

## On-farm tree planting and tree diversity in the Kigezi Highlands and Mabira Buffer Zones

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### Abstract

A study was conducted on 105 farms around Bwindi Impenetrable National Park (BINP), Mgahinga Gorilla National Park (MGNP), Echuya and Mabira forest reserves between February and June 2000 to assess on farm tree planting and tree diversity. Group discussions and interviews were used to collect information on the following: farming history and land tenure, method of land acquisition, agricultural crops grown, tree species planted and those growing naturally, uses of trees and constraints to tree planting. On-farm survey was conducted to collect information on land size, tree diversity and management and the proportion of land under tree cover. The average land holding is 4.04 ha around BINP, MGNP and Echuya forest reserve and 13.63 ha around Mabira forest reserve. Land is bought or inherited in fragmented form. Less than 10% of the farms are under tree cover and 71% of the trees planted around BINP, MGNP and Echuya forest reserve are indigenous, whilst 31% are indigenous around Mabira forest reserve. The average number of tree species per farm around BINP was 11.43, MGNP 7.06, Echuya forest reserve 6.93 and Mabira forest reserve 10.26. It is concluded that farmers are willing to plant trees on their farms but the constraints to tree planting are lack of planting stock, small land sizes, poor extension service and farmers' perception that agricultural crops cannot be integrated with trees on the same piece of land.

**Key words:** Tree diversity, farmers, tree products, user groups, protected areas

### Introduction

A key element in Uganda's agricultural sector development policy and strategy is the modernisation of agriculture focused on increased and sustainable food production (NARO, 2000). This is to be achieved by improving agricultural techniques and practices and optimal land use. Integration of trees in the farming systems is a major provision in the Plan for Modernisation of Agriculture (PMA). Trees provide a wide variety of products such as timber, poles, firewood, charcoal, fruit, medicines, fodder and bean stakes. They also provide services such as erosion control, slope stabilization, soil fertility replenishment, carbon sequestration, hydrological functions, boundary marking, shade, shelter, windbreaks, cultural and spiritual significance. Traditionally, local communities living around gazetted forests did not plant trees because they obtained forest products freely from the forests. However, current levels of deforestation suggest that the rising demand for tree products will have to be met by increased levels of tree planting (Simons *et al.*, 2000). While traditional forest plantations will satisfy some of this demand, there is likely to be a substantial increase in the planting of trees on farms. Farmers in densely populated areas are already motivated to plant trees on their land. Several studies have

shown that tree planting increases with increasing human population densities in continuously cultivated small farms (Bradley *et al.*, 1985; Patel *et al.*, 1995; Pretty *et al.*, 1995; Place, 1995; Harris, 1996; Place and Otsuka, 1997).

There have been several initiatives and programmes in community forestry in the last 10 years aimed at promoting tree planting in Uganda. While some successes have been noted, tree planting options such as agroforestry need to be explored. Agroforestry broadly defines tree planting on farms in all its various forms such as single trees, scattered trees in fields, lines or small blocks of trees, farm forestry, tree-crop rotations, trees in multistrata systems or trees in home gardens (Simons *et al.*, 2000). A major advantage of agroforestry is that it provides tree products and environmental benefits simultaneously. For example, a recent study in south western Uganda based on aerial photographs from 42 parishes found that in 1960 agriculture contributed 35% of the total tree cover, but this had risen to 58% by 1995 (Place and Otsuka, 1997).

When most off-farm sources of tree products are exhausted, there is usually economic incentive for farmers to increase tree cultivation on farm to provide fuelwood, fodder, poles and other products. Therefore, areas of low tree cover or high population density are logical places to target on-farm tree planting. According to Kindt and Lengkeek (1999),

farmers in such places often plant a variety of tree species although the tree density may be low. A study conducted on 200 farms in western Kenya recorded a total of 190 tree species. Even though the average farm size was less than two hectares, an average of 16 tree species per farm was observed.

