International Scholars Journals

African Journal of Wood Science and Forestry ISSN 2375-0979 Vol. 13 (5), pp. 001-011, May, 2025. Available online at www.internationalscholarsjournals.org © International Scholars Journals

Article

Ecological Strategies for Woody Plant Management in North Cameroon's Indigenous Land Use Systems

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Accepted 16 January, 2025

The dry savannahs of Africa are fragile environments at the ante-room of desertification. The stability of this ecosystem depends on ephemeral herbs and grasses and several tress and shrubs which play a variety of roles in traditional land use systems. Despite a wealth of indigenous knowledge on their uses demographic pressure and commodification of rural products are imposing biological stress on these vital resources. The study investigates the role of trees and shrubs in the traditional land use systems of this ecosystem, the ethnobotanical uses and the indigenous knowledge base on their management for livelihoods. It uses a combination of primary and secondary data sources to establish the various indigenous uses of woody species for livelihood systems, soil and water management and indigenous agro-silvopastoral practices and concludes that there is a wealth of indigenous knowledge on the uses and functions of these resources which can be tapped and developed with experimentation. This should serve as a starting point for innovating the traditional land use systems and ensuring the sustainability of woody resources, ecosystem stability and fighting desertification. Finally, it identifies the scope for the sustainable management of vegetal resources in dry lands.

Key words: Trees, shrubs, dry savannahs, uses and functions, degradation, management, land use systems, sustainability.

INTRODUCTION

The dry savannahs of Africa are characterized by recurrent droughts and famines, demographic pressure, overgrazing, over-cultivation and associated biological stress on the environment. The basic needs in forage and fuel wood are provided by wooded savannah and thorn bushes which unfortunately are unsustainably exploited, and are ravaged by uncontrolled fires and poor management of tree and shrub resources. Yet, the roles trees and shrubs play in traditional farming systems in general are very wide and have been described by many authors (Everist, 1972; Walker, 1980; Harmand, 1994; Beets, 1989; Brandstrom et al., 1979; Boudet and Toutain, 1998). Their roles are extremely varied and depend to a large extent on the land use practices of the people involved, population growth, traditional beliefs and values, ecology of the locality, the types of local livelihoods or indigenous uses, the level of household income and change in socio cultural habits. In the dry savannahs of North Cameroon the role of trees and shrubs has been investigated from a biogeographical and geographical perspective (Seignobos, 1982; Mahamat, 1983) and by agronomists interested in the development of agroforestry and silvopastoral management (Harmand, 1989; Peltier et al., 1998; Harmand, 1994).

This paper investigates the role of trees and shrubs in traditional farming systems, the ethnobotanical uses, the indigenous knowledge base in agro-silvopastoral management and identifies the scope for innovation.

THE STUDY AREA

North Cameroon is situated between latitudes 7°30'N and 13°N and longitudes 9° and 15°E. This region is semi arid in the north and sub humid in the south. Studies of the climate and hydrology of the region include those of Suchel (1982) and Olivry (1986).

Recent soil studies include the work of Brabant and Gavaud (1985) and vegetation studies by Letouzey (1985). Seghieri (1990), Donfack (1993) and le Bourgeois (1993) have investigated the functioning of various ecosystems of the area.

