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SUSTAINABLE LAND MANAGEMENT AND TREE TENURE: THE CASE OF *PARKIA BIGLOBOSA* IN THE NORTHERN REGION OF GHANA

Esther Ekua Amoako
University for Development Studies
Faculty of Renewable Natural Resources
Department of Ecotourism and Environmental Management
P.O. Box 1882, Tamale, Ghana
ekubee@yahoo.com

Supervisor
Dr Karl Benediktsson
University of Iceland
kben@hi.is

ABSTRACT

The African locust bean tree (*Parkia biglobosa*) is a multipurpose species found in savannah agroforestry parklands, important for preventing land degradation as well as for providing food and other products. The study focuses on how traditional land and tree tenure arrangements affect tree populations in three traditional areas in the Northern Region of Ghana (Dagomba, Gonja and Mamprusi) and the implications of these arrangements for sustainable land management. A total of six focus group discussions were held in the three study communities and six key informants, two from each community, were interviewed. The discussions and the interviews were intended to solicit information on the system of tenure in the three traditional areas. A tree census was conducted to estimate the densities of *Parkia biglobosa* in crop fields and fallow fields. All interviewees and focus groups recognised the importance of *P. biglobosa* as an integral component of their livelihood. Medicinal, food, environmental and socio-economic benefits of the tree were identified. Tree densities differed considerably, being lowest in the Mamprusi. Respondents from focus groups and key informant interviews indicated that women, men and children have access to tree products. People need permission to have access to the products in the Dagomba traditional area. Women and men have rights of access but not control over the trees in all three areas. Tenant families do not have access to and control over trees on farmlands. Recent reductions in tree populations were attributed to bush burning, the use of modern implements in agriculture, high demand for fuel wood, negligence and, in the Mamprusi traditional area, the inactivity of traditional authority. The study shows that differences in tenure systems in the three traditional areas have implications for *Parkia biglobosa* populations and also for sustainable land management. Traditional tenure systems with some forms of regulation seem to protect the trees from destruction compared to the kind of open access system identified in the Kperiga in the Mamprusi traditional area.

Keywords: *Parkia biglobosa*, tree tenure, sustainable land management, traditional areas, Ghana

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1. INTRODUCTION

The use of land for diverse productive purposes provides a major share of livelihood and income in many countries in Africa (Toulmin 2009). However, pressure from population growth, urbanization, and indiscriminate extraction of land resources has rendered land an increasingly scarce resource. Sustaining the productive capacity and continuous use of land is therefore highly necessary. People use several strategies and techniques to ensure sustainable land use. One of the most pressing concerns of researchers and development practitioners in land resource management is to encourage and stimulate those indigenous land use practices that may increase, in a sustainable manner, the productivity of the land to provide food and income for the rural people. It is imperative to create conditions that allow communities to be innovative in their natural resource management issues, building on tradition where appropriate but being open to modifications and new institutional solutions (Gyasi et al. 2004; Hagen 2008; Gyasi 1995).

Trees play a very important role in sustainable land use, land rehabilitation and environmental sustainability as a whole. One of several integrated strategies used for ensuring sustainable land management centres on protecting trees on farms, and even planting trees where they are absent. This is commonly referred to as *agroforestry* (Fifanou et al. 2011). Indigenous trees are important components of the agricultural landscape in West Africa, especially in the semi-arid 'agroforestry parklands', where scattered trees are present in crop fields. Most farmers reportedly retain trees in cultivated fields for their valuable products and the service role they play in the soil. However, the pressure on land to meet the food demands of the ever growing population has resulted in decreasing numbers of indigenous trees (Boffa 1999; Poudyal 2011).

It is therefore important to protect indigenous tree species and habitats in order to conserve trees which are under increasing threat from modern methods of farming, bush burning, pollution, urbanisation and population growth, the combined effect of which has been devastating. Urgent actions are required in some cases to prevent the species and habitats from completely disappearing (Amissah 2009).

In the past, communities in Ghana have used traditional methods – exclusive user rights and taboos among others, to manage their natural resources. However, recent socio-economic changes and modern religious beliefs have also put these methods under stress, resulting in unsustainable use of resources. Besides, previous approaches by governments and some development agents were often disruptive of the traditional methods and apparently excluded indigenous knowledge and communities in resource management. This approach usually resulted in conflicts between governments and rural people. A paradigm shift has occurred in resource management, which assumes a more inclusive approach. Tapping into indigenous knowledge of these methods and finding ways to improve upon them is seen as necessary in order to achieve the aim of sustainable land management (Sarfo-Mensah & Oduro 2007; Berry 2009).

In the Northern Region of Ghana, traditional agroforestry parklands have contributed significantly to the sustenance of poor rural people who derive their livelihood from agriculture and resources in the savannah ecosystem (Songsore 1996). However, about 30–40% of the land is now degraded through poor soil management, deforestation and overgrazing (SCI-SLM 2009). The area has low and erratic rainfall. Cultivation of crops and animal grazing mostly occurs in the parklands. Some common indigenous tree species found

in these agroforestry parklands are the African locust bean or dawadawa tree (*Parkia biglobosa*), the sheanut tree (*Vitellaria paradoxa*), kapok (*Ceiba pentandra*), baobab (*Adansonia digitata*), and mango trees (*Mangifera indica*). These are referred to as 'subspontaneous species', as most of the undesirable species have consciously been eliminated (Blench & Dendo 2004). Apart from food provision, the trees in these parklands are a major source of timber and non-timber products, which contribute to the livelihood of local communities and individuals (Schreckenberg 1996; Boffa 1999).

Parkia biglobosa is one of the predominant tree species in the Northern Region of Ghana and plays an important role in the lives of the people. The tree provides food, medicine and wood for buildings and fuel, and is very important in soil amelioration and environmental protection. It is commonly found within communities: in cultivated fields, bush fallows and settlements (Peiler 1994; Boffa 1999).

However, ownership and usufruct rights regarding trees take various forms within the Northern Region of Ghana. *Parkia biglobosa* is especially interesting in this regard. In some areas and among certain ethnic groups, such as the Dagomba, all trees in a particular area are owned by a title holder referred to as the *Dohinaa* (literally translated as 'dawadawa tree chief'; Dohi = dawadawa trees, naa = chief). The *Dohinaa* has the right to harvest the fruit of all dawadawa trees in his area, regardless of the ownership of the land itself. With the exception of community chiefs and some elders who normally own some trees, other community members acquire their permission if they want to harvest the fruit. This contrasts with other useful tree species, such as the sheanut tree (*Vitellaria paradoxa*), which are communally owned. The unique tenure arrangement for the *P. biglobosa* also confers some responsibilities to the *Dohinaa* for managing the trees and thus for ensuring their protection from destruction (Buabeng 1998; Sarfo-Mensah & Oduro 2007). This system of ownership is not prevalent among other major ethnic groups in the Northern region, such as the Mamprusi and Gonja. Tree tenure systems are thus complex and diverse and have enormous repercussions for sustainable land management.

The discrepancies between tree tenure and land tenure have invariably been an issue of considerable concern for sustainable land management in Ghana. This is particularly important in the management of economic / multipurpose indigenous tree species, as about 78% of the total land area in Ghana belongs to traditional land owners (Damnyag et al. 2011). In the Northern Region of Ghana, traditional tenure systems separate land tenure from tree tenure rights. This may affect different land users and may affect the resources. Damnyag et al. (2011) observed that land and tree tenure arrangements are among the major causes of depletion of land resources and deforestation in Ghana and most probably in agroforestry parkland in the Northern Region. Studies have revealed that tenant farmers do not take good care of *Parkia biglobosa* trees on farms in the Dagomba traditional area (Buabeng 1998; Poudyal 2011). Land tenure arrangements by leasehold and customary freehold apparently deny farmers and private owners (in the Dagomba traditional area) control and restrict access to these important trees. The consequence is a reduction in tree populations and increased land degradation, as the trees are not actively protected from destruction (Damnyag et al. 2011).

In the light of these observations, the research reported here sought to analyse the different ownership systems and management of *Parkia biglobosa* and assess the implications of different management systems for tree density and sustainable land management. Answers were sought to the following specific research questions:

A. What are the systems of *Parkia biglobosa* ownership in the Dagomba, Gonja and Mamprusi traditional areas and the relationships between the systems of ownership and tree population densities?
B. What are the implications of tree tenure for sustainable land management?
C. What are the perceptions of local people about the tree and land management in their communities?
D. What are the gender dimensions of tree ownership and management?

2. LITERATURE REVIEW

2.1 Sustainable land management, livelihood and tree tenure

At the core of the concept of sustainable land management is the awareness by land users of their own environment and the need to protect it from degradation, for the benefit of both the present population and future generations. The goal is to reconcile the dynamics of society with conditions and changes in nature so that the various services provided by ecosystems – livelihood, regulation of natural processes, cultural significance and other supporting services – can be maintained (Liniger et al. 2011). According to Zinck and Farshad (1995), sustainability also refers to the ability of a system to withstand internal and external stress from natural but mainly anthropogenic forces and how long the system needs to recover from such stress.

Sustainable land management thus considers time and other factors available for land resilience and for agro-ecosystems to be maintained through management. It involves a strong commitment to environmental quality and aims at curbing land degradation through means such as agroforestry, afforestation, reforestation, crop rotation, and conservation-oriented tillage practices. The incorporation of organic manure and the biological control of weeds and diseases are all intended to maintain or improve the productivity of soil and reduce pollution by agrochemicals (Zinck & Farshad 1995).

