects in particular on the dynamic of trees species, which are elements of the system. The dynamic of *V. paradoxa* may therefore be well influenced by human activities ; authors like Pélissier (1980) stated that the expansion of *V. paradoxa* is linked to human activities

However it is noticeable that the impact of human practices on the ecology, the spatial distribution, and the genetic diversity of *V. paradoxa* has been poorly investigated and a strong research is needed. We carried out this study in Southern Mali (West Africa) with the objectives of studying the impact of human practices on:

- the spatial distribution of *V. paradoxa*,
- the phenology and natural regeneration of the species, and finally,
- the genetic diversity dynamics.

Methodology

Two sites (MPeresso and Koumantou) and three stands (field, fallow and forest) where retained. In each stand, karité trees were marked, measured, monitored for spatial, and dynamic studies. Descriptive statistics were used to study the growth of adult trees and the dynamic of natural regeneration. Flowering and fruiting were described and analysed using logistic regressions. The spatial distribution of trees were analysed using spatial statistics (Ripley's K-hat function) (Kelly et al., 2004a). Molecular markers (microsatellites) were used to study the structure of the genetic diversity and its temporal and spatial dynamics (Kelly et al., 2004b).

Results and Discussion

The spatial pattern of *Vitellaria paradoxa* became progressively more aggregated from field to fallow and to forest (Kelly et al., 2004a). Hence in fields, the spatial pattern was just a little aggregated (case of Koumantou) or tended to be regular at small distances and then randomly distributed at other scales (case of Mperesso). The aggregation may be explained by the seed dispersal mode of *Vitellaria paradoxa,* but its superiority at Koumantou may be due to the intensity of the regeneration and the higher production of fruits at this site - as observed during two years of phenology monitoring (Table 2). The more aggregated pattern can also be explained by different agro-climatic conditions, which are more favourable at Koumantou compared with Mperesso (1000 – 1100 mm versus 680 mm of annual mean rainfall), and the level of land use pressure (higher at Mperesso compared to Koumantou because of the high level of cotton production, using more mechanised agriculture).

The distribution of the regeneration, its density and its growth were found different when comparing the fallow to the forest. In the fallow, the regeneration was met across the whole parcel whereas in the forest it appears in patches very often under *Vitellaria* trees or under other trees species. Table 1 shows the averaged values of several parameters measured on the natural regeneration of *V. paradoxa*.

High level of flowering and fruiting was observed in all treatments at Koumantou, whereas at Mperesso, only the field shows a high level of flowering and fruiting (Table 2). Variations according to year were also observed in each site.

Table 1. Average parameters of natural regeneration of *V. paradoxa* in the two stands (fallow and forest)

	FALLOW		**FOREST (type of patches)**						**FOREST (all types)**	
Averaged			**RUV**		**RUOS**		**RWACA**			
Parameters	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**	**2002**	**2003**
H (cm)	152.4	139.4	105.7	103.2	117.8	137.1	87.0	84.8	105.1	107.2
CGL (cm)	13.4	12.1	9.2	8.7	9.5	10.6	5.4	9.5	8.4	8.6
CBH (cm)	13.0	12.2	8.0	6.6	8.0	6.3	5.3	9.5	7.38	6.7
Density of seedlings (nb/ha)	6330	7060	12997	15196	5343	5561	20354	18424	1100	1086

H: height; CGL: Circumference at Ground Level; CBH: Circumference at Breast Height;.
RUV: Regeneartion Under Vitellaria trees; RUOS: Regeneration Under Other Species; RWACA: Regeneration Without Any Cover Above

Table 2. Results of the monitoring of flowering and fruiting for *V. paradoxa* at Koumantou and Mperesso in southern Mali

	KOUMANTOU						MPERESSO					
	Field		Fallow		Forest		Field		Fallow		Forest	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
Marked	100	100	100	100	100	100	100	100	100	100	100	100
Monitored	100	100	100	100	100	92	100	98	99	99	100	100
Flowered	97	99	96	94	77	69	82	95	10	15	16	23
Fruited	91	97	93	94	61	60	60	61	0	0	5	7
Died	0	0	0	0	7#	8#	0	2#	1¤	1¤	0	0

7 individuals died in the forest at Koumantou in 2001 were cut by the farmer; another trees was also cut in yielding to 8; the 2 individuals died in field at Mperesso were also cut by the farmer.
¤ 1 individual was broken by wind in the fallow at Mperesso.

From logistic regressions, it appears that site is very important factor explaining flowering of *Vitellaria paradoxa*. This analysis allowed also to realise that site is not the only important factor since treatment i.e. the way the stand is managed by the farmers in each site as well as parameters of individual trees like the girth are or could be important in explaining the flowering.

As far as the genetic diversity is concerned, the inbreeding coefficients were not significantly different from zero in most cases ($F$is = -0.025 in forest and 0.045 in fallow), suggesting that the species is probably outbreeding. There was a weak decrease of $F$is with age, suggesting inbreeding depression. Differentiation of stands within each cohort was weak (Fst = 0.026**, 0.0005ns, 0.010ns for adults, juveniles and regeneration), suggesting extensive gene flow. Cohorts within each stand were little differentiated (Fst = -0.001 and 0.001 in forest and fallow, respectively). The spatial genetic structure was more pronounced in the fallow than in the forest where adults showed no spatial structuring. So, despite the huge influence of humans on the life cycle of *Vitellaria paradoxa* growing in parkland systems, the impact on the pattern of genetic variation at microsatellite loci appears rather limited (Kelly et al., 2004b).

It appears from this study, that human activities through land management (field, fallow, forest) influence many aspects of *V. paradoxa*. The intensity of this impact varies however according the studied domain. For instance when considering the spatial distribution, the phenology, and the natural regeneration, the impact of human practices is obvious in the sense that the field appears to be highly better than the fallow and forest in regularity of the distribution of trees, in flowering and fruiting. Because of human activities, the fallow appears to be better than the forest in installation and growth of natural regeneration because of previous activities and management mode. But when considering the genetic diversity and its structure, the impact is less obvious (weak variation of genetic diversity parameters, weak differentiation of stands and cohorts, weak spatial genetic structure) possibly because of the buffering effect of extensive gene flow among unmanaged and managed populations.

Acknowledgements

We are very grateful to EU and INCO DC (contract no. ERB I C18-CT98-0261) for the financial assistance and the way the project was managed, to IER (Mali) and Cirad-forêt (France).

References

Bagnoud N, Schmithüsen F, Sorg J-P. 1995. *Bois et Forêts des Tropique*, n° 244, 9-25.
Pélissier P. 1980. ORSTOM
Petit RJ. 2001. *Forest Ecology and Management,* 5692, 1-22.
Kelly BA, Bouvet J-M, Picard N. 2004a. *Agroforestry Systems*, 60, 3-11.
Kelly BA, Hardy O, Bouvet J-M. 2004b. *Molecular Ecology*, 13, 1231-1240.