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FARMER KNOWLEDGE AND EXPERIMENTATION WITH TREES AND TREE CULTIVATION IN AGROFORESTRY SYSTEMS IN RWANDA

By

Christoffel Johannes Petrus Antonius Maria den Biggelaar

A DISSERTATION

Submitted to
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ABSTRACT

FARMER KNOWLEDGE AND EXPERIMENTATION WITH TREES AND TREE CULTIVATION IN AGROFORESTRY SYSTEMS IN RWANDA

By

Christoffel Johannes Petrus Antonius Maria den Biggelaar

Although Rwandan farmers have used trees for numerous purposes for centuries, the active planting and management of woody vegetation on-farm has been a relatively recent innovation. The goal of this research was to determine and understand the processes of agroforestry knowledge generation by farmers underlying these changes in resource management and usage. In particular, the study focused on farmer experimental methods related to the integration of trees on the farm. As agriculture is both a social and technico-economic endeavor, and as knowledge generation is embedded within productive processes, a social-constructivist perspective of science and technology was used as a framework for this study.

The research focused on a group of 44 locally identified tree experts, chosen in a two stage process using a ranking game and community interviews. A comparison group of 71 farmers was chosen randomly from those identified in the game as less-knowledgeable about agroforestry. In-depth methods used to study knowledge/technology generation included biographical case studies of tree experts, tree inventories, a socio-economic survey, participant observation and focus group interviews.

Ranking game informants identified tree experts as farmers cultivating a diversity of trees on their farm in accordance with the philosophical meaning of knowledge: knowing a plurality of objects or notions. Ranking game and socioeconomic survey results showed agreement on key variables used to distinguish farmers. Tree experts had more land, trees and tree species, but the tree density on comparison farms was more than two times higher. This points to a differentiation in knowledge between expert and comparison farmers. Consultants identified the lack of local

communication and information exchange networks as the major drawback to advancing endogenous agroforestry knowledge.

The study concludes that collaboration between knowledge systems may beneficial for both. A synthesis between systems will increase the effectiveness of ongoing scientific agroforestry research and development but, more importantly, it will empower, legitimize and enhance the existing endogenous capacities for identifying problems and developing solutions, which will be an important step towards enabling rural people themselves to alleviate their poverty.

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To my parents, the late Hein den Biggelaar and Jet den Biggelaar-Simmelink. They told me so, with perseverance, you can be all that you can be (even obtain a Ph.D.!). Thanks!!!

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CHAPTER I

INTRODUCTION

1. Statement of Need

The amount of forest resources in Rwanda has steadily decreased, especially since the beginning of this century due to rapid population growth[1], a limited land base and growing competition for resources (Gatera 1980; Nwafor 1979; Runyinya 1980). But, in spite of dwindling tree resources, the cultivation and management of woody species remains important in present day farming systems in Rwanda (Balasubramanian & Egli 1986; Baumer & Runyinya 1987; Egger 1986; Hummel 1988; N'Diaye 1988; Pinner 1988). Trees are the primary sources of energy and construction material; their cultivation is also encouraged as a means to prevent soil erosion, to increase soil fertility through mulching and green manure, and to provide products such as fruit, medicine, fibers etc. Over time, farmers have generated extensive knowledge about the management of indigenous tree species for these purposes. In addition, they have acquired and adapted a wealth of knowledge of exotic species and silvicultural practices introduced since the 1930's to the particular micro-ecological and socioeconomic conditions of their farms. However, little attention has been paid to the dynamic and continuous processes of knowledge production by farmers made necessary to adapt to ever changing environmental, political and socioeconomic circumstances. Rapid rural appraisals and agroecosystems analyses done by the numerous development projects in the country have basically been inventories at one point in time, giving an impression of stable and static farming systems.

The **goal** of this study will be to determine and understand the historical and contemporary processes involved in the generation and adaptation of knowledge and technology of agroforestry by the farmers themselves. This study will not be an investigation aimed at describing existing agroforestry systems. Agroforestry is only the medium through which the processes involved will be investigated. However, some description will be necessary to understand the processes of knowledge generation because of the extensive interactions between these processes and the

[1]The population density in 1948 was 77 persons per square kilometer, in 1970 150 and in 1990 277 persons per square kilometers.

existing stock of knowledge, but this will remain secondary to the main theme of the study. As agriculture is as much a social endeavor as a technico-economic one and as knowledge production is thoroughly ingrained within productive processes (van der Ploeg 1991), a social constructivist perspective of science and technology (Bijker 1987; Knorr-Cetina 1981; Latour 1987; Pinch & Bijker 1987) will be used as a framework for this study.

The study and understanding of farmer-based processes of innovations in agroforestry, particularly farmers' knowledge, logic and motivation towards experimentation, was recommended by the participants of an international seminar on agroforestry at Kigali, Rwanda, as the main strategy to further agroforestry practices in Africa (CTA 1988). Knowing the inner workings of the endogenous knowledge system, who the experimenters are within the systems, what their objectives and methods are is important to 1) better integrate agroforestry and tree planting policies and practices into the general context of each country and its agrarian economy (CTA 1988); 2) improve the selection of farmers participating in on-farm agroforestry research by choosing people already familiar with experimentation; plugging into existing networks of experimenting farmers can potentially reduce the cost of on-farm research (for examples on such participatory technology development, see Chambers et al. 1989; Farrington 1988; Farrington & Martin 1988; ILEIA 1988; Rhoades 1987); 3) improve the designs of both on-farm and on-station experiments; and 4) help to build interfaces between the endogenous and the exogenous (scientific) knowledge systems leading to integration or synthesis between them (den Biggelaar 1991; Box 1988; Chambers & Ghildyal 1985; Chambers & Jiggins 1987; Chambers et al. 1989). The synthesis between the two systems will help strengthen, empower and legitimize endogenous capacities for identifying problems and developing solutions, and will be an important step in a strategy of enabling rural people themselves to alleviate their poverty.

2. Introduction to Rwanda

Rwanda is located in eastern Central Africa between latitudes 1° 4' S and 2° 51' S, and longitudes 28° 53' E and 30° 53' E. It is surrounded by Uganda in the North, Tanzania in the East, Burundi to its South and Zaire in the West (see Figure 1).

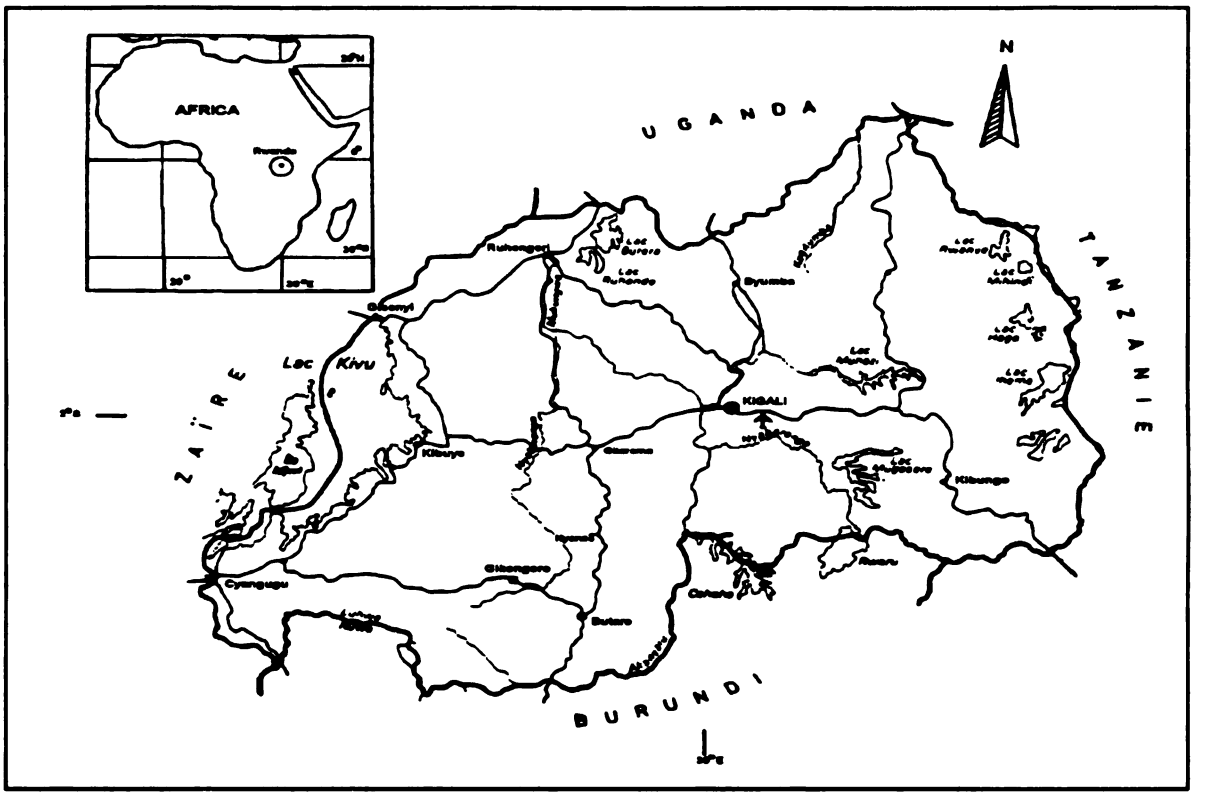


Figure 1: Rwanda: location of the country in Africa, major cities and rivers.

The total area of Rwanda is 28,338 square kilometers, of which approximately 18,725 km^2 is usable for agro-sylvo-pastoral activities (Djimde 1988), the remainder being national parks and natural forest areas. Delepierre and Prefol (1973) and the World Bank estimated that about 8,000 km^2 of the land was cropped during the early 1970s. However, Niang and Styger (1990) put the amount of land actually being cultivated much higher at 13,500 km^2. The additional land is being cropped at the expense of natural forest areeas, pasture land, and land only marginally suitable for cultivation (i.e. land on very steep slopes, highly erodable land, and the very acid, low fertility soils of the Zaire-Nile Divide).

The World Bank (1977) estimated forest cover in the 1970s at about 126,000 hectares; estimates made by Sorg (1980) put the area in forest at 225,000 hectares. Both these estimates include natural forests as well as forest plantations. Using an average of these two estimates and a population of 6,000,000 people, Niang and Styger (1990) evaluated the area of forest available

per inhabitant at 0.3 hectares. It should be born in mind that wood covers 95% of Rwanda's energy needs, particularly at the household level.

2.1. Relief

The country ranges in altitude from 1,000 meters in the east to 4,500 meters in the north-west. The highest peaks are the Birunga volcanoes found in Volcanoes National Park which straddles the border of Rwanda, Uganda and Zaire. It is the home of the famous mountain gorillas. The country is divided by a mountain range in the western part of the country which forms the division between the Zaire and Nile watersheds. The mountains in this 160 kilometers long chain range in altitude from 3,000 meters in the north to 2,750 meters in the south, with a dip to about 2,100 meters in the center of the chain in Kibuye Prefecture (see Figure 2).

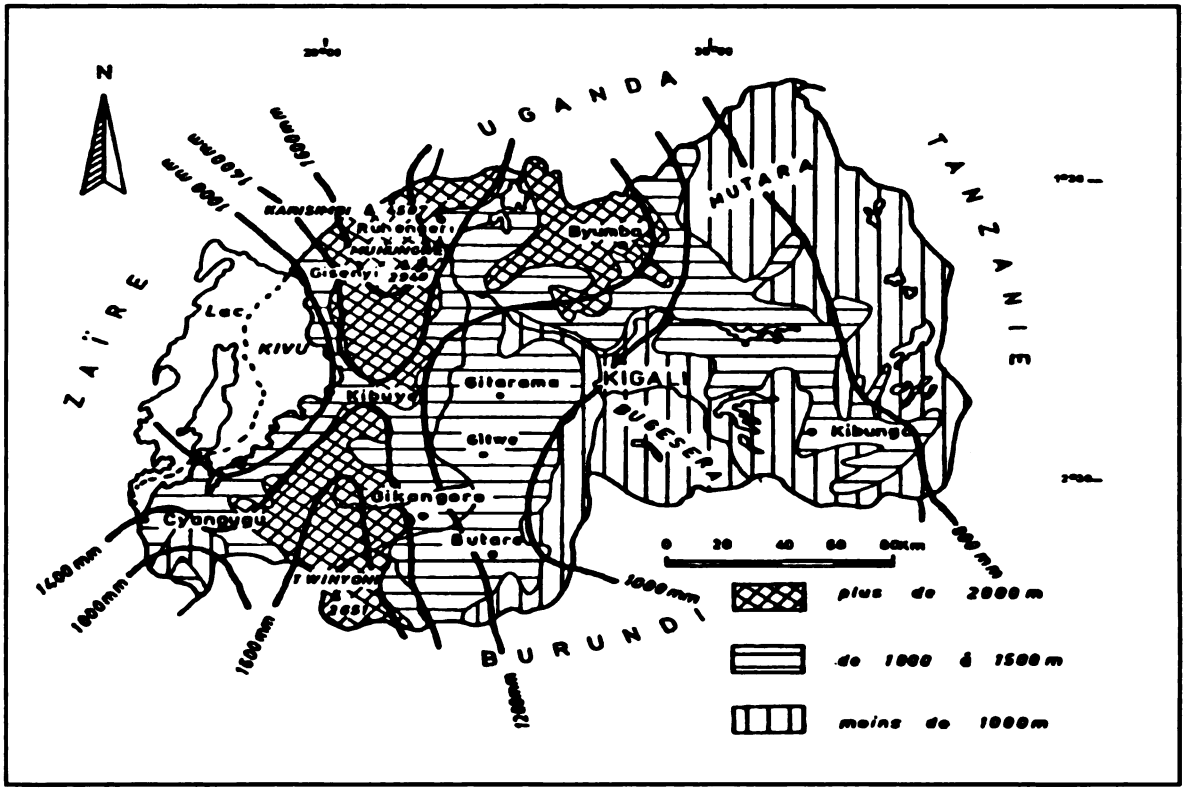


Figure 2: Isohyet and relief map showing the correlation between altitude and rainfall (source: Rossi 1984).

The landscape is characterized by a series of long, sharply defined hills, with steep convex slopes and flat ridges which are intersected by deep valleys, the bottoms of which are formed by marshy plains. These steep slopes do not prevent farmers from using the land for cultivation. The steepest slopes are found along the Zaire-Nile Divide and in the northern highlands. According to Rossi (1984), 70% of the area cultivated has slopes greater than 10%, with fields on 5% of the cultivated area having slopes greater than 80%.

2.2. Climate

Although Rwanda is located just south of the equator in the tropics, its climate is rather unique and different from what can be expected based on its latitude (Sirven et al. 1974). Because of its high altitude, both temperatures and rainfall are more moderate compared to the surrounding hot and humid equatorial regions, even though the climate still follows the same annual cycles. Both temperature and precipitation are determined by the country's physiognomy. Average temperature on the central plateau is about 19-20° C, and decreases about 0.5° C with every 100 meters increase or decrease in altitude. Average temperature in Ruhengeri, located at 1,860 meters, is 17.7° C, in Byumba (2,235 meters) 15.7° C, Butare (1,755 meters) 19.9° C, Kigali (1492 meters) 20° C, and in Bugarama (900 meters) located in the east it is 24° C. Within each region, temperatures are rather stable, with small annual amplitudes.

Rainfall also depends on altitude, and increases with higher altitudes. Precipitation varies from about 800 millimeters in the east to about 1600 millimeters in Volcanoes National Park (see Figure 2). Rain falls in a bimodal pattern. In the first rainy season, lasting from September to December, about 27% of the total annual precipitation is recorded. This first wet season is followed by a short dry period (mid-December to January); in this period, rains do not stop completely except in the eastern part of the country, but do slow down considerably. The long rainy season starts in February and last until mid-May to early June; 40% of annual precipitation falls during these months. The long dry season last from two months (in the North-West and on the Zaire-Nile Divide) to four months in the East, from mid-May to mid-September.

2.3. Population

In spite of its small size, Rwanda is very densely populated. The country has one of the highest population growth rates (3.1%) in the world, and its population density of 252 persons/km^2 is comparable to Bangladesh. According to the latest census, carried out in 1991, Rwanda has a population of 7.1 million people, 2.3 million people more than in the previous census carried out in 1978. Excluding national parks and natural forest areas, populations density in 1991 was 382 persons/km^2. Using the 13,250 km sq of land effectively cultivated according to Niang and Styger (1990), density is even higher at 526.9 persons/km^2. Since the population is not evenly distributed over the country, local densities may be as high as 800 persons/km sq agricultural land.

There is little urbanization in Rwanda; 95% of the population lives in rural areas, mainly living from subsistence farming. The largest city, the capital Kigali, has only about 200,000 inhabitants. Belgian colonial rulers as early as the 1920s predicted imminent wide-spread famines in Rwanda because of the rapidly growing population (which at that time was anywhere from 1.5 to 2 million people) and severe land degradation due to over-cultivation and deforestation. In spite of these predictions, agricultural production of subsistence crops broadly kept pace with population increases until about 1977 (Reyntjes, 1991), mainly by expanding cultivation on new land in the east and by draining the previously uncultivable valley bottoms. Since then, as Reyntjes wrote, the area of land annually made available for subsistence crops has increased by only 1.4% and, crop yields have been declining simultaneously because of erosion and declining soil fertility due to intensive cultivation.

2.4. Economic conditions

According to 1989 estimates by the World Bank, cited by Reyntjes (1991), gross national product (GNP) was equivalent to US$ 310 per head. These same estimates pointed to an annual rate of increase in GNP of 1.3%, although on a per capita basis GNP declined by 1.9% per annum during that same period.

The agricultural sector accounted for about 40% of Rwanda's gross domestic product in 1989, and engaged an estimated 91% of the labor force. About 95% of the total value of agricultural production is provided by subsistence crops (Reyntjes 1991). The principal crops, in order of importance, are bananas, sweet potatoes, cassava, beans, sorghum, rice, maize and peas. The major export crops are coffee (65% of export revenue in 1990) and tea (21.5% of export revenue). Until the mid-1980s, considerable revenue was also obtained from pyrethrum (Rwanda was the third largest producer in the world in 1980) and quinquina, but production and revenue of both these crops has severely declined.

Rwanda does not have much of an industrial sector; industries are dominated by food processing plants of coffee, tea, brewery, a sugar factory, and a cigarette factory. The country does have some mineral deposits (gold, tin, wolframite being the main ones), but its long distance from any ports (Mombasa in Kenya being 1,200 kilometers over land) and volatile world prices, particularly for tin, make profitable exploitation very difficult.

2.5. Land use systems and their principal constraints

There have been several attempts to divide the country in a number of areas with similar characteristics in order to facilitate agricultural policy and development planning. The most widely used is the delimitation in agroecological zones made by Delepierre (1974). This author distinguished twelve zones based on soils, altitude and precipitation but did not include the crops and animals produced by the farmers in this determination. These 12 zones have a north-south orientation corresponding to the topographical features of the country. Because crops and animals are the primary factors distinguishing farming systems, Olson and Campbell (1993) performed a cluster analysis of actual production data at the commune level of the major crops and animals. The 8 farming systems regions Olson and Campbell defined show a more distinct east-west pattern, and match the old cultural regions better than Delepierre's agroecological zones. The old cultural regions refer to areas with distinct personalities resulting from the natural environment, history, mission influence and administrative divisions. In areas where the present day prefectures are different from these former cultural regions, people still identify themselves more with the latter than the former. Thus, what crops and animals people actually produce

appears to be more dependent on the cultural norms and values in a particular region on what crops to grow, how to grow them, and which animals to keep than on biophysical potential. However, neither the agroecological zoning nor the farming systems regionalization take trees or the actual cropping systems into account.

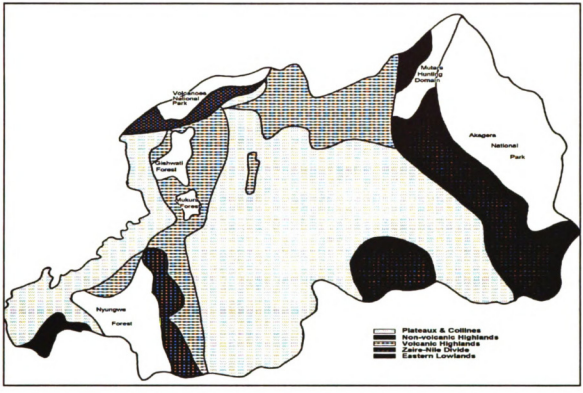


Figure 3: Map showing major agroforestry system zones as determined by D&D (source: Niang and Styger 1991).

For agroforestry, however, a multi-disciplinary perspective is necessary, taking into account not only biophysical conditions but also socio-economic factors, present land-use patterns and cropping systems. To assess the potential for agroforestry in Rwanda, ICRAF, with the help of the Institut des Sciences Agronomiques du Rwanda (ISAR) and the Université National du Rwanda (UNR) carried out a nation-wide Diagnosis and Design (D&D) in 1987-88 (Djimde 1988). The D&D exercise resulted in dividing the country into five zones, namely Plateaux et Collines, Non-Volcanic Highlands, Volcanic Highlands, the highlands of the Zaire-Nile Divide, and the Eastern Lowlands (see Figure 3). Table 1 provides an overview of the major features

of each zone, their farming systems and their major constraints which could, potentially, be solved by agroforestry.

From Table 1, it can be seen that soil erosion, declining soil fertility and shortage of wood for fuel, timber and staking material, are major constraints throughout the country. In spite of considerable development efforts for over 50 years, these problems remain similar to the ones identified by the Belgian colonial rulers in the late 1920s (Thomas 1940; Tondeur 1937) except for the occurrence of periodic famines.

The establishment of an arboretum at Ruhande in 1932 was inspired by the need to reforest the countryside to prevent erosion and soil fertility decline and to provide various wood products to the local population. Similarly, the Belgians introduced a number of new crops, both subsistence crops (cassava, vegetables, potatoes) as well as export crops (coffee, tea) to combat the frequent episodes of famine ravaging the country periodically in the first decades of this century (Fallon 1930). As can be seen in Table 1, these introductions have had a profound effect on the agricultural systems of the country, both in terms of the crops being produced as on the woody vegetation found in the landscape. The present, widespread acceptance and cultivation of particularly cassava, eucalyptus and grevillea introduced at that time are an indication of the changing nature of endogenous knowledge, the necessity of agricultural research to bring such changes about, and the successful blending of endogenous and exogenous knowledge to make the new technologies and crops work in the local context. In the next section, a more detailed description will be given of tree growing practices in Rwanda.

3. History of tree growing practices in Rwanda

According to Everaerts (1939) the country was almost completely forested before the arrival of the Tutsi pastoralists in the 1500's.[2] Schoenbrun (1993), in an historical analysis of agriculture

[2]Everaerts wrote that the "Tutsi needed land for grazing their cattle and abhorred forest." However, this may be a biased observation: since in European agriculture cattle subsist mainly on grasses and other herbaceous material, the author may not even have considered the possibility of using trees as a source of fodder.

Table 1: Characteristics of the agroforestry system zones (Source: Djimde 1988; Niang & Styger 1991).

	Plateaux & Collines	Non-Volcanic Highlands	Volcanic Highlands	Zaire-Nile Divide	Eastern Lowlands
Altitude	1500-2100 m	> 1900 m	> 1900 m	> 2100 m	< 1500 m
Rainfall	1000-1400 mm	1400-2000 mm	1300-1600 mm	1400-1800 mm	800-1000 mm
Temperature					
Average	9° C	16° C	16° C	18° C	22° C
Minimum	10° C	5° C			26° C
Maximum	30° C	25° C			14° C
Soils	Histosols & inceptisols in valleys Inceptisols, ultisols & entisols on the hills	Humults and humitropepts, medium to low fertility, acid to very acid, high in clay	Andepts, fertile, low to medium acidity, high humus content	Humitropepts, low fertility, highly acidic (Ph 3.7-4.8)	Ultisols, vertisols and entisols of low fertility and highly erodable
Avg. farm size	1.1 ha	1.0 ha	1.0 ha	2.0 ha	2-2.5 ha
Principal crops	Sweet potatoes, cassava, beans, maize, bananas colocasia, soybeans	Maize, peas, potatoes, wheat, barley, bananas, beans, sorghum, sweet potatoes	Maize, peas, potatoes, wheat, barley, bananas, beans, sorghum, sweet potatoes	Maize, peas, potatoes, wheat, barley, bananas, beans, sorghum, sweet potatoes	Bananas, sorghum, beans, peanuts, cassava, maize
Cropping system	Most in association, intensive	Mostly as monoculture, intensive	Monocultures predominate, intensive	Extensive cropping	
Major cash crop	Coffee	Tea	Pyrethrum	Tea	Bananas
Livestock	Cows, pigs, goats and sheep; intensive, semi-stabled	Sheep, goats; cows (1/5 of households); intensive, semi-stabled	Cows, sheep and goats; intensive, semi-stabled	Cows, goats, sheep, chickens; extensive	Cows; extensive
Predominant trees	Eucalyptus, Grevillea, A. mearnsii, Markhamia, Ficus spp, avocado, Pinus spp, Erythrina, Draceana, Euphorbia, Callitris; On the rugo and in/around the fields	Eucalyptus, Acacia, Pinus spp, Draceana, Erythrina; Mostly on the rugo, rarely in the fields	Polyscias, Eucalyptus, Euphorbia, Bamboo; On the rugo and as field markers	Vestiges of primary forest, Polyscias, Erythrina, Ficus spp, Eucalyptus. Extensive fallows of Pteridium & Dissotus	Acacia spp, Teclea nobilis, Apodytes
Major constraints	Low soil fertility, soil erosion, lack of land, shortage of wood (fuel, timber) and fodder	Soil erosion, acidity, Small farm sizes, declining soil fertility, shortage of fuelwood and staking material	Shortage of timber, fuelwood, fodder and staking material; Erosion is less important	Very acid soils; hail storms; violent winds during the dry seasons; low insolation	Irregular, low rainfall; termite damage; lack of fodder, timber and fuelwood; declining soil fertility; soil erosion

in the Great Lakes area of East Africa, estimated deforestation, based on pollen records, to have begun as far back as 3000 B.C. Deforestation was already well under way even before the Tutsi arrived in Rwanda, and by around 1,000 A.D the country looked much as it looks today. As Schoenbrun writes:

> .... as early as 3000 B.C. in Kigezi, and not later than 1000 B.C. throughout the region, lower- and medium altitude forests in valleys began to shrink significantly, leaving rises in grassland pollen percentages in stratified deposits. .... Then, beginning as early as 2000 years ago in Rwanda and Burundi, and certainly by 1500 years ago elsewhere, secondary and degraded forests expanded at the expense of more mature forest communities. Herders and farmers, who probably lived on the hillsides or the valley bottoms of the area, cleared forests by burning and cutting and may have utilized the remaining ridgetop forest refuges as managed food sources in times of famine and/or as ritual and burial sites. The older, long-fallow practices began to intensify throughout the region well before 1500 years ago, leading to a reduction of even climax secondary forest. By a thousand years ago a constellation of vegetation types similar to those found today dominated the Great Lakes region.

In the early part of this century, dense forests had decreased to about three percent of the Ruanda-Urundi territory, or 6.5 percent when one would include the savanna areas (Everaerts, 1939:361).[3] The lack of trees was not considered a serious problem. Early agronomists often considered trees to be more of an obstacle than an aid for agricultural development (although the proliferation of agroforestry projects and activities in the last ten years is slowly changing this situation). Other than fruit trees and a few economic woody species (such as coffee, tea, oil palm in the case of Rwanda), early agronomists made no mention of trees in their descriptions of the farming systems of the country (see for example Mortehan 1921 and Everaerts 1939). Yet, in spite of the severe deforestation in the country and the lack of attention paid to trees and forests, trees remain important for farmers.

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[3]Everaerts evaluated the total forested area in the Ruanda-Urundi territory at 145,000 hectares in 1939. Sorg (1982) estimated the forested area of Rwanda alone on the basis of various sources at between 170,000 and 180,000 hectares. According to Préfol and Delepierre (quoted by Nwafor (1979: 62)), the country had 228,102 hectares of forest and reafforested land (8.6 % of cultivable land of the country estimated at two-thirds of total land area). This would indicate an increase in forested area, even though the main forest areas have decreased at a rate of 1,600 hectares per year between 1957 and 1977 according to Sorg. These numbers are contradictory and cannot be considered as definite. More recent articles also provide widely varying estimates as to the amount of forested area still present in the country.

A later ethnographic study by Bourgeois (1957) found that "people do not cultivate any fruit trees, apart from bananas. Only through the stimulus of the Europeans have local people started to plant tomatoes, and some rare papayas, mangos, citrus, avocados, pineapple, strawberries and prunes." A few lines later, though, the author stated that "children collect several fruits in the wild, namely malaguetta pepper (Afromomum sanguineum), *inyonza* (Carissa edulis), cape gooseberry (Physalis peruviana), blackberries (Rubus inedulis), *umusagara* (Pentas zanzibarica) and others." Apparently, local fruits were not considered fruits by Western observers.

Bourgeois's account of woody species for other uses is more extensive, especially his description of trees and shrubs planted in and around the compound which include a number of species that are propagated by planting large leafless branches.[4] The latter often were used to build a dense enclosure to protect against animals and thieves, and included the following species: Erythrina abyssinica, several Ficus spp., Euphorbia tirucalla, Acanthus pubescens, Carissa edulis, Pentas zanzibarica, Combretum molle and C. queinzii, Dracaena papahu, Pennisetum grass and cassava stems. These woody species provided a mixture of food, wood for cooking, construction and fabrication of utensils and tools, bark for fiber to make clothing and rope, as well as medicines for people and animals. Trees around the compound were primarily planted for timber, and included Markhamia lutea, Vernonia amygdalina, Euphorbia tirucalli, and Ficus spp. No description was given about the use of woody species outside of the compound such as on field boundaries (where they are presently very common), or scattered on the fields.

These findings are substantiated by later descriptions of the richness of tree growing practices reported by Balasubramanian and Egli (1986), Gibson and Muller (1987), Pinner (1988), and Hummel (1988). For example, Balasubramanian and Egli found that 86% of the farmers in the Bugesera-Gisaka-Migongo (BGM) region had an average of 9 fruit trees (avocado, citrus, mango, guava, jack and passion fruits) on their farms, in addition to many other species (Eucalyptus, Grevillea, Ficus spp., Sesbania, Cassia, Markhamia to name but a few). Hummel's research in

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[4]The species so propagated are not identified. The author gave the impression that all species planted in dense hedges around the compound are propagated by branch cuttings, which may or may not have been the case.

Muyaga (Butare Prefecture) counted on average of 89 trees per farm enterprise (84 trees per hectare).

"Scientific" farm forestry has been promoted in Rwanda since the 1930's. Due to the imposition by the Belgian territorial administration, numerous rapidly growing exotic trees (eucalypts, grevillea, black wattle, cypress, cassia and others) were planted in community and private woodlots and along contours as a means to limit deforestation, provide fuelwood and timber, and help combat soil erosion (Lens 1949; Dubois 1954; Languy 1954; Derenne 1989).[5] Agroforestry as it is now called is, therefore, not a new idea in the country: an extensive endogenous knowledge system has developed around the incorporation of trees in the farming systems of Rwanda. This endogenous knowledge, however, has over the years incorporated many ideas from outside. An example of the endogenization of exogenous knowledge is the large interest farmers have in planting various exotic fruit trees (such as mango, avocado, prunes) and timber/fuelwood species such as Grevillea and Eucalyptus. These latter species have become firmly entrenched, evidenced by the fact that farmers have given them names in the local language (*gereverya* and *inturusu* respectively).

The switch from the term "indigenous" to the term "endogenous" in the above paragraph is a deliberate one made because of the many negative connotations connected with the word indigenous. The definition in Webster's Dictionary given to the term "indigenous" is not really applicable to knowledge and technology: 'existing, growing or produced naturally in a region or country; innate, inherent, inborn'. Since knowledge is neither naturally occurring, nor innate, I prefer the term 'endogenous knowledge'. The term "endogenous" refers to something

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[5]Everaerts (1939) estimated the total area reforested at the end of 1938 at 22,000 hectares: 9,723 hectares in Ruanda and 9,878 hectares in Urundi, the difference being tree plantings along roads and private woodlots. Communities were obliged to establish one hectare of forest per 300 people each year. The reasons given by the author for stimulating reforestation were to combat to a shortage of fuelwood and timber, while a secondary reason given was to combat the irregularity of rainfall (although Everaerts admitted that this would take thousands of hectares to accomplish). Preferred species were eucalypts, Acacia decurrens var. mollis (syn. A. mearnsii), cypress, Grevillea robusta which was gaining popularity but planting was constrained by a lack of seed, Casuarina planted along the roads, Maesopsis eminii in regions with bad termite problems, and Markhamia lutea which has an excellent wood but is slow growing. Black wattle and cypress were less favored by the farmers, since the first suffered from bacterial blight and the second was very demanding of a good soil and maintenance during the first years.

"developing from within, originating internally" (Webster 1986), and is a much better description of the nature of local knowledge and technology systems. However, it does not preclude the fact that elements of exogenous knowledge systems may become endogenized over time. An endogenous knowledge system is thus a system of knowledge developed from within a local social system (e.g. ethnic group within a defined geographical or biophysical area) based on its beliefs, meanings, values and norms as opposed to exogenous knowledge systems which comprise all non-local (including the Western scientific) knowledge systems. Such a distinction makes it easier to distinguish differences in knowledge systems from different geographic areas or ethnic groups. The distinction between endogenous and exogenous knowledge systems is thus only a relative one, the relativity being from which point of view one looks at and studies these systems.[6] For these reasons, the term endogenous will be used throughout this study.

The oldest formal agroforestry project in the country that sought to promote the use of trees on farms as a low-input, ecologically sustainable way for agricultural development is the GTZ financed "*Projet Agropastoral de Nyabisindu*", which has been in operation since 1969. The project serves as a model for agroforestry projects elsewhere in Africa, and has been described extensively in the literature. Agroforestry is defined as a holistic approach to land use, based on the combination of trees and shrubs with crops, pastures or animals on the same land unit, either in sequence or all at the same time (Lundgren 1982). In reality, as Rocheleau et al. (1989) write, 'most farmers cannot easily separate this from the integration of woody plants into agricultural and pastoral landscapes. Whereas formal agroforestry science is based on the systematic placement of trees relative to crops and pastures, rural people are often more concerned about the fit of the whole agroforestry practice, and trees in general, into the larger landscape.'

Since 1980, many other projects in Rwanda have added an agroforestry component to their agenda, or were established with the specific purpose of promoting agroforestry systems in a particular area of the country (CARE-Gituza, BGM, Swiss-Aid Forestry Pilot Projet in Kibuye, UNDP/FAO Projet d'Intensification Agricole de Gikongoro, USAID Farming System Research

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[6]Van der Ploeg (1991: 79) also talks about endogenous and exogenous innovations as innovations that can be brought about through and by farmers themselves or are dependent on outside sources (industry or research) respectively.

and Natural Resource Management projects, World Bank agricultural projects in Kigali and Gitarama, the IDA financed FSR project in Karama to name but a few). These projects have been successful in developing agroforestry technologies (to quote Thrupp 1989, "scientized packages") that work under research station conditions and with large inputs of technical assistance, but less successful in getting these packages accepted by farmers as evidenced by low rates of adoption of the packages as a whole (Kerkhof 1990; N'Diaye 1988), even though farmers do plant large numbers of trees. The low success rate of these projects (as elsewhere in Africa) is mostly due to the imbalance of technical and social expertise (oversimplification of production systems, 'homogenization' of landscape, acceleration of the processes of resource degradation and selective impoverishment of women, the poor and/or ethnic minorities) and from lack of accountability to their rural clients (Rocheleau et al. 1989). Examples in Rwanda of the simplification of production systems and homogenization of the landscape are the emphasis of most projects on alley cropping using leucaena, sesbania or cassia, thereby neglecting any locally developed systems of integrating trees into the landscape using indigenous tree species. Also, given a choice and without pressure from (project) extension agents, farmers appeared to favor Eucalyptus and Grevillea for timber production, or fruit trees, over any leguminous tree species for soil fertility maintenance and fodder (Kerkhof 1990).

4. Theoretical considerations.

Agroforestry is relevant as an approach if it is viewed in a broad sense and is implemented in a way that is sensitive to people's needs and priorities, and if it takes the sociocultural and economic context in which these systems developed into account. Surveys are useful to assess the existing farm situation and to determine people's needs, priorities, problems and constraints, but they have three major limitations: (1) they provide only a static picture (a "snapshot") of a situation at one point in time; (2) they fail to discover the needed contextual aspects of the needs, priorities, problems and constraints; and (3) they do not give an historical account of why particular systems exist and the role played by farmers in developing the systems (not only as producers of crops and livestock but especially as landscape managers and reproducers of the systems). Müller and Scherr (1990), in a comparative study of 165 agroforestry projects in Africa, found that most projects used surveys for needs assessments, but that few used them for

linking the results to technology design issues or exploring sociocultural factors such as farmers attitudes, interests, and indigenous technologies and knowledge related to trees. While surveys are necessary and useful to national policy formulation, to determine existing farming systems and practices and to establish a benchmark to assess change over time, they are not sufficient for the development of new agroforestry technology.

Projects generally carry out surveys when first operational in the field to determine farmer problems and constraints, and subsequently work on developing technologies eliminating these problems and constraints. No one would question the fact that needs, priorities, problems and constraints may not be the same when viewed from a different knowledge system or epistemological perspective. The underlying view of most agroforestry projects remains that science knows best, or, to put it in the words of Feyerabend (1988: 3), "The excellence of science is assumed, not argued for." Questionnaires are constructed by scientists and researchers on the basis of a Western epistemology; answers obtained may be perceived to indicate a problem by the researcher, but the respondent will only answer questions and not question their validity with respect to his/her own world view. As Feyerabend (1988) states, there are many different kinds of science, first world science is only one science among many others. Each science tradition may, therefore, arrive at different conclusions about what constitutes a problem, priority or need, and what acceptable solutions will be. Science and technology are above all socially constructed entities (Knorr-Cetina 1981; Bijker et al. 1987; Feyerabend 1988). "It is social groups that give meaning to technology and problems are defined within the context of the meaning assigned by a social group or a combination of social groups. Because social groups define problems of technological development, there is flexibility in the way things are designed, not one best way" (Pinch and Bijker 1987).

It is, therefore, not sufficient to find out what the existing agroforestry systems and technologies are as formal surveys do and have done as a starting point to solving problems and constraints, but more important to determine how such systems and technologies came into being, what the meanings are that people assign to them, how the knowledge upon which they are based is generated, and how they change over time under pressure of changing sociocultural, economic, political and environmental conditions. As Thrupp (1989) writes,

> Traditional [agroforestry] knowledge may become marginalized or lose its value when well-intentioned scientists and researchers "scientize" it by examining it with formal empirical methodologies using laboratory/controlled trials. Although such studies often attempt to verify or demonstrate the function of people's practices and ideas, this form of systemization can be inappropriate to appreciate the true function and subtle complex nuances of such knowledge systems. .... There is undoubtedly some value in this kind of scientific investigation and validation. However, problems arise because most agroforestry research is abstracted from small farmers' conditions and neglects the knowledge basis upon which such local practices are developed. This kind of exploitative and scientized approach to the study and use of indigenous capacities perpetuates the usual patterns of marginalization and displacement, and it seldom improves participation and livelihoods of people.

Are there, therefore, more fundamental ways of understanding and perceiving agroforestry systems (i.e., from an emic perspective) that will enable a better integration of the two knowledge traditions? A thorough understanding of the endogenous knowledge of existing land-use systems is essential for improving existing or developing new systems. As Balasubramanian and Egli (1986) write:

> The small farmer systems of the [Bugesera-Gisaka-Migongo (BGM)] region have evolved over a period of continuous land scarcity which has forced the farmers to try to innovate and produce more food with the skillful use of locally available resources. Study and understanding of the existing systems evolved through ages by the industrious and inventive small farmers must be the starting point for the research to develop improved systems.

However, in order to gain an emic understanding of endogenous knowledge of land-use or agroforestry systems, it is not sufficient to study agroforestry knowledge only. It is also necessary to familiarize oneself with the world in which this knowledge is embedded. In Appendix I, some background information wil be provided on the philosophical basis of the Rwandan view of the world based on studies by Kagame (1956) and Balibutsa (1985). This information will be helpful to put findings of this study into perspective.

4.1. The socially constructed nature of agroforestry knowledge

Agriculture and agroforestry exist only because people are involved in shaping their environment in ways that are more beneficial to them than exploiting the environment in a natural state by hunting and gathering. The existing tree-crop-animal systems of Rwanda (having evolved from

centuries of experience) are a reflection of people's needs for subsistence and their ideas of the "ideal" spatial and temporal arrangement and choice of species of plants and animals to meet these needs, even though the systems are "not well-managed agroforestry systems" (Balasubramanian and Egli, 1986) as defined by outsiders. This does not necessarily mean that these systems are "bad" and static or unchanging; viewed from the endogenous epistemology they are perceived to be the best that can be achieved to guarantee a sustainable, albeit perhaps minimal, subsistence income and food supply. Farmers are always willing to consider new species and varieties, and seem to be in a constant search for optimal arrangements, species and crop mixes. Farmers do not keep such information to themselves, indeed, their fields are wide open for everyone to see. Brush (1993) talks in this context of collective invention in which changes tend to be incremental. "Each small step is not truly a new invention, but taken together, the steps transform technology as much as individual invention." The systems appear to be in almost perpetual flux to meet new needs and adapt to changing ecological, economic, social and political conditions. The almost constant tinkering of the farmers is, however, closely matched by the experiments of researchers and scientists employed by the various projects and the national agricultural research institute. While the technology packages (e.g. alley cropping) developed by the latter may have very low adoption rates, such packages often are a prime source of inspiration and material for the farmers' own tinkering to make the exogenous, scientific technologies work in their own farm conditions or to develop new technologies on the basis of these packages (Sumberg and Okali 1988). This means that endogenous technology and knowledge must be a starting point, but that one cannot exclude "Western" scientific approaches to solving problems and constraints. The numerous exotic crops, fruit, timber and fuelwood species introduced by Belgian researchers and now forming common elements of the farming systems attest to both the extensive tinkering of the farmers and the necessity of scientific research.

Endogenous and exogenous knowledge and technology systems are, therefore, not mutually exclusive. A synthesis of the two systems, as called for in an earlier paper (den Biggelaar 1991) would prevent the marginalization of the endogenous knowledge system and the loss of much valuable agroforestry technology. Simultaneously, it will better ground future technology development within the cultural and social context in which the new technologies will be applied.