Ensuring sustainable land management is a way of improving rural livelihoods, the judicious use of indigenous multipurpose tree species and local innovations. Another strategy found to create a positive interaction between local communities and government is the provision of incentives that improve alternative sources of livelihoods while promoting environmental protection. These reduce the vulnerability of community livelihoods to environmental degradation, therefore demonstrating and encouraging sustainable land management (Berry & Olson 2001).

Land tenure defines how the right of access to and control over land and land resources is allocated. It is a longstanding area of concern in environmental and sustainable land management (Bugri 2008). Tenure rights vary according to community settlement history, population density, the availability of land, and cultural traditions regarding political authority. Generally five traditional forms of access to land have been identified: by first occupancy; by inheritance; by gift; by customary authority; and by borrowing. Traditionally, land in most parts of Africa is not individually or privately owned, because it is intended to ensure the continuous existence of clan, family and a group of people (Boffa 1999).

In West Africa, rights of land ownership are generally heritable. However, chiefs have greater authority than the ordinary people in most land transactions within their respective jurisdictions. Studies have shown that borrowing plays a positive role in the sustainability of

land use, because it creates the possibility for farmers to avoid over-cultivation of land with poor fertility, or prematurely taking the land out of fallow (Boffa 1999). A recent study conducted in the Northern Region of Ghana by Poudyal (2011) reports that various systems of tenure influence the behaviour of individuals, households and communities managing the land and other resources. The importance of a tree species and system of ownership invariably determines the management of the tree.

Similarly, Boffa (1999) reports that the management of trees is influenced by the type and intensity of the agro-systems associated with specific ethnic groups and even individuals. These factors thus determine the tree species structure, composition and density in agroforestry parklands across different ethnic locations.

Demographic changes, however, have an immense influence on the use and management of parklands. Poudyal (2011) confirms that increasing population growth and increasing demand for parkland products has led households to selectively eliminate species of less value and protect preferred tree species on and outside their farmlands, for their multipurpose (economic, socio-cultural, environmental) benefits. The study further observes that land tenure and tree tenure cannot be dissociated, since most cultural systems determine the tenants' access to and control over the trees and their products.

Nonetheless, community control and tenure over land, and presumably trees, is in most cases extensive. In Ghana, the National Land Policy declares the government's intention to collaborate with traditional authorities and other stakeholders to promote ecosystem maintenance and biodiversity conservation (Berry 2009). The policy thus recognizes that land tenure rights have implications for the management of trees and other natural resources. It has been observed that even though farmers in all areas of Ghana retain economic and multipurpose trees on their farms, the norm is that the traditional owner of the land has rights over the products of these trees, unless the owner has specifically transferred this right (Boffa 1999; Blench & Dendo 2004).

Indigenous people and small-scale farming communities are the prime users of land resources, which form a part of their historical heritage and which determine their livelihoods. The way nature is perceived, known and managed among indigenous peoples is determined by their socio-economic motives (Barrera-Bassols et al. 2006). Most rural livelihoods are natural resource dependent. It is therefore important that land use and management should be based on a multi-purpose natural resource management strategy that acknowledges the active interplay of human institutions, and ecological systems (Barrera-Bassols et al. 2006).

Afforestation, reforestation, and maintenance of traditional agroforestry parkland emphasise the long-term environmental benefits of woody species in sustainable land management. These benefits are particularly applicable to the fragile ecosystems of the Sahelian and Sudanian zones (Guinko & Pasgo 1992) . Woody species have proven to provide sustainable productive capacity of the agro-ecosystem and the environment as a whole. This is because fertilizer application may not be very effective in replenishing lost soil nutrients in savannah agro-ecosystems. Low or high rainfall affects utilization of nutrient resources within the short growing period and thus affects crop growth. For instance, Breman and Kessler (1995) observed higher soil nutrient content in the topsoil under tree canopies than in adjacent open land in semi-arid areas. It was indicated that soil fertility decreases with radial distance from the centre of the canopy or tree bole. Moreover, vegetation cover increases land productivity and potential through rainfall interception which reduces the direct impact of rain drops on the soil surface and promotes water infiltration and recycling of nutrients, among other benefits.

Nonetheless, the systems of access to, control and management of multipurpose woody species in different societies mostly determine the importance attached to the tree and hence its protection from destruction and control by other members of communities. This is such an important avenue for research since multipurpose trees such as *Parkia biglobasa* are integral in rural livelihoods and sustainable land management.

2.2 Parkia biglobosa

2.2.1 Botany and environmental conditions

Parkia biglobosa (Jacq.) R. Br. ex G. Don grows to a height of about 15–20 m and to 1.5 m in trunk diameter (Fig.1). They reach their maximum height after 30–50 years, and can grow for about 100 years (Sina & Traoré 2002). It has a wide umbrella-shaped crown (extending to about 10 m) but a relatively short stem, not always straight. The tree has greyish-brown scaly bark and has fine feathery bipinnate leaves made up of many leaflets and red, club-shaped flower heads about 5 cm in diameter (Peiler 1994; National Research Council 2006).

Fig 1. Parkia biglobosa *trees in agroforestry parkland in the Northern Region of Ghana (Photo: Eric Lawer).*

The tree may start flowering at 7 years while still relatively small. Flowering coincides with the shedding of leaves; new foliage, however, develops after peak flowering. At maturity, the ripe pods are dark brown in colour and contain numerous black seeds embedded in a powdery light yellowish and somewhat reddish endocarp (Sina & Traoré 2002). Seeds are globular ovoid, slightly flattened laterally. However, the testa is hard, smooth and lustrous with a tightly enclosing cotyledon. The pods measure about 15-45 cm long and 2 cm wide and appear in slightly bent, long hanging clusters. Flowering and fruiting occur in the dry season (Peiler 1994; Hall et al. 1996; Sina & Traoré 2002).

Parkia biglobosa grows where the mean annual rainfall is between 800 and 1500 mm. However, in Nigeria it has been found to grow in areas with rainfall as low as 650 mm. It

grows well within a mean annual temperature range of 25–29°C. The tree grows on a wide range of alluvial soils and is known to grow on shallow drift sands as well as deep soils with good drainage and good fertility. It also survives on poor, rocky sites, however. It is a characteristic component of wooded farmlands, often present in rangelands (Hall et al. 1996; National Research Council 2006).

2.2.2 Geographical distribution

Parkia biglobosa is essentially a savannah species, but also common in deciduous forests. In Senegal, it extends to the northern limit of the Sudanian Region; further east it is less widely found in the drier northern parts, but reaches the southern boundary of the Sahel in Nigeria and Niger. Thus the species is found in more than twenty countries in Africa, including Ghana (Fig. 2). It is also found in the Caribbean Islands (NRC 2006).

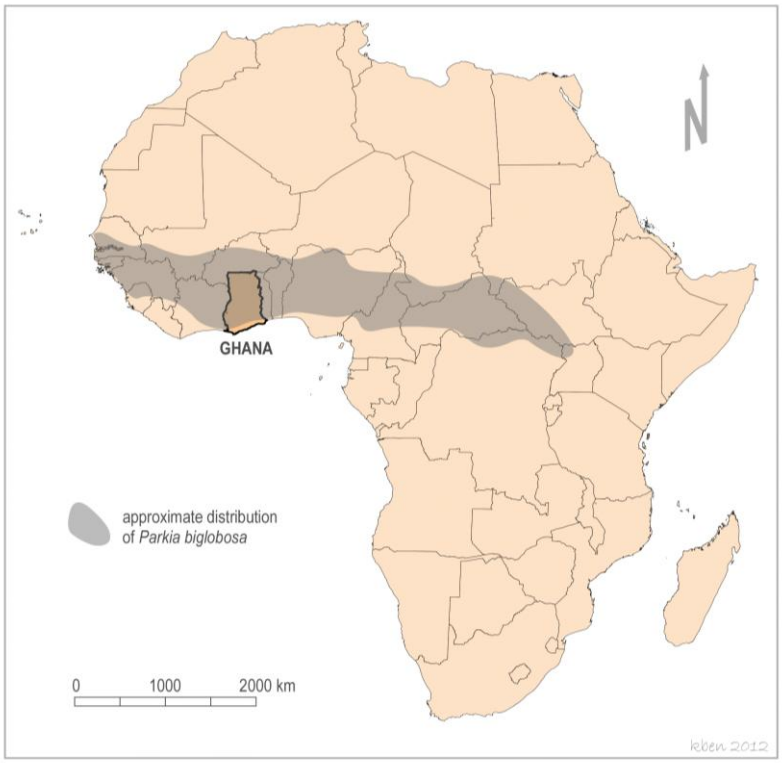

Fig. 2. *The distribution of* Parkia biglobosa *in Africa (Map: Karl Benediktsson, 2012, based on Boffa 1999).*

2.3 *Parkia biglobosa* in farming systems

Parkia biglobosa is well known to farmers in the savannah ecological zone. It is well adapted to the environment and has high economic value. The plant is preserved in fallow fields or compound farms[1] to provide edible fruit for humans or browse for livestock. It is also used as medicine (Sabiiti & Cobbina 1992; Boffa 1999; Koura et al. 2011).

The tree is not just an excellent windbreak and shade tree; it benefits the soil as well. Even though it is a legume, it does not nodulate. Nonetheless, the tree has an association with endomycorrhizal fungi, which improves nutrient uptake efficiency. Soils under the crowns are improved by the dung and urine of livestock that take shelter under the tree for shade and

[1] 'Compound farming' is a traditional farming system in tropical Africa, where subsistence crops, tree crops, and sometimes cash crops are grown mainly around homesteads (Torquebiau 1992)

sometimes for browse. Jonsson (1995) indicated that rangelands in Burkina Faso showed a higher nitrogen content in topsoil under *Parkia biglobosa* canopies than under canopies of *Vitellaria paradoxa*. Similarly, enhanced concentration of total nitrogen and available phosphorus was observed from soil samples taken at a 30 cm depth under crowns as compared to outside of the tree. High concentrations of organic matter and less acidity in soil were also recorded. It was further noted that the concentration of minerals increased with tree size (Kater et al. 1992; Tomlinson et al. 1995).

