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USE AND MANAGEMENT OF TWO MULTIPURPOSE TREE SPECIES (*PARKIA BIGLOBOSA* AND *DETARIUM MICROCARPUM*) IN AGROSILVOPASTORAL LAND-USE SYSTEMS IN BURKINA FASO

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SUMMARY

In many tropical regions various types of indigenous forest management systems may be found, many of which include agroforestry practices. Although the presence of such indigenous management systems is now generally acknowledged, still little attention has been given to describe and analyze the different kinds of specific management practices. The purpose of this paper is to contribute towards a better understanding of the nature of indigenous management practices for woody resources. In indigenous forest management systems often a variety of valuable tree species are present. Each of these species is often managed in a specific way. Different kinds of management practices may be distinguished: controlled use, protection/maintenance, (assisted) regeneration, stimulation production of desired products and decreasing competition on other crops. This is demonstrated by comparing the management practices of two tree species found in the agri-silvopastoral land-use types of Burkina Faso. These species, *Parkia biglobosa* (Néré) and *Detarium microcarpum*, both have a high social and economic value. The species produce various products which may be used for household consumption as well as for manufacturing and sale. The products are not only collected from wild trees, but are also harvested from trees, which are actively managed. The article describes both the institutional basis as well as the nature of the various management practices and indicates how the implementation of specific practices is related to the nature of the species as well as the land-use system in which a tree is growing. Special attention is given to practices for controlled utilization, purposeful regeneration and selective cutting. These practices aim either at better production of fruits (Néré) or of wood (Detarium), or at limiting the negative effects of trees on crops (esp. Néré). Also the ringing of Néré to stimulate fruit production and seed setting is described.

The implementation of the different management practices is influenced by the conditions with respect to land and tree tenure. Several regulations for controlled use of valuable tree species have been formulated at state or local level. In various cases, state legislation is contradictory to local management practices. For instance, the forestry law forbids the cutting of live parts of trees, therefore farmers can prune only secretly. Although the value of indigenous management practices such as pruning and ringing have been demonstrated, forestry agents normally forbid these practices out of fear that permission to cut a part of one tree species will lead to cutting of parts or even entire trees of other species. These constraints to the implementation and further development of the indigenous tree management practices could be overcome by carrying out further research on the merits of the different management practices. Rather than to forbid any cutting of live parts of trees, the forestry service should train farmers how to improve their management practices and thus to optimize production.

It is concluded that indigenous management of woody resources should not be constructed as involving the maintenance of spatially-delineated (agro)ecosystems, but rather as the maintenance of a mixture of individually valued tree resources. As a result of this 'diversified resources' management strategy a continuum in management characteristics is present both with respect to management practices and management institutions.

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1 INTRODUCTION

As a result of the droughts of the 1970s and 1980s in the Sahel, much concern has been voiced about the processes of land degradation and desertification in this region. It has generally been agreed that these processes can only be effectively controlled through improved land-use practices by the local communities. One important approach to counter the degradational processes is to stimulate improved community management of forest and tree resources. Under this approach local communities are stimulated to participate more actively in forestry development activities. In the 1970s first attention focused on tree planting as a means to control land degradation, but more recently efforts are directed at a more integrated approach of "gestion et amenagement du terroir villageoise" (Bognetteau-Verlinden et al., 1992; Kessler & Wiersum, 1995). Within this framework the importance of focusing attention on all aspects of forest management rather than on reforestation only is now recognized (Fries, 1991).

Already since colonial times in the Sahelian countries government efforts have been undertaken to introduce effective forest management. These efforts were based on professional or 'scientific' management systems in which a uniform, centralized and bureaucratic management system was employed. This management system was characterized by its focus on the forest-related interest of the colonial powers, and custodial state control with government administrative units (Bertrand, 1985; Freudenberger, 1993). Under influence of the new strategy of stimulating community forestry since the end of the 1970s the efforts to improve forest management shifted gradually to an approach which aimed at increased local participation. As a result of the experiences gained with this approach it is now recognized that many indigenous community forest management systems do exist. These evolved on basis of local initiatives rather than being externally sponsored (Arnold & Dewees, 1995). They are characterized by a set of different institutional as well as technical characteristics than the professional forest management systems (Wiersum, 1997). These indigenous community forest utilization and management systems are considered to offer good scope for further development of forest management systems which are adjusted to the present social and ecological conditions (Wiersum, 1993; Kajembe, 1994).

Although the relevance of the indigenous forest management systems as a basis for further development of innovative management systems is often acknowledged, up till the present most studies have focused on indigenous forest utilization only (e.g. Bergeret & Ribot, 1990; Malgras, 1992). Generally, still little is known about how the farmers' valuation of forest resources finds its expression in specific forest resource management practices (Raintree, 1991). Furthermore, little insight exists with respect to the factors which influence the intensity of these management practices as a component of the total farming strategies (Wiersum, 1993, 1996; Arnold & Dewees, 1995). In development projects, forest management is normally considered to relate towards ecological or statutory defined objects rather than to socially-constructed resources (Fortman & Nihra, 1992). The diversity in community forest management types and the normative pluriformity underlying them (Wiersum & Lekanne dit Deprez, 1995) is often underrated. Consequently, suggestions for improvement are often based on the norms and perceptions of the planners of development interventions rather than on the location-specific norms and values with respect to forest resource utilization and management.

Also in the Sahel little systematic efforts have yet been made to analyze the various characteristics of indigenous forest management as well as their dynamics With the exception of *Faidherbia albida* (CTFT, 1989; Vandenbeldt, 1992), little is still known about the local management practices which are used to maintain trees in various local land-use systems (Niamir, 1990; Kessler & Boni, 1991; Shepherd, 1992; Mathias-Mundy et al., 1992). Savenije (1993) who reviewed 320 references on tree management concluded: "... it appears that traditional silvicultural practices have not been systematically studied in the Sahel zone (....) it is rarely described in detail how and with what intentions these practices are carried out, at what scale, with what kind of effect and how usefull they are under the present conditions". Consequently, forestry services generally believe that farmers' tree management practices are irrational and only involve the indiscriminate and opportunistic harvesting of (parts of) trees. And the official forestry regulations are focused on protecting the trees which are present in the local farming system rather than at stimulating effective management (Freudenberger, 1993).

At present, however, there is an increased interest for the way the local communities are managing their woody resources. Recently, in Burkina Faso several meetings concerning national research priorities have concluded that it is very important to study traditional agroforestry systems, their dynamics and their economic and social importance. (Ouedraogo, 1993). Also Ouedraogo (1995) emphasized the necessity to study indigenous knowledge when researching options for improved silvicultural management practices. Similarly, at an ICRAF seminar held in Ouagadougou in October 1993, a priority status has been formulated for investigations on the existing management of traditional agroforestry systems.

In order to contribute towards a better understanding about the ways in which local people manage the woody resources within the agrosilvopastoral land-use systems in the Sahel, the Antenne Sahélienne UAW/UO and the Forestry Department WAU started in 1992 a research project to elucidate the nature and dynamics of the indigenous forest management systems in Burkina Faso. Following on a general review of the status of agroforestry in Burkina Faso (Kessler & Boni, 1991), several detailed studies on the use and local management practices of various tree species were carried out. The purpose of these studies was to describe the presence and characteristics of local tree management practices and to assess the factors which influence the intensity of such measures. Also the dynamics of the management practices were analyzed.

The purpose of this report is to present some interim results of this research. The report will focus specifically on two tree species which were intensively studied, i.e. *Parkia biglobosa* and *Detarium microcarpum*. The results of various detailed studies on these species, which were carried out between 1991 and 1996 will be summarized and compared. Whenever relevant, the information is extended by information obtained in other (Burkinabè) studies. The report is structured as follows: first some general theoretical considerations on how to conceptualize indigenous management of tree resources will be presented. Next a general description about the main characteristics of the different types of agrisilvopastoral land use in Burkina Faso will be given. In paragraph 4 an overview is given of the research methodologies. The selected tree species and research locations are described as well as the kind of data collected. In paragraph 5 a description of the social and economic importance of the two species is given. This is followed in paragraph 6 with a description of the various

management practices which were observed. In the concluding paragraph 7 these data are compared and further discussed.

2. INDIGENOUS FOREST AND TREE MANAGEMENT

Forest management may be defined as the process of making and effectuating decisions with regard to the use and conservation of forest resources and the organization of the related activities (Wiersum, 1997). Forest resources are the attributes of the forest which are considered relevant for mankind because of either utilitarian, ecological or cultural values. As indicated by this definition, forest management should not be considered to be based on an all-encompassing, undifferentiated positive attitude towards forests in general, but on a selective respect towards specific components of the forests which are culturally conceived as being valuable (Persoon, 1992; Sow & Andersen, 1996). Such valued forest components may be either specific treespecies or particular stands of trees.

Indigenous (or community) forest management may be defined as the process of making and implementing decisions with regard to the use and conservation of forest resources within a local territory, and in which the decisions are primarily based on the norms and interests and the social interactions of the people living within the territory (Wiersum, 1995). It consists of different types of planned and deliberate activities, which are executed either individually or by a group of rural people, and which enhance the quantity and quality of tree resources or makes their use more sustainable (Shepherd, 1992). In many regions, community forest management has gradually evolved locally (Wiersum, 1997). Such indigenous management should not be assumed to be locationally and practically homogeneous. Firstly, many community forest management practices are usually not carried out as a specialized activity, but they form an integrated component of the local land-use management system. The locally perceived values of trees primarily depend on the role of different tree species within the local farming system and the need for forest products within the local households. But in addition, tree resources may also hold a cultural or religious value (Shepherd, 1992; Wiersum, 1997). Consequently, important differences in the valuation of forest resources may exist between different categories of the local population, e.g. between agriculturists and herders, or between man and women (Rocheleau, 1987). Secondly, within a local territory there are usually various landscape niches in which trees are growing; the tenurial status of these niches may vary (Fortmann & Nihra, 1992; Freudenberger, 1993). Consequently the values of trees also depend on their location. For obtaining a good understanding about community forest management, one should therefore not proceed from biological or statutory definitions of forest, but rather from an empirical analysis of how different groups of local people define and value the various components of the local woody biomass within the framework of their total land-use systems (Fortmann & Nihra, 1992; Wiersum, 1993).

Generally speaking, forest management involves the implementation of deliberate practices aimed at the controlled utilization, protection and regeneration of forest resources (Wiersum, 1997). Consequently, indigenous management practices may involve measures to assure equitably distribution of valuable products, to assure the continued presence of forest resources, and/or to stimulate improved production of the desired products (Shepherd, 1992). In case that ample resources are present, forest utilization is often of an open-access nature.

