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Study of Floristic Diversity and the Structural Dynamics of Some Species Providers of Non Woody Forest Products in the Vegetable Formations of the Centre East of Burkina Faso

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Abstract: The goal of this study is to contribute to a better knowledge of certain species providing Non Woody Forest Products (NWFP) in the Centre East of Burkina Faso. This study aims to determine the state of the resources in *Vitellaria paradoxa*, *Balanites aegyptiaca*, *Tamarindus indica* and *Lannea microcarpa*. For this purpose, an inventory of the vegetation was carried out in circular pieces of land of 1250 m^2, as a sample of the zone of work, based on the chart of occupation of the grounds. We are identified 158 species comprising 90 genera and 47 families. Those species represent more than 90% of the trees from which various parts are used in food, traditional pharmacopeia and the craft industry. We also showed that because of the strong anthropisation of the zone, the bad pedoclimatic conditions and the permanent bush fires, the regeneration and growth of *Vitellaria paradoxa*, *Balanites aegyptiaca*, *Tamarindus indica* and *Lannea microcarpa* are disturbed.

Key words: PNFL, species providers, regeneration, durable management, Burkina Faso

INTRODUCTION

Forest products constitute an important source of income for the rural populations of Burkina Faso. Therefore, the component environment is a strategic axis in the implementation of the Strategic Framework of Fight against Poverty in Burkina Faso (Burkina Faso Ministry of Economy and Development, 2004).

Forest installations, initially focussed on the production and exploitation of high commercial value wood (Marshall and Newton, 2003) did not take into account the economic importance of other tree products. However, certain products formerly described as sub-products or secondary products play important socio-economic roles as much as wood itself (Anderson and Farrington, 1996; FAO, 1995). It is the case of *Vitellaria paradoxa*, *Balanites aegyptiaca*, *Tamarindus indica*, *Adansonia digitata* and *Lannea microcarpa*. However, the exploitation of these resources remains artisanal with an uncontrolled management (Sunderland and Ndoye, 2004). Perceived as a gift of nature, these woody phytogenetic resources were not under any rules of durable management in rural areas in Burkina Faso. However, the influence of human activities on the dynamics of vegetation and ecosystems evolves with demographic growth and constitutes a threat for the survival of many utility species (Lykke *et al*., 1999; Backer *et al*., 2004). Thus, the perenniality of these species is compromised in certain formations of vegetation and particularly in tree savannas, shrubby savannas and fields. In fact the vegetation of Burkina Faso which is dominated (up to 2/3) by the formations of the savannas (Paré, 2008), is still undergoes deep structural and floristic changes because of anthropic pressures and recurring droughts (Lindqvist and Tengberg, 1993; Gijsbers *et al*., 1994; Agnew and Chappell, 2000). This results in an accentuation of the phenomenon of desertification, involving a higher mortality rate of woody species and a degradation of the vegetation (Baumer, 1994; Ræbild *et al*., 2007; Wittig *et al*., 2007). However, the diversity and the structure of the vegetation constitute indicators of the quantitative and qualitative evolution of the cover of vegetation (Millogo-Rasolodimby and Guinko, 2006). Therefore, the purpose of the present study is to determine the floristic diversity and structural dynamics

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of species providers of non woody forest Products in two types of savannas and fields in the Centre East of Burkina Faso.

MATERIAL AND METHODS

The zone of study: The studied zone is a protected area located between the communes of Bissiga and Tenkodogo (Province of Boulgou) and Lalgaye (Province of Koulpélogho) in the Eastern Centre Region of Burkina Faso. This zone is at 325 km from Ouagadougou the capital of Burkina Faso in the East on the National Road Tenkodogo Ouargaye at 30 km from Tenkodogo and 12 km from Ouargaye. This zone covers 30 ha (Fig. 1).

The Eastern Centre Region of Burkina Faso has been created by law n°2001-013 of July 2, 2001 in Burkina and is located between 1°0' of longitude west and 0°45' of longitude East, between 12°35' and 10°55' of latitude north. This zone which is a frontier of Togo and Ghana covers a surface of 14656 km^2. On the administrative level, it includes 3 Provinces, 30 communes including 6 urban communes and 24 rural communes with 711 villages. Its population amounted to 1.132.023 inhabitants in 2006 including 946.065 living in rural areas. It represented 8.24% of the total population of the country in 2006 according to Ministère de l'Economie et des Finances, Institut National de la Statistique et de la Démographie (2007) and the principal ethnic groups are the Bissa, Mossi, Yanna, Peulhs and Koussassé. It is an area of reception of migrants (54.435 migrants in 2006). The climate is a Soudano-Sahelian type, ranging between isohyets 800 and 1000 mm and it belongs to the climates of savannas and is characterized by a contrast between one season of rains of a few months and a long dry season. The annual average temperature is 33°C and can reach a maximum of 41°C. We can distinguish one fresh period from November to February and a hot period from March to May.