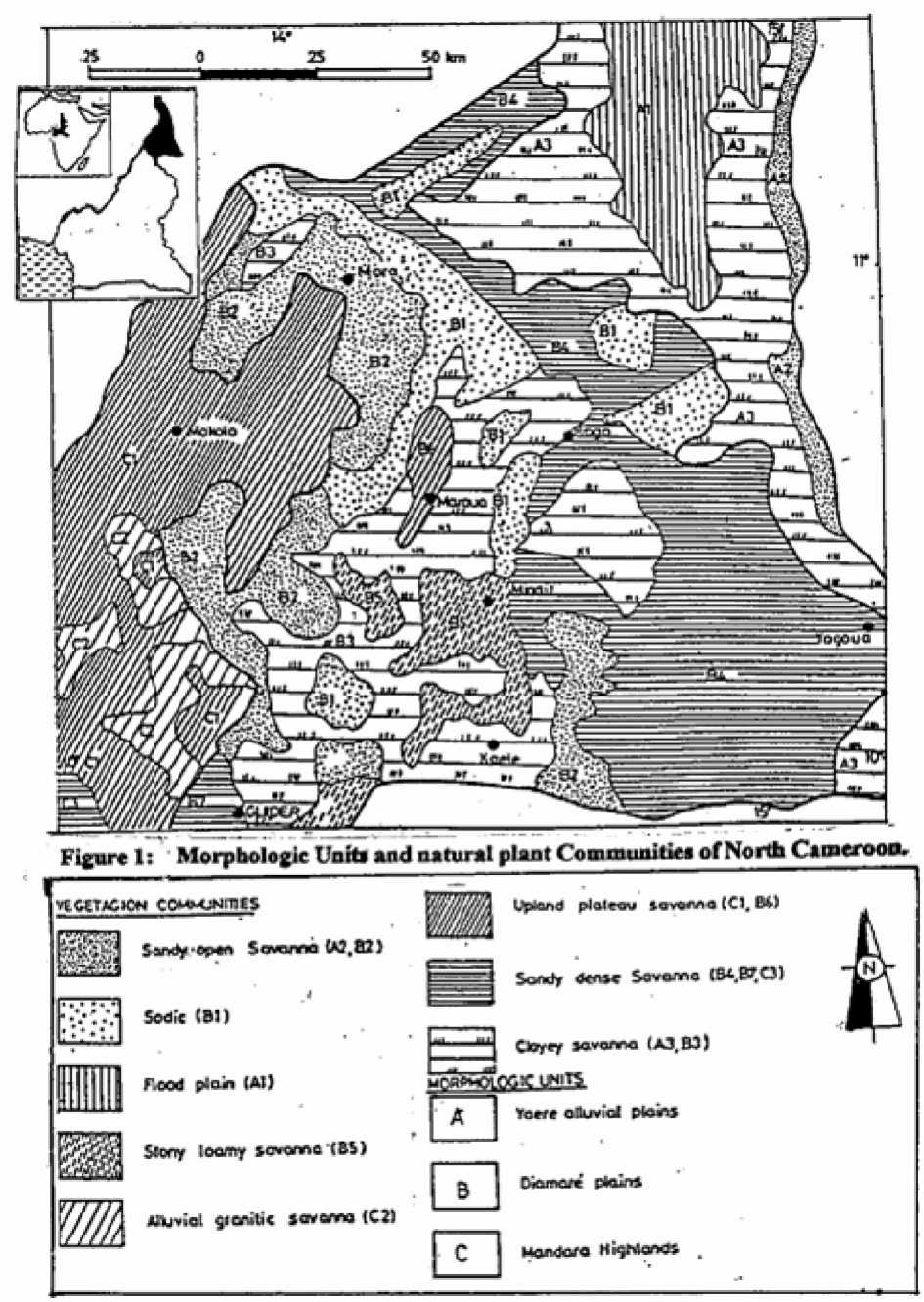

Figure 1. Morphologic units and natural plant communities of north Cameroon. Source: Donfack et al. 1996; Brabant and Gavaud, 1985; Brabant, 1976 and Fulton et al. 1974.

Analysis by Donfack, Boukar and M'Biandoun (1996) confirm a spatio- temporal variability in the distribution of rainfall and high rainfall erosivity. This is a major factor determining crop yields and biomass productivity. Pedologic units broadly conform to three geomophoplogic units or land systems: mountains and uplands; pediments and outwash plains or colluvial plains, and recent and old alluviums. Floristic communities are closely related to these land facets and the spatio-temporal distribution of rainfall. The northern parts of the region are Sahelo-Sudanian with 800 mm of rainfall per year while the southern parts are Sudano-Guinean with 1000 to 1300 mm of rainfall per year.

Natural plant communities in the area were studied with respect to the rainfall distribution in time, soil characteristics, the vegetation period and anthropogenic impacts. These natural plant communities are presented in Figure 1. For each plant community the rainfall concentration during

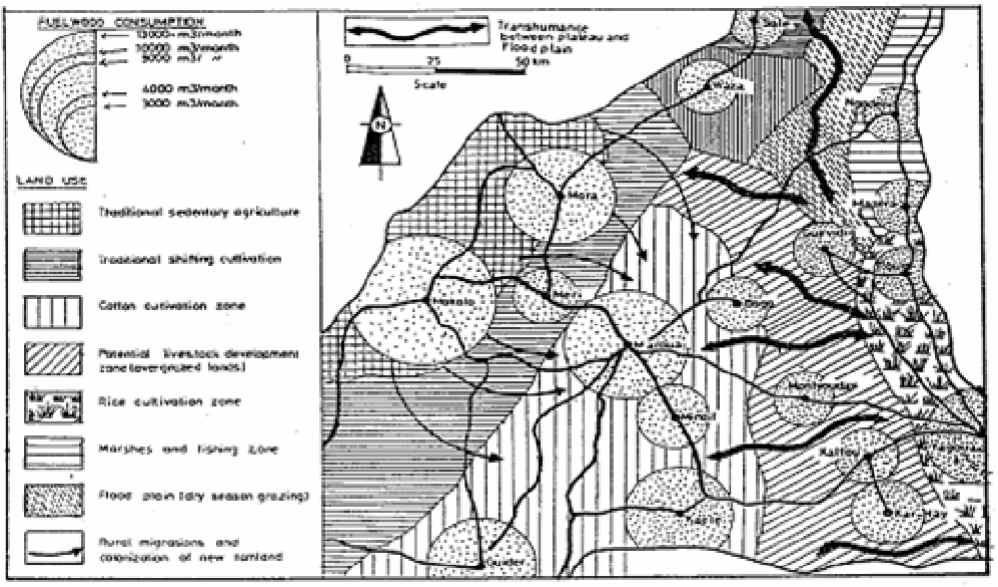

Figure 2. Landuse sytems and vegetal resource exploitation in North Cameroon.

the wet season is as follows (Fulton et al., 1974);

Sandy open savannah: 85% of total rainfall occurs in July and August.
Sodic zones: 75% of rainfall occurs in July, August and September.
Flood plain: 90% of rainfall occurs in the period from June to September.
Stony loamy savannah: 85% of rainfall occurs in June to September.
Alluvial granitic savannah: 85% of annual rainfall occurs in June to September.
Upland plateau: 85% rain occurs in June to September.
Sandy dense savannah: 80% of rain occurs in June to September.
Clayey savannah: 80% of rain occurs in July and August.