Table 1 Management practices for woody resources

1. **(Controlled) Utilization practices**
   - 1.1 Leaf harvesting
   - 1.2 Fruit harvesting
   - 1.3 Bark harvesting
   - 1.4 Coppicing
   - 1.5 Pollarding of stem or branches
   - 1.6 Lopping of stem or branches
   - 1.7 Bending and partial cutting of branches for fodder production

2. **Protection and maintenance practices**
   - 2.1 Fencing around tree
   - 2.2 Weeding around young trees
   - 2.3 Removing competition of shrubs or other trees
   - 2.4 Watering (young) trees
   - 2.5 Sanitary pruning
   - 2.6 Application of (locally prepared) pesticides
   - 2.7 Fire management (localized burning, fire-control strips)

3. **Practices aimed at stimulating production of desired products**
   - 3.1 Selecting coppice shoots
   - 3.2 Ringing
   - 3.3 Rejuvenation pruning
   - 3.4 Pruning to produce V-poles

4. **Regeneration practices**
   - 4.1 Protecting natural regeneration
   - 4.2 Stimulating root sprouting
   - 4.3 Seeding
   - 4.4 Transplanting wildlings
   - 4.5 Planting cuttings
   - 4.6 Nursery raising and subsequent transplanting of seedlings
   - 4.7 Planting of bought seedlings

5. **Interface management practices**
   - 5.1 Cutting low branches
   - 5.2 Root cutting
   - 5.3 Canopy pruning to reduce shade
   - 5.4 Mulching with tree leaves

In case that resources are becoming more scarce, initial management practices often consist of controlling their utilization through the definition and control of user rights. Only in a second instance such socially-oriented forest management practices may be further enhanced by biologically-oriented practices such as the stimulation of tree growth and production, and regeneration of useful species (Shepherd, 1992; Wiersum 1997). These practices may be directed at the resource itself (e.g. coppicing, pollarding and pruning, vegetative or generative propagation), at limiting competition from less-desired components of the natural vegetation and fauna (e.g. weeding, thinning, controlled grazing), or at balanced production of various useful resources (e.g. trees and food- or foddercrops) (Niamir, 1990; Shepherd, 1992; Campbell et al., 1993; Savenije, 1993). A summary of the various kinds of management practices is given in Table 1.

A forest management system does not only consist of the implementation of management practices, but it also includes an organizational structure for decision making on the following aspects (Wiersum, 1993):

* What kind of activities should be carried out (objectives for forest management, the kind of practices to be carried out),
* Who can benefit from the forest resources (distribution of forest products between and within specific user groups), and
* Who is responsible for the management (implementation and control structure which ensures that the proposed activities are carried out as planned).

Due to the multifunctional nature of forests there often exist different forest users groups (Rocheleau, 1987; Shepherd, 1992), each of which may or may not have a specific organization for forest management; these may be either synergetic or competitive. Consequently, community forestry is not only characterized by an normative pluriformity with respect to forest resources but also with respect to organizational aspects (Wiersum & Lekanne, 1995).

Indigenous forest management regimes should not be considered to be static, but rather dynamic. Both their organizational characteristics and technical features may be adapted in response to changes in ecological conditions and socio-economic changes (Shepherd, 1992; Wiersum, 1993; Arnold & Dewees, 1995). Four types of land-use processes may result in adaptive strategies: (a) reduced availability of tree resources or declining access to them caused by restrictions on forest access; (b) increased demands for tree products caused by population growth or expanding markets; (c) increased needs for trees to act as barriers against land degradation (e.g. through control of water and wind erosion), and (d) increased use of trees to demarcate fields during the process of privatization of land (Shepherd, 1992; Scherr, 1995). In the past it has often been assumed that indigenous resource management regimes could not cope with the first two processes: the increasing land-use pressures would result in their break-down and a need to introduce new externally-sponsored practices. But it is now increasingly recognized, that the combined effects of the four processes may also result in induced innovations leading to more intensive (forest) resource management (Arnold & Dewees, 1995; Mortimore, 1995; Wiersum, 1997). Such innovations in forest resource management may involve a co-evolution in both perceptions on resources, management practices as well as organizational characteristics. Development interventions aimed at stimulating more intensive resource management will be most effective if they follow the trends of such autonomous change and strengthen them (Mortimore, 1995). In order to identify which development interventions hold most promise of being effective one needs

therefore to have a thorough understanding of the complex processes inducing more intensive forest resource management and a detailed insight in the nature of community forest management, including the range of technical options and their organisational features (cf. Raintree, 1991; Arnold & Dewees, 1995).

3 AGRISILVOPASTORAL LAND USE IN BURKINA FASO

Within the semi-arid zone of West Africa much of the landscape is characterized by (agri)silvopastoral land-use systems which are used for multiple purposes. Basically two different types of such land-use types can be distinguished: farmed parklands and silvopastoral lands.

Farmed parklands

Farmed parklands ('parcs arborés') are one of the most widespred land use systems in the West African Sahel; their presence and general characteristics have been well-documented (Pullan, 1974; Raison, 1988; Kessler & Boni, 1991), These systems are characterized by the growing of scattered multipurpose trees in a regular pattern on croplands or recently fallow fields. The trees are deliberately associated with the agricultural environment because of their specific use. Tree species composition and density depend on ecological, economic and sociological factors such as the density and diversity of trees in the original vegetation, the attitude of people towards trees, land and tree tenure practices, agricultural practices and the possibilities of commercialisation of tree products (Pullan, 1974; Raison, 1988). In Burkina Faso the dominant tree species of the parklands are *Vitellaria paradoxa* or shea butter tree (Karité), *Parkia biglobosa* or locust bean tree (Néré) and *Faidherbia albida* or winter-thorn tree (Balanzan). In addition, a variety of other species of lesser importance may be present in the farmed parklands such as *Adansonia digitata*, *Bombax costatum*, and *Tamarindus indica*. The density of the trees is usually between 15 and 30 trees per hectare (Kessler and Boni, 1991, Ouedraogo, 1993). Normally, sorghum is the common crop grown in this fields, but in addition also millet, cowpeas and/or groundnuts are cultivated. During the dry season livestock is usually allowed to graze on the crop residues.

Silvopastoral lands

Also the silvopastoral lands are characterized by the fact that they are grazed by livestock and that they are used to collect woody products. But in contrast to the farmed parklands on these lands no agricultural cropping takes place at least for one full year cycle (Kessler & Wiersum, 1992). There may be several reasons for not cropping such lands (adapted from Kessler & Wiersum, 1992):

a. The area has not yet been cleared for agricultural use, either because of low potential for arable cropping in relation to population density, or because of legal status;
b. The area has been reserved as a permanent village grazing area or as a village forest;
c. The area is an old fallow field which is not yet reclaimed for cropping or which has even been abandoned for agricultural cropping because of severe soil degradation.

Consequently, the silvopastoral lands are characterized by much more pluriform characteristics in respect to soil and vegetation conditions than the farmed parklands. The silvopastoral lands are normally used much less intensively than the farmed parklands.

As indicated by the description of the silvopastoral lands, the distinction between these lands and farmed parklands are not absolute, as changes from one to another may take place. Nonetheless, the distinction between these two categories of land use may assist in obtaining a good understanding of the range in management characteristics for natural resources. It may be assumed that the differences in characteristics of farmed parklands and silvopastoral lands are reflected in the tree management practices.

4 RESEARCH AREA AND METHODOLOGY

4.1 Species selected

The selection of species to be included in the study was guided by the hypothesis that trees whose products have a considerable economic value and which clearly display signs of human interventions, are most likely to be managed by indigenous practices. Furthermore, it was considered that it would be worthwile to study both dominant and less dominant tree species. On basis of these criteria it was decided to focus the studies in particular on *Parkia biglobosa* (Néré) and *Detarium microcarpum*.

The Néré tree was selected because it has traditionally an important social value and is highly valued for its fruits which are manufactured into various commercial products. Due to its high value, this tree is regularly subjected to various management practices. As an example of a less dominant species *Detarium microcarpum* was selected. Also this species provides commercial products, in the form of both fruits and fuelwood, which are marketed in Burkina even in areas where the tree does not grow. Although this tree is not as conspicious as Néré and Karité, it still is widespred. Although various observations indicate that in several local communities this tree is subject to active management practices, the tree has hardly been studied by scientists.

Parkia biglobosa is one of the most important trees growing in the farmed parklands (Ouédraogo, 1995). It is a large, leguminous trees which can reach a height of 15-20 meter. It forms pods about 45 cm long and 2 cm wide, which contain seeds embedded in a yellow fruit pulp.

The species is indigenous to the savanna zones of West Africa, with a natural range extending from 5 N to 15 N and 16 W to 32 E (Hopkins and White, 1984). Maiga (in Ouédraogo, 1995) has localised the most important distribution of Néré populations in Burkina Faso (Figure 2). The limit for spontaneous distribution of Néré is situated about 75 km North of Kaya. Several regions can be distinguished with populations of the species and other regions where the trees are more or less isolated. These populations mostly result from selective protection of the species when clearing land for agriculture (Nikiema A., 1993; Ouedraogo, 1995). Néré trees are also present in the natural savanna and on fallow lands. Isolated Néré trees are often the result of deliberate planting and seeding by the local population (Guénéba, 1994).