The methodology of inventory is mainly based on the systematic inventory with the point quadrat method (Lanly, 1981; De Vries, 1986; Schreuder *et al*., 1987; Shiver and Borders, 1996). It focused on units of small land on a sample elaborated from a map of occupation of the grounds (Bazoun, 2007). These units of small land distributed in the various formations of vegetation are circular with 19,95 m of ray and a surface of 1250 m^2 as recommended size in inventory for the countries of French-speaking Africa in the North of the equator including Burkina Faso (Kaboré, 2007; Sylla and Picard, 2005) (Fig. 2). This inventory has been realized from 15th October to 10th November 2007. This period is appropriate for the phenological study of the vegetation, this allowed to the identification of species.

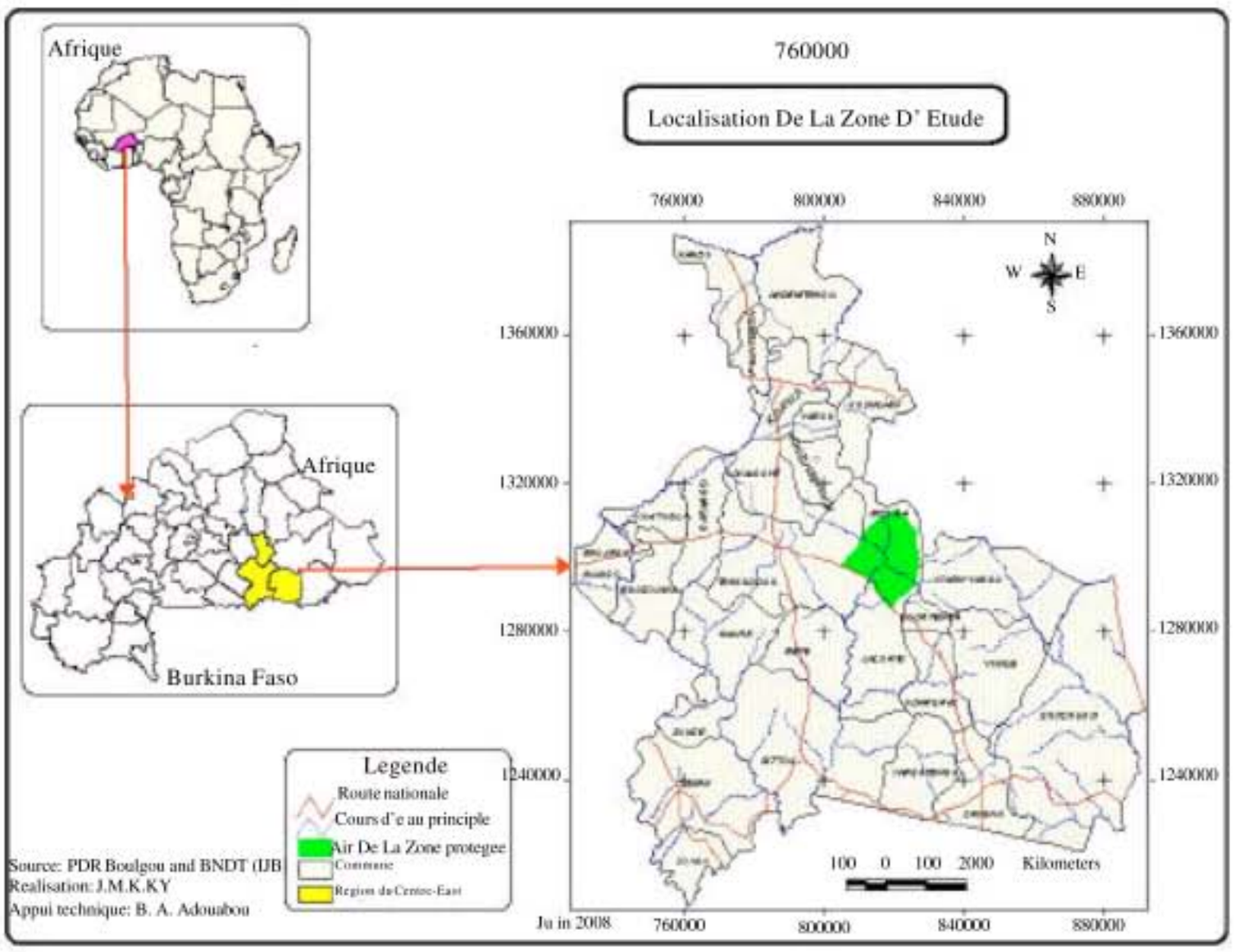

Fig. 1: Map of localization of squares in the Center East of Burkina Faso

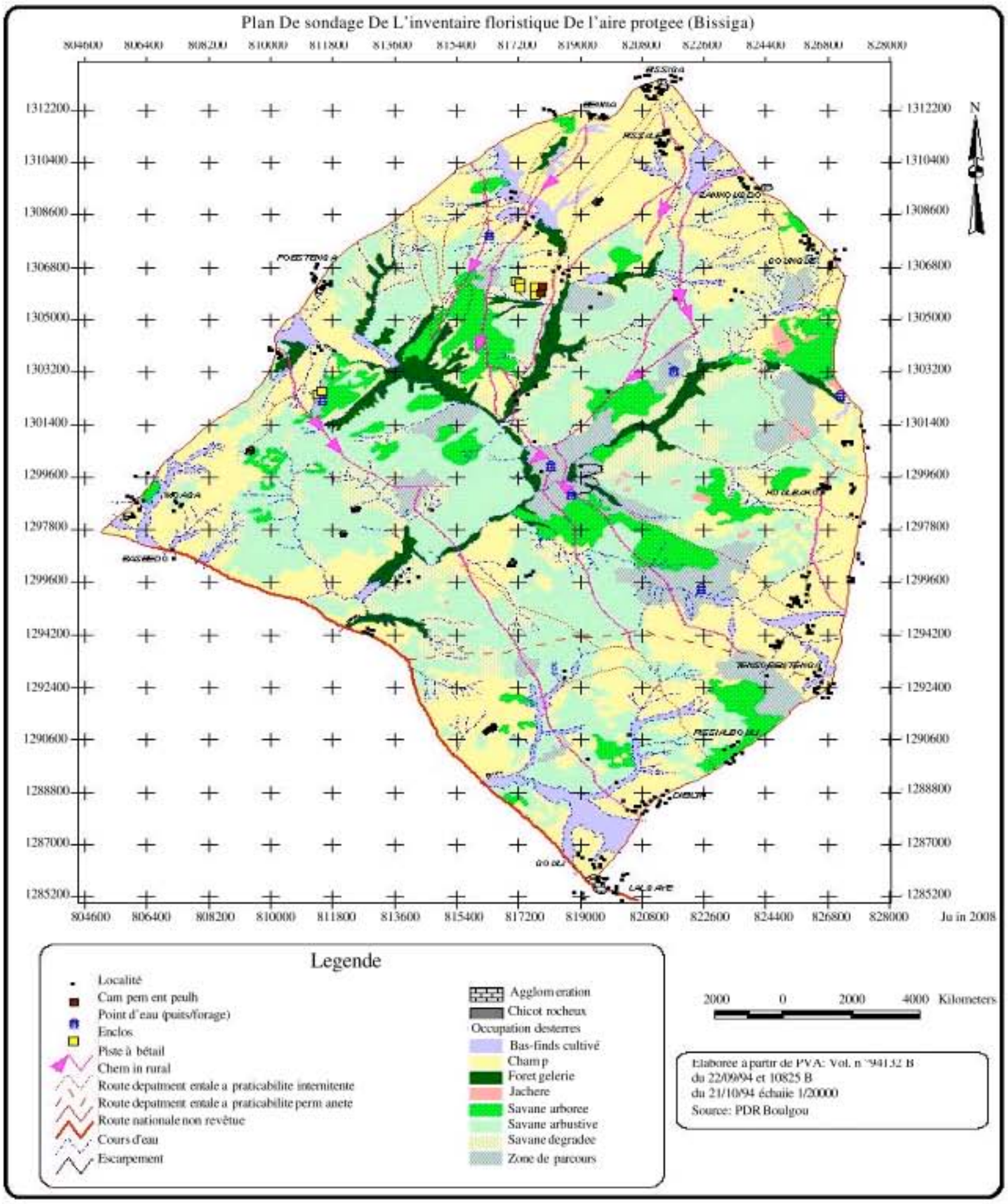

Fig. 2: Sample design

For each type of vegetation, the research carried out gave for tree savannas 15 surveys on a surface of 1.875 ha, for shrubby savannas, 33 surveys on 4.125 ha and for fields 48 surveys on 6 ha, respectively accounting for 13.9, 30.5 and 44.4% of the total surface inventoried.

The material used is composed of GPS, compasses, ribbon metres, ropes and machetes.

The inventory concerned individual plants with height ranking above 1.30 m. In each survey account, the list of woody and herbaceous species is drawn up. The statements related to the diameter at chest level (1.30 m), the height, the health condition, the ground, the anthropic disturbances and phenology. Regenerations were noted on the whole of these small squares. The data were collected on inventory cards and the species were identified from the flora and lexicons (Von Maydel, 1986; Arbonnier, 2000; Bosch *et al*., 2002).

RESULTS

The vegetation of the zone of study consisted of 158 species comprising 90 genera and 47 families. The woody species accounted for 41% of the listed species. The species providing NWFP constitute more than 90% of the trees from which various parts (fruits, sheets, bark, root, flowers and latex) are used in human consumption, animal feed, human and veterinary pharmacopeia and in handicraft industry. The majority of plants species listed, 75%, are in the tree savannas, shrubby savannas and fields (Table 1). The species most used as NWFP are *Vitellaria paradoxa*, *Balanites aegyptiaca*, *Tamarindus indica*, *Lannea microcrapa* and *Adansonia digitata*.