This paper presents the results of a study carried out between February and June 2000 around BINP, MGNP, Echuya and Mabira forest reserves. The major aim was to provide baseline information for development of workplans for agroforestry research to conserve and enhance biodiversity in the Kigezi Highlands and the Mabira buffer zone. The specific objective was to assess on-farm tree planting, tree diversity and management around these protected areas. This information is lacking and yet on-farm tree planting cannot be promoted without knowing the tree species that farmers are currently planting, the species that they would be willing to plant, the products they expect to get from them, the agricultural crops that can be integrated with trees and the constraints to tree planting and management. The need to provide this information provided the basis for this study.

### Study area

#### BINP and MGNP

BINP and MGNP are Afromontane forests formerly Forest Reserves gazetted in 1932 (BINP) and 1941 (MGNP), and Animal Sanctuaries, gazetted in 1930 (MGNP) and 1964 (BINP). BINP is one of the richest forests in East Africa, with 205 tree species (ten of which are found nowhere else in Uganda), 336 species of bird (including six species listed in the Red Data Book) and 202 species of butterfly (Howard, 1991; Cunningham, 1996). MGNP is well known for its Afroalpine vegetation, the mountain gorilla and Red Data Book bird species.

Both forests have a long history of occupation which probably dates back to 32,000-47,000 years ago (Cunningham, 1996). Forest clearance for agriculture begun about 2,200 years ago (Taylor, 1990; Taylor and Marchant, 1995) with the arrival of Bantu speaking peoples. Three main ethnic groups live adjacent to the forests: the Bakiga, the Bafumbira and the Batwa. The Bakiga predominate around BINP and the Bafumbira around MGNP. The Bakiga and Bafumbira are agriculturists. The Batwa are forest dwellers, dependent on hunting and gathering. They have a long history of trading their forest products for food from neighbours.

The population density around both forests is 200-400 people per km<sup>2</sup>, being among the highest in the continent (Cunningham, 1996). There has been rapid population increase, and the area has a history of out-migration to other parts of the country. Land use is intensive with sorghum, millet, wheat, Irish potatoes, beans, peas, bananas, and cassava as the major crops. The wide range of crops reflects the altitude range (1100-2600 m).

#### Echuya forest reserve

Echuya Forest Reserve is located in south western Uganda

in Kabale and Kisoro districts. The forest is 3.2 km wide and 14.4 km long and about 3,200 ha. It lies along the ridge separating Lake Bunyonyi in the east from the Bufumbira lava plains in the west. Its southern boundary is also the international boundary between Uganda and Rwanda. The vegetation is dominated by mature even stands of Bamboo (*Arundinaria alpina*) forest. In many areas of the forest there are scattered stands of *Macaranga monandra* and other woody shrubs (Howard, 1991). The area surrounding the forest is densely populated with 750-1,000 persons per km<sup>2</sup>. The population is composed of the Bakiga, Bafumbira and Batwa (pygmies); with the Bafumbira forming the majority (70%). The Batwa live in or at the boundary of the forest.

#### Mabira forest reserve

Mabira forest is located 20 km north of Lake Victoria shoreline, immediately to the west of the Victoria Nile (Howard, 1991). It is between Kampala and Jinja. The reserve occupies parts of Buikwe and Nakifuma counties in Mukono district. It has an area of 306 km<sup>2</sup> occupying gently undulating country characterised by numerous flat-topped hills and wide shallow valleys.

Over the last 20 years, uncontrolled exploitation of this forest became a serious problem, and the forest assumed a major economic importance not only as a source of illegal timber, but more importantly as a source of agricultural produce grown by illegal settlers. Mabira is a major source of charcoal for the nearby towns of Jinja, Mukono, Lugazi and Kampala and a major source of firewood for the nearby tea and sugar estates, and the brick makers. The forest is a major source of building poles, domestic firewood, bushmeat, fibres, wild fruits, and herbal medicines (Forest Department, 1996). Exploitation pose threats to the integrity of the forest and the greatest of these is agricultural settlement. The forest is surrounded by densely populated agricultural lands (230 persons per km<sup>2</sup>). The Baganda are the dominant ethnic group living around the reserve; others are the Basoga and a mixture of several Nilotic tribes.