The vegetative period is very short. Consequently, the vegetation is restricted to ephemerals. These are herbs, forbs and grasses. Perennial trees must be drought resistant.

The agricultural and pastoral land use systems of the area have been studied by De Steenhuijsen (1995), Dugue et al. (1994), Njoya et al. (91996). The main farming systems are as follows.

1) Extensive grazing systems with transhumance.
2) Crop-livestock production systems involving bush fallowing and extensive grazing
3) Shifting cultivation systems in piedmont areas practiced by migrant farmers from the Mandara and Mindif Mountains.

Droughts and crop failures are characteristic of the area. Overgrazing, deforestation, bush fires, soil degradation due to poor farming and grazing techniques, and associated soil erosion are causing a desertification of the region. This has necessitated the development of an indigenous knowledge base on the management of trees and shrubs which can be refined with careful scientific investigation.

STUDY METHODS AND DATA SOURCES

The first phase of the study involved observations and analysis of farming systems in three villages in order to identify the role of trees and shrubs in various agrosystems and the indigenous knowledge base. These were complemented by ethnobotanical surveys of farms having useful woody species, their uses and plant parts har-vested by farmers. The second phase involved a study of woodlots in order to identify the most cherished species, management practices, and yields per rainfall regime and soil type. The above data were complemented by secondary data. The third ohase was concerned mainly with mapping. Land use systems were mapped and updated by field observations, use of the Global Positioning System, the 1996 National Geographic Institute (Yaounde) aerial photographs, the work of Iyebe and Seignobos (1996) and Ndenecho and Lambi (1998). Monthly fuel wood consumption requirements for the main semi-urban and urban settlements were estimated and mapped based on an average monthly consumption of 2.5 m^3 per household and the total number of households per settlement.

RESULTS AND DISCUSSIONS

Figure 2 presents the land use systems in the study area and the monthly fuel wood consumption estimated for the main settlements. The agricultural and pastoral land use systems were investigated in the mountain and piedmont