Néré is a multipurpose species (Sabiiti & Cobbina, 1992; Ouédraogo, 1995) which is highly valued for its the various food products which can be obtained from its fruits. The fresh fruit pulp contains up to 60% sugar (saccharose) and is edible. It is often fermented to 'soumbala'

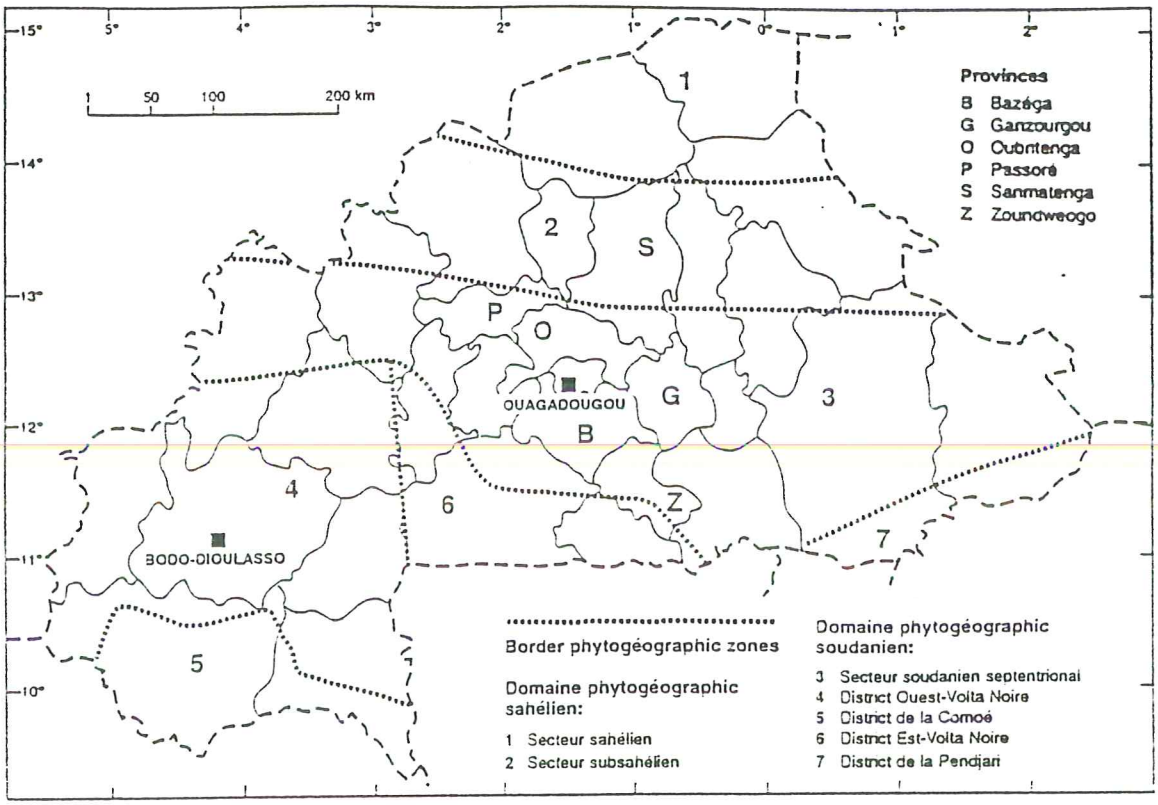

Figure 1 Ecological zones of Burkina Faso and location of research area

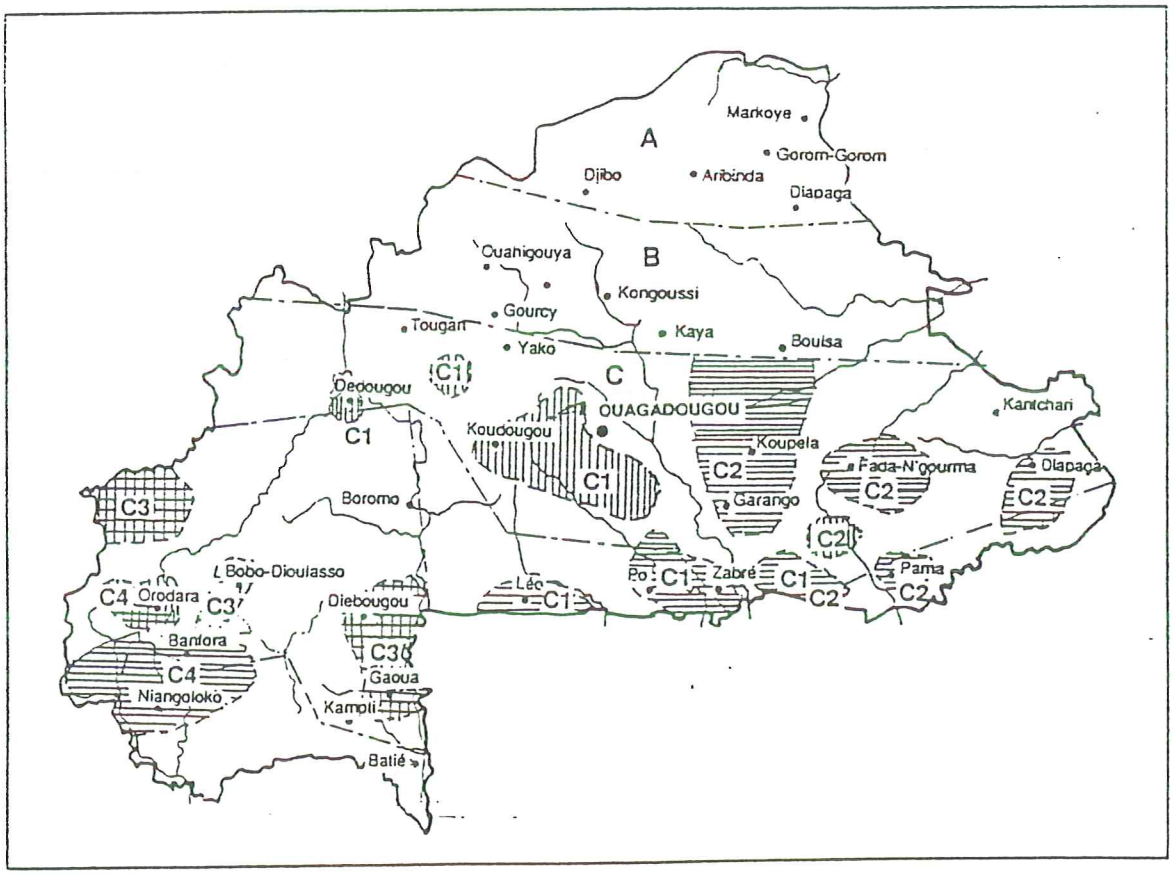

Figure 2 Distribution of *Parkia biglobosa* populations in Burkina Faso (after Ouédraogo, 1995)

which serves as a seasoning for sauces. It may also be used to produce a flour. Various parts of the tree such as leaves and bark are also used for medicinal purposes.

Detarium microcarpum (family Caesalpiniaceae) is a small deciduous tree which may reach a heigt of 8 - 10 meters. It has globulous fruits of 2.5 - 4 cm diameter which contains seeds which are embedded in a green fruit pulp. It is indigenous in the Soudan zone of West Africa, it is reported to be present in Guinée, northern Ivory Coast, Mali, Burkina Faso, Niger, Cameroun and Soudan. In Burkina Faso the species is reported to occur specifically in fallow vegetations and open savannas subject to regular burning (Guinko, 1984). The leaves of the tree are relatively unpalatable and the tree is resistant to defoliation, cutting and fire. Consequently, the tree often increases in response to grazing (Breman & Kessler, 1995). In some vegetations the tree provides over 80% of the standing biomass of useful trees (IRBET/CNRST). The tree is occasionally also maintained on croplands, although its presence in the farmed parklands is much less common that of Néré.

The species is valued both for its wood used for fuel and construction purposes as well for its fruits. In some areas this tree provides over 60% of the fuelwood needs (IRBET/CNRST, 1996). The fruitpulp is sweet and rich in vitamins; it is eaten fresh or after cooking; it is also used for the preparation of local beer ('dolo'). The fruits, bark and roots are also used for medicinal purposes (Malgras, 1992; Roovers, 1995).

4.2 Methods of data collection

The research was carried out in two ecological (phytogeographic) zones of Burkina Faso, i.e. the zone Sub-sahélien and the zone Nord-Soudanien (Figure 1). Within each zone most studies were predominantly located in the provinces of Sanmatenga and Zoundweogo. In some cases, additional observations were also made in other provinces.

As the research was basically of an explorative nature, it consisted of a series of smaller studies. Two main types of studies were carried out:

a) Market studies to ascertain the economic importance of the products of the studied species.
b) A series of observational studies on various management practices.

Market studies

In 1990 a study was carried out to assess the role of tree-based food products on the market of Zitenga (Oubritenga province) (Pasgo, 1980; Smeenk, 1991). The results of this study can be compared with a study on the marketing of timber and non-timber products in the Yako region (Passoré province) carried out in 1990 by the Institut du Développement Rural (IDR) (Zida, 1990; Nikiema R., 1993).

Studies on tree management practices

In 1990 two monitoring studies started on the effect of Néré trees on crop production in the farmed parklands (Kessler, 1992) and on dynamics of the parklands (Gijsbers et al., 1994). In 1992 these studies were followed by a series of small, mostly observational, studies aimed at assessing various kinds of indigenous tree management practices. The selection of management practices was of an ad-hoc nature and primarily based on the observation of the

existence of certain interesting management practice. The following more detailed studies were carried out:

(i) Study on pruning of Néré trees

In 1993 a study on pruning of Néré was started. The aim of this study was to determine the methods of pruning, the reasons for pruning and the factors influencing pruning practices. The effect of pruning on the tree itself was also taken into account (Timmer, 1994; Timmer et al, 1996).

The study consisted of a survey in three areas located along a north-south transect from Kaya (Sanmatenga province) in the north to Ouagadougou and to Manga (Zoundweogo province) in the south (Figure 2). Observations were made in a radius of 50 km around the cities. On basis of these observations 21 villages in which pruned trees occur were selected in which 83 trees and 56 tree owners were surveyed. Data were collected by both observations, semi-structured interviews with tree owners, local authorities and other villagers, and tree measurements (Timmer, 1994). Some additional data were collected in the villages of Sarogo (Zoundweogo province) (Roovers, 1995) and Nobéré (Zoundweogo province) (Van der Vleuten, 1995).

(ii) Study on ringing of Néré

During the study on Néré pruning another management practice of these trees was discovered: "ringing". In 1995 a detailed study concerning this practice was executed in the village of Nobéré (Zoundweogo province). By means of observations, interviews and measurements data were collected on the extent to which this technique is practiced as well as the objectives for doing so and on the way these practices are carried out (Van der Vleuten, 1995).

(iii) Study on regeneration of Detarium

In 1994 a study was started out to assess the importance of Detarium for the populations and the local management practices for this species in Zoundweogo province (Roovers, 1995; Van der Vleuten, 1995). Special attention was given to the process of Detarium regeneration and to practices of Detarium coppicing. Also observations were made on the influence of Detarium on crops growing under the tree (Nortier, 1996a). Data collection was carried out through observations and tree measurements. This research took place in Zoudweogo province in the village of Sarogo and the sylvopastoral zone of Sondré Est.

5 SOCIAL AND ECONOMIC IMPORTANCE

5.1 Social importance of Néré and Detarium

In the research area two main ethnic groups can be distinguished, i.e. the Mossi and the Fulani. The first ethnic group are originally sedentary agriculturists, while the second group consists mainly of pastoralist. As a result of their different livelihood strategies, it may be expected that these two groups differ in their appreciation of trees and tree products. In order to obtain information on how the two groups value both Néré and Detarium, Roovers (1995) interviewed 40 Mossi farmers in Sarogo and 40 Fulani families in the Sondré Est (Zoundweogo) about their relative preference for various tree species and their products (Table 2).