Farmers grow food crops such as sorghum and maize under its canopy, even though research has shown a decrease in yield of sorghum (Kessler 1992; Bazié et al. 2012). In Mali, Kater et al. (1992) found cotton production severely impaired under canopies of *Parkia biglobosa*. However, the same report indicated that millet was less affected by the tree. In addition to reduced crop yields, Kessler (1992) observed that weed growth was more abundant under the canopy of the tree than in open fields, contributing to poor crop growth.

Further, farmers in Benin reported that the tap roots and superficial roots of the tree present in the field hamper cultivation (Schreckenberg 1996). Tomlinson et al. (1995) indicated that competition between the tree and the roots of crops is another factor which may influence crop performance. However, it is likely that increased nutrient availability near the bole would compensate for the increased competition for nutrients under the tree crown. Figure 3 shows tree crop association in an agroforestry parkland in the Northern Region of Ghana.

Fig. 3. *Tree-crop association in the fields. (Photo: Eric Lawer)*

In addition to the important role that *Parkia biglobosa* plays in soil conservation and environmental protection, the leaves are occasionally eaten as a vegetable (Sina & Traoré 2002). The fruit that matures in the dry season provides a good food supplement for children at a time when food supplies in the home are almost depleted in many households. The yellow pulp, rich in carbohydrates and vitamin C, is normally processed into powder. Amongst the Dagombas in Northern Ghana, the powder is referred to as dozim *(Do = dawadawa zim =* powder). It is eaten as a sweet, especially by children, and may be added to porridge as a

sweetener instead of sugar. Decoctions prepared from the husks have been found to contain cementing agents which makes excellent painting for laterite earth or mud floors and walls (Fig. 4) (Adewoye et al. 1986).

The most important use of *P. biglobosa* is the fermentation of seeds to produce a nutritious condiment known as *soumbala* in French-speaking West Africa and *dawadawa* in Ghana and Nigeria. The seeds are an important source of protein for poorer families and the fermented product has often been referred to as a cheese substitute (Hall et al. 1997). A recent development has been the production of stock cubes and powder from fermented dawadawa seeds in Nigeria and Ghana. Hall et al. (1997) reported that dried seeds may be ground to produce a fine powder and macerated in water to form a drink. The seeds are also roasted to form a coffee substitute. Figure 5 shows washing of seeds for the preparation of the condiment.

Fig. 4. *Plastering of mud walls using decoctions from the husk of* Parkia biglobosa *(Photo: Margaret Shao 2002).*

Fig 5. *Washing of seeds to prepare dawadawa (Photo: Eric Lawer).*

The numerous benefits of *Parkia biglobosa* makes it an integral component of local livelihoods in Ghana and West Africa. Nonetheless, despite the positive attributes of the trees for land management and local livelihoods, people may destroy or cut down the trees for various reasons, both because of socio-cultural or economic reasons and tenure arrangements. Land and tree tenure arrangements may be a disincentive to the protection of trees such as *Parkia biglobosa* (Damnyag et al. 2011). This may have long term negative effects on the productivity of the land. The multipurpose nature of the tree and the special characteristics of its ownership and management thus make it an important focus in sustainable land management.

3. METHODS

3.1 Study area

The Northern Region, lying mostly between 8–10°N and 0–2°W, occupies an area of about 70,383 km^2 (UN 2004). It is the largest region in Ghana in terms of land area. The region shares boundaries with the Upper East and the Upper West Regions to the north and the Brong Ahafo and the Volta Regions to the south. The land is mostly flat, with an altitude of about 150 m above sea level. The region is drained by the Black and White Volta Rivers and their tributaries (Fig. 6).

Fig. 6 . *The districts of Ghana and the study communities (Map: Karl Benediktsson 2012).*

3.1.1 Climate and soils

The study area lies between sub-humid and semi-arid climatic regimes. Thus the region is relatively dry. The amount of rainfall recorded annually varies between 750 and 1050 mm. The temporal distribution of rainfall is unimodal, with the rainy season beginning in May and ending in October. The dry season starts in November and ends in March/April. Maximum temperatures occur towards the end of the dry season and minimum temperatures in December and January, with an annual mean temperature of 25°C. The *harmattan* winds, which occur during the months of December to early February, have considerable effect on the temperatures in the region, which may vary between 14°C at night and 40°C during the day (Blench 1999b; Kranjac-Berisavljevic et al. 1999).

Voltaian sandstones are predominant in the region, which is characterized by light sandy soils, but inclined to concretions and hardpan (Blench 1999b). There are granites which have better water retention capacity. The corresponding ochrosols are moderately drained and less prone to degradation than the sandy soils. Valley bottoms also contain higher amounts of fertile soils suitable for the cultivation of rice and vegetables.

3.1.2 Vegetation

The vegetation is guinea savannah which is gradually transforming into Sudan savannah woodland, characterized by drought-resistant trees such as the *Acacia spp*., *Adansonia digitata*, *Vitellaria paradoxa*, *Parkia biglobosa*, *Mangifera indica*, *Ceiba pentandra* and *Azachdiracta indica*, interspersed with grasses such as *Andropogon gayanus* and *Heteropogon contortus* (Blench & Dendo 2004).

The natural vegetation is gradually being depleted, as numerous trees of most species have been deliberately removed from the parklands. Annual bush fires are one of the contributory factors to the decreasing number of trees. The sacred groves found in communities, however, are a replica of the original or natural savannah ecosystem. (Blench & Dendo 2004; Sarfo-Mensah & Oduro 2007).

3.1.3 Population and social structure

The region has a population of nearly 2.5 million, representing over 10 per cent of the total population of the country (Ghana Statistical Service 2010). Population density is relatively low, or less than 37 persons per km^2. The majority of the population lives in the rural areas. The region has five paramount chiefdoms (traditional areas): Mamprusi, Dagomba, Gonja, Nanumba and Mo. Each traditional area represents a major ethnic group in the region. The population of these groups varies. The largest group is the Dagomba, with over 30% of the region's population (figures from the 2000 population census, taken from Jönsson 2007). The Mamprusi and the Gonja, each, comprise over 7% of the population. The ethnic groups of the Northern Region share certain prominent social attributes: all are hierarchical and patriarchal in traditional leadership structures (Jönsson 2007)

3.1.4 Agricultural systems

Agriculture accounts for more than 90% of household income and employs more than 70% of the population in the region (Nyari 2008a). It is mainly rain-fed, albeit with a few irrigation sites, and production is mainly for subsistence. The farming system usually involves a combination of growing food crops and keeping animals for multiple purposes. Among the

major crops grown are maize (*Zea mays*), millet (*Panicum miliaceum*), rice (*Oryza sativa*), yam (*Dioscorea* spp.), cassava (*Manihot esculenta,* specific to West Gonja district), and various pulses and vegetables. The farming practice in this area follows a traditional agroforestry system where staple crops are cultivated among indigenous economic trees for about 6-8 years. The cropped fields are allowed to rest for a fallow period of about 7–10 years to replenish soil fertility by natural regeneration after several years of continuous cultivation. Cropping is also done around the home compounds and in valleys or along water bodies. These compound farms are usually permanent, because the soils are replenished by the continuous supply of household waste and manure from livestock (Gyasi 1995).

The major staple foods (maize, millet, and yam) are grown by families for consumption at home and/or for sale and are managed by men. Women usually grow vegetables on marginal lands or intercropped in the compound farms. In most rural communities of the Northern region, women are engaged in farming activities as well as a wide variety of small-scale agro-processing for the local market as well as for home consumption. In addition to the cultivation of crops, the rearing of cattle, sheep, goats and fowls is an integral component of agricultural systems in the Northern Region.

The growing population is reducing the length and frequency of fallows in some area, thereby reducing the resilience of the land (Songsore 1996; Ngeleza et al. 2011). The application of animal manure to increase soil fertility is common, although the use of chemical fertilizers is regarded as more convenient. The hoe is the most important implement used for the work on the farm, although the use of bullock and tractor-drawn ploughs for land preparation has increased in the last 20 years. There are also considerable parkland areas which have not been cultivated, either because of low soil productivity or because they have been left to lie fallow for a very long period as agriculture in the area is changing from shifting cultivation to a more sedentary system.

3.1.5 Characteristics of the selected communities

Three communities were selected on the basis of a previous study by the author (Buabeng 1998), conducted to ascertain the impact of ownership and management on *Parkia biglobosa* production in the Dagomba area. A comparison of this system of management with that in two other traditional areas was seen as a fruitful way to extend this study. The communities selected were Damongo Zongo in the Gonja traditional area, Nafarang in the Dagomba traditional area, and Kperiga in the Mamprusi traditional area. The characteristics of each community are presented briefly below.

Damongo Zongo is a community within the capital of West Gonja district, Damongo. Farming and hunting are the basic occupations for men. The women are involved in farming but also in some local industries, e.g. *gari* (local food prepared from cassava) processing, shea butter extraction and petty trading. The district has a highly diverse population of 22 ethnic groupings, including nomadic herders who settle in the remote areas outside the communities. The major ethnic group, however, is Gonja. The Gonja traditional area has vast areas of land, larger proportions of which have never been cultivated or have been abandoned as farmland for a long time (referred to in this report as *wild*). The area is characterized by fairly good agricultural land. Damongo Zongo is about 20 km away from Mole National Park, which contains many species of wildlife.