More than 85% of the inventoried vegetation is in good health condition, 14% of the trees are cut or sick. Nearly all the vegetation is subjected to bush fires and the pasturage of animals (Fig. 3a-d, Table 1).

Woody savanna: In this vegetation the repartition in classes of diameters presents the bell-shaped or J-shaped species. More than 95% of the species are less than 15 m high. Individuals with height ranging from 0 to 2 m account for 0% for *Vitellaria paradoxa* and *Lannea microcarpa* whereas it reaches 20 to 40% for *Tamarindus indica* and *Balanites aegyptiaca*. Individuals with the topreaching 15 m of height are between 0 to 10%. In tree savannas *Vitellaria paradoxa* have the highest density (46 feet ha^{-1}) followed by *Balanites aegyptiaca* (21 feet ha^{-1}) and then come *Lannea microcarpa* and *Tamarindus inidica* which is the least dense species (Table 2). *Vitellaria paradoxa* is also the most frequent (8.57%) followed by *Lannea microcarpa* then come *Balanites aegyptiaca* and *Tamarindus indica* (Table 3).

Relative abundance is higher for *Vitellaria paradoxa* followed by *Tamarindus indica*, then come *Balanites aegyptiaca* and *Lannea microcarpa* (Fig. 4a-d).

Shrubby savannas: In this vegetable formation the classes of diameters are characterized by bell-shaped histograms for the whole of the species except *Lannea microcarpa* which presents a sequenced form in L. As for the 4 species, more than 97% of the individuals have a height ranging from 2 to 15 m. Below 2 m and beyond 15 m the individuals are less represented and account for 2 to 3% (Fig. 4-6). In shrubby savannas *Vitellaria paradoxa* is denser (29 feet/ha) and is followed by *Tamarindus indica*, *Lannea microcarpa* and *Balanites aegyptiaca* (Table 2). *Lannea microcarpa* is the most frequent species (20%)