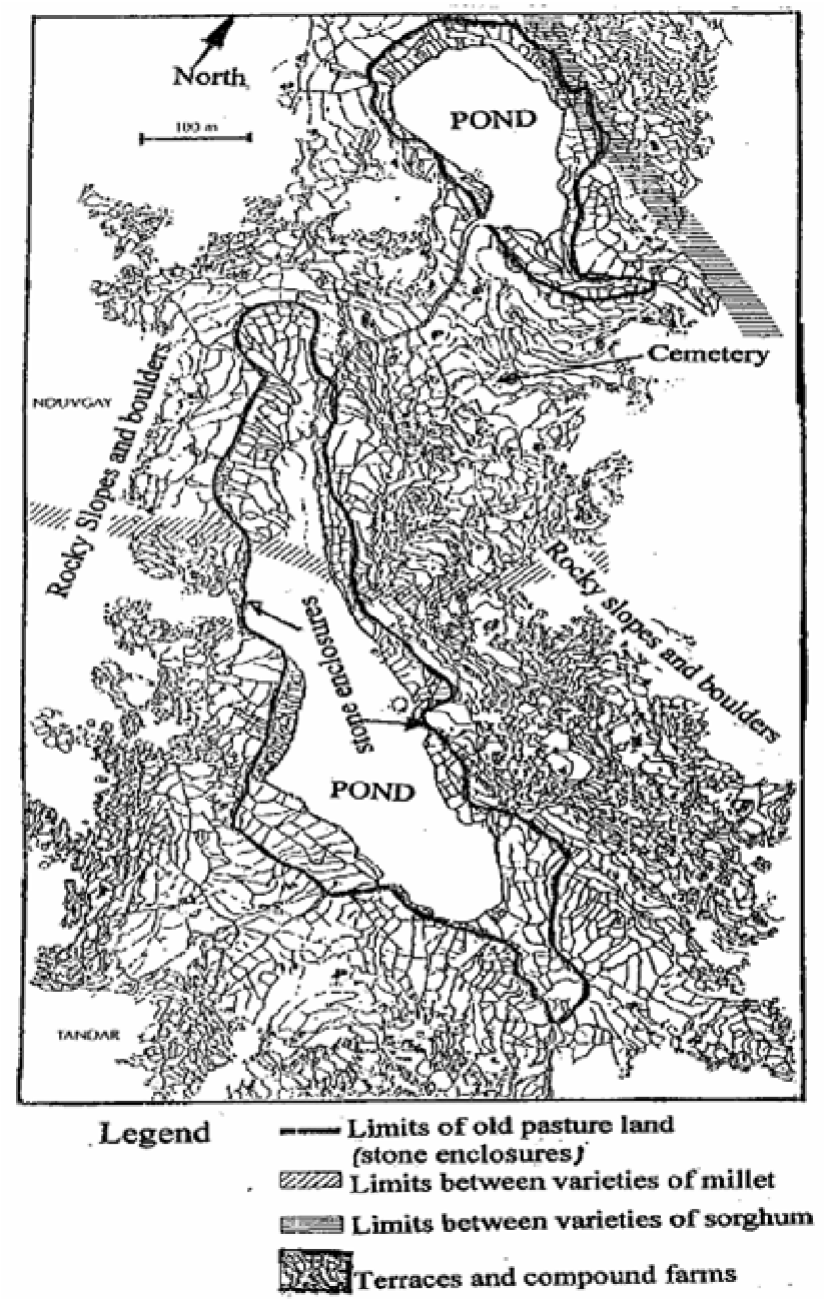

Figure 3. Mountain Land use: Terraced slopes and land use in Way – river.

zones.

Mountain agrosystem

In the mountain zone the Mafa tribe cultivates short cycle crops such as groundnuts, millet, sorghum and cowpeas. The system has evolved over several centuries and is characterized by terraced slopes, home-gardens, outlying fields and the integration of trees and shrubs. In order to conserve soil and water by reducing runoff volume and velocity terraced slopes are stabilized with trees and shrubs. The landscape of Way- River village is a patch-work of boulders, rocky slopes and granitic inselbergs, homesteads and terraced slopes with woody species (Figure 3). The main uses and functions include:

1) *Phoenix reclinata* for poles and leaves for weaving of mats.
2) *Pachystela brivipes* for charcoal and fuel wood.

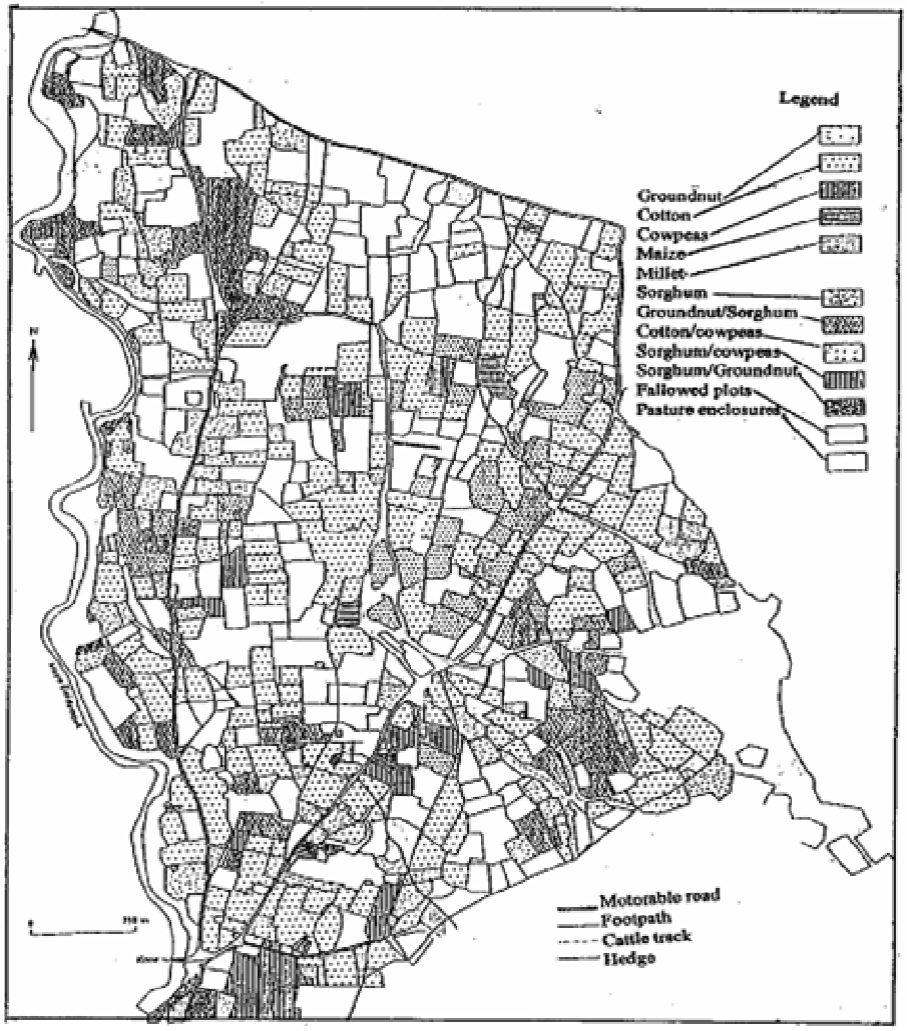

Figure 4. Land use in piedmont zone: Dakotcher village.