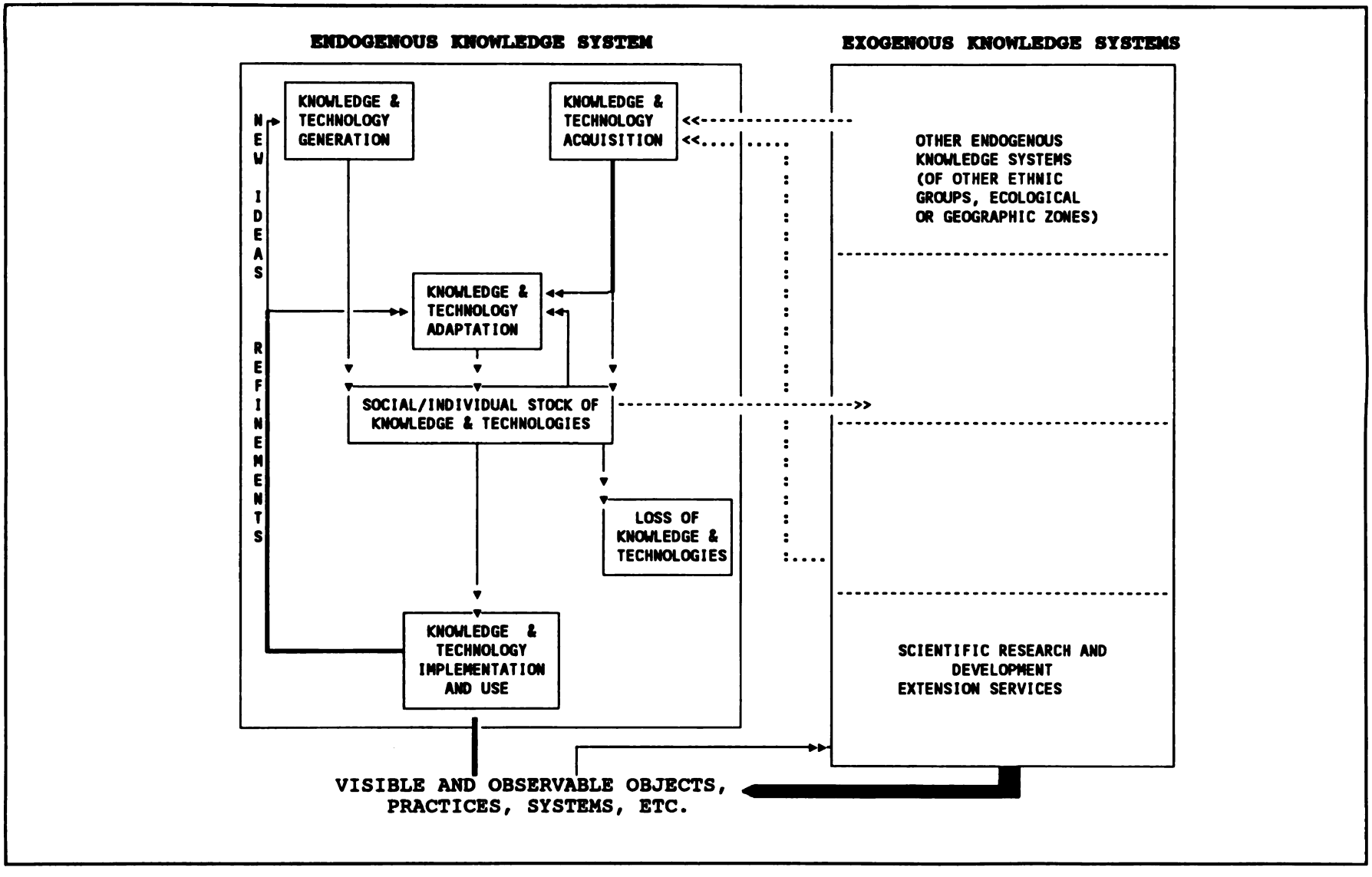


Figure 4: Conception of various processes taking place within the endogenous knowledge system, and its relations with exogenous knowledge system. (Adapted from: den Biggelaar 1991).

However, in order to bring such a synthesis about, one would have to know how each of the two systems are organized and function. A study of agroforestry systems cannot limit itself to studying trees, crops and animals, but must above all focus on the people that designed and use the systems. The concept of a societal knowledge production and use system (cf. Holzner and Marx 1979) is useful in this respect as an organizing device. The term knowledge system as used by these authors refers to the particular view that emerges when one studies the social distribution of knowledge-related processes. Holzner and Marx distinguished between four different, but interrelated, social activities in the knowledge system: (1) knowledge production, i.e. the creation of new knowledge; (2) the organization of knowledge into coherent bodies; (3) activities and institutions of knowledge storage; and (4) knowledge application, that is putting knowledge to use in solving of practical problems, and implementation, absorption into everyday routines of explicitly knowledge-based plans for action. Figure 4 provides a schematic of these various activities within the endogenous knowledge system, as well as its relations with exogenous knowledge systems.

As Holzner and Marx emphasized,

> The distinctions between these various activities (or processes as they were called by den Biggelaar) refer to interdependent and often fused aspects of the empirical knowledge system. It would be erroneous to argue that knowledge production is independent of the other functions; indeed, knowledge application particularly may be intertwined with production processes.

It is the interweave of these various activities within the endogenous knowledge system with production processes and with the social structure that makes these systems so obscure for outsiders and so hard to apprehend for participants in the scientific knowledge system. The endogenous knowledge system acts as a sort of "black box" for outsiders. Results from the endogenous knowledge system, i.e. the particular facts and artifacts that are determined via surveys and described in reports emanating from them, are relatively easy to uncover. But how and why the system was developed, how it operates, who the "researchers" in the system are, how they proceed in their experimentation, and why they experiment is much more difficult to grasp. 'In societies in which knowledge is not codified, but transmitted through the learning of skills embedded in social roles, taking the form of wisdom, the knowledge system does not appear as an empirically separate aspect of social structure' (Holzner and Marx 1979).

5. Research objectives

The goal of the proposed investigation is to take a look inside this black box of the endogenous knowledge system particularly as it relates the production of knowledge and technologies of agroforestry systems in Rwanda. The objective is not to give a detailed account of tree growing and use practices and of the interactions between trees, crops and animals occurring on the farm, or to describe the distribution of agroforestry knowledge in a particular geographic area. This study will focus on the dynamic aspects of agroforestry to determine the 'how' and 'why' questions of changing tree growing practices on Rwandan farms in order to determine the processes involved in the production of endogenous knowledge and technology. Agroforestry is, therefore, only a medium chosen to gain an understanding of the processes involved, just like other authors have chosen the bicycle, fluorescent light bulb or a biochemistry laboratory. Latour (1987) also argues for such procedures detailing the processes of knowledge production:

> .... surprisingly few people have penetrated from the outside the inner workings of science and technology, and then got to explain it to the outsider how it all works. For sure, many young people have entered science, but they have become scientists and engineers; what they have done is visible in the machines we use, the textbooks we learn, the pills we take, the landscape we look at, the blinking satellites in the night sky above our head. How they did it, we don't know. Some scientists talk about science, its ways and means, but few of them accept the discipline of becoming also an outsider; what they say about their trade is hard to double check in the absence of independent scrutiny. Other people talk about science, its solidity, its foundation, its development or its dangers; unfortunately, almost none of them are interested in science in the making. They shy away from the disorderly mixture revealed by science in action and prefer the orderly pattern of scientific method and rationality. Defending science and reason against pseudo-sciences, against fraud, against irrationality, keeps most people too busy to study it.

Even though Latour's statement refers to outsiders looking into the (Western) scientific knowledge system, it applies equally well (perhaps even more so) to outsiders looking into the endogenous knowledge systems. Balasubramanian and Egli, as well as many others having described "traditional" farming systems in Rwanda, have not attempted to gain an understanding of the logic of the systems, of how and why the knowledge and technology of these systems came into being and the role played by the farmer-experimenters in this process. This is reflected in their statement that "the [existing] agroforestry systems [in the BGM region] are not well-

managed systems." However, as Latour argues, without such an understanding of how science and technology develop out of the disorderly mixture of ideas and practices, one cannot really understand what constitutes science and technology ('What is called knowledge can't be defined without understanding what gaining knowledge means' (Latour 1988)).

This study will be one of an outsider looking inside the "black box" of agroforestry knowledge and technology production to determine what the active role of farmers has been and continues to be as regards changing tree growing and use practices, and then to describe and explain the processes involved to the outsiders. The active role refers to the active engagement of farmers of adapting existing ideas, technologies and uses and/or of experimenting to arrive at new ideas, technologies and uses to optimize patterns of integration of woody species in their farms given existing socio-economic, cultural and political conditions. The dynamic aspects of agroforestry systems refer to the adaptation of the systems over time and space. The active role of farmers in these efforts should be seen as diametrically opposed to the passive adoption of pre-chewed externally developed technologies-as-they-are, as the formal research/extension establishment would like the farmers to do (see for example Pottier 1989). This passive approach was also criticized by Thrupp (1989) and the participants of the international agroforestry seminar at Kigali in 1988. A number of recommendations made at this seminar specifically called for the investigation of farmers' knowledge and farmer-based innovations.

Not every farmer will have the same propensity for experimentation, largely as a result of differing socio-economic and political positions within the community and differing biophysical conditions on his/her farm. Neither will every farmer have the same aptitude towards experimentation and innovation. Such varying conditions imply that different farmers will experiment with different technologies and, since there exists no uniform experimental method as in formal science[7], may use widely diverse methodologies and approaches. Thus, even if farmers experiment with the same technology or basic idea, they may arrive at completely different solutions (for example, a pastoralist will emphasize leaf and pod production while a sedentary farmer may be more interested in timber, even though in both cases the same tree

[7]Although Knorr-Cetina (1981) questioned whether formal science really has a uniform methodology.

species is involved). It may, therefore, be better to talk about "farmer systems" than farming systems. The absence of a farming system in a particular area partially explains the difficulty of development projects of adapting technology in ways acceptable to farmers.

5.1. Research questions

1. How have tree growing practices changed over time in general or as a result of experimentation? (species choice, arrangement, uses, place, management, intercropping practices, first order interactions between trees, crops and animals)

   NOTE: While this could be a dissertation in itself, this information is needed to build a contextual frame of reference in which to place the other questions.

2. Who are the experimenting farmers? What differentiates them from other farmers in the community? (socio-economic status, farm size, land quality, external sources of income, travel, connections, political position, aptitude.....)

3. Why do farmers experiment? What are their objectives for experimentation?

4. Where did the idea, practice ... forming the basis of the experiment originate?

5. How do farmers themselves define "experimentation"?
   a. Are there common elements in the methodology experimenting farmers use?
   b. What, how, why and how long was testing done before adoption or rejection?
   c. What are the adoption/rejection criteria (why or how is a particular practice better or worse than existing practices)?
   d. When and under which conditions can a new practice or technology be used?
   e. What other changes in production technology are needed to make a change practical and worthwhile?
   f. Is there a difference in the above factors (a. through d.) between trees and annual crops or tree/crop combinations?

6. Contributions of This Study

An international seminar on agroforestry organized in Rwanda in 1988 had as the main theme the efficiency of trees in agrarian production and rural landscapes. Participants in the seminar observed that "there are few specific agroforestry research programs, and even rarer to come across research work which is interested in the traditional ways of maintaining, training and exploiting local species" (CTA 1988). Further, "many development projects are based on prefabricated models, and on faulty, indeed superficial, knowledge of existing agricultural

systems" (CTA 1988). However, it was found to be imperative that researchers are able to grasp and use the concepts, language and reasoning of farmers in order to be able to discuss results of research work with the farmer users. The importance of this study is that it will fill some of the lacunae in the understanding of the logic and knowledge about agroforestry in Rwanda. In this "farmer first" (borrowing from Chambers et al. 1989) effort, it will follow Rakotomanana (1988):

> After putting our heads together, we realized that the whole rural world is a closed map waiting to be explored. We still have to learn about the farmer's preoccupations, his motivations, strategies and open-mindedness towards innovative processes.

Only through an understanding of farmers' preoccupations, motivations, strategies and innovations can bridges be build between the endogenous and scientific knowledge traditions. But studies on trying to understand endogenous knowledge systems and on how to synthesize endogenous and exogenous knowledge systems are rare, especially in the field of agriculture; Box's work with cassava cultivators is an exception in this area. Such holistic study of complete systems and synthesis between endogenous and exogenous knowledge systems is more common in the medical field (see for example Janzen 1978; Slikkerveer 1990). The objective of the study of Box (1988) was to arrive at an improved design of on-farm research by building interfaces between the two knowledge systems leading to "network integration", the synthesis of knowledge systems as it was called by den Biggelaar (1991). This could be accomplished by translating cultivator experiments into scientific designs and adapting scientific trials to local conditions. It is the synthesis of the two knowledge traditions which will, according to Box, lead to new knowledge particularly through the improvement on-farm research designs. If the processes of endogenous knowledge production and the logic of farmer experimentation are known, farmers and researchers together can explore better experimental designs meeting both the objectives of the farmers and the requirements of researchers of statistical reliability and validity.

Knowing who the experimenters are in the endogenous knowledge systems, and what their objectives and methods are, can also improve the selection of farmers participating in on-farm research and make such research more effective. Plugging into existing networks of experimenting farmers can potentially reduce the cost of on-farm research, and increase the

effectiveness of such research since the participants are already familiar with the concepts and practices of doing research, even though additional training may be necessary. In addition, such an approach will help to strengthen, empower and legitimize endogenous capacities for identifying problems and developing solutions for these problems, which is considered by den Biggelaar (1991) as the most important step in a strategy of enabling rural people themselves to alleviate their poverty.

Earlier studies of endogenous knowledge have been descriptive in nature (as the name ethnography indicates) and rarely considered how the knowledge and technology from which these systems evolved developed. Examples that were found include the previously mentioned study of Box on cassava cultivation in the Dominican Republic, Richards on experimenting rice farmers in Sierra Leone (Richards 1986) and work by Rhoades on potato storage in Peru (Rhoades 1987). However, these studies dealt only with one crop or one aspect of the cultivation of a particular crop, not with a complete farming systems as one would need to do studying farmer experimentation with agroforestry. Such an approach was also recommended by the agroforestry seminar participants: 'All activities linked with agriculture, animal husbandry, the production of animal feed and forestry should be fitted as a coherent whole into the same frame of reference where the farmer is concerned' (CTA 1988).

Lastly, the study will test the applicability and suitability of the social construction of science and technology framework to endogenous knowledge systems. Previous research using the framework all involved an analysis of the production Western industrial technologies or scientific facts in research laboratories. It is believed that the tight interweave of social and agricultural production processes in which experimentation is embedded make the framework particularly attractive to study the production of knowledge and technology as socially mediated processes in a Third World setting.

7. Overview of the dissertation

This dissertation consists of nine chapters. Chapter I introduces the topic of the research, the basic characteristics of the country, history of tree growing practices in Rwanda, and the

theoretical approaches to the topic. The methods used to study and understand the production of endogenous agroforestry knowledge, both from an endogenous and from an exogenous perspective, are addressed in Chapter II. This chapter will also discuss the choice of the study areas (Maraba and Simbi *secteurs* in the *commune* of Maraba (Butare) and Kibingo *secteur* in the *commune* of Karama (Gikongoro)) and provides a description of major features of these *communes* and *secteurs*. Chapter III reports on the results of the ranking game used for the identification of the farmers most knowledgeable about agroforestry and tree cultivation practices in the study areas conform research question two (Who are the experimenting farmers?). The results will also answer the second part of this research question (What differentiates the experimenting farmers from other farmers in the community?) from an emic, non-quantitative point of view.

In Chapters IV and VII, a more systematic, quantitative approach will be taken to differentiate highly knowledgeable farmers from those less knowledgeable about trees and tree cultivation practices. Chapter IV analyses the results of a socio-economic survey of tree expert and control farmers (demographic characteristics, education, socio-economic status, farm size, land quality, livestock, external sources of income, political position and connections). The results of an extensive inventory of all tree species (*ibiti*) cultivated on the land of the tree experts and comparison farmers is the subject of Chapter VII. In this chapter, an attempt will be made to classify the great variety of *ibiti* found in the study areas in order to facilitate the understanding of teh indigenous agroforestry systems.

In Chapters V and VI, results of extensive discussions with consultants will be presented regarding the possibilities and reasons for practicing agroforestry, and on the nature of knowledge and how it is obtained, respectively. In both chapters, sections wil be devoted to the gender aspects of tree cultivation practices and agroforestry knowledge. The ideas reported in these chapters will be helpful in interpreting the results of the tree inventory discussed in Chapter VII, as well as in providing an understanding of the how and why of farmer experimentatal practices discussed in Chapter VIII.

The development of agroforestry through farmer experimentation is the subject of Chapter VIII and addresses research questions 3 through 5, namely: Why do farmers experiment and what are their objectives for experimentation? Where did the idea, practice, ... forming the basis of the experiment originate? and How do farmer themselves define "experimentation"? The results reported in this chapter are based on one-on-one discussions with individual farmers, observations made during the field research, and on discussions in two series of focus group meetings. It should be noted that these discussions and observations did not yield sufficient information to answer the above research questions in detail, particularly the subquestions under research question 5. To obtain more and better information regarding farmer experimental methods and evaluation of experiments, a small on-farm experiment of new tree species was set up with the consultants/tree experts. Since this experiment was implemented towards the end of the field research period, no results were available by the time researcher left the field. For this reason, no observations and results of actual experimental practices used by farmers have been incorporated in Chapter VIII.

Finally, Chapter IX provides a summary of the key findings and recommendations for future studies, and for research, extension and development.

It should be noted that none of the chapters specifically addresses research question 1 (How have tree growing practices changed over time in general or as a result of experimentation?). However, as noted in Section 5.1 of this chapter, the information resulting from this question is used as a contextual frame of reference in which the other questions are placed, and is interwoven throughout the various chapters of this dissertation.

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CHAPTER II

METHODS

1. Introduction

The goal of this study is to determine what the active role of farmers has been and continues to be as regards the development of agroforestry systems and changes in tree growing and use practices. The emphasis, however, is not on the agroforestry systems per se. The systems are only the medium used in order to understand the knowledge and logic behind these systems, in particular to describe and explain the processes farmers use in the production of agroforestry knowledge and technology. To understand the processes of endogenous knowledge and technology production and the farmers' role in these processes, more than one method is needed. Understanding processes of knowledge production requires close interactions with the people involved. Further, these processes have to be framed within the present farming systems situation in the area of study. In addition, since changes in farming systems and the experimentation connected with these changes are often carried out as a reaction to changing socioeconomic, political or environmental conditions, historical factors have to be taken into account to determine what farmers are reacting to. It is, therefore, necessary to study and describe (1) the historical development of these systems (both from the exogenous and the endogenous perspective) and (2) the present agroforestry systems existing in the area of study and the needs, priorities, problems and constraints of farmers managing these systems. The historical account may provide clues as to why the present systems are what they are, and what the role of farmers and outside interveners has been in developing these systems. The study of the present agroforestry systems may provide information about farmer experiments under way in order to eliminate problems and constraints or to meet new needs and priorities, and will provide information on the processes of knowledge production as they are occurring.

Multiple methods have been used in this research to gain insight into the historical and contemporary processes of endogenous knowledge development using both detached and involved approaches. These methods, described in more detail in this chapter, include (1) a review of rural development of Rwanda since the 1920's, particularly in the areas of agriculture and

forestry; (2) contributions to a national agroforestry survey; and (3) field level data collection consisting of a ranking game to identify research subjects, guided farm tours, participant observation, focus group interviews, structured interviews on tree growing histories, a formal survey to collect socioeconomic data, and an inventory of tree species.

2. Agriculture and forestry development in Rwanda from an exogenous perspective

A study of historical information pertaining to agricultural development and agroforestry research carried out in Rwanda since 1920 was undertaken over a two-year period before the actual field research. This involved an extensive search of existing sources of agriculture and forestry related material on Rwanda and neighboring Burundi and Kivu province of Zaire (which are socially and culturally similar and also have comparable ecological conditions) at the National Agricultural Library of the US Department of Agriculture, the US Library of Congress, the reference center of the US Agency for International Development, the Michigan State University library. Because many books and articles, particularly research articles and books from the colonial period, are not available in the US, additional research was done in September 1991 at the *Musée Royal de l'Afrique Central* in Tervuren (Belgium); the archives of the *Institut National pour l'Etude Agronomique du Congo belge* (INEAC) in Brussels, the institute charged with agricultural research in Congo and Ruanda-Urundi from its creation in 1933 until these countries gained their Independence in 1962; and the *Bibliothèque Africaine* of the Belgian Ministry of Foreign Affairs in Brussels. Most of the information collected has been analyzed and written up as a background document for the National Agroforestry Survey (den Biggelaar, 1991). The section on the history of tree growing practices in Rwanda in Chapter I is abstracted from this document.

The literature review continued during the period of the field work in Rwanda. The host institution for the research, the *Institut des Sciences Agronomiques du Rwanda* (ISAR), had well-organized libraries both at its main station in Rubona and at the forest research department at Ruhande. These libraries were helpful in obtaining more in-depth and actual (recent historical) information about agroforestry systems and about recently completed and ongoing agroforestry research in the country.

3. National agroforestry survey

In 1991, a national survey was carried out by the *Division des Statistiques Agricoles* (DSA) of the Rwanda Ministry of Agriculture to provide quantitative data on socio-economic characteristics of the population, tree growing practices, and problems and constraints related to soil degradation and agroforestry. The survey instrument was developed in collaboration with Ms. Jennifer Olson, MSU Department of Geography, and Dr. Dan Clay of the MSU Department of Sociology and Agricultural Statistics and Policy Analysis Project (ASPAP), a USAID project supporting the DSA. Data were collected at both field (plot) and household levels. At the field level, information collected included species, location, uses, and influence of trees on soil erosion and fertility. The questions at the household level were aimed at collecting socio-economic information related to tree growing and use, with detailed questions pertaining to the use of woody species for particular purposes (fuelwood, timber, lumber, stakes and fodder).

In the original research proposal, the information obtained from the agroforestry survey (especially the plot level data) was to be used to describe the present agroforestry systems in Rwanda, broaden the inferences of the data obtained from interviews with the research subjects in this study, and to determine differences between the latter and the general farming population. However, after devoting many hours to cleaning the data sets and performing initial analyses, the weakness of the data became apparent. The assumptions about Rwandan agroforestry systems used to develop the survey instrument and misinterpretation of species names by the interviewers in the field make the validity of the field level results questionable, limiting the ability to provide the information needed for description, inference and comparison.[1] For this reason, it was decided not to use the results of the National Agroforestry Survey and to collect the necessary information as part of the present study, at least for descriptive and comparative purposes. A comparison sample of farmers was chosen in the research areas in addition to the sample of

[1]Even though species names were given in kinyarwanda in the survey instrument, it was assumed (falsely as was found out later) that their are no regional differences in these names. This often let to confusion among the interviewers. Interviewers also did not use a uniform method of counting trees, which posed serious problems for the many species that are coppiced. Thirdly, limiting the inventory to the three most important species as determined by number of trees per species did not give an adequate picture of the true nature of the agroforestry systems practiced in the country, as will be seen from the inventory done as part of the present research (see Chapter V).

research subjects. A formal survey on the socio-economic characteristics and an inventory of tree species was executed on both the sample of research subjects and the comparison sample. The choice of these samples will be described in Section 5 of this chapter.

4. Choice of study area

It was assumed that the processes involved in the social construction of agroforestry knowledge and technology are not tied to anyone particular geographic area. While it would be ideal to study the processes in different places along an ecocline to determine whether farmers use different methods and approaches, such methods and approaches were postulated to be much more uniform than the agroforestry systems themselves. Time and logistical constraints prohibited including several widely separated research sites along an ecocline. However, the mountainous character of Rwanda and the fact that farmers' fields are scattered over hill tops, slopes and valley bottoms to take maximum advantage of micro-ecological features still permitted a study of agroforestry under a range of conditions, albeit on a smaller scale.

A final choice of a research area was not made before departure for Rwanda, but was decided upon after consultation with researchers of ISAR and local authorities in Rwanda. ISAR researchers suggested an area in the commune of Karama in Gikongoro Prefecture. Karama is located in the zone of action of the *Projet Agro-Pastoral de Nyabisindu* (PAP), and ISAR was interested in an independent assessment of the impact of this project in promoting agroforestry in the commune. The initial visit to the commune to discuss the research with local authorities revealed that there was a second project promoting agroforestry in the commune, namely the *Projet Agricole de Karama* led by a Belgian volunteer. Since the objective of this research was to study and understand endogenous processes of agroforestry knowledge production, there was a concern that the presence of these projects would unduly influence these processes. However, because ISAR was the host institution it was politically impossible to reject Karama commune as a research site. We therefore decided to look for a commune without any rural development projects at present, and which had not had any projects in the past. Within the prefectures of Butare and Gikongoro, only three such communes existed, namely Maraba, Ruhashya and Rusatira. Of these three communes, Maraba was chosen as the second research site. Ruhashya

was rejected because the Rubona research station, the main ISAR research station, is located within this commune. As Ruhashya farmers are a frequent target of surveys by researchers because of this close proximity to the Rubona station, we were told that "farmers in this commune suffer from survey fatigue" and would not appreciate another research project. Rusatira was rejected because it posed more logistical problems to get to; its location in relation to Karama was also too awkward to facilitate the coordination of activities at the two sites.

4.1. Characteristics of the study areas

Both Maraba and the eastern part of Karama are located in the same agroecological zone, i.e. the Zone des Plateaux et Collines (ICRAF D&D classification) or the Central Plateau agroecological zone (Delepierre classification; Delepierre, 1974). The western part of Karama is part of the Zaire-Nile Crest agroecological zone.

Within these two communes, the actual research sites were chosen after discussions with the local authorities and extension personnel based within the communes. In the commune of Maraba, two *secteurs* were chosen, Simbi and Maraba, located in the center and the southwest part of the commune respectively. In Karama, the *secteur* of Kibingo was chosen; it is a long and narrow, L-shaped *secteur* in the center of the commune, dissecting it from north to south. The location of these communes is given in Figure 5; the next section will provide more detailed descriptions of each of the research sites.

4.1.1. Maraba commune

The *commune* of Maraba is located in the western part of Butare Prefecture, bordering Gikongoro Prefecture (see Figure 6). The *commune* is bi-sected by the main, paved road from Butare to Gikongoro and Cyangugu. The *commune* consists of gentle sloping hills dissected by numerous streams and valleys. These valley bottoms are fertile and intensively cultivated, especially during the dry season. The slopes become steeper towards the southern part of the *commune*, where the Huye mountain chain forms the border with neighboring *communes* to the south. The highest point in the Huye mountain chain is 2278 meters. Practically all land up to about 2050 meters

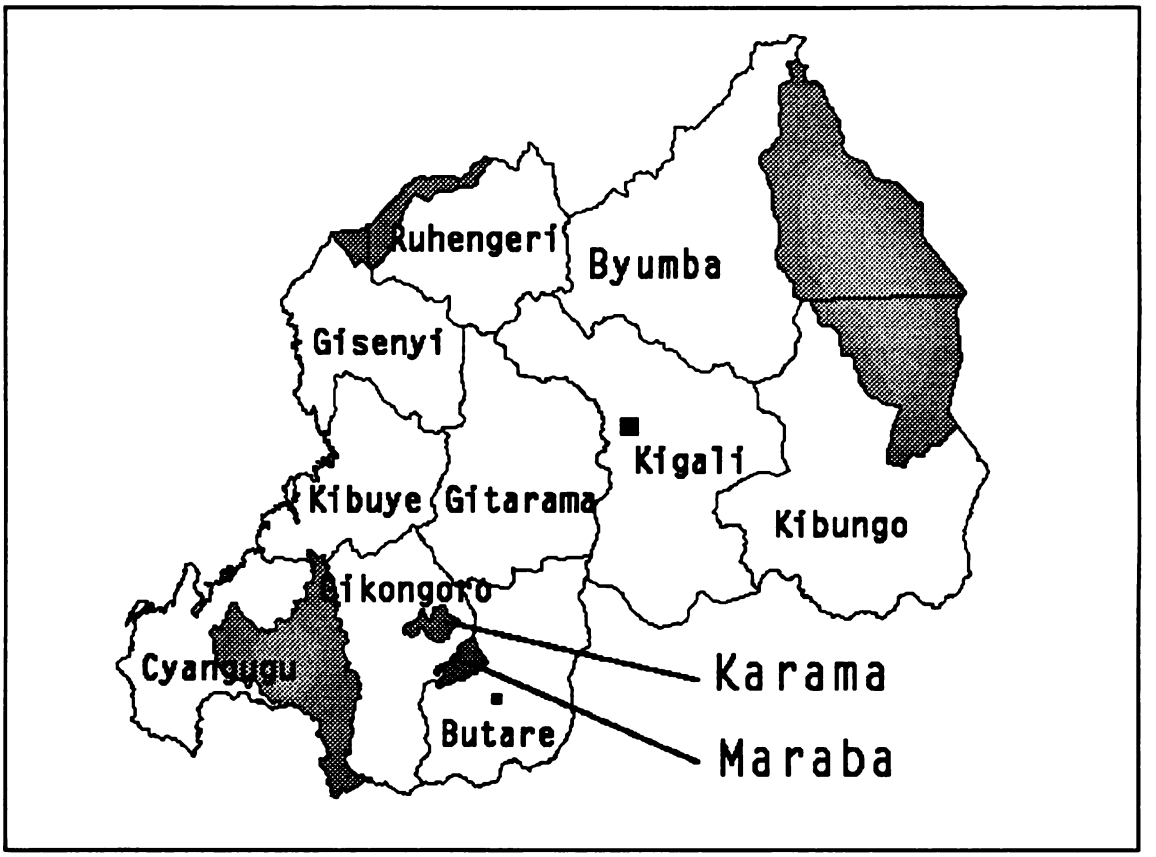


Figure 5: Location of the research sites.

is cultivated or occupied by communal forests. However, due to increasing pressure on the land, some new farms were observed being carved out of the pastures and forests above that level.

The area is one of the oldest settled areas in Rwanda, and had one of the highest population densities in the country before Independence. According to Prioul (1981), the Bwanamukare natural region, to which Maraba belonged at the time, had a population density of 183 persons per square kilometer based on data from the 1948 census. However, the population density per unit of arable land was just above average for the Ruanda-Urundi territory, with 356 persons per square kilometer of arable land.[2]

[2]The average density per square kilometer of cultivated land was 295, ranging from 166 in Mosso (now in Burundi) to 668 in Budaha, now a part of Gisenyi Prefecture in Northwestern Rwanda.

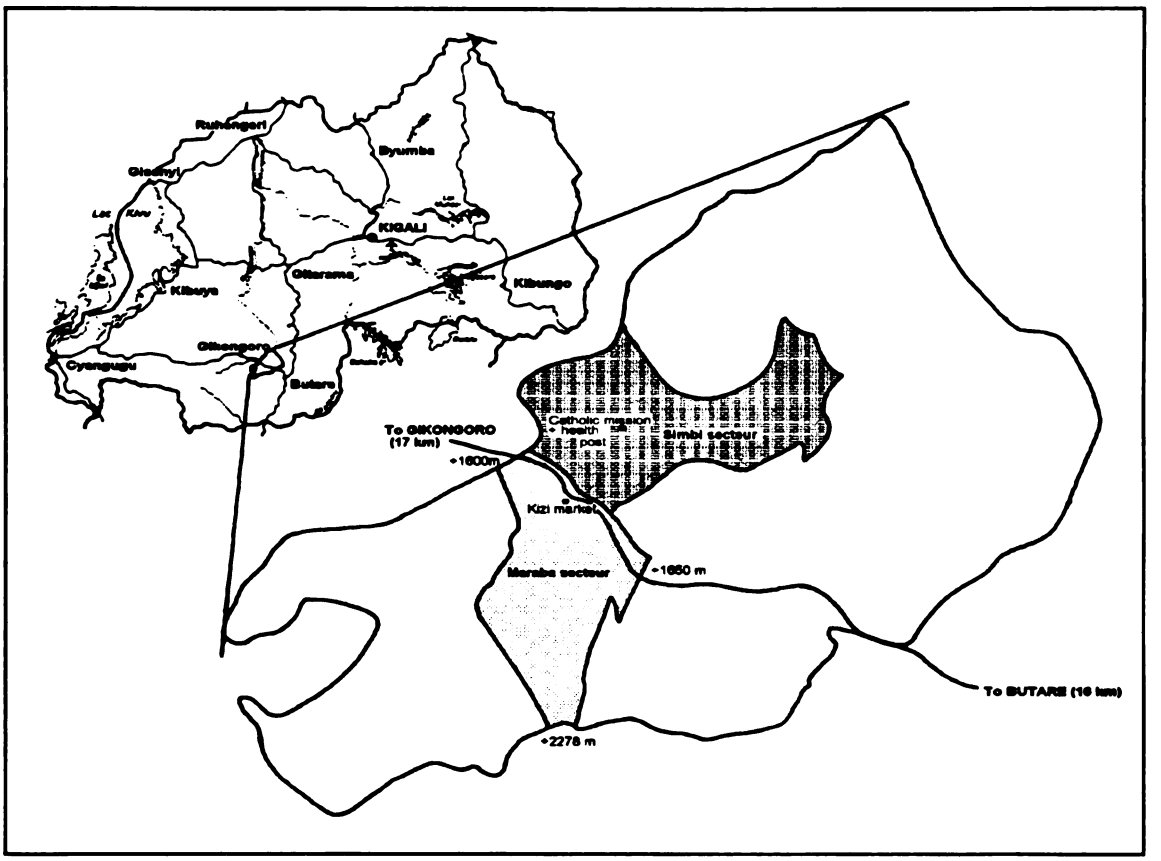


Figure 6: Commune of Maraba and the research sites.

The population of Maraba has increased since 1948, as can be seen in Table 2. Since the census of 1948 was based on a different administrative division, data from that census cannot be compared directly with data from later censuses. However, taken on a population per square kilometer basis, one can see that the population density has increased by more than 300%. The growth rate, however, has been much lower than the national average of 3.1% over the 13 year period between the two censuses of 1978 and 1991. The lower population growth rate can be explained by the outmigration that has taken place due to a lack of land within the *commune*. The majority of these people have migrated to the Mayaga region in eastern Butare, Bugesera in southern Kigali Prefecture, and to Kibungo Prefecture in the eastern part of the country. Less than one quarter of the population have migrated within their *commune* of origin, principally by carving out farms on steep slopes and former pastures only marginally suited for agriculture.

Because it was mainly the young men that migrated, birth rates (47 ‰) have also slowly fallen below the national average (51 ‰) in 1970 (Prioul 1981). These lower birth rates were coupled with higher infant mortality rates (150 ‰ versus 135 ‰). The lower growth rates resulting from the combined effect of lower birthrates and higher infant mortality rates, and the large outmigration from Maraba are changing the population dynamics of the *commune*. These factors are especially marked in Maraba and Simbi *secteurs* (Figure 7).

Table 2: Population and population density in Maraba commune and the two research sites, 1978 and 1991.

	Area (km^2)	Population 1978	Population 1991	Density 1978	Density 1991	Average growth rate (%)
Maraba commune	84.8	32,016	41,281	378	476	1.97
Maraba secteur	7.0	3,114	3,871	445	553	1.69
Simbi secteur	8.5	3,236	3,595	381	423	0.81

The high population density is also reflected in the size of the farms in the *commune*. Over half the households cultivate less than 0.25 hectares of land, with only 14% of the households cultivating more than 1.5 hectares (Figure 8). Farm size appears to be independent of household size, since the amount of land cultivated does not increase with the number of persons in the household as could be expected. More importantly, farmers with more land do not necessarily have more children. Although most of the farms over 1.5 hectares are operated by households consisting of more than 5 persons, within each household size group the majority of households has less than 0.25 hectares of land (Figure 9). For example, the majority of households of more than eight persons cultivates less than one-quarter of a hectare. Given the traditional inheritance pattern of dividing the land equally between sons, it is not difficult to imagine the future of farming in the *commune*.

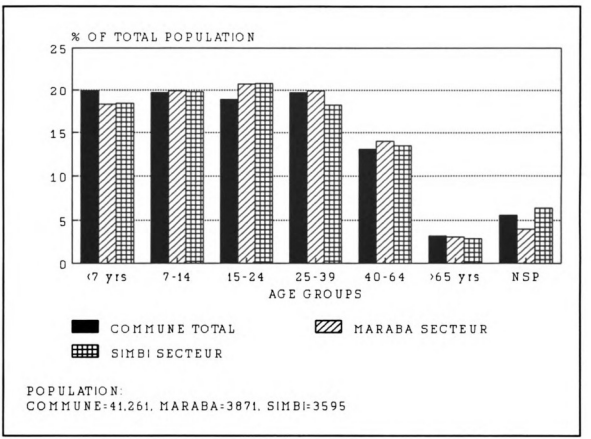


Figure 7: Age groups in percentage of total population in Maraba commune (source: Commission Communale de Planification 1989).

The average household in Maraba is composed of 4.98 persons (2.41 males and 2.57 females), with a family labor force of 2.40 persons/household.[3] Almost two persons per household are able to read and write, even though less than one completed primary education. Forty two percent of persons older than seven years of age never have had any education, although this percentage is much higher for women (52.6%) than for men (37.2%). Only about 3.4% of all people in the *commune* had post-primary or higher education.

[3]It should be noted that according to the 1991 census, the population of Maraba was less than the figures given in the Communal Development Plan (39,689). Since the census also found a higher number of households, the average household size was only 4.54 persons, a half person per household less than indicated in the Plan.

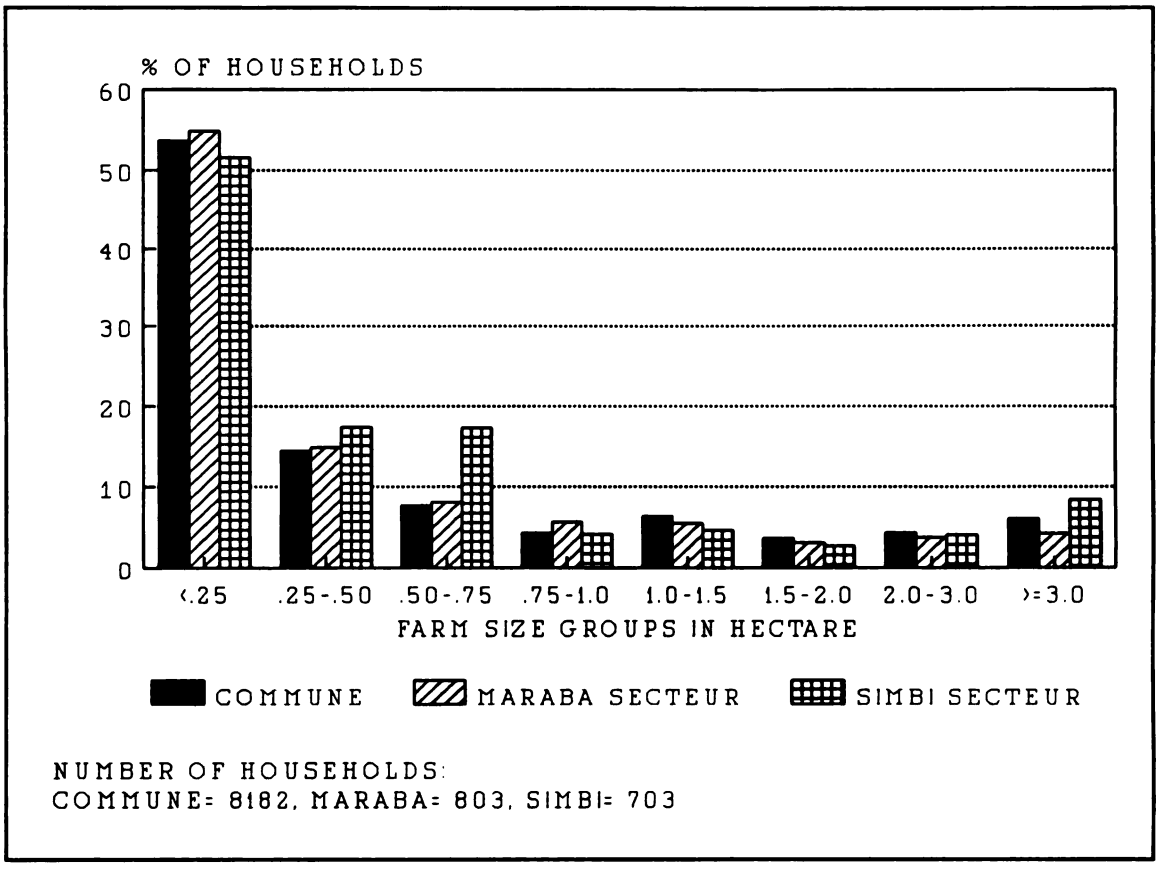


Figure 8: Percentage distribution of households according to farm size, Maraba commune (source: Commission Communale de Planification 1989).

One eighth of all households are headed by women; these women household heads are divided almost equally between older widows (> 65 years of age) and women in the age group 35-44 years who are most likely divorced. Table 3 provides a detailed overview of household composition.

4.1.1.1. Economic conditions

The major occupation in Maraba is farming. The principal crop is sweet potatoes, which occupy one-third of all arable land, followed by sorghum (15.6%), beans (13.6%), cassava (9.3%) and bananas (6.1%) (Commission de Planification Communale Maraba, 1989). Bananas are more prevalent in Simbi than in Maraba since most of the latter *secteur* is too high for bananas (above 1,800 meters). Coffee is the principal cash crop, and Maraba is one of the major coffee

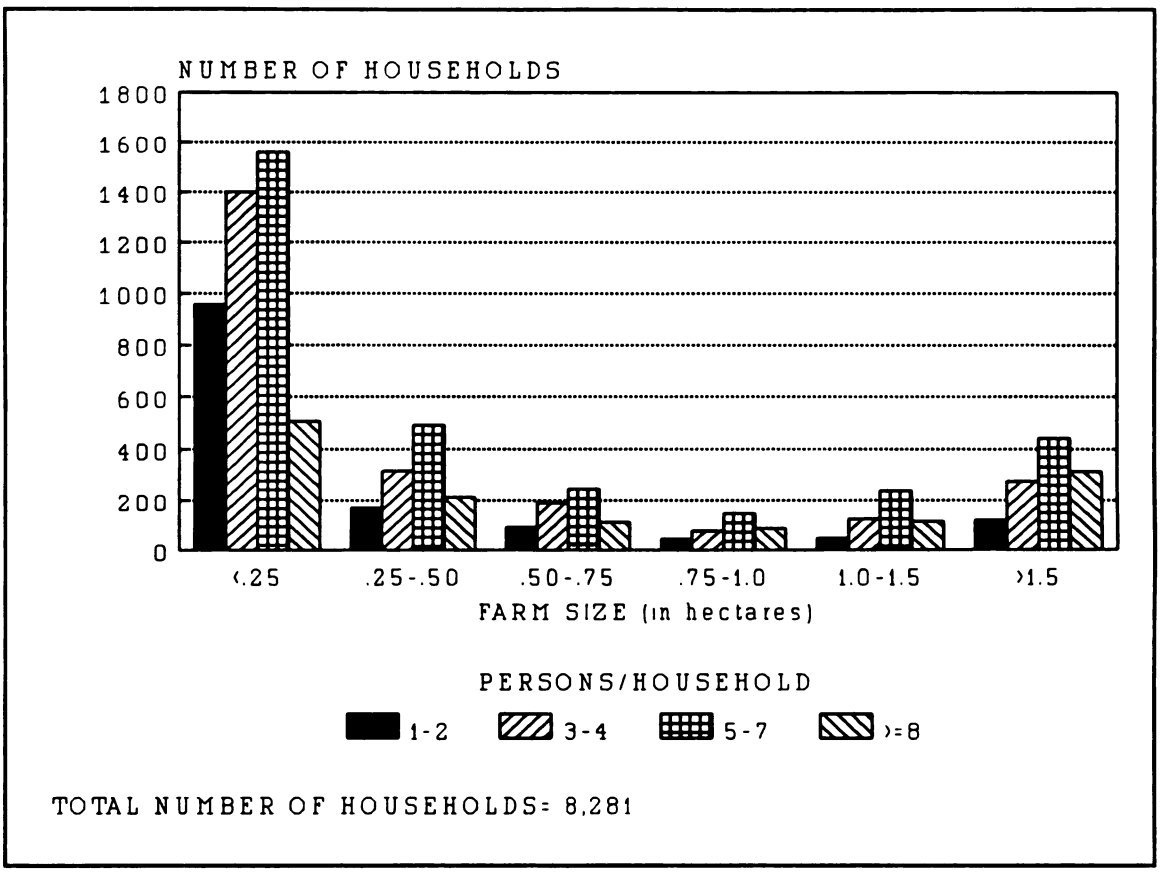


Figure 9: Distribution of farm size according to the number of persons per household, Maraba commune (source: Commission Communale de Planification 1989).

producing *communes* of Rwanda. Eighty-five percent of households in Maraba *secteur* and 90% of households in Simbi grow coffee, with an average of about 150 bushes per household.