Kperiga community is about 1 km from the district capital of West Mamprusi district, Walewale. Farming is the basic occupation of the inhabitants. Women are also involved in

petty trading. The major ethnic group is Mamprusi, with Kassena, Builsa and Frafra as some of the minority ethnic groups, who are mostly migrant settlers and tenant farmers from the neighbouring Upper East Region. The community is located within a district which is growing fast, with great expansion of human settlements and infrastructure in recent years. The community is characterised by less extensive fallow lands and uncultivated fields than Damongo Zongo and Nafarang.

Nafarang is one of the communities in the Tolon-Kumbungu district. The community is about 18 km west of Tamale, the capital of the Northern region. Nafarang is rural and represents a homogeneous Dagomba community. Farming is the primary occupation of the people. In terms of soil fertility, the community is located within one of the poorest districts in the Northern Region.

In order to facilitate comparison, some characteristics of the three study communities are summarised in Table 1.

Table 1. *Three selected communities and districts. Each community represents a traditional area in this study. 'Land pressure' refers to the demand for land for other uses other than leaving it in the original state.*

Community	District	Traditional area	Land pressure	Ethnic diversity
Nafarang	Tolon-Kumbungu	Dagomba	low	low
Damongo Zongo	West Gonja	Gonja	low	high
Kperiga	West Mamprusi	Mamprusi	high	moderate

3.2 Methodology

3.2.1 Sources of data

Both primary and secondary data were used in the study. Various secondary sources of information, including books and journals as well as published and unpublished reports and other materials, were used. Qualitative data were collected through key informant interviews and focus group discussions (cf. Sherry & Marlow 1999; Laws et al. 2003). A census of trees was also undertaken to collect quantitative data on tree densities in the three communities. Primary data were collected by two research assistants from the Department of Range and Wildlife and the Department of Extension and Resource Economics at the University for Development Studies in Tamale, and one contact person in each of the communities. The focus group discussions and key informant interviews were audio- and video-recorded and also recorded in writing. The package was sent to the author via email and airmail.

3.2.2 Key informant interviews

Interview guides (Appendix IA) were prepared and sent to two research assistants via email. The interviews were conducted in all the selected communities. Purposive sampling was used to select respondents for the key informant interviews. At Nafarang, one *Dohinaa* and one women's leader, or *magazia*, were interviewed. Two community leaders, female and male, were interviewed in Kperiga and also in Damongo. Thus a total of six key informants were

interviewed in the three communities. The main aim for the interviews was to solicit information about the systems and management of the trees in each of these communities.

3.2.3 Focus group discussions

Discussion guides (Appendix IB) were prepared and sent to the research assistants, who moderated the discussion sessions. This was essentially an outline of the key issues to be discussed by the groups. A total of six focus groups, each comprising a group of 6–12 people, were held in all three communities, or two in each (Appendix 2). The discussions were all held within a period of three days. They yielded qualitative data about the systems of management of the dawadawa tree, the role of the tree in sustainable land management, and people's views on the systems of management. Discussions were held separately for groups of men and women. The method was used to explore the systems of ownership in the three traditional areas, and to assess whether the various systems of tenure have implications for tree populations and how they affect community members at large. Data from the focus group discussions and key interviews were interpreted using standard qualitative data analysis methods.

3.2.4 Tree census

An enumeration of *Parkia biglobosa* was conducted to examine the impact of the different tree tenure systems on tree densities. The sampling was designed so as to give an estimate of the densities of trees in two land use types (crop fields and fallow fields) within the three communities. Areas of 10,000 m^2 (1 hectare) each of each land use, 1 km away from the community, were selected and four 20x20 m quadrates were selected within these areas. The number of *Parkia biglobosa* trees was recorded in each quadrate, taking into account both saplings and mature trees. A total of 24 quadrates were laid out in both crop fields and fallow fields in the three communities. The total number of trees in each quadrate and each land use type were extrapolated as a measure of density for the communities. The data were then used to compare the relationship between the communities and systems of ownership.

A handheld GPS (Geographical Position System) device was used for recording the coordinates of the communities, and sampled units. The coordinates of each sampled tree were used to create maps that show the densities and distribution of trees in each of the communities. However, data on vegetation were presented in tables and graphs.

3.2.5 Limitations of data

On the whole, these different forms of data yielded rich information about the conditions in the three communities. Nevertheless, some limitations came to light when analysis had begun. These were to some extent due to the absence of the author, even if the research assistants did a very thorough and good job. For instance, information on how the quadrates were located for tree census was insufficient and did not allow the author to make maps of the distribution of trees within quadrates, as had been planned. Also, some further probing during interviews would sometimes have been desirable.

4. RESULTS

4.1 Densities of Parkia biglobosa

4.1.1 Number of trees in crop fields and fallow fields

This section illustrates tree densities in each community comparing the total number of trees per hectare in crop fields and fallow fields (Fig. 7). *Parkia biglobosa* densities of saplings and mature trees were observed to be higher in crop fields in Damongo Zongo and Nafarang than the estimates for Kperiga. Again, in fallow fields, the density of mature trees and saplings was the highest in Nafarang, lower in Damongo Zongo, and Kperiga had the lowest number of trees (Fig. 7). See Appendix 3.

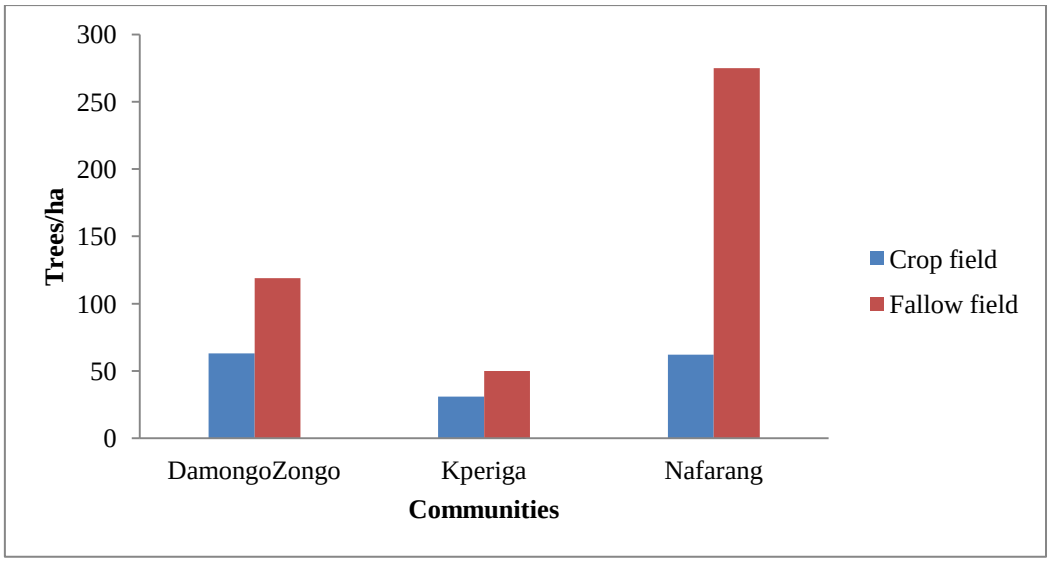

Fig. 7. *Densities of* Parkia biglobosa *according to land use type in the three study communities.*

4.1.2 Tree densities in crop fields

The total number of saplings estimated in crop fields was highest in Nafarang, much lower in Damongo Zongo, and no saplings were recorded in Kperiga (Fig. 8). All three communities had mature trees in the crop fields. Damongo Zongo had the highest density of mature trees; the same densities were estimated for both Kperiga and Nafarang.

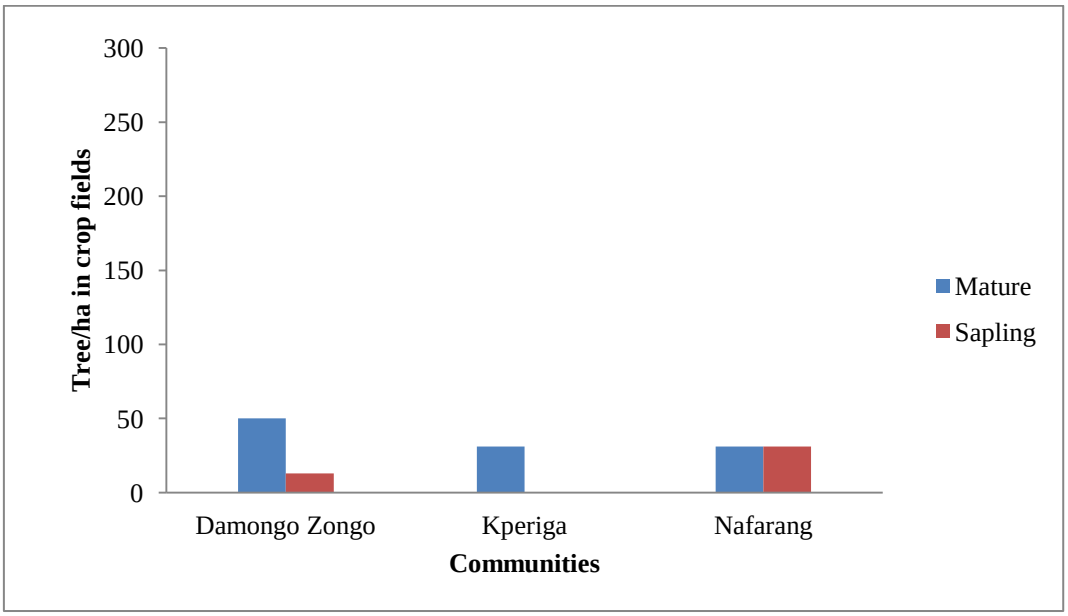

Fig. 8. *Densities of saplings and mature trees in crop fields in the three study communities.*

4.1.3 Tree densities in fallow fields

Densities of saplings estimated for fallow fields in Nafarang were much higher than in Damongo Zongo and Kperiga. All three communities, however, had fairly similar numbers of mature trees in the fallow fields (Fig. 9). See Appendix 3.

