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Management and Use of Wood Resources in Agroforestry Parks in the Northern Sudanian Zone of Burkina Faso

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Abstract: - In sub-Saharan Africa, trees are integral part of the cropping systems, and form a major source of nutrient to the soil as well vital products to the farmers. Therefore, this study was conducted to evaluate the management and use of wood resources in agroforestry parks in the Northern Sudanian zone of Burkina Faso. This study was conducted in eight villages (Baonguen, Gourango, Godé, Tampélga, Ramonkodogo, Saria, Villy and Rana) around the Institute of Environment and Agricultural Research (INERA) of Saria (Burkina Faso). The method used was direct questionnaire with open and semi-structured questions. The reasons guiding the choice of woody trees to preserve in the farms, their management methods and their uses by farmer were collected. The results show that all the producers in the area save woody trees on their farms. In addition, the reasons guiding the choice of tree species saved are above all, the supply service (97.5%), and as far as shrubs are concerned, it is the production of firewood (41.3%). The management practice for shrubs in the field is to cut at the base of the trunk. This is done by 100%, 100%, 95% and 5%., during field preparation, first weeding, second weeding and ridging respectively. Shrub species in the field are involved in satisfying various needs of the producers (food, medicinal, etc.). Agroforestry thus allows farmers who practice it to harvest in their agrosystems many products that would otherwise have been harvested from the forest. These results indicate that agroforestry parks are real supply areas for timber and non-timber forest products. Thus, they can guide decision-makers in making decisions concerning the promotion of the agroforestry park system.

***Keywords**: - Park Management, Use of Woody Plants, Shrubs in the Field, Burkina Faso.*

I. INTRODUCTION

Covering an area of 274,000 Km^2, Burkina Faso is a Sahelian country located in the heart of West Africa. The rural sector occupies an important place in the national economy, since it employs more than 3/4 of the population through agriculture. It also generates more than a third of the gross domestic product (GDP) (MAHRH, 2009). Despite the fact that agriculture is considered the main source of economic growth (Compaoré, 2008), however it is highly dependent on rainwater. This dependency on rainfall predisposes Burkina Faso just like other Sahelian countries, to suffer from water and rainfall deficits, resulting in early drying up of surface water bodies, the lowering of the general level of water tables and environmental degradation. This situation causes a major setback for the country's socio-economic development. Other factors causing this setback include demographic pressure, new farming techniques, resource exploitation, and land management. Furthermore, the combined effects of climate change and human activities have concomitantly contributed to soil impoverishment and accelerated degradation of plant communities (MECV, 2007; PANA, 2007) and production systems.

In the arid and semi-arid zones of West Africa, the agrarian landscape is characterized by the agroforestry park system (Bationo *et al*., 2012). Specifically, in Burkina Faso, this traditional land-use system has existed for several decades as part of the management and maintenance of soil fertility. The agroforestry park system helps in conserving a few useful or less problematic woody plant species

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alongside crops in the fields. These reserved plants, comprising of trees and shrubs, are multipurpose and provide the locals with enormous goods and services such as food, fuel, fodder, medicinal products and also building materials. Many authors affirm the importance of the adoption of this system for its contribution in improving soil quality. Thus, Bationo *et al*, (2012) observed that the maintenance of trees and shrubs scattered in the fields, in association with crops, is certainly related to various reasons but some are maintained and managed to improve the chemical and physical properties of soils. For example, on semi-arid lands, conservation agriculture with woody trees retains water in the soil, maintains soil temperature and protects the soil from wind and water erosion (IIRR and ACT, 2005). Thus, the use of shrubs to reduce erosion and conserve soil fertility has been found necessary to partially offset these problems (Ky-Dembele *et al*., 2000; Yélemou *et al*., 2007).

In the central-western region of Burkina Faso, as in other parts of the country, there is strong pressure on natural resources, particularly wood resources and this could affect agricultural productivity because of the importance of woody resources to improving soil quality. Thus, there is need for exhaustive inventory of the contribution of woody resources in the field to the satisfaction of producers' needs. This inventory will comprise of their reasons for choice of species to keep on the field, management methods, and the goods and services the woody species in the fields provide to producers. The objective of this study is to document the reasons that guide the choice of woody species kept in the fields, their management practices and their uses.