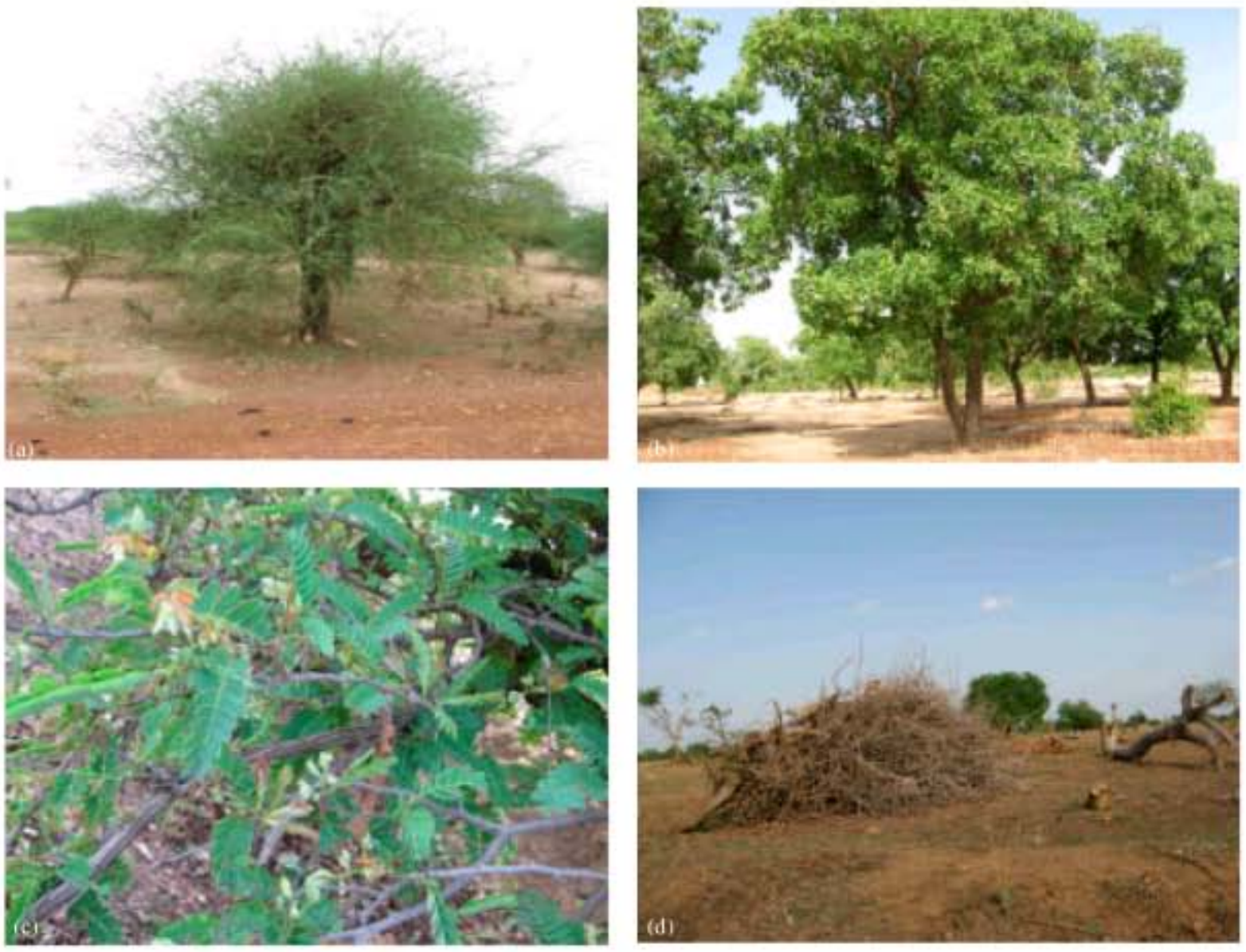

Fig. 3: (a) *Balanites aegyptiaca*, (b) *Vitellaria paradoxa*, (c) *Tamarindus india* when flowering and (d) *Lannea microcarpa* half-compartment during clearing

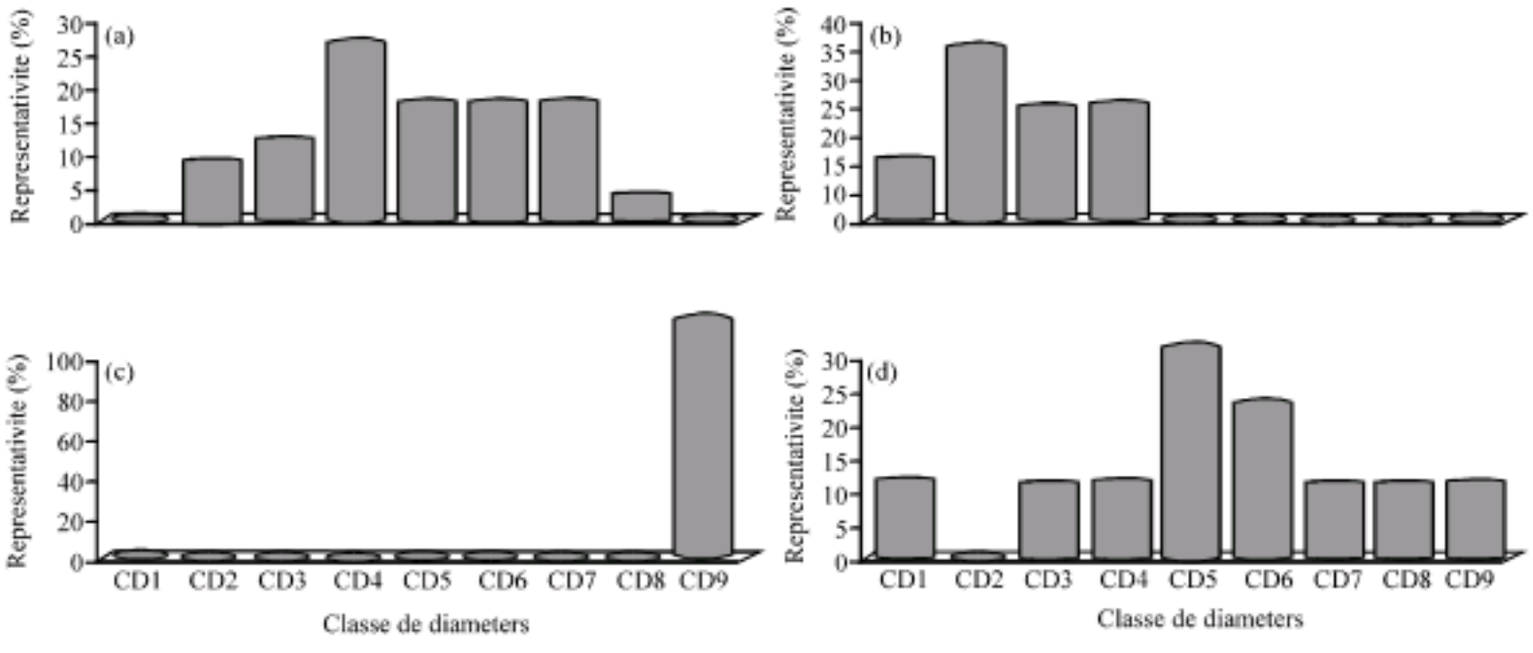

Fig. 4: Distribution of diameter classes of 4 species in a wooded savannah vegetation. (a) *Vitellaria paradoxa*, (b) *Balanites aegyptiace*, (c) *Tamarindus indica* and (d) *Lannea microcarpa*