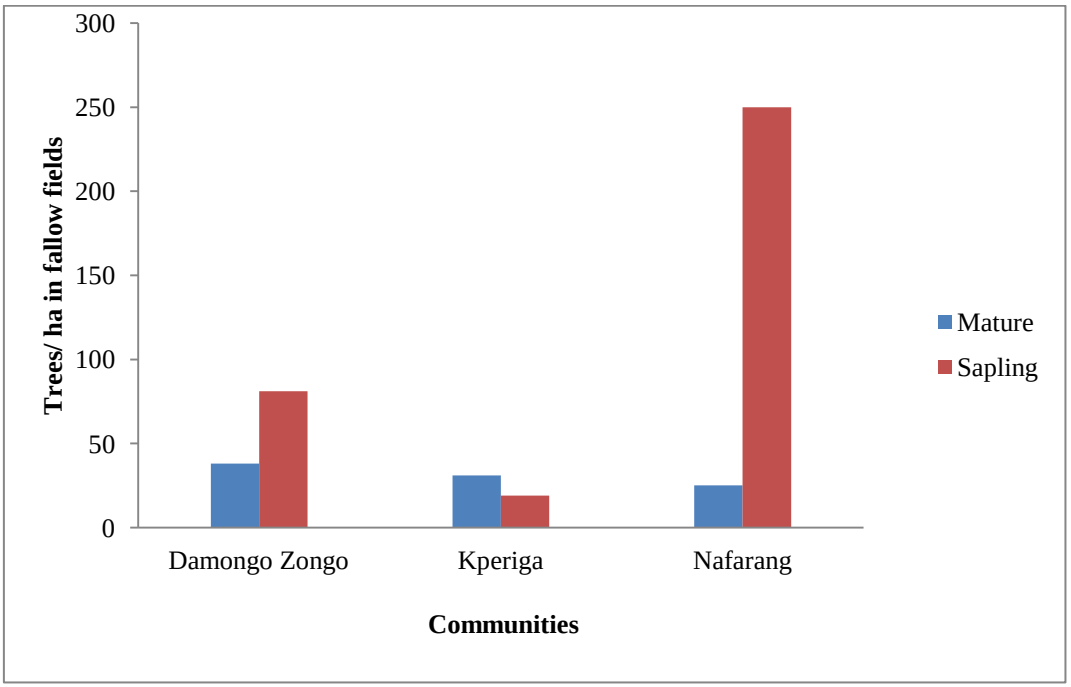

Fig. 9*. Densities of saplings and mature trees in fallow fields in the three study communities.*

4.2 Importance of Parkia biglobosa

The key informants and focus groups affirmed the usefulness of *Parkia biglobosa* for their households and communities. The benefits were categorised into products and services, the latter including both environmental and socio-economic benefits (Table 2). They noted the nutritional importance to households and the income derived from sale of *dawadawa*, which is particularly helpful to women who are involved in the processing and sales of the condiment. The medicinal value of the tree was discussed, with descriptions of the various parts of the tree and ailments which they are used to cure. A key informant stated:

If I go to farm and have stomach ache, I just cut the bark and chew and I feel better.

The use of leaves as fodder was also mentioned. Furthermore, the environmental benefits of the tree were mentioned. The crown provides shade, and decomposed leaves serve as a source of organic nutrients to the soil (Table 2).

Table 2. *The diverse products and services provided by* Parkia biglobosa

Product or service	Benefits
Product	
Pulp	Processed into powder for preparation of porridge
Seed	Processed into fermented cakes and used as condiment in soups and stews Dried or roasted as cure for hypertensive patients
Husk	Boiled/ soaked in water for plastering mud walls and floors
Ash	Derived from burnt wood and used for making soap
Leaves	Used as medicine and fodder
Bark	Used as cure for stomach ache
Pruned branches	Firewood, yam stakes
Service	
Environmental	Leaf fall improves soil fertility Wide crown provides shade Erosion prevention
Socioeconomic	Employment and income for women who sell the fermented cakes

Source: Field data

4.2.1 Access to fruit and distribution of benefits

In Nafarang, both focus group discussions and key informant interviews indicated the chief grants permission to community members to harvest the fruit. The chief specifies which areas community members could harvest from within the boundaries of the community. When asked about access to the products, the women discussants said:

Ask the chief and he will allow you to harvest from a particular place. Due to a decreasing number of trees, everyone has access to few trees.

However, in both Damongo and Kperiga it was mentioned that people need permission to harvest from another person's farm. Tenant farmers are not allowed to harvest fruit from the farms. Otherwise there is open access to the fruit and other products from the wild. Respondents from the women´s focus group discussion in Damongo Zongo said:

If you are not the owner you need to ask for permission and the product would be shared between you and the farm owner. You do not need permission to harvest from the wild.

These comments were very similar to those made in Kperiga:

Those who own the trees on their farms harvest the products. Others also go to the wild to harvest.

Discussions about who benefits from the tree products revealed that men, women and children benefit from the tree products. Women process and sell the condiment to support household income, and when the products are used to prepare meals everybody benefits nutritionally.

4.3 Systems of tenure

The study confirmed that in Nafarang (Dagomba traditional area), the tree/chief system prevails and has not changed over the years. The chiefs are responsible for the management of the trees in their areas of jurisdiction, which normally end at the boundaries of their community lands. The chiefs ensure the protection of the trees from destruction by fire and humans. They are also responsible for the *pacification* of the trees[2] for a good harvest. The chiefs supervise and monitor the harvesting of fruit during the fruiting season. They have the authority to sanction individuals who are found destroying or cutting down trees, by confiscating the product and demanding the payment of fines. Culprits found cutting the trees are fined according to the size of the log or lumber. The study revealed that the *Dohinaa* performs these duties with the assistance and support of the community chiefs, sub-chiefs and elders who are specifically assigned to assist in the protection of the trees against destruction. Farmers who have the trees on their farms are, however, also expected to assist in the protection of the tree.

In Damongo Zongo (Gonja traditional area), the study revealed that the trees are owned by traditional landowners, who are the chiefs, sub-chiefs and family elders. Rules or restrictions are not particularly strict, especially as far as one can collect the fruit of the tree from the wild, i.e. in areas that have never been cultivated or have been abandoned from farming for a very long time. Even though the traditional landowners have some level of control, and can sanction people who are found cutting the tree by payment of fines, there are no strong boundaries as to where to harvest or not, especially if fruits are harvested from the wild. The only restriction is that a person cannot harvest fruit from another person's farm without permission. Perpetrators who are not indigenes are said to pay higher fines.

[2] 'Pacification' refers to incantations made to the gods of the land to make peace with the trees for good fruit and a bumper harvest. This is normally done at the beginning of the fruiting season.

The care of the trees on the farms, the informants maintained, is purposely based on self-interest; the farmer's motive for protection is to secure fruit (for seeds and pulp) for the family, whereas the herbalist for instance will protect the tree for its medicinal usefulness. This self-interest, they commented, is not directly economic, as the returns from the sales of dawadawa are meagre as compared to the she nut trees, the product of which is sold in both local and international markets. A major role for protection and care, mentioned in the key informant interviews and iterated in the discussions, is the announcements made by the chiefs every year to remind and warn people to refrain from deliberately cutting down or burning the trees, especially during the dry season. Nonetheless, both the landowners and farmers are responsible for the tending and protection of the trees.

Interviews and focus group discussions in Kperiga (Mamprusi traditional area) revealed that trees on farmlands are owned by the traditional landowners, and trees within the settlement are owned by the chiefs. Everybody, including traditional landowners, settler migrants and tenant farmers, has free access to trees growing in the wild. These groups of people have the right over the use of the trees and are responsible for their protection. Similar to Damongo Zongo and Nafarang, tenant farmers are not allowed to harvest fruit from trees on farm lands. They always need permission from the landowner to harvest from the farm.

4.4 Recent changes in the number of trees

When asked whether the number of trees had been increasing or decreasing in the last five to ten years, the responses revealed a decrease in tree population in all the three communities. A number of reasons were mentioned. Altered farming practices, population growth, bush burning, indiscriminate felling of trees for fuel wood, and simple negligence were suggested as the major factors leading to the decline in tree population.

4.4.1 Reasons

Generally, the focus group discussions and key informant interviews revealed that the naturally regenerated saplings or seedlings are mostly destroyed by farmers to have enough space and sunlight and to make way for the cultivation of staple crops such as maize and yams. Mature trees are cut because they are shady and prevent sunlight from reaching cultivated crops. However, others indicated that the shade does not affect crops like pepper and some leafy vegetables, and these crops grow very well under the tree.

In Nafarang, it was observed that the number of trees has decreased in crop fields but increased in the wild and the fallow fields. It was indicated that some of the farmers who do not benefit directly from the tree may not take good care of the saplings. The reduction in tree population was blamed on the use of modern farm implements such as ploughs, which destroy the roots of both matured plants and seedlings. The *Dohinaa* emphasized that people are not allowed to cut trees for making charcoal; it is the pruned branches that are used as firewood and yam stakes.

