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## RESEARCH ARTICLE

# EVALUATION OF THE FARMER MANAGED NATURAL REGENERATION (FMNR) IN THE VITELLARIA PARADOXA C.F. GAERTN PARKS LAND IN SOUTH CENTRAL BURKINA FASO

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## ABSTRACT

The shea tree is the one of the most important tree in the Sahel because of it economic, social and other ecosystem services for the local communities. This study aims to evaluate the level of natural regeneration of *Vitellaria paradoxa* C.F. Gaertn (shea) and others important trees in the agroforestry parks using the Farmer Managed Natural Regeneration (FMNR) technique in the villages of Dongo, Katcheli and Torem, in South Central region of Burkina Faso. For this, FMNR was evaluated in five (5) farmers' fields per village and fifteen (15) fields for the 3 villages. In each field, the assessment was done in Five (5) plots of 2,000 $m^2$, for an exhaustive inventory of all tree species. The results show that the tree species with a regular distribution in the field are in population importance order *Vitellaria paradoxa* C.F. Gaertn, *Pilliostigma reticulatum, Diospyros mespiliformis, Gardenia erubescens, Adansonia digitata,* and *Azardirachta indica.* The assessment also shows that The global trees regeneration rate is 48.62% in Katcheli, 46.51% in Torem and 33.06% in Dongo. These rates are below 50% and this is mainly due to land preparation for crop production in these agroforestry parks. The dominant tree naturally regenerated and managed by farmers is *Vitellaria paradoxa* C.F. Gaertn (shea), representing 85.39% in Torem, 75% in Dongo and 69.14% in Katcheli. The Farmer Managed Natural Regeneration (FMNR) technique can be used to increase the regeneration if farmers are trained and closely followed.

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# INTRODUCTION

The shea tree, *Vitellaria paradoxa C.F. Gaertn*, is a tree very characteristic of the Sudanian savannahs zone with multiple uses (Guira and Zongo, 2002; Sawadogo *et al*., 2016). The density of the shea stand depends on the region and is around 30 trees per hectare (War, 2007). In Burkina Faso, Thiombiano *et al*., (2016) estimated a total shea population of 195 million trees for the country. The specie, has always been protected by farmers who keep it in their farms during land clearing and by it also protected by in Burkina (Sawadogo, 2018). Shea tree is well known because of its social and economic importance. Shea kernels are ranked as the fifth largest export product after gold, cotton, cashew nuts and sesame in Burkina Faso in 2011 (MCIA, 2012). In 2015, it was estimated that shea kernel exports brought > 27.2 billion CFA francs to the country (MCIA, 2016). Despite its socio-cultural, economic and ecological interest for the population, the shea density is declining in Burkina Faso. This decrease in density is linked to unfavorable climatic conditions and human activities (Gaisberger *et al*., 2017; Ouédraogo *et al*., 2017), the ageing of natural stands (Kaboré *et al*., 2012), the low domestication of the species (Sawadogo *et al*., 2016; Sawadogo, 2018) and the low growth of the species (Gnanglè, 2016).

Many studies show an abundant proliferation of shea seedlings on farms, but hardly survive due to inappropriate agricultural practices and the short duration of fallow land (Kaboré *et al*., 2012). It therefore necessary to assess the impact of FMNR on the diversity and density of tree species, including shea. It is with this in mind that the present study was initiated with the overall objective of evaluating the effect of Farmer Managed Natural Regeneration (FMNR) practice on the species diversity and density, under different farming conditions.

# MATERIALS AND METHODS

***Location of the study area:*** The study was conducted in three (3) villages (Torem, Dongo and Katchéli) of Pô commune, capital of Nahouri province. The commune of Pô is located between the following coordinates: 11°19'03"N and 1°11'29"W to the north, 11°11'49N and 0°57'51"W to the east, 11°00'24"N and 1°06'50"W to the south and 11°10'52"N1°12'42"W to the west. The study area covers an area of 1642 km². Po is 90 km from Manga; capital of the region and 145 km from Ouagadougou th capital of the country. Map 1 shows the study area. Pô region has raw mineral soils, poorly evolved soils, brownified soils, iron and/or manganese sesquioxide

soils, hydromorphic soils and vertisols (PCD, 2010). The climate is South Sudanian- with rainfall between 1000 and 1200 mm. The vegetation is wooded-wooded savannah, including a tree stratum (Béné *et al*., 2014). Po region has significant forests and the weel known one is the, Po National Park, also known as Kaboré Tambi National Park (Guima 2022).