Livestock rearing was prominent in the *commune* before Independence, with large tracts of land reserved for the royal cattle. However, due to increasing population pressure and declining farm sizes, the majority of households no longer can afford to keep animals. Nearly 62% of all households do not have any animals at all, with the remainder mostly having only one or two. Goats are becoming more numerous than cattle, a reflection of decreasing farm sizes and lack of sufficient pasture for larger animals. Figure 10 shows the distribution and the number of different animals per household.

Table 3: Household characteristics.

	Maraba commune	Maraba secteur	Simbi secteur
Men	2.41	2.35	2.44
Women	2.57	2.47	2.68
Total	4.98	4.82	5.11
0-14 years	2.25	2.04	2.28
15-64 years	2.58	2.63	2.68
> 65 years	0.16	0.15	0.15
Knows how to read	1.97	2.00	2.02
Knows how to write	1.91	1.91	1.98
Primary education	0.78	0.78	0.89
Secondary education	0.05	0.07	0.06

Analogously to the reasons for declining livestock ownership, a majority of households cannot afford to keep land in trees as a woodlot. On average, 40% of households in Maraba *commune* have no woodlots, this percentage being higher in both Simbi (47.7%) and Maraba *secteur* (42.8%). For households that do have a woodlot, it is usually very small (less than 5 ares). Only households with larger land holdings have more land in trees, primarily because they do not have sufficient labor to cultivate all their land (Figure 11).

There is a small market at Kizi, in Maraba *secteur*, which serves the west central part of Butare Prefecture and the east-central part of Gikongoro Prefecture. The market is held twice weekly on Tuesday and Friday. The Friday market is the largest of the two, and includes a livestock market which attracts farmers from a wide area. It is the only livestock market in Gikongoro and western Butare Prefectures. Since prices are much lower than at the Butare city market (although only 16 kilometers away), many people from Butare shop at the Kizi market. During the coffee marketing period from June to September, many merchants also try to sell their wares (cloth, used clothes, luxury items, hardware, etc.) to take advantage of the flush of money during these weeks. The buying and selling of animals also is more active during this period, with many farmers selling off their animals before they lose weight as this period coincides with the dry season. Extra money is often needed during this period not only to buy food for the family, but

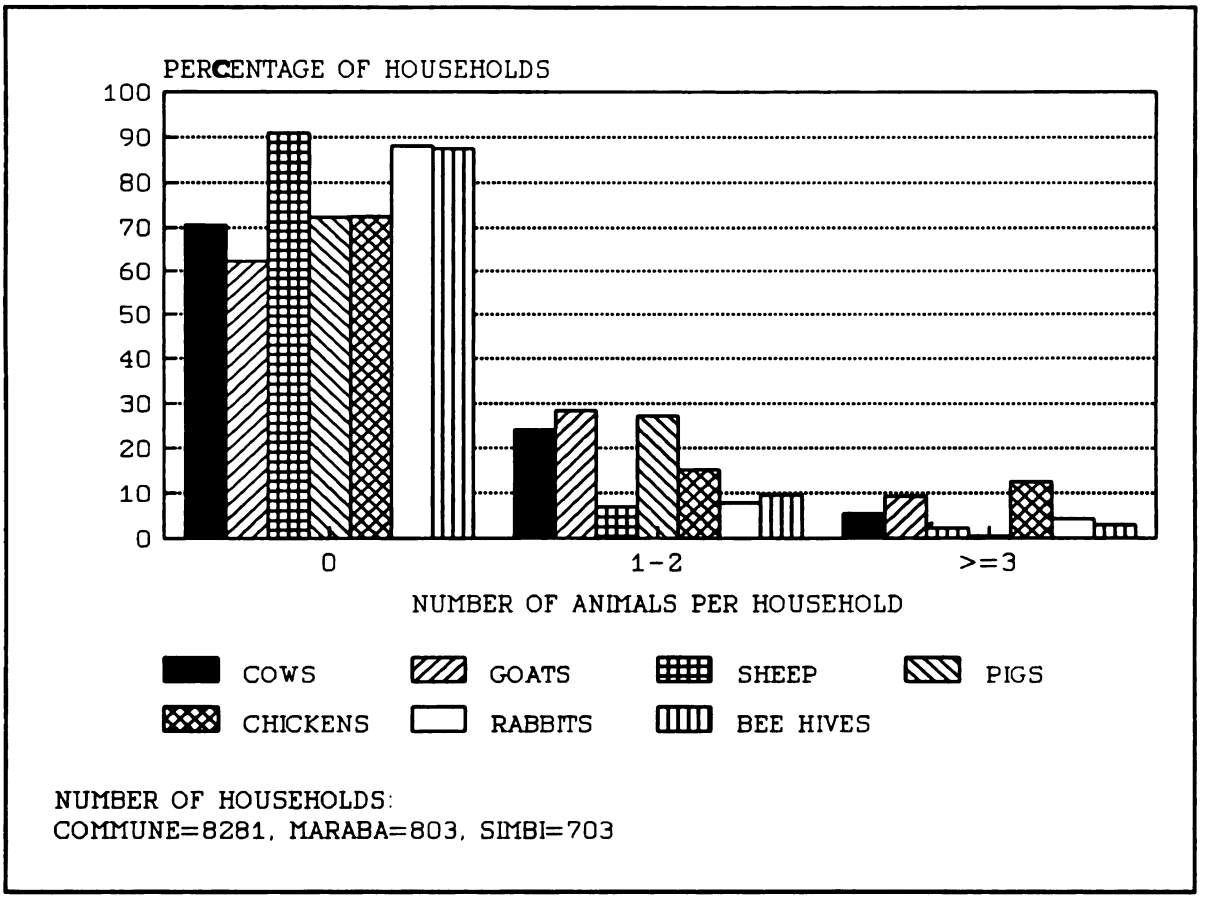


Figure 10: Percentage of households with farm animals of various kinds and average number of animals of each per household (source: Commission Communale de Planification 1989).

for travel to visit relatives or to find temporary work in the cities, and to pay for marriages which tend to concentrate in this relatively low labor season. There are several small shops, bars and restaurants as well as a pharmacy located around the market.

4.1.1.2. Social conditions

Both Maraba and Simbi *secteurs* have one primary school each to serve the children of the respective *secteurs*. The Simbi school is run by the Catholic mission, while the school in Maraba is a state school. The mission also operates a small clinic, maternity and health education center at Simbi which serves the whole *commune*. The clinic possesses a minivan which serves as ambulance to transport people to one of the hospitals in Butare if necessary.

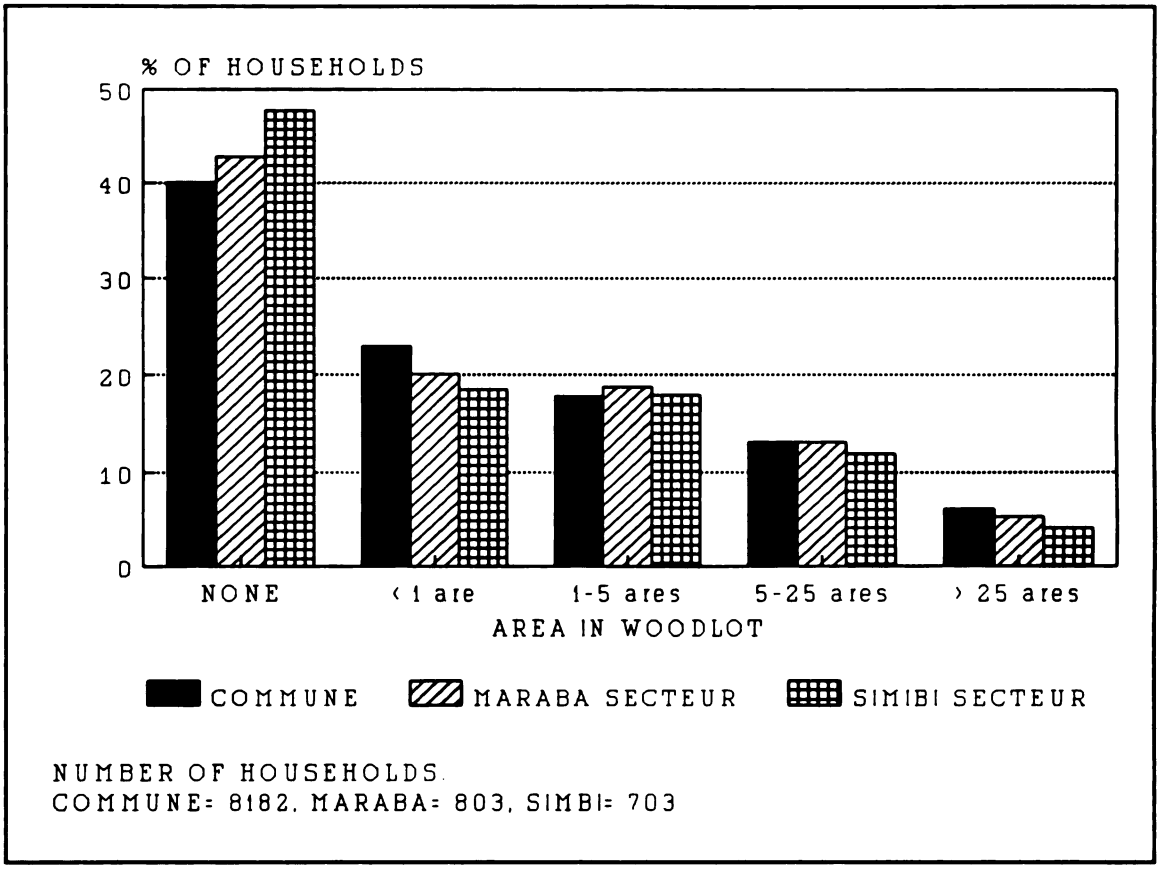


Figure 11: Average size of woodlot per household in Maraba commune and Maraba and Simbi secteurs (source: Commission Communale de Planification 1989).

Most of the population in the two *secteurs* has access to good drinking water from centrally located spigots. The *commune* employs a plumber who takes care of the maintenance of the waterpipes, spigots and watertanks. The *commune* is hooked into the national electricity network, but other than merchants, the mission, and some of the higher paid functionaries of the *commune* administration, few people can afford to get connected.

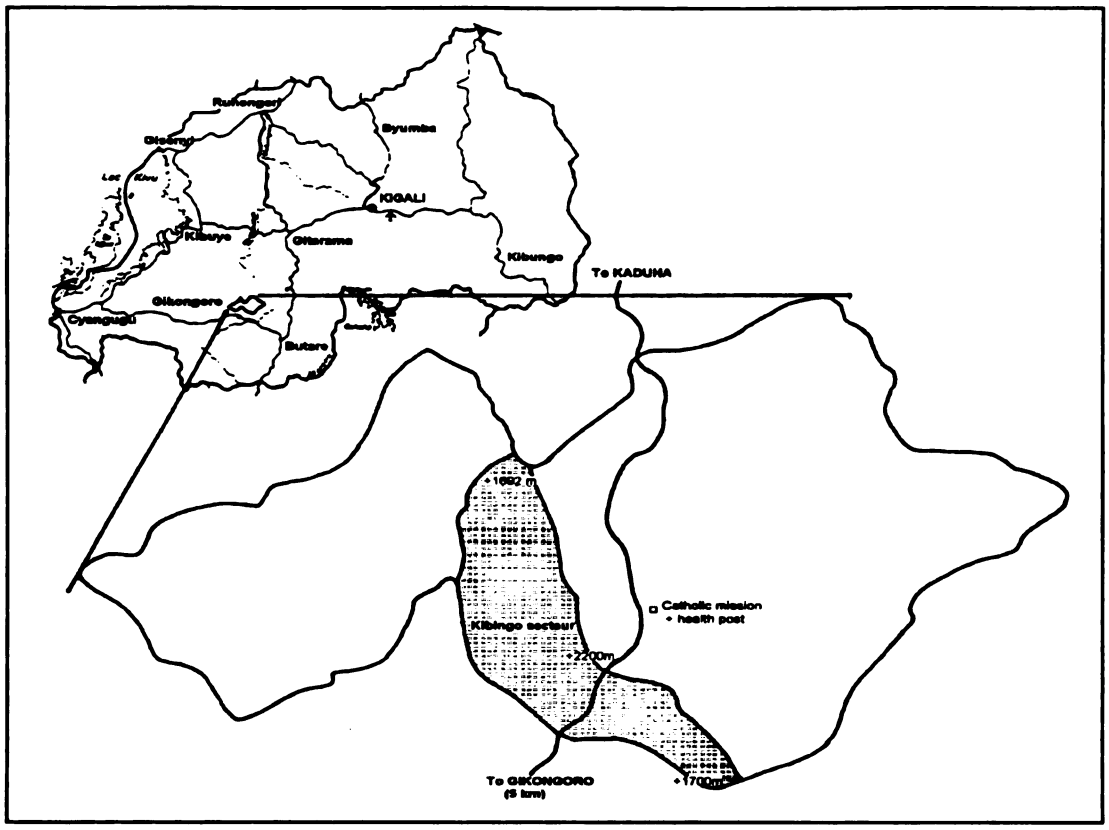


Figure 12: Karama commune and Kibingo secteur.

4.1.2. Karama *commune*[4]

Karama *commune* is located in Gikongoro Prefecture approximately 5 kilometers north of Gikongoro town and 36 kilometers from Butare (see Figure 12). The road between Gikongoro town and Karama is a dirt road that is passable year-round and well-maintained as it is a major road into the interior of the Prefecture. The *commune* is situated at a somewhat higher elevation than Maraba, and covers two agroecological zones; the eastern part belongs to the Plateaux et Collines agroecological zone, whereas the western part is part of the Zaire-Nile Crest. The landscape in the eastern *secteurs* of Karama looks much the same as in Maraba, with rolling hills intersected by many streams and valleys. Kibingo *secteur* is situated in the transition zone

[4]Since we were not able to obtain a copy of the Communal Development Plan for Karama commune, the information in this section is less detailed and exhaustive than that provided for Maraba.

between these two zones. The hills in this *secteur* are much steeper, landslides and gully formation are common, and the valleys are much narrower. As a consequence, the *secteur* has few streams, and those that are found are trickles formed from springs originating on numerous places along the hill crest. The western and southern border of Kibingo *secteur* are formed by wider valleys whose cultivation is shared with farmers from other *secteurs* and from the neighboring *commune* of Nyamagabe. Parts of these valleys have been improved with better drainage systems and a more rational (in the words of the prefectoral rural engineering agent) arrangement of fields.

Before Independence, Karama belonged to the chefferie of Bufundu. Bufundu roughly covered the area of the present *communes* of Mudasomwa, Nyamagabe, Kinyamakara, Karama, and Rukondo. According to Noel Macumu (pers. com.), a former sous-chef in Bufundu, the area had less than 20,000 people in 1955. In 1978, the population of Karama alone was 24,716, and the population density was 328 person per square kilometer (Delepierre, 1980). According the census of 1991, the population had reached 30,631, with the population density having increased to 406 person/km sq. In the period between 1978 and 1991, the population of Kibingo increased from 3,465 to 4,895, while the population density increased from 347 to 490 persons/km sq (Table 4). From Table 4, it can be seen that population growth rates in Karama *commune* have been much lower than the national average of 3.1% during the period between 1978 to 1991. The growth rate for the *commune* is comparable to the one for Maraba. However, the rate for the *secteur* of Kibingo has been much larger, indicating that people still see opportunities to expand farming by bringing pasture land into cultivation and thus see less need to migrate out of the *secteur*.

Table 4: Population and population growth rates in Karama commune and Kibingo secteur.

	Area (km^2)	Population		Density		Average growth rate (%)
		1978	1991	1978	1991	
Karama commune	75.4	24,716	30,631	328	406	1.67
Kibingo secteur	10.0	3,465	4,895	347	490	2.69

The average household size in Karama is 4.87, which is slightly above the national average of 4.74 persons/household (2.35 males and 2.52 females).

4.1.2.1. Economic conditions

As in Maraba, the main occupation of people in Kibingo *secteur* is farming. The crops grown are much the same also, except for bananas and coffee. Kibingo is a long, L-shaped ridge ranging in elevation from about 1700 meters in the south-east to 2100 meters in the center, and again descending to about 1800 meters in the northern part. These elevations are above the range for bananas. Farmers do grow coffee, but not as extensively as in Maraba. The reason for this is that Kibingo was almost exclusively pasture land until Independence, with crop cultivation limited to the area immediately surrounding the *rugo*. Even at present, pastures occupy about 40% of the land area of the *commune* (Technosynesis, 1987). The major food crops are sweet potatoes, cassava, sorghum, peas and beans. The latter crop has made rapid inroads into the farming systems after recent introduction of climbing beans by ISAR/CIAT. Previously, farmers produced bush beans, but these disappeared almost completely due to diseases and their susceptibility to aluminum toxicity resulting from increasing soil acidity due to continuous cultivation.

Because of the presence of two development projects in Karama, many of the valleys have been improved in the last ten years: the streams have been canalized and a fish bone pattern drainage system installed. However, these improvements have not benefitted the majority of farmers;

while many farmers previously had access to small pieces of land in the valleys, after improvement the land was redistributed to "cooperatives" to which mostly only the better-off farmers belong. Thus, small marginal farmers have been cut off from a valuable source of land for dry season cultivation critical to their family's survival.

Cattle ownership is more prevalent than in Maraba as there are still extensive areas in pasture. Goats and sheep are also widespread, but very few farmers were found to raise chickens, bees, pigs or rabbits compared to Maraba. Land pressure is not (yet) as extreme as in Maraba, so that farmers can still afford large animals and have not been forced to abandon traditional attachment to cattle.

There is no market in Karama *commune*, although some farmers show up everyday to sell their produce at one end of the soccer field of the secondary school. However, many farmers travel to the market in Gikongoro town on Saturday. In Cyanika, there are a few small stores selling basic necessities (cigarettes, soap, matches, candles, kerosene, etc.), and a number of bars and places to drink urgwagwa (banana beer). For most needs, people shop in Gikongoro.

Roads into Kibingo *secteur* are all dirt roads in a bad state of disrepair. Many small bridges were about to collapse. The roads were passable in the dry season, but after a rain they became quite a tour de force to pass. A food-for-work project started last year to maintain the internal road system of the *commune* using labor intensive methods, which should make some more isolated areas of the *commune* more accessible.

4.1.2.2. Social conditions

There are no primary schools located in Kibingo *secteur*. To attend school, children have to walk to the mission school in Cyanika (just north of the center of the *secteur*) or the government school in Buhiga along the main road to Gikongoro. The mission in Cyanika also runs a small clinic and maternity, as well as a secondary school.

There was no running water in Karama until the end of 1992, when a water system with centrally located spigots became operational. This system extended into Kibingo, but did not yet include spigots in all areas of the *secteur*. Electricity was available in Cyanika (mission, clinic, secondary school, *commune* administration, *sous-prefecture* and some of the bars and small stores) but not in Kibingo.

Because Kibingo was settled later than the *secteurs* in the eastern part of Karama, the settlement pattern is somewhat different. While households still live predominantly scattered over the hills, many houses are also located along the roads (particularly in the south-eastern part of the *secteur*) and in "proto-villages" in the northern part. This settlement pattern was chosen to conserve cultivable land and build the houses on the flat hill tops and land that was unsuitable for cultivation anyway (too shallow, rocky, etc.). The fact that the hills are much steeper in Kibingo than in the research sites in Maraba also forced people to concentrate their dwellings on more level ground.

5. Selection of research assistants

Two research assistants were engaged for the duration of actual data collection in the field (May through December 1992), one in Maraba (covering Maraba and Simbi *secteurs*) and one in Karama (covering Kibingo *secteur*). The assistants were chosen from among candidates suggested by the local extension officers in each of the two *communes* based on a set of minimal qualifications provided to them. These qualifications were: born and resident in the commune; having some education but no agricultural education or training; ability to speak, read and write French; willingness to do a fair amount of travel on foot within the chosen *secteurs*; and lastly, and most importantly, ability to listen to and learn from the farmers. The lack of training in agriculture was deemed necessary as previous experience in Africa and a review of the literature on extension activities in Rwanda indicated that people with agricultural schooling are often not willing to learn from farmers and too easily dismiss farmers' practices as traditional or backward. A study of endogenous knowledge, however, requires an open, non-judgmental approach in which farmer practices are considered from a positive point of view while simultaneously

questioning them in order to understand why farmers act the way they do and the logic behind the observed tree cultivation practices.

The candidates proposed by the extension officers were asked for interviews with the researchers. During the interview, candidates were asked to write a one-page essay in French regarding the importance of trees in Rwanda, and were subjected to a half hour question and answer discussion. Two young men were selected and engaged on a day-to-day basis for a one-month trial period. As their performance was satisfactory during the trial period, the assistants were then engaged on a monthly basis for the duration of the study.

The assistants were given on-the-job training by the researcher in accordance with the various tasks at hand. The assistants were closely involved in all stages of the research: organizing the initial meetings in the secteurs to explain the objectives of the research and to ask farmers for their collaboration; preparing lists of all farmers (male and female) in each secteur, organized by *cellule* and *colline*; ranking game; organizing and leading the focus group meetings; executing the case study interviews; collecting socioeconomic data; executing the tree inventories; and collecting historical data on agriculture and tree cultivation practices in the study areas from key informants. The assistants mostly worked independently, with the researcher alternating between the two research areas to work with and supervise each assistant two or three days a week. As neither of the two assistants had any experience with data collection, interviews and leading meetings with farmer groups, and as the research methods to be used were rather fluid (methods developed and were refined as the study progressed), constant supervision and adjustments were necessary. During the days that the researcher would accompany the assistants, new data would be collected in the morning, while afternoons were spent reviewing the work done in the previous days, and ask questions and clarifications or provide additional explanantions on research questions and methods as needed. At least once a month, the researcher would invite an assistant to visit and work in the other *commune*, so the assistants could work together, learn from each other, and learn about agroforestry in a different area. In the majority of focus group meetings, both assistants and the researcher would be present as this facilitated leading the discussions and note taking.

6. Data collection at the farm level

As mentioned in Chapter I, while necessary it is insufficient to only *describe* what the endogenous knowledge systems of agroforestry are. One also has to understand the systems, the logic behind them, and how they function. The analysis of historical documents and surveys are too large scale and crude a method to discern the logic and functioning of the systems in one particular area. The goal of this study is to identify and to comprehend the various processes involved in 'gaining knowledge', which can only be achieved by close interactions with the bearers of the knowledge upon which the systems are based and with those that produce such knowledge. To understand the choice of particular methods to study the processes of knowledge and technology production, a brief return to social constructivism will be made.

According to Knorr-Cetina (1981),

> It [is] not enough to place the social scientist in the field of investigation to study it from "within", that is to engage in a kind of methodological relativism (as opposed to objectivism) which gives maximum control over information obtained to the subjects under study rather than to the scientist. Methodological relativism is not just to understand, but to let speak.

Box (1988) was told the same thing by one of his farmer subjects (Virgilio) during research in the Dominican Republic:

> Shortly after we met, Virgilio said: 'Lucas, I understand you want to know. You are a scientist and you want to know. But there is only one way to know what I know about cassava. Speak with me; don't speak to me like others did. Ask me about my life and I will tell you about cassava.

Box was interested in farmers experimenting with cassava, and Virgilio was time and again mentioned by other farmers in the area as the most knowledgeable person on cassava cultivation. But, as Virgilio himself made clear to Box, it is impossible to find out the reasons for his experiments with cassava if one would remove the experiments and the knowledge thus obtained from their context. As Box (1987) writes:

> Virgilio did not just want to give me information on cassava; he wanted to indicate to me what the logic was behind the information. Knowledge is more than a collection of facts; it also refers to the set of rules which determine what is important and why. .... This set of rules is what I shall call "logic", in the sense of a particular mode of reasoning viewed as valid, regarding the

> interrelation of phenomena. .... My use of the term "logic" is therefore analogous to paradigm. Basically these concepts indicate that there are rules by which we define problems and acceptable solutions.

According to Knorr-Cetina (1981), any study trying to determine the fabrication of knowledge and technology and the logic behind them needs an approach that is context-sensitive.[5] In other words, the approach has to take the specific historical, political and socio-cultural factors into account in order to understand the choice of facts and artifacts made by the researchers or experimenters. An appropriate analogy can be found in comparing this approach to that of environmental adaptation in biological evolution. As Knorr-Cetina writes:

> Like adaptation, acceptance of facts and artifacts can be seen as the result of [specific] contextual pressures which come to bear on the scientists' [and farmers'] selections in the environmental niches provided by the laboratories [or farmers' fields]. If such an interpretation is taken for granted in biological evolution, why is it not an equally plausible characterization of the process of selective "survival" of scientific results? It certainly has the advantage of specifying as potentially relevant the larger social context in which [endogenous] science [and technology] are embedded and of which scientists' [and farmers'] decisions form a part.

The disadvantage of such contextual contingency as noted by Knorr-Cetina (i.e. if one does not know the decision criteria because of varying contexts over time and place, it is difficult to predict which selections scientists are most likely to make) is, in my opinion, less relevant in endogenous knowledge systems. Scientists in the formal science tradition can afford to make "wrong" choices from infinite possibilities; their choices do not have a direct bearing on productive processes of society and neither theirs nor society's livelihoods are directly affected by them (although there may be a time lag involved). By contrast, experimenting farmers in the endogenous knowledge system do not have such a luxury. Experimentation is primarily carried out as part of an overall production strategy to enhance food and income security over time and space within the present socio-economic and bio-physical context. Wrong choices may, therefore, have disastrous consequences. Experimenters are **farmers** in the first place, and decision criteria will most likely be closely related to regular production decision criteria aimed at the provision of subsistence and income. To determine the decision criteria of the particular facts and artifacts produced (as Latour called it "understanding what gaining knowledge means") and the contexts

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[5]This section is adapted from the cited work of Knorr-Cetina.

in which the decisions were made requires methodologies that (a) put the investigator close at the site of production and (b) provide for frequent interaction with the subjects. The first method (a) was called "methodological intersubjectivity" by Knorr-Cetina (1981) by which she meant that one has to be directly engaged in the action where it takes place ('it requires engagement rather than detachment; contact rather than distance; interest rather than disinterest; ....'). The second method (b) was referred to as "methodological interactionism", 'which guarantees that th[e] ethnographer remains interested in the practices, rather than the cognition, of its subjects' (Knorr-Cetina 1981). However, one cannot really separate cognition from practices; studying one means also studying the other in order to make sense of the practices.[6] As Feyerabend (1988) wrote, 'Reason and practice are not two different kinds of entities but part of a single dialectical process.' Particular research methods that best integrate methodological engagement and interactionism as described by Knorr-Cetina above will be used in the present study. These methods include an adaptation of the wealth ranking game, case studies to get an endogenous view of the history of agroforestry, and participant observation to study present farmer involvement with experimentation and knowledge production.

6.1. Wealth ranking adapted: Choice of informants and first understanding of endogenous logic

A random selection of informants was out of the question, since, if the statement that not all farmers have the same propensity and ability for experimentation is true, we might not have found any or too few farmers experimenting with trees on their farms in the sample. Secondly, since the objective of the study was to comprehend the processes of acquiring/adapting and/or generation of knowledge and technology of agroforestry, we wanted to interact with the farmers most knowledgeable on the subject, "knowledge" and "being knowledgeable on agroforestry" defined from an "emic" perspective. In addition, the most knowledgeable people would need to be identified by fellow farmers in the same area. An adaptation of the "wealth-ranking game" (Grandin, 1988) appeared to be suitable both to determine the study's subjects, what knowledgeable means in the local context, and how this knowledge is distributed within the community.

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[6]And, in this study, cognition will be used only to make sense of the practices, to understand how people rationalize what they are doing.

In wealth ranking, three to four respondents, either from different predetermined social strata or picked at random, are asked to rank the farmers according to their wealth. Before proceeding with the ranking game, the term on which farmers are to be ranked (in this case wealth) has to be operationalized in local language so that informants will be unambiguous concerning their meaning. The name of each head of family in the community is written down on a 3-by-5 card, and respondents group these cards in as many piles as they want from rich to poor. After that, respondents are asked why they divided families in the number of piles they did and what the differences between the various piles are. The classification of each person ranked in\s converted into a score. The scores obtained from different informants are averaged and ranked from high to low with the help of a spreadsheet, which gives researchers an idea of the relative wealth of each member of the community. The ranked scores are then divided in a number of strata of persons of similar wealth. One thus obtains an idea of wealth strata in the community in local terms from a local perspective.

The same procedure, however, can be used to stratify the community on other variables. For example, Sylvermann (1966) used "prestige" as the ranking variable in research in a central Italian village. Grandin and Sylvermann used these strata subsequently for stratified sampling for more in-depth formal or informal surveys.

6.1.1. Application of the ranking game in the field

In this study, an adaptation of the wealth ranking procedure was used to stratify the community on two variables: Game 1) "good" farmers and game 2) farmers "knowledgeable about trees and tree cultivation." This ranking procedure was chosen because of its advantage of getting to know the 'ways in which people construe the world of their experience, and then describe it in categories inherent to those structurings' (Knorr-Cetina 1981).[7] Thus, in addition to determining one's subjects for further in-depth study, this method provided an emic perspective of "good

[7]A game to determine farmers' priorities, problems and needs was also used by the 1990 Cameroon team of the International Course for development-oriented Research in Agriculture (ICRA). This game was based on an adaptation of the Mancala gameboard, and was very well received both by the counterpart interviewers (extension and community development agents of the Ministry of Agriculture) and by the farmer-respondents (see Arze et al., 1990).

farming" and "knowledge of trees" and helped researcher to gain a preliminary understanding of the logic of endogenous agroforestry systems. In addition, the method provided some quantitative information on a relative scale on how these factors were distributed within a community.

The game was used with two modifications in this study. First, the ranking was performed with the goal of identifying the **individuals** most knowledgeable about agroforestry. As described in Section 3 of Chapter I, tree growing practices have been promoted in Rwanda for 60 years to control soil erosion and promote fuel wood production. The variable "good farmers" was chosen to determine whether, after all these years of promoting tree cultivation, farmers identify such tree cultivation with good farming practices. The second variable was the crucial variable to determine the experimenting agroforesters, the farmers like Virgilio.

Second, the cards that were used did not have the names of heads of household, but of **individual male and female farmers**. In many societies it is the female farmers who collect and cultivate the bulk of tree crops, and they would be excluded if heads of household were to be used since only a small percentage of households is headed by females in Rwanda (around 20%).

6.1.2. Operationalizing the ranking terms

The operationalization of the terms by which farmers were to be ranked in the local language, Kinyarwanda, namely "good farmers" and "farmers knowledgeable about trees and tree cultivation", was done in informal interviews with Rwandan researchers, the Kinyarwanda language instructor with whom the researcher was taking lessons, as well as some key informants from the study zone. The latter was necessary to re-translate the formal, grammatically correct Kinyarwanda terms into language understood by farmers.

6.1.2.1. Good farmers

The term for "good farmers" was easy to translate into Kinyarwanda, and informants readily understood what was meant. However, the language does make a distinction between crop farmers (*abahinzi*, sing. *umuhinzi*) and livestock farmers (*aborozi*, sing. *umworozi*). Since most

Rwandan farmers cultivate crops and keep some livestock, both words are frequently used in combination and we followed this custom. For the ranking game, "good farmers" was translated as *abahinzi-borozi beza* so that one or other group would not be excluded from the meaning of the ranking term.

6.1.2.2. Farmers knowledgeable about agroforestry

The operationalization of the ranking criterion "knowledgeable about trees and tree cultivation" posed a greater challenge for two reasons. First, since there is no equivalent term for "knowledgeable" in Kinyarwanda, a descriptive equivalent had to be found. In Kinyarwanda, the same word is used for knowledge and for experience (*ubumenyi*) (Kagame 1958), indicating that knowledge is gained through experience (see Appendix I-1). Having *ubumenyi* implies having knowledge of (experience with) many different things or notions since knowledge of (experience with) a limited number of notions cannot be constituted by the term *ubumenyi*. Thus, in the area of agroforestry knowledge, having many trees on the farm meant that one has experience with tree cultivation and, by consequence, more knowledge of trees and tree cultivation. However, to be recognized as being knowledgeable about trees, having experience cultivating many different tree species appeared to be more important than specialization in the cultivation of one or two species only. Thus, while in absolute terms, the number of trees for fuelwood and timber (primarily Eucalyptus and Grevillea) on the farm were often the greatest, persons having few Eucalyptus or Grevillea but many species for, e.g. medicinal purposes, were deemed more knowledgeable. Therefore, species richness on the farm was used as a proxy criterion for differentiating highly knowledgeable from less knowledgeable farmers. Whereas respondents had difficulty differentiating people on the basis of the abstract terms "knowledge" and "knowledgeable", discriminating on the basis of the number of species farmers cultivated on their farms was relatively easy, at least for male farmers. However, women (especially younger ones), who according to custom migrate to their husband's farm, often had more problems because they were not sufficiently familiar with the other farms on their *colline*.

Second, during the execution of the game it was observed that discussions with informants on the topic of knowledge of trees often reverted to discussing medicinal plants and their uses, whereas

discussions on trees in general more often concentrated on planting and maintenance activities and on the competitive aspects of various species. This correlation between knowledge of trees and medical practices may be a reflection of the correlation that exists between the nouns used for tree (*igiti*) and medicine (*umuti*). The two words use the same radical (*-ti*), and according to Kagame (1958), nouns with the same stem are related (cf. *-ntu* for various categories of beings). Before 1962, trees were rarely grown on the farm, but medicinal plants and the wood necessary for fuel and construction were gathered from natural forests and forest galleries. For fuel and timber gathering activities, one needs only knowledge on various wood qualities, but not on tree planting and maintenance. To some extent, the latter is true for medicinal plants collected in the wild also; however, one would have to know in much greater detail the different parts of the plants to be used, in which doses, for which diseases and ailments, how to prepare and mix them for maximum effectiveness, etc. Trees were planted and cultivated for medicinal reasons before people started planting them for fuel or timber, and most families appeared to have had a basic "living pharmacy" on their *rugo* (species such as Vernonia amygdalina, Euphorbia tirucalli and Tetradenia riparia being the most common ones). For this reason, people may have come to identify knowledge of trees with medicinal plants and healing activities. Since the majority of tree species found on the farm were planted or being maintained for medicinal purposes, coupled with the common relationship that people made between knowledge of trees and knowledge of medicines, the choice of species richness as a principal criterion for ranking was reinforced. However, people also recognized colleagues not having a large species diversity on their farms as highly knowledgeable because they were recognized as very skilled healers of particular diseases and ailments using medicinal trees and shrubs that they did not cultivate on their farms but collected from natural vegetation patches or other farms. The Kinyarwanda translation of the ranking criterion "being knowledgeable about trees" used was *"Abahinzi-borozi nyamwete"* or *"Abahinzi-borozi bafite ubumenyi bw'ibiti bwinshi."* Additional explanations at the beginning of the game tried to make the criterion clear to respondents and to be as inclusive as possible so as not to limit respondents in their interpretations of the criterion and subsequent ranking of fellow farmers: having many different trees (i.e. tree species) on the farm, knowing many trees, and knowing how to plant and maintain or use trees very well.

6.1.3. Choice of informants and sample size

After initial meetings in each *secteur* with farmers and authorities, the conseillers were asked to prepare a list of all farmers (both male and female) in their respective *secteurs*, subdivided by *cellule* and *colline*. In total, there were 2159 households in the three *secteurs* combined (704 in Maraba, 746 in Simbi and 709 in Kibingo). According to Grandin (1988), if the level of agreement within a community on the ranking criterium is high, 3-4 informants are sufficient.[8] In the first collines in which the game was completed, an equal number of informants (three) was used for both games. An almost perfect agreement was found on the "good farmer" criterion between informants, but less so for the "knowledgeable farmer" criterion. The agreement on the former extended to both men ranking men and women ranking women, as well as when the scores for men and women were combined at the household level. Since the primary objective of the ranking game was to find the most knowledgeable farmers in each of the *secteurs* and because of the greater number of contradictory rankings, it was decided to concentrate on the "most knowledgeable farmer" game so that there would be at least 4 informants for each colline for this game, with none (for *collines* with less than 20 households) to 4 informants for the good farmer game for *collines* with more than 20 households. Given these limitations and the number of *collines* in the three *secteurs* combined, the sample size was determined to be 241 informants, or about 11% of all households. A systematic sample of every tenth name was taken from the lists prepared by the *conseillers*, alternating men and women so that the final sample contained 121 men and 120 women.

After selection of the sample size and the determination of respondents for the game, 2159 cards were prepared with the name of each farmer in the three research areas. The cards contained a code for the research area (*secteur*, *cellule* and *colline*), a number for the household, and the name of the person. The cards were prepared in a fashion that the husband's name appeared on one side, and the wife's name on the other; for single households, one of the sides would remain

[8]Grandin (1988: 15) stated that 3-4 respondents are sufficient, since the level of agreement within a community on wealth characteristics was found to be high. She found a Spearman Rho correlation of 0.91 (range of 0.84-0.98) between scores of individual informants and the final score from 12 separate games with 41 informants. Specific rules and details about the game can be found in the above cited work of Grandin. Only a very brief description of the game is given here.

blank. However, men and women were ranked separately. This system was advantageous in eliminating many "unknowns" during the ranking game, especially among women. As stated before, women move to their husband's farm upon marriage, and would be unfamiliar with the names of other women unless they could place them at a particular farm identified through the husband's name. For older women, this was rarely necessary as they came to know the colline quite well after some time. By contrast, younger women often had to ask for confirmation in order to place the name mentioned at a particular farm before rendering a judgement in which pile to place the card.

The form used to register the rankings and the ranking criteria provided by respondents, as well as the instructions provided to the research assistants are found in Appendix II-1.

6.2. Community and focus group interviews

At two points during the field research, a series of focus group interviews were held, namely at the end of the ranking game and after termination of the biographic case studies. The first round of meetings was held at the *cellule* level during the months of July and August 1992. The purpose of this first series of group interviews was 1) to discuss what we had been doing in their *secteurs* during the first two-and-one-half months of the research project; 2) to discuss our observations and impressions of agricultural and tree cultivation practices that were contradictory or not well understood; 3) to question people further on the topic of knowledge (what it means, how one gets it, gender differentiation); and 4) to discuss and confirm the ranking criteria used by respondents to differentiate good from less competent farmers, and highly knowledgeable from less knowledgeable farmers. Towards the end of the meetings, the names of 10-15 persons (men and women) were given to confirm whether they were indeed the best and/or most knowledgeable farmers. From the list of most knowledgeable farmers, the audience was then asked to choose 2-4 persons who would be asked to participate in the second phase of the research (the biographical case studies). However, people were free to choose other persons not mentioned in the list if they thought the other persons were particularly knowledgeable but somehow were not identified as such with the game. A special effort was made to include persons specializing in local medicine who were often not ranked very high in the game. However, they possess an

enormous amount of knowledge about trees and vegetation histories. Second, it helped to include women since they are recognized as the most knowledgeable regarding local healing practices.

In total, thirteen meetings were held, one in each *cellule*. Dates, times and meeting places were decided upon in collaboration with the *conseillers* of each *secteur*. The meetings were open to all; invitations were extended orally through the *conseillers* of the *secteurs* and the *chefs* of the *cellules*. As the months of July and August fall during the dry season, meetings were held in the open air in a centrally located place within each *cellule*. Each meeting was attended by between 5 and 85 persons; on average, 22 men and 12 women attended each meeting, not including the numerous children always present.

The second series of focus group meetings took place in November and December, 1992, upon termination of the biographic case studies. The meetings were held indoors and hosted by one of the tree experts. Eight meetings were held with groups of 4-5 tree experts and their spouses at a time; in total, 90 persons attended these meetings. The discussions in these meetings focused on the findings of the case studies with a particular emphasis on the nature of knowledge and on gaining knowledge in general and agroforestry knowledge in particular. Several questions also pertained to farmer research methods and evaluation of experiments using hypothetical situations in order to test their reactions and approach to problem solving and experimentation. Again, a list of questions was prepared in advance to guide the discussions.

The setup was the same for both series of interviews. A list of ten questions was prepared in advance to guide the discussions. The questions were prepared in French, then translated in Kinyarwanda by the research assistant working at the Maraba and Simbi research sites. The question were subsequently translated back into french by the research assistant in Kibingo in order to determine whether they understood the questions in the same terms. Changes were made if items were unclear, and the questions were then discussed in a meeting with both assistants present. French and the Kinyarwanda versions of the discussion questions are provided in Appendix II-4 and II-5 for the first and second series of focus group interviews respectively.

During the first series of interviews, all ten questions were discussed. Because the discussions during the second series of interviews were much more involved and interactive, only six questions were addressed in each of the eight meetings. In each meeting, the six questions were chosen in a way that they would be discussed at equal frequency. The order in which they were posed varied in each meeting.

Each meeting lasted between one and two hours. As much as possible, both assistants would be present at each of the meetings; one would lead the discussions, while the other would take notes and assist the discussion leader as necessary. All meetings were also taped recorded. The tapes were later transcribed and translated into French by various persons with a linguistics training at the university level.

6.3. Biographical case studies on the history of agroforestry: An endogenous perspective

The persons deemed most knowledgeable on trees and tree cultivation (those persons selected by the audience from among those identified with Game 2 during the first series of focus group meetings) were asked to serve as consultants on the topic to obtain a better understanding of tree cultivation and use. These consultants were not always the same as the "good" farmers of Game 1. A biographical analysis (the method described in this section is based and adapted from Box 1988) was done on each consultant selected. Box described this technique as 'a reconstruction of cultivator biographies with respect to a particular crop in order to learn about the discontinuities in crop cultivation and the experiments done to adapt to changing circumstances or to improve available technology.' These biographies were collected in the form of case studies using two key questions: What trees were grown on the land when you started your farm? Why were they grown?[9] (see Appendix II-2). This information was then compared with the tree species subsequently growing on the farm up to the present in order to determine discontinuities in tree cultivation: changes in species and/or varieties, cultural practices, placement or otherwise. At each point of discontinuity, the historic context and the reasons for the discontinuity were reviewed to make sure that they were understood in the same terms.

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[9]In the study of Box, who was primarily interested in cassava cultivation, this question was: What was the oldest cassava variety you remember being grown when you were young? What was it like?

6.4. Participant observation and guided farm tours

The fourth method that was used comprised several components that can broadly be grouped under the term participant observation and included observation of farm activities, guided farm tours, and informal opportunistic discussions with people on their farm or at the market. This enabled us to (1) obtain an understanding of the daily routine of rural life; (2) observe farming practices first hand; (3) observe any experiments under way in a total systems perspective; and (4) engage in discussions to understand the logical relationships between practices and experiments and trees, crops and animals. Once people got to know us and what the research was about, they often asked us to come and look at their farm or a particular (rare) tree species they cultivated. The fact that their systems and practices were not ridiculed and criticized as backward and primitive, indeed these were the object of the research, helped in gaining the confidence of people and piqued their interest in this outsider who wanted to learn about their agriculture and their knowledge about agriculture.

6.5. Inventory of trees

The objective of the research was to obtain an "emic" perspective of agroforestry, and to determine and understand farmers' knowledge of agroforestry and its sources. In this research, the term "tree" was interpreted broadly and determined by the farmers themselves, who were asked to show us all the trees [*ibiti* (sing. *igiti)* in Kinyarwanda] they cultivated on their farm. Many species thus identified do not qualify as "trees" in the western epistemological sense. What was found was much closer to what Kagame (1958) provided as a translation of the word *ibiti* in his dissertation La Philosophie Bantu-Rwandaise de l'Etre: plants that are not grasses.[10]

The inventory was undertaken on two samples of farmers (44 tree experts and 70 non-experts, further referred to in this paper as "comparison group"). The selection of the tree experts has

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[10]In contrast, the word grasses [*ibyatsi]* is described as: plants that are not trees (*Les végetaux non-arbres*).

been described above in Section 5.1. The comparison group of 71 farmers was chosen randomly from among the persons identified as having little to no knowledge of agroforestry.