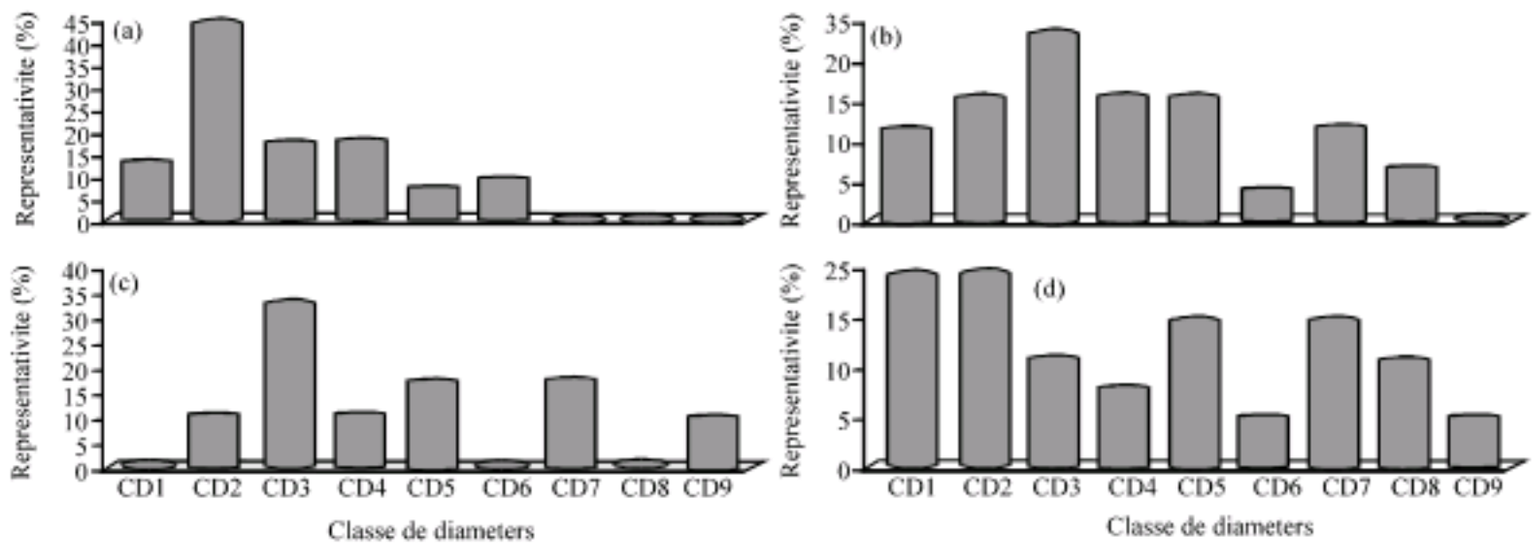

Fig. 5: Distribution of diameter classes of 4 species in a shrubby savannah vegetation. (a) *Balanites aegyptiaca*, (b) *Vitellaria paradoxa*, (c) *Tamarindus indica* and (d) *Lannea microcarpa*