Table 2 Relative preference for vrious products of *Parkia biglobosa* (Néré) and *Detarium microcarpum* amongst different ethnic groups (rank number amongst .. commonly used tree species)

Product	*Parkia biglobosa*		*Detarium microcarpum*	
	Mossi	Fulani	Mossi	Fulani
Traditional medicine	2	8	3	2
Fruits	3	6	4	3
Human nutrition	2	5	4	6
Fuelwood	5	-	4	6
Construction wood	-	-	3	-
Animal feed	-	-	-	-

As indicated by Table 2 the Néré tree is highly appreciated by the Mossi population of Sarogo and to a lesser extend by the Fulani of Sondré-est. The fact that the Fulani hold the species in lower value than the Mossi may be caused by the fact, that there are usually clear ownership rights on the Néré trees. Traditionally these were held by the Mossi village chiefs (see paragraph 6.2.1). These ownership regulations may have prohibited the Fulani to harvests trees. Amongst the Mossi, the Néré is not only highly valued for its fruit products, but also for its medicinal properties. All parts of the Néré but especially the bark (46 %), roots (17 %) and leaves (11 %), are used by the rural households to heal many different diseases. The pulp and soumbala are also used against paludism and jaundice (Guénéba, 1994; Ouédraogo, 1995). The species is not appreciated as fuel wood, because its odour seems to inhibit the production of the *Lagenaria siceraria* (calebass), a plant who grows often nearby the kitchen. (Ouédraogo, 1995; Van der Vleuten, 1995).

The products of the Néré and especially soumbala, are not only appreciated for their utilitarian values, but also for cultural reasons (Ouédraogo, 1995). For Mossi a gift of soumbala to someone shows that one has respect for the other person and thus helps to maintain social relations. Similarly, Gourounsi, Bobo and Lobi people sent soumbala annually to their children who live outside the family compound. On the average a person may spent 1200 FCFA (Samo) to 25000 FCFA (Lobi) yearly on soumbala gifts depending on the ethni and the abundancy of the species in the environment. For several ethni soumbala is important at certain ceremonies like mariages, child birth, circumcission and initiation rites and funerals. (Guénéba, 1994). The young branches of Néré are sometimes used to form a carriage for human corps during the funeral. This ceremony is part of Bissa tradition and is found in the study area, mainly in the Guiba and Nobere departments (Ouédraogo, 1995; Van der Vleuten, 1995).

Also Detarium is valued both for its nutritional and medicinal values, but the wood of this tree is also appreciated. For both Mossi and Fulani the species is most important for traditional medicine. Mossi appreciate the species also for wood and nutrition. The Fulani appreciate these two use to a lesser extent. This may be caused by the fact that in Sondré-est, a sylvopastoral zone, many different tree species are present in abundance. Therefore more alternative species may be present. Furthermore, the need for construction wood is influenced

by the type of house construction, and the Fulani need other wood qualities for their houses than the Mossi.

An interesting example of the various values of Detarium has been reported from the Dogon region in Mali (Van Beek & Banga, 1992). During the *puro* rite the firewood stacks collected by women are searched by masked men for the presence of firewood of *Detarium microcarpum*. This tree is considered to represent the conflict between males and females about the utilization of natural resources. The women need firewood for cooking and making pottery, but the men enjoy its fruits too much to allow the women to cut the trees for firewood.

5.2 Marketing of Néré and Detarium products

The fruit products of both Néré and Detarium are not only consumed in local households, but also marketed. They illustrate the commercial value of various non-timber forest products. In two separate market studies on non-timber forest products in the towns of Zitenga (Oubritenga province) (Pasgo, 1990; Smeenk, 1991) and Yako (Passoré province) (Zida, 1990) a total amount of 18 products from 12 tree species and 26 products of 13 tree species respectively were recorded.

With respect to Néré both its fruits, flour and soumbala are marketed. These products have a high commercial value and they are sold throughout the year. Both in Zitenga and Yako not only locally produced fruits were sold, but also fruits from other regions such as the provinces of Boulkiemdé, Kadiogo and Mouhoun.

Next to the fruits and butter from Karité (*Vitellaria paradoxum*), Néré is the most important traded non-timber forest product in Burkina Faso. Normally the harvest of the pods start in June and throughout the rainy season fresh fruits are regularly sold. Once the agricultural season is over, women start manufacturing the soumbala. Consequently, during the dry season the amounts of marketed fruits gradually diminish. This may be illustrated by the sale figures from Zitenga. During the period August - February and February - August 2015kg and 846 kg respectively of fruits were marketed. Soumbala can be stored relativele easily and the sales of this product are therefore relatively equally spred over the year. For instance, in Zitenga the marketed amounts of soumbala were 1552 kg and 1137 kg for the periods August - February and February - August respectively. The great commercial value of the Néré products may also be illustrated by the data collected on this market. During one year on this market an estimated total of 2860 kg of seeds and 2690 kg of soumbala were marketed. The sales of the fruits and soumbala generated an revenu of CFA 448.000 and CFA 1.025.000 respectively against CFA 411.000 and CFA 1.085.000 for Karité nuts and butter. The Néré sales respresented an estimated 12% and 28% of the total market sales (Nikiema R., 1993). The high commercial value of Néré is also demonstrated by the fact, that in the Burkinabè town of Pouytenga reportedly per week 100 sacs of Néré pods are imported from Ghana and Togo (Guénéba, 1994).

The manufacturing of Néré grains into soumbala is an intensive activity requiring much labour as well as inputs in the form of fuelwood. Women with free access to the grains normally transfer only a part of the grains to soumbala to be used for home consumption.

They prefer to sell the remaining grains in unprocessed form. Rich women prefer buying soumbala to processing it themselves. Thus, only women that are relatively poor and who have no access to Néré trees, will buy Néré grains on the market. They manufacture all those grains into soumbala and sell most of it again to cover the costs of buying the grains and manufacturing it. Only a small part of the soumbala produced by them is kept for home consumption (Nortier, 1996a).

Also Detarium is an important commercial product. Both fuelwood and fruits of this species are marketed. For instance, Detarium wood forms an important component of the fuelwood which is produced in the Nazinon forest for supply to the capital of Ouagadougou (IRBET/CNRST, 1996). The fruits of this species are marketed mostly in relative small quantities; it is only sold during the fruiting season. For instance, in Zitenga the fruits of this species were only present on the market during the period from February to August. Nonetheless, the value of this species is demonstrated by the fact, that although Detarium does not grow in the province of Passoré, fruits were still sold on the Yako market; these fruits derived from the provinces of Mouhoun and Yatenga. In Zitenga only locally produced fruits were sold.

Interestingly, there is a clear gender differentiation in the marketing of Néré and Detarium products. Whereas the sale of Néré products is an exclusive activity of women, Detarium fruits are normally sold by men. For women the sale of Néré products forms an important opportunity for income generation. For instance, in Zitenga the average revenu of the soumbala sales amounted to CFA 3090 per day per women selling this product. During the periods that soumbala is in short supply these revenus may even be much larger. For instance, in April 15 women sold soumbala each earning an average of CFA 6185/day, while the six women selling soumbala in November each earned an average CFA 9000 (Nikiema R., 1993).

5.3 Economic effects of combined tree-crop growing

As indicated earlier, both Néré and Detarium trees are grown on croplands. The maintaince of these trees allows farmers to diversify their production and to reduce the production risks under the prevailing uncertain rainfall conditions. This has been amply proven with respect to Néré (Ouédraogo, 1995). The trees may have several effects on the crops. At the one hand, through their micro-climatic effects and litter production they may contribute to the maintenance of soil conditions. Also the input from manure from animals resting in shade beneath the tree and from birds roosting in the crown may contribute to maintain soil fertility under the tree. Consequently, both the soil humidity and fertility under the Néré canopy are often better than outside the canopy. For Néré a better soil fertility status under tree canopies has been observed for both nitrogen, potassium, magnesium and phosphorous (Kessler, 1992; Kater et al., 1992, Tomlinson et al., 1995). Such higher soil fertility is demonstrated when trees have recently been cut or have died, in such cases crop yields are often higher than in the open field (Kessler, 1992).

But on the other hand the tree canopies cause a light reduction for the crops growing under them. For Néré a light reduction of up to 80% have been reported (Kessler, 1992). This shade effect offsets the positive effects of the increase in soil fertility (Kessler, 1992).

Consequently, crops growing under Néré canopy develop and mature more slowly and are more susceptible to insect and parasites attacks than crops growing outside the canopy covered area. Especially large Néré trees may depress crop yield under their canopy up to 55-70 % (Kessler, 1992; Kater et al., 1992). The maintenance of Néré trees on croplands may thus cause a loss in crop production. However, these losses are normally counterbalanced by the yields of the Néré. For instance, Kessler calculated a loss of FCFA 1500-3000 for millet production against a production value of FCFA 5000 for Néré fruits.

With respect to Detarium less information on its effects on crop production are available. In a preliminary study it was found that under this tree crop production of sorghum is not much reduced (Nortier, 1996a). This is not surprising as the tree has only a small and very open crown. This crown apparently creates little shade, sufficient to reduce soil temperatures but not important enough to have a negative effect on crop production. On the other hand, the tree can protect only few animals against sunshine thus accumulation of manure is quasi-absent.

6 MANAGEMENT PRACTICES

6.1 Types of tree management practices

As discussed in paragraph 2, five categories tree management may be distinguished:
- controlled utilization
- protection and maintenance
- stimulating production of desired products
- (assisted) regeneration
- decreasing negative effects of the tree on its environment

In Table 3 an overview is given of which kind of these practices were observed for either Néré or Detarium during our studies. Whenever relevant also information from related Burkinabè studies (e.g. Guénéba, 1994; Ouedraogo, 1995) has been added to this table. From this table it can be observed that in general Néré is more intensively managed than the Detarium. With respect to Néré both practices for controlled utilization and for stimulating production and regeneration take place. Whereas for Detarium practices are restricted to controlled utilization and stimulation of coppice regrowth. For Néré also various practices directed at decreasing the tree's influence on crops are present; this is not the case for Detarium. In the following paragraphs further details of the main management practices will be presented.

The different management practices between Néré and Detarium are obviously related to the specific characteristics of the species. For instance, Detarium coppices easily in contrast to Néré, consequently for Detarium less conscious measures for regeneration are needed than for Néré. The data in Table 3 indicate that there seems also to be a correlation between the value of the trees and the intensity of its management. As discussed in paragraph 5, Néré is higher valued than Detarium. This higher value of the Néré trees is reflected by the fact that whereas Néré is a dominant species in the farmed parklands, Detarium is more prominent in silvopastoral vegetations. Furthermore, Néré is subject to a wider range of and more intensive management practices.