In the tree expert group, inventories of all tree species (*ibiti*) were taken in conjunction with repeated visits to discuss the history and farmers' knowledge of tree cultivation for different "blocs" of the farm. A "bloc" is a group of individual fields that are used in a similar manner, and four blocs were distinguished for this research: *rugo* or home compound, *intoki* or banana fields if present, *imirima* or food crop fields, and *ishyamba* or woodlot. Inventories of farms of the people in the comparison group were done in a single visit that combined the fielding of this survey with the collection of socioeconomic data of the household. The same information about each tree species was collected from both groups. However, due to time constraints in the visits to the comparison group farmers, the information on tree uses is less detailed and, in some cases, was not obtained at all.

A form was prepared upon which to register the information requested of each tree species. The information collected about each species included species name, age, number of trees per species, tree tenure, and location of the trees; why, when and who planted the species, or in case species were natural, why farmer left them; how the species was used and which parts of the species for each particular use; how the species was maintained, by who and when; and lastly, who harvested the species and at which time of the year. A code sheet was developed to facilitate entering the information on the form. Both the form and code sheet are given in Appendix II-3.

6.6. Socioeconomic characteristics of tree experts and comparison farmers

The objective of this study was not only to find and interact with the persons most knowledgeable about agroforestry (knowledgeable as defined from an emic perspective) and to understand the dynamic nature of the knowledge they possess, but also to determine the difference between these local tree experts and the general population in the study areas. As mentioned previously, the original plan to use the DSA National Agroforestry Survey and related agricultural surveys for this purpose was dropped because of the weaknesses discovered in the agroforestry survey and its implementation. In addition, neither of the two *communes* were included in the DSA sample.

Since socioeconomic data needed to be gathered from the sample of tree experts anyway, it was decided to extend the data collection effort to the sample of comparison farmers.

Since it was necessary to collect identical information from each farmer in the two groups of consultants that could be statistically analyzed in order to draw profiles of local agroforestry experts and non-experts according to the research questions specified in Chapter I (Section 5.), a formal survey was deemed most appropriate. The objective of the survey was not to collect a large amount of detailed information about each consultant, but to obtain a minimal data set to answer the research questions. The instrument was developed on the basis of the research questions as specified in the research proposal and various elements identified in the literature as important in distinguishing farmers that experiment from those that do not. Questionnaires previously used by other projects in Rwanda as a guide in developing the instrument and in formulating the questions.

In order to determine what differentiates tree experts from other farmers in the community, the characteristics that were identified as potentially having a bearing on answering the research questions were grouped in eight categories in the instrument, namely:

1. Past and present residence;
2. Family status: marital status, number of children, age, years of farming experience;
3. Education and training;
4. Past and present employment and/or community functions;
5. Land: farm size, soil quality, fragmentation, tenure, changes in size in the last five years;
6. Labor: family labor, hiring labor in or out;
7. Livestock: total number present on the farm, resident non-owned animals, owned non-resident animals; and
8. Awareness of and openness to new ideas through contacts with the outside world: access to information and new (agroforestry) technologies through travel, visitors at the farm, and collaboration with projects and/or extension, sharing of new knowledge/technologies with others, and the seeking of help in case of problems on the farm. This information helped in determining the source of the ideas for any experiments, or of particular species and arrangement of trees found on the farms.

The instrument was passed for comments to ICRAF/ISAR researchers, and pre-tested with several farmers. Modifications were made as necessary in the questions and accompanying instructions if clarifications to question were warranted. The questions were written in French on the form to be used, and were translated in Kinyarwanda during the interview. Before the actual start of the data collection, the instrument and the instructions were discussed with and explained to the research assistants in order that each one of them would interpret the questions similarly. A copy of the questionnaire is provided in Appendix II-6.

7. Data analysis

The results from the ranking game were entered into a spreadsheet (Lotus 2.1) for analysis. The rankings were translated into scores using the procedure described by Grandin (1988). The score given to a particular person depended on the number of piles created by the informants. The scores were calculated using the following formula:

$$\text{score} = \frac{100}{\text{number of piles}} * \text{pile number}$$

For example, if respondent had created four piles, the scores would be:

Pile number	Meaning	Score
1	Most knowledgeable	25
2	Knowledgeable	50
3	Somewhat knowledgeable	75
4	Not knowledgeable	100

The scores obtained for each individual farmer (man or woman) from the different informants were then averaged and sorted from low to high, with lower scores indicating better or more knowledgeable farmers. Scores for men and women were combined to an average household score because there were not enough informants for either one category to make valid comparisons. As stated in Section 6.1.3., rankings from at least three informants are necessary to make valid comparisons. Time and money did not permit collection of rankings from enough informants of either gender to allow comparisons of men and women separately. Thus, the

average scores in reality represent household (not individual) scores.[11] The average scores, identification numbers and number of informants having ranked each individual were subsequently transferred into SPSS/PC+ for additional analyses to compare the good farmer and knowledgeable farmer scores.

The qualitative information regarding the different groups of farmers created by the informants during the ranking game was entered into a word processor and sorted by pile number to which they belonged. Identifying information (*commune*, *secteur*, *cellule* and *colline* code numbers) was discarded, so that ranking criteria could be analyzed unbiased and across geographic areas. Pile numbers were entered at the beginning of each paragraph, which helped to sort the statements. The grouped ranking statements were analyzed and tallied manually, and organized in as few as possible discrete categories to facilitate the detection of particular patterns, areas of concordance or disagreement in methods and approaches used by different consultants. Frequencies were calculated of the number of particular ideas expressed in the categories created.

The primarily quantitative data from the tree inventories and the socioeconomic questionnaires were entered into a microcomputer using SPSS/Data Entry II and analyzed using SPSS/PC+ 5.0 statistical package. Analyses included frequencies, descriptive statistics, and, to determine differences between the three *secteurs* and between expert and comparison group farmers, crosstabulations and related statistics (chi-square, Cramer's V, Spearman's r) for nominal and ordinal data, and t-tests, one-way analyses of variance and least significant difference range tests for ratio and interval data.

The transcripts of the focus group interviews and the biographical case studies were entered in a computer with a word processor (Wordperfect), and subsequently transferred in SmarText for analysis. This software facilitated the process of combining and recombining information in a number of different permutations, which helped to reveal clues not otherwise detectable.

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[11]In selecting the best and most knowledgeable farmers that were presented at the end of the first series of focus group interviews, individual scores were taken into account. In most cases, both husband and wive were indicated as being very good farmers and both their names were presented together during the meeting. There was often less agreement on the knowledge score, and, by consequence, only one or the other spouse was named in the list of most knowledgeable tree farmers.

Although the original intention was to do all the analysis of the results of the focus group interviews, case studies and the qualitative statements from the ranking games with the help of SmarText (to calculate frequencies of key ideas and detection of particular patterns), this proved to be all but impossible. All information collected and/or transcribed was in French, and it was not possible to enter words with accents for Boolean searches in SmarText.[12] Secondly, there are many different ways to express similar ideas, and the program was unable to take this fact into account. Thus, additional analysis would be necessary to complement the results obtained from an initial analysis with SmarText to take the complex language factor into account before final presentation of the results. Therefore, it was decided to perform the content analyses, tallying and grouping of the qualitative data manually, as this appeared to be faster and more thorough than relying solely on computer analysis of the data.

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[12]Although accents were preserved when transferring text between Wordperfect and Smartext, the inability of entering accents in words to be used for Boolean searches meant that the Smartext program was unable to find the word in the text as it did have the accents. It treated words with and without accents (even though otherwise spelled in the same way) as different words.

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CHAPTER III

IDENTIFICATION OF FARMER AGROFORESTRY EXPERTS USING A RANKING PROCEDURE AND COMMUNITY INTERVIEWS

1. Introduction

Over time, Rwandan farmers have generated extensive knowledge about the management of indigenous tree species for fuelwood, construction material, and a host of useful products such as fruit, medicine, fibers, condiments, etc. In addition, they have acquired and adapted a wealth of knowledge of exotic species and silvicultural practices introduced and encouraged since the 1930's (first by the Belgian colonial administration, since Independence in 1962 by the government of Rwanda and in the last two decades by numerous (agro)forestry projects in the country) as a means to prevent soil erosion, increase soil fertility through mulching and green manure, and combat the perceived shortage of fuelwood in the country. However, little attention has been paid to the dynamic and continuous processes of knowledge production by farmers made necessary to adapt to ever changing environmental, political and socioeconomic circumstances as a result of these external interventions. The emphasis has been on studying the visual artifacts (that is the crops, soils, animals and trees that make up farming systems or agroforestry systems) that are the outcome and a reflection of the knowledge that farmers possess, not on that knowledge itself. The goal of this study is to determine and understand the historical and contemporary processes involved in the generation and adaptation of knowledge and technology of agroforestry by the farmers themselves. In this research, agroforestry will be used as the medium, the visual result of the knowledge system through which these processes will be investigated.

Studying what farmers' knowledge of agroforestry is, how farmers obtain (generate and/or adapt) this knowledge implies that one needs to find the persons most knowledgeable and most active in knowledge production. Two basic assumptions underlie this research. First, it is assumed that knowledge is not equally distributed throughout a community; some farmers will be more knowledgeable about trees and tree cultivation than others. Second, not every farmer will have the same propensity for experimentation, largely as a result of differing socio-economic and

political positions within the community and differing biophysical conditions on his/her farm. A random selection of informants would be out of the question, since, if the above assumptions were true, we would not find any or too few farmers experimenting with trees on their farms in the sample. Thus, the first task in the field was to identify the persons most knowledgeable about agroforestry for which an adaptation of the wealth ranking game (Grandin 1988) was used. The advantage of this method was that it allowed the researcher to get to know the 'ways in which people construe the world of their experience, and then describe it in categories inherent to those structurings' (Knorr-Cetina 1981). The ranking game was chosen because it appeared to be suitable both to determine the study's subjects, what knowledgeable means in the local context, and how knowledge is distributed within the community. A more detailed description of the game and how it was used for this research is provided in Section 6.1 of Chapter II, while the methods used to analyze the results are described in Section 7 of that chapter.

2. Results

About half the informers divided farmers up in three groups (the minimum number stipulated in the explanations) while the other half divided them in four or more groups. The division of farmers in five or six groups occurred only in the "knowledgeable about trees" game. Table 5 is based on the ranking statements provided by 47 farmers (22 men and 25 women). The mean age of the informers was 47.7 years for women and 45.4 years for men. Table 6 is based on the ranking criteria provided by 142 respondents: 70 women with an average age of 45.6 years and 72 men with an average age of 47.0 years. While in total 241 persons participated in the game, only criteria of 189 people have been used in creating the above tables. The criteria of the remaining 52 persons have not been included for two reasons. First, one of my field assistants initially misunderstood the tasks and grouped people according to being good tree farmers (instead of using the term "being good farmers in general"). While this did not invalidate the results (which ended being very similar to the ranking for "farmers knowledgeable about agroforestry"), it was decided to exclude them in the construction of the above tables. Second, the criteria used for describing each of the groups of farmers created by these 52 informants did not differ significantly from those used in preparing Tables 5 and 6. Thus, while frequencies of

individual variables may be higher, they would not alter the conclusions of who are good and inept farmers, or highly knowledgeable and least knowledgeable farmers.

It should be noted that not all variables describing "good farmers" and "farmers most knowledgeable about agroforestry" in Tables 5 and 6 have the same frequency. The criteria are extracted from the actual statements describing each group of farmers created by the informants, and the criteria used varied between them. Low frequencies or blanks do not mean that particular variables were not applicable to some farmers; they only indicate that these variables were not used in describing the different groups created by informants.

2.1. Characteristics of good farmers

The most cited variable distinguishing farmers on the criteria "good farmers" was the size of their harvests. The best farmers are able to realize a surplus to sell, while the farmers characterized as "least good" are deficit producers, that is, they do not produce enough to feed their families. The middle groups (good and mediocre farmers) obtain harvests sufficient to feed their families, with good farmers having small quantities to sell as well but not regularly. The amount of production realized is thus the criterion defining differences between farmers for the ranking variable "good farmers." The other variables in Table 5 are variables that explain the reasons for being either surplus or deficit producers.

The surplus producers have large land holdings with better soil quality; because they have access to more land, they can keep cattle which produces manure which helps maintain soil fertility and boosts soil quality. Larger farm size also means that they have more place to plant trees. These farmers are also characterized as being rich because of the greater number of resources they command (particularly land and cattle), and because either they themselves or their children have or had steady salaried jobs.

The deficit producers have very small farms with bad soils, none or just a few small animals (chickens, goats, sheep or pigs) and little to no manure. While farmers know that bad soils can be made productive with the addition of manure, they do not use it because they do not have

Table 5: Variables used to differentiate farmers according to the "Good farmer" criterion.

	Best farmers	Good farmers	Mediocre farmers	Inept farmers[2]
Harvests				
Large, plentiful	40	18		
Sufficient	2	24	18	
Small, deficient		1	3	41
Soil quality				
Good	26	15	4	1
Bad		2	5	26
"Flat" land	4			
Well-maintained land	2			
Terraced land	1			
Farm size				
Large	12	7	3	3
Medium	1	4	4	
Small		4	1	10
No land				1
Animals				
Cattle	42	28	9	6
Cattle or small animals	2	14		
Small animals	4		3	3
Small animals or none			2	2
No animals	2	9	13	32
Manure				
Abundant	9	1		
Yes-sufficient	20	16		
Little or none		4	5	20
Use compost only		6		3
Trees[1]				
Many	6			
Some	2	1	3	1
None				2
Plant in "modern way" (i.e. in lines)				
Yes	27			
No	7	19	5	
Non-farm labor is necessity to survive				
Yes				2
Wealth				
Rich	5			
Poor			1	4
Social				
Mostly single women or older persons				4
Consult extension workers	3			

[1] Trees were not a specific ranking criteria, info was obtained after additional questioning on tree cultivation of various groups of farmers created by respondent.
[2] According to the informants, the number of people in this group has been increasing in the last few years.

access to it. Small animals (goats, sheep and pigs) produce too little manure to bother with, and it is difficult to collect when animals are free roaming or staked at different places within the farms during most of the day.[1] They are mining the soil leading to a further decrease in soil quality, but have no choice. To make up for the production deficit, these farmers often work for others, either for money or in-kind payments (crops and/or fuelwood). The majority of people in this group are single women (widowed or divorced women), old people that have already given most of their land to their sons upon their marriage, and young couples establishing their own households.

According to the informants, there is little difference between the first two groups (best and good farmers), except that the former cultivate in a "modern" way (*guhinga kijyambere*, meaning they plant in lines and/or use lime, fertilizer or agrochemicals to control pests and diseases) and more often consult with and get help from extension workers than the latter. Mediocre farmers are those that are on the edge: presently, they can still produce enough to feed their families but they are able to do so only by changing from large to small animals (or eliminating stock keeping altogether), and by converting pasture and woodland to crop production. The next generation will probably not be so fortunate as they will have to deal with smaller properties due to the inheritance system dividing land equally among sons.

2.2. Characteristics of farmers knowledgeable about trees and tree cultivation

As explained in the methods section, the choice of species diversity in the ranking procedure was a reflection of the relationship between tree knowledge and medicinal trees, and the contribution of medicinal trees to species diversity. During the ranking interviews, informants used the variable "number of species" as the main criterion to distinguish between most and least knowledgeable farmers and divided farmers in different groups accordingly. The statements that informants provided describing each of the groups they created provide finer distinctions between

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[1]According to Rwandan farmers, it is only cows that produce manure in significant quantities and of good quality. While compost is being advocated by extension and agricultural development projects, few farmers believe it to be worthwhile as a source of nutrients, principally because they do not think plants alone will add anything worthwhile to the soil.

the groups (see Table 6), although the elements they used to describe them are similar to those used for differentiating between surplus and deficit producers.

Because species richness was used as the principal criterion to distinguish farmers, it is no surprise that the farmers identified as the most knowledgeable about agroforestry all have many tree species on their farm. However, the explanatory variables farm size (mentioned 105 times) and presence or absence of cattle (mentioned 109 times) are more often cited to characterize these farmers than species richness (mentioned 96 times). Large farms have more land to plant trees, and can, therefore, have more trees in total and have a greater species diversity. Similarly, cattle provide manure with which soil fertility can be maintained; indeed, farmers in this group were identified as those having a sufficient (mentioned 18 times) to abundant (mentioned 42 times) manure supply. The ability to maintain soil fertility on at least part of the farm means that a harvest sufficient to feed the family (and perhaps some surplus) can be obtained from less land, thus freeing some land for the cultivation of tree crops. The most knowledgeable farmers were also identified as being richer than others, having woodlots, and continuing to plant more trees on their farms every year. Although few respondents mentioned where their fellow farmers had obtained their knowledge, for farmers in group one (those most knowledgeable about tree and tree cultivation) "self" was mentioned most frequently, meaning that these farmers were more likely to generate knowledge through their own trials and observation. This is also reflected in the statement that these farmers were actively engaged in searching and obtaining planting materials.

For groups two and three, species richness is the principal distinguishable variable, more so than to differentiate groups one and two. However, comparing groups one, two and three, one can see that species diversity declines. In group one, farmers have between 5 and 14 tree species, in group 2 farmers have between 1 and 9 species, while the majority of farmers in group three fall in the category "less than 4 species." Simultaneously with decreasing species diversity, there is a decrease in farm size in these three groups indicating a relationship between farm size and tree diversity. Animal ownership is about equal in each of these groups, even though the number of farmers without animals is increasing from 7 in group 1 to 17 in group 3. About one-quarter of the statements on species diversity for the farmers in group three mentioned that these farmers

Table 6: Variables used to differentiate most knowledgeable from least knowledgeable farmers.

	Most knowledge				Least knowledge
	1	2	3	4	5
Number of species					
>=15	6				
10-14	48	11	3		
5-9	41	38	23		
<=4	1	38	90	43	29
Only on the rugo			43	22	23
Soil quality					
Good	22	5	8	1	
Bad		3	6	2	2
Farm size					
Large	94	42	40	1	4
Medium	10	21	27		1
Small	1	12	57	34	39
No land				1	2
Animals					
Cattle	82	43	63	7	4
Small animals	20	28	25	17	11
No animals	7	10	17	12	17
Manure					
Abundant	42	3			
Yes-sufficient	18	6	8		1
Little or none		1	9	4	7
Use compost only			1		
Source of information/knowledge					
Self	13	2	1		
Extension workers	2				
Non-farm labor is necessity to survive					
Yes				1	6
Wealth					
Rich	39	1			
Poor				27	12
Specialists					
Traditional medicine	12	8	4	25	5
Cultivate med. plants	3	1		6	
Collect med. plants	4	2	2	12	
Furniture, objects, etc.		2	4	2	2
Various					
Actively plant trees					
Yes	28				
No			10		
Actively seek plant mat.	5	1			
Maintain trees well	10				
Have knowledge, few trees		15	14	5	
Need all land for crops			26	16	15
Have a woodlot	13				

have no trees other than those on the *rugo*, an indication that farmers in this group are increasingly being squeezed for land for crops and are eliminating trees as a consequence. This is also supported by the observation made by the informants that these farmers need all their land for crops and therefore cannot cultivate trees, mentioned 26 times for this group.

The least knowledgeable farmers (groups 4 and 5) are characterized as having only trees on the *rugo* (particularly those in group 5), or, in addition to trees on the *rugo*, having one or two species in their fields. They have small farms, with none or only a few small animals and little to no manure. Lack of land was an often heard reason for not having trees or only having few of them, in spite of the recognition of the importance of trees. The *rugo* is therefore an important location for agroforestry, since this is the only place left for cultivating trees for the majority of farmers.

An interesting point concerning the less knowledgeable tree farmers (groups 3 to 5 in Table 6) is that their grouping as less knowledgeable in the game may not necessarily mean that they have less or no knowledge of trees. On several occasions, farmers pointed out that knowledge of trees does not necessarily correlate with cultivating trees, or having large numbers of trees or tree species on the farm. Knowledge of trees can be obtained independent of having trees on the farm, particularly if it concerns knowledge on the use of medicinal trees. This is supported by the variable "Having knowledge, few trees" in groups 2, 3 and 4, mentioned 34 times in the statements explaining the different groups of farmers created by respondents. In addition, about 44% of the statements on the number of species for people in group 2 and 57% and 66% of the statements for groups 3 and 4, respectively, indicate that persons in these groups have fewer than 4 species on their farms, but still are very to somewhat knowledgeable about trees.

The largest number of traditional medicine specialists was found in group 4; these people, according to informants, usually do not have a large species diversity or many trees in total, but they do have an enormous knowledge of tree uses for specialized purposes. Their concentration in group 4 may, therefore, not be an accurate reflection of their true knowledge. Often, medicinal shrubs are grown secretly or hidden between crop plants, so that other people do not

know the actual species diversity of healers' farms. Informants, therefore, were not able to accurately rate them using species richness as a principal criterion. About half the healers in group 4 were also said to collect the plants they use for their practice in the wild or from other farms, which again may be a reflection of the unfamiliarity of the larger community with healers farms and tree cultivation activities. The majority of healers studied subsequently in this research did cultivate their own medicinal plants, although they would use some collected elsewhere also.

During a presentation of the preliminary results of the two ranking games for researchers at the Forestry Department of ISAR, a comment was made that the variables used to distinguish various groups of farmers have a large covariation: surplus producers have large farms with cattle, a greater number of animals in total and thus more manure, abundant harvests, more trees, and are richer; deficit producers have small land holdings with poor soils, no or few small animals only, do not produce enough to feed their families, have few trees, and are poor. In the Western, scientific world view, we like to think of farm enterprises (animals, crops, trees, etc.) as completely separate and independent, so that there would be no covariation between each of the enterprises. In other words, the variables used to describe different groups of farmers should not show any covariance. For Rwandan farmers, however, such separation of enterprises does not exist: they are all part of an organic whole to be manipulated so as to realize a long-term sustainable subsistence livelihood (which is not necessarily the same as a sustainable production). Enterprises are not independent entities, but do very much co-vary as a result of the micro-management of available resources to maintain the organic whole. For this reason, there is a great similarity between variables used to differentiate good from bad farmers, and highly knowledgeable from less knowledgeable farmers.

2.3. Are good farmers also the most knowledgeable about trees and tree cultivation?

The reason for undertaking rankings on both good farmer and most knowledgeable about agroforestry criteria was to determine whether, after 15-20 years of agroforestry research and development and the presence of 30+ agroforestry development projects in Rwanda, farmers have come to identify being good farmers with practicing agroforestry and being highly knowledgeable about trees and tree cultivation. A logical conclusion of the similarity between

the variables used to describe good farmers and those used to describe farmers knowledgeable about trees (see Tables 5 and 6) is that there is no difference between the two rankings, or, in other words, the best farmers are also the most knowledgeable, and the inept farmers are the least knowledgeable. If this were the case, one could limit one's determination of a sample to the "good farmer" ranking game, since informants agreed much more on who were good and inept farmers than on who were knowledgeable and who were not. But is this necessarily the case?

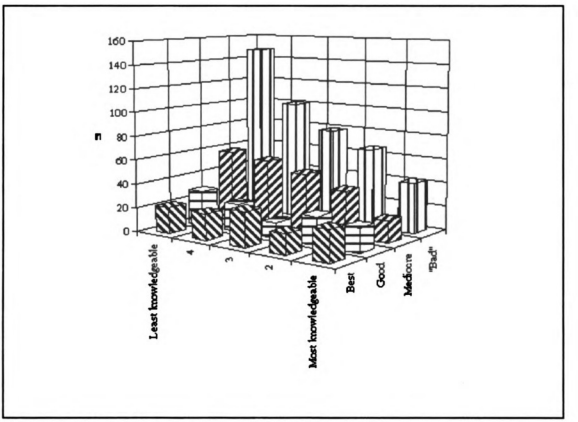


Figure 13: Graphical cross tabulation and chi-square of the good farmer and knowledgeable farmer scores; column heights represent the number of households in each square in Figure 1.

To test whether or not good farmers are also the most knowledgeable about agroforestry, the average scores of each farmer on the "good farmer" ranking were plotted against the average score on the "knowledgeable about trees ranking" criterion. Figure 13 shows a three dimensional graph of the cross-tabulation of the two scores. Only farmers in Maraba and Simbi *secteurs* of

Maraba Commune are plotted; because of a misunderstanding by one of the research assistants in the objective of the good farmer ranking, the results of this game in Karama Commune are not usable for the purpose intended. In the secteurs of Maraba and Simbi, rankings were obtained for a total of 1455 households. Because informants did not always know their fellow farmers and because not all households had rankings for both criteria, only 873 cases are included. Descriptive statistics for both scores indicate that most farmers are deficit producers or have little to no knowledge of trees (mode for both scores being 100). These statistics also show that the average farmer falls within the mediocre farmer group (mean score of 70.9) and has a moderate knowledge of trees (mean score of 64.9, putting him/her in knowledge group 3). Given the fact that over half the households in Maraba Commune have less than 0.25 hectares of land (Commission Communale de Planification Maraba, 1989), and that farm size is an important determinant in both good farmer and knowledgeable farmer scores, these statistics are not unexpected.

In Figure 13, a graphical representation is given of the cross tabulation between good farmer and knowledgeable farmer scores.[2] In this figure, we can see that the largest number of cases is found in the group of "least knowledge, deficit producers," namely 148 or 17% of all cases included. Only 26 cases (3% of all cases) are identified as the most knowledgeable and very good farmers at the same time. Of the total of 873 cases plotted, half are characterized as deficit producers.[3] However, only 29% of the total number of cases plotted were characterized as least knowledgeable, indicating that being a deficit producer does not automatically mean having no knowledge of trees. An interesting observation in this regard is that the distribution of the good farmer groups closely matches the distribution of farm size groups in the two *secteurs* of Maraba *commune* included in the plot in Figure 13 (see Table 7). This can be seen as a confirmation of the validity of the use of farm size as a differentiating variable for the criterion "Good Farmers."

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[2]The numbers upon which the graph is based and the percentages used to explain the graph can be found in Appendix III-1. Cell counts in the crosstabulation table correspond to the total number of cases in each cell of Figure 13.

[3]Additional research, measuring actual household production and consumption, would be necessary to verify if this is actually the case. The high percentage of farmers labeled deficit producers are, however, an indication of the severe stress and of a bleak future for agriculture in Maraba.

Table 7: Comparing the distribution of the percentage of households in the various "good farmer" groups with the percentage of households in various farm size groups.

Best farmers	13.3%	> 1.5 hectares	13.1%
Good farmers	12.4%	.75-1.5 hectares	9.9%
Mediocre farmers	24.5%	.25-.75 hectares	23.8%
"Bad" farmers	49.8%	< .25 hectares	53.2%

Of the farmers identified as the most knowledgeable about trees and tree cultivation (106 cases), nearly one quarter (24.5%) are also good farmers. However, 39.6% of those knowledgeable farmers were rated as being deficit producers. Similarly, of the surplus producers (116 cases), an almost equal number were rated least knowledgeable (19.0%) and most knowledgeable (22.4%). Within the best and good farmer groups, the distribution between the various categories of being knowledgeable is rather even. Within the good farmer categories, however, group three has a slightly lower than expected number of cases and group 5 has a higher than expected number of cases. Within the mediocre and deficit producer groups, the distribution of the number of cases according to the "knowledgeable about agroforestry" criterion is highly skewed towards the least knowledgeable category, in other words, many more farmers in these groups have little knowledge of agroforestry than farmers that do have such knowledge. But, as mentioned above, this does not mean that all mediocre and deficit producers have little or no knowledge of agroforestry.

To statistically examine whether being a good farmer is related to being knowledgeable about agroforestry, a Chi Square test of independence was done. The null-hypothesis being tested is that there is no association between being a good farmer and being a knowledgeable farmer. The Pearson Chi Square value is 36.15, which is highly significant ($p < .01$) (for the results of the statistical analyses, see Appendix III-1). However, Chi Square has a tendency to always be significant if one has a large sample size as is the case in the above calculation of the statistic in which 873 cases were used. A better measure to test the strength of the association between two variables for tables greater than 2x2 is Cramer's V. V takes sample size and table dimension into account, and can attain the maximum of 1 for tables of any dimension (Norušis 1990). V for the distribution of good farmers vs. knowledgeable farmers groups is .117, and is also highly significant ($p < .01$). Therefore, we reject the null-hypothesis and accept the alternative

hypothesis that good farming practices are related to being knowledgeable about trees and tree cultivation. However, as V is small, the relation between being a good farmer and being a farmer knowledgeable about trees and tree cultivation is not very strong. This is confirmed by the Spearman rank correlation coefficient. The Spearman r of .14 is highly significant but again indicates only a weak correlation between the two ranking criteria. Since there does appear to be a relationship between being a good farmer and being knowledgeable about trees, can the former criterion be used to predict the latter? To answer this question, Goodman & Kruskal's Lambda and Tau, measures based on the idea of proportional reduction in error, were computed (Norušis 1990; Reynolds 1990). Norušis (1990) described these measures as "essentially ratios of a measure of error in predicting the values of one variable based on the knowledge of that variable alone and the same measure of error applied to predictions based on knowledge of an additional variable." Although both these statistics are significant, their values are very small (Lambda is .011, Tau is .009), indicating that about 1% reduction in error is obtained when being a good farmer is used to predict being a farmer knowledgeable about trees. Thus, while there is a relationship between being a good farmer and being knowledgeable about agroforestry, the relationship is too weak to depend on good farmers (who are relatively easy to identify with a high degree of agreement between different informants as shown in the ranking procedure used in this research) as subjects of a study of endogenous knowledge of agroforestry.

3. Reconfirmation of findings: community interviews

After termination of the ranking games, a series of community interviews were held to discuss the initial findings with the people, to discuss the ranking criteria used by the informants to differentiate individuals, and to present the names of the best and most knowledgeable farmers as a verification of the results obtained from the game.

During these meetings, a summary of the statements characterizing good farmers and most knowledgeable farmers were read to the audience. For each of the two games, both the statements referring to the best and the worst groups were read, that is, those for surplus and deficit producers and those for farmers most and least knowledgeable about trees. Criteria for groups between these two extremes were not provided. After reading the criteria, a list of 10-12

farmers (male and/or female) identified as the best farmers or the most knowledgeable farmers was given to determine whether people agreed with the persons identified with the ranking game. These farmers were those having the lowest average scores obtained from rankings of at least three informants. Since the average scores concerned households, not individuals, the names of both husband and wife were read, unless one or the other was clearly ranked as not being a best or most knowledgeable farmer.

3.1. Observations regarding the good farmer criterion

The audience of the various meetings generally agreed with the criteria as outlined in Table 5, except for the fact that good farmers are rich and have good soils 'that produce even without manure.' According to the persons present, nobody is rich in Rwanda, as expressed in the following statements:

> 'Good farmers are not all rich; it is a question of survival, nobody is rich. One lives [well] because of one's own efforts.'
>
> 'It is inconceivable that there are rich farmers! How can one find money without a diploma?'
>
> 'We cannot be rich if we are not offered any materials to increase production.'
>
> 'They are not very rich because they do not have cars.'
>
> 'A rich farmer! That does not exist! Everybody is obliged to buy beans to eat.'

After additional explanations that "being rich" was only relative to the average farmers in the region, and not compared to white persons or *commerçants* in town, people understood what was meant and agreed that some farmers are better off than others even though they are not rich in absolute terms: 'It is true that certain persons among those mentioned have a satisfactory living standard, and are rather well-off.'

A second disagreement arose over the fact that good farmers have good, fertile soil that "can produce crops without the addition of manure" (literal translation of statements made by some informants). While they do agree that good farmers do have better soils, they do not think that this eliminates the need for manure:

'Nobody cultivates without manure if he or she expects a good production.'

'There is no good harvest, unless one has the money to buy manure.
In our region, nobody can affirm that he has an abundant harvest, that she has a soil that does not need manure, that he has a surplus to give to others, that she gets help from extension workers, that he has sufficient land.'

'Nobody harvest anything without fertilizing his soil. One does not harvest anything without manure.'

'You probably talk about people in Kibungo, or in Ruhengeri where lava fertilizes the soil. Or in the Mayaga region, where one can have good harvests without using manure. But even there, things are beginning to change.'

These statements and the discussions from which they were taken reaffirm the importance of manure and its necessity to obtain good harvests. Having manure (which implies having cattle) and being able to maintain soil fertility appeared to be the most important variable in explaining who is a good farmer or not, because having manure implies large harvests, and possibly a surplus to sell. In this regard, having cattle and manure seem more important than having a large piece of land. However, having a large farm makes it possible to reserve some land for pasture for cattle or other animals.

In one of the meetings, there was a long debate on whether women could be good farmers or not. Several men stated that we had only used women as informants who only gave the names of other women as good farmers. This could not be so, according to them, because women can never be considered good farmers as "women do not cultivate, they merely put some seeds in the land prepared by the men." The men thus feel that we were tricked and that the results were, therefore, not valid. However, several other people present, especially the women, disputed this chauvinist attitude, even giving an example of a woman who is one of the best farmers in the area.

People accepted most of the persons identified as the best farmers with the help of the game in all but one of the thirteen meetings held. In some cases, they questioned the inclusion of one or two persons because they did not match some of the characteristics mentioned in the good farmer profile. In two of the meetings people also suggested adding the names of some farmers that were not mentioned. In the one meeting that was the exception, people rejected all persons

identified with the game as being good farmers because the people identified "are all poor and destitute." As my assistants, overhearing informal discussions among those present, told me after the meeting, this was more a reflection of the general sentiment that nobody is rich in Rwanda and the idea of the assumed benefits the people specifically cited as good farmers would obtain from being so identified.

3.2. Observations regarding the knowledgeable about trees criterion

The comments made on the variables describing knowledgeable farmers were more varied in the topics covered. In almost every meeting held, the audience commented on the fact that the rarity of trees on their farms was not due to a lack of understanding of the importance of trees but due to the smallness of their farms. In their opinion, one cannot plant trees without a large farm. However, having a large farm does not automatically mean having many trees; some farmers do have large pieces of land, but still have few trees on their farm and little knowledge about them because the land is infertile. In addition, one person mentioned that people who lack vast tracts of land, have few animals and who do not make an effort to obtain seedlings can also have an extensive knowledge of trees. It is not due to unwillingness that some people do not actively seek plant material; but if one has no place to plant any trees, it does not make sense to do so.

Some men present at the meetings questioned whether women do, or even can, have knowledge of trees. Concerning medicinal uses of trees, both genders agreed that women have a more extensive knowledge of trees than men. But regarding the planting and maintenance of trees, and the development of new knowledge, women were judged incompetent:

> 'As regards the maintenance of trees, a woman is not competent. It is the men who goes to discover a certain species because he already knows its utility, because he has a specific objective in mind. Only later does the woman notice that her husband is cutting the tree and feeds it to his animals. Thus, it is only much later that the woman discovers the importance of the tree. An example is leuceana which we [the men] planted without the knowledge of our women.'

This sentiment was not shared by everyone. In other meetings it was acknowledged that women can have extensive knowledge of trees, and do also contribute to that knowledge through their

experiments with medicinal plants, the planting of fruit trees between the beans, etc. Thus, even the men admitted that

> '.... it is the women who have the most knowledge about trees but if a woman knows many tree species, her husband must know them also.'

This is a reflection of Rwandan tradition that women cannot have more knowledge than men, and therefore the latter can not admit that such is possible even if it is actually the case.

The presentation of the list of persons identified as the most knowledgeable about trees was more contentious than the presentation of the list of the best farmers, and led to lengthy discussions. The general feeling was that people expected benefits beyond being a consultant for the second phase of the research, and therefore wanted to have their name included in the list. In some meetings, everybody became an instant expert with many trees on his/her farm. The majority of persons identified were, however, accepted as truly being the most knowledgeable farmers. As in the good farmer game, some persons were not deemed very knowledgeable and it was suggested that they be deleted from the list, while suggestions were also made for other persons to be added. Because of the special knowledge that traditional doctors possess, the names of two or three that were identified by several informants were also included in the list of knowledgeable farmers. However, this often led to disputes because traditional doctors do not advertise themselves, and thus their healing practices were often unknown to the larger community. It was therefore difficult for the audience to agree or disagree on the persons identified as healers.

4. Sample construction: Selection of consultants for the second phase of the study

Toward the end of the focus group interviews, participants were asked to choose two to four people among the 10-15 persons identified with the ranking game as the farmers most knowledgeable about trees and tree cultivation. If participants did not agree with any of the persons identified and presented to them, they could nominate others. A special effort was made to include persons specializing in local medicine who were often not ranked very high during the game. However, they possess an enormous amount of knowledge about trees and vegetation histories. Second, it helped to include women since they are recognized as the most

knowledgeable regarding local healing practices; as knowledge of trees is equated with knowledge of traditional medicine (see Section 2.1.2.), including women healers was considered a valid approach within the framework of this study.

In total, 44 agroforestry experts were chosen as consultants for the second part of the study: 22 in Kibingo and 11 each in Maraba and Simbi. It should be stressed that this sample of tree experts is not proportional to or representative of the total population in the research areas. The men and women included in the sample were chosen by the communities according to their criteria of what constitutes "being knowledgeable about trees and tree cultivation." The 44 persons in the sample are, therefore, community identified tree experts; in the remaining chapters of this dissertation, they will be addressed as "tree experts" for brevity.

A comparison group of 71 farmers was chosen randomly from among the persons identified as having little to no knowledge of agroforestry, that is persons from knowledge groups 2 to 5 (see Table 6). For each *cellule*, twenty random numbers between 1 and the total number of households in the *cellule* were generated. These random numbers were then matched with their knowledge score, and any persons falling within the scores of group 1 (i.e. the most knowledgeable farmers) were eliminated. Five (in Kibingo) to six persons (in Maraba and Simbi) per *cellule* were randomly picked from those remaining to be included in the sample, for a total of 35 persons in Kibingo, and 18 in both Maraba and Simbi. One person was eliminated from the sample in Maraba because he was unable to sensibly answer any questions; no replacement of this person was made because of time considerations.

5. Lessons learned about using a ranking game for subject identification

5.1. Benefits of using a participatory approach for subject selection

The wealth ranking game was originally conceived to determine wealth strata within a community, which could then be used as a sampling frame for further research. In this research, the game was used both to study how people understand the meaning of "being a good farmer" and "being knowledgeable about agroforestry" and to identify the subjects (individuals) for further

study. The positive aspects of the game are that it succeeded in both these objectives. The game approach was also very well received by the farmers. Since we did not ask direct questions about the informant and his/her family, people did not feel threatened and rarely refused to collaborate. During the course of the game, only one person refused outright to participate; another, older woman, stated that she was sick most of the time, rarely leaving her house anymore, and did not know people well enough any longer to be able to give us accurate responses.

A secondary benefit of the game was that it allowed the researcher and the assistants to thoroughly get to know all corners of the study areas, as informants for the games were drawn randomly from a prepared list that included farmers from all *collines* of the three *secteurs* were included. The game helped to establish the researchers' presence in the area, gain people's confidence, and helped people to get used to strangers running around their farms asking [dumb] questions. From the game interviews and the guided farm tours carried out in conjunction with the game, we obtained a good understanding about the linkages between people, crops, trees, animals, soils and land to build a comprehensive picture of the agricultural system which would have taken much longer to obtain in any other fashion.

The game had an average accuracy of about 85% in its ability to identify the best and most knowledgeable farmers as determined from the responses from the community interviews. The accuracy was higher for the identification of the "good farmers" than for the identification of the "knowledgeable farmers" since the ranking criterion for the latter was more abstract and open to different interpretations. A higher accuracy could have been obtained by interviewing additional informants, spending more time initially to verify the accuracy of the list of farmers in the area (a few names were inadvertently omitted from the lists), and closer supervision of research assistants.

5.2. Potential difficulties and pitfalls

The negative aspects of the game are twofold. First, it is time consuming and easily leads to "research fatigue," that is that due to the repetitiveness inherent in the method, assistants may forego probing questions and pay less attention to details in the descriptive statements

differentiating groups of farmers. To minimize the latter, the number of informants to be contacted by the research assistants on any given day was limited to four, although this meant that the overall time to complete this phase of the study was longer (about 35 person-weeks) than anticipated. Given the fact that Rwandans do not live in nuclear villages but scattered over the hills, much time was also spent walking to reach the informants. It was, therefore, hardly possible to reach more than four respondents a day. However, the spread-out settlement pattern provided good opportunities to study the landscape, meet people, and observe farming practices and agroforestry systems.

Second, women made less good informants than men, although this was also age dependent. Since women upon marriage move to the husband's farm and family land, they are strangers on the *colline* and have much difficulty identifying and ranking other women. While young women rarely knew any women on the *colline* beyond their immediate neighbors, even older women often did not know their colleagues, and were able to rank them only after the names of their husbands were given. Whether this may have influenced the ranking is not known, although it may have done so with the "farmers knowledgeable about agroforestry" rankings since trees are owned and maintained by men. However, women did admit their superior knowledge of medicinal trees and practices, and did not shy away from identifying other women who had this knowledge and ranking them accordingly. It appeared to be less of a problem for the good farmer game, since the ability to provide for the family was a prime criterion and women have a large responsibility in feeding the family.

6. Summary and conclusions

6.1. Good farmers

Size of harvests was the variable most often used by informants to differentiate good and inept farmers. While informants could not know harvest size of their colleagues in absolute terms, they used this term metaphorically to indicate that a farmer's ability to produce enough to feed his/her family or not. Thus, the best farmers are surplus producers (i.e., they produce enough to feed their family and perhaps have some surplus to sell), while the majority of inept farmers

are deficit producers who do not harvest enough to cover the family's food requirements and may have to supplement food supplies through off-farm labor activities. The other variables that were used to distinguish various groups of farmers are variables that explain why some farmers are surplus producers and others are not. In this regard, animals, particularly cattle, and the availability of manure appear to be more important in producing sufficient food than large farm sizes. Farmers are very well aware of the decrease in soil fertility over the last decades, how that has affected production, and the importance of manure to ameliorate the soils. However, due to declining farm sizes, fewer farmers are able to maintain cattle on their farms, and thus no longer have a supply of manure to maintain soil productivity.

6.2. Knowledgeable farmers

The terms having a diversity of trees and, to a lesser extent, having a large number of trees in total were used as substitutes for "being knowledgeable" in the ranking game. This made sense since the same word is used for knowledge and experience. The most knowledgeable farmers thus have a great diversity of tree species on their farm, and, by consequence, the least knowledgeable farmers have only a few, if they have trees at all. Animals and manure again are used to differentiate farmers, but in contrast to the first ranking criterion (good farmers), farm size is also important. While sufficient food can be produced from a relatively small area if one has manure to maintain or enhance soil fertility, trees need space. Therefore, people with larger farms are able to plant and cultivate trees in greater numbers than farmers only having small plots of land. Presence of animals and availability of manure are equally important in this regard, since they make it possible to produce enough food from a smaller piece of land, thus freeing some land for trees and/or grazing.

The majority of farmers in the study areas have less than 0.25 hectares of land; for these farmers, the *rugo* is an important location for tree cultivation activities. With farm sizes decreasing with each generation, the *rugo* may become the only location where farmers can produce trees to meet the varied needs for tree products in the future.

There is no one-on-one relationship between cultivating trees on the farm and having knowledge. Informants often stated that one can have knowledge without having many trees on one's farm, thereby indicating that knowledge of trees may be of a different nature for the various groups of farmers (i.e. farmers having many species on their farm having knowledge of planting and cultivating trees, while those with few trees primarily having knowledge of use aspects of trees).

6.3. Comparing good farmers with those knowledgeable about agroforestry

There is a large covariation between the variables that informants used to describe the different groups of farmers they created. The variables that informants used to describe various groups are also similar for the two games. This is understandable as Rwandan farmers, unlike researchers trained in the Western scientific world view, do not consider various enterprises as independent entities. Enterprises do very much co-vary as a result of the micro-management of available resources as an organic whole, to be manipulated so as to realize a sustainable livelihood, which is not necessarily the same as realizing sustainable production.