In Damongo Zongo, the reduction in the number of trees was attributed to the activities of nomadic herders living in the bush. They prune the branches and sometimes fell the tree for their animals to browse, especially during the dry season when the grasses are dried up. Moreover, the herders were said to cut the tree for fuel wood. Slash-and-burn methods of clearing the land for farming, especially on new farms, were mentioned as another contributing factor. The growth of parasitic plants on the trees had also been observed.

The tree was indicated not to be a preferred species for making charcoal by the local people. Conversely, it came to light that some people do cut down the tree to burn charcoal, especially in Kperiga, to meet not only the household demand for charcoal but also for sales. The trees are also destroyed through uncontrolled bush burning, and deliberate burning of tree roots to eliminate the trees either to use for fuel wood or to make the fields easy to farm. Besides, natural causes such as wildfires and dying of older trees were mentioned. Yet another factor that was indicated to have resulted in the reduction in the number of trees was that the tree takes a long time to mature and bear fruit. Therefore people are not motivated to protect the naturally regenerated seedlings.

4.4.2 Effects

When asked whether the continuous reduction in the number of trees had an effect on the community, almost all the interviewees and focus groups responded in the positive. They all recognized that reduction in tree numbers would mean a low availability of seeds, and hence low incomes for the women who are involved in the processing and sales of condiments (*dawadawa*). Women would walk long distances into the wild to harvest the fruit. The focus groups noted that:

> *If measures are not taken to control the rapid decline in the population, the low number of trees would eventually put some women out of business.*

In Nafarang, the female key informant explained that:

> *There will be reduction in the nutritional quality and taste of food.*

Asked about the effects of a declining tree population on the land, most of the key informants (with the exception of one) observed that a reduction in the number of trees would lead to soil erosion. In Nafarang, key informants mentioned the following concerns:

> *Decrease in soil fertility due to reduced number of trees (Dohinaa).*
>
> *Soil fertility will decline since there will be little decomposition (Magazia).*

In Damongo Zongo, the female respondent iterated that:

> *It exposes the soil to erosion and reduces their contribution to soil fertility. Trees preserve soil moisture.*

The male respondent did not, however, recognise the importance of the tree in soil preservation. He indicated that:

> *In terms of nutrients it has no effect on the soil, since crops grown near/under the canopy don't grow well.*

The respondents in Kperiga were not ignorant of the importance of the tree to the soil. They mentioned several things:

> *Fewer trees will shed less leaves annually to improve the soil fertility. Frequent cutting leaves the land bare, which can lead to soil erosion (*male respondent*).*

The shedding of leaves improves the soil. The roots compact the soil and help prevent erosion (female respondent).

4.5 Tree ownership, management and sustainable land use

The management of the trees, as was mentioned by key informants in the Nafarang and Damongo Zongo communities, includes thinning, weeding and pruning. Overcrowded, naturally regenerated seedlings are thinned out to allow the remaining seedlings to grow well. Weeds are cleared around seedlings during the dry season to protect the trees from destruction by fire. The trees are also pruned to improve fruiting. No specific management practices were indicated in Kperiga. It was observed, however, that the tree grows naturally.

Most of the responses from the discussions and interviews showed a high awareness of the role the trees play on the farm and even outside the farm. Some aspects of the importance of the trees in land management that were mentioned are the improvement in soil fertility, soil moisture and provision of shade on farmlands and homesteads. It was indicated that a low tree population implies the exposure of land to various forms of land degradation. However, one key informant did not see any importance of the tree, particularly on farmlands. He specified that the presence of the trees shades the crops too much and hinders their growth, as discussed above.

The system of ownership in Nafarang (Dagomba traditional area) to some extent puts some checks on the destruction of trees. However, the interview with the *Dohinaa* or tree chief, as well as the focus group discussions, revealed that it is becoming increasingly difficult to control or minimize destruction of trees because of population growth. The tree chief said:

We try to maintain a cordial relationship with the farmers so that they can help take good care of the trees on their farms so that we all benefit. Some people do not care for the trees, even though they know the importance of the trees.

He also indicated that it is difficult to control or prevent people from the cutting the trees because they are so scattered and some fields are far away from the settlements. It was then suggested that government and research institutions should encourage plantations of dawadawa trees, which could be more easily managed than those growing in the wild.

4.6 Prospects for protection and increase in the *Parkia biglobosa* populations

When asked whether the number of trees could be increased, the focus group discussions and the key informant interviews in all three areas indicated a belief that the number of trees could be increased. It was mentioned that there are new (naturally regenerated) seedlings every year in the bushes and on the farms, which need to be protected to grow and replace the older ones which are dying off. It was also revealed that the number of trees can be increased if people are educated to grow them in the form of plantations. People should not cut the trees to grow plants like *Jathropha spp.* and cashew. It was mentioned that landowners should allow their tenants to harvest or share the products to motivate them to take good care of the trees.

In Nafarang and Damongo Zongo, the perception of people on the management of the trees was positive. They proposed that traditional ownership should be strengthened and be stringent on those who destroy the trees. The following were concluding remarks from the focus group discussions in Damongo Zongo:

The traditional rules should be blended with education on the importance of the trees. The collective decisions of community members to legally and strictly enforce the traditional rules will help protect and preserve the trees' (men's focus group).

There are strict traditional rules on management of the trees and the people caught felling trees are punished and charged with a fine. The community chiefs announce every year to remind and warn people not to deliberately cut down or burn dawadawa trees, especially in the dry season (women's focus group).

Nafarang focus groups indicated that:

The traditional rules are appropriate, but legislations should be passed to help back the chiefs to enforce the rules (men's focus group).

The traditional rules should not be changed, but the only thing to do to increase tree populations is to plant some on farms or to establish plantations. Organisations should help with seedlings to do this. They again indicated that they would rather use the few available seeds for food than to plant (women's focus group).

Responses from Kperiga, on the other hand, revealed that there are no rules on tree management in the area. However, if people were educated on the economic value of the tree, destruction (cutting and burning) of the trees could be minimized. The focus groups and the key informants responded that the community could meet and make laws on the protection of the tree and fines imposed on offenders. These were their comments:

We have to meet as a community to make decisions on how to manage and protect the tree species. Because there are currently no traditional rules on the protection of the trees, people burn the trees without any punishment (men's focus group).

Currently there are no rules on the tree management in this community. But if we educate people on the economic value of the tree, people can stop cutting and burning down the tree. The community can meet and make laws on the protection of the tree and fines imposed on offenders (women's focus group)

5. DISCUSSION

5.1 The systems of ownership in the Dagomba, Gonja and Mamprusi traditional areas

It seems warranted to assume that the different systems of ownership in the communities (Nafarang, Damongo Zongo, and Kperiga) to a large extent depict the real situation in the three traditional areas in the Northern Region. The systems of ownership and management in the three selected communities representing these three traditional areas may be described as stringent (Dagomba), partially stringent (Gonja) and less stringent (Mamprusi) in functionality.

The *Dohinaa* system in the Dagomba traditional area has bylaws that regulate control and access rights and management of the trees. A number of studies have confirmed this system of tenure among the Dagomba (Buabeng 1998; Blench 1999a; Poudyal 2011). The study revealed that the system of ownership and management recognise the tree as a legacy, thus protecting the tree for both its use and non-use values. This is presumably the motive of

having chiefs who are responsible for the protection of the trees from destruction. The study identified the *Dohinaa* system as a kind of common property with strict traditional regulation on access to and control over the tree and its products. The *Dohinaa*, in this case, may be seen as a custodian of the trees.

The system of ownership in the Gonja traditional area is moderately restrictive in the management and ownership of the trees. Even though ownership rights are clearly defined within in the communities and on farmlands, the system excludes trees in the wild under this system of ownership. This may be due to a large land area in this traditional area, which limits the control of ownership and management of the trees in the wild or outskirts of the communities. One remarkable role of the traditional authorities as revealed in the study is the annual reminder and announcement sent to community members to protect all economically important trees, including *Parkia biglobosa*, a*g*ainst destruction. This gesture portrays the importance attached to all economic species in the traditional area.

The Mamprusi traditional area, on the other hand, has a kind of liberal system, somewhat similar to the Gonja, where the care and protection of the tree is the decision of the users. The traditional authorities are passive, however, and have no hard-and-fast rules for the protection of the tree. The trees in the parklands on the outskirts of the town of Walewale are held in common, even though there are limitations on harvesting fruit from farms and within communities.

5.2 The relationships between the systems of ownership and tree population densities

The *Dohinaa* system in the Dagomba area has some traditional checks and balances which govern the access to and control over the trees and its products. Hence, the system of tenure and management is probably reflective of the high tree density estimated particularly in the fallow fields in Nafarang, as compared to Damongo Zongo and Kperiga (Fig. 7, Appendix 3). Mature tree estimate in the same fallow field in Nafarang was much lower than the estimates for Damongo Zongo and Kperiga. The low density of mature trees in the fallow fields in Nafarang could be attributed to fact that many saplings and mature trees were destroyed during the cropping period through the use of tractor-drawn ploughs, burning during land preparation, and wildfire; factors which were noted in the interviews and discussions as having contributed to decline in the number of trees. These factors, as observed earlier by Songsore (1996), are a threat to the continuing presence of the tree, and hence, to ecosystem functions.