II. MATERIALS AND METHODS

Study sites

The present study was conducted in eight villages within a radius of 15 Km around the research station of the Institute of Environment and Agricultural Research (INERA) of Saria. These villages are Baonguen, Gourango, Godé, Tampélga, Ramonkodogo, Saria, Villy and Rana. They are located in three communities of the province of Bulkiemdé: Koudougou, Nandiala, and Ramongo (Figure 1). The coordinates of the center of the town of Koudougou are 2°21'51" west longitude and 12°15'3" north latitude. The average altitude is 300m. The climatic context is characterized by a rainy season of 6 to 7 months with an annual rainfall ranging from 626 to 980 mm (period 2000-2019) and a dry season of 6 to 7 months. The dominant winds are the continental trade winds and harmattan during the dry season and monsoon during the rainy season. The soils of Saria are ferruginous tropical (Salawu, 2009). The average depth varies between 50 and 80 centimeters. It is limited by the presence of concreted cuirass (Zougmoré *et al.*, 2004). The landscape is marked by shrubby to tree-covered savannah and agrosystems (agroforestry parks and fallow land). The area is characterized by a high population density (152 habitants/km^2). Agriculture is the main activity and the main crops consists majorly of cereals.

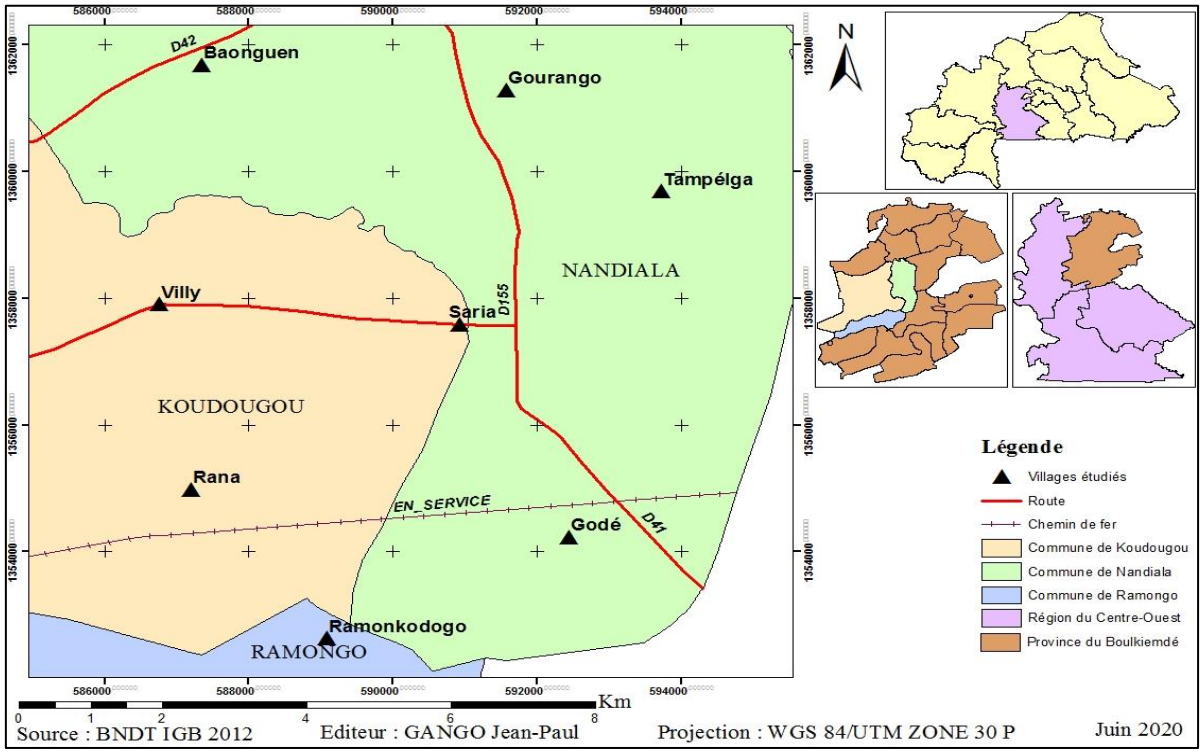

Figure 1 : Location of the Study Area

Methods

Sampling

The simple random sampling technique (Houéhanou *et al*., 2016) made it possible to retain 10 informants in each village, regardless of gender, ethnicity or religion. Thus, the sample size was 80 people spread across the eight villages. A direct questionnaire with open-ended and semi-structured questions (Dourma *et al*., 2010; Klotoé *et al*., 2013) were used to collect information. It concerned the choice of

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woody species conserved in the parks, the management methods and the benefits of the shrubs. The parts of the plant that are used and their purposes were also noted. The interviews took place during the months of May - April of the year 2020. They were conducted in the national language Mooré in the producers' homes or farms.