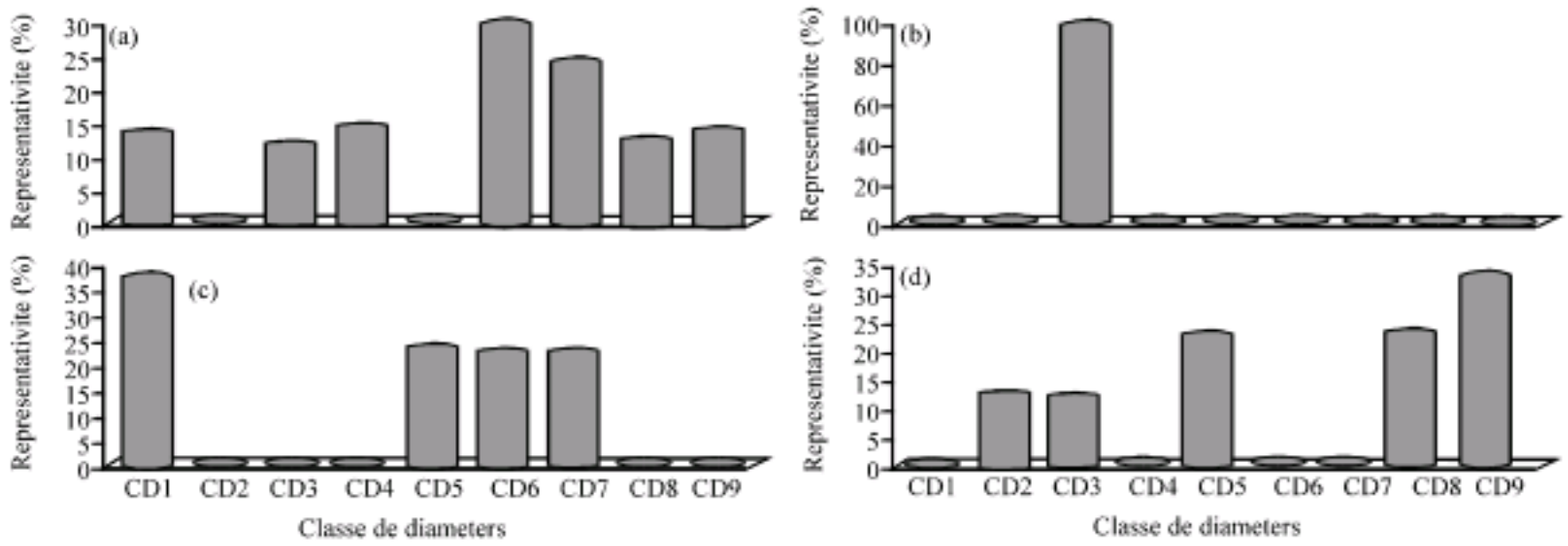

Fig. 6: Distribution of diameter classes of 4 species per fields. (a) *Vitellaria paradoxa*, (b) *Balanites aegyptiaca*, (c) *Tamarindus indica* and (d) *Lannea microcarpa*. CD: Classifies diameter (cm). CD1 = 1à5; CD2 = 6 to 10; CD3 = 11 à15; CD4 = 16 to 20; CD5 = 21 to 25; CD6 = 26 to 30; CD7 = 31 to 35; CD8 = 36 to 40; CD9 = more than 40

followed by *Balanites aegyptiaca* (15.71%), *Vitellaria paradoxa* (11.42%) and *Tamarindus indica* (Table 3). As for the abundance of species in shrubby savannas, it is dominated by *Vitellara paradoxa* followed by *Lannea micropcarpa* and *Balanites aegyptiaca* then by *Tamarindus indica* (Fig. 5a-d).

Table 1: Repartition of the families by type of vegetable formation

Families	Forest gallery	Tree-savannas	Shrubby savannas	Fallows	Fields
Anacardiaceae	**6**	19	35	**3**	10
Annonaceae	**0**	0	4	**0**	1
Balanitaceae	**3**	8	20	**1**	8
Bignoniaceae	**0**	1	0	**1**	0
Bombacaceae	**0**	1	2	**2**	3
Caesalpiniaceae	**28**	14	87	**33**	37
Celastraceae	**0**	1	1	**0**	0
Combretaceae	**41**	81	140	**30**	22
Ebenaceae	**10**	6	2	**9**	15
Euphorbiaceae	**3**	1	0	**0**	0
Fabaceae	**0**	1	2	**0**	2
Loganiaceae	**0**	0	2	**0**	0
Meliaceae	**2**	0	0	**0**	1
Mimosaceae	**18**	37	111	**7**	24
Moraceae	**2**	4	1	**0**	7
Myrtaceae	**7**	0	0	**0**	0
Olacaceae	**0**	7	2	**0**	0
Rhamnaceae	**1**	0	6	**6**	0
Rubiaceae	**5**	14	20	**4**	2
Sapotaceae	**4**	42	33	**17**	54
Sterculiaceae	**0**	2	11		0
Tiliaceae	**0**	5	6	**0**	0
Verbenaceae	**3**	0	0	**0**	0
Total	**134**	242	489	**118**	192

Bold values are in dark-studied vegetable formations

Table 2: Specific density by species and vegetable formation

	Specific density (No. of feet ha^{-1})		
Vegetable formation species	Tree-savannas	Shrubby savannas	Fields
Vitellaria paradoxa	46	29	25
Balanites aegyptiaca	21	14	13
Tamarindus indica	8	26	6
Lannea microcarpa	15	15	18

Table 3: Frequency of the various species by vegetable formation

	Frequency (%)		
Vegetable formation species	Tree-savannas	Shrubby savannas	Fields
Vitellaria paradoxa	8.57	11.42	24.28
Balanites aegyptiaca	2.85	15.71	7.14
Tamarindus indica	1.42	4.28	5.71
Lannea microcarpa	7.14	20.00	5.71

Fields: The classes of diameters present bell-shaped histograms for *Vitellaria paradoxa* and *Tamarindus indica*. The form is J for *Lannea micrcarpa* and L for *Balanites aegyptiaca*.

The heights of the trees in the fields lie between 2 and 15 m. The individuals having a height ranging between 5 and 15 m are the most represented (65 to 90%). Young trees ranging between 1 and 5 m of height are very slightly represented.

In the fields, *Vitellaria paradoxa* has the highest density (25 feet ha^{-1}), followed by *Lannea microcarpa*, *Balanites aegyptiaca* and *Tamarindus indica* (Table 2). *Vitellaria paradoxa* is also the most frequent species (more than 24%) followed by *Balanites aegyptiaca* and *Lannea microcarpa* and *Tamarindus indica* (Table 3). In term of abundance *Vitellaria paradoxa* is more abundant in the zone followed by *Balanites aegyptiaca* and *Lannea microcarpa* which have almost the same abundance and finally by *Tamarindus indica* (Fig. 6a-d).