Table 3 Management practices of *Parkia biglobosa* and *Detarium microcarpum*

MANAGEMENT PRACTICE	PARKIA BIGLOBOSA	DETARIUM MICROCARPUM
(Controlled) Utilization practices		
Leaf harvesting	+	
Fruit harvesting	x	x
Bark harvesting	x	x
Coppicing		x
Pollarding of stem or branches	x	
Lopping of stem or branches	x	
Partial cutting branches		
Protection and maintenance		
Protecting young trees	x	+
Removing competing shrubs/trees		
Watering (young) trees		
Sanitary pruning	x	
Pest & disease control	n.s.	n.s.
Fire management	n.s.	n.s.
Stimulating production of desired products		
Selecting coppice shoots		x
Ringing	x	
Rejuvenation pruning to stimulate fruiting	x	
Pruning to produce straight or V-poles		+
Regeneration practices		
Protecting natural regeneration	x	
Stimulating root sprouting		x
Seeding	x	
Transplanting wildlings		
Planting cuttings		
Nursery raising & transplanting of seedlings		not succesful
Planting of bought seedlings		
Interface management		
Cutting low branches	x	
Root cutting		
Canopy pruning to reduce shade	x	+
Mulching with tree leaves		+

x regular practice + occasional practice n.s. not studies

6.2 Controlled utilization

The value of both Néré and Detarium is reflected by the fact that there exist several local regulations with respect to their ownership and harvesting rights. These tree tenure aspects will be described for Néré and Detarium respectively.

6.2.1 Néré

In Burkina Faso the Néré trees were traditionally owned by the village chief, who is responsable for the allocation of the fields. The trees were considered his property and all harvested fruits should be presented to him. After the chief had decided his due portion of the yield, the farmer could retain the remaining portion. Consequently, historically a farmer had only usufructuary rights on the trees growing on his allotted fields (Ouedraogo, 1995; Nortier, 1996). Progressively, however, the influence of the chiefs is decreasing and the traditional tenure rights on Néré are changing. In some regions, such as Kenédougou and Boulgou the Néré tree and its fruits are at present owned by the cultivator of the field. In most areas, cultivators still feel a sense of remaining loyalty to the village chief, but they decide independently on the amounts of harvested fruits to be handed over to them. Eventually only a symbolical amount is handed over. A similar development has also been reported from Mali. In two villages in the Tominian region ownership from Néré it was found that the traditional ownership of Néré trees shifted from the village chief to family chiefs (Van der Poel et al., 1992).

The traditional control of village chiefs over Néré were not only related to its ownership, but also included his control over harvesting periods. Historically, in certain provinces of the central Mossi plateau (Sanmatenga, Ganzourgou and Passoré) the harvesting season was opened by a ceremony in which the chief harvested the first ripe pod and ate it in a dish which he shared with the "gods of the tree". Only afterwards the general harvest of Néré pods was allowed. This practice prevented preliminary abusive harvests of non mature fruits. At present this practice has also been replaced by individual decision-making by farmers. In order to prevent losses by theft there is a tendency to start harvesting already early (Ouédraogo, 1995; Timmer et al, 1994).

Although the ownership rights on Néré trees are gradually becoming privatized, this does not mean that anyone may grow néré trees on his croplands. In case that farmers borrow a piece of land to cultivate, any Néré growing on the lands remain under ownership of the original landowner. Thus, the fruits of these trees are for the tree owner and not for the cultivator. Moreover, the cultivator is not allowed to seed or plant a Néré on the borrowed field as this act is interpreted as a method to impose ownership on the field (Guènèba, 1994).

In addition to these traditional tree tenure rights, also the gouvernment has formulated regulations to protect the Néré trees. In Burkina Faso the "Ministère d'Environnement et du Tourisme" is responsible for the legislation concerning natural resources, including trees. In view of their great value, several tree species growing in the farmed parklands (including Néré, Karité, and Baobab) have been accorded a special protected status by the forestry law. These trees or any parts of them may not be cut when still alive. Only when parts of the tree are dead, these parts may be cut. This regulation intends to protect the trees irrespective of whether they are present on fields, fallow or as a part of a natural vegetation. However, the

result is that farmers are discouraged to apply certain management practices such as pruning (see paragraph 7.2).

6.2.2 **Detarium microcarpum**

With respect to Detarium the regulations on utilization are less elaborate than those for Néré. Traditionally, in Burkina Faso no regulations on the use of Detarium in the natural vegetation seem to have existed. Trees that grow outside the agricultural area may normally be used by any inhabitant of the village. This contrasts with the mild taboos against cutting of Detarium exercised by the Dogon in Mali (Van Beek & Banga, 1992). Trees growing on agricultural fields and in young fallows are the property of the owner of the field. He and his family may use the tree and its products freely. But the cutting of fresh wood is everywhere forbidden by the gouvernmental forestry service.

In view of its commercial value, fruits of Detarium are increasingly harvested for marketing instead of for subsistence consumption. As a result increasingly fruits are harvested as soon as possible, especially on sylvopastoral areas where no regulation is imposed and where the first person to come is the one to harvest the most. Consequently, increasingly fruits are harvested when they are still green and unmature. Furthermore, often all fruits are harvested without leaving any fruits for regeneration, consequently the generative regeneration has become almost absent (Roovers, 1995).

In response to the increased commercial value of Detarium in some cases the village chief has intervened to protect the species better. An example of such local initiative was encountered in the village forest of Sarogo (Zoudweogo). Here it was decided in 1991 to protect a Detarium forest. This forest had developed on the fallow fields of the village chief. The son of this village chief had been selected by the villagers as a 'paysan forestier' (forestry farmer). The appointment of such 'paysan forestier' are stimulated by the Forest Service; their task is to assist the gouvernmental forestry agent with the promotion of forestry activities in the village. Although the installment of such 'paysans forestiers' has met with variable results (Scholten, 1993), in the case of Sarogo this position was taken seriously. The establishment of the village Detarium forest resulted from the initiative of the local 'paysan forestier'. This village forest was installed with the purpose to conserve the existing Detarium stand and to maintain its production capacity. This village forests is subject to the following regulations:

a) Fruits may only be harvested on days set by the village chief;
b) Dead wood may be collected individually, but it is expressedly forbidden to cut fresh wood;
c) Traditional medicines may also be collected individually, but only from dead wood.
d) It is forbidden to let livestock roam freely in the forest;

All villagers respect this regulation. It has also been planned that the harvested Detarium fruits would be marketed jointly with the income to be used to form a village development fund. First, some villagers still harvested individually and kept the revenues for themselves (Roovers, 1995), but gradually the joint marketing of products is gaining more acceptance.

6.3 Optimizing production

Three specific measures to optimize the production of tree products were observed during our studies: (a) pruning of Néré, (b) ringing of Néré, (c) coppicing of Detarium.

6.3.1 Pruning of Néré

Although according to the official state regulations no live wood may be cut from the Néré trees, in practice Néré trees may be actively pruned. There exist a large variation in pruning practices from intensive to extensive (Timmer, 1994; Timmer et al., 1996, Ouedraogo, 1995). During the intensive cutting most of the main branches are cut, while the more extensive methods only involve the removal of selected branches. Intensive pruning is more common on the permanent village fields than on more distant bush fields; on the village fields 55 % of all prunings consisted of intensive pruning versus 26 % on the bush fields. Pruning mostly takes place in April and May to enable the pruned trees to benefit from the rainy season which starts in June (Timmer, 1994).

There are two main motives for such pruning (Ouedraogo, 1995; Timmer et al., 1996):

- Improvement of fruit production on rejuvenated branches and tree survival (sanitary pruning)
- Reduction of the influence of the tree on its environment: shade reduction and decreased danger of falling branches.

As indicated in paragraph 5.1 the wood of Néré is not particularly valued. Only when there is no alternative some families use Néré prunings as fuelwood (Roovers, 1994). Consequently, local people did not indicate the increase in wood production as a motive for pruning.

a. Pruning to increase fruit production

The major reason for pruning trees is to rejuvenate branches and thus to increase fruit production; Timmer (1994) found that 59% of farmers practicing pruning indicated improvement of tree survival and productivity as the main motive for pruning. Normally, such pruning takes place before the onset of the rains. Especially in older trees the rejuvenating motive is important: for trees younger than 30 years this motive was mentioned by 25 % of the respondents and for trees older than 60 years by 38 %. For such rejuvenation often relatively intensive pruning is practiced. Only 22 % of the respondents indicated intensive pruning of trees younger than 30 years, while 55 % indicated intensive pruning for trees over 60 years old. In contrast to such intensive pruning, moderate pruning mostly (93%) takes place in October and November, this is done mainly for exploitation of wood (69 %). Only few branches are cut by this method. Pruning types that do not involve removing of the central axis are preferred; they are considered less dangerous for the pruner. In most cases pruning is practiced irregularly, but in one case a farmer was found who pruned every 4 years half of each Néré tree. The pruned part had to grow four years before bearing fruits again. The half that was not pruned produced still fruits during this period. This part was pruned once the other part produced again (Timmer, 1994).

b. Pruning to diminish shading of crops

As demonstrated by a Mossi proverb, farmers are aware that the shade of Néré trees diminish crop yields: " On ne tire pas double profit du Néré: gagner ses fruits et gagner du mil sous son feuillage" (Guénéba, 1994). In some cases, farmers may decrease such light competition by pruning. This, however, is not very common; Timmer (1994) found that only

3% of the farmers mentioned the prevention of shade as a reason for pruning. Another way of dealing with the shade competition of the Néré trees is to select shadow tolerant crops like chili peppers and sweet potatoes for cultivation under the Néré canopies. Such cultivation does not only allow a better use of the shaded soils, but it also adds to the diversification and risk reducing strategy of farmers.

Although various reasons exist for pruning Néré trees, there are also reasons for not pruning. A major reason for not pruning is the fear that a forestry agent will fine a farmer for cutting even a small part from a tree. Other reasons for not pruning are (a) the temporary loss in fruit production, as it takes normally three years before the new branches produce fruits, and (b) the separation between land and tree ownership.

There are some indications that pruning is gradually increasing in importance. In the past, the density of Néré trees was often higher than at present, and sufficient tree regeneration took place. But as result of the recent drought periods regeneration is now less common, especially in the Sub-Sahelien zone. Consequently, rejuvenation of the existing trees is now becoming more important. However, such pruning must be exercised with care. Some farmers indicated that during drought years, when trees are moisture-stressed, they should not be pruned as this would only add to the tree stress. Indeed, some farmers in the Kaya region claim that since the onset of the droughts and the degradation of soils trees no longer support intensive pruning (Timmer, 1994; Timmer et al, 1996).

6.3.2 **Ringing to increase fruit production of Néré**

According to farmers different types of Néré trees may be distinguished with respect to their fruit production. They distinguish trees that produce every year, those that produce every two years and those that never produce fruits. Trees which do not produce fruits are also divided in three groups: those that do not produce flowers, those that do not produce fruits and those that do not produce seed (the pods are empty). For trees belonging to the two latter cases a traditional practice is sometimes used for stimulating fruit and seeds production: ringing (Van der Vleuten, 1995). This practice may be observed not only in Zoundweogo province being practiced by Nobéré farmers, but also in other provinces.