Data Analysis

The data collected was entered and organized using Microsoft Excel spreadsheet software. They were then analysed by SPSS 17.0 software and the following indices were calculated from these data:

Frequency of service citation (FCS):

$$Fcs = \frac{NCs}{N} X100$$

NCs is the number of informants who use or acknowledged benefiting from the service.
N is the total number of informants interviewed,

Average frequency of service citation (FCM):

$$FCM = \frac{\sum FCS}{Ns}$$

FCS is the frequency of use of a service and Ns the number of services considered.

The usual value of species (UV) for each use category was calculated to show the importance that the population places on a given species in the locality**:**

$$\boldsymbol{UV = \frac{\sum U}{N}}$$

U is the number of times a species is mentioned and **N** is the total number of informants,

The Informant Consensus Factor (Fic) according to Heinrich *et al*. (1998**)** is an index that expresses the variability in the forms of wood use (Gning *et al.*, 2013). Its value varies between 0 and 1 and is close to 1 when a reduced number of species is used for a given use. On the other hand, the value is close to 0 when a high diversity of species is mentioned for the same use.

$$\boldsymbol{Fic} = \frac{\mathrm{N_{ur}} - \mathrm{Nt}}{(\mathrm{N_{ur}} - 1)}$$

Where **Nur** (User-reporters Number) is the number of uses indicated in a given category and

Nt (Number of Taxa) is the number of species indicated in the same use category.

The level of fidelity (FL) is an expression that shows the importance that populations give to a species for its role. Its formula is as follows:

$$FL(\%) = \frac{N_p}{N} \times 100$$

Np represents the number of mentions of a species for its role and **N**, the total number of uses for any purpose.

Then, the matrix made up of all the shrub species cited for use × 5 types of use (human food, animal feed, pharmacopoeia, handicraft, combustion) was subjected to a correspondence factorial analysis with Xlstat software (version 14.3.07, Addinsoft, 2007) to identify possible species-use groups.

III. RESULTS

General characteristics of the population.

The informants interviewed for this study are of "Mossi" ethnicity, all of whom are farmers and are at least 30 years old. The age group [45; 60 [years contains 47.5% of the informants. The majority are non-literate (75%). Of those who have attended school, only 11.3% have reached post-primary school level. Agriculture is their main activity and their level of equipment is low (only 25% own a manga hoe) (Table I).

Table I: General characteristics of the population

Number of respondents	Like	Main activity	Age	Level of education	Ethnicity	Equipment
80	Male (82.5%) Women (17.5%)	Agriculture (93,8%) Trade (6,3%)	[30 ; 45[=30% [45 ; 60[=47,5% [60 ; 75[=21,3% [75 ; + [=1,3%	Never attended (75%) Koranic (2.5%) Primary (8.8%) Rural School (2.5%) Post-primary (10%) High school (1.3%)	Mossi (100%)	Daba alone (28.7%) Daba and plough (46.3%) Daba, plough and manga hoe (25%)

Reasons for woody field savings and species saved

All respondents conserved woody species on their fields. The ecosystem services for which timber is reserved are diverse. Woody species are kept primarily for their supply service (97.5% and 13.8% for the food service for tree and shrub species respectively). Following supply services, regulatory and support services are the most frequently cited. (Table II).

Table II: Reasons for choosing woody plants to save in the field

Service	Type	Frequency of citation (%)	
		Trees	Shrubs
Procurement	Food	97.5	13.8
	Firewood	15	41.3

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Regulation	Rain attraction	5	0
	Ombrage	5	0
Support	Soil protection	38.8	3.8

The species that are saved in the field by the farmers are diverse (Table III). However, there is a preference for certain tree species such as *Lannea microcarpa*, *Vitellaria paradoxa* (92.5% each), *Azadirachta indica* (78.8%) and *Parkia biglobosa* (48.8%). As regards shrubs, *Piliostigma spp* (42.5%) and *Guiera senegalensis* (35%) are preferred by producers.

Table III: Woody species spared in the field

N°	**Species**	**Frequency of citation (%)**
Treespecies		
1	*Lannea microcarpa* Engl. &K.Krause	92.5
2	*Vitellaria paradoxa* C.F.Gaertn.	92.5
3	*Azadirachta indica* A.Juss.	78.8
4	*Parkia biglobosa* (Jacq.) G.Don	48.8
5	*Sclerocarya birrea* (A.Rich.) Hochst.	20
6	*Faidherbia albida* (Delile) A.Chev.	13.8
7	*Bombax costatum* Pellegr. &Vuillet	12.5
8	*Anogeissus leiocarpa* (DC.) Guill. &Perr.	11.3
9	*Ficus spp*	11.3
10	*Diospyros mespiliformis* Hochst. ex A.DC.	7.5
11	*Tamarindus indica* L.	6.3
12	*Mangifera indica* L.	5
13	*Acacia nilotica* (L.) Delile	2.5
14	*Adansonia digitata* L.	2.5
15	*Eucalyptus camaldulensis* Dehnh.	2.5
16	*Pterocarpus erinaceus* Poir.	2.5
17	*Afzelia africana* Pers.	1.3
18	*Balanites aegyptiaca* (L.) Delile	1.3
Shrubspecies		
19	*Piliostigma spp*	42.5
20	*Guiera senegalensis* J.F.Gmel.	35
21	*Ximenia americana* L.	22.5
22	*Ziziphus mauritiana* Lam.	22.5