Nonetheless, the unwillingness of some people to take care of the trees because they neither own nor have direct control over them may be another reason for the lower number of mature trees estimated for both crop fields and fallow fields compared to densities in Damongo Zongo and Kperiga (Fig. 8 and 9) (cf. Poudyal 2011). In addition, it was revealed during the interview with the *Dohinaa* that management and protection of the trees from destruction is dependent on individual chiefs. The regime of a *Dohinaa* can decrease or increase the number of *Parkia biglobosa* trees in the community. The *Dohinaa* remarked that:

> *...strong chiefs ensure good management, and weak chiefs or management result in tree decline.*

The Gonja area may be categorised as having a partially stringent system of tenure, which allows access and partial control over the tree. This somewhat reflects the density estimated for both crop fields and fallow fields (Fig 8 and 9). Considerable numbers of mature trees

were estimated both in crop field and fallow fields, as against the estimates in Nafarang and Kperiga (see Appendix 3). This may be the impact of the chiefs' caution or annual announcements to community members to refrain from destruction of economic tree species in the area. The destruction of trees was invariably attributed to the changes in farming systems, including the use of tractors and agrochemicals, but these factors, they noted, were more harmful to the saplings than to the matured tree. This might have accounted for the low number of saplings recorded in the crop fields. However, the activities of herders were noted as very worrisome. The herders live in the outskirts of communities and have free access to the trees and products since the extent of ownership and management is limited to areas within the community boundaries. The herder groups may not be considered as community members and therefore the yearly announcement may not be relayed to them.

The system in the Mamprusi area is lenient and less stringent compared to the other two areas regarding access to and control of the tree and its products. There were no defined rules about the protection of the tree, despite the several benefits indicated in the focus group discussions and key informant interviews. The absence of regulations has most probably resulted in the low densities of saplings and mature trees estimated in both crop fields and fallow fields which were the lowest recorded in the three study communities (Fig.7, Appendix 3). The results indicated that, as with any common-pool resource in any part of the world, the absence of regulation can lead to depletion of the resource (cf. Ostrom 1990; Ratner 2011). This points to the attitude of the people exploiting resources without taking responsibility for managing these resources. Key informants and focus groups in Kperiga highlighted the need for a more active traditional role in protection of the tree.

Nonetheless, the tree densities estimated in the three study communities cannot exclusively be attributed to the systems of ownership, since the number of years of cropping of each sampled crop field and fallow field were not considered in this study. Zinck and Farshad (1995) explain that sustainability considers time factors for regeneration of land resources. Moreover, the diversity within the agricultural systems, from one ethnic group to another and even among individual households, cannot be overemphasized (Boffa 1999).

5.3 The implications of tree tenure for sustainable land management

The three systems of ownership and management identified in the study revealed some implications on sustainable land management which can be harnessed to reduce the decline in the tree populations and achieve the long term benefits of sustainable development (Hagen 2008).

The **Dagomba** and **Gonja** systems apparently provide some form of protection for the trees against destruction, thus minimizing reduction in tree populations. The reason behind these actions is most probably based on the multipurpose benefits of the tree, as was categorically indicated in the focus group discussions and key informant interviews (Table 2). Thus, the protection of the tree is not only for long term benefits in soil amelioration, but also for a continuous supply of wood and non-timber forest products (cf. Fifanou et al. 2011). It is therefore implied that crop production can be sustained and livelihoods enhanced as the trees are found to be an important component of the traditional farming systems in the region.

When asked about the impact of decreasing tree numbers, the responses in three communities signified that people were very much aware of the role trees played in sustainable land management. The key informants and the focus groups observed that the continuous reduction the number of trees would increase land degradation through soil erosion and decline in soil

nutrients. A key informant mentioned that people should not cut the indigenous trees down and grow *Jathropha spp*. This has been confirmed in a study by (Nyari 2008) which showed that vast areas of land have been cleared of indigenous trees and being replaced with *Jathropha spp* for biofuel production in some communities in the West Gonja district. That report indicated that this new initiative would rip rural people of their local livelihoods as large areas of parklands are cleared.

The system in the **Gonja** traditional area presumably is fair in terms of access and management of trees but not so much in terms of control. This system could, however, easily motivate communities to protect the trees by sensitization and education through the traditional authorities, as revealed in, for instance, the men's focus group discussions in the Damongo Zongo.

Conversely, the tenure system prevailing in the **Dagomba** traditional area, which restricts people from control of and sometimes access to *Parkia biglobosa* even on privately owned lands could be a disincentive to the protection of the tree, especially newly regenerated seedlings. It was indicated in the women's focus group discussion in Nafarang that some people did not care about the trees because they did not own them (cf. Poudyal 2011). The implication for land management is that, if community members are not motivated, the system would most probably perpetuate the decline of the trees. The *Dohinaa*, however, stated that it is a fair arrangement:

> *There is mutual benefit between both tree chiefs and the farmers who take care of trees on their farms*.

The system of ownership in the **Mamprusi** traditional area, which allows free access and little control, has on the other hand, had some negative effects on the densities of the tree, both in crop fields and fallow fields (See Appendix 3). It was quite obvious that the use of the tree and its products, with no regulation in management and protection of the trees from destruction, could have contributed to the decline of the tree population compared to Damongo Zongo and Nafarang. Anthropogenic factors associated with such population growth cannot be overemphasized. This is because of the proximity of Kperiga to the West Mamprusi district capital, Walewale. The population of the district is growing fast and Walewale is a nodal town that is easily accessible by road from the neighbouring region and ethnic groups. Thus the community could be subjected to an influx of migrants, which could lead to population pressure on land. Hence the demand for fuel wood was high, as repeatedly emphasized in the interviews and the focus group discussions. Without any control or appropriate rights of ownership, this situation could further exacerbate the decline in the number of trees (Damnyag et al. 2011).

Further, the comparatively low densities of mature trees estimated in crop fields and fallow fields in Kperiga indicate that farmers would maintain and continuously use the farmland with low tree densities. This is because it is a more favourable condition in terms of reduction in shade for some preferred crops, and would not make it necessary to leave the land to fallow. The continuous mining of soil nutrients may eventually reduce the resilience of the soil (Zinck & Farshad 1995).

Population pressure may probably be another factor leading to the continuous cropping of the land, resulting in the low density of mature trees and no saplings in crop fields in Kperiga (Fig. 5, Appendix 3). The intensification of cropping on a piece of land for a long period of time, and reduced fallow periods, is most probably a strategy to cope with the increasing

population pressure on agricultural land use, and also a way of claiming rights of ownership to a piece of farmland. This has been observed before in the Northern Region of Ghana (Boserup 1981; Mikkelsen & Langohr 2004). This is in contrast with Boffa's (1999) observation that the borrowing of land enhances sustainable land management by giving farmers an option to avoid over-cultivation. Nonetheless, the coping mechanism against population pressure could, however, promote innovation in farming systems and sustainable land management (Boserup 1981).

Again, the lowest number of saplings observed in Kperiga is an indication of the low regeneration of trees in the area, which is a serious threat to tree population and hence to sustainable land management (Boffa 1999; Poudyal 2011). Poudyal (2011) argues that it is easier for farmers to destroy saplings without being noticed than destroying the mature trees.

Nevertheless, in all three study communities, tree-crop interaction was repeatedly specified by all key informants and focus groups as another major factor that has led to reduction in tree densities. Even though the observation may not be directly linked to the system of ownership, it is worth highlighting in the study. The study confirmed that most crops do not grow well under the trees, but grow very well in open fields (Kater et al. 1992; Kessler 1992; Bazié et al. 2012). However, Bazié et al. (2012) suggested that shade-tolerant crops should be cultivated under crowns of *Parkia biglobosa*, or tree crowns should be pruned to ensure the availability of light for crops.

Importantly, climatic and edaphic factors play a significant role in vegetation densities in all three areas. Damongo Zongo is more favourably located, compared to Nafarang and Kperiga, in terms of soil fertility and weather conditions. A combination of good management and education could rapidly increase the number of trees in the Gonja traditional area.

5.4 Perceptions about the tree and land management in the three communities

The outcome of the focus group discussions and interviews revealed that people in Nafarang and Damongo Zongo approve of the systems of ownership in their traditional areas, but requested external support in terms community sensitization and education. The observation in Nafarang, however, is in contrast to studies conducted by Buabeng (1998), which revealed that most respondents in the Dagomba area blamed the decline of dawadawa trees on the system of ownership. The study indicated that it was only people who knew that they would become chiefs and *Dohinaas* in future who did well to protect the naturally regenerated seedlings on their farms. Further, the study observed that there is no fair share of fruit between tenant farmers and *Dohinaas*. Even though tenant farmers are also responsible for the upkeep of the trees on their farms, in years of poor yield they may be denied their share of the products. This was, however, justified by the *Dohinaa´s* assertion that the care and protection of the tree depends very much on the *Dohinaa,* who is supposed to ensure a good relationship with farmers. This implies that keeping a good relationship with farmers and other community members can be motivating for them to care for the trees, thus promoting sustainable land management.

Nonetheless, the group discussions in Nafarang and the *Dohinaa* himself indicated that it is becoming increasingly difficult to protect the trees from destruction and checking people's attitudes as communities expand. This raises the issue of sustainability of the system of tenure in the Dagomba traditional area.

Responses from Kperiga, however, called for a more proactive role of the traditional authority in the management of the trees in the Mamprusi area. The study was seen to be a wake-up call for the protection of the trees in the area. This was realised in the comments made by the focus groups of the necessity for community members to meet to discuss the issue, and recognising through the discussions that the near-absence of rules and regulations was the major cause of tree decline.

5.5 Gender dimensions of tree ownership and management

Women have access to products in the agroforestry parklands, especially in bush fallows, as revealed in the study. Poudyal (2011) also observes that the harvesting of fruit in parklands is to some extent regulated by women. However, individual women in the northern part of Ghana do not own indigenous trees, except on very rare occasions when a woman is made a chief in a community in the Dagomba traditional area. Then she can have access to and control of *Parkia biglobosa* trees (Buabeng 1998). A key informant in Kperiga iterated that:

> *...landowners protect the tree on their farms for their wives to harvest.*

With the exception of the Dagomba traditional area, women and men who are not indigenes have access to fruit in the wild. Thus, in all the study communities, most women have the right of access to the tree products by virtue of marriage to a an indigene or by kinship, and not control, as also observed by Poudyal (2011).