### Methodology

Seventy five farmers living around BINP, MGNP and Echuya forest reserve and 30 farmers living around Mabira forest reserve were interviewed and their farms surveyed. Group discussions and interviews were used to collect information on farming history, land tenure, crops grown, livestock reared, decision making on tree planting, and constraints to tree planting. On-farm walks were conducted to collect information on land size and use, method of land acquisition, trees planted and naturally growing, tree diversity and management, the proportion of land under tree cover, and the products got from trees and their uses. The proportion of the farm under tree cover was estimated by the eye. Pairwise ranking was used to prioritise tree products desired by farmers. Data were entered in MS Excel and used to obtain summary statistics.

## Results and Discussion

### BINP, MGNP and Echuya forest reserves

#### Land tenure and use

The average land holding was 4.04 ha which is higher than 1-3 ha reported by Bagoora (1998). Decision on farming is usually taken jointly by husband and wife, but the decision to plant

trees is taken by either the husband and wife or the husband alone. Ninety six percent of the farmers said they were willing to spare extra land to plant trees. Those who were unwilling to plant trees cited lack of land and competition of trees with agricultural crops as the major constraints to tree planting. Forty percent said they would plant trees in specially designated parts of their farm and 30% said they would plant trees separately from the agricultural crops to reduce the effect of shading (Tables 1a and b).

Over two thirds of the farmers indicated that they inherited land and one third said they either bought or acquired it freely. Nearly all the land was bought or inherited as fragments and 62% said they faced difficulties in managing such land. For example, walking long distances to the fields, destruction of crops/trees by livestock, transporting harvested crops over long distances, vandalism and theft of trees.

**Table 1a. Tree planting in the Kigezi Highlands (N=75)**

Question and options	Frequency
Who makes decision on farming?	
Husband and wife	64
Wife	9
Husband	2
Who makes decision on tree planting?	
Husband and wife	39
Wife	7
Husband	29
Would you spare land to plant trees?	
Yes	72
No	3
How would you integrate trees with crops?	
Mix with crops	18
Plant trees separately	22
By zoning	32
Cannot mix trees with crops	3

#### Crop and livestock production

The agricultural crops grown are sweet potatoes, Irish potatoes, beans, maize, garden peas, banana, yams, pumpkins, passion fruits, coffee, tobacco, wheat, sorghum, millet, cabbage and onions. The livestock kept are cows, goats, sheep, rabbits, pigs and poultry. Rabbits and pigs are reared in stalls, cows, sheep and goats are tethered or grazed in the fallow and poultry are reared in the traditional free range system.

#### Tree planting and management

The tree establishment and management practices that farmers carried out were tree nursery bed preparation, watering of seedlings, fencing of nurseries, weeding, manuring, thinning, pruning, pollarding and climber cutting (Table 2). It is surprising that less than 10% of the farmers said that they knew nursery bed preparation and management because according to a field extension agent working for CARE-DTC project in Rubuguri parish, farmers have been taught how to raise tree seedlings. During the farm walks, it was noted that farmers managed their trees by pruning to maintain their

**Table 1b. Land tenure and tree management in the Kigezi Highlands (N=75)**

Question and options	Frequency
How land was acquired	
Obtained freely in unsettled areas	7
Bought	61
Inherited from father	67
Is land acquired as fragments?	
Yes	71
No	5
Difficulties with managing trees on fragmented land	
Yes	47
No	28
Which difficulty?	
Walking long distances	13
Destruction of trees by livestock	6
Transporting harvested products	12
Vandalism	9
Theft of tree/products	27

**Table 2. Tree management practices carried out by farmers in the Kigezi Highlands (N=75)**

Tree management practice	Frequency
Nursery bed preparation	6
Fencing nursery bed	7
Watering seedlings	1
Weeding	54
Manuring	3
Thinning	23
Pruning	36
Pollarding	3
Climber cutting	1
Nothing is done	3

shapes and pollarding to reduce the amount of shading on agricultural crops.