Modes of management of woody plants in the field

For shrub species, cutting at the basis of the trunk is the common management practice. It is practiced by all farmers at the beginning of the rainy season during field preparation and at the first weeding. At the second weeding, 95% of the respondents were cut the shrubs while 5% saved them. At ridging, the majority of producers (91.3%) keep the shrubs. For tree species, pruning concerns particular species such as *Lannea microcarpa* and *Azadirachta indica*. The most pruned tree species is *A. indica* with 41.3% compared to 18.8% for *L. microcarpa*. The foliar biomass and twigs resulting from these practices are used for mulching in

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the incrusted areas of the field among all growers (Figure 2). Some growers practice both mulching and burning (3.75%). The small wood from the receptacle is primarily used as domestic fuel. Producers estimate that the biomass of *G. senegalensis* and *P. reticulatum* when used in mulching increases crop yield by 88.8% and 81.3% respectively. They also believe that the biomasses do not have the same speed of decomposition. In fact, 85% of the *G senegalensis* population decomposes faster and 80% believe that *Piliostigma spp* decomposes slowly (Figure 3).

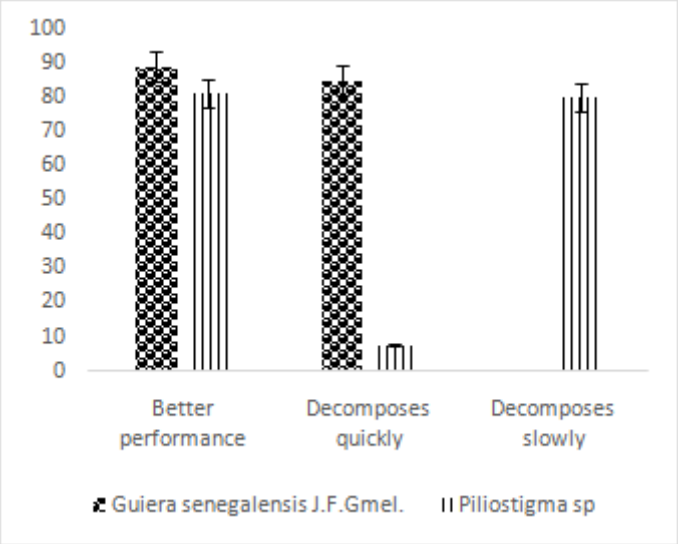
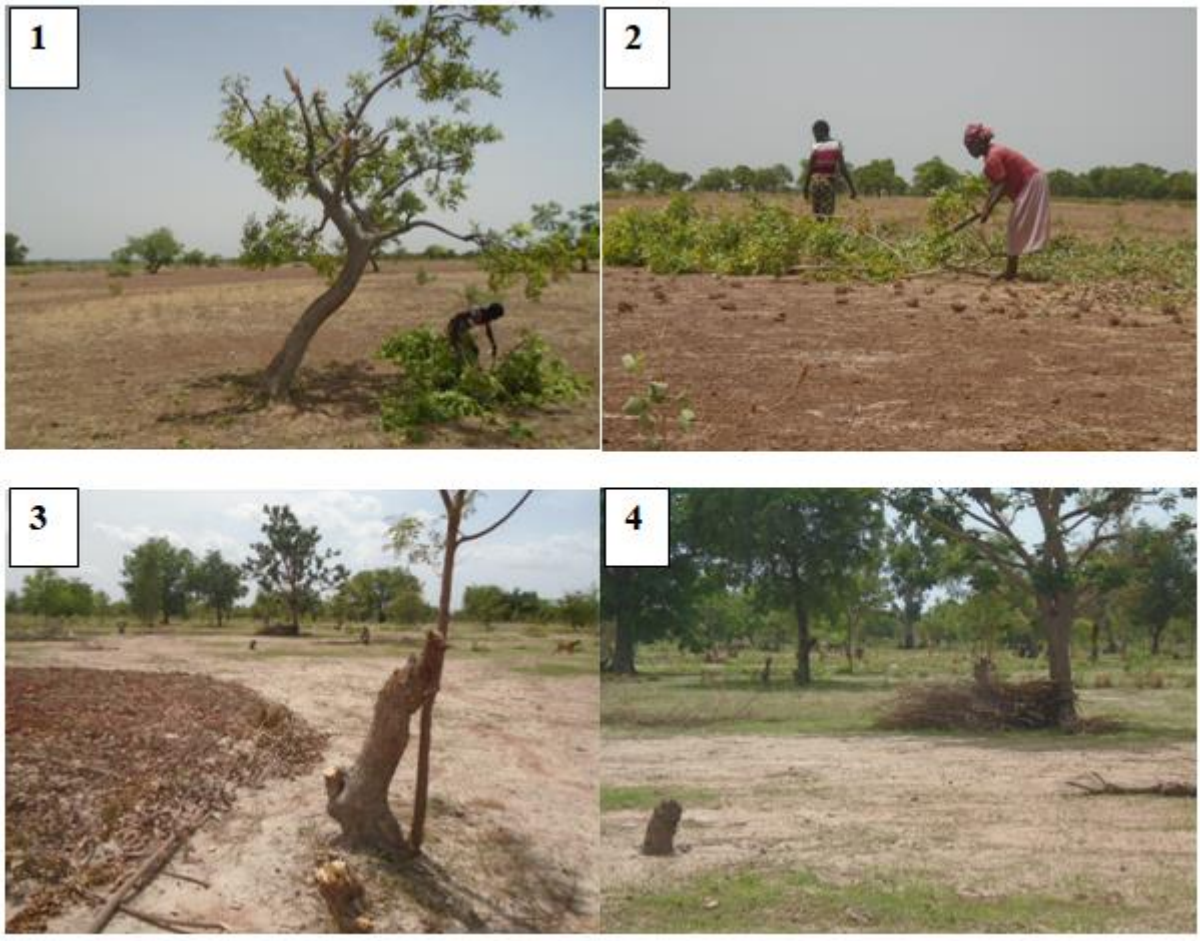