Ringing consists of cutting a ring of bark out of the trunk at a height of 80 - 130 cm. The width of the ring varies between 5 to 15 cm, but is mostly less than 10 cm. It is very important that the ring is rather shallow and that one does not cut too deep. Only a small part of the bark may be taken away. The practice only has the desired effect when it is done just before flowering in the month of February. Farmers claim that after ringing the tree forms pods which contain seeds, while otherwise the tree would produce only flowers. According to some farmers this practice results still in the same year in improved fruit yields, but other farmers claim that improved yields will be obtained only in the year after pruning. Some trees show several scars from ringing which seems to indicate that apparently the treatment is effective because the farmer continued it for several years. But it is also possible that farmers ring every time on exactly the same spot (Van der Vleuten, 1995). Ringing cannot be done more than once every two years as otherwise the tree becomes too stressed. And in case it is not done careful enormous, almost cancerous, scars can be formed.

Ringing was formertimes also practiced in fruit cultivation in temperate zones (Tromp et al., 1976; Gautier, 1987). There are various hypotheses on the effect of this practice. According to Tromp et al. (1976) it limits vegetative growth and stimulates the development of floral buds by either blocking the transport of assimilates and thereby limiting photosynthesis or by changing the concentration of the Gibbereline growth hormones. While according to Costes (1983) ringing is effective as it blocks the downstream of sap keeping it available for the aerial parts of the tree. The abundancy of the sap allows an abundant fructification the next season. When ringing is combined with pruning the number of vegetative organs is reduced leaving again more sap for the young branches which may flower vigorously and produce a lot of pods.

6.3.3 Coppicing and pruning of Detarium

In contrast to Néré Detarium wood is generally valued especially for construction purposes (paragraph 4.1). Some farmers who are particularly interested in wood production, start "managing" Detarium from a young age. Clearing the land normally implicates cutting all shoots from Detarium. Some farmers select one shoot which grows nicely in a vertical direction and leave it, cutting all the others. The selected one is stripped of his leaves to a hight of about 20 cm. Side branches and new shoots are cut away yearly. When the trunk has reached a certain lenght and dimension it will be cut for construction wood. The remaining trunk will easily form new coppice shoots and hence the practice can be repeated several times. This system provides some families regularly with construction wood and guarantees a certain tree density on the field (Van der Vleuten, 1995).

In case that Detarium trees are growing on croplands, they are sometimes pruned. The main reasons for such pruning acoording to farmers is decrease shadow for the crops and to increase fruit production of the tree. The leaves are left on the field as mulch and fertilizer. The branches are used as fuel wood after drying (Roovers, 1995). Without human intervention many Detarium trees shed their leaves and small branches when conditions are unfavorable (dry season) thereby automatically mulching the soil and decreasing the shade for the crops. Therefore pruning seems not very necessary (Van der Vleuten, 1995).

6.4 Regeneration practices

6.4.1 Néré

In many parts of Burkina Faso it can be observed that most Néré trees are old and not very productive. Except in the west and south west of Burkina often there are not sufficient young trees to replace the old trees (Guénéba, 1994). Between the central part of Burkina (700 mm of rain) and the northern limit of the propagation of Néré (500 mm of rain), the regeneration of Néré is very low if not totally absent (Ouédraogo, 1995). The presence of seedlings seemed to be determined by moisture availability, the presence of seed trees and the intensity of fruit exploitation. For instance Gijsbers et al (1994) found in an area with annual rainfall between 400-700 mm that young plants of Néré were only present in valleys. Seedling survival is often poor because of the combined effects of drought, bush fires and browsing (Nikiema A., 1993; Guenéba, 1994). Direct human influences should not be neglected: the fact that hardly any Néré seedlings were found on the territory of the village Petit Samba (Province of Passore), may be due to the scarcity of the trees and to the fact that fruits are

exploited intensively before maturity (Gijsbers et al, 1994). The total and premature exploitation of the néré fruits is also mentioned by Guénéba (1994) as a danger to the regeneration of the species.

In our studies no indications were found for the regeneration of the species either by planting or seeding. The Mossi farmers do not to seem to consider that this activity is necessary (Roovers, 1995; Timmer 1994; Van der Vleuten, 1995). Inadvertent or purposeful spreading of seeds through animal manure does not occur, because after digestion seeds loose their germination power (Nikiema, 1993). But amongst other ethni in other parts of Burkina Faso, farmers have been reported to increase the number of Néré on their fields by seeding. This practice seems to be widespred amongst the Gourounsi (Guenéba, 1995). It has also been observed that woman of the Bobo seed Néré secretly on the fields of their husbands; they will benefit from the fruits of the tree while their husband will suffer from the decrease in cereal harvest. In other regions, however, such as the Sissili province for instance, people think that "each person who plants a tree dies before he can taste the trees fruits". Obviously, this limits the willingness to actively regenerate the trees (Ouédraogo, 1995). A special case of "assisted regeneration" from seeds is present along the railroad Abidjan-Ouagadougou. Here rather extensive populations of Néré have emerged as a result of thrown away seeds. These were leftovers from the Néré-based rations that the labourers carried with them during periods of forced labour. The same phenomenon can be seen at Kénédougou where populations of Néré result from massive deplacements of Samory Traorés army in 1887-1888 (Ouédraogo, 1995).

In Burkina Faso planting of Néré trees is normally not practiced as planted trees show a tendency to die soon after planting (Guénéba, 1994). However some farmers transplant natural seedlings from under the Néré canopy to other places on their own fields.

6.4.2 **Detarium**

For Detarium generative regeneration from seeds mostly seems to be absent because seedlings appear to have a high mortality. After germination, the seedling invests its energy first in root development and the aerial parts die off in the dry season. Only after three to four years the aerial parts can withstand the dry period (Roovers, 1995). This phenomenon gives the impression that generative regeneration is very difficult.

However, the species is easily propagated by vegetative regeneration. After cutting many new shoots are formed from the trunk. And when roots are wounded e.g. during ploughing, many shoots are formed from the roots. Under stress situations such as bush fires or severe droughts, the tree drops many of its branches, leaving an almost bare trunk. But once the stress is over, new branches grow from the wounds of the old ones (Roovers 1995; Van der Vleuten 1995). This excellent vegetative propagation is well known to farmers, who may even stimulate it.

7 DISCUSSION AND CONCLUSION

7.1 The pluriform nature of indigenous management of tree resources

The data about the different ways in which Néré and Detarium are managed support the view, that the management practices are primarily directed at specifically valued components of the woody vegetation rather than at the vegetation in its totality. As various woody components are valued differently in dependence on their intrinsic characteristics, the indigenous management of forest resources is characterized by pluriformity. Such pluriformity may relate to both actual practices being carried out as well as the organizational basis of the management.

The pluriformity of indigenous management is demonstrated by the variation in management practices for either Néré or Detarium. Various factors influence the kind of management practices which are executed as well as their intensity, such as the location where the trees are growing. The management practices vary between different land-use zones with management practices on the silvopastoral lands being less intensive than those in the farmed parklands. On the farm lands the management practices are prediminantly based on individual rights, but these rights are not exclusive as demonstrated by the example of Néré. On these lands the most intensive forms of management are found including measures for stimulating productivity and sometimes even regeneration. On the silvopastoral lands management is mostly based on priority rights to products by either descent or residence groups. On these lands the management practices are often restricted to measures for controlled utilization. In case that regeneration is stimulated, this mostly results from the specific characteristics of trees resprouting after cutting than from specific practices to stimulate propagation. On both the farmed parklands and the silvopastoral lands the management practices are primarily directed at regulating the distribution of valuable products and maintaining the productive properties; only on the farmed parklands some additional attention is also given to limit the effects of trees on the associated crops.

With respect to its organization, indigenous forest resource management may be based on either a group or an individual activity. As demonstrated by the example of the Néré, which was originally managed on communal basis with the 'chef du terre' having priority rights to the fruits, but which management is now mostly privately organized, in some cases practices which were originally based on the regulation of group activities are now becoming privatized. It has been hypothesized that such privatization is related to increased labour inputs (Shepherd, 1992). When comparing Néré with Detarium it is obvious that the mostly privately-owned Néré trees are managed more intensively than the Detarium trees which often cannot be privately claimed. This observation is in agreement with this hypothesis. As discussed in paragraph 2, such intensification may result from various processes. On basis of our findings it seems most probable that the intensification of the Néré management has been stimulated by the increased commercial demands for its products in combination with the decrease in its natural regeneration due to more intensive land use and drought. However, relations such as those between commercialisation and privatization are anything but straighforward. The example of the Detarium village forest indicates that under certain conditions increased marketing opportunities may result in new group management activities rather than in privatization.

With respect to management practices a clear gender differentiation may also be noted. Sometimes it is suggested that men are primarily involved with managing tree resources (especially construction wood) for commercial purposes, while women have the responsibility for collecting and maintaining tree resources used for food, cooking and medicinal use at household level. Our data indicate that such a dichotony is too simple. In Burkina Faso both men and women are involved in marketing non-timber tree products. But these sales concern different species; Néré products are marketed by women, while Detarium fruits are sold by men. For both species sometimes a competition between the tasks of women and men may be observed. As witnessed by the secret seeding of Néré by women on crop fields (Guenéba, 1995) for this species fruit production by women competes with the grain production by men. And the example of the Dogon region (Van Beek & Banga, 1992) illustrates that for Detarium fruit production by men may compete with fuelwood production by women. Such competition should not be viewed to strictly, however. For although women are generally responsible for manufacturing and marketing of Néré products, this does not mean that men are not involved in managing Néré trees. On the contrary, various management practices such pruning and ringing are carried out by them.

As a result of the pluriform nature of the indigenous management of the woody resources and the many intricaties influencing the kind and intensity of the management practices , a large differentiation in management types may be distinguished. These differences are not discrete, however. Rather there exists a continuum in practices from the management in the silvopastoral lands to the management on private farmlands. As noted already in paragraph 3, in several cases tracts of land alternate over time between farmed parkland and silvopastoral land use. When the land is farmed mostly private tree rights predominate, but when the lands are under old bush fallow often group rights reassert themselves (Shepherd, 1992). In other cases there may exist discrete boundaries between the farmed parklands and silvopastoral areas. Under such conditions a certain tree species may occur on both land-use types. In this case management tends to be more intensive on the private farmlands than on the silvopastoral lands, but such differences are gradual rather than distinct.