3) *Croton zambezicus* pruned to encourage the initiation of floral buds (harvested and sold for local uses).
4) In the talwegs there is a selection of woody species used for soil and water conservation such as *Acacia ataxacantha*, *Syzegium guinensis*, *Garcinia afzeli* and *Albizia zygia*. These are conserved in water catchments.
5) *Ficus spp.* such as *Ficus dicranostyta* and *Ficus albutifolia* provide forage and shade, and the exudates have traditional uses.
6) Fruit trees include Vitex doniana and Diospyros mespiliformis.
7) Trees providing poles include *Ziziphus mauritiana*, *Terminalia brownii*, A*nogeissus leiocarpus* and *Halarrhena floribunda*. These are mainly found on terrace embankments.
8) Trees are rarely found on terrace shelves but for *Faidherbia albida* whose growth is well controlled.
9) Park trees are regularly pruned, for example, *Faidherbia albida* every 3 years, *Anogeisus leiocapus* every 4 years and *Ficus dicranostyla* every 2 years. A farmer has up-to-date knowledge of trees and shrubs in his field. Generally, pastures are enclosed in terraces during the dry season.

Piedmont agrosystem

The Diamare plains or piedmont zones are colonized by migrant farmers from the Mandara Mountain. Dakotcher village has a population of about 867 young farmers (Iyebi and Seignobos, 1992) and an average farm size of 0.4 ha (Figure 4). It occupies a crest whose valley slopes are protected by *Anogeissus leiocarpus* but the valleys are dry. The tree species are similar to those in the uplands but for the absence of knowledge on the use of trees as an anti-erosion measure.

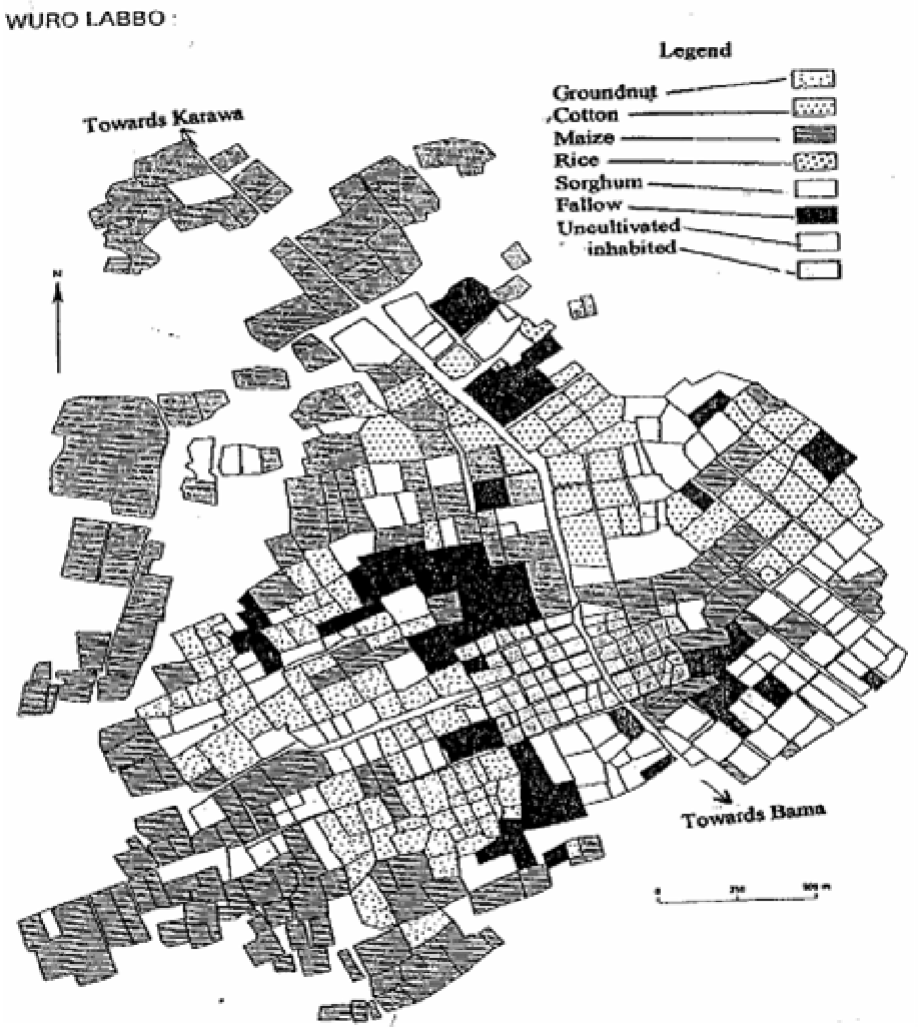

Figure 5. Landuse in piedmont zone: Woro Labbo village.