Figure 3: Producers' perceptions of the ability of *P. reticulatum* and *G. senegalensis* to decompose and improve yields of associated crops



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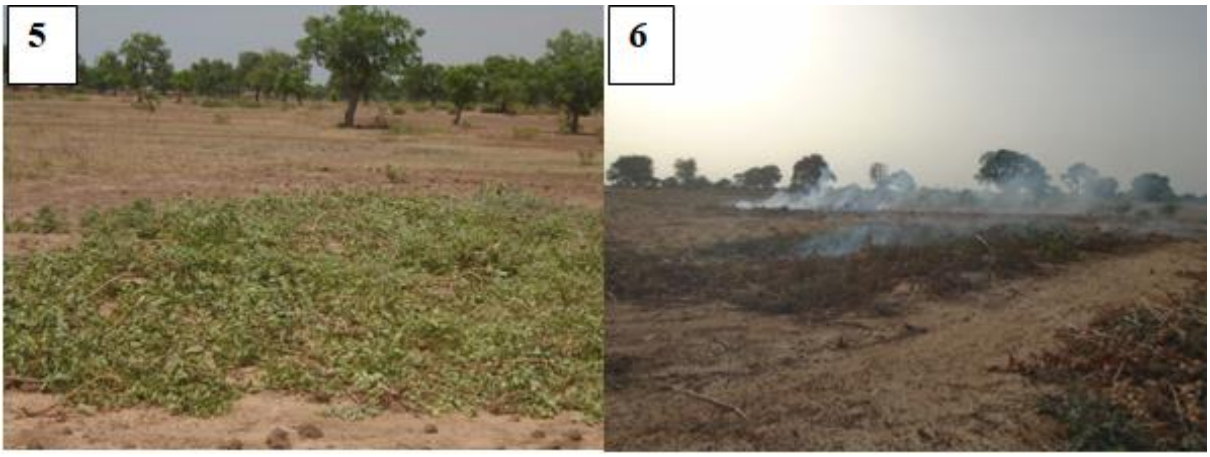

Figure 2: Uses of woody foliar biomass in the field for the fertilization of incrusted parts

1. Peeled *Lannea microcarpa*; **2**. Foliar biomass of *Lannea microcarpa* in mulch
3. *Azadirachta indica* cut and foliar biomass in mulch, **4.** Wood pile of *Azadirachta indica*
5. Foliar biomass of shrub species in mulch; **6**. Foliar biomass of shrubby species in burnt mulch

Species-use relationships

The search for possible links between the shrub species in the parks and their uses made it possible to distinguish three groups (Figure 4). The first (G1) consists of *C. micranthum*, which is used by producers exclusively for its artisanal role. Group 2 (G2) consists of *G. senegalensis* and *P. reticulatum* which are characterized by their multiple uses (animal feed, health care and domestic fuel). The third group (G3) consists of *Z. mauritiana* and *X. Americana* which are used mainly in human food.