7.2 Development options

As indicated by the various indigenous management practices for both Néré and Detarium, valuable tree species may be managed by controlling access to trees as well as by carrying out measures to stimulate the production of desired products. At present, some of these control measures seem to become less important as a result of the breakdown of the traditional authority of the village leaders. However, such loss of traditional authority does not automatically result in the breakdown of the indigenous management practices. Rather it may result in a further adaptation of the management system. This is demonstrated by the replacement of the traditional communal control practices for collecting Néré fruits by individual control practices. In some cases also new control measures emerged based on the new forms of community authority, as demonstrated by the example of the establishment of the Detarium village forest stimulated by the newly appointed 'paysan forestière'.

A much more important limiting factor on the indigenous management practices is the introduction of the official state legislation on forest management. Formal regulations have put the responsability for managing trees with forestry agents (MTET, 1983), disregarding

the fact that in many areas well-functioning indigenous management systems were already present (Ouédraogo, 1995). For instance, farmers who recognize that a Néré tree will not continu to produce well without regular pruning, often play hide and seek with the forestry agents and they apply their management practices illegally for the better of the tree (Timmer et al, 1994; Ouédraogo, 1995; Guénéba, 1994). In some cases, the gouvermental forestry agent acknowledges that the indigenous management practices such as pruning of Néré trees is advantageous. But still they forbid it as cutting of all wood and especially of protected trees like Néré is forbidden by law (Timmer et al, 1994; Roovers, 1995: Van der Vleuten 1995).

The strict adherence to official regulations sometimes have rather contradictory results. For instance, cutting all shoots from Detarium is allowed during the clearing of the land. In this case Detarium is considered to be a shrub for which no permission is needed to clear it. But when a farmer leaves one shoot to grow till it has reached a dimension which is suitable for construction wood, it may no longer be cut as it is now considered as a tree protected by law (Van der Vleuten, 1995).

The strict government regulations leave little room for further improvement of the indigenous management. Consequently, little efforts are given to develop the indigenous management practices further and/or to train farmers in how to optimize their management practices. For instance, only in a few cases initiatives have been undertaken to train farmers in the application of improved pruning techniques. Van der Vleuten (1995) described such an initiative being undertaken around Nobéré to train farmers how to make a proper cut in order that the wound will not become infected. Unfortunately the training was based on european practices and the proposed cutting tools were not available on farmers level, if even available in Burkina at all.

Obviously there is a good scope for further development of the indigenous management practices. Already valuable recommendations might result from studies aimed at obtaining a better understanding of the farmers practices and testing the effect of them in a systematic way (e.g. Cisé, 1984). If the gouvernment of Burkina Faso is serious about stimulating community involvement in natural resource management, it should take the indigenous management serious and consider how such management practices could be included in the forestry law. This would bring with it an important change in the present policy which is directed at the total protection of trees and forests ("forêt classé"), and which forbids any exploitation of living wood by the population. Recently a first step in this direction was made by starting some trials (BKF-projects) to allow controlled wood exploitation. A next step might be to allow controlled management of parkland trees, based on traditional practices which have proved their utility. Further research may reveal more practices worthwhile for further development. In case that forestry agents would participate in such research, they may be easier to convince that certain practices do not endanger tree survival but on the contrary ameliorate tree performance. And a subsequent joint training of forestry agents and farmers in promising techniques would be useful in order to prevent abuse by ignorance by either farmers or forestry agents.

7.3 Conclusion

Although this report is dealing with two tree species only, still the data support the view, that indigenous management of woody resources should be constructed as involving the maintenance and manipulation of a spectrum of specific tree species rather than of spatially-delineated (agro)ecosystems (Sow & Andersen, 1996). As a result of this 'diversified resources' management strategy a continuum in management characteristics is present. Within this continuum two dimensions can be discerned: a continuum from forest stands to isolated trees growing on croplands, and a continuum in management institutions from communal to private. The management intensity of the woody resources depend on both their value to the local communities as well as their presence in specific tenurial niches (*sensu* Fortmann & Nihra, 1992). On communal lands the management practices primarily consist of measures for controlled utilization. The management practices are mainly conservation-based and aim at equitable sharing of the products, but do not involve much measures for improving production or stimulating regeneration of specifically valued species. On the private (crop)lands more intensive management practices prevail: not only measures to control use, but also measures to stimulate production and regeneration of specific tree species as well as to limit negative effects of trees on crops may take place (Nortier, 1996b). This information is in agreements with the observations of Gilmour (1990) and Shepherd (1992) about the relations between institutional characteristics of indigenous forest management and the intensity of management practices. It reflects the tendency that tree ownership rights tend to become stronger under the more intensive management as characterized by increased labour inputs (Shepherd, 1992). But this trend is highly influenced by government regulations and the way in which they are enforced.

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REFERENCES

Arnold, J.E.M. & P.A. Dewees (1995) Tree management in farmer strategies; responses to agricultural intensification. Oxford University Press, Oxford, UK.

Beek, W.A.E. van & P.M. Banga (1992) The Dogon and their trees. In: E. Croll & D. Parkin (eds), Bush base: culture, environment and development. Routledge, London, p. 57-75.

Bergeret, A. & J.C. Ribot (1990). L'arbre nourricier en pays Sahélien. Paris, Editions Maison des Sciences de l'Homme.

Bertrand, A. (1985) Les nouvelles politiques de foresterie en milieu Sahélienne. Cahiers de la Recherche Développement 8: 25-34.

Bognetteau-Verlinden, E., S. van der Graaf & J.J. Kessler (1992) Aspects de l'aménagement intégré des ressources naturelles au Sahel. Wageningen Agricultural University, Tropical Resource Management Papers No. 2, 104 pp.

Breman, H. & J.J. Kessler (1995) Woody plants in agro-ecosystems of semi-arid regions, with an emphasis on the Sahelian countries. Springer Verlag, Berlin.

Campbell, B., I. Grundy & F. Matose (1993) Tree and woodland resources - the technical practices of small-scale farmers. In: P.N. Bradley & K. McNamara (eds), Living with trees, policies for forestry management in Zimbabwe. World Bank Technical Paper No. 210:29-62.

Cisé, M.I. (1984) Synthèse des essais d'ébranchages pratiqués sur quelques arbres fourragers sahéliennes de 1978 à 1983. ILCA/CIPEA, Bamako, Programmes des zones aride et semi-aride.

Costes, E. (1983) Traumatismes destinés à améliorer la production des arbres fruitiers tropicaux, Traditions et avenir des techniques de taille, DEA d'écologie tropicale, Université des Sciences et Techniques du Languedoc, Académie de Montpellier

CTFT (1989) Faidherbia albida (Del.) A.Chev. (synonym Acacia albida Del.): a monograph. Centre Technique Forestier Tropical, Nogent-sur-Marne, France, 66 p.

Fortman, L. & C. Nihra (1992) Local management of trees and woodland resources in Zimbabwe: a tenurial niche approach. Oxford Forestry Institute, Oxford, UK, O.F.I. Occasional Papers No. 43.

Freudenberger, M.S. (1993) Tree tenure and farmed parkland agroforestry systems in the Sahel: constraints and opportunities. Paper ICRAF/IRBET/CILSS/LTC International Symposium on agroforestry parklands. Ouagadougou, Burkina Faso.

Fries, J. (1991) Management of natural forests in the semiarid areas of Africa. Ambio 20(8): 395-400.

Gautier, M. (1987) La culture fruitière. Volume 1: L'arbre fruitier. Agriculture d'aujourd'hui, Lavoisier, Paris.

Gijsbers, H.J.M., J.J. Kessler & M.K. Knevel (1994) Dynamics and natural regeneration of woody species in farmed parklands in the Sahel region (Province of Passore, Burkina Faso), Forest Ecology and Management 64: 1-12.

Gilmour, D.A. (1990) Resource availability and indigenous forest management in Nepal. Society and natural resources 3: 145-158.

Guénéba, K.I. (1994) Etude socio-economique de la gestion de Parkia Biglobosa (Jacq) R.Br. Ex G. Don (Néré) au Burkina Faso, Mémoire de fin d'études, Institut du Développement Rural & Centre National de Semences Forestières, Ouagadougou, Burkina Faso

Guinko, S. (1984) La vegétation de la Haute Volta. Thèse doctorat d'état Sciences Naturelles, Université Bordeaux II, France.

Hopkins, H.C & F. White (1984) The ecology and chorology of Parkia in Africa, Bull Jard Bot Nat Belg 54: 235-266

IRBET/CNRST (1996) Assistance scientifique au Projet Aménagement forestier PNUD/BKF/93/003. Rapport No. 001. Ministère d'Enseignement Supérieure & Recherche SCientifique/Ministère d'Environnement et d'Eau, Ouagadougou, Burkina Faso.

Kajembe, G.C. (1994) Indigenous management systems as a basis for community forestry in Tanzania: a case study of Dodoma urban and Lushoto Districts. Wageningen Agricultural University, Tropical Resource Management Paper No. 6.

Kater, L., S. Kanté & J.L. Sanogo (1992) Agroforesterie au Mali-sud: Karité et Néré associés aux cultures, Etude de l'influence du karité et du Néré sur le coton, le sorgho et le petit mil à Koutiala et à Kadiolo. DRSPR Sikasso, Mali, rapport de recherche.

Kessler, J.J. (1992) The influence of karité (Vitellaria paradoxa) and néré (Parkia biglobosa) trees on sorghum production in Burkina Faso, Agroforestry systems 17: 97-118

Kessler, J.J. & J. Boni (1991) L'Agroforesterie au Burkina Faso. Ministère de l'Environnement et du Tourisme, Ouagadougou, Burkina Faso & Université Agronomique de Wageningen, Les Pays-Bas, Tropical Resource Management Papers No. 1.

Kessler, J.J. & K.F. Wiersum (1992) The multi-dimensional nature of silvopastoral areas in the Sahel region. In: R. de Jong, T. Nolan & J. van Bruchem (eds), Natural resource development and utilization. Future research and technology management in soil-plant-animal-human systems. Commission of European Communities & Wageningen Agricultural University, Wageningen, p. 143-145.

Kessler, J.J. & K.F. Wiersum (1995) Forest policy development in the Sahel: contexts, processes, contents and impacts. Antenne Sahélienne Université Agronomique Wageningen, Pays Bas & Université de Ouagadougou, Burkina Faso, Document de projet No. 34, 34 p.

Malgras, R.P.D. (1992) Arbres et arbustes guérisseurs des savanes maliennes. Efitions Karthala, Paris, France.

Mathias-Mundy, E., O. Muchena, G. McKiernan & P. Mundy (1992) Indigenous technical knowledge of private tree management: a bibliographic report. Technology and Social Change Program, Iowa State University, Ames, Iowa, USA, Bibliographies in Technology and Social Change No. 7, 175 pp.

MTET (1983) Réglementation Forestière (matière ligneuse). Ministère des Transports, de l'Environnement et du Tourisme, Ouagadougou, Burkina Faso.