DISCUSSION

Overall abundance, density and frequency of species providers of non woody forest product are in irregular evolution as indicated by the shapes of diameter growth in the three types of studied vegetation. Therefore, in woody and shrubby savannas as in fields, all the species and the vegetation structure are disturbed (Williams *et al.*, 1996). *Vitellaria paradoxa* is dominating in terms of abundance, as well as frequency and density except in shrubby savannas where *Lannea microcarpa* is more frequent. This is confirmed by (Kéré, 1998), who showed that savannas in the Sudanian Sector are mainly dominated by *Vitellaria paradoxa.* That can be explain by the fact that the populations has preserved as much as possible the most utile species and particularly *Vitellaria paradoxa* (Boffa, 1999, 2000) The spacing out in the repartition of bell-shaped and J-shaped classes of diameters reveal ageing populations for *Vitellaria paradoxa* and *Tamarindus indica* what shows the irregular evolution of these species (Skarpe, 1990). Indeed in the various types of the vegetation and specifically in the fields, these very utility species have a very low capacity of regeneration according to Dupriez and Leener (1998) and present subjects of large diameters withheights often rising above 15 m and can even reach 20 m. This is the result of the particular care that the populations bring to these species because of their obvious socio economic interest (Boffa, 1999; Devineau *et al.*, 2009). *Vitellaria paradoxa* and *Tamarindus indica* are the main species used by the populations of the zone either for their needs (family consumption) or for marketing. The effects of ploughings and their protection against animals and bush fires have a beneficial influence on the species in the fields in terms of growth in diameter, height and productivity as indicated by (Boffa, 2000). In shrubby savannas *Balanites aegyptiaca* presents a regular growth and evolution in spite of the disturbances noticed in most species. This species grows particularly on old ferric soils. In the same way the frequency of *Lannea microcarpa* in this vegetable formation due to the fact that groupings of *Lannea microcarpa* characterize shrubby savannas in association with *Acacia machrostachya* and *Cassa sieberiana. Lannea microcarpa* is well distributed in shrubby savannas but this species meets problems of growth in strongly anthropized zones; such is the case in our zone of study. The aging of this species might be caused by the intensive and uncontrolled exploitation for human and animal, by clearings for the installations of

news fileds and by the bush fires, the attacks of animals, the conditions of station (Kéré, 1998; Ouédraogo *et al*., 2006) but also by the destruction of the young seedlings during the clearings and with the abusive cutting of trees for various needs. According to present observations *Balanites aegyptiaca* is better regenerated in shrubby and less inn woody savannas. There is very little regeneration for *Vitellaria paradoxa* because they are destroyed by fires, droughts and clearings. *Tamarindus indica* presents less young individuals and an nearly non-existent regeneration. Although, in the Sudanian, formations the potential of regeneration exists (Gijsbers *et al*., 1994). *Vitellara paradoxa, Balanites aegyptiaca*, *Tamarindus indica* and *Lannea microcarpa*, regenerate badly except for *Balanites aegyptiaca* in certain parts of shrubby savannas. This is due to the anthropic pressions, bush fires, animals and to the conditions of the station as noted by Kéré (1998). It is also due to the destruction of young seedlings during the clearings and with the abusive cutting of trees for various needs.

The bell-shaped structures or J indicate that in savannas, shrubs and fields, species evolve abnormally (Scholes, 2002). Indeed, there is little regeneration and aging vegetation. With the exception of *Vitellaria paradoxa*, young plants are cut, burned or overfished. We note that in shrubby savannas, species are better conserved and evolve more regularly than in fields and wooded savannas especially for *Balanites aegyptiaca*, *Lannea microcarpa* and to a lesser extent for *Vitellaria paradoxa*. For *Vitellaria paradoxa*, the structure of diameter classes has an L-form which means, according to the Scientific Council for Africa (CSA), a normal development of the forestry point of view.

CONCLUSION

Though, characterized by a strong demographic growth, the area of the Centre East of Burkina Faso is rich in cash providers of NWFP with an important potential which is a socio economic asset for the country. In the study area *Vitellaria paradoxa*, *Balanites aegyptiaca*, *Tamarinus indica* and *Lannea microcarpa* have an evolution characterized by a lack of regeneration, inhibited growth and aging of populations. This potential is increasingly prone to very strong anthropic pressures and an uncontrolled exploitation which, could compromise the regeneration of these species and their perenniality, destroy one of the principal sources of additional income for the rural populations. The intensive and uncontrolled exploitation of species providers of NWFP, climatic risks and bush fires cause damage and prejudice to the woody phytogenetic resources and contribute to their rarefaction with a risk to see them disappearing. The study of the floristic composition as well as that of the structure of the vegetation reveal a weak regeneration of the principal species providers of NWFP such as *Vitellaria paradoxa*, *Tamarindus indica*, *Lannea microcarpa* and *Balanites aegyptiaca*. These species are disturbed in their regeneration and their growth. The large trees we meet in the fields and savannas could not be replaced if measures of conservation and restoration are not undertaken. In the same way, the installation of new fields, the exploitation of the non woody forest products, the non-organization of the actors of NWFP and the absence of a concerted management plan constitute considerable constraints for the perpetuation of resource providers of NWFP. It is necessary for a better management of these resources to develop strategies of conservation and durable management which would involve all the actors by implementing the agro forestrytechniques of conservation.

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