The statistical analyses on the crosstabulation of the good farmer scores and the knowledgeable farmer scores indicate that there is some association between being a good farmer and being knowledgeable about cultivation of trees. However, the correlation between the two (0.14) is too weak to draw any definite conclusions, and, as the Lambda and Tau statistics are very small, being a good farmer or not cannot be used to predict whether one is also knowledgeable about agroforestry. The correlation between scores may, therefore, be an artefact related to the similarity of ranking criteria used by informants to differentiate the various categories, even though the rankings were obtained before the criteria were asked for, and different informants provided the rankings for the "Good farmers" and "Knowledgeable farmers" games.

The statements of the farmers that one can be knowledgeable about trees without being a good farmer, that is, without a large farm with good soils, many cattle and plentiful supply of manure, may, therefore, have some merit. Deficit producers may not have many trees or a great diversity of tree species on their farms, but they do possess a wealth of knowledge mainly on use aspects of trees and perhaps on the cultivation of a limited number of species. There may, therefore,

exist a differentiation and/or a specialization of knowledge between surplus and deficit producers, with the former being the innovators of new tree species and practices, and the latter being the keepers of much traditional wisdom regarding the uses of trees and their importance for society.

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CHAPTER IV

SOCIO-ECONOMIC CHARACTERISTICS OF TREE EXPERTS AND COMPARISON FARMERS

1. Introduction

Agriculture and agroforestry exist only because people are involved in shaping their environment in ways that are more beneficial to them than exploiting the environment in a natural state by hunting and gathering. In other words, they are socially constructed forms of production. Not only have farmers developed the visible artefacts, the particular agroforestry systems, but over time they have also generated extensive knowledge about the management of indigenous tree species within these systems. In addition, they have acquired and adapted a wealth of knowledge of exotic species and silvicultural practices introduced since the 1930's to the particular micro-ecological and socioeconomic conditions of their farms. The particular tree-crop-animal systems presently found in Rwanda are a reflection of people's needs for subsistence and their ideas of the "ideal" spatial and temporal arrangement and choice of species of plants and animals to meet these needs. Outsiders (or even other farmers) may have different opinions about the ideality of these arrangements and production systems, but since the production systems are socially constructed entities, their ideality is determined by the individual or the social group who constructed the systems. Wide variations in agroforestry systems may (and do) occur between farmers within the same community, as needs differ between households and individuals. In addition, some farmers may be more willing, have a greater aptitude or more resources to tinker with new technologies and ideas, so that some farmers will be recognized by the wider community to be more knowledgeable (in this case about trees and agroforestry) than others. The results of the ranking game presented in Chapter III indicate that such a differentiation does indeed exist.

In Chapter III, the differentiation between tree experts and comparison farmers was presented using qualitative statements on a relative scale regarding the knowledge of agroforestry and the nature of its constitution. The primary purpose of the ranking game and the subsequent community interviews was not to study this knowledge per se but to identify the persons most

knowledgeable about trees and tree cultivation. With the ranking game, we were able to make a fairly decent distinction between and characterization of persons with much and little knowledge about trees. However, since the choice of criteria was left to the informants and what they thought important and necessary to make the distinction between knowledgeable and non-knowledgeable farmers, no uniform criteria were employed by the various informants. As was shown by the varying frequencies of ranking criteria in Tables 5 and 6 in Chapter III, the criteria used differed widely between informants. In this chapter, a quantitative approach will be used to determine the differences between agroforestry experts and non-experts in order to answer the questions of who the experimenting farmers are and what differentiates them from other farmers in the community.

1.1. Methods

A formal survey (see Appendix II-6) was used to gather data from two samples of farmers: a sample of 44 tree experts was identified through the ranking procedure and community interviews, while a comparison group of 71 farmers was randomly chosen from the farmers identified during the game as being less or not knowledgeable about trees and tree cultivation (see Section 4 in Chapter II for more detailed information on how the samples were selected). Data collected included demographic characteristics, education, employment and farm resources (land, labor and animals). Statistical analysis of this set of uniform characteristics will be used to (1) differentiate tree experts and comparison farmers and (2) confirm or reject the validity of the ranking game and its findings as a tool of identifying individuals most and least knowledgeable about agroforestry.

In the tables in Section 2 of this chapter, significant differences between the two groups (tree experts and comparison farmers) are indicated by "A" ($p < .01$) and "B" (p.05); significant differences within groups (i.e. between the three *secteurs*) are indicated by small letters from "a" through "d". Unless otherwise indicated, significance levels refer to those obtained from t-tests and one-way analyses of variance.

2. Results and Discussion

2.1. Demographic characteristics

2.1.1. Composition of the samples

A total of 114 persons were interviewed to collect data on socioeconomic characteristics, namely 44 tree experts and 70 non-experts identified as "comparison farmers" in this chapter. Although the latter sample comprised 71 farmers, one person was eliminated from the sample of Maraba secteur because he was not able to sensibly answer any questions; no replacement of this person was made because of time considerations.

The majority of the consultants were male; in the tree expert group 15.9% of consultants were female, while 28.6% of comparison farmers were female (see Table 9). Almost all consultants were married (84.3% of comparison farmers and 88.6% of the tree experts, respectively). Of the female consultants, almost three-fifths were widowed or divorced and act as heads of the household. The remaining two-fifths of women responded in the absence of their husbands, or because they were the de facto farm managers since their husbands had salaried jobs and were mostly absent during the week (the Rwandan work week being 5.5 days/week). The average percentage of female headed households was 19% in the control group (ranging from 12% in Maraba to 28% in Simbi), and 9% in the tree expert group (9% in Simbi and 14% in Kibingo). In Maraba, none of the persons chosen as informants for the second phase of the study were women; therefore, there are no female headed households among the tree experts in this *secteur*. The actual percentage of female headed households in the region is more accurately reflected in percentages in the control group, since the consultants in this sample were chosen randomly, whereas the persons in the tree expert group were purposively chosen with the ranking game.

It should be noted that female heads of household do not accrue any ownership rights over the land. Women merely function as temporary caretakers for their sons, and when the latter so wish, they may reclaim all land without granting usufruct rights to their mothers. Divorced

Table 9: Number of respondents and their marital status.

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
NUMBER OF RESPONDENTS								
Total	35	17	18	70	22	11	11	44
Male	26	13	11	50	18	10	9	37
Female	9	4	7	20	4	1	2	7
OF WHOM ARE								
MARRIED								
Total	35	17	16	68	18	11	10	39
Male	26	14	10	50	17	10	9	36
Female	5	3	6	14	1	1	1	3
WIDOWED								
Total	5	6	3	12	3		2	5
Male	1	1	2	4			2	2
Female	4	5	1	8	3			3
DIVORCED								
Total	1		5	6	3		1	4
Male			1	1	2			2
Female	1		4	5	1		1	2
MALE HEADED HOUSEHOLDS								
Total	29	14	13	56	19	11	10	40
FEMALE HEADED HOUSEHOLDS								
Total	6	2	5	13	3		1	4
% of all households	17%	12%	28%	19%	14%	0%	9%	9%

women are often in a more precarious situation, since they cannot claim even caretaker status for the land, and cannot gain access to land independently.

2.1.2. Age and years of farming experience

The average age of the consultants was significantly higher in the tree expert group (57 years) than in the comparison group (45 years) (see Appendix IV-1). The maximum age of both groups did not differ much. However, the minimum age among comparison group consultants was 22, while it was 34 in the expert group. A related question, asking for the number of years that consultant had lived on his/her farm, shows a similar pattern, the average being 22 years in the comparison group and 33 years in the tree expert group. The difference between the two group is significant ($p < .01$). From these two numbers (average age and years having lived on the farm) one can establish that the average consultant established their farm as an independent unit between the age of 22 to 25 in both groups.

2.1.3. Place of birth and other residences in the past

The majority of consultants in both groups were born in the *commune* in which they presently live and farm (see Appendix IV-2). The largest number of non-native farmers was found in Kibingo, followed by Maraba. Simbi, which was settled before the other two *secteurs* and already densely occupied at the time of Independence, attracted few settlers from outside Maraba *commune*. People that settled in Kibingo were all from *communes* neighboring Karama, whereas those that migrated to Maraba *commune* were all from various *communes* in Gikongoro. Most consultants in both groups have always lived on the land they presently farm (95.6% of comparison farmers and 86.4% of tree experts). Some had salaried jobs in the past, so that they lived in various places before returning to farm their inherited land, or to ask for some land from the authorities. Salaried jobs and multiple residences were more common among the tree experts than among the comparison farmers. Two persons had lived in Uganda for some time; this country was a popular attraction for many young men seeking to earn money until the early 1970's when the economy collapsed due to the civil war in that country.

2.1.4. Number of children

As can be expected, the number of children is higher in the tree expert group than in the comparison group, the former being of higher average age and further advanced along the family life cycle than the latter. There is a highly significant difference in average total number of boys and girls per household between the two groups (see Appendix IV-3). The average tree expert household has 3.5 boys and 3.8 girls, of whom 2.4 and 2.8 are living at home. The average comparison farmer household has 2.4 boys and 2.7 girls, with 2.0 boys and 2.2 girls still living at home. The between group difference in the average number of boys and girls (still) living on the farm is significant. The households in the three *secteurs* within each group do not differ significantly in the average number of boys and girls in total or those living at home. It should be noted that the number of children among the households surveyed does not appear to show a decreasing number of children as was seen in Figure 7 in Chapter II. Most households in the two samples belong to the previous generation where the number of children was high; in the averages presented in Appendix IV-3, the younger households with fewer children are outweighed by the older, more established larger households.

There is also a significant between group difference in the number of boys having moved outside the *secteur* of their parents' residence. Because there is little future in farming for many young men as land becomes scarcer due to equal division of land among sons, many leave the area to seek land or employment elsewhere. On average, 1.2 boys of comparison farmer households and 2.5 of tree expert households have sought opportunities outside the *secteur* in which their parents' farm is located. The number of consultants reporting such migration of sons is particularly high in Kibingo, where sons have migrated in 20% of comparison farmer households and in 45.5% of tree expert households. Within the tree expert group, the number of boys living outside the *secteur* of Kibingo is significantly different from the number doing so in Maraba and Simbi.

To the question how many boys already had received a piece of land as inheritance and were farming it, consultants indicated that on average 1.7 and 1.8 boys in the comparison farmer and tree expert group, respectively, were doing so. The difference between and within groups is not significant. Such division of land between sons takes place when sons get married, before the

(male) head of the family dies. From the average age of consultants and the mean age at which sons establish their own, independent farm, we can deduce that farm size start to decrease when the male household head is between 45 and 50 years old. The total amount of farm land owned may decrease even though there still may be a need to cultivate all this land to feed the remaining family members.[1] The intergenerational dynamic of farm sizes engendered by this inheritance system may have important implications for agroforestry development.

2.2. Education

2.2.1. Heads of household

As was shown in Table 3 in Chapter II, the level of education of the people in Maraba *commune* is low, with 42% of the population above seven years of age never having had any education, 30% having between one and four years and 25% between five and eight years of primary education. These figures are about average for the whole of Rwanda. In the two groups of farmers considered in this study, the level of education appears to be somewhat higher than the previous *commune* data indicate. In both groups, about 70% of the male heads of households indicated having had a mean of four years of primary education (see Appendix IV-4a). while The percentage of educated male heads of households is lowest among tree experts in Simbi (50%), while the percentage of tree experts in Maraba who mentioned having had at least some years of primary education is highest (82%). The average number of years of primary education is highest in Kibingo and lowest in Simbi in both the comparison and expert groups. Only one comparison farmer and two tree experts (both in Kibingo) indicated that they had attended one or two years of secondary school.

Almost one-third of comparison farmers in Maraba and Simbi, one-third of tree experts in Maraba and three-fourth of tree experts in Simbi reported having attended other formal educational institutions, primarily vocational schools. Attendance at such schools was very low

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[1]The total area cultivated, however, may be enhanced by renting or borrowing land from other farmers to make up for the lost amount of owned land. As we will see later in this chapter, renting and borrowing land is common in the study areas.

in Kibingo. On average, persons who have attended vocational schools completed slightly more than three years of education at these institutions (3.2 and 3.1 years in the comparison and expert groups, respectively).

In absence of any agricultural development projects in Maraba *commune*, it is not surprising that none of the consultants indicated participation in short-term training programs. In Kibingo, only four persons indicated that they had attended training programs provided by the PAP Nyabisindu project. All four were tree experts. PAP appeared to have concentrated its efforts on a small number of so-called "pilot farmers," and did not succeed in reaching the wider population of the *commune*. In spite of this project operating in Karama *commune* for 12 years, very little of these efforts appear to have spread beyond the "pilot" farmers to the general farm population of the area.

Education of women and girls in Rwanda is generally much lower than for men and boys, and the results of the survey confirm this fact. Only two out of 14 female heads of households among the comparison farmers, and one of four female heads of household in the tree expert group had received primary education (see Appendix IV-4a). In both groups, the average number of years of school attendance was five years. Four women in the comparison group, one in Maraba and three in Simbi, had attended a mean of 1.3 years of other formal education; for all these women, this involved attendance of the *Foyer Sociale*, a home economics and literacy program run by the Catholic Church at Simbi.

2.2.2. Women not being heads of household

The percentage of women not being female heads of household having had education is much higher than the percentage of female heads of household. Fifty-one percent of the wives of the comparison farmers and 31% of the wives of tree experts attended primary school (see Appendix IV-4b). In the comparison group, the average number of years of women's school attendance was slightly higher (5 years) than among the male heads of household in this group (4 years). In the tree experts group, the mean number of years of education was similar between men and women (4.2 and 3.9 years respectively). The percentage of women with some primary education

was higher in the comparison group than in the expert group, with more women in Kibingo having received an education than women in the other two *secteurs*. Only about one-fifth of the wives of tree experts in Maraba and Simbi have attended school. Only one woman, the wife of a tree expert in Kibingo, had completed five years of secondary school; she was presently working as a primary school teacher in the *commune*.

Some women also attended other formal educational institutions, but their number was lower than the number that attended primary school. Again, the number of women who attended these schools is lower in Kibingo than in the other two *secteurs*. Comparison group women completed a mean of 2.7 years of these schools, whereas tree expert women completed a mean of 4.0 years. Attendance was highest among women in Maraba, where 73% of the women attended the *Foyers* or other similar programs.

A few farmers do have two wives, mainly in Simbi. Because of the low number of cases, it is not possible to make general statements about the education of second wives from the data in Appendix IV-4b.

2.3. Employment and community functions

Although all persons interviewed were farmers, some also had a job paying a regular salary at present or in the past. These extra resources helped overcome the uncertainties of and dependency on farming, and also meant access to resources that the majority of farmers did not have. However, only few people were lucky enough to have a salaried job at present, namely one person (1.4%) among the comparison farmers and 4 (9.1%) among the tree experts (see Appendix IV-5). A higher number of consultants in both groups had had salaried work in the past, namely five persons (7.1%) in the comparison group and ten (22.7%) in the expert group. Again, the Chi Square statistic of the difference between observed and expected number of persons in the two groups who had a salaried job in the past is significant. The Chi Square statistic of the differences between observed and expected frequencies between *secteurs* within each group for both past and present employment is not significant. The kind of jobs that people mentioned include teacher, soldier, extension worker, domestic, bricklayer, catechist, artist,

public service in national or local government, and laborer. All persons who had a salaried job in the past or do so at present are men.

Compared to salaried jobs, a higher percentage of consultants in both tree expert and comparison farmer groups presently hold non-paid community functions (see Appendix IV-5). Among the comparison farmers, five persons (7.1%) hold such a function, while eight persons (18.2%) do so in the tree expert group. In the latter group, one-in-five consultants in Kibingo has some community function or other, whereas only one in ten does so in Simbi. The number of people involved in community functions among the comparison farmers is much smaller, although there is a slight increase in the number of persons doing so from the past, from three to five. In contrast, the number of community function holders among tree experts has gone down from the number doing so in the past from ten to eight. Community functions that were mentioned included catechist; president of the *Jeunesse Ouvrière Chrétien* (JOC), cooperative, farmers' association or political party; treasurer of the cooperative; family planning counselor; secretary of the *Banque Populaire*; pilot farmer; herder; chief of 10 houses. Some consultants included unpaid, sometimes forced, labor that they had to perform for the local chefs before Independence in this category, such as being a domestic and the digging of anti-erosion ditches on the chefs' land. Again, all but one of the non-paid community functions reported were held by men. The lone exception was an older woman who still felt bitter about having been forced to dig anti-erosion ditches without payment. Chi Square tests done to determine whether there are any differences between the two groups reveal that the difference among comparison farmers and experts is not significant for functions at present, but is highly significant for functions in the past.

Another way in which families are able to muster additional resources is through salaried jobs of their children. Nearly one-third of tree experts reported that they have at least one child with a salaried job, with the percentage of consultants being higher in Kibingo and Simbi (36.4%) than in Maraba (18.2%). Among the comparison farmers, on the other hand, only four consultants (5.7%) indicated that children have salaried jobs. The difference between tree experts and comparison farmers is highly significant, but there is no difference between *secteurs* within each group. But having children with a regular, salaried job does not automatically mean that these

children will help their parents. When asked the question if and how children with a job do help their parents, three out of four consultants in the comparison group answered affirmatively (see Appendix IV-5). The farmers in the comparison group are generally poorer, younger and have smaller holdings. More children in this group are not yet married even if they have a job. In addition, older sons, particularly if they are employed and if they are from a female headed household, are expected to help pay for school expenses of younger siblings still living at home. In the expert group, only half the consultants said their employed children do help. The consultants in this group are mostly older and further advanced on the family cycle. Often, their children are married and have their own families to take care of, and a larger number have moved outside the *secteur* of their parents' residence, as was shown in Section 4.1.4., making children feel less obliged to help their parents. The kind of help that children do provide their parents includes money, food, clothing and payment of school fees and expenses for younger siblings. Some consultants also mentioned that children gave them tools or improved seeds, but this was not common.

2.4. Resources: Farm labor

When asked a direct question whether or not consultants had sufficient labor in the family to carry out all agricultural tasks, 98% of consultants answered affirmatively (see Appendix IV-6). One consultant in each of the two groups said they did not have enough labor in the family, and that this shortage had not changed over time. Whether or not this was actually the case, or whether consultants did not understand the question is not clear, particularly in the tree expert group. In a follow-up question on whether consultants hired farm laborers, about 34% of the farmers in the tree expert group said that they did, with 13.6% stating that they did so on a permanent basis. The percentage was especially high in Kibingo (18.2%); this is understandable as a greater number of persons in Kibingo hold salaried jobs or non-paid community functions. About one-fifth of tree experts hire labor on a temporary basis, mainly during the months of September and October at the start of the first planting season, and in March when most of the coffee is harvested. In the comparison farmer group, only five out of 70 consultants (8.5%) indicated that they hired labor, with only one person in Kibingo hiring labor on a permanent basis. None of the comparison farmers in Simbi hire laborers. The main month during which

comparison farmers hire labor is March (for the coffee harvest), and also in September and October to help in preparing the fields for planting. The Chi Square statistic indicates that there is a highly significant difference between tree experts and comparison farmers in labor hiring practices.

The question of whether consultants do work for other farmers resulted in a mirror image of the question about hiring labor, with 37.7% of comparison farmers but only 9.1% of tree experts stating that they do work as laborers for other farmers (see Appendix IV-6). Chi Square statistics indicate that this difference is highly significant. The peak months for temporary farm work are the same as those indicated in the previous paragraph on the hiring of farm labor, namely September/October and March. Four of the comparison farmers indicated working as farm laborers on a permanent basis, and nearly one-third seek temporary farm work at some time during the year. Temporary farm work is especially widespread among comparison farmers in Simbi, where 38.9% of consultants indicated such employment. However, even in Kibingo and Maraba, nearly one-third of the consultants mentioned working for other farmers temporarily. As most of the farmers in the comparison group have very little land and other resources enabling them to survive by farming alone (as will be shown in the following sections on land and animals), these figures are an indication that a class of landless (or near landless) laborers may be emerging in Rwanda.

Among the tree experts, only one person works full-time as a farm worker for other farmers, while three persons indicated working on and off during the year. However, the temporary work by persons in this group concerns mainly labor provided as neighbor help or as part of labor exchange groups, where farmers work on each other's farm by tour with the host providing banana and/or sorghum beer.

2.5. Resources: Land

Land is the primary resource for agricultural production, and one that is becoming increasingly scarce in Rwanda due to the rapid population growth as discussed in Chapters I and II. The results from the ranking game (Chapter III) indicated that farm size is an important determinant

to differentiate between good and "inept" farmers, and between farmers highly and least knowledgeable about tree cultivation. However, the ranking criteria informants used were of a comparative nature and not based on hard data. In this section, the results of the questions related to consultants' land resources will be provided. This information will be helpful in quantifying the differences between comparison farmers and tree experts. The section is organized in several subsections related to farm size, land tenure and changes in farm size in the last five years, parcelling and leasing of land, and soils.

2.5.1. Farm size

The data in Table 10 indicate that there is a highly significant difference in farm size between comparison farmers (whose mean farm size is 18 ares[2]) and tree experts (average farm size 127 ares). In both groups, farm sizes are largest in Kibingo (24 and 217 ares in the comparison farmer and tree expert groups respectively). In the comparison group, the average farm size in Kibingo (24 ares) is significantly different from the average farm in Maraba (11 ares); the within group differences between *secteurs* are significant. In the expert group, the average farm in Kibingo (213 ares) is significantly different from both Maraba (53 ares) and Simbi (37 ares), and within group differences between *secteurs* are highly significant. In Maraba and Simbi, the maximum farm size does not exceed one hectare, even among tree experts. The smallest farms encountered were around two ares, which is barely enough to build a house and have a small kitchen garden, let alone cultivation of enough food to feed a family.

The larger farm sizes in Kibingo need to be qualified. Many farmers obtained land grants from the authorities during the 1960's, which were usually large. Many of these farms have not (yet) been subdivided among sons for their inheritance. Larger farms were also necessary because soils are much poorer, having many rock outcrops not suitable for cultivation. Thus, many of the consultants having farms of 2 or more hectares only cultivate a small portion of the land, the remainder being left in pasture or in woodlots.

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[2]One are is 100 square meters; 100 ares is one hectare.

Table 10: Total farm size (in ares), valley land cultivated and owned, and size of valley bottom land (in ares).

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
TOTAL FARM SIZE (ares)								
Mean	24 c	11	14	18 b	213 c,d	53	37	127 A,a
Standard Deviation	20	6	14	17	167	21	22	144
Minimum	2	2	2	2	12	17	9	9
Maximum	104	20	50	104	480	92	81	480
n	31	16	16	63	20	11	10	41
DOES FARMER CULTIVATE VALLEY LAND?								
NO								
Count	15	6	6	27	2	2		4
Count Percent	42.9%	35.3%	33.3%	38.6%	9.1%	18.2%		9.1%
YES								
Count	20	11	12	43	20	9	11	40 C
Count Percent	57.1%	64.7%	66.7%	61.4%	90.9%	81.8%	100.0%	90.9%
DOES FARMER OWN THE LAND IN THE VALLEY?								
NO								
Count		1		1	2	3		5
Count Percent		11.1%		2.6%	10.5%	33.3%		12.8%
YES								
Count	18	8	12	38	17	6	11	34
Count Percent	100.0%	88.9%	100.0%	97.4%	89.5%	66.7%	100.0%	87.2%
SIZE OF VALLEY LAND CULTIVATED (ares)								
Mean	3.2	2.1	2.5	2.7	15.4	3.7	3.5	9.5 B
Standard Deviation	2.9	1.4	1.1	2.2	29.0	1.5	2.5	21.2
Minimum	1	1	1	1	1	1	1	1
Maximum	12	5	4	12	99	6	10	99
n	20	11	11	42	20	9	11	40

A=between group difference significant at p<.01
B=between group difference significant at p<.05
C=between group chi square significant at p<.05

a=within group difference between secteurs significant at p<.01
b=within group difference between secteurs significant at p<.05
c=within group difference between Kibingo and Maraba significant at p<.05
d=within group difference between Kibingo and Simbi significant at p<.05

An important means of compensating for small farm sizes is access to valley bottom land, which can be cultivated year-round. The ability to cultivate valley land is especially important for small farmers, where a harvest of sweet potatoes during the dry season is a welcome addition to the diet during this period. As the data in Table 10 indicate, less than two-thirds of the consultants in the comparison group cultivate valley land. In contrast, 91% of tree experts cultivate land in the valleys. The Chi Square statistic indicates that this difference between groups is significant at $p < .05$. Of the consultants indicating that they cultivated valley land, almost all (97.4% in the comparison group and 87.2% in the expert group) indicated that they owned this valley land. Only one person in the comparison group and five in the expert group stated that they leased valley land instead. In addition to fewer people mentioning cultivating valley land, comparison farmers own and cultivate smaller pieces than tree experts. Comparison farmers cultivate a mean of 2.7 ares of valley land (range of 1 to 12 ares), whereas tree experts cultivate a mean of 9.5 ares (range of 1 to 99 ares). The mean valley area cultivated by tree experts is significantly higher than the mean area of valley land cultivated by comparison farmers.

Tree experts, therefore, command significantly more land than comparison farmers, not only on the hills but also in the valleys. These results confirm the use of farm size as a major criteria in differentiating farmers during the ranking game.

2.5.2. Land tenure and changes in farm size

In the comparison group, the dominant mode of obtaining land is through inheritance, reported by 95.7% of the consultants (see Appendix IV-7). Five persons indicated having gotten some land through a gift from the authorities, with three indicating having purchased land. The picture is quite different in the tree expert group. Again, inheritance is the most frequently mentioned way of obtaining land, but it is not as dominant as among the comparison farmers. Only 61.4% of tree experts obtained land through inheritance. A large number (18 persons or 43.2%) did get their land as a gift from the authorities. Two consultants reported having purchased their land, and an equal number had gotten land in another fashion. The difference in ways in which people obtained their land is highly significant (Chi Square 24.54, $p < .01$).

The low number of land purchases is due to the fact that there is no market for land and the lack of official laws enabling land transfers through buying and selling. Officially, all land belongs to the State, which is the sole land owner; families/clans can establish permanent usufruct rights on this land, which in practice resemble ownership. However, such ownership is not legal, and people do not have official title to the land. Since usufruct rights are granted to the extended family or clan, not to an individual family, land transfer is also difficult since traditional tenure arrangements prohibit the sale of land without the approval of the extended male relatives.

2.5.2.1. Changes in farm size over the last five years

A majority of farmers in both groups indicated that the size of their farm had not changed during the last five years. The number reporting no change was higher among the comparison farmers (81.4%) than among tree experts (61.4%) (see Appendix IV-7). A Chi Square test indicated that this difference is significant. There is no difference between *secteurs* within each group. Only four persons indicated an increase in farm size, primarily through inheritance. These increases concern young farmers who have inherited land in the last five year in order to start their own farm; one comparison farmer mentioned having received some land from a friend as a gift. Most of the changes in farm size concerned decreases, mainly because of giving land as inheritance to sons. Sixteen (36.4%) tree expert and ten (14.3%) comparison farmers had had a decrease in size; decreasing farm sizes were especially frequent in Kibingo, where more than half the tree experts and slightly less than one quarter of comparison farmers had smaller pieces of land than five years ago. The higher incidence of inheritance as a cause of diminishing farm sizes is a result of the fact that Kibingo did not begin to become heavily settled and farmed until the 1960's, when many persons obtain their land grants from the authorities. These families have now reached the stage that their sons are marrying and claiming their land, which, as a consequence, decreases the size of the remaining land. Expropriation was mentioned by one tree expert. In this case, a significant part of the land the farmer owned in the valley was taken by the authorities in order to install a better drainage system and a more rational division of land (as determined by a Western scientific perspective) by the Projet de Développement Agricole de Gikongoro. This land was not returned to the farmer upon completion of the work, but was allocated to farmer cooperatives in both Karama and neighboring Nyamagabe *commune*, who

share the valley as a common border. Some consultants indicated having sold some land, but as explained above, this was not very common.

2.5.3. Land leasing

In contrast to the near absence of a market to buy and sell land, there is an active market in leasing plots of land for various time periods. It is one strategy used to gain access to pieces of land in different micro-ecological niches not found on consultants' own farms. As could be expected, few comparison farmers loan land to other farmers, as most of the people in this group have small farms to start out with. Only 10% of comparison farmers do rent land to others, most of them in Kibingo (see Appendix IV-8a). Two consultants rent out the same plot on a permanent basis, while four persons reported renting land to others occasionally on a yearly basis. The average rent received was 321 Rwandan francs (F.Rw.) per year (approximately US$2.--). Some farmers reported providing land free of charge to a poorer neighbor; the maximum rent charged by comparison farmers was 700 F.Rw.

In the tree expert group, 27.3% of farmers indicated renting land to other farmers, the majority of whom are located in Kibingo. Since farm sizes are much larger in this *secteur* than in either Maraba and Simbi, Kibingo farmers are better able to rent out land than their colleagues in the other two *secteurs*. Tree experts in Maraba and Simbi rent out the same plot of land to other farmers on a permanent basis, while lease terms in Kibingo are more varied. The average amount of rent charged by tree experts is slightly, but not significantly, higher than the amount charged by the comparison farmers, namely 358 F.Rw. However, the maximum amount is much higher (1,200 F.Rw.), even though some land is loaned free of charge also.

The Chi Square distribution of the results of the question of whether or not consultants loan land to other farmers indicate that the difference between the two groups is significant (see Appendix IV-8a).

As can be seen in Appendix IV-8b, a similar percentage of consultants in the comparison and expert groups indicated that they rented land from other farmers, namely 32.9% of comparison

farmers and 31.8% of tree experts (the Chi Square was not significant). In Maraba, half of the comparison group consultants mentioned renting in land, but only 16.7% of consultants in Simbi do. The most common arrangement mentioned was renting land continuously but changing the plot yearly, followed by renting the same plot of land on a permanent basis. In the tree expert group, 36.4% of consultants in Maraba and Simbi rent land (most of them rent the same piece of land year after year) and 27.3% in Kibingo. In the latter *secteur*, lease terms were more varied, ranging from renting the same plot on a permanent basis to occasionally renting a plot for the dry season. The average rent amount consultants pay for land does not differ significantly (1294 versus 1286 F.Rw.). None of the farmers received land free of charge, and rent amounts paid are much higher than amounts received for land rented out to other farmers. The amount of rent paid for a plot of land varied between 200 and 6,000 F.Rw. per year. The amount of rent charged or paid depends on the size of the plot, soil quality, location, relation between lesser and lessee, and the economic status of the latter. In general, valley land commands a higher price than land on the hill, particularly during the dry season.

2.5.4. Parcelling of land

As was seen in Section 2.5.1., farm sizes are significantly smaller in the group of comparison farmers than in the group of tree experts. Within each farm, however, land is divided in a number of fields located at varying distances from the *rugo*, and are not necessarily contiguous. A field is a unit of land with distinct management characteristics for a particular purpose. In Table 11, a breakdown is given of the average number of fields and the main crops produced on them. Fields were categorized in six main groups, namely fields for food crops, bananas, coffee, permanent pasture, fallow and woodlots. Banana fields are named in this fashion because bananas form the dominant overstory on these fields. However, bananas are not the only plants cultivated; many other species may be found as well on these fields, particularly fruit and medicinal trees, condiments, tobacco and food crops such as beans, squashes and gourds, and peppers. Isolated banana trees may also occur on the food crop fields. Mixed cropping is practiced on both types of fields. Banana fields are located closest to the *rugo*, while woodlots are the farthest removed. The difference between fallow and permanent pasture is only a matter of the length of time in which a field is left to regenerate. Fallows often last only one season,

Table 11: Mean, minimum and maximum number of fields according to their main uses, and number of consultants reporting having a particular field type.

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
NUMBER OF CROP FIELDS								
Mean	3.9	3.4	3.5	3.7	6.5	5.9	4.5	5.9 A
Standard Deviation	1.7	1.9	1.4	1.7	3.2	1.2	1.5	2.6
Minimum	1	1	2	1	3	4	2	2
Maximum	11	7	6	11	16	8	7	16
n	35	17	17	69	22	11	11	44
NUMBER OF BANANA FIELDS								
Mean	2.2	1.6	2.1	2.0	3.1	2.5	2.3	2.7 A
Standard Deviation	1.0	.6	1.4	1.1	1.6	1.1	1.0	1.3
Minimum	1	1	1	1	1	1	1	1
Maximum	4	3	6	6	7	4	4	7
n	29	15	15	59	20	11	11	42
NUMBER OF COFFEE FIELDS								
Mean	1.5	1.5	1.3	1.5	2.5	1.2	1.6	2.0 A,a
Standard Deviation	.8	.7	.6	.7	1.3	.4	.7	1.1
Minimum	1	1	1	1	1	1	1	1
Maximum	4	3	3	4	5	2	3	5
n	32	13	15	60	21	9	10	40
NUMBER OF FIELDS IN PERMANENT PASTURE								
Mean	2.2	1.0	.	2.1	2.8	1.3	1.0	2.3
Standard Deviation	1.5	.	.	1.5	2.1	.5		1.9
Minimum	1	1	.	1	1	1	1	1
Maximum	5	1	.	5	8	2	1	8
n	13	1		14	16	4	3	23
NUMBER OF FALLOWED FIELDS								
Mean	1.5	.	2.0	1.6	2.8	1.3	1.0	2.5 B
Standard Deviation	.9	.	1.2	1.0	1.5	.6		1.5
Minimum	1	.	1	1	1	1	1	1
Maximum	4	.	4	4	6	2	1	6
n	14		5	19	19	3	2	24
NUMBER OF WOODLOT FIELDS								
Mean	2.3	1.0	1.2	1.8	2.7	1.0	1.1	2.0 a
Standard Deviation	2.0		.4	1.6	1.2		.3	1.2
Minimum	1	1	1	1	1	1	1	1
Maximum	8	1	2	8	5	1	2	5
n	23	8	9	40	22	10	9	41

A=between group difference significant at p<.01
B=between group difference significant at p<.05
a=within group difference significant at p<.01

particularly on the smallest farms, and the vegetation on these fallows consists of weeds and low quality grasses only.

Comparison farmers have a total of 12.7 fields on average, making the average field size approximately 142 square meters. The large number of fields on the small farms in this group are not only an indication of farm fragmentation, but also of the intensive micro-management of the land to take full advantage of variations in soil conditions and differences in slope and aspect. Within the comparison farmer group, the average number of fields of various kinds does not vary significantly between *secteurs*. There are no fields with permanent pasture in Simbi, with only one person in Maraba stating having just one field in permanent pasture. Similarly, only 28% of consultants in Simbi reported having on average two fields in fallow, with no one Maraba having any fallow fields. The number of comparison farmers reporting fields in permanent pasture and fallow is higher in Kibingo, but even so less than half of the consultants indicating having fields of these types. About two-thirds of the comparison farmers in Kibingo, and half the comparison farmers in Maraba and Simbi mentioned having woodlots. Farmers in Kibingo have two fields in trees, while the farmers in the other two *secteurs* have only one woodlot plot. There are no differences in the number of fields of various kinds between men and women, except for the number of fallow fields. Female comparison farmers have significantly fewer fields in fallow than their male colleagues.

The total number fields of tree experts is 17.2 with an average size of 738.4 square meters. The difference in the average number of fields of various types between comparison and expert groups is highly significant for fields in food crops, bananas and coffee, and significant for the number of fields in fallow. Within the tree expert group, there are highly significant differences between the *secteurs* in the average number of fields with coffee and in trees (see Table 11). There is a significantly higher number of fields with coffee and woodlots in Kibingo compared to Maraba and Simbi (2.5 vs. 1.2 and 1.6 for coffee fields, and 2.7 vs. 1.0 and 1.1 for woodlots respectively). In Kibingo, tree experts also have a significantly higher number of fields in food crops (6.5) compared to Simbi (4.5). In the group of tree experts, all (or almost all) consultants indicated having fields with food crops, bananas, coffee, and trees. However, as in the group of comparison farmers, the number of consultants reporting having permanent pastures and

fallows is much lower in Maraba and Simbi than in Kibingo. In the latter *secteur*, 73% reported having fields in permanent pasture and 86% having fields in fallow, compared to 36% and 27% in Maraba and 27% and 18% in Simbi for these types of fields respectively. In addition, the average number of fields in permanent pasture and fallow is much higher in Kibingo (2.8) than in the other two *secteurs* (1.3 and 1.0 in Maraba and Simbi respectively). There were no differences between male and female tree experts regarding the number of different fields.

In both groups, one can see that with diminishing farm sizes and increasing pressure on a limited land base, pastures and fallows are being shortened and/or abandoned altogether, as all land is needed for crop production. Since farm sizes in Kibingo are large in comparison to those in Maraba and Simbi, both comparison farmers and tree experts can still afford to maintain some land in pasture, fallow and trees. However, if the present population growth rate in Kibingo of 2.69%, even though it is lower than the national average of 3.1%, continues, more and more land will be converted to crop land in this *secteur* as well. This trend is already visible in the contrast of comparison farmers and tree experts within this *secteur*. Converting fallow and pasture land to crop land, however, also means less fodder available for animals, leading to decreasing manure supply and further deterioration of soil fertility. The latter will thus suffer from the dual action of shortened or abandoned fallows and pastures, as well as from diminishing manure supplies.

2.5.5. Soils

In addition to asking about the number of fields of various types, farmers were asked about the major soil types on each type of field. Two soils could be specified for each field type. The names of the soils that farmers gave are the Kinyarwanda names. The *Département d'Etudes de Milieu et des Systèmes de Production* (EMSP) of ISAR did a study of local soil types in three *communes*, one of which was Karama, but they were not able to place the various soils in the USDA or FAO soil classification system (ISAR, 1991). Table 12 below provides an overview of the main characteristics of the soils found in the three *secteurs* of this study.

Table 12: Major characteristics of soils common in southern Rwanda.

	Mugugu	Urunombe	Urubuye	Urusenyi	Umusenga	Igishonyi
% sand	56.4	44.8	54.2	58.3	60.8	46.4
% > 2mm	12.4	14.1	51.6	40.4	7.8	22.5
% loam	8.3	12.3	16.0	11.5	11.2	14.7
% clay	35.3	43.0	29.8	30.1	28.0	16.4
% org. matter	1.91	2.13	2.76	2.80	1.64	1.98
Avg. Ph	5.35	5.71	6.00	6.09	5.72	6.36

Source: ISAR, 1991.

Mugugu = heavy clay soil
Urusenyi = sandy soils
Urunombe = red, lateritic soil
Inombe = red, lateritic soil more clayey and heavier than urunombe
Igishonyi = light colored chalk soils mixed with mica
Umusenga = sandy soils, but with better water retention than urusenyi

Urusenyi is the preferred soil type for the cultivation of a wide variety of crops; these soils are sandy, having a high enough clay content for good water retention but their elevated content of material >2 millimeters (40.4%) also assures good drainage. They are easy to work with a hoe, contrary to *mugugu* soils. *Mugugu* soils have a high clay content and are very heavy; they cannot be hoed easily, especially after a good downpour. *Mugugu* soils also have a lower organic matter content and are more acid (pH 5.35), making them less suitable for crops such as beans and peas. Cassava, however, is frequently cultivated on *mugugu*. *Urunombe* soils have a higher clay content than *mugugu*, but are somewhat less acid (pH 5.71) and have a slightly higher organic matter content. *Urunombe* soils have a reddish-brown color, as they contain more laterite than other soils. *Inombe* soils are similar to *urunombe* soils, except that their clay content is higher and they are more prone to crust forming after a rain. This makes *inombe* unsuitable for cultivating some crops easily damaged by crusting (beans, peas, corn), especially early in the season when crops start to emerge. As shown in Appendix IV-9a to f, *urusenyi*, *mugugu* and *inombe* are the most common soil types in the three study areas. *Umusenga* soils are sandy soils, but with a lower content of material >2 millimeters (7.8%) than *urusenyi*; they have a much lower organic matter content than *urusenyi* (1.64%) but a better water retention. *Umusenga* soils

are only found on farms of tree experts in Maraba. *Igishonyi* soils are chalk soils mixed with mica. They are not well suited for crops. They only occur in Kibingo, where farmers have planted coffee and woodlots on them.

Farmers will use fields given these soils and their general suitability for various crops. However, due the fact that not all farmers have fields of desired soil types, one finds that the predominant fields (for e.g. food crops) are not found on *urusenyi* but on the somewhat less desirable *mugugu* soils. In general, *urusenyi* is the most preferred soil type, followed by *mugugu*; both soil types are used for food crops, bananas and coffee. *Mugugu* soils and less desirable soils such as *inombe*, *umusenga* and *igishonyi*, are the most common soil under pasture, fallow and woodlots. soils (see Appendix IV-9d,e,f). Very few people are using *urunombe*.

From the data in Appendix IV-9a to f, one can see that there are preferences for using soils for particular crops, but that these preferences are not set in stone. Which soil type is used for which crop does not only depend on the soil, but also on location, slope, aspect and distance from the *rugo*. For example, one does not plant bananas at the fringe of one's land even if the soil is optimal for this crop there but only marginally so right next to the *rugo*, since the risk of theft is too great planting them far from one's sight. Such land is better used for a woodlot. The matter is even more complicated because there is much variation within each soil type, even though it still is called by the same name (the data for each soil given in Table 12 are averages calculated from a number of samples of each soil type taken in the three *communes* where the EMSP study was done). Also, due to the mountainous nature of the Rwandan landscape, soils can vary greatly even over a short distance.

Crops, therefore, are often produced on soil suboptimal for them, as other factors are taking into account in choosing which crop to produce where. These variations within and between soils explain in part the active market in leasing land in order to gain access to plots of land with conditions slightly different from those found on one's own farm. The high number of fields and their seemingly very fragmented nature, even on the smallest farms, can also be seen as a strategy to gain access to an array of sites with diverse soil and ecological conditions, which are each intensively managed (as much as possible) as homogenous units.

2.6. Resources: Animals

Animals, especially cattle, are an important part of Rwandan farming systems. Traditionally, cows not only had symbolic value and formed the basis of Rwandan culture, but they are also a sign of wealth. Today, cattle are still held in high esteem, and are valued more than other animals as a sign of wealth and, more importantly, as a source of manure. More than other animals, having cattle means being able to maintain soil fertility and, by consequence, being able to realize sufficient harvests to feed one's family. Thus, in the ranking games, the presence or absence of animals was mentioned more frequently than farm size to differentiate good from inept farmers, and highly knowledgeable from least knowledgeable.

The data in Table 13 confirm the findings of the ranking games. Not only do fewer comparison farmers possess animals (71.4% of comparison farmers have animals, compared to 90.9% of tree experts), even if they do have animals they have fewer of them than tree experts. Animal possession is lowest among comparison farmers in Simbi, where only half the consultants indicated that there were animals present on the farm. Only one-fifth of the comparison farmers had an average of one cow present on the farm. In contrast, 28 out of 44 tree experts (63.6%) mentioned having cattle, with the average household having slightly more than 2 cows. The mean number of cows is significantly higher in the expert group (2.2) than in the comparison group (1.3). A lower number of tree experts in Simbi reported having cows, but there average number per household was somewhat higher in this *secteur*.

Pigs are the most common animal, as indicated by the number of households owning them (see Table 13). Three quarters of the tree experts but less than half the comparison farmers owned pigs. The average number of pigs per family was slightly more than one (1.2 pigs in tree expert households vs. 1.1 pigs in comparison farmer households). Goats are also popular, and are present on 28 out of 70 comparison farms, and 27 out of 44 tree expert farms (see Table 13). The average number of goats is significantly higher in the tree expert group than in the comparison farmer group (2.3 vs. 1.6 respectively). About half the farmers in Kibingo in either group have goats on their farm; the proportion of households with goats is highest in the tree expert group in Simbi, and lowest among the comparison farmers in the same *secteur*.

Table 13: Percent of consultants having farm animals, and average and maximum number of various animals present on the farm.