In Koza plain, the common species include *Anogeissus leiocarpus, Faidherbia albida, Khaya senegalensis, Tamarindus indica, Acacia sieberiana* and *Stereospermun kunthianum.*

These migrant farmers from the Mandara cultivate both upland crops and other cash crops grown in the lowlands as shown in Figure 4. Figure 5 on the other hand shows an extensive land use system in Wuro Labbo village established by Mafa migrants. Farm sizes range from 0.25 to 0.5 ha. Agricultural production is more market-oriented.

The rural space in general is characterized by natural pastures composed of park savannahs, a mosaic of farmlands, fallowed fields, home gardens and outlying fields. In the lowlands woody species are deliberately protected and managed for multiple uses (Table 2).

Table 2 presents the useful plants retained in the natural pastures and farmlands, and the plant parts or or-gans harvested by local people in the Diamare and Chad plains (Piedmont zone). These plants and other useful trees and shrubs are common in the park savannahs of the area. *Acacia albida* is browsed by cattle and propagated by dung. It is deliberately planted in fallows for its nitrogen fixation ability. *Borassus aethipum* provides food and spices, the *Ficus* are grown as a shade tree and as a browse plant. It is indicative of a landscape characterized by sedentary agriculture and little cattle husbandry. In the Mandara Mountains, *Khaya senegalensis* is grown as a shade tree, while *Acacia albida* is grown for fuel and construction wood. *Grewia spp, Ziziphus mauritiana* and *Terminalia brownii* are planted to stabilize terraces on steep slopes. *Vitex doniana* and *Celtis integrifolia* provide edible fruits. *Diaspiros mespiliformies* and *Garcinia alzelic* fruits provide vegetable oils. *Strophantus spp* is planted uniquely for construction poles.

Among the Molfoudaye people, *Ficus spp, Anogeissus leiocarpus* and *Guierra senegalensis* are planted for agro-silvopastoral purposes. In Doukoula area, *Celtis integrifolia, Ficus grghalocarpa, Tamarindus indica* and *Parkia biglobossa* are planted for agro-silvopastoral purposes unlike the Moussey area where the parks are

Table 1. Degree of vegetation degradation in North Cameroon.

Community site (land facet)	Map code (Figure 1)	Degree of degradation of the potential vegetation
Sodic	B 1	75 to 100 % of the potential plant community has been degraded and replaced by annuals
Sandy, open savannah	A2,B2	50 to 75% of the potential plant community has been degraded and replaced by annuals or other species.
Alluvial / granitic savannah	C 2	
Clayey savannah	A3,B3	25 to 50% of the potential plant community has been degraded and replaced by annuals and other species.
Sandy dense savannah	B4,B7,C3	
Flood plain	A 1	The present plant community is almost the same as the potential plant community. Degradation has been minimal. This is because of remoteness from man

Source: Fulton et al. (1974).

Table 2. Some useful trees and shrubs and plant organs exploited in the Piedmont Zone.

Species	Useful plant parts
Acansonia digitata	FP, FG, FL, GO, A
Anacardium occidentale	FP, FG
Annona senegalensis	FP, FL, F
Balanites aegyptiaca	FP, FG, GO
Borassus aethiopum	FG, GO, A, FP, FL
Bosca senegalansis	FP, FG, A
Butyrospermum parkii	FG
Cadaba fannosa	FP
Celtis integrifolia	FP, FG
Hyphaxene thebaica	FP, FG
Mangifera indica	FP, FG
Moringo oleifera	FP, FL, FG, A
Parkia blglobosa	FP, FG
Phoenix dactylifera	FP, FG
Sterculia setigera	FP, GO
Strychnos spinosa	FG, FG
S. Innocua	FP, FG
Tamarindus indica	FP, FL, FG
Zizipnus mauritiana	FP, FG
Cananrium schweinfurthii	FG

FP = leaves and buds, FL = flowers, FG = fruits and grain, A = roots and bark, F = fruits (pulp), G = seeds, GO = gum

Table 3. Some tree species used for fuel wood and construction timber in dry savannahs of North Cameroon.

Species	Fuel wood	Charcoal	Construction wood
A. nilotica	++	++	++
A. senegalensis	++	++	++
A. seyal	++	++	++
A. lebbeck	+	+	+
A. indica	++	++	++
D. sisoo	++	++	++
K. senegalensis	++	++	++
P. julifora	++	+	+
T. indica	++	++	++
Z. mauritiana	++	++	++

Key: ++ Excellent, + Averagely good.

dominated by *Prosopis Africana, Parkia biglobossa* and *Ficus gnaphalocarpus*. The paleo-sand dunes in the Yagoua – Limani area are agropastoral parklands. The dunes and inter- dune alkaline soils are colonized by *Acacia seyal* and *Acacia senegalensis*. These areas are used for dry season grazing of goats and cattle. Some of these trees are planted in live fences, shelterbelts, at the edge of terrace embankments, enclosures around homesteads or home gardens and night paddocks.