**Material**

The focus for this study was on shea tree, *Vitellaria paradoxa C.F. Gaertn*, characteristic of the Sudanian savannahs zone of Burkina Faso (Guira and Zongo, 2002; Sawadogo *et al*., 2016). The technical equipment used for the assement and measurement consists of tape measure for measuring the circumference of the shea trees.

**Methods**

To assess the effect of FMNR on the diversity of the tree stand in the farms, a sampling of 5 farms per village (Dongo, Katcheli and Torem) was done, i.e. 15 farms for the three villages. The farms were selected on two transects in an east-west and north-south direction (Dramé and Berti, 2008). The sampling consisted of placing inventory plots of 2000 m2 (50 m x 40 m), (Dramé and Berti, 2008). Ineach village, 5 inventory plots (15 plots for the 3 villages) have been placed as follow:1 one in the east, one in the west, one in the north, one in the the south and one in in the center, for a total of. In each plot, an exhaustive inventory of all species of trees has been carried out. The measurements focused on the circumference at the base of the trunk. For multi-caule individuals, the clump was considered as an individual and the measurement concerned only the dominant stem. The circumference at the base of the trunk was measured using a flexible tape. The following parameters were estimated:

The observed density or true density (Dob) obtained by the ratio of total number of individuals in the sample (N) to the sampled area (S).

$$\text{Dob.} = \text{N/S} \qquad \text{Equation 2.1}$$

***The centesimal frequency of a family (CF)*** is equal to the ratio as a percentage of the specific frequency (FS = number of times a specie of that family has been encountered) to the total number of individuals recorded (N).

$$\text{FC} = \text{FS/N x100.} \qquad \text{Equation 2.2}$$

**Total species richness (S)** is the total number of species in the population considered in a given ecosystem.

**The regeneration rate (R)** is calculated using the following formula:

$$\text{R} = \frac{\text{Number of individuals regenerated}}{\text{Number of individuals total}} \times 100 \qquad \text{Equation 2.3}$$

**Statistical analysis**

Data were entered in Excel (Microsoft Excel 2013) spreadsheet,. An analysis of variance (ANOVA) was done using the XLSTAT 2016 software. The Tukey test was used to compare means at 95% confidence.

# RESULTS AND DISCUSSION

**Results**

**List of trees species identified in the FMNR inventoried in the villages (Dongo, Katcheli and Torem):** Table 2 shows the trees species identified in the FMNR inventoried in the villages of Dongo, Katcheli and Torem. The dominant species in Dongo are *Vitellaria paradoxa* C.F. Gaertn with a density of 93 plants per ha, *Pilostigma reticulatum* with a density of 11 plants per ha and *Gardenia erubescens*, with a density of 10 plants per ha. The regeneration rate for the village of Dongo is 33.06%. The dominant species in Katcheli agroforestry parks are again *Vitellaria paradoxa* C.F. Gaertn with a higher density of 71 plants per ha, *Adansonia digitata* with a density of 15 plants per ha, and *Azadirachta indica* with a density of 10 plants per ha. The regeneration rate for Katcheli village is 48.62%. The dominant species in Katcheli agroforestry parks are *Vitellaria paradoxa* C.F. Gaertn with a density of 70 plants per ha and *Parkia biglobosa* with a density of 15 plants per ha. The regeneration rate for Katcheli village is 46.51%.

**Table 2. List of tree species identified under the FMNR in the villages of Dongo, Katcheli and Torem**

| Villages | Spec | Family | Observed Density |
|---|---|---|---|
| Dongo | *Vitellaria paradoxa* C.F. Gaertn | Sapotaceae | 93 |
| | *Piliostigma reticulatum* | Caesalpiniaceae | 11 |
| | *Gardenia erubescens* | Rubiaceae | 10 |
| | *Adansonia digitata* | Malvaceae | 1 |
| | *Diospyros mespiliformis* | Ebenaceae | 3 |
| | *Tamarindus indica* | Fabaceae | 1 |
| | *Parkia biglobosa* | Mimosaceae | 3 |
| | *Guira senegalensis* | Combretaceae | 1 |
| Katcheli | *Vitellaria paradoxa* C.F. Gaertn | Sapotaceae | 71 |
| | *Adansonia digitata* | Malvaceae | 15 |
| | *Diospyros mespiliformis* | Ebenaceae | 4 |
| | *Gardenia erubescens* | Rubiaceae | 2 |
| | *Azardirachta* | Méliaceae | 10 |
| | *Piliostigma reticulatum* | Caesalpiniaceae | 1 |
| | *Ficus lyrata* | Moraceae | 6 |
| Torem | *Vitellaria paradoxa* C.F. Gaertn | Sapotaceae | 70 |
| | *Parkia biglobosa* | Mimosaceae | 15 |
| | *Piliostigma reticulatum* | Caesalpiniaceae | 1 |