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
% HAVING ANIMALS	80.0%	76.5%	50.0%	71.4%	86.4%	90.9%	100.0%	90.9% C
NUMBER OF COWS								
Mean	1.4	1.0	1.0	1.3	2.1	2.3	2.6	2.2 A
Standard Deviation	.5		.	.5	.9	.9	.9	.9
Maximum	2	1	1	2	4	4	4	4
n	11	2	1	14	15	8	5	28
NUMBER OF GOATS								
Mean	1.3	1.8	2.8	1.6	2.9	2.2	1.6	2.3 B
Standard Deviation	.8	1.3	2.9	1.4	1.4	1.6	.5	1.4
Maximum	4	4	7	7	6	5	2	6
n	18	6	4	28	13	5	9	27
NUMBER OF SHEEP								
Mean	1.3	1.0	.	1.3	2.1	2.0	3.5	2.3 A
Standard Deviation	.5		.	.5	.7	1.4	2.1	1.1
Maximum	2	1	.	2	3	3	5	5
n	6	2		8	10	2	2	14
NUMBER OF PIGS								
Mean	1.1	1.1	1.0	1.1	1.3	1.3	1.1	1.2
Standard Deviation	.3	.3		.2	.6	.5	.3	.5
Maximum	2	2	1	2	3	2	2	3
n	16	10	5	31	15	6	9	30
NUMBER OF CHICKENS								
Mean	1.8	4.8	3.2	2.9	2.8	7.6 b,c	4.1	4.7 A,a
Standard Deviation	.8	2.9	1.8	2.1	1.3	4.3	4.4	3.9
Maximum	3	8	6	8	5	17	13	17
n	11	5	5	21	11	8	7	26
NUMBER OF RABBITS								
Mean	3.6	1.8	2.0	2.8	4.3	2.3	2.5	3.2
Standard Deviation	2.5	.5	.8	2.0	3.6	1.5	2.3	2.8
Maximum	7	2	3	7	12	4	7	12
n	8	4	4	16	7	3	8	18
NUMBER OF BEE HIVES								
Mean	2.0	1.0	3.0	2.1	2.7	3.7	6.5	4.3 B
Standard Deviation	.8	.	1.4	1.1	2.1	1.5	9.2	5.8
Maximum	3	1	4	4	7	5	25	25
n	4	1	2	7	7	3	6	16

A=between group difference significant at p<.01
B=between group difference significant at p<.05
group chi square significant at P<.05

a=within group difference significant at p<.01
b=within group difference between Maraba and Kibingo C=between significant at p<.05
c=within group difference between Maraba and Simbi significant at p<.05

Sheep are the least popular among the larger domestic animals. They are often kept as companions for cows, since, in farmers' opinion, they make cows more docile and easier to handle. They are not kept for meat since, according to local preferences, it does not taste as good as goat or beef.[3] The average number of sheep is significantly higher in the expert group (2.3) compared to the comparison group (1.3) ($p < .01$). No sheep were found among comparison farmers in Simbi, while more households in Kibingo in both groups had sheep than farmers in the *secteurs* of Maraba and Simbi (see Table 13). The highest mean number of sheep of 3.5 was found in the expert group in Simbi, although only two consultants had sheep on their farm.

In spite of what might be expected, chickens and rabbits are not widespread, even though their rearing is not land dependent as are cattle, goats, sheep and pigs. Less than one-third of consultants in the comparison group indicated having chickens, with an mean of 2.9 chickens per household. This number was highly significantly different from the mean number raised in tree expert households, who reported having an average of 4.7 chickens (see Table 13). There is also a highly significant difference in chicken ownership between *secteurs* in the tree expert group, with the average number of chickens being significantly higher in Maraba (7.6) than in either Kibingo (2.8) or Simbi (4.1). The higher mean number of chickens in Maraba *secteur* in both expert and comparison groups can be explained by the presence of the market, which provides a regular outlet for chickens at a good price (250-400 F.Rw.). Fewer consultants reported raising rabbits, perhaps because the animal is more difficult to raise, is more vulnerable to diseases, and is a frequent target of theft. There is no significant difference in the mean number of rabbits per household between expert and comparison groups. Farmers in Kibingo have the highest average number of rabbits per farm, and farmers in Maraba the lowest. In the latter *secteur*, fewer farmers are also raising rabbits compared to the other *secteurs*.

Bee keeping is practiced by a small number of farmers, principally for honey. Honey fetches a good price on the market, and is also used for brewing sorghum and banana beer in order to

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[3]In contrast, people in the Buberuka Highlands in northern Rwanda rear and eat sheep on a larger scale than farmers in the southern Rwanda.

make them sweeter and more alcoholic. Honey is also used for producing mead. Only 10% of comparison farmers practice beekeeping, and about one-third of tree experts do. The mean number of hives is significantly higher among tree experts (4.3 hives) than among comparison farmers (2.1 hives). The highest percentage of beekeepers is found among tree experts in Simbi, where farmers also have the highest mean number of hives (6.5). Farmers in this *secteur* are organized in a small beekeepers cooperative. With the help of a grant, they have established a small warehouse, and were able to buy two honey extractors and stainless steel storage tanks. They market their honey as a group, and are therefore able to guarantee a steady supply and price for their members. It should be noted that Rwandan bees are not the same as "African killer bees," but are very docile. Some farmers were observed keeping their hives within ten meters of their house, without any problems of attack or nuisance.

The data in Table 13 provide information on the number of animals present on the farm. But, presence does not necessarily mean that farmers also own these animals. As in the case of land, animals may be leased to or from other farmers. It is a way to access manure or other benefits from animals even if one cannot afford to own an animal oneself. In this case, one obliges oneself to take care of the animal in exchange for the manure or milk. It is also possible that one has an animal, but no longer has sufficient land to keep fields in pasture and, by consequence, is unable to feed it. In this case, one can loan the animal to another farmer who feeds and takes care of it without losing ownership and one's savings. Therefore, in addition to asking about the number of animals present on the farm, consultants were asked if there were any animals that they owned but were not presently residing on the farm, and about animals that were residing on the farm but that they did not own. The results are provided in Appendix IV-10a and b. Owned but absentee animals are more common among tree experts than among comparison farmers, particularly in Kibingo (see Appendix IV-10a). About one-third of tree experts (16 persons) having animals reported that some were not residing on the farm, compared to about 8% (4 persons) for comparison farmers. Goats are the most frequently mentioned animal residing elsewhere. Kibingo tree experts also reported the greatest diversity of owned but non-residing animals.

Appendix IV-10b gives an overview of the number of animals residing on the farm but which are not owned by the consultants. Of the consultants indicating that there were animals present on the farm, more than half the comparison farmers in Kibingo and Simbi, and half or more than half the tree experts in Maraba and Simbi indicated that the animals present were not owned by them. Non-owned resident animals were reportedly lowest among comparison farmers in Maraba. Again, goats were most frequently mentioned as residing on the farm but not being owned. In the comparison group, pigs were the next most commonly borrowed animal. Except for chickens, the mean number of borrowed animals in the comparison group equals one per species. In the tree expert group, pigs and chickens are the next most frequently borrowed animals. The average number of borrowed animals per expert household is larger than among the comparison group, especially in the case of goats and sheep. The differences in mean number of owned non-resident animals and in the number of resident non-owned animals between the comparison and expert groups are not significant for all types of animals.

3. Key findings

Tree experts are older and have a longer farming experience. Since *ubumenyi* means both knowledge and experience, it is logical that the tree experts are considered more knowledgeable than the comparison farmers. However, the age-knowledge relationship is not automatic, as several older comparison farmers were not considered experts. There must, therefore, be other factors in addition to age and experience that explain why someone is more knowledgeable about agroforestry.

It was expected that education would have an influence on innovativeness and being an expert or not, but no significant differences were observed between tree experts and comparison farmers in the number of years of schooling. Women are generally less well educated then men. Although the mean number of years of education is similar, the percentage of women that had attended school is much lower. Four persons in total attended secondary schools (one comparison farmer, two tree experts and one tree expert wife). Only four tree experts in Kibingo had participated in short-term training with the PAP project, as they collaborated with this project as pilot farmers.

Thirty-four percent of tree experts hire labor, one-third of which is hired on a permanent basis. By contrast, almost 40% of farmers in the comparison group indicated seeking work at other farms to supplement earnings. The latter farmers have very little land and other resources enabling them to survive by farming alone. These findings indicate that a class of landless (or near landless) laborers may be emerging in Rwanda.

Tree experts have significantly more land than comparison farmers, both on the hills and in the valleys. These results confirm the use of farm size as a major ranking criterion for differentiating farmers by the informants consulted during the game.

Women cannot own land. In female-headed households, women are the temporary caretakers of the land for their non-adult sons. They do not accrue transferable, permanent usufruct rights to land as men can.

The systems of land inheritance in which land is divided equally among sons, leads to a progressive fragmentation of farm land and increasing miniaturization of farms over time. The intergenerational dynamic of the inheritance system, whereby land is given to sons upon marriage and not at the death of the head of the household, limits the time horizon in which farm land is under effective of control of the head of household as a complete unit. These facts may put severe limitations on the possibilities for the development of agroforestry in Rwanda.

Leasing land is a common strategy used by both tree experts and comparison farmers as a means to gain access to land in different micro-ecological niches. As trees cannot be eliminated, planted or harvested on leased land, possibilities for agroforestry are limited. In addition, as land is leased primarily on a temporary basis, it diminishes the incentives for farmers to invest in erosion control, soil improvements or agroforestry as returns on investment cannot be realized within the lease period.

The majority of farmers in both groups own farm animals. However, comparison farmers rarely own more than one animal species. Of the animals they do own, the mean number of animals per species is lower than in the tree expert group. Cattle are a sign of wealth and are the primary

source of manure. Only 20% of comparison farmers have an average of one cow. In contrast, 64% of tree experts have an average of 2 cows. Lack of cattle severely limits manure supplies and the ability to maintain soil fertility and productivity. Agroforestry could be a solution (and is actively promoted for this purpose), but its feasibility is constrained by the very small farm sizes and the miniature plots that make integration of a sufficient number of trees to maintain soil fertility difficult if not impossible.

4. Summary and conclusion

In Chapter I, knowledge (*ubumenyi*) was defined as knowing and having experience with a plurality of objects or notions. Thus, in the case of knowledge of trees and agroforestry, informants consulted during the ranking game attributed "being highly knowledgeable" to farmers that had a great diversity of trees on their land (see Chapter III). But are knowledge and experience with a diversity of tree species (obtained through either use or cultivation of these species) the sole factors distinguishing highly knowledgeable from non-knowledgeable farmers? The objective of this chapter was to study any differences between tree experts and non-experts on the basis of demographic and socioeconomic characteristics not directly related to agroforestry knowledge. The picture that emerges from the results of the socioeconomic survey resembles the results obtained from the ranking game, even though several characteristics (notably age, marital status and children, education, and employment and community functions) were not considered by the consultants as important ranking criteria. However, significant to highly significant differences were found in farm size and the number of animals of various kinds, and these two factors also were prominent differentiating criteria used by consultants in the game.

As tree experts are older and further advanced on the family life cycle, the number of children in expert households is greater than in comparison farmer households. Tree expert households also have a higher mean number of sons living outside the *secteur* of their parents' residence, where they have obtained land and/or employment. The number of sons having migrated is particularly high in Kibingo, where almost half the households indicated that sons had moved out of the *secteur*. This could be related to the greater number of farmers who had migrated themselves in search of land, and presently having salaried employment or having had such

employment in the past. In spite of the larger farm sizes in Kibingo which could provide a living for these sons even if subdivided, Kibingo tree experts may be more supporting and open to the idea of their sons seeking better opportunities elsewhere than experts in Maraba and Simbi.

Employment, both past and present, is more frequent among tree experts than among comparison farmers, particularly in Kibingo. While the salaries these persons receive are (were) generally low, the money does (did) provide the household with additional resources which enable them to better absorb risk associated with experimentation with new ideas and technologies. Tree experts also hold more volunteer community positions, although the number doing so is lower at present than the number doing so in the past whereas the opposite is true for comparison farmers. The older tree experts are removing themselves from holding such functions, while democratization efforts in the country has opened up opportunities for new leaders in newly created community groups and political parties. While these volunteer community positions do not provide direct monetary benefits and additional resources to the household, they do increase people's position in the community, and increase their access to information and help from the authorities if needed which may provide some benefits in the long term.

Both groups indicated that they have enough labor in the household for all farm tasks. However, more tree experts than comparison farmers do also hire labor, indicating that perhaps they do have a labor shortage (particularly during the peak periods of preparing the land for the first planting season and during the coffee harvest season), even though they did not acknowledge having a labor shortage when directly asked whether they had enough labor. Labor is hired both permanently and on a temporary basis. In contrast, more than one-third of the comparison farmers seek temporary work on other farms to supplement their income, as their own farms are too small to produce enough to feed their families.

As mentioned previously, tree experts own and cultivate significantly more land than comparison farmers both on the hillsides and in the valleys, although there are great variations between individuals within each of the two groups. Because of this larger farm size, a number of tree experts are able to lease land to other farmers. An equal percentage of farmers in both groups indicated renting in land in order to increase the amount of land cultivated or to gain access to

soils and micro-ecological conditions not found on their own land. This is surprising given the greater farm size of the tree experts. However, it is understandable in view of its use as a management strategy to maximize production while minimizing risk by spreading one's production efforts over as many different plots of varying soil and ecological conditions. This strategy is also reflected in the fragmentation of the farm land, which is high in both groups with a mean of 12.7 and 17.2 fields in the comparison and expert groups respectively. However, the average field size in the expert group is five times bigger (738 m^2) than in the comparison group (142 m^2). Although comparison farmers have significantly fewer fields of all types, particularly noticeable is the near absence of fields in permanent pasture and fallow, and the low number of farmers with woodlots. This phenomenon is especially striking among comparison farmers in Maraba and Simbi, but it appears that fallow and permanent pasture are also decreasing among tree experts in Kibingo.

With regard to soil type and quality, no particular trend could be observed. Desirable and less desirable soils were found on farms in both groups. In absence of a market for land, there is no concentration of good soil types in the hands of better-off farmers with low quality soils remaining for the poor farmers. Soil qualities depend on what land is inherited or obtained from the authorities, and little can be done about it except through leasing land in or out. As we saw above, this is a much used strategy. Although soil quality was used as a ranking criterion (but not a prominent one), the better soil quality found on farms of the most knowledgeable farmers may be due to the fact that they have cattle and manure and thus able to maintain fertility better than comparison farmers. Therefore, while the soil type is the same, tree experts may have slightly better than average *mugugu*, *urusenyi* etc. soils.

More tree experts than comparison farmers have animals, and they also have a greater mean number of cows, goats, sheep, pigs, chickens and bees. The mean number of rabbits was not significantly different between the two groups. The larger number of cows in the expert group is particularly important since cows have an important symbolic value in Rwandan culture, are a sign of wealth, and are the most important source of manure necessary to maintain soil fertility and, by consequence, realize a good production.

In conclusion, tree experts are generally older and more experienced farmers who can muster greater resources (land, labor and animals) and are, therefore, better able to absorb the risks associated with experimentation with new ideas and technologies. While greater resources enable tree experts to experiment, not all experts do have extensive resources. A few comparison farmers do have more land, labor and animals than some tree experts, but are not recognized as being knowledgeable about trees. Being a tree expert or not is not only a question of having resources and the ability to take risk. Other factors also play a role in ascribing the title of tree expert to certain farmers. These other factors will be explored in Chapters VI and VIII, which report on discussions with farmers on the questions of knowledge and "being knowledgeable," and the development of agroforestry and technology through farmer experimentation, respectively.

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CHAPTER V

FARMERS' PERSPECTIVES ON INDIGENOUS AGROFORESTRY PRACTICES

1. Introduction

Photographs of Rwanda taken in the early years of the twentieth century show landscapes almost devoid of trees. Colonial accounts describing the agricultural sector and indigenous agricultural practices (Everaerts 1939; Mortehan 1921) do not mention the use or cultivation of trees by farmers until Bourgeois' ethnographic study of Rwanda and Burundi published in 1957 (Bourgeois 1957). According to outside observers (i.e. persons trained in and adhering to the Western scientific knowledge tradition) the amount of forest resources in Rwanda has steadily decreased since the beginning of this century (Gatera 1980; Nwafor 1979; Runyinya 1980). However, according to Balasubramanian & Egli (1986, 1989), Baumer & Runyinya (1987), Egger (1986), Hummel (1988), N'Diaye (1988) and Pinner (1988), the amount of tree resources in the landscape actually increased during this period as farmers were (are) well aware of the importance and the numerous benefits trees provide. Indeed, the disappearance of forests was often cited as a primary motivation for introducing certain species on the farm. Thus, while forests, natural woodlots and forest galleries have all but disappeared under influence of increasing population and pressure on the land, farmers have transformed a formerly near treeless landscape in a landscape dotted with many trees. However, these trees are more dispersed over the landscape in highly integrated in agro-sylvo-pastoral systems. Trees remain the primary sources of energy and construction material in the country, and their cultivation is also practiced as a means to prevent soil erosion, to increase soil fertility through mulching and green manure, and to provide products such as fruit, medicine, fibers etc.

Over time, farmers have not only generated extensive knowledge about the introduction and management of indigenous tree species on their farms, but they also have acquired and adapted a wealth of knowledge of exotic species and silvicultural practices introduced since the 1930's, first by the Belgian colonial rulers and later by various development programs. These combined interventions in the landscape by both farmers and outsiders have led to very complex and multifaceted agroforestry systems. This is compounded by the fact that what constitutes a tree

(*igiti*) in Rwandan epistemology is different from what is understood by the term in the western world view. For Rwandan farmers, trees are all plants that are not grasses (Kagame 1958). The resulting agroforestry systems are more difficult to appreciate for researchers trained in the Western scientific tradition, as the inclusion of annuals and perennials, in addition to trees and shrubs, makes the systems infinitely more complex. In this chapter, results will be given from community and focus group interviews with male and female farmers on the possibilities of on-farm tree cultivation practices in relation to farm size, gender, and competition with crops in order to obtain an emic perspective of agroforestry.

2. Results and discussion

2.1. Can trees and crops be cultivated together?

According to the literature, agroforestry is a land use system that has long been widely practiced in many African countries, but researchers have only recognized it as a viable land use system in the last 20 years (Wiersum 1988; Cook and Grut 1989). Participants of the community and focus group interviews expressed contradictory opinions on whether or not they traditionally practiced agroforestry. A minority stated that they practiced agroforestry in the past because the soils were still fertile, but no longer do so at present. These answers imply that agroforestry is only possible on fertile soils, not as a means to restore fertility. Since the soils in the past were more fertile, similar yields could be obtained from less land than is possible at present leaving a place for tree production. However, even at that time, the trees that were present and maintained on the farm were not planted but occurred naturally, were seeded by birds, or were left from on old, abandoned *rugo*. Thus, farmers practiced a form of "passive" agroforestry; they were not actively engaged in planting and integrating trees with crops or pastures on their land. The examples they cited were the maintenance of natiurally occurring Sesbania sesban, Markhamia lutea, Ricinus communis and Indigofera erecta within crop fields, and the maintenance of trees as indicators of property borders. As soil fertility declined, more land was needed for crop production and gradually trees were eliminated.

Most people at the meetings said that agroforestry was not practiced in the past, citing the following reasons:

- people had no interest in planting trees, as they could be found freely on the hills;
- suitable trees did not exist;
- even if someone had trees on his/her farm, these were strictly separated from the crops; and
- people did not know the importance of trees and tree planting.

Most participants agreed that agroforestry is possible, but it depends on the species and the particular location and arrangement. All traditional (i.e. indigenous) trees can be used for agroforestry, as they are less competitive with crops, and the following specific systems were mentioned by the audience:

- Euphorbia tirucalli, Draceana afromontana and Synadenium grantii for fences around the fields and as boundary markers; the first two can also be used for the construction of the rugo.
- Senecio mannii is good to plant between the crops as it brings "freshness"[1] to the fields and can be used as live staking material for beans and yams.
- Carica papaya, Euphorbia tirucalli, Markhamia lutea, Vernonia amygdalina, Tetradenia riparia, Ricinus communis, Coleus kilimandschari can be planted on the anti-erosion ditches and associated with all crops.
- Ficus thonningii, Markhamia lutea, Tedradenia riparia, Vernonia amygdalina, Erythrina abyssinica, Citrus aurantium vulgare, Citrus limon, Cajanus cajan, Ficus vallis-choudae, Botryocline ugandensis, Ricinus communis, Nicotiana tabacum (wild tobacco), Sesbania sesban and Ocimum suave are all compatible with crops and can be planted in a variety of arrangements, including integration within the field.
- Sesbania sesban, Cajanus cajan and Indigofera indica are species that are especially compatible with leguminous crops (beans, soybeans and peas).

Most exotic trees are considered unsuitable for agroforestry as they are either too competitive or damage the soil. Eucalyptus and avocado are considered the worst in this regard. Cedrela

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[1]The word that was used by the person who translated the tape of this meeting was *fraîcheur;* it is not known whether this means fertility or shade and coolness.

serrata and Leuceana leucocephela were mentioned as exceptions, while contradictory opinions were expressed concerning Grevillea and avocado. Avocado is recognized as highly competitive, but its benefits outweigh the disadvantages associated with this species. Grevillea is widely planted on Rwandan farms as boundary markers, windbreaks, to stabilize terraces and in woodlots. Farmers' experiences indicate that the negative effects of Grevillea become more pronounced as the tree gets bigger. Food crops associated with this species located close to the trees dry out. Farmers attributed this effect to increased leaf fall and slow decomposition of the leaves. Grevillea leaves apparently have no negative effect on coffee, as these leaves were the most frequently used mulching material under coffee bushes. However, large Grevillea trees growing next to a coffee field do show negative effects on the coffee due to shading and below ground competition for water and nutrients.

In the discussion in the next sections, more information will be given about the reasons why farmers plant trees, and the relationships between tree planting and gender, farm size and field type.

2.2. Why do farmers plant trees?

Discussions related to this question emphasized the utility of trees. The cultivation of a wide variety of tree species is a function of their different purposes and utility as providers of fuelwood, medicines, timber, stakes, etc. Preference for a certain species, one's knowledge of trees and enthusiasm for planting trees were only mentioned once, while two people mentioned farm size as an influence on the number of trees and variety of species.

All consultants agreed that having many species on one's farm was necessary and a good thing, because of the many problems farmers face, particularly medical problems of both people and animals. In order to avoid having to go long distances to find a plant when a family member or an animal is sick, people plant various trees in their fields in combination with crops as a precaution. As will be seen in Chapter VII, the variety of tree species found on the farms studied is primarily due to the large number of species planted for medicinal uses. Woody species are, in most households, used as a "family pharmacy" which gets more elaborate and extensive if

one's knowledge of healing practices increases. Several persons mentioned during the tree expert biography interviews that they had introduced species on their farm after having been treated successfully for some illness or other by a healer using the particular species. One consultant, who had been trained by a medicine expert in Uganda who treated him after he was poisoned there, had brought back seeds from a number of healing plants from that country. However, he had no luck in growing these Ugandan trees on his farm, as none had survived the trial.

Several women talked about trees for their food value as trees can provide fruits, spices, yeasts, vegetables. As one woman stated: "We consider such trees as food crops." This is an important statement. Women are primarily responsible for the household food production in Rwanda but are by tradition not allowed to plant trees. However, an exception is made for both fruit and medicinal trees, both of which increase household food security and well-being. By considering fruit trees as food crops instead of as trees, women have been able to circumvent the traditional ban on tree planting similar to calling Leuceana a "fertilizer bush" in Nigeria (Cashman, 1988). Several women also emphasized the fact that one could also sell fruits on the market in order to buy foods not produced in sufficient quantities on their own land (particularly beans) and household necessities (soap, cooking oil, salt, ...).

2.3. Tree planting and gender

The question whether or not women can plant trees generated much discussion among people present at the various meetings. Traditionally, women were not allowed to plant trees. This appeared to be unrelated to any cultural taboos but more to the fact that, as in much of Africa, with the act of planting a tree one established ownership rights over the land on which it is planted. This was confirmed by the statement that there is no prohibition against women to plant trees, but that the trees women do plant are said to belong to their husbands because the land on which they are planted belongs to their husbands. Thus, in Rwanda, inheritance rights override rights to land that the simple act of planting trees would establish, at least if these trees are planted by women. In addition, as there is practically no more free land to be had in Rwanda (all land being fully used), the custom of establishing ownership through tree planting has all but disappeared.

Even though there is (no longer) a formal prohibition for women to plant trees, women are still restricted in the kind of trees they can plant. It is now commonly accepted that women plant fruit and medicinal trees, as these contribute to the family's food reserves and health for which women carry the prime responsibility. They are not allowed to plant forest trees and trees that grow tall, except during national tree planting day, if they are widowed or divorced, or in case their husbands are absent or sick. In effect, a woman without a husband is considered "a man."

Men, particularly older men, objected more strongly to tree planting by women: it is the custom that men plant trees, women planting trees is inconceivable in their mind. Men's objections were fourfold: 1) women's short-term perspective and preference for crops that occupy the soil for a short time and produce something edible, 2) the inability of women to forecast the utility and value of trees in the future, 3) women's lack of time between household chores, child rearing and cultivating food crops, and 4) women's lack of strength. The following quote by one of the participants expresses these objections well:

> Normally, the planting of trees requires a lot of strength, for example to dig the plant holes when the soil is hard, or for the transport of 30-40 seedlings over a long distance from the nursery to the house. These activities, as well as others, demand a lot of effort that women are incapable of providing. On the other hand, Rwandan men cannot, for example, sweep the house, cook, and wash the dishes other than in an emergency. However, as these activities are important, men want that the women take care of the chores, and that they take charge of the outside activities considered difficult for women to do, including the planting of trees. In my opinion, this is the reason why women do not plant trees.[2]

Some women objected strongly to these male chauvinist contentions and traditional role expectations with statements such as "We women have arms also" and "Women can project the utility of trees in the future as well as men." The notion expressed by some men that women do not have time and prefer to use the land for short duration food crops was also not supported by

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[2]D'habitude, la plantation des arbres requiert beaucoup de forces, par exemple pour le creusement des trous sur un terrain dur, pour le transport de 30 à 40 jeunes plantes sur une longue distance de la pépinière à la maison. Ces travaux et bien d'autres exigent des efforts que les femmes sont incapables de fournir. Par ailleurs, l'homme rwandais ne peut pas, par exemple, balayer la maison, faire la cuisine, nettoyer le couvert sauf dans le cas d'un pis-aller. Comme ces derniers travaux sont quand même importants, l'homme veut que la femme s'en occupe et qu'à son tour il se charge des travaux de l'extérieur considérés comme difficile, dont la plantation des arbres. A mon avis, c'est pour cela que les femmes ne plantent pas des arbres.

women. Women's responsibility for the family's food security was precisely the main reason women cited for planting trees producing fruit, condiments and spices, as trees play a vital role in attaining and increasing food security. Some shifts are, however, occurring in traditional role patterns, as two persons (supported by several others) mentioned that nowadays husband and wife often help each other with the various agricultural tasks on the farm, including tree planting and management.

Lack of sufficient land was mentioned twice as a reason why women did not plant trees. Even though they would like to plant some trees on their fields, the extremely small size of their farms made it impossible to plant even a single fruit tree as the competition with food crops would be too great.

Whether or not one plants trees depends above all on the initiative of each person, man or woman. Usually, it is the man who takes such initiative; women rarely do. However, a number of people present at the meetings and met during the many walks around the study areas stated that many species on the farm are planted by the husband at the suggestion of the wife as she felt it necessary to have certain species on the farm to maintain the health of the children. But this is rarely admitted, since "*l'homme s'approprie tout ce qui est fait par une femme.*"[3]

2.4. Tree planting and farm size

Farm size appeared to be correlated with having both many trees and a great species diversity on the farm. During the first set of focus group meetings, two questions were asked about the possibility of practicing agroforestry: 1) Is agroforestry possible for farmers who have little land? and 2), related to the previous question, What will be the effect of decreasing farm sizes on the possibility of planting trees in the future? Participants in the meetings not only discussed the problem, but proposed several solutions ranging from the simple (better arrangements for crop/tree integration) to the very radical (regrouping of people in villages and redistributing of the land thus freed up).

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[3]Man appropriates all that is done by a woman.

The vast majority of participants agreed that if you have only a small piece of land, one has to choose between either planting food crops or trees, but not both. If the choice is between trees and crops, one woman explained, she would choose the latter as you can't feed trees to a hungry child. In her opinion, on small holdings trees may lead to chronic malnutrition. Almost everyone present agreed that it is not possible to plant trees on a small farm, as trees are incompatible with crops and damage the soil.[4] In the farmers' experience, once trees are introduced crop yields will visibly decrease. Even bananas, a traditional staple widely cultivated in particular for the brewing of *urgwagwa* (banana beer), were mentioned as hindering the normal development of associated crops such as sorghum and beans. In the farmers' opinion, there are no trees that do not damage the soil, because there are no trees without roots or that do not give shade. Trees' damage to the soil refers primarily to their negative effect on soil fertility, even though some species (particularly mentioned were papaya, orange and guava) are less damaging than others. Eucalyptus and avocado are considered the worst in terms of competition with crops, with crops planted close to eucalypts being visibly affected. Avocado damages a circle of up to eight meters around the base of the tree. But since avocado is a very useful tree (both as a food source for the family, a source of income from the sale of surplus fruits, and the occasional provision of some fuel wood), it is considered possible to plant 2-3 avocado trees in one's fields, since the production of avocadoes far outweighs the production of food crops lost.

Participants repeatedly referred to the damaging effects of Eucalyptus, citing this species as the worst in terms of damaging their soils. Even though Eucalyptus is ubiquitous in the research areas (indeed, some of the younger farmers referred to it as an indigenous tree species) and provides people with a multitude of products, it cannot be grown on small farms as the risks associated with it are too great. Although farmers have learned from experience not to plant Eucalyptus in and around their fields, Grevillea is most commonly found along or in the fields as windbreaks, boundary markers and on the terrace edges. However, farmers in both Simbi and Maraba complained about the fact that this species is bad for the surrounding soil and associated

[4]The statement that trees are incompatible with crops and damage the soil contradicts other statements made by the consultants that indigenous tree species can be used for agroforestry as they do not compete with crops. Although indigenous species are competitive, they are less competitive than newly introduced exotics. As a result of experience, farmers may (unconsciously) have selected less competitive species, varieties and tree forms/shapes for inclusion in their agroforestry systems.

crops, citing specific examples of negative influences of Grevillea on crops and coffee. At one of the meetings, an extension worker was present who explained to the farmers that the problem is not due to the Grevillea, but is caused by a lack of proper and sufficient tree management (pruning of the branches and the roots) by the farmers. This caused an immediate uproar among the participants who complained that, if this were so, why they were never told about proper maintenance techniques for this species after all these years.

Most farmers do not see any possibilities of planting trees on their farms, as most of their parcels are already very small and continue to diminish in size with every generation. The following quote by one participant summarizes the opinions of many:

> They have forced us to plant trees in our small holdings instead of planting them in uninhabited areas, especially for those who have children. My son also has to have a piece of land as his inheritance and for his survival. Therefore, I do not see how this land can suffice for my son, his brother and myself if, in addition, we have to practice reforestation. We thought that you (the researcher) were going to redistribute the trees planted here and there. We do not see any other possibilities.[5]

Others were more optimistic, and considered agroforestry the only solution to the provision of tree products in the future in spite of the negative effects of trees on their soils. However, much depends on the proper arrangements (the best place, according to the audience would be along the anti-erosion ditches) and choice of species. Although all tree species are considered to be bad for the soil and to diminish crop production, one needs to find a species that has the least negative influence on both. Women objected to these male schemes for increasing the number of trees on the farm, since soil productivity and fertility have already declined so much that agroforestry would only further decrease yields.

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[5]On nous a forcé de planter les arbres dans nos petits terrains au lieu de les planter dans les endroits inhabités, surtout pour ceux qui ont des enfants. Mon fils doit aussi avoir un part sur mon terrain pour son héritage et pour sa survie. Je ne vois donc pas comment ce terrain peut suffire à mon fils, ses petits frères et moi-même si on y pratique encore le reboisement. Nous avions penser que vous alliez nous partager les arbres plantés ici et là. Nous ne voyons pas d'autres possibilités.

2.4.1. Solutions proposed by the audience

Participants in the focus group meetings not only discussed the difficulty (of not impossibility) of practicing agroforestry on small farms, and the uncertain future of agroforestry in the face of diminishing farm sizes, but also offered suggestions for potential solutions to meliorate the situation. These solutions can be grouped in two broad categories, one having to do with the land, the other with the trees (species and arrangements).

On large farms, people should reserve some land for a woodlot. For people who have small farms, the State should provide each family with a piece of land of 1-10 ares to plant some trees. Another possibility suggested would be to distribute the State and communal forests among the people. As the inheritance system and population growth are the primary forces behind decreasing farm sizes, the State should increase the land holdings of each family so that each family has an equal piece of land. One way to accomplish this would be through a reform of the land tenure system. Although population growth was mentioned several times as a contributing factor to the problem of small farms and farm fragmentation, the audience did not offer concrete suggestions of what to do about it. The most radical solutions proposed were that everyone should cultivate together with the State being the sole land owner (i.e. collective farming), and a the regrouping of people in agglomerations built on the least fertile places:

> The State must look for means to build agglomerations concentrated on the least fertile areas; the good land remaining can thus be reserved for agriculture and trees. We notice that the forest has been planted on the good soil, and that the farmers live on the higher altitude, i.e. they live on the crests of the hills. An example is that of the Nyarucyamu and Nyarurembo forests, where the trees are planted on good soil. These forests have to be divided among the people to practice agriculture. Another forest can be planted on the crests of the mountains according to what was done in Bihushi to replace the Nyarurembo forest. Alas! See the forest of Rugarama, the area upon which it is located could feed a thousand people![6]

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[6]L'Etat devrait chercher les moyens de nous construire des agglomérations regroupés sur des endroits non-fertiles; la bonne terre restante serait alors réservée à l'agriculture et aux arbres. Nous constatons que la forêt a été plantée sur la bonne terre et que les paysans occupent les hautes altitudes, c'est-à-dire qu'ils habitent sur les sommets de montagne. L'exemple a donnée est celui de Nyarucyamu et de la forêt de Nyarurembo, où la forêt est plantée dans la bonne terre. Elle doit donc être partagée entre les gens qui y pratique de l'agriculture. Elle serait alors remplacée par une autre qui serait plantée sur les sommets des montagnes à l'instar de Bihushi. Hélas! Voilà cette forêt de Rugarama, a surface sur laquelle elle est plantée ne pouvait-elle pas nourrir un millier de personnes!

Tree based solutions proposed stressed the importance of planting trees that are less competitive, that do not damage the soil and can be grown together with crops so that they will not prevent one from harvesting sufficient quantities of food crops to feed the family. Specific arrangements participants offered as suggestions limiting competition were the planting of trees on the rugo, along the anti-erosion ditches or as hedges around the property. It should be noted that some of these arrangements are already being used. One participant suggested that people make arrangements among each other to specialize; one person would grow trees on his land, another bananas and other food crops, and subsequently they would exchange the harvests. In each of the meetings, participants called on the government for more research on trees that do not the destroy the soil and damage the crops. Some of the older farmers disagreed with this, saying that in the past farmers planted a number of species (such as Euphorbia tirucalli, Markhamia lutea, Ficus spp, and Cajanus cajan) that would be suitable as agroforestry species today. But farmers would like to increase the number of options available to them, and mentioned the following characteristics which trees should have: compatible and non-competitive with crops, do not provide too much shade, do not spread roots too far out into the soil, can be used as live stakes for climbing beans, and produce fuelwood and fruit simultaneously.

> Personally, I believe that the State must look for ways and means to increase research on trees that no not damage the soil. It is true that, even if trees damage the soil, not all trees damage it to the same extent. Certain trees are much worse than others (for example Eucalyptus). In my opinion, Grevillea is also bad. But I would also like to give you some examples of trees that are not too competitive: Leuceana and Cedrela. Therefore, researchers must find us trees that are less competitive vis-à-vis our crops.[7]

> Considering the small size of our properties, I have seen trees that resemble Sesbania. These trees grow like Sesbania, but do not have a long growing cycle and do not occupy our soil for a long time. One can plant them in a field of beans, and they can provide support to climbing beans. After the first bean harvest, we weed them and one can plant another crop of beans at a later date. Normally, they are planted along the anti-erosion ditches. They do not give too much shade, and do not damage the crops. They can also be used as fuelwood. They give an abundance of seeds, so that one can multiply the trees oneself. Regarding the question posed by

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[7]Personnellement, je vois que l'Etat devait chercher les voies et moyens de mener des recherches sur les arbres qui n'abîment pas le sol. Il est vrai que même si les arbres abîment le sol, ils ne l'abîment pas au même dégrée. Certains arbres sont plus mauvais que d'autres comme *inturusu* (Eucalyptus spp). Pour moi, le gereveriya est aussi mauvais. Je donnerais, cependant, un exemple des arbres qui n'exagèrent pas: *lesena* (Leuceana leucocephela), *sederera* (Cedrela serrata). Les chercheurs devraient donc nous trouver les arbres qui n'abîment moins nos plantes.

> M. on the subject of researchers having to search for trees which can provide fuelwood and fruit simultaneously on our small farms: these researchers must do everything they can for this important task. I will also talk to the agronome to help us find these researchers. This is what I have to say to the present assembly.[8]

2.5. Where can trees be planted within the farm?

The objective of this question was to learn more about land tenure and its effect on tree planting and agroforestry. However, participants of the meetings interpreted the question much broader to include not only tenure, but also soil and tree characteristics, crops to be grown in the field and, in one case, aspect.

In general, farmers can plant trees on all land except on land that is rented or borrowed or is *ingarigari*. *Ingarigari* is land which belongs to the lineage, and is managed by the oldest male member of the extended family; the latter can cultivate this land himself, or can loan the whole or parts of this land to other family members if they have a particular need for extra land. Planting trees on land of one's parents is prohibited, even though one knows which piece of land one will inherit in the future, as one does not yet own this land. Similarly, if one obtained land from the *commune*, one can plant trees only if the *commune* has given you permanent usufruct rights.[9] Within the household, though, women cannot plant trees on the land where they want, but only on the location(s) indicated by their husbands, or, in case they are widows, by their sons. An exception to this rule are trees planted by women during National Tree Day. Thus,

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[8]S'agissant de l'exiguïté de nos propriétés, j'ai déjà vu des arbres semblables aux *iminyegenyege* (Sesbania sesban). Il s'agit d'arbres qui grandissent comme *iminyegenyege*, mais qui ne mobilisent pas le sol pour longtemps. On peut les planter dans un champ de haricots. Ils peuvent jouer le rôle de tiges pour haricots grimpants. A la première récolte de haricots, on les sarcle et on peut, à une autre période, y planter d'autres haricots. D'habitude, ils sont plantés autour des fosses anti-érosives. Il n'ont pas d'ombrage et n'abîment pas les plantes. Ils peuvent faire le feu. Ils ont beaucoup de graines si bien qu'on peut soi-même les faire pousser. A propos de la question soulevée par M. au sujet des chercheurs devant trouver des arbres qui peuvent à la fois servir comme bois de chauffage et nourrir les gens sur les terrains étroits: ces chercheurs doivent se mobiliser pour cette tâche combien importante. Je vais rappeler l'agronome pour qu'il nous les trouve. C'est cela que j'avais à dire à la présente assemblée.

[9]In Rwanda, as in much of Africa, the State is the sole land owner, and farmers are given permanent usufruct rights which can be transferred from father to sons. In practice, farmers interpret the permanent usufruct rights as ownership.

even though women cultivate the land intensively year in and year out, they do not accrue any decision-making rights over that land beyond those associated with seasonal crops.

In addition to tenure, farmers take a number of factors into account in deciding which species to plant where within the farm as the following quote illustrates:

> One cannot plant trees in all the fields one cultivates because there is a risk that the trees would compete with the crops. I cannot conceive of a field in which sorghum, Pennisetum, bananas, sweet potatoes, Ficus thonningii and Euphorbia tirucalli are mixed. A certain weighting is essential. For this reason, one uproots some bananas so that the sweet potatoes can grow well.[10]

If one has enough land, separation of crops and trees is the preferred agroforestry arrangement. On large farms, trees are most often planted on infertile pieces of land unsuitable for crops, such as shallow soils, rock outcrops, gravely soils and soils with a hardpan close to the surface. Farmers, both big and small, also prefer to cultivate food crops in separate fields. But in view of decreasing farm sizes, such separation becomes increasingly impossible and new, more intimate arrangements of trees and crops become necessary. One woman stated that you need at least one tree in each field, particularly if the field is on a slope as the tree will help stabilize the soil. Fruit trees are good for this purpose as, with the exception of avocado, they do not compete with crops. However, one cannot plant too many trees within one's fields as land is needed for food crops. How many trees can be planted in a field depends on the crop to be produced. For example, women do not like to plant trees in or around fields with sweet potatoes, as trees decreases the yield of this crop. For this reason, few trees are found on valley land, the main area used for the production of sweet potatoes. If trees and crops need to be produced on the same field, trees are preferably planted on the anti-erosion ditches. This has the additional advantage of stabilizing and reinforcing these ditches.

Cypress, Eucalyptus and avocado cannot be used to mark the property boundaries, as these species are too competitive and damage the soil of your neighbors. To mark property

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[10]On ne peut pas planter les arbres dans tous les champs qu'on cultive parce qu'il y a le risque que ceux-ci gênent les cultures. Je concevrais mal un champ où sorgho, pennisetum, bananes, patates douces, umuvumu et umuyenzi sont mêlés. Une certaine pondération s'impose. C'est pourquoi, par exemple, on arrachera quelques bananiers pour que les patates douces puissent bien pousser.

boundaries, Euphorbia tirucalli, Synadenium grantii, Vernonia amygdalina and Markhamia lutea are the preferred species as they do not have any negative influences on the soil.

3. Key findings

In the past, people practiced a form of passive agroforestry, where naturally-seeded trees were maintained on the land. The only active planting of trees took place on the rugo, where Euphorbia tirucalli, Vernonia amygdalina and Ficus spp were planted as live fences around the compound. Most needs for tree products could be satisfied by exploiting the natural vegetation on the hills and along the valley bottoms. With more land brought under cultivation as a result of increasing population pressure, it became less and less possible to depend on this natural vegetation to secure the necessary tree products. Over time, people have become more active in planting trees on their land, made possible also by the overthrow of the kingdom in 1959 and the abolishment of traditional chief-client relationships based on cattle ownership and the exigency of keeping land in pasture.

Farmers' statements that "all traditional (i.e. indigenous) trees can be used for agroforestry as they are non-competitive with crops" may be a reflection of their long observation of the behavior of naturally occurring trees in their fields vis-a-vis crops. The passive agroforestry practices in the past may therefore have been less passive than assumed or admitted, as farmers may have engaged in selecting out trees that did not provide direct benefits or were too competitive. The "all" in the above statement may indicate that competitive indigenous trees have been eliminated over time, leaving only those that are compatible with crops. While consultants were not able to verbalize whether or not they had engaged in experimental practices in the past, it is obvious that these past experiences were and are being used in designing the agroforestry systems found in the study areas at present.

The utility and tangible benefits trees provide are the prime reasons to plant trees. For women, this means that they can plant trees for food (fruit, spices, yeasts, etc.) and medicine, as these products contribute to household food security and well-being for which they carry primary responsibility.

There are no formal prohibitions for women to plant trees. That women customarily do not plant trees appears to be related to the fact that one cannot plant trees on land over which one has no ownership. As the land belongs to the men, women cannot plant trees on the land unless they seek permission of their husbands. Thus, in spite of women providing the bulk of the labor for crop production, they do no accrue any decision-making rights over the land beyond those associated with seasonal crops.