#### Tree cover, species abundance and uses

Table 3 shows the proportion of farmland under tree cover in the Kigezi Highlands i.e. around BINP, Echuya and MGNP. The average proportion of farmland under tree cover was 6.8% (SE=0.7). There were more trees planted on the farms (78.1%) than those growing naturally or retained during land preparation (21.9%). There were 51 woodlots owned by 68% of the farmers. Seventy one tree species were recorded on the farms and the average number of tree species per farm around BINP was 11.43, Echuya forest reserve 6.93 and MGNP 7.06. The parts of trees used and the percentage of respondents who mentioned them were: stems (82.8%), fruits (17.8%), leaves (8.8%), and bark (6.1%). The trees were used for curving, making tool handles, bee hives, beer boats and canoes, as boundary makers, building poles, for shade, fencing, basketry, provision of fodder, timber, medicine,

firewood, food, charcoal, ropes, bean stakes, slope stabilization, soil fertility improvement and as wind breaks.

#### Constraints to and opportunities for tree planting

Farmers indicated that the major constraints to tree planting were land fragmentation and scarcity, lack of planting material and poor extension service which could have guided them on how to integrate trees with agricultural crops on the same piece of land. These are common problems in the development of agriculture and forestry in Uganda and need to be addressed in the plan for modernisation of agriculture spearheaded by the National Agricultural Research Organisation (NARO). The problems of land fragmentation and scarcity are often intricately linked to population growth. However, there are opportunities for increasing on-farm tree planting in the Kigezi Highlands based on farmers' willingness to plant trees to provide the desired products and services.

#### Mabira forest reserve

##### Land tenure and use

The average size of land holding was 13.63 ha. Eighty three percent of the farmers said that husband and wife make decisions jointly on farming and 60% said husband and wife make decisions on tree planting. All the farmers (100%) said they would spare some land to plant trees and 73% indicated that they would integrate trees with agricultural crops on the same piece of land (Tables 4a and b). This response was not

**Table 3. Proportion of farmland under tree cover around BINP, MGNP and Echuya forest reserve (N=75)**

Forest/NP	Mean (%) farm area under tree cover	Standard deviation	SE
Bwindi ImpenetrableNP	9.63	7.18	*1.31
Echuya forest reserve	4.76	3.64	*0.67
Mgahinga Gorilla NP	5.53	5.65	*1.46

**Table 4a. Tree planting around Mabira buffer zones (N=30)**

Question and options	Frequency
Who makes decision on farming?	
Husband and wife	25
Wife	4
Husband	1
Who makes decision on tree planting?	
Husband and wife	18
Wife	5
Husband	7
Would you spare land to plant trees?	
Yes	30
No	0
How would you integrate trees with crops?	
Interplant with crops	22
Plant in separate zones	2
Plant in separate zones and intercrop	6
How is land acquired?	

**Table 4b. Land tenure and tree management around Mabira buffer zones (N=30)**

Question and options	Frequency
How is land acquired?	
Renting from landlords	6
Inheritance	9
Acquired freely from public land	2
Bought from others	23
Is land acquired in fragmented form?	
Yes	7
No	23
Difficulties with managing trees on fragmented land?	
Yes	4
No	26
What are the difficulties in managing trees on fragmented land?	
Damage of fruit trees by baboons and monkeys	3
Walking long distance to the fields	1
Destruction by livestock	1
Transporting harvested products over long distances	1
No difficulty	26

surprising because farmers around Mabira forest grow crops such as banana and coffee, which can be integrated with trees. More than 70% percent of the farmers said they bought the land and 23% indicated that land is usually inherited in fragmented form.