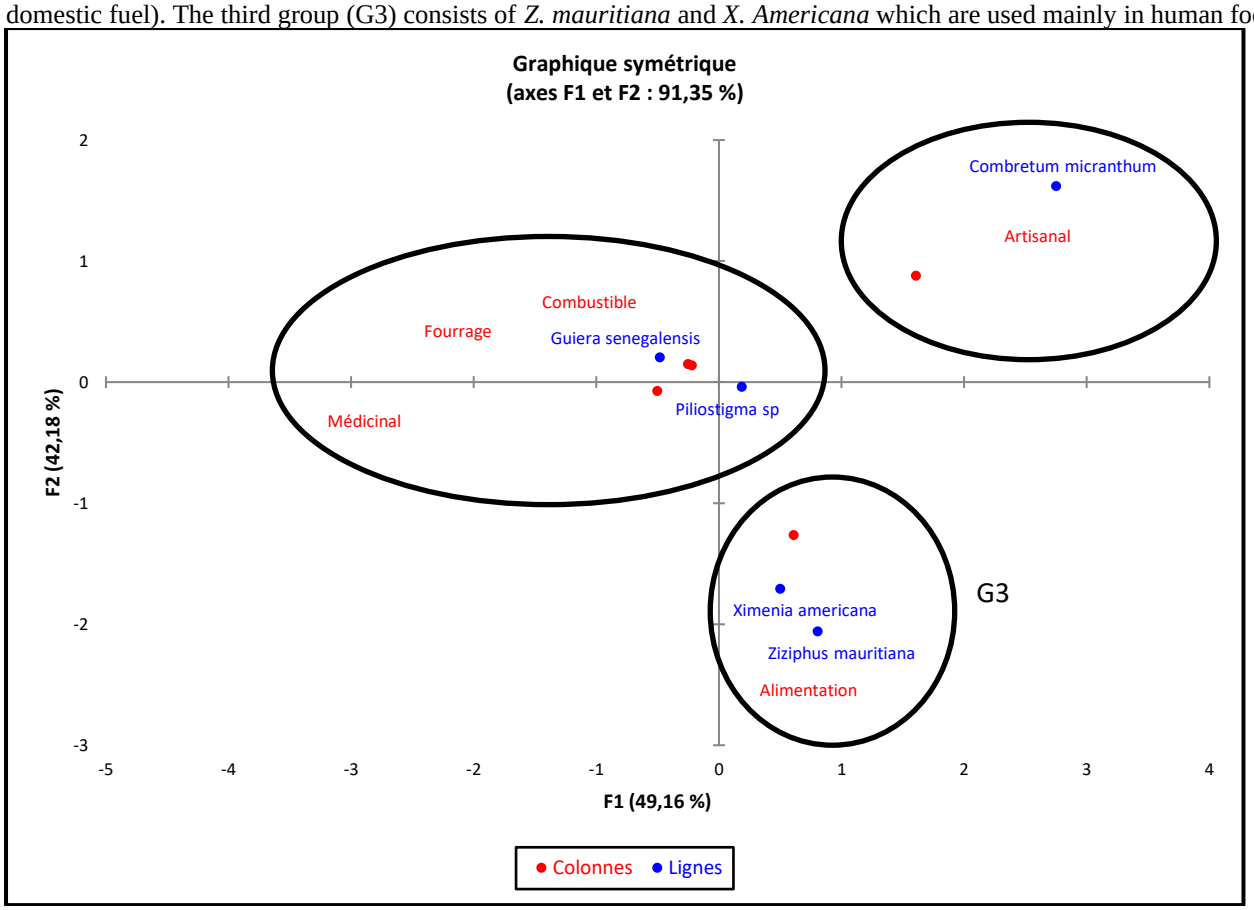

Figure 4: Shrub-species-uses linkages

Uses of shrubs in the field

It appears that shrub species play an important role in the life of producers. Almost all producers (99%) use wood from shrub species as a domestic fuel. Also, 94% of the respondents mentioned that shrubs in the field are used as cattle feed.

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Furthermore, shrubs in the field are used for human food, health care and handicrafts by 93%, 89% and 91% of the population respectively (Figure 5).