**Source:** Field survey, 2022

***Centesimal frequency of tree species families in Dongo parks with FMNR:*** The results of the study show that in the village of Dongo, the species richness is 8 species grouped into 8 families (Figure 4). There are significant variations in the centesimal frequencies of tree species families in the Dongo agroforestry parks with FMNR. The dominating families are: Sapotaceae (75.61%), Caesalpiniaceae (8.94%) and Rubiaceae (8.13%). The density observed for all species is 123 individuals per ha. For regenerated species, the observed density is 41 individuals per ha while the density of non-regenerated species is 83 individuals per ha.

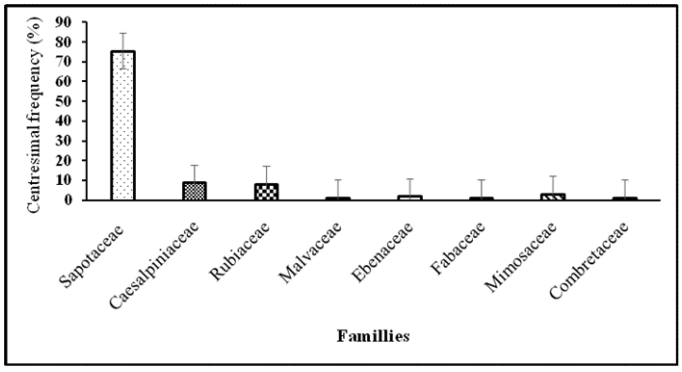


**Figure 1. Centesimal frequency of tree species families in Dongo parks with FMNR**

***Centesimal frequency of tree species families in Katcheli parks with FMNR:*** In the village of Katcheli, the species richness is composed of 7 species grouped into 7 families (Figure 5). There are significant variations in the centesimal frequencies of tree species families in Katcheli FMNR parks. The Sapotaceae (65.14%) show the highest number of spcies followed by Malvaceae (13.76%), Meliaceae

(9.17%) and Moraceae (5.5%). The density observed for all species together is 109 individuals per ha. The observed density for regenerated species is 53 individuals per ha while non-regenerated species is 56 individuals per ha.

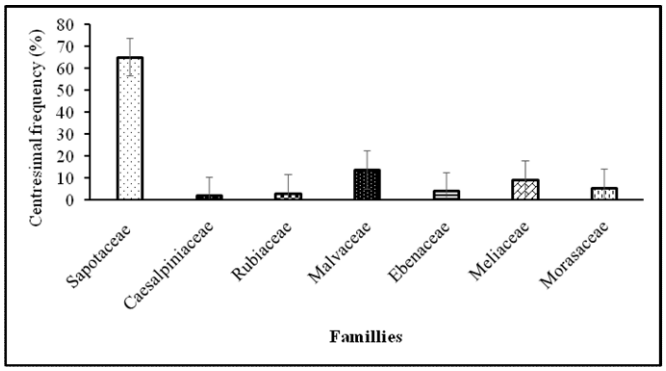


**Figure 2: Centesimal frequency of tree species families in Katcheli parks with FMNR**

***Centesimal frequency of tree species families in Torem parks with FMNR:*** in Torem village, the results show that the species richness is 3 species grouped into 3 families (Figure 6) with significant variations. The Sapotaceae (81.40%) are the first groupe followed by Mimosaceae (17.44%). The density observed for all species is 86 individuals per ha. The observed density for regenerated species is 40 individuals per ha while non-regenerated species is 46 individuals per ha.