As farms are already very small and continue to diminish in size with each generation, it is becoming more and more difficult to associate trees and crops on the farm. In farmers' opinion, there are no trees that are non-competitive with crops and do not damage the soil. But, in spite of the fact that all trees are considered to be bad for the soil and to negatively influence crop production, farmers consider agroforestry the only solution to obtaining tree products in the future. To make this possible, it is imperative to find species and arrangements with the least negative influence on crops and soils. Farmers are well aware of and sensitive to the biological interactions between trees, crops and soils. These interactions are the primary criterion used in the decision which species to plant and at which location to plant, and, later, to evaluate the performance of the species. Farmers, therefore, demand more research on suitable crops and arrangements in order to increase the number of options available to them.

4. Summary and conclusion

In the past, agroforestry was not or at least not widely practiced in the three study areas. However, farmers did use many tree species, as the needs of the households were varied and numerous. With increasing population, more land was needed for cultivation of food crops, leading to the virtual disappearance of forests and forest galleries from the landscape. Since farmers did recognize the need for the many products and benefits trees provided, they increased their cultivation on their own farms. Over the years, many indigenous and exotics species have been incorporated into the agricultural systems, often in complex arrangements over space and time. Utility and other (potential) benefits were cited as the primary reasons why farmers plant trees. As there are many species which can meet the diverse needs of farmers, which species actually are planted depends on a number of factors: gender, farm size, personal interests,

motivation and preferences for certain species, and the initiative of each person. Women are primarily interested in trees producing food (fruit, yeasts, seasonings, ...) and medicines, while men expressed a preference for lumber trees and those producing construction poles. Neither gender expressed much interest in fuelwood trees, and fuelwood did not appear high on the list of farmer priorities of problems to be addressed by agroforestry research.

Farm size is an important determinant in the decision to practice agroforestry or not. It is not that small farmers do not recognize the importance of trees, but the increasing competition between trees and crops for the limited land base makes the decision on which species to plant exceedingly difficult. Most farmers considered agroforestry the only possible solution to the provision of tree products in the future, even though in their opinion all tree species are bad for the soil and diminish crop production. With farm sizes diminishing with each generation, the choice of the right species that has the least negative influence on crops and soils and proper arrangements will become more and more crucial. To help them make these difficult choices, farmers requested more research on suitable species in order to increase the number of options available to them. It should be stressed, though, that farmers emphasized the word 'options'; they were less interested in instant, ready-made solutions. In other words, they would like to increase the number of species available to them, but they do not like to be told that these have to be grown in particular arrangements or on particular locations within their farms. Other suggestions that were made to increase people's access to tree resources would require political decisions and included the reform of the land tenure system, the distribution of national and communal forests among the farmers to be managed cooperatively by them, and the reorganization of the Rwandan landscape by establishing villages on the least fertile places in order to free the good land for cultivation. Whether any of the suggestions related to tenure and landscape reorganization are feasible and would provide a solution to the problems farmers face could be a subject for further study. What these suggestions do show is that farmers are well aware of the difficult predicament they are in and are not averse to changes (even drastic ones) if these would be necessary to meliorate their situation.

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CHAPTER VI

AN EMIC VIEWPOINT ON THE NATURE AND ACQUISITION OF KNOWLEDGE

1. Introduction

Appendix I-1 provides a brief disucssion of the construction of the Rwandan universe, its metaphysical categories, and the differences between *ikintu* (things, i.e. minerals, plants and animals) and *abantu* (people). Animals and people are both considered to be sensitive beings, but Rwandan philosophy puts them in different metaphysical categories. The differentiation is made on the basis of differences in attributing intelligence to animals and people. Both animals and people can "know intelligence," i.e. they are smart, clever, perspicacious. Intelligence in this sense is the object of knowledge, not the instrument of knowledge. Using intelligence as an instrument of knowledge means to "have intelligence," which can only be attributed to people. According to Kagame (1958), people possess several particularities in relation to intelligence that animals do not have, namely the ability to think/remember, compare and invent, to which Balibutsa (1985) added the notions of to think/reflect, analyze, explain, meditate and see/understand. These actions are the instruments with which people are able to obtain and generate knowledge.

Knowledge or science are both rendered by the word *ubumenyi* in Kinyarwanda. Science (not to be confounded by science as understood in Western epistemology) is to be understood as the possession of knowledge as contrasted with ignorance or misunderstanding. In addition, to have *ubumenyi* implies having a plurality of knowledge because a simple knowledge limited to one object or a limited number of notions cannot be constituted under the term *ubumenyi* (Kagame 1958). Although the philosophical discussion in Appendix I-1 helps to appreciate the logic of the Rwanda world and the differences between metaphysical categories of being, and to understand what knowledge is (or is not), is does neither explain differences in knowledge and the content of that knowledge between people, nor the ways in which knowledge is obtained, nor how people enhance their knowledge over time. Nevertheless, such understanding is imperative to determine and understand the processes of knowledge/technology generation, acquisition and adaptation which is the main goal of the present study. In the case of agroforestry knowledge and

technology, the study of farmer-based processes of innovations in agroforestry (in particular, farmers' knowledge, logic and motivation towards experimentation) was, however, recommended by the participants of an international seminar on agroforestry at Kigali, Rwanda, in 1988 as the main strategy to further agroforestry practices in Africa (CTA 1988).

Over time, farmers have not only generated extensive knowledge about the management of indigenous tree species, but also have acquired and adapted a wealth of knowledge of exotic species and silvicultural practices introduced since the 1930's first by the Belgian colonial rulers and later by various development programs. These combined interventions in the landscape by both farmers and outsiders have led to very complex and multifaceted agroforestry systems, which are often difficult to understand for researchers trained in the Western scientific tradition. However, this does not invalidate either the indigenous or the scientific agroforestry systems, or the knowledge upon which they are based. As Feyerabend (1988) stated, there are many different kinds of science, first world science is only one science among many others. Each science tradition may, therefore, arrive at different conclusions about what constitutes a problem, priority or need, and what acceptable solutions will be. Science and technology are above all socially constructed entities (Knorr-Cetina 1981; Bijker et al. 1987; Feyerabend 1988). "It is social groups that give meaning to technology and problems are defined within the context of the meaning assigned by a social group or a combination of social groups. Because social groups define problems of technological development, there is flexibility in the way things are designed, not one best way" (Pinch and Bijker 1987).

Thus, if it social groups that give meaning to technological development and define problems and solutions accordingly, then we should study and address the community instead of, or in addition to, the individual. In Chapters III and IV, the information upon which the results are based was collected from individuals. Inferences about the community or particular groups within the community are made through statistical manipulation of the data, using the assumption that the individuals interviewed were able to (and did) provide correct information. Although at times the information obtained from a consultant during the ranking game or the tree expert biographies appeared contradictory to the general picture of local agroforestry systems and the nature of endogenous agroforestry knowledge, it was not politic to question the consultant about it for fear

of loosing his/her cooperation. Based on prior experiences in development and on the initial meetings held in the research areas to explain the objectives of this research, it was decided to organize a number of community and focus group interviews as participants in such meetings often correct and complete inaccurate information in responses given by others. An initial series of thirteen meetings for the general population was held to discuss preliminary findings on the nature of the agricultural systems in the area, the role of trees in the landscape, and the gender differentiation in knowledge about tree cultivation. The second series of meetings (focus group interviews) was restricted to the tree experts and their spouses, and focused in particular on questions of the nature of knowledge (in particular agroforestry knowledge), what it means to be knowledgeable about something and how one can become knowledgeable, and lastly, questions related to experimentation with trees and tree cultivation as one way of acquiring/generating knowledge.

This chapter will be devoted to the results of the discussions related to the topic of "knowledge" and "being knowledgeable." This information will be supplemented with the results of the questions related to access to information from the socioeconomic survey, which will help explain knowledge differences between tree experts and comparison farmers and confirm the validity of grouping of farmers in these categories. The results of discussion related to farmer experimental activities will be the subject of Chapter VIII. More detailed information about the methodology used for the community and focus group interviews can be found in Section 6.2. of Chapter II, whereas information on the methodology of the socioeconomic survey is provided in Section 6.6.

2. Results and discussion

2.1. What is knowledge and how does one obtain knowledge?

Discussions about the topic of knowledge revealed several recurring themes: intelligence, experience, communication, and putting information in practice. All four themes have to be present for a person to be recognized as "knowledgeable." Knowledge manifests itself through

the intelligence one has in one's heart.[1] Being knowledgeable about something means knowing its utility, holding its secrets and showing a sustained interest in it as revealed through one's actions. Some considered knowledge to be "natural" (i.e. a gift of God)[2], some stated that it results from experience, while others mentioned it is obtained by being well-informed and having gone to school (although they considered knowledge learned in school "artificial knowledge"). Whatever, the source of knowledge, one needs to put the information into practice for it to be recognized as knowledge. For example in the case of medicine, a person will be recognized as a healer if he or she is capable of curing certain diseases successfully with a number of patients. Thus, the knowledge of a healer is revealed through his actions as a healer. And for other things it is the same: knowledge manifests itself through one's realizations, for example a person having planted many species of trees, and taking care of them very well. Others will recognize you as being very knowledgeable about trees when they visit your farm.

2.2. Individual versus collective knowledge

People in the meetings emphasized the differences in knowledge between themselves. In the words of one participant:

> Our knowledge remains diversified because we lack the time and a framework -- for example meetings -- where we can inform ourselves of and exchange our respective knowledges. This would allow us to have a common knowledge.[3]

While some collective knowledge is necessary for any society to function, one could assume that the person who provided the above information referred to agroforestry knowledge in particular. However, in another meeting where this topic was discussed, someone stated that, "*En général, les connaissances collectives sont acquises en classe. Du reste, chacun possède ses facultés*

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[1]Rwandans believe that intelligence is located in the heart, not in the head. As discussed in Appendix I-1, the heart's function is to centralize and orient sensations.

[2]The following statement is an example of such natural knowledge: "Personne ne vous apprend à téter, et on ne se fait pas apprendre comment cultiver les haricots, comment cuire les patates douces. L'instinct de conservation nous pousse à faire certaines choses."

[3]Notre connaissance reste diversifiée parce que nous manquons de temps et de cadre d'échange -- les réunions par exemple -- grâce auquel on pourrait s'informer mutuellement de nos connaissances respectives. Ceci permettra d'avoir une connaissance commune.

individuelles qu'il peut exploiter de façon spécifique selon sa nature." Thus, at least in the area of agroforestry and tree knowledge, there does not appear to be any collective knowledge as such knowledge is not acquired in school. Individual exchanges of information do take place, but not on a regular and organized basis as the following dialogue between one woman healer and the researchers makes clear:

> Q: Do you have a collective knowledge of trees, in other words, is your knowledge of trees similar to that of other people?
>
> A: No, it is different. N. treats ifumbi from which mother suffer. He has his own knowledge about the treatment of this disease and I have mine. But, now we have exchanged our knowledges and we have harmonized our treatment of ifumbi.
>
> Q: But can you confirm to us: Do you know whether other healers treating ifumbi have the same knowledge that you have about ifumbi and its treatment?
>
> A: No! We do not know what they know, as they also do not know what we (i.e. N. and I) know.[4]

People offered various reasons why their knowledge of agroforestry differs. The differentiation in knowledge starts at birth, as God does not equip everyone equally. In addition to the intellectual abilities obtained at birth, knowledge varies because of the different knowledge inherited from one's ancestors and passed on from parents to children in each generation. Whether someone becomes a carpenter, a blacksmith, or a healer of cow diseases, or a farmer depends to a large degree on both birth and education and training provided by the parents. In addition, to be recognized in later life as highly knowledgeable about or as a specialist in a certain area depends what one does with the initial information. People differ in character, interests and taste; some are more serious in their tree planting activities than others; some persons have a feeling for experimentation and research and are constantly tinkering in search

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[4]Q: Est-ce que vous avez une connaissance collective des arbres, c'est-à-dire, est-ce que votre connaissance des arbres est la même que celle des autres personnes?

A: Non, elle diffère. N. traite ifumbi qui attaque les mamans. Il a ses propres connaissances [sur le traitement de cette maladie] et moi j'ai les miennes. Mais actuellement nous avons échangé les connaissances et nous avons harmonisé notre traitement d'ifumbi.

Q: Est-ce que tu peux nous affirmer: Est-ce que tu sais si les autres guérisseurs d'ifumbi ont les mêmes connaissances que vous sur ifumbi et son traitement?

A: Ah, là, non! Nous ignorons ce qu'elles savent comme elles ignorent aussi ce que nous (i.e. N. et moi) savons.

of new knowledge and technologies. Others do not have such a drive and are satisfied with what they have and know. In addition to these personal characteristics, economic circumstances may facilitate a differentiation in knowledge. In the area of agroforestry knowledge, knowledge acquisition and experimentation are greatly aided by having a large farm, hence more opportunity to experiment, as was seen in Chapters IV and V.

2.3. Agroforestry knowledge and gender

During the ranking game, an equal number of men and women were asked to rank their fellow farmers on their *colline*. The analyses were, however, done at the household level by combining the scores obtained for husband and wife from the various informants. This combination of scores was decided upon based on the statements of numerous informants that if women are knowledgeable about trees, their husbands must also be knowledgeable. These statements may have been inspired by the traditional belief that women cannot admit that they have more knowledge than their husbands (Bucyobukiro, personal communication). In addition, since knowledge was defined primarily as having a large species diversity on the farm and such could only be possible through the efforts of the husband, the latter must also be knowledgeable about trees. From the information obtained from the consultants during the ranking game, there were some indications that the nature of the knowledge of trees and agroforestry differed between men and women. To confirm this finding and to determine which of the two sexes, in the farmers opinion, is more knowledgeable about trees, a deliberately ambiguously worded question was included in the questions for the first series of focus group meetings (see Question 9 in Appendix II-4). The discussions related to this question were the most animated and contentious in each of the thirteen meetings in the series of community interviews. Table 14 provides an overview of the various opinions expressed regarding this question, and the response frequency.

Table 14 shows that a majority of farmers present at the focus group meetings supported the view that women are more knowledgeable about trees. This conclusion was reached in spite of the fact that the vast majority of persons who attended these meetings were male (286 men attended the community interviews versus 156 women). From the statements collected, it also is clear that men's and women's knowledge is not the same. Men's knowledge relates to "big" trees

Table 14: Frequency of statements about agroforestry knowledge and gender.

Frequency	Statements about men being more knowledgeable
4	Men (no further explanations given)
3	Men have more knowledge because of their more frequent travels from which they bring back new species
3	Men, because they dig the holes and do the planting
3	Men know more about tree planting, maintenance etc
2	Men know the different species better than women
1	Men are more important
1	Men have more knowledge of big trees
1	Men have more knowledge in general, but women know more about medicinal plants
1	Men plant trees without caring much about their utility
1	Men are more active in searching for new species
1	Men, as they are responsible for their land and what is planted on it
1	In Rwandan tradition, men take care of all aspects of tree cultivation
1	It is men who cut the trees, sells them and makes objects from them
1	Those who plant the trees (i.e. men) know their utility better than women
24	Total number of statements favoring men

Frequency	Statements about women being more knowledgeable
12	Women have more knowledge of medicinal trees, their preparation and use
7	Women are the first to know the utility of trees, but men also have their knowledge
6	The general conclusion is that women have a greater knowledge of trees (including exotic trees) than men
3	Women know more about species identification and species' names
3	Men only plant the trees, but women have more knowledge of them
2	Women (without further explanations)
2	Women have more knowledge about trees, more than men
2	Women know plants for yeast, seasoning, etc.
1	Women are normally the doctors. If they do not know the right medicine, they will ask other women. Girls are trained from a young age in the healing arts by being asked to gather the necessary plants and by observing their preparation
1	It is women who harvest the medicinal plants shown by other women
1	Women know more about the qualities of fuelwood
43	Total number of statements favoring women

(Eucalyptus, Grevillea, Markhamia to name but a few), the planting and management of trees, the introduction of new species and/or varieties of trees, and the decision making aspects related to species choice, place, timing of planting and harvesting (i.e. cutting of the whole tree).

Women's knowledge is confined to species identification, naming of species, and the utility, use and harvesting of tree products such as yeasts for brewing beer, seasoning, medicine, fuelwood qualities, love potions, etc. As knowledge of the use and utility of trees, particularly for medicinal purposes, is valued very high in society and as women are especially skilled in human healing practices, women are considered more knowledgeable about trees than men. However, there are men with extensive knowledge of healing plants and practices, as there are women that do not know anything about them. As was seen in the introductory part of this section, knowledge depends on intelligence obtained at birth, education and training by parents and one's interest and curiosity in discovering and learning about things, possibly leading to be recognized as a specialist. As all these factors vary between individuals regardless of gender, knowledgeable and non-knowledgeable persons can be found in each group.

2.4. Is knowledge about trees essential for tree planting and agroforestry activities?

Consultants were equally divided on the question whether or not some prior knowledge about trees is necessary to practice agroforestry. For traditional (i.e., indigenous) tree species which were already cultivated by the ancestors and which were found on the farm upon inheritance of the land, no knowledge is necessary as people have seen them from early childhood. For newly introduced, exotic trees, people would need instruction as "*on ne peut pas planter un arbre qu'on vient de voir pour la première fois.*" The knowledge that was emphasized as important was firstly information about the utility of a species, secondly information about method of propagation and where and how to plant it, and thirdly where one can obtain the necessary seeds, seedlings or cuttings. Other farmers, especially neighbors, were cited most frequently as sources of such information, of which the following quote is an example:

> One plants a tree species because one has seen its utility for a neighbor. Up till now, we have not planted any trees without having learned about their utility first. But there are recently introduced species, such as Pinus and others, which we have planted after we heard talks about their utility, the beauty of its lumber, ...[5]

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[5]On plante un arbre parce qu'on a remarqué son utilité pour le voisin. Si non, nous n'avons pas jusqu'à présent commencé à planter les arbres sans qu'on ait remarqué leur utilité. Mais il y a des espèces récemment introduits tel que le pinus et d'autres que nous avons trouver bien de cultiver suite au faite qu'on nous parlait de leur utilité, de la beauté de leurs planches, ...

Thus, in addition to observing a species or practice on a neighbor's farm and seeing the benefits that neighbor gets from them, farmers' interests in something new may be also piqued by just hearing about the benefits of certain new technologies. However, seeing with one's own eyes remains the most powerful incentive to try out a new idea, as the following Rwandan proverb (from Nkongori 1957) makes clear:

Aho kubwirwa urakibonera

(Plutôt que d'entendre raconter, puisses-tu voir toi-même)

(Nkongori 1957)

A second group of consultants maintained that prior knowledge of a new species or practice is not necessary, and that farmers were able to cultivate a new species without knowing its name, planting and management methods nor its utility. Whether or not prior knowledge is necessary depends on one's personal preferences, the spirit of research of each person, the amount of risk (s)he is willing to take, one's imagination of possible future benefits of the species or practice, and, lastly, on the sort of tree, its aspect and physical form. In the opinion of this group of consultants, it is normal and a good habit to try out things even without having any knowledge about them, as one gains something new. The following dialogue illustrates this habit:

> Consultant 1: A real-life example: One day I went to Butare. I stopped at Rwabuye to rest a bit when I saw a plant that I did not know but fell in love with. I uprooted it, and I continued on my way to Butare. I stayed overnight in town. The next day, I returned with my plant and I planted it on my farm. Afterwards, I learned that it was a guava tree, but it was not yet known in my region when I planted it. Therefore, it is possible to plant a tree without knowing its name or its utility.[6]

> Consultant 2: An example that I can give is that of gapeli (Physalis peruviana) which I planted and from which I have earned 150,000 F.Rw. Walking in a forest, I came upon these plants. I observed them with a lot of curiosity. One day, I bought their seeds with a boy for 15 F.Rw. I planted them amongst my coffee trees. After a while, I devoted a whole field to the young seedlings I obtained. This field enabled me to deliver fruits to KONFIGI for a total sum of 150,000 F.Rw. When one discovers a tree, one observes it. If one finds the tree

[6]Consultant 1: Un exemple vécu: Une fois j'allais à Butare. Arrivé à Rwabuye, je me suis arrêté pour me reposer et j'ai vu un plant qui m'était inconnu et je l'ai aimé. Je l'ai arraché, et j'ai repris mon chemin jusqu'à Butare. J'ai passé la nuit en ville. Le lendemain je suis rentré avec mon plant et je l'ai planté. Par après il s'est avéré que c'était un goyavier mais il n'était pas encore connu dans ma région quand je l'ai planté. Donc, il est possible de planter un arbre sans toute fois connaître son nom et son utilité.

> which could provide an certain, important benefit, one takes this tree home. This is the case for medicinal plants of which the importance and utility are learned from neighbors who have used them to treat their children. One does everything possible to introduce these plants within one's own fields also.[7]
>
> Consultant 3: What I can add to the above is that in most cases the neighbor one approaches provides the information concerning the manner of planting such trees, and its yield. The person who introduced gapeli spread this species amongst us, and we now have cultivated this plant in our region for over 15 years.[8]

This group of consultants is more willing to take risks in their quest for knowledge and discovery of new technologies that may contribute to a better livelihood. Even if they know little about a species, they all said that it is possible to discover its benefits during growth or after its harvest. If the idea does not meet expectations, one can always cut the trees and replace them with another species. It is also a sort of pride for these farmers to experiment to leave something new for their own posterity, and to provide a showcase for neighbors to come and observe and hopefully try the innovations on their farms also. For the latter farmers, who form the majority of the population, observing what neighnors or friends have done and asking them the necessary information in order to follow their example remains a powerful motivation to adopt new technologies:

> If we notice a certain tree that is useful for a neighbor, we introduce this tree on our own farms and pass the knowledge gained with it to our posterity. An example not far from us is the introduction of fruit trees, coffee, and eucalyptus

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[7]Consultant 2: Un exemple que moi je peux donner est celui des gapeli (Physalis peruviana) que j'ai planté et qui m'ont rapporté 150.000 Frw. En marchant dans une forêt, je m'étais aperçu de ces plantes. Je les ai observées avec beaucoup de curiosité. Un jour j'ai acheté leurs semences à un garçon pour 15 F.Rw. Je les ai plantés dans mes caféiers. Après un certain temps, j'ai consacré tout un champ aux jeunes plants que j'avais obtenus. Ce champ m'a permis de fournir à KONFIGI des fruits pour une somme de 150.000 F.Rw. Lorsqu'on découvre un arbre, on l'observe. Si on trouve un arbre qui peut procurer un certain gain très important, on l'amène tout près de chez soi. C'est le cas des plantes médicinales dont l'importance et le rôle sont appris des voisins qui en ont fait l'usage pour traiter leurs enfants. On fait tout ce qui est possible pour les avoir aussi dans ses champs.

[8]Consultant 3: Ce que je peux ajouter à cela, c'est que la plupart du temps le voisin qu'on approche fournit des informations concernant la façon de planter tel arbre et son rendement. Ce monsieur qui a introduit gapeli l'a répandu un peu partout et ça fait au moins 15 ans que nous le cultivons dans la région.

> in the region by chief Semugeshi. We have always followed examples even before we had agronomes and extension workers to help us.[9]

The importance of neighbors and friends as a source of knolwedge and new ideas is also expressed in the following Rwandan proverb collected by Nkongori (1957):

Ubwenge burarahurwa

(Le savoir, comme le feu, s'obtient du voisin)

In the following section, more information will be given on how farmers acquire new knowledge and technologies from outside sources, that is from information based on Western scientific knowledge system obtained from research and extension as well as from information based on indigenous experimentation obtained from fellow farmers.

2.5. Access to information

The last section of the socioeconomic data survey was devoted to determining access to information about tree species, tree management methods, and new farming practices (see Appendix II-6). Information access was divided in three parts: the active seeking of new species and ideas during travel, the passive acquisition of species and tree management ideas from visitors to the farm, and the cooperation with development projects or the agricultural extension service to try out new practices on the farm. Farmers were also asked if they would share their experiences with new species and methods with other farmers, and whether they would actively seek the help of specialists if they had problems on their farm. Whereas the results provided in discussed in Chapter IV referred to demographic and socio-economic characteristics of tree experts and comparison farmers and to the amount of resources they have at their disposition, the information in this section will shed more light on differences in the level of activity related to knowledge acquisition between comparison farmers and tree experts, and help understand why tree experts are called "experts."

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[9]Selon qu'on remarque que tel arbre est utile pour le voisin, on l'introduira chez soi et on léguera à la postérité sa culture. L'exemple non loin de nous est l'introduction des arbres fruitiers, du caféier, et de l'eucalyptus dans la région par le chef Semugeshi. On a donc toujours suivi des exemples avant d'avoir des agronomes et des moniteurs agricoles à notre service.

2.5.1. Travel to other places

Kugenda cyane gutera kubona

(Marcher beaucoup donne à voir)

(Nkongori 1957)

In spite of poor transportation facilities outside of the urban centers and along the major roads between them, people do travel in search of work, to visit relatives or to attend ceremonies. The number of tree experts indicating that they have traveled is significantly greater than the number of comparison farmers (Chi Square $p < .01$) (see Appendix VI-1). Eighty-nine percent of tree experts have traveled, compared to 54.3% of comparison farmers. Among the latter group, farmers in Maraba have traveled least, while those in Kibingo have traveled most. This situation is reversed among the tree experts. The Chi Square statistic indicates that the difference between *secteurs* within the comparison farmer group is significant ($p < .05$). While the destinations are varied, the data in Appendix VI-1 indicate that the majority of comparison farmers (60.5%) travel only short distances, either to other *secteurs* within the *commune* in which they live, or to neighboring *communes*.[10] Only in Simbi have the comparison farmers that have traveled also ventured further from home to other *prefectures* and to other countries. In the tree expert group, not only have a larger percentage of consultants traveled, they have also traveled much further. The majority of experts indicated that they have traveled to other *prefectures* (56.4%), while one-third have traveled to other countries or to the city (meaning either Butare or Kigali), respectively. The percentage of experts having traveled to other countries and *prefectures* is highest in Simbi (70%), and lowest in Kibingo (11.1% and 44.4% respectively).

Travel by itself does not make a person gain new knowledge, but it is a means of increasing one's experiences by obtaining new tree species and observing new tree management methods. Of the 38 comparison farmers that mentioned they had traveled, only six (15.8%) indicted that

[10]Since more than one destination could be mentioned, percentages under "DESTINATION" may add to more than 100%.

they had brought back some seeds or seedlings of new tree species.[11] All six indicated that they had planted the seeds or seedlings of the new species they had brought back from their travels in order to try them out and determine their suitability under their own farm's conditions. A significantly higher percentage of tree experts brought back new species from their travels, namely 48.7% (Chi Square $p < .01$). The percentage of experts having done so is highest in Kibingo (66.7%) and lowest in Maraba (27.3%). Again, all the persons that had brought back seeds or seedlings of new tree species had planted them on their farm to try them out.

When asked whether they had observed new methods of managing trees (pruning, coppicing, planting etc.), the answer from both comparison farmers and tree experts was a resounding "NO." The reason for this could be that farmers are not interested in different tree management methods, or that these methods are not significantly different from what they are already doing to be observant of them, at least not consciously.[12] Farmers do not have a fixed set of management practices for each particular species, but will use a range of practices according to their circumstances, objectives, needs and desires and use these on all species on the farm if possible. Tree management is not only species dependent, but also varies with the location of the species on the farm. For example, cypress located on the *rugo* will be managed intensively to form a dense hedge, those planted as a windbreak along the fields may be managed for stakes, while those planted in a woodlot are managed for timber.

2.5.2. Visitors coming to the farm

Farmers rarely receive visitors to discuss agricultural problems in general and agroforestry practices in particular. Only six comparison farmers (8.6%) indicted that they had received visitors on their farm who had brought them seeds of new tree species (see Appendix VI-2a),

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[11] "New" does not necessarily mean that the species is exotic to the area. It refers to being new to the respondent's farm, where it previously was not found. Thus a new species could be either an exotic or an indigenous species.

[12] During the focus group meetings, they did admit that Rwandan farmers are imitators, and that "seeing is believing." In general, they admitted that they do copy practices from their friends and neighbors, but when asked directly about it, they would either deny that they did so or said that they could not remember where they saw or learned a certain practice.

while three persons (4.3%) indicated that visitors had showed them new tree management practices (see Appendix VI-2b). In the tree expert group, the situation is similar. Of the total number of tree experts, 15.9% (all of them living in Kibingo) had received visitors who had brought them tree seeds or seedlings (see Appendix VI-2a), while three persons (6.8%) had received visitors who had described new tree management methods (two in Kibingo and one in Maraba) (see Appendix VI-2b). All but one comparison farmer and all tree experts had tried the new tree species. The reaction to the new management practices was more favorable, with two out of three persons in each group trying them out (see Appendix IV-2b).

Who the visitors were varied between the two groups. In the comparison group, visitors were predominantly local (parents, *agronome de commune*, *conseiller* or burgomaster); only one person mentioned having had a visit of an ISAR researcher, with whom she was collaborating for an on-farm trial. In the expert group, the visitors that provided the consultants with tree seeds were predominantly outsiders (ISAR researchers and agronomists of the PAP and PAK projects); only one person mentioned that the visitor that brought the seeds was the *agronome de commune*. The latter was the only visitor mentioned regarding the question which visitors showed them new tree management methods. It appears, therefore, that the collaboration with ISAR and the agroforestry projects in Kibingo is limited to the provision of tree seeds or seedlings, but that farmers are not given advice on the maintenance and management of the species that they have been given. The low number of farm visits reported, even in the tree expert group, is testimony to the low level of activity of the agricultural extension services, even if they are supported by development projects as is the case in Karama.

2.5.3. Exchange of information and experiences regarding new ideas or problems

2.5.3.1. Sharing of experiences with new tree species and management methods

More than four-fifths of the comparison farmers responded that they never discuss their experiences with new tree species or management methods with other persons, while only half the tree experts stated that they never do so (see Table 15a). The remainder of the consultants in both groups said that they discuss their experiences from time to time; only one expert stated

that he does so on a regular basis. The difference between the two groups is highly significant (Chi Square $p < .01$), while the difference between *secteurs* within each of the two groups is significant. The percentage of people reporting sharing their experiences is lowest in Kibingo in both groups (5.7% and 27.3% in the comparison and expert groups respectively). Of the comparison farmers indicating that they do discuss their experiences with others, neighbors and friends were the most frequently mentioned (63.6%), followed by *agronomes de commune* (36.4%). One consultant each stated discussing his/her experiences with brothers/sisters and ISAR researchers, respectively. In the tree expert group, the most frequently mentioned person with whom experiences are shared are the *agronomes de commune* (63.6%), followed by neighbors and friends (40.9%). Project agronomists and ISAR researchers were mentioned only in Kibingo by one, respectively two, consultants. The *conseiller* and "other" were mentioned by one person in Simbi and Maraba, respectively.

2.5.3.2. Discussion of farm problems

Regarding the question of whether consultants discuss any problems on their farm with others in order to get advice or seek solutions, almost one-third of comparison farmers and two-thirds of tree experts answered affirmatively (see Table 15b). The Chi Square statistic is highly significant ($p < .01$) for the difference between groups, and is significant for differences between *secteurs* within each group. Farmers in Kibingo in both groups are the least active in discussing their farm problems, with 14.3% of comparison farmers and 33.3% of tree experts indicating that they did so. Farmers in Maraba discuss their problems the most, with 58.8% of comparison farmers and all the tree experts indicating that they discuss their farm problems with others. Almost all consultants mentioned discussing farm problems with others from time to time (i.e. when they occur); one comparison farmer in Kibingo stated that (s)he sought advice on problems on a regular basis, and one said that (s)he would do so only when asked. Of those that do discuss their farm problems with others, the majority mentioned consulting the *agronomes de commune* (60.9% of comparison farmers and 71.4% of tree experts), followed by "Other" (34.8% and 64.3% respectively). "Other" in most cases refers to the veterinary assistant; since comparison farmers have fewer animals, it is logical that they have less need for consultations with this person than tree experts. Other persons mentioned to discuss farm problems with were neighbors

Table 15a: Do farmers discuss their experiences after trying out new species or methods with other farmers?

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOES FARMER DISCUSS EXPERIENCES WITH NEW SPECIES AND METHODS?				b				A,b
NO, NEVER	33	13	11	57	16	2	4	22
Count Percent	94.3%	76.5%	68.8%	83.8%	72.7%	18.2%	36.4%	50.0%
YES, FROM TIME TO TIME	2	4	5	11	6	8	7	21
Count Percent	5.7%	23.5%	31.3%	16.2%	27.3%	72.7%	63.6%	47.7%
YES, REGULARLY						1		1
Count Percent						9.1%		2.3%
IF YES, WITH BROTHERS+SISTERS	1			1				
Cases Percent	50.0%			9.1%				
NEIGHBORS+FRIENDS	1	2	4	7	2	6	1	9
Cases Percent	50.0%	50.0%	80.0%	63.6%	33.3%	66.7%	14.3%	40.9%
AGRONOMES DE COMMUNE		2	2	4	4	3	7	14
Cases Percent		50.0%	40.0%	36.4%	66.7%	33.3%	100.0%	63.6%
COUNCILLOR							1	1
Cases Percent							14.3%	4.5%
PROJECT AGRONOMISTS					1			1
Cases Percent					16.7%			4.5%
ISAR RESEARCHERS	1			1	2			2
Cases Percent	50.0%			9.1%	33.3%			9.1%
VETERINAIRE						1		1
Cases Percent						11.1%		4.5%

A=between group chi square significant at p<.01

a=within group chi square significant at p<.01
b=within group chi square significant at p<.05

Table 15b: Do farmers discuss any problems that occur on the farm with other people?

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOES FARMER DISCUSS CROP ANIMAL OR TREE PROBLEMS WITH OTHERS?				a				A,a
NO, NEVER Count Percent	30 85.7%	7 41.2%	10 55.6%	47 67.1%	14 66.7%		1 9.1%	15 34.9%
YES, FROM TIME TO TIME Count Percent	3 8.6%	10 58.8%	8 44.4%	21 30.0%	7 33.3%	11 100.0%	10 90.9%	28 65.1%
YES, REGULARLY Count Percent	1 2.9%			1 1.4%				
YES, IF THEY ASK ME Count Percent	1 2.9%			1 1.4%				
IF YES, WITH NEIGHBORS+FRIENDS Cases Percent	1 20.0%		1 12.5%	2 8.7%				
AGRONOMES DE COMMUNE Cases Percent	2 40.0%	6 60.0%	6 75.0%	14 60.9%	7 100.0%	5 45.5%	8 80.0%	20 71.4%
PROJECT AGRONOMISTS Cases Percent						1 9.1%		1 3.6%
ISAR RESEARCHERS Cases Percent	1 20.0%			1 4.3%				
VETERINAIRE Cases Percent	1 20.0%	5 50.0%	2 25.0%	8 34.8%		9 81.8%	9 90.0%	18 64.3%

A=between group chi square significant at p<.01

a=within group chi square significant at p<.01
b=within group chi square significant at p<.05

and friends, ISAR researchers and project agronomists. However, given the presence of two agricultural development projects in Karama and several on-farm trials of ISAR in this *commune*, it is surprising that ISAR researchers and project agronomists were not mentioned more frequently by consultants in Kibingo as persons with whom farmers discuss their problems.

A general observation regarding the questions of whether farmers discuss their experiences with new technologies and their problems is that consultants in Maraba and Simbi appear to be much more active than their counterparts in Kibingo, in spite of the development assistance provided to farmers in Karama *commune*. This could be due to the fact that these projects work with a few pilot farmers to the exclusion and neglect of the general farm population, creating a small, select group of elite farmers on whom resources and efforts are concentrated. This appears to confirm the findings by Pottier (1989). Most farmers, therefore, may feel by-passed and do not feel that they can discuss their problems with others. The absence of projects in Maraba and Simbi makes farmers operate on a more equal basis, and more open and willing to sharing ideas and experiences. The semiweekly market at Kizi in Maraba *secteur* may also contribute to the greater openness in both Maraba and Simbi, as these events are a great opportunity to meet other farmers, the extension workers, and the local functionaries (*chefs de colline*, *conseillers of the secteurs*, etc.).

2.5.4. Contacts with development projects or extension services for access to and testing of new technologies

Lastly, consultants were asked if they had cooperated with agricultural extension or project personnel to test a number of new technologies. The technologies explicitly mentioned included new cropping practices, improved seeds, new tree species, new tree management methods, fertilizers, lime and terracing. In the comparison group, a higher percentage of consultants in Maraba and Simbi indicated that they had done so than consultants in Kibingo (see Table 16). In the tree expert group, a higher percentage of consultants in Maraba and Simbi cooperated with the extension service to test new cropping methods, improved seeds, fertilizers and lime; for the other technologies, new tree species, new tree management methods and terracing, the percentage of farmers in Kibingo was greater, but the Chi Square statistic to test differences between

Table 16: Number and percentage of consultants who have cooperated with projects or extension to test new agricultural/agroforestry technologies.

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
NEW CULTURAL METHODS								A
n	3	3	4	10	9	8	7	24
Count Percent	8.6%	17.6%	22.2%	14.3%	40.9%	72.7%	63.6%	54.5%
IMPROVED SEEDS				b				A,b
n	3	6	6	15	8	8	8	24
Count Percent	8.6%	35.3%	33.3%	21.4%	36.4%	72.7%	72.7%	54.5%
NEW TREE SPECIES								
n	2	4	4	10	7	3	2	12
Count Percent	5.7%	23.5%	22.2%	14.3%	31.8%	27.3%	18.2%	27.3%
NEW TREE MGT. METHODS								B
n		1		1	3	1	1	5
Count Percent		5.9%		1.4%	13.6%	9.1%	9.1%	11.4%
FERTILIZERS				b				A,a
n	3	7	4	14	4	10	10	24
Count Percent	8.6%	41.2%	22.2%	20.0%	18.2%	90.9%	90.9%	54.5%
LIME APPLICATIONS								A
n	2	2	2	6	5	7	2	14
Count Percent	5.7%	11.8%	11.1%	8.6%	22.7%	63.6%	18.2%	31.8%
TERRACES								B
n	1	1		2	6	2	1	9
Count Percent	2.9%	5.9%		2.9%	27.3%	18.2%	9.1%	20.5%

A=between group chi square significant at p<.01
B=between group chi square significant at p<.05
a=within group chi square significant at p<.01
b=within group chi square significant at p<.05

cooperators and non-cooperators was not significant. The higher percentage of cooperators for these three technologies in Kibingo is not surprising, as they are the main technologies being promoted by both PAP and PAK. Particularly noticeable are the high percentages of tree experts in Maraba and Simbi who cooperated to test fertilizers (90.9%), improved seeds (72.2%), and new cropping practices (72.7% and 63.6% in Maraba and Simbi respectively). Of all the technologies mentioned, the lowest percentage of cooperators was found for new tree management methods in both groups of consultants.

Except for the testing of new tree species (Chi Square not significant), and the testing of new tree management methods (Chi Square $p < .05$), the differences between the expert and comparison groups in the observed and expected frequencies of cooperators and non-cooperators is highly significant (Chi Square $p < .01$). Within the comparison group, significant differences between *secteurs* were observed for the testing of improved seeds and fertilizers. Within the tree expert group, there are significant differences between *secteurs* between the observed and expected frequencies for improved seeds and lime (Chi Square $p < .05$), while the difference for fertilizers was highly significant (Chi Square $p < .01$) (see Table 16). Overall, tree experts have more access to new technologies than the comparison farmers. However, this difference may be due to the fact that they are more actively seeking out new ideas and technologies. Again, the situation in Maraba and Simbi appears to be more egalitarian than in Kibingo, even though the percentage of comparison farmers cooperating with extension to test new technologies is less than that among tree experts. In general, though, access to these new technologies will be gained only if farmers (be they tree experts or not) actively seek them by going to the extension offices and ask for them. As was seen in Section 2.4.2., waiting for extension workers, ISAR researchers or project agronomists to come and visit your farm may be an exercise in futility.

3. Key findings

Consultants perceived knowledge as having four aspects, namely intelligence, experience, communication and putting information into practice. To be recognized as being knowledgeable about something by one's fellow farmers depends not only on what one knows but equally on how one can explain that knowledge to another person and provide sufficient and reliable

information about it so that the other person can attain the same benefits. In short, besides knowing facts, real knowledge is first a willingness to do something with these facts, second to put them into practice, and third to communicate your knowledge about these facts to others. These findings are both startling and interesting, as they are analogous to what Western societies ascribe to their scientists: knowing basic facts, putting these into practice in experiments, communicating the results and the knowledge gained from of these experiments in journals and in scientific meetings, and replicability (i.e. other scientists should be able to obtain the same results, all else being equal). However, the level at which Rwandan tree experts (as one category of indigenous scientists) operate and the methods they use are quite different from the one at which researchers trained in the Western knowledge tradition operate.

The communication networks between tree experts amongst each other and between them and other farmers are neither very extensive nor very well organized. Participants in the community and focus group interviews perceived this as a barrier to advancing their knowledge. In this regard, the community and focus group interviews were received very positively by the people that participated, not only as a forum in which they provided the researcher with the necessary information, but above all in which they could exchange information amongst each other and learn something about their agroforestry systems and knowledge without it being labeled backward and traditional.[13]

From the discussion in the focus group interviews, it became clear that tree **production** knowledge is less valued than tree use knowledge. In addition, as everyone possesses his/her own particular knowledge, knowledge is differentiated not only according to gender but also between individuals within each gender. In the area of agroforestry knowledge, this differentiation is due to the fact that tree species, species arrangements and uses vary enormously between farms as will be seen in the following chapter. Even if farmers do have the same species, someone can have some knowledge about this species (its uses, properties, ...) that other

[13]At some meetings, we left with a feeling that they were perhaps the first time that people were given an opportunity to discuss these topics freely and openly, perhaps bolstered by the fact someone was taking a serious interest in their knowledge about agroforestry.

farmers do not have. What is important in this regard is the complementarity of the different knowledges individuals (male and female) possess ("*Ce qui importe c'est notre complémentarité*").

Women are recognized as being the most knowledgeable in the field of trees, as women have extensive knowledge of use aspects of trees (for food, medicine, fuelwood qualities, etc). But even though women are responsible for assuring the food security of the family, they have no formal rights to the land and have little decision making powers regarding non-food production activities, especially when trees are involved. However, women can, on the one hand, veto their husbands' plans to plant certain trees in or around the fields, and on the other hand can request their husbands' to plant trees if that would contribute to the household food security and health. Agroforestry projects should, therefore, perhaps focus initially on the female farmers to convince them of the benefits and the utility of new trees species and agroforestry practices, and subsequently explain to the men how to go about planting new species and putting improved agroforestry technologies into practice. Consulting women will become more important as, with continuously decreasing farm sizes leading to an increased competition between trees and crops, a greater percentage of total cultivated land will need to be devoted to crops. As will be seen in the next chapter, integrating (additional) trees in these mini-farms will become more and more difficult in the future.

The breadth of world experience of tree experts is much greater than of the comparison group, as they observed farming systems and tree species different from those found in the region where they presently farm. Almost all tree experts reported having traveled outside the *secteur* of residence, mostly to other prefectures, countries and various cities in Rwanda itself. In contrast, only about half the comparison farmers had traveled, but the distance they traveled was much more limited, with primary destination being other *secteurs* within the *commune* and neighboring *communes*. While they travel, tree experts are also more observant of new tree species not found on their own farm or region, but not of new or different tree management methods.

In general, farm visits by extension workers and project personnel are rare. Most of the visits where visitors had brought tree seeds or shown the farmer new management methods were made to tree expert farms in Kibingo in connection with the PAP and PAK projects. While the total

number of farmers having been shown new management methods is too low to make a definite statement, it does appear that it is important that extension workers or others visit the farm to demonstrate such methods using the farmers' own trees in order to increase to possibility of adoption of such methods.