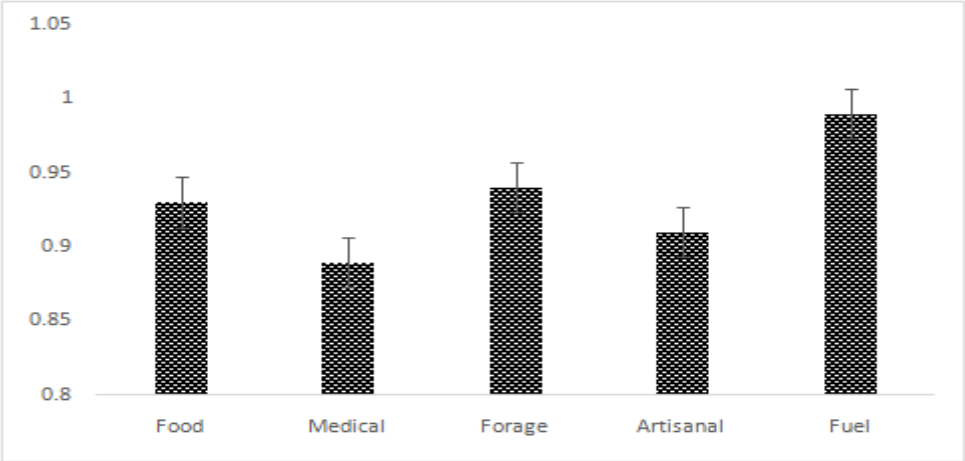

Figure 5: Citation rates for different uses of shrubs in the field

Modes of use of the different shrub species found in parks

A total of five shrub species in the agroforestry parks were mentioned by producers for their uses (Table IV). These were *Ximenia americana*, *Zizuphus mauritiana*, *Piliostigma sp* and *G. senegalensis*. The fruits of *X. americana* are edible (71.43% FL) and the roots can be used as a decoction for treatment of stomach aches (28.57% FL). However, very few growers use this species, as evidenced by the low use values (0.06 and 0.11 for the dietary and medicinal role respectively). The dietary and medicinal roles of *Z. mauritiana* are known to the population and the fruits of the species are consumed while the roots are used in decoction to treat stomach and toothache.

The species of the genus *Piliostigma* (*P. reticulatum* and *P. thonningii*) are multipurpose. The juice from their leaves is used to acidify tô (national dish). The fruits crushed or not can be used with or without other ingredients as animal feed (7.67% FL). The genus *Piliostigma* is also used to treat several ailments such as chicken pox, injuries, fatigue. While the barks are used as ropes and in handicrafts, they are also used to make objects such as chairs, beds etc. *C. micranthum* is quoted exclusively for its role in the craft industry (making chairs, beds and baskets).

Species	Organs used	Use	Mode of use / diseases treated / objects manufactured	FL (%)	Value in Use
Ximenia americana	Fruits	Food	Direct consumption	71.43	0.06
	Roots	Medicinal	Stomach aches: decoction to drink	28.57	0.11
Ziziphus mauritiana	Fruits	Food	Direct consumption	87.5	0.08
	Roots	Medicinal	Stomach aches: decoction to drink	12.5	0.12
	Roots	Medicinal	Toothache: gargle the mouth with the decoction		0.01
Piliostigma sp	Sheets	Food	extraction of the juice to acidify the to	17.56	0.28
	Fruits	Forage	direct or crushed in combination with other foods	7.67	0.12
	Sheets	Medicinal	Chicken pox: decoction to be washed	2.29	0.01
	Sheets	Medicinal	Fatigue: combine with the leaves of Piliostigma sp (decoction to be drunk and washed)		0.01
	Bark	Medicinal	Wounds: dry, grind and apply		0.01
	Bark	Crafts	Strings	11.45	0.18
	Branches	Fuel	Combustion	61.07	1
Guiera senegalensis	Sheets	Forage	Direct consumption	8.04	0.11
	Sheets	Medicinal	Malaria and the common cold: decoction to be washed and drunk	19.64	0.15
	Sheets	Medicinal	Certain skin diseases: decoction to be washed		0.01
	Sheets	Medicinal	Snake bite: chew the leaves and use with to suck out the venom		0.01
	Branches	Crafts	Chairs	0.89	0.07
	Branches	Fuel	Combustion	71.43	1
Combretummicranthum	Branches	Crafts t	Chairs, beds and baskets	100	0.29