Mortimore, M. (1995) Caring for the soil. Agricultural expansion, population growth, and natural resource degradation in the Sahel. In: A. Reenberg & H.S. Marcussen (eds), The Sahel, ethnobotany, agricultural and pastoral strategies, development aid strategies. Sahel-Sudan Environmental Research Initiative, Copenhagen, Denmark, SEREIN Occasional Paper No. 1:55-77.

Niamir, M. (1990) Herder's decision making in natural resource management in arid and semi-arid Africa. Forestry Department, FAO, Rome, Community Forestry Note No. 4.

Nikiema, A. (1993) Regeneration of Parkia biglobosa (Jacq. R. Br. ex G. Don.) in an agroforestry system, M.Sc. Thesis, Department of Forestry, Wageningen Agricultural University, Netherlands

Nikiema, R. (1993) Commercialisation des produits alimentaires et forestiers provenant des parcs agroforestiers, synthèse de deux études réalisées dans deux provinces du Burkina Faso. Paper ICRAF/SALWA Atelier National sur les "Parcs Agroforestiers", CNRST/IRBET, Ouagadougou, Burkina Faso.

Nortier, N.T. (1996a) Boomgebruik in Burkina Faso (Tree utilisation in Burkina Faso). Antenne Sahelienne, Université Agronomique Wageningen, Les Pays-Bas, Rapport des étudiants No 63.

Nortier, N.T. (1996b) Niet-houtige boomprodukten in Burkina Faso: beheer en gebruik (Non-timber treeproducts in Burkina Fasao: tree management and use of products). Antenne Sahelienne, Université Agronomique Wageningen, Les Pays-Bas, Rapport des étudiants No 64.

Ouedraogo, A.S. (1995) *Parkia biglobosa* (Leguminosae) en Afrique de l'Ouest: Biosystématique et amélioration. Dissertation Wageningen Agricultural University, The Netherlands

Ouedraogo, S. (1993) Les parcs agroforestiers au Burkina Faso, Document de travail préparé pour ICRAF/SALWA, Atelier National sur les "Parcs Agroforestiers", CNRST/IRBET, Burkina Faso

Pasgo, L.J. (1990) Utilisation et commercialisation des produits ligneux et non ligneux des essences forestières locales dans le Département de Zitenga. Mémoire de fin d'études à l'Institut du Développement Rural (IDR), Université de Ouagadougou.

Persoon, G. (1992) Ecological balance and innovations: cases from the forest. In: J.P.M. van der Breemer, H.T. van der Plas & H.J. Tieleman (eds), The social dynamics of economic innovations. Studies in economic anthropology, DSWO Press, Leiden University, the Netherlands, Studies in Social Anthropology No.10: 113-127.

Poel, P. van der, B. Kaya & A. Coulibaly (1992) Bois et arbres a Minso/Sokoro, Leur presence, utilisation et droits dans deux villages pres de Tominian, DRSPR Sikasso, Mali, Rapport de recherche.

Pullan, R.A. (1974) Farmed parklands in West Africa. Savanna 3(2): 119-141.

Raintree, J.B. (1991) Socio-economic attributes of trees and tree planting practices. FAO, Rome, Community Forestry Note No. 9.

Raison, J.P. (1988) Les 'Parcs' en Afrique: état des connaissances et perspectives de recherches. Centre d'études africaines, EHESS, Paris, Document de Travail

Rocheleau, D.E. (1987) The user perspective and the agroforestry research and action agenda. In: H.L. Gholz (ed), Agroforestry: realities, possibilities and potentioals. Martinus NIjhoff, Dordrecht, Netherlands, p. 59-87.

Roovers, J. (1995) Etude par des arbres fruitiers de Burkina Faso: *Detarium microcarpum*, son phénologie, son milieu et son utilisation, et *Parkia biglobosa*, une essai sur la taille. Antenne Sahelienne, Université Agronomique Wageningen, Les Pays-Bas, Rapport des étudiants No 42.

Sabiiti, E.N. & J. Cobbina (1992) *Parkia biglobosa*: a potential multipurpose fodder tree legume in West Africa. International Tree Crops Journal 7: 113-139.

Savenije, H. (1993) Sylvicultural management practices in the Sudan and Sahel zone with emphasis on the silvopastoral vegetations, a compilation of literature. Antenne Sahélienne de l'Université Agronomique Pays Bas & Université de Ouagadougou, Burkina Faso, Programme de Recherches SPS (Aménagement et Gestion de l'Espace Sylvo-pastoral au Sahel), Document de projet No. 17.

Scherr, S.J. (1995) Meeting household needs: farmer tree-growing strategies in western Kenya. In: J.E.M. Arnold & P.A. Dewees, Tree management in farmer strategies; responses to agricultural intensification. Oxford University Press, Oxford, UK, p. 141-173.

Scholten, A. (1993) Rapport d'étude, partie 2. Le bilan du système de paysan forestier au Sanmatenga. SNV Association Néerlandais d'assistance au développement & Département Forestier de l'Université de Wageningen, the Netherlands.

Shepherd, G. (1992) Managing Africa's tropical dry forests, a review of indigenous methods. Overseas Development Institute, London, UK, ODI Agricultural Occasionsal Paper 14.

Smeenk, A. (1991) L'arbre et le rôle de ses produits alimentaires au marché et au ménage. M.Sc. thesis, Forestry Department, Wageningen Agricultural University.

Sow, M. & J. Andersen (1996) Perceptions and classification of woodland by Malinké villagers near Bamako, Mali. Unasylva 47(186): 22-27.

Sow, M. & J. Andeson (1996) Perceptions and classification of woodland by Malinké villagers near Bamako, Mali. Unasylva 47(186): 22-27.

Timmer, L.A. (1994) Le Néré taillé, Une étude sur les buts et les types de taille de Néré (Parkia biglobosa (Jacq.) Benth.) et la relation avec sa structure. Antenne Sahélienne, Université Agronomique Wageningen, Les Pays-Bas, , Rapport des étudiants No 27,

Timmer, L.A., J.J. Kessler & M.A. Slingerland (1996) Pruning of Néré trees (Parkia biglobosa (Jacq.) Benth.) in Burkina Faso, West Africa, as a silvicultural practice in semi-arid regions. Agroforestry systems 33: 87-98.

Tomlinson, H., Z. Teklehaimanot, A. Traore & E. Olapade (1995) Soil amelioration and root symbioses of *Parkia biglobosa* (Jacq.) Benth. in West Africa. Agroforestry Systems 30: 145-159.

Tromp, J., H. Jonkers & S.J. Wertheim (1976) Grondslagen van de fruitteelt: de fysiologie van de fruitboom. 's Gravenhage, the Netherlands.

Vandenbeldt, R.J. (1992) Faidherbia albida in the West African semi-arid tropics: proceedings of a workshop. ICRISAT, Patanchery, India, 208 p.

Vleuten, J. van der (1995) Gestion traditionelle de Parkia biglobosa et Detarium microcarpum: une étude sur la taille et bague de Parkia et des characteristiques important pour la developpement d'un système de gestion de Detarium. Antenne Sahelienne, Université Agronomique de Wageningen & IAHL Velp, Les Pays-Bas, Rapport des étudiants No 75,

Wiersum, K.F. (1993) Systèmes indigènes d'exploitation et de gestion de la végétation boisée au Sénégal. In: J.P.M. van den Breemer, R.R. Bergh & G. Hesseling (eds), La foresterie rurale au Sénegal, participation villageoise et gestion locale. Leiden University, the Netherlands, Leiden Development Studies No. 12: 135-154.

Wiersum, K.F. (1995) Forestry and rural development. Lecture notes. Forestry Department, Wageningen Agricultural University.

Wiersum, K.F. (1996) Domestication of valuable tree species in agroforestry systems: evolutionary stages from gathering to breeding. Paper International Confeernce on Domestication and commercialization of non-timber forest products in agroforestry systems, ICRAF, Nairobi.

Wiersum, K.F. (1997) Indigenous exploitation and management of tropical forest resources: an evolutionary continuum in forest-people interactions. Agriculture, Ecosystems and Environment (in press)

Wiersum, K.F. & B.E.J.C. Lekanne dit Deprez (1995) The forestry agent at the interface between local-level environmental management and external policies: reflections on forestry interventions in the Sahel. In: C.A. Drijver, B. Venema & J.P.M. van den Breemer (eds), Local resource management in Africa. J. Wiley, Chichester, UK.

Zida, D. (1990) Utilisation et commercialisation des produits ligneux et non ligneux des essences forestières locales dans le Département de Yako, province du Passoré. Mémoire de fin d'études à l'Institut du Développement Rural (IDR), Université de Ouagadougou.

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AUTRES PUBLICATIONS

- Hien, F.G. (1995). La régénération de l'espace sylvo-pastoral au Sahel: Une étude de mesures de conservation des eaux et des sols au Burkina Faso. Tropical Resource Management Papers No. 7, WAU, Wageningen, Pays-Bas.
- Kessler, C.A., W.P. Spaan, W.F. van Driel et L. Stroosnijder (1995). Choix et modalités d'exécution des mesures de conservation des eaux et des sols au Sahel. Tropical Resource Management Papers No. 8, WAU, Wageningen, Pays-Bas,94p.
- Zeeuw, F. de (1995). Sécurité foncière et gestion des ressources naturelles dans la Boucle du Mouhon - Burkina Faso. Tropical Resource Management Papers No. 9, WAU, Wageningen, Pays-Bas, 45 p.
- Kiepe, P. (1995). No Runoff, No Soil Loss: soil and water conservation in hedgerow barrier systems. Tropical Resource Management Papers No. 10, WAU, Wageningen, Pays Bas.
- Slaats, J. (1995). Chromolaena odorata fallow in food cropping systems; an agronomic assessment in South-West Ivory Coast. Tropical Resource Management Papers No. 11, WAU, Wageningen, Pays-Bas.
- Reuler, H. van (1996). Nutrient Management over Extended Cropping Periods in the Shifting Cultivation System of south-west Côte d'Ivoire. Tropical Resource Management Papers No. 12, WAU, Wageningen, Pays-Bas
- Oneka, M. (1996). On Park design:looking beyond the wars. Tropical Resource Management Papers No. 13, WAU, Wageningen, Pays Bas.
- Graaff, J. de (1996). The price of Soil Erosion: an economic evaluation of soil conservation and watershed development. Tropical Resource Management Papers No. 14, WAU, Wageningen, Pays Bas.
- Sterk, G. (1997). Wind Erosion in the Sahelian Zone of Niger: processes, models, and control techniques. Tropical Resource Management Papers No. 15, WAU, Wageningen, Pays Bas.
- Mando, A. (1997). The role of termites and mulch in the rehabilitation of crusted Sahelian soils. Tropical Resource Management Papers No. 16, WAU, Wageningen, Pays Bas.