Tree experts are more active in asking help in case of problem on the farms, seeking new ideas and technologies, and discussing their experiences with others. In both groups, farmers most frequently consult the *agronome de commune* for help if they encounter problems with crops, animals or trees, followed by the veterinary assistant. Experts and comparison farmers in Maraba and Simbi are more likely to ask assistance to the *agronome* or the veterinary assistant than their colleagues in Kibingo. Tree experts are also more open to discuss their experiences with new tree species and tree management practices with others than non-experts, particularly in Maraba and Simbi. Thus, in spite of the presence of two agricultural development projects in Karama *commune* in addition to the government extension service, farmers in Kibingo appear more isolated and closed to discussing their experiences and problems with others.

New agricultural or agroforestry technologies can be accessed by anyone who goes and asks the extension workers for them, but tree experts are more likely to do so than comparison farmers. Thus, a significantly higher percentage of tree experts than comparison farmers had tested new technologies. Within the comparison group, the percentages of farmer collaborators were higher in Maraba and Simbi than in Kibingo for all seven technologies mentioned. In the tree expert group, percentages of collaborators were higher in Kibingo only for the three technologies specifically promoted by the PAK and PAP projects (tree species, tree management methods and terracing), although the observed number of collaborators is not significantly different from those in Maraba and Simbi.

4. Summary and conclusion

There are parallels in what constitutes "being knowledgeable" in the endogenous and scientific knowledge systems. The characteristics that farmers provided to describe their experts (intelligence, experience, putting information into practice, and communication) are similar to

what westerners use to describe their scientists and researchers. In both societies, we find a differentiation of knowledge between individuals according to age, gender, abilities, interests, motivation, etc. Where indigenous experts and western-trained researchers do differ is in the nature and content of their knowledge (i.e. what facts are important to know and what each of them knows, respectively), the methods used to generate new knowledge, and the ways to store and communicate this knowledge. It is especially in the latter two aspects (knowledge storage and communication) that the scientific knowledge system excels and the endogenous knowledge system lags. Farmers did recognize the near absence of a mechanism of knowledge communication as a major handicap for advancing their knowledge. However, in absence of conferences, workshops, journals, information super-highways and dirt roads, researchers would feel just as isolated and constraint in increasing their and their discipline's knowledge. Therefore, to stimulate endogenous knowledge generation and technology development, it would be necessary to create appropriate communication networks between experimenting farmers amongst each other and between them and the general farm population.

This study has looked at rwandan farmers knowledge of and experimentation with trees and tree cultivation using a group locally identified tree experts as the main source of information. As was seen in Chapter IV, these tree experts generally are older and more experienced farmers who can muster greater resources (land, labor and animals) than general farm population represented in the comparison group. Tree experts are, therefore, better able to absorb the risks associated with experimentation with new ideas and technologies. However, not all experts do have extensive resources. A few comparison farmers do have more land, labor and animals than some tree experts, but are not recognized as being knowledgeable about trees. Being a tree expert or not is not only a question of having resources and the ability to take risk, but more a question of the willingness to do so and having an internal drive or motivation to discover, to innovate and leave something to improve the life of one's posterity. In addition, tree experts are better informed through travel and observance of new species and practices during those travels, more aggressive in seeking help and advice from extension and veterinary services, and more active in seeking and obtaining new technologies such as improved seeds, new cropping methods, fertilizers, lime and tree species. They also are more open and willing to discuss their experiences with them with other farmers and extension personnel. These characteristics of the

local tree experts form the context for the discussion on farmer experimentation and experimental methods in Chapter VIII.

Before turning to that discussion, the next chapter will look at the results of an inventory of all *ibiti* grown on the farms of tree experts and comparison farmers. As nearly all farmers were found to cultivate trees on their land, we must assume that these farmers have some knowledge of trees and tree cultivation. Are the tree experts, therefore, truly the most knowledgeable about agroforestry? If so, are there differences in the nature of knowledge between the two groups? Also, some background on the agroforestry systems practiced by the farmers in the study areas will be helpful in clarifying experimental methods and farmer tree research strategies. In the following chapter, we intend to answers the above questions and explain the complex and diverse nature of rwandan agroforestry systems.

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CHAPTER VII

SPECIES DIVERSITY IN INDIGENOUS AGROFORESTRY SYSTEMS: BRINGING ORDER IN PERCEIVED CHAOS

1. Introduction

According to Everaerts (1939), Rwanda was almost completely forested before the arrival of the Tutsi pastoralists in the 1500's. Schoenbrun, in a historical linguistic study on agriculture between the Great Lakes of East Africa, disputed this finding, stating that deforestation may have begun as far back as 500 B.C. (Schoenbrun 1990 and 1993). It is undisputed, though, that the amount of forest resources in Rwanda has steadily declined, especially since the beginning of this century due to rapid population growth, a limited land base, and growing competition for resources (Gatera 1980; Nwafor 1979; Runyinya 1980). Yet, in spite of the severe deforestation resulting in dwindling forest acreage, the cultivation and management of woody species on farm has actually increased over the years, particularly in the last 30 years. Whereas pre-Independence people depended largely upon the natural vegetation in the landscape to meet their needs for tree products, farmers now actively plant and manage trees and shrubs on their land to provide a wide array of products and services such as fruits, medicines, fibers, fodder, fences, boundary markers and staking materials (see discussion on indigenous agroforestry practices in Chapter V). The encouragement of tree cultivation since the 1930's, first by the Belgian colonial administrators, and, since Independence, by the various governments of Rwanda (particularly since 1973) often with assistance of development projects, also helped in changing people from only being tree-consumers to becoming tree producers in addition to consumers. The combined effects of both farmers' efforts and external pressure to plant more trees in recent decades have resulted in an increase in the total number of trees in the landscape and the complex agroforestry systems found in Rwanda today (Balasubramanian & Egli 1986 and 1989; Baumer & Runyinya 1987; Egger 1986; Hummel 1988; N'Diaye 1988; Pinner 1988; Tassin 1989). This chapter will present evidence of the complexity of contemporary agroforestry systems using the results of a tree inventory undertaken as part of this study. The methods used to collect the information is described in Section 6.5. in Chapter II.

Farmers considered "being knowledgeable about trees and tree cultivation" to be synonymous with having a large diversity of tree species on one's farm. As we saw in Chapter I, *ubumenyi* implies having knowledge/experience of many different things since knowledge/experience with a limited number of notions (objects, ideas) cannot be constituted under the term *ubumenyi*. Thus, informants interviewed during the ranking game used species diversity as a proxy for the criterion "being knowledgeable about trees and tree cultivation" (see Chapter III). The formal inventory of all tree species on consultants (both tree experts and comparison farmers) farms will, therefore, also serve to verify the validity of using species diversity as a proxy variable.

As the objective of the research was to obtain an "emic" perspective of agroforestry, what was to be included as a "tree" was determined by the farmers themselves. Consultants were asked to show us all the trees (*ibiti* sing. *igiti* in Kinyarwanda) they cultivated on their farm. Many species thus identified do not qualify as "trees" in the western epistemological sense, but were in accord with the translation of the word *ibiti* Kagame (1958) provided in his dissertation La philosophie bantu-rwandaise de l'être: plants that are not grasses.[1]

2. Results and discussion

2.1. Species diversity

A total of 152 tree species [*ibiti*] were found on the farms of the two samples studied. Including trees observed during visits and guided tours of farms undertaken during the ranking game, 193 species were found on and around farms in the three study areas. This diversity of species is remarkable as most farmers said that there were no or few trees on the land when they started farming. Indeed, when older people were asked to compare the vegetation at present with that of their youth, all stated that there are many more trees now in and around the farm and in the general landscape than when they were young. The only trees they remember being present on the farm were those planted on the *rugo* and between the bananas immediately surrounding the

[1]In contrast, the word grasses (*ibyatsi*) is described as : plants that are not trees (*Les végétaux non-arbres*).

rugo. All species presently found on the farm, therefore, have been purposively planted and managed by the farmers in the last two to three decades. The reason for planting and maintaining so many different tree species is to meet the diverse needs for tree products (fuelwood, poles, lumber, food, fruit, stakes, medicines, etc.). While wood needs could be satisfied with few species, for medical problems it is necessary to plant many different species to treat the many diseases and parasites from which people and animals suffer. Because of this great species diversity, the tables presented in this paper use combined statistics for each group and/or *secteur*. A complete list of all species encountered on consultants' farms during the ten months research period, giving both the names in Kinyarwanda and their Latin equivalents, is found in Appendix VII-1. Appendix VII-2 provides a list of the average number of trees/species found on the farms of tree experts and comparison farmers and the number of occurrences of each species, disaggregated by *secteur*.

2.1.1. Diversity differences between experts and comparison farmers

Tree experts have a greater diversity of tree species on their farms (average 34 species) than comparison farmers (average 12 species) (see Table 17). The difference in the number of species per farm is highly significant. In part, this can be attributed to the way tree experts were identified. Since there is no equivalent term for "knowledgeable" in Kinyarwanda, we had to use a description of what we meant by "knowledgeable about trees" during the ranking game: people who know many trees; people who know how to plant, cultivate and use trees very well; people who have many trees on their farm; people who have many different tree species on their farm. Emphasis was particularly given to the latter aspect (tree diversity). While not exactly known at the time, later discussions in group meetings confirmed that knowledge is gained through experience, and that experience with many different tree species is more important to gain expertise and knowledge than just having many trees of a few species. This is conform the findings of Kagame (1958). It is also confirmed by the figures in Table 17, which show that the number of trees per species is greater in the comparison farmer group than in the tree expert

Table 17: Mean number of trees per species (all species combined), mean number of species and mean number of trees on the different groups of fields.

	Comparison farmers				tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
RUGO								
Mean trees/species	7	23 c	22 e	15 a	7	22 c,d	10	10 a
Standard Deviation	11	46	54	36	13	41	26	24
Maximum	83	250	300	300	75	200	210	210
n farmers	35	15	15	65	22	11	11	44
Avg. no. species on bloc	4.6	5.5	4.9	4.9	9.7 c	5.7	7.1	8.0 A,b
Avg. no. trees on bloc	32	127	108	74	68	125	71	81
FOOD CROP FIELDS								
Mean trees/species	21	19	18	20	17	13	13	15
Standard Deviation	46	56	43	48	42	27	35	38
Maximum	370	460	274	460	371	168	260	371
n farmers	34	17	18	69	20	6	7	33
Avg. no. species on bloc	5.1	7.1 c	6.7	6.0	17.1	17.2	15.6	16.8 A
Avg. no. trees on bloc	107	135	121	120	291	224	203	252
BANANA FIELDS								
Mean trees/species					19	13	11	14
Standard Deviation					39	26	29	30
Maximum					215	170	230	230
n farmers					3	8	6	17
Avg. no. species on bloc					17.7	15.1	15.0	15.5 A
Avg. no. trees on bloc					336	196	165	217
WOODLOTS								
Mean trees/species	102	38	143	96	88 e	46	28	71 b
Standard Deviation	212	55	304	208	214	131	49	184
Maximum ++	999	200	999	999	999	874	240	999
n farmers	21	4	5	30	22	11	9	42
Avg. no. species on bloc	3.0	3.5	2.0	2.9	11.0 e	7.8	5.4	8.9 A,b
Avg. no. trees on bloc	306	133	286	278	968	359	151	632
TOTAL								
Mean tree/species	28	22	26	26	35 c,e	22	14	27 a
Standard Deviation	93	52	84	82	122	69	35	98
Maximum ++	999	460	999	999	999	874	260	999
n species/cases	396	218	202	816	846	373	325	1544
Avg. no. species on farm	11.4	12.8	11.3	11.7	38.7	33.9	29.6	34.4 A
Avg. no. trees on farm	319	282	294	304	1355	746	414	929
Est. avg. farm size(are)	24 c	11	14	18a	213 c,e	53	37	127 A,a
Avg. no. trees/hectare	1329	2564	2100	1689	636	1408	1119	731

A=between group difference significant at p<.01
B=between group difference significant at P<.05

++ 999 is a dummy variable used when a large number of trees could not be counted exactly

a=within group difference significant at P<.01
b=within group difference significant at P<.05
c=difference between Kibingo and Maraba significant at P<.05
d=difference between Maraba and Simbi significant at P<.05
e=difference between Kibingo and Simbi significant at P<.05

group in each of the different blocs inventoried[2], although the differences between expert and comparison groups are not significant. However, within each group there are some significant differences in number of trees/species between *secteurs*. The mean number of species cultivated on each bloc of the farm is significantly higher ($p < .01$) on the tree expert farms than on the comparison farmer farms. Species diversity is particularly high on the food crop fields and the banana fields of the tree experts, with an average of 16.8 and 15.5 species, respectively. Woodlots of comparison farmers have little diversity (three species on average); in addition, less than half the farmers in this group have a woodlot (two-thirds of the comparison farmers in Kibingo and about one-quarter of the comparison farmers in Maraba have a woodlot). In contrast, almost all tree experts had woodlots, the exception being two experts in Simbi.

2.2. Tree tenure and tree planting

In both groups, more than four-fifths of all trees are owned and planted by men (male heads of the household) (see Tables 18a and b). Wives plant 4.4% of all tree species, but own only 2.6% in the comparison farmer group and 3.8% in the tree expert group. In local custom, women cannot plant trees, except those providing medicines or food/fruit. This is in accord with women's traditional role of feeding and caring for the family. Female heads of households do plant and own more trees than wives, because (1) they function as caretakers of the farms after their husbands die and before sons take over the land as inheritance, (2) they have to provide for the family, and (3) they are equated with men and are allowed to both make farm management decisions and to plant trees including those providing fuelwood and timber. In this sense, single women (female heads of household) are equated with men ("*Les femmes sans maris sont des hommes*"). Since more women among the comparison farmers are single, they own more trees (15.9%) than their counterparts in the tree expert group (8.7%). This difference in tree ownership does not result from women's tree planting activities, where both categories of women planted an equal number and proportion of tree species. This can be explained by the fact that (1) single women do not plant any more trees after their husbands die or divorce them, and (2)

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[2]While farmers in the comparison group do grow bananas, the number of stems was usually very small. On a percentage basis, the area index of associated crops was higher than for bananas, thus these fields were classified as food crop fields rather than banana fields.

Table 18a: Tree ownership according to who planted the species, comparison farmers (n=number of species-cases).

TREE TENURE STATUS	Who planted the species?							TOTAL
	MALE HEAD OF HOUSEHOLD	FEMALE HEAD OF HOUSEHOLD	WIFE	HUSBAND AND WIFE	CHILDREN	OTHER	WHOLE FAMILY	n=821
MALE HEAD OF HOUSEHOLD	493		20		11	33	5	562
Column Percent	86.9%		64.5%		50.0%	86.8%	50.0%	80.4%
Row Percent	87.7%		3.6%		2.0%	5.9%	0.9%	100.0%
FEMALE HEAD OF HOUSEHOLD	57	30	7		9	3	5	111
Column Percent	10.1%	100.0%	22.6%		40.9%	7.9%	50.0%	15.9%
Row Percent	51.4%	27.0%	6.3%		8.0%	2.7%	4.5%	100.0%
WIFE	12		4	1	1			18
Column Percent	2.1%		12.9%	100.0%	4.5%			2.6%
Row Percent	66.7%		22.2%	5.6%	5.6%			100.0%
CHILDREN					1			1
Column Percent					4.5%			.1%
Row Percent					100.0%			100.0%
OWNER OF THE FIELD						2		2
Column Percent						5.3%		.3%
Row Percent						100.0%		100.0%
OTHER	5							5
Column Percent	.9%							.7%
Row Percent	100.0%							100.0%
TOTAL	567	30	31	1	22	38	10	699
Column Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Row Percent	81.1%	4.3%	4.4%	0.1%	3.1%	5.4%	1.4%	100.0%
NATURALLY SEEDED								122
% of all tree species								14.9%

Table 18b Tree ownership according to who planted the species, tree experts (n=number of species-cases).

TREE TENURE STATUS	Who planted the species?							TOTAL
	MALE HEAD OF HOUSEHOLD	FEMALE HEAD OF HOUSEHOLD	WIFE	HUSBAND AND WIFE	CHILDREN	OTHER	WHOLE FAMILY	n=1551
MALE HEAD OF HOUSEHOLD	882	1	23	3	13	48	5	975
Column Percent	92.0%	1.9%	44.2%	75.0%	39.4%	73.8%	100.0%	83.3%
Row Percent	90.5%	0.1%	2.4%	0.3%	1.3%	4.9%	0.5%	100.0%
FEMALE HEAD OF HOUSEHOLD	31	50	3	1	10	7		102
Column Percent	3.2%	94.3%	5.8%	25.0%	30.3%	10.8%		8.7%
Row Percent	30.4%	49.0%	2.9%	1.0%	9.8%	6.9%		100.0%
WIFE	15	1	25		3			44
Column Percent	1.6%	1.9%	48.1%		9.1%			3.8%
Row Percent	34.0%	2.3%	56.8%		6.8%			100.0%
ALL HOUSEHOLD MEMBERS TOGETHER	27	1	1			10		39
Column Percent	2.8%	1.9%	1.9%			15.4%		3.3%
Row Percent	69.2%	2.6%	2.6%			25.6%		100.0%
CHILDREN	3				7			10
Column Percent	.3%				21.2%			.9%
Row Percent	30.0%				70.0%			100.0%
OWNER OF THE FIELD	1							1
Column Percent	.1%							.1%
Row Percent	100.0%							100.0%
TOTAL	959	53	52	4	33	65	5	1171
Column Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Row Percent	81.9%	4.5%	4.4%	0.3%	2.8%	5.6%	0.4%	100.0%
NATURALLY SEEDED								380
% of all tree species								24.5%

such women rely more on their children and outside (hired) labor for tree planting and maintenance. The increasing reliance on children and outside help for tree maintenance and harvesting activities is not restricted to trees owned by women only, as shown in the tables in Appendices VII-3 and VII-4. Men continue to provide most labor involved for both maintenance (68% in the comparison farmer group and 66% in the tree expert group respectively) and harvesting of trees (43% and 40% respectively). But even for trees owned by men, an increasing role is played by children and others (mostly hired labor) in tree maintenance, and of women, children and others in tree harvesting. Children's labor is especially important in female headed households, where they provide the bulk of these chores: about 50% of the species are maintained by children, and about a third are harvested by them. In total, children maintain and harvest 14-15% of all trees, these percentages being about equal in both the tree expert and comparison farmer groups. Thus, while tree planting remains largely an adult male activity, the activities of tree maintenance, management and harvesting increasingly involve other household members, particularly children.

It should be noted that 54% of all tree species in the tree expert group and 21% of all tree species in the comparison farmer group are not maintained, either because they are still too young or do not require any management in the farmers' opinion. As mentioned previously, many trees would be classified as annuals or perennials in the Western scientific system, and may therefore not need much maintenance (pruning, coppicing etc.). Similarly, 16% of all tree species of the comparison farmers and 13.3% of all tree species in the tree expert group are not harvested, principally because the trees are still too immature to provide any usable products or services.

2.3. Reasons for planting trees

There are differences in reasons for planting trees between both tree experts and comparison farmers as well as between the various persons who planted the trees within each group. For farmers in the comparison group, the main reasons given for planting certain species indicate a direct necessity for tree products: fuelwood, construction poles, lumber and food (see Table 19a). Medicines are less important overall, but are an important reason for women to plant trees as they are the main providers of health care within the family and the keepers of the household

"medicine cabinet." Service functions and more intangible, indirect tree benefits (erosion comparison, climate amelioration, beneficial for associated crops, bee keeping, religious purposes, source of revenue) are less mentioned as reasons for planting trees. While men planted trees primarily to provide fuelwood, timber, lumber and to construct the *rugo*, women planted the trees mostly to feed and heal the family. However, in female headed households the reasons are more varied because of the many needs of the household for which these women are responsible. Trees planted by the whole family (men, women and/or children) and those planted by children are almost exclusively fruit trees to supplement and add variety to the diet.

Reasons given for planting trees in the tree expert group are similar to the reasons given by the comparison farmers: to provide food, fuelwood, money and medicine for the family and its members. However, tree experts emphasized the service functions and more intangible benefits were more often as reasons for having planted trees (13.5% of all reasons given) than farmers in the comparison group (8.3%) (see Table 19b). Planting trees for medicinal purposes is much more prominent for women in the tree expert group than in the comparison farmer group, with food the second most important reason. This is a reversal of the order of reasons given by women in the comparison farmer group. Again, female heads of households show a greater diversity of reasons for tree planting than wives. As in the comparison farmer group, children of tree experts plant trees primarily for the food they provide. But, in contrast to children of the comparison farmers, their reasons for planting also include future benefits that those trees may provide (fuelwood, timber, construction poles, medicines). Tree experts farms are generally larger than those of farmers in the comparison group; the former, therefore, can afford to devote more land to medicinal trees, and to give some land to children for tree planting and agricultural activities even before the land is officially given to them as inheritance. Comparison farmers do not have such luxury, and need all the land they have to provide food for the family; thus the planting of fruit and other trees by children providing direct benefits to the family's diet is allowed, but not of other trees.

Traditional religion was scarcely mentioned by either group and may be due to the pervasiveness of Christianity. However, many tree species important in traditional religion (*kubaandwa*) also have medicinal properties, and many healing practices are strongly interwoven with traditional

Table 19a: Reasons for planting various tree species according to who planted them, comparison farmers.

REASONS WHY PLANTED:	Who planted the species?							TOTAL
	MALE HEAD OF HOUSEHOLD	FEMALE HEAD OF HOUSEHOLD	WIFE	HUSBAND AND WIFE	CHILDREN	OTHER	WHOLE FAMILY	
BENEFICIAL FOR CROPS	21	2				1	1	25
Cases Percent	1.9%	3.9%				1.6%	6.7%	1.9%
PROTECTS THE SOIL	13							13
Cases Percent	1.2%							1.0%
MATERIAL FOR NON-AG ACTIVITIES	184	6	1			6	2	199
Cases Percent	16.5%	11.8%	3.2%			9.4%	13.3%	15.3%
SOURCE OF REGULAR REVENU	54	2		1		5	1	63
Cases Percent	4.9%	3.9%		100.0%		7.8%	6.7%	4.8%
TRADITIONAL RELIGION	7	1						8
Cases Percent	.6%	2.0%						.6%
SOURCE OF HUMAN FOOD	105	12	19		16	3	8	163
Cases Percent	9.4%	23.5%	61.3%		64.0%	4.7%	53.3%	12.5%
SOURCE OF ANIMAL FOOD	61	2				3		66
Cases Percent	5.5%	3.9%				4.7%		5.1%
CONSTRUCTION MATERIAL	93	4	1		1	7		106
Cases Percent	8.4%	7.8%	3.2%		4.0%	10.9%		8.2%
FUEL FOR COOKING AND NON-AG ACTIVITIES	247	8			3	21	2	281
Cases Percent	22.2%	15.7%			12.0%	32.8%	13.3%	21.6%
BOUNDARY MARKER	29					9		38
Cases Percent	2.6%					14.1%		2.9%
CONSTRUCTION OF THE RUGO	172	6			3	4		185
Cases Percent	15.5%	11.8%			12.0%	6.3%		14.2%
TRADITIONAL MEDICINE	73	8	10		2	3		96
Cases Percent	6.6%	15.7%	32.3%		8.0%	4.7%		7.4%
OTHER	54					2	1	57
Cases Percent	4.9%					3.1%	6.7%	4.4%
TOTAL	562	30	31	1	22	36	10	692
Count Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Responses Percent	198.0%	170.0%	100.0%	100.0%	113.6%	125.0%	180.6%	187.9%

NOTE: Up to three reasons could be mentioned for each species.

Table 19b: Reasons for planting various tree species according to who planted them, tree experts.

REASONS WHY PLANTED:	Who planted the species?							TOTAL
	MALE HEAD OF HOUSEHOLD	FEMALE HEAD OF HOUSEHOLD	WIFE	HUSBAND AND WIFE	CHILDREN	OTHER	WHOLE FAMILY	
BENEFICIAL FOR CROPS	63	2	3		1	3	1	73
Cases Percent	3.4%	2.5%	4.3%		1.9%	2.4%	11.1%	3.3%
BENEFICIAL FOR CLIMAT	4							4
Cases Percent	.2%							.2%
PROTECTS THE SOIL	92	2	4		2			100
Cases Percent	5.0%	2.5%	5.8%		3.8%			4.6%
MATERIAL FOR NON-AG ACT.	268	6			5	28	1	308
Cases Percent	14.5%	7.6%			9.6%	22.2%	11.1%	14.1%
SOURCE OF REGULAR REVENU	59	2		1	1	4		67
Cases Percent	3.2%	2.5%		16.7%	1.9%	3.2%		3.1%
TRADITIONAL RELIGION	32				2	1		35
Cases Percent	1.7%				3.8%	.8%		1.6%
SOURCE OF HUMAN FOOD	222	10	18	3	25	7	4	289
Cases Percent	12.0%	12.7%	26.1%	50.0%	48.1%	5.6%	44.4%	13.2%
SOURCE OF ANIMAL FOOD	136	3	2		2	10		153
Cases Percent	7.4%	3.8%	2.9%		3.8%	7.9%		7.0%
CONSTRUCTION MATERIAL	128	2			2	20	1	153
Cases Percent	6.9%	2.5%			3.8%	15.9%	11.1%	7.0%
FUEL	325	8	5		6	24	2	370
Cases Percent	17.6%	10.1%	7.2%		11.5%	19.0%	22.2%	16.9%
BOUNDARY MARKER	76	1	2			3		82
Cases Percent	4.1%	1.3%	2.9%			2.4%		3.8%
CONSTRUCTION OF THE RUGO	144	1	2			5		152
Cases Percent	7.8%	1.3%	2.9%			4.0%		7.0%
TRADITIONAL MEDICINE	219	37	29	2	3	17		307
Cases Percent	11.9%	46.8%	42.0%	33.3%	5.8%	13.5%		14.1%
BEE-KEEPING	15					1		16
Cases Percent	.8%					.8%		.7%
OTHER	60	5	4		3	3		75
Cases Percent	3.2%	6.3%	5.8%		5.8%	2.4%		3.4%
TOTAL	957	53	51	4	33	65	5	1168
Count Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Responses Percent	192.6%	149.1%	135.3%	150.0%	157.6%	193.0%	180.0%	187.0%

NOTE: Up to three reasons could be mentioned for each species.

religious practices. It was perhaps out of secrecy or out of shame that religious purposes were not cited more often, because, according to a recent study by Taylor (1992), traditional religious practices are still common in Rwanda.

2.4. Comparing reasons for planting with actual use of trees

In Tables 20a and b, a comparison is made of the reasons for originally planting various species and how these species presently are used. These tables show that while most trees are used according to their original intent (for example, most trees planted for fuelwood are also used for fuelwood), they are also used for many other purposes. Medicinal trees are the most precise in their use, but even they are being diverted for other uses. Actual uses change and use pressure increases over time as needs and circumstances change, particularly as farm sizes continue to decrease leading to increasing competition between crops and trees for a limited land base. Thus, the necessity for multipurpose trees, which becomes more acute as farm sizes decrease. This does not mean that all uses have to be known or that the multipurpose character of a tree species has to be clearly established before a new species is introduced. Farmers are capable of adapting existing resources to new opportunities; an example of this creativity is the "invention" of producing stakes from existing tree species (especially from Grevillea robusta, but also from Cupressus lusitanica and Pinus spp) after the introduction of climbing beans in 1987 (Twahirwa 1992).

An overview of which species are actually used by farmers for various purposes is provided in Table 21. This table shows the total number of species used for a particular purpose (for example, 60 species were reported being used for fuelwood), and the most important species used for that purpose (in the case of fuelwood, Grevillea robusta, Eucalyptus spp, Vernonia amygdalina, Euphorbia tirucalli, Cupressus spp, Acanthus pubescens and Ficus thonningii). The species that are underlined are those that are used for that purpose by more than 50% of the total number of consultants in the two samples combined (the first four species in the above list).

The data in Table 21 indicate that two-thirds of the total number of species inventoried on consultants' farms are used for medicinal purposes (106 species out of a total of 152). As the

Table 20a: Reasons for planting various species versus their actual use, comparison farmers.

SPECIES UTILIZATION	Why were species planted							
	BENEFICIAL FOR CROPS	PROTECTS THE SOIL	MATERIAL FOR NON-AG ACTIVITIES	SOURCE OF REGULAR REVENU	IMPORTANCE IN TRADITIONAL RELIGION	SOURCE OF HUMAN FOOD	SOURCE OF ANIMAL FOOD	CONSTRUCTIO N MATERIAL
FUELWOOD	11	10	96		3	21	28	40
Responses Percent	42.3%	76.9%	48.0%		37.5%	13.0%	41.8%	37.7%
CONSTRUCTION POLES	5	3	21	1		1	9	32
Responses Percent	19.2%	23.1%	10.5%	1.6%		.6%	13.4%	30.2%
CARPENTRY WOOD	9	4	89	1	2	4	10	28
Responses Percent	34.6%	30.8%	44.5%	1.6%	25.0%	2.5%	14.9%	26.4%
HOUSEHOLD OBJECTS	1		43	1	1	4	8	
Responses Percent	3.8%		21.5%	1.6%	12.5%	2.5%	11.9%	
FOOD	1		3	22		103	1	
Responses Percent	3.8%		1.5%	34.9%		63.6%	1.5%	
YEAST FOR BEER	1	2	6			29	18	2
Responses Percent	3.8%	15.4%	3.0%			17.9%	26.9%	1.9%
FODDER	1	6	16			3	41	1
Responses Percent	3.8%	46.2%	8.0%			1.9%	61.2%	.9%
STAKES	10	6	56			1	6	36
Responses Percent	38.5%	46.2%	28.0%			.6%	9.0%	34.0%
MEDICINES	1	3	5	2	1	22	12	3
Responses Percent	3.8%	23.1%	2.5%	3.2%	12.5%	13.6%	17.9%	2.8%
FENCES, BOUNDARIES		1	13			6	5	2
Responses Percent		7.7%	6.5%			3.7%	7.5%	1.9%
COMPOST, MULCH	10	4	18			1	1	23
Responses Percent	38.5%	30.8%	9.0%			.6%	1.5%	21.7%
CARPETS, MATS, ROPES	1	1	12				12	2
Responses Percent	3.8%	7.7%	6.0%				17.9%	1.9%
OTHER	1		3	1	1			
Responses Percent	3.8%		1.5%	1.6%	12.5%			
TOTAL No. OF CASES	21	13	163	25	5	132	58	74
Responses Percent	200.0%	307.7%	190.5%	44.4%	100.0%	120.4%	225.4%	159.4%

Continued on the next page.

Table 20a: Continued.

SPECIES UTILIZATION	Why were species planted					TOTAL
	FUEL FOR COOKING AND NON-AG ACTIVITIES	BOUNDARY MARKER	CONSTRUCTION OF THE RUGO	TRADITIONAL MEDICINE	OTHER	
FUELWOOD	171	13	66	27	7	194
Responses Percent	60.6%	34.2%	35.3%	27.8%	12.5%	70.8%
CONSTRUCTION POLES	40	2	17	3		51
Responses Percent	14.2%	5.3%	9.1%	3.1%		19.3%
CARPENTRY WOOD	82	5	23	1	4	105
Responses Percent	29.1%	13.2%	12.3%	1.0%	7.1%	37.6%
HOUSEHOLD OBJECTS	19	4	9	4		43
Responses Percent	6.7%	10.5%	4.8%	4.1%		13.5%
FOOD	6			5	2	114
Responses Percent	2.1%			5.2%	1.8%	20.5%
YEAST FOR BEER	31	2	35	26	19	69
Responses Percent	11.0%	5.3%	18.7%	26.8%	33.9%	24.6%
FODDER	12		20	8	1	42
Responses Percent	4.3%		10.7%	8.2%	1.8%	15.7%
STAKES	67		5	2	21	75
Responses Percent	23.8%		2.7%	2.1%	37.5%	30.2%
MEDICINES	24	2	24	73	1	79
Responses Percent	8.5%	5.3%	12.8%	75.3%	1.8%	24.9%
FENCES, BOUNDARIES	28		73	16	1	76
Responses Percent	9.9%		39.0%	16.5%	1.8%	20.8%
COMPOST, MULCH	30		2		9	37
Responses Percent	10.6%		1.1%		16.1%	14.1%
CARPETS, MATS, ROPES	11		10		6	20
Responses Percent	3.9%		5.3%		10.7%	7.9%
OTHER	2	1	2		2	8
Responses Percent	.7%	2.6%	1.1%		3.6%	1.9%
TOTAL No. OF CASES	229	16	137	77	56	502
Responses Percent	185.5%	76.3%	152.9%	170.1%	128.6%	301.7%

NOTE: Up to five uses and three reasons for why a species was planted could be mentioned per species.

Table 20b: Reasons for planting various species versus their actual use, tree experts.

SPECIES UTILIZATION	Why were species planted							
	BENEFICIAL FOR CROPS	BENEFICIAL FOR THE CLIMAT	PROTECTS THE SOIL	MATERIAL FOR NON-AG ACTIVITIES	SOURCE OF REGULAR REVENU	IMPORTANCE IN TRADITIONAL RELIGION	SOURCE OF HUMAN FOOD	SOURCE OF ANIMAL FOOD
FUELWOOD	39	1	75	212	12	11	63	78
Responses Percent	53.4%	25.0%	75.0%	68.8%	17.6%	30.6%	21.8%	50.6%
CONSTRUCTION POLES	14		35	95	4	1	3	27
Responses Percent	19.2%		35.0%	30.8%	5.9%	2.8%	1.0%	17.5%
CARPENTRY WOOD	19	1	49	232	2	11	8	21
Responses Percent	26.0%	25.0%	49.0%	75.3%	2.9%	30.6%	2.8%	13.6%
HOUSEHOLD OBJECTS	4		1	69	2	5	22	20
Responses Percent	5.5%		1.0%	22.4%	2.9%	13.9%	7.6%	13.0%
FOOD	9	2	8	9	59	4	236	4
Responses Percent	12.3%	50.0%	8.0%	2.9%	86.8%	11.1%	81.7%	2.6%
YEAST FOR BEER	6		18	14		1	39	42
Responses Percent	8.2%		18.0%	4.5%		2.8%	13.5%	27.3%
FODDER	11		24	30	1	1	19	130
Responses Percent	15.1%		24.0%	9.7%	1.5%	2.8%	6.6%	84.4%
STAKES	34	1	33	106	2	3	11	40
Responses Percent	46.6%	25.0%	33.0%	34.4%	2.9%	8.3%	3.8%	26.0%
MEDICINES	4		14	14	7	8	57	37
Responses Percent	5.5%		14.0%	4.5%	10.3%	22.2%	19.7%	24.0%
FENCES, BOUNDARIES	3		10	17	1	5	14	25
Responses Percent	4.1%		10.0%	5.5%	1.5%	13.9%	4.8%	16.2%
COMPOST, MULCH	31	1	17	51	3	1	10	9
Responses Percent	42.5%	25.0%	17.0%	16.6%	4.4%	2.8%	3.5%	5.8%
CARPETS, MATS, ROPES	3		1	18				13
Responses Percent	4.1%		1.0%	5.8%				8.4%
OTHER	8	2	11	8	2	7	13	3
Responses Percent	11.0%	50.0%	11.0%	2.6%	2.9%	19.4%	4.5%	1.9%
TOTAL No. OF CASES	71	4	99	308	68	33	289	154
Responses Percent	253.4%	200.0%	296.0%	284.1%	139.7%	161.1%	171.3%	291.6%

Continued on the next page.

Table 20b: Continued.

SPECIES UTILIZATION	Why were species planted							TOTAL
	CONSTRUCTION MATERIAL	FUEL FOR COOKING AND NON-AG ACTIVITIES	BOUNDARY MARKER	CONSTRUCTION OF THE RUGO	TRADITIONAL MEDICINE	BEE-KEEPING	OTHER	
FUELWOOD	122	331	36	83	60	5	29	473
Responses Percent	79.7%	89.5%	43.4%	54.6%	19.4%	31.3%	39.7%	98.7%
CONSTRUCTION POLES	118	118	4	38	7	1	9	179
Responses Percent	77.1%	31.9%	4.8%	25.0%	2.3%	6.3%	11.0%	40.4%
CARPENTRY WOOD	101	184	22	35	5	4	27	291
Responses Percent	66.0%	49.7%	26.5%	23.0%	1.6%	25.0%	37.0%	61.5%
HOUSEHOLD OBJECTS	6	21	9	17	14	1	4	96
Responses Percent	3.9%	5.7%	10.8%	11.2%	4.5%	6.3%	5.5%	16.6%
FOOD		40		6	33	1	3	269
Responses Percent		10.8%		3.9%	10.7%	6.3%	4.1%	35.3%
YEAST FOR BEER	3	37	16	26	53	3	11	115
Responses Percent	2.0%	10.0%	19.3%	17.1%	17.2%	18.8%	15.1%	23.0%
FODDER	5	39	3	46	35	2	9	161
Responses Percent	3.3%	10.5%	3.6%	30.3%	11.3%	12.5%	12.3%	30.3%
STAKES	64	110	8	29	18	1	34	200
Responses Percent	41.8%	29.7%	9.6%	19.1%	5.8%	6.3%	46.6%	42.2%
MEDICINES	2	37	29	25	294	5	14	335
Responses Percent	1.3%	10.0%	34.9%	16.4%	95.1%	31.3%	17.8%	46.7%
FENCES, BOUNDARIES	11	26	24	73	31	2	4	134
Responses Percent	7.2%	7.0%	28.9%	48.0%	10.0%	12.5%	5.5%	21.0%
COMPOST, MULCH	43	67	3	6	4		17	102
Responses Percent	28.1%	18.1%	3.6%	3.9%	1.3%		23.3%	22.4%
CARPETS, MATS, ROPES	1	3	1	4	2		5	23
Responses Percent	.7%	.8%	1.2%	2.6%	.6%		6.8%	4.4%
OTHER	6	16	6	8	12	3	22	58
Responses Percent	3.9%	4.3%	7.2%	5.3%	3.9%	18.8%	27.4%	10.8%
TOTAL No. OF CASES	153	370	80	150	309	12	75	1158
Responses Percent	315.0%	278.1%	194.0%	260.5%	183.8%	175.0%	252.1%	453.3%

NOTE: Up to five uses and three reasons for why a species was planted could be mentioned per species.

Table 21: Total number of species and most important species used for particular purposes.

Utilization	Total No. of species used	Most important species*
Fuelwood	60	Grevillea robusta, Eucalyptus spp, Vernonia amygdalina, Euphorbia tirucalli, Cupressus spp, Acanthus pubescens, Ficus thonningii
Construction poles	27	Eucalyptus spp, Grevillea robusta, Cupressus spp, Vernonia amygdalina
Timber	28	Grevillea robusta, Eucalyptus spp, Cupressus spp, Ficus thonningii, Euphorbia tirucalli
Woodworking	23	Ficus thonningii, Euphorbia tirucalli, Persea gratissima, Clerodendrum rotundifolium, Markhamia lutea
Food, fruit, spices	32	Persea gratissima, Psidium guajava, Coffea spp, Capsicum frutescens, Carica papaya
Mulch	30	Grevillea robusta, Eucalyptus spp, Pavetta ternifolia, Acanthus pubescens, Pinus spp
Yeast for beer	13	Vernonia amygdalina, Euphorbia tirucalli, Vernonia spp
Fodder	32	Ficus thonningii, Vernonia amygdalina, Acanthus pubescens, Draceana afromontana, Leuceana leucocephela
Stakes	43	Grevillea robusta, Cupressus spp, Acanthus pubescens, Vernonia amygdalina, Eucalyptus sp, Clerodendrum johnstonii/fuscum
Medicines	106	Vernonia amygdalina, Euphorbia tirucalli, Tetradenia riparia, Synadenium grantii, Clerodendrum johnstonii/fuscum, Clerodendrum fuscum, Vernonia spp
Fencing	34	Euphorbia tirucalli, Draceana afromontana, Ficus thonningii, Vernonia amygdalina, Cupressus spp, Eucalyptus spp
Shade	4	Persea gratissima, Acacia sieberiana, Manihot glaziovii, Ficus thonningii
Compost	11	Tephrosia vogelii, Crotolaria incana, Vernonia amygdalina, Cajanus cajan
Rope	7	Ficus thonningii, Acacia mearnsii
Carpets/mats	1	Ficus thonningii
Other	38	Erythrina abyssinica, Ricinus communis

* Underline means species used by more than 50% of tree experts and comparison farmers combined.

words for tree (*igiti*) and medicine (*umuti*) share the same radical *-ti*, and as people considered knowledge of trees to be synonymous with knowledge of medicines, the large share of medicinal species is not unexpected. The species most commonly used as medicine (Vernonia amygdalina and Euphorbia tirucalli) are also used as fuelwoods by a majority of consultants, and, to a lesser extent, as yeasts for brewing beer, and for fences. In addition, these two species are used for a number of other purposes. The table, therefore, also gives an indication of the ubiquitous

nature and of the multipurpose character of species. Table 21 also shows that people manage and use a much greater number of tree resources for a particular purpose than commonly assumed. The diversity of species is not only the result of what is ecologically possible to produce on the farm with the available resources (many of the species found occupy specific niches within the farm that are not suitable for cultivation which would otherwise remain unused), but it is a deliberate strategy to spread risk in order to meet unexpected events (drought, flooding, hail storms, diseases, etc.) and economic uncertainties.

2.5. Farm size, diversity and number of trees

The results of the socioeconomic survey discussed in Chapter IV indicated that tree experts have an average farm size of 1.27 hectares, which is significantly different (at $p < .01$) from the size of comparison group farms of 0.18 hectares. For both comparison farmers and tree experts, the total number of trees per farm is greatest in Kibingo as a result of larger farm sizes (0.24 and 2.13 hectares respectively); farm size in this *secteur* is significantly greater than farm sizes in either Maraba (0.11 and 0.53 hectares for comparison farmers and tree experts, respectively) or Simbi (0.14[3] and 0.37 hectares, respectively). Most tree experts in Kibingo obtained their land through land grants from the authorities immediately before and after Independence; according to Noel Macumu (pers. com.), a *Sous-Chef* of Bufundu at the time, Karama was only sparsely populated before Independence, with most land reserved as pasture for the chiefs. The land obtained through grants was usually larger in size than the average farm, particularly in Karama where the slopes are much steeper and the soil quality rather poor. In addition, many of these farms have not yet been subdivided between sons and most retain their original size. In contrast, comparison farmers and the majority of tree experts in Maraba and Simbi obtained their land through inheritance, and much of it has been subdivided since they initially started farming it. The larger farms in Kibingo translate into larger woodlots with a greater number of trees, but simultaneously these farms have less trees on the *rugo* compared to farms in the other two *secteurs* (see Table 17). The inverse relationship between number of trees in woodlots and on the *rugo* is particularly noticeable in the group of comparison farmers. As more woodlots are

[3]The difference in comparison group farm size between Kibingo and Simbi is not significant.

cleared to feed the family and to provide land for sons, more trees are planted on the *rugo* where they do not compete with crops.

While tree experts do have a greater variety of tree species and a greater total number of trees, comparison farmers have an average tree density more than twice that found on tree expert farms: 1689 trees/hectare (ranging from 1329 to 2564) compared to 731 trees/hectare (ranging from 636 to 1408 trees/hectare) (see Table 17). Thus, there seems to be an inverse correlation between land size and number of trees/hectare. Because this study aimed at understanding agroforestry knowledge and how such knowledge is obtained, it focused on the farmers who, in their own view, were the most knowledgeable. As mentioned before, farmers consider experience resulting from cultivating a diversity of species a prerequisite for gaining expertise and knowledge. However, a study of agroforestry systems should perhaps focus on the comparison farmers. Comparison farmers seem to manage much more complex systems with a higher degree of integration of trees and crops on a small piece of land. This demands a higher level of management skills to balance the multiple requirements of the family for food and tree products, making the choice of species more precarious. It also indicates that agroforestry knowledge of the two groups studied may not be the same, at least as can be inferred from the species inventory considered here. Other, mainly socio-economic, factors (discussed previously in Chapter IV) need to be considered to distinguish between tree experts and comparison farmers.

2.6. Locational flexibility and utility indices