Table 3 presents the woody species exploited for wood and timber for rural and urban needs (Figure 2) . With a rapid demographic growth rate of 3.6% per year (Dugue et al., 1996) there will continue to be biological stresses on the useful trees and shrubs. Timber, fuel wood and forage needs of the people have to be supported by the shrub and wooded savannahs which unfortunately are being degraded by uncontrolled bush fires and over-grazing. The silvopastoral management of the savannah is a concern to development workers. Peltier and Eyong (1989) demonstrated that protection against bush fire is necessary for the regeneration of forage in degraded areas and that protection against invasion by cattle, goats and sheep facilitates recolonisation and regeneration of natural pastures. There is also the need to protect the invasion of farmlands by cattle (Ntoupka, 1994; Harmand et al, 1992). The following plant species are planted for live hedges:

1) *Jatropa curcas*: Direct seeding at the onset of the rainy season.
2) *Jatropa curcas and Commiphora africana:* Planted by cuttings at the end of the dry season (March).
3) *Ipomea fistulosa*: Planted at the middle of the rainy season (July, August).
4) *Sisal:* planted at the beginning of the rainy season (June, July).

Farmers prefer these species because of their rapid growth

despite some management problems:

1) *I. fistulosa* and sisal often invade nearby farms.
2) *J. curcas* and *C. africana* produce very porous hedges that cannot prevent trespassing by animals.

In order to overcome these problems some farmers have adopted thorny woody species for live hedges. These include *A. nilotica* and *Bauhinia rufeseens*. These are pruned to a height of 0.8 to 12 m.

Acacia hockii, dichrostachis glomerata and *Piliostigma reticulata* are fire tolerant and can withstand intense browsing. These trees therefore proliferate where the incidence of bush fires is low and constitute important fuel wood resources. Trees with a girth of about 12 cm are capable of reconstituting their biomass in 3 to 4 years. The frequency of wood harvesting can be controlled and reduced below 4 years in order to avoid its rapid invasion and recolonisation of natural pastures. On the contrary *Anogeissus leiocarpus* has a very slow rate of regeneration requiring that harvesting be delayed (over 6 years) in order to guarantee sustainability. It also needs to be protected against bush fires in order to enhance natural regeneration by seeds.

There is a general decline in the production of wood in the area due to very short harvesting rounds of 3 to 4 year durations. In the short – term such intense exploitation depletes the savannah of its woody species. This further complicates the problem of managing the savannah for fuel-wood production, browse availability and pastures free from invasion by undesirable trees. It was observed that natural pastures with limited incidences of bush fires were rapidly recolonised by woody species and the grasses shaded out. Some management lessons can be drawn from these scenarios as development paths.

The management of dry savannahs by associating wood production with pasture improvement programmes.

The protection of natural vegetation communities against dry season bush fires and the promotion of wet season grazing and browsing should permit the regeneration of woody species, ephemeral herbs and grasses. Selective harvesting of wood can then take place after 5 - 6 years.

Tree felling at a height of 2 m from the ground surface can protect the wound of the stump from fire attack as well as coppicing from browsers and therefore ensuring regeneration. This method is practiced by farmers in felling species such as *Anogeissus leiocarpus, Balanites aegyptiaca, Tamarindus indica* and *Acacia spp*. on farmlands.

Frequently browsed species should be conserved and their integration in crop, crop-livestock and livestock production systems encouraged.

The above agro-silvopastoral management model seeks to develop a stratum of woody species for wood production and for dry season browsing above a grass/herb strata used as natural pastures (Boudet and Toutain 1980).

Table 4 presents the results of multipurpose tree trials carried out on various soils and rainfall regimes in the study area. The results have yielded a variety of multipurpose trees (fuel wood, construction wood). *Eucalyptus camaldulensis* was imported from Australia. Apart from wood production the leaves constitute good quality browses. *Azadirachta indica* (native of India) is used for extensive reforestation. It is regenerated by seeds and farmers use it as a shade plants, for fuel wood plantations and woodlots, the leaves are an insecticide and are also medicinal. Local *Acacia* species are nitrogen fixing and therefore are planted in fallows for soil enrichment, and the provision of fuel wood. *Acacia senegalensis* has a medicinal exudate used in the food and perfume industry. *Acacia polyacantha* produces an exudate with similar uses. *Acacia nilotica* is mainly used for hedgerows. *Ziziphus mauritiana* is a shade tree on most soils. In Mandara Mountains it is used to stabilize farm terraces (Fenyo, 1994). *Parkia biglobosa* provides edible fruits and is grown in woodlots on ferruginous soils, sandy soils and alluvial soils. *Borassus aethiopium* grows slowly. Useful parts include leaves, fruits and wood. Its propagation is encouraged on alluvial soils, sandy and ferruginous soils. Propagation is by direct seeding (Harmand et al., 1996).