### Crop and livestock production

The agricultural crops grown are coffee, sugarcane, tobacco, vanilla, banana, sweet potatoes, soy bean, millet, sorghum, yam, egg plant, tomatoes, pumpkins, pineapples, passion fruits, and cabbage. Of these, coffee, banana, yams, egg plant, pumpkin, pineapple, vanilla and passion fruits can be integrated with trees. The livestock kept are cattle (by zero grazing), pigs (sty feeding), rabbits (hutch feeding), goats (tethered), sheep (tethered) and poultry (kept in the free range system).

### Tree planting and management

Eighty seven percent said they would plant trees on their farms and would not find difficulties in managing them even if the fields are scattered (Tables 4a and b). Thirteen percent said they would find some difficulties in managing trees in scattered fields because of problems such as damage of fruit trees by baboons and monkeys (10%), destruction of young trees by livestock (3.3%), and difficulty in transporting harvested crops over long distances (3.3%). Theft of trees and vandalism were not considered to be serious problems in tree management. The tree management practices that the farmers said they are carrying out are given in Table 5.

#### Tree cover, species abundance and uses

The mean tree cover on the farms was 6.47% (SE"0.83). The average number of tree species per farm was 10.26. Nine farmers had woodlots and only one of these was a *Eucalyptus* woodlot. Seventy percent of the farmers planted indigenous trees such as *Ficus* spp and *Maesopsis eminii*. The rest were managing trees retained during land preparation. Fifty two tree species were recorded on the farms around Mabira buffer zones. They were used for curving and fencing, making bark cloth, bee hive, basketry, canoes, tool handles, charcoal, provision of timber, medicines, fodder, ropes, firewood, and slope stabilization, soil fertility improvement and windbreaks. The parts of trees used and the percentage of respondents

are: stems (65.3%), fruits (35.3%), leaves (25.5%), and bark (9.5%).

Constraints to and opportunities for tree planting. The major constraints to on-farm tree planting were land scarcity and fragmentation, lack of planting material, and inadequate knowledge of raising tree seedlings and tree management. Although land fragmentation and scarcity are common constraints to tree planting in the Kigezi Highlands and around Mabira buffer zones, the two areas have different population densities and the magnitude of the problem is unlikely to be the same. Future strategies to promote on-farm tree planting needs to take into account the population factor. There are opportunities for promoting on-farm tree planting around Mabira buffer zones because there is a great demand for firewood in the nearby urban markets and for use in the surrounding sugar and tea estates.

### Conclusions and recommendations

Farmers living around BINP, MGNP, Echuya and Mabira forest reserves have the perception that agricultural crops cannot be integrated with trees on the same piece of land. As a result farmers have not planted many trees and less than 10% of the farmlands are under tree cover. Farmers around BINP, MGNP, Echuya and Mabira forest reserves have planted different tree species. Of these 71% are indigenous around BINP, MGNP and Echuya forest reserve and 31% are indigenous around Mabira forest reserve.

More than 70% of the trees found on farmlands around BINP, MGNP, Echuya and Mabira forest reserves were planted by farmers. The average number of tree species per farm is 11.43 (BINP), 6.93 (Echuya forest reserve), 7.06 (MGNP) and 10.26 (Mabira forest reserve). It was noted that farmers are willing to plant trees but tree planting has been constrained by land scarcity and fragmentation, inadequate planting material and poor extension service that has left farmers with little knowledge of the appropriate ways of establishing and managing trees and woodlots. In spite of these problems, there is a great potential for promoting on-farm tree planting especially around Mabira forest to supply firewood to the tea and sugar estates and the neighbouring urban markets.

Furthermore, there is a need to assess the needs of the farmers for tree and forest products and to conduct on-farm trials before introducing agroforestry/on-farm tree planting around BINP, MGNP, Echuya and Mabira forest reserves. This is vital because the choice of tree species to be planted needs to be guided by the forest products that are highly demanded by the farmers.

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**Table 5. Tree management practices carried out by farmers around Mabira forest reserve (N=30)**

Tree management practice	Frequency
Nursery bed preparation	1
Nursery fencing	1
Manuring	1
Weeding and watering	28
Thinning	4
Pruning	9
Pollarding	8
Climber cutting	1

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