Table IV: Uses of shrubs in the field

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IV. DISCUSSION

The producers of the Saria area have a good knowledge of the importance of woody plants in their fields. They all (100%) spare trees and shrubs in their fields. The reasons why the woody trees are spared in the field are diverse, however it is mostly for the supply service. For trees, it is the satisfaction of food needs (97.5%), and for shrubs it is the production of firewood (41.3%). Woody trees constitute an almost indispensable food supplement for the populations of rural areas (Gning *et al*., 2013). Authors have pointed out that human food is the main role of woody trees (Gning *et al*., 2013; Sarr *et al*., 2013, Akouehou *et al*., 2013). Thus, *Vitellaria paradoxa* (92% citation frequency) and *Parkia biglobosa* (48.8%) are the species that benefit most from the attention of producers. These two species are frequent in fields in the sudanian zone of Burkina Faso (Ouédraogo *et al*., 2009). *P. biglobosa* is prized by the populations for its seeds, which are used to make "Soumbala", a flavouring that is widely used in cooking among the populations of the zone. As for *V. paradoxa*, it is loved by producers especially for the butter made from its almonds. The case of *Azadirachta indica* (78.8% quote) species is prized by producers, not for its role in human food but for its wood and its role in maintaining and improving soil fertility. The existence of these species in the park is mainly due to human activities. Thus, in the area of our study most of the neem parks are constructed parks, the rest is generally the work of birds that spread the seeds around residential areas (Yélemou, 1993). Bationo *et al* (2012) reported that "Neem is managed by producers to provide fuel wood, construction and handicraft wood, biomass for mulching (soil fertility improvement), insecticide and oil for soap making".

The common practice of managing shrubs in the fields is cutting practiced by 100% of the population. It is carried out mainly during the field preparation phase and at the first weeding.

As for the trees, pruning is practiced. The foliar biomass resulting from these practices is mainly used to mulch the encrusted areas of the field. For 85% of the respondents, the foliar biomass of *P. reticulatum* decomposes slowly compared to that of *G. senegalensis*. The slow decomposition of *P. reticulatum* was reported by Yélemou (2010). Producers believe that mulching allows good crop growth and improved yields. For trees in the field, the most pruned species is *Azadirachta indica* and the products sought during this practice are firewood and foliar biomass which are also used in mulching. The use of woody foliar biomass in mulching is a common practice in the central plateau area and has been reported by many authors (Yélemou *et al*., 2007; Bationo *et al*., 2012). This practice contributes to water and soil conservation.

Shrubs in the field are used daily to meet the needs of producers. They are used for human food (*Ximenia americana*, *Ziziphus mauritiana*, *Piliostigma sp*), in animal feed (*Piliostigma sp*, *G. senegalensis*), in the traditional pharmacopoeia (*X. americana*, *Z. mauritiana*, *Piliostigma spp.*, and *G. senegalensis*), in handicrafts (*Piliostigma sp.*, *G. senegalensis.*, and *C. micranthum*), and as fuel (*Piliostigma spp*., *G. senegalensis*). Thus, certain shrub species in the field such as *Piliostigma spp*., and *G. senegalensis* are multi-purpose (food, pharmacopoeia, handicraft, and fuel) while others such as *C. micranthum* (handicraft) and *Ximenia americana*, and *Ziziphus mauritiana* (food) are almost single-purpose.

Many ailments such as stomach aches, toothache, chicken pox, wounds, snake bites, malaria, and flu are treated by the organs of the shrubs in the field. Several sources agree that the traditional use of medicinal plants forms the basis of curative and even preventive medicine for low income populations (Dounias *et al.*, 2000; Ouattara *et al*., 2016; Lawin *et al*., 2016; Yaovi, 2018).

V. CONCLUSION

The results of this study allowed us to appreciate the reasons which guide the choice of the indigenous farmers to spare trees in their fields in the Saria zone of Burkina Faso. The main reasons as found by this study are mainly the supply of food and firewood for the trees and the maintenance of soil fertility for the shrubs.

Thus, in the parks, the tree must show its importance for the producers in order to guarantee its conservation. During the preparation of the fields, some tree species such as *L. microcarpa* and *A. indica* are pruned and shrubs such as *P. reticulatum* and *G. senegalensis* are collected. The foliar biomass obtained from these practices are used to fertilize the incrusted parts of the fields and the wood is used as domestic fuel. The Producers have generally multiple uses for the woody material on their farms.

The socioeconomic importance of woody plants in the parks includes food, medicine, fuel wood and handicrafts. This raises hope for the conservation of the plant resource in the area. Indeed, community areas for the supply of forest resources are becoming increasingly scarce. Thus, each producer tends to keep in their fields the trees and shrubs needed to meet their needs. Agroforestry thus enables farmers who practice it to harvest at home (in their agrosystems) many of the products they used to harvest in the forest. In order for producers to continue to benefit from the advantages of their parks, investigations should continue with the aim of equipping them with the right technical skills to enable them to take full advantage of their parks while preserving the natural resources found there.

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