Further, the focus group discussion with women in Kperiga and Damongo Zongo revealed that men cut down the trees to grow cereals, which are major staple foods for home consumption and sales. This is because of the shady nature of the trees which normally impede growth and crop yields. They indicated, however, that vegetables such as pepper and *ayoyo (Cochorus olitoris)* grow very well under the trees (cf. Pouliot et al. 2012).These are crops normally grown by the women. There is an indication that women probably have a limited influence when it comes to the decision of cutting/destruction or protection of the trees, even though they are the primary users of tree products.

It was observed in all communities, both in the focus group discussions and key informant interviews, that declining tree populations would affect household nutrition since the dawadawa contains some protein and fatty acids (Teklehaimanot 2004). Women involved in the processing and sales of the condiments (*dawadawa*) and flour (*dozim*) will be affected even though the income from sales is negligible compared to that of shea butter. Further, the men in Nafarang pointed out that it would mean giving more 'chop money' (money for buying food on a day-to-day basis) to buy substitutes for the condiment.

Women focus group discussions in Damongo Zongo revealed that women do clear weeds and thin out overcrowded regenerated seedlings on the farm by way of tending and protecting the trees. In Nafarang, however, it was indicated that men do the weeding and thinning. This is probably due to the cultural underpinnings of gender divisions of labour, which vary from one ethnic group to another in the Northern Region. While harvesting of fruit is mostly done by men in Nafarang, this is gradually changing in Damongo Zongo and Kperiga, where women are now said to do the harvesting of fruit.

Focus groups and key informants in all the three communities specified that women process the seeds into condiments, which are sold and used by women in cooking. The plastering of

floors and walls using decoctions prepared from the husk is another specialty for women, after the men have erected the mud or laterite houses.

The awareness of the various environmental and socio-economic benefits of *Parkia biglobosa* was high among both men and women focus groups and key informant interviews in all three study communities. Also, both women and men had good knowledge of the importance of the tree in sustainable land management, as indicated above (cf. Koura et al. 2011). The high level of knowledge among communities about the role of the tree in environmental protection serves as a good basis for sustainable land management.

6. CONCLUSIONS AND RECOMMENDATIONS

The study revealed three different systems of tree tenure, which determine the management of *Parkia biglobosa* in the three traditional areas studied. The *Dohinaa* system in the Dagomba traditional area is restrictive in access to and control over the tree and its products, whereas the system in the Gonja traditional area allows access but partial control, and a less restrictive tenure system prevails in the Mamprusi traditional area, approximating open access.

A similarity was observed between all three areas in that tenant farmers (mostly non-natives) do not have access to and control over tree products on the farms. The Gonja and Mamprusi systems have provision of access to fruit in the wild by tenant farmers. However, the *Dohinaa* system in Dagomba prohibits especially non-natives access to the tree and tree products, both on farms and outside the farms. Natives have access only with the permission from the *Dohinaa.*

Tree densities estimated from the quadrates that were sampled reflect to some extent the systems of tenure and management identified. The systems of ownership and management in Gonja and Dagomba traditional areas both hold some promise for sustainable land management, which cannot be said about the open access system in Mamprusi. Nonetheless, whether the *Dohinaa* system will be able to stand the test of population growth with its attendant effects is an issue that needs to be considered.

Also, the study revealed that the decrease or increase in tree population depends on how rural people under a particular system of ownership are motivated to care for the trees and guard against their destruction.

The study observed that negative tree-crop interactions, high demand for charcoal (especially in Kperiga), and the use of modern farm implements are the major causes of tree decline, besides tenure arrangements. If these factors are not checked, they may have a serious implication for sustainable land management. The study confirms that the rural people are highly resource-dependent and have ways of protecting resources they deem important for their livelihood, as observed in Nafarang and Damongo Zongo. They only need some level of external support and motivation to actively manage the tree as well as other natural resources.

Furthermore, gender considerations in tree tenure and management could promote sustainable land management, as both men and women groups consider *Parkia biglobosa* an important tree in their households and communities in general. The inability of women to take decisions about tree protection, however, is an issue of concern.

The study recognises that the communities have good knowledge of the implications of the increase or decrease in tree populations for sustainable land management. When formulating strategies for minimizing the decline in tree population, the active participation of people in these communities is essential.

Finally, as this study only covered three traditional areas, a comparative study is necessary to explore the tenure and management systems in the other two traditional areas (Nanumba and Mo) in the Northern Region of Ghana. A follow-up study is also needed to monitor the growth of the saplings in the fallow fields in all three areas.

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APPENDICES

APPENDIX IA. Sample of guide for focus group discussions

The impact of the traditional management systems on *Parkia biglobosa* Populations and Sustainable land management in the Northern Region of Ghana.

Give a brief background on the study. The importance of the tree to people in the Northern Region of Ghana and the impact of the different management systems of ownership on tree population and sustainable land management. ***Please note that the points in brackets are to assist you probe and facilitate the discussion.***

Section A: Background Information

- Name of Community:
- Date:
- Number of participants

Section B - Ownership and management of trees

Do the participants think that the dawadawa tree important in the farmland of this community?

If so, in what way is it important? (For people's livelihood? Fruit? Marketed or for own consumption? Firewood? Soil preservation)

Do you think that the number of trees in the area increased or decreased in the last 5-10 years?

If it has increased, why? Who has been planting new trees? If it has decreased, why? Lack of planting? Neglect of existing trees?

Have the changes in farming practices over the years affected the number of trees?

In what ways?

Who owns the dawadawa trees in this community? (*Tree chiefs? Community chiefs? Landowners? Tenants?)*

Do women own dawadawa trees?

Who takes care of / manages the dawadawa trees? (*Men/ Women/Landowners/Tree chiefs?)*

Who benefits from the products of the tree? *(Everybody in the community? Landowners/tenants where the trees grow? Only the tree chiefs and their families?)*

Do women and men benefit equally? If not, how?

Who makes decisions about how the products of the tree are distributed?

Have you benefited from the way the trees are managed in the community?

How?

Do you think that the dawadawa trees are cared for and/or actively protected?

By the landowners /farmers/ tenants? *By the tree chiefs? If they are cared for and protected, how is it done?*

If not, how do you see signs of neglect? What are they?

Do you think that the number of dawadawa trees in this community can be increased?

If you do think so, why? How could this be achieved?

Do ownership rules help or hinder this? (*If you do not think there should be more dawadawa trees, why?)*

Thinking about the future of this community, what do you think about the tradition of ownership and management of dawadawa trees, appropriate or do they need to change?

(If they need changing, in what way? Why? How could they be changed? By official legislation and enforcement? By community debate and collective decisions?)

APPENDIX IB. Sample of Guide for Key informant Interview

The impact of the traditional management systems on *Parkia biglobosa* populations and sustainable land management in the Northern Region of Ghana.

Give a brief background of the study; The importance of the tree to people, particularly in the Northern Region of Ghana and the impact of the different management systems of ownership on tree population and sustainable land management. Please encourage respondents to answer as truthful as possible, assure them that we will not write names anywhere as we want to make the information as anonymous as possible. **(Please note that the bullet points are to assist you to probe further).**

Section A: Background Information

- Date
- Name of community
- Respondent's Name.
- Sex: M / F
- Ethnic group
- Age:
- Level of education
- Household size (Number of people)
- Primary occupation

Section B- Ownership and management of trees

Please, let respondent start by telling you something about the farming in the communities.

Are dawadawa trees important in this community? In what ways?

Do you think dawadawa trees are important on your farmland? In what ways?

Are dawadawa trees outside your farmland important to you? In what ways?

Have changes in farming practices over the years affected the number of trees? How?

(*Use of tractors? Other farm implements*?)

Who owns dawadawa trees in this community?

(Women / men/ community / Chief / Community leaders / Traditional land owner?)

What is the system of ownership?

(Communal / private / individual farmer or tenant / tree chieftaincy?)

Who takes care/ responsible for management of dawadawa trees in this community?

(*Chiefs/Men/ Women Community/ Farmers/Traditional land owner*)

Do individual community members have access to products (fruits, fuelwood) from the tree? How?

What is/are your role(s) as a community leader in the management of dawadawa trees?

What do you think about the tree number of trees in the last 5 -10 years?

Has the tree population been increasing, on farms or outside farms?

Has the tree population been decreasing, on farms or outside farms?

What do you think are the main reasons for changes in the number of trees?

How do you think the change in the number of trees affects the community?

Men, Women,

How do you think the change in the number of trees affects the land/soil?

Has the number of trees changed because of the system of ownership?

What do you think is the future of the number of dawadawa trees in this community?

What can you do as a leader to increase the number of trees in the community?

APPENDIX II. Data on type of focus group, number of participants and dates

Community	Type	Number of Participants	Session date
Damongo zongo	Women	10	15-06-2012
	Men	6	
Nafarang	Women	12	20-06-2012
	Men	7	
Kperiga	Women	12	16-06-2012
	Men	7	

APPENDIX III. Density of *Parkia biglobosa* in two land use types in three communities, expressed in trees per hectare

Density of *Parkia biglobosa*	**Community**					
	Damongo zongo		**Kperiga**		**Nafarang**	
	Crop field	**Fallow field**	**Crop field**	**Fallow field**	**Crop field**	**Fallow field**
Mature	50	38	31	31	31	25
Sapling	13	81	0	19	31	250
Total	63	119	31	0	61	275