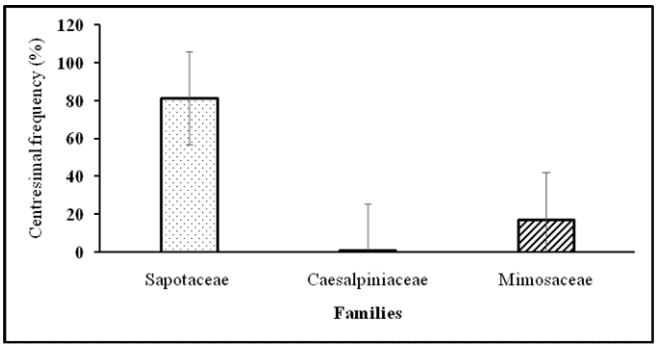


**Figure 3. Centesimal frequency of tree species families in Torem parks with FMNR**

# DISCUSSION

The results of the study show similar species richness in the three villages, the. The highest centesimal frequencies was observed for the Sapotaceae, the Cesalpinaceae, the Malvaceae, the Rubiaceae, the Mimosaceae and the Ebenaceae. The species with regular distribution were *Vitellaria Paradoxa* C.F. Gaertn, *Pilliostigma reticulatum*, *Diospyros mespiliformis*, *Gardenia erubescens*, *Adansonia digitata*, and *Azardirachta indica*. The food and economic importance of these species may explain their regular distribution in farmers' fields. Indeed, the FMNR offers the local population the opportunity to have access to higher quantities of wood and non-wood products of species such as *Vitellaria paradoxa* C.F. Gaertn *Diospyros mespiliformis*, *Gardenia erubescens*, *Pilliostigma reticulatum*, *Adansonia digitata*, and *Azardirachta indica*. These trees and their non timber forest products are used for multiple purposes such as food and forage, traditional medicine and handicrafts. Although self-consumed, these products are also a source of alternative and significant income that contributes to improving the living conditions of the population. The farmers' perception of the effect of certain tree species on soil fertility and crop yields may explain their presence in the fields. According to Yélemou et al. (2007), the practice of mulching of an encrusted area of the field with the leaf biomass of *Pilliostigma, reticulatum* by farmers at the beginning of the growing season improve the development of the associated crops and therefore a good yield. Our results are in line with those of Botoni et al. (2010) and Lawali et al. (2018) in Niger who also identified these species as part of the species used in natural regeneration. The regeneration of *Vitellaria paradoxa* C.F. Gaertn was higher in the three study areas than the other species. The high economic value of shea through the sale of kernels or the processing into butter may explain the high practice of FMNR on the species by farmers. Coulibaly-Lingani *et al*. (2011) reported that among non-timber forest products, shea kernels and the *Parkia biglobosa* (dawa-dawa) seeds are the highest incomes providers to the farmers. Also, environmental disturbances and human an animal pressure on natural resources may explain the low regenerative capacity of some species, as indicated by Ouédraogo *et al*. (2006) and Kagné (2012). However, the regeneration rate in the three study areas is less than 50%, demonstrating that the density of young trees is lower than that of the adult trees stand in the study area. This indicates a slight rejuvenation of the various agroforestry parks in general, because the demographic status of young plants is a major factor in the dynamics of the renewal of tree stands (Ouédraogo *et al.*, 2006). This low rate of regeneration can be explained by the fact that in the context of FMNR, which is carried out in the fields, farmers do not leave a high density of trees that can subsequently become a source of disturbance for crop productions operations. These results corroborate those of Ganaba (2005) who found tree regeneration (low) rates of 2.61 and 9.45% respectively for agricultural and pastoral land in the Sahelian zone of Burkina Faso.

# CONCLUSION

The climate change associated with the degradation of agroecosystems are the major constraints to the ecosystem restoration, agricultural production and a threat to the income-generating activities of rural populations in Burkina Faso. The aim of this study was to evaluate the effect of the FMNR on tree species diversity of *Vitellaria paradoxa C.F. Gaertn*. The results of the study show that the families with the highest centesimal frequencies are Sapotaceae, followed by Caesalpinaceae, Malvaceae, e Rubiaceae, Mimosaceae and Ebenaceae. The Species with regular distribution were *Vitellaria paradoxa C*.F. Gaertn, *Pilliostigma reticulatum*, *Diospyros mespiliformis*, *Gardenia erubescens*, *Adansonia digitata*, and Azardirachta indica. The regeneration rate in the three study areas is less than 50%. The results show a weak dynamic in the renewal of tree stands. The results on FMNR suggest that to increase the resilience of rural populations, it is necessary to raise awareness and build the capacity of farmers on FMNR practice and shea park management. Based on these results obtained and the outlook, it would be interesting to determine the factors that influence the practice of FMNR by the farmers.

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