Densely populated rural settlements in the area provide a good opportunity for the development of village wood lots and fuel plantations. Unfortunately, development efforts in this direction have not been fruitful. This is because farmers have their preferential choices of useful multi-purpose trees (Harmand, 1994; Damou, 1995). However, individual plantations are being realized with the introduction of the “tuangya” system and *Eucalyptus camaldulensis*.

Table 5 presents tree species used as live fences or hedges. The region is also characterized by a harsh climate and strong winds. On farmland and natural pastures most of the species have been degraded and are mostly refuged in live fences and hedges around homesteads. Most of them are propagated by seeds. Wind and water are therefore, important natural agents of propagation. Unfortunately, the browsing of young trees by cattle, sheep, goats and horses hinders growth. Seasonal fires in the area destroy most young seedlings. In live fences and hedges these are planted either by suckers or cuttings.

Conclusion

Trees and shrubs will for a long time continue to play a vital role in traditional farm families in the region, and despite the neglect in incorporating them into both crops and pastoral production systems for proper management. Some conclusions can be formulated thus:

Table 4. Exotic and indigenous trees planted in woodlands in the North Cameroon Savannahs.

Species	Origin	Soil type	Rainfall (mm/yr)	Wood yield (m^3/ha/yr)
Eucalyptus camadulensis	Exotic	Vertisols	800	1.5-2.5
		Planosols	800	1.0
		Sandy and Ferruginous	500	0.3
		Sandy and Ferruginous	1000	0.9
		Sandy and Ferruginous	1000	2.5-3.5
		Ferruginous soils	1000	3.5
Dalbergia sissoo	Exotic	Vertisols	800	3.5
		Planosols	800	0.55
		Lithosols and Vertisols	800	1.0-30.
Azadirachta indica	Exotic	Planosols	800	2.0
		Ferruginous soils	800	0.1
		Vertisols	800	1.0-2.0
Leucaena leucocephala	Exotic	Ferriginous soils	1000	0.1
Acacia seyal	Local	Vertisols	800	3.2
Acacia polyacantha	Local	Ferruginous soils	1000	3.0
Acacia senegalensis	Local	Vertisols	800	1.4
Acacia hockii	Local	Vertisols	800	1.5
Acacia nilotica	Local	Vertisols	800	1.6
Anogeissus leiocarpus	Local	Vertisols	800	1.0

Source: Peltier, 1988; Harmand, 1989; Harmand et al., 1992; Brugiere et al., 1994.

Table 5. Plant species encouraged by rural development agencies for hedgerows and live fences in North Cameroon.

Species	Method of propagation			
	Cuttings	Layering	Suckers	seeds
Acacia ataxacantha	*		*	*
A. senegal				*
A. seyal			*	*
A. sieberiana			*	*
A. pylacantha	*		*	*
Adenium obsesum	*		*	*
Albizzia adiantifolia	*			*
A. glaberima	*			*
A. lebbeck	*		*	*
Anacardium occidentale	*	*		*
Anogeissus leiocarpus				*
Balamites aegyptiaca				*
Bauhinia refescens				*
Boswellia dalziellii		*	*	*
Carnarium schweifurtii				*
Cassia siamea			*	*
C. singueana			*	*
Casuarinas equisotifolia			*	*
Combretum aculeatum	*		*	*
Commiphorra aculeatum	*		*	*
Commiphorra kerstingii			*	*
Cyperus esculentus			*	*

Table 5. Contd.

Species	Method of propagation			
	Cuttings	Cuttings	Cuttings	Cuttings
Dichrostachys glomerata	*	*		*
Dracaena arborea			*	*
Eleusine coracana				
Eucalyptus spp.			*	*
Euphorbia desmondi	*		*	*
E. kamerunica	*		*	*
E. unispina	*		*	*
Erythrina spp.	*		*	*
Ficus spp.	*		*	
Grevilles robusta			*	*
Harungana madagascariensis	*		*	
Hibiscus sabdariffa	*		*	
Ipomea Sp.	*		*	
Jatropha curcas	*		*	
J. gossypiifolia	*		*	
Kheya senegalensis				*
Moringa oleifera	*			*
Parkin biglobosa		*	*	
Podocarpus mannii			*	*
P. milanjanus			*	*
Polyscias fulva			*	
Spathodea campanulata				
Ziziphus spp.	*	*		*

Trees and shrubs have a great potential for improving productivity of the major production systems (range and crop lands).

The region is equipped with forage suitable agro-forestry and browse plants that require appropriate management to enhance crop-livestock production.

Browse species are sufficiently rich in their crude protein contents as to maintain animals in the dry season (Peltier and Eyong, 1989).

Many multipurpose trees and shrubs could be found in all the ecological niches and could be an incentive for both agro-forestry and ruminant production.

There is a great need for controlled grazing and increased fodder production.

With increasing demographic pressure in the region these resources are rapidly being degraded. There is need to reconstitute, innovate and protect the indigenous wooded savannah. Research and development actions should focus on the agro-silvopastoral management of the wooded savannahs, studies on ecosystem functions and the flow of nutrients (materials) and energy, and on improvement of fallows with multipurpose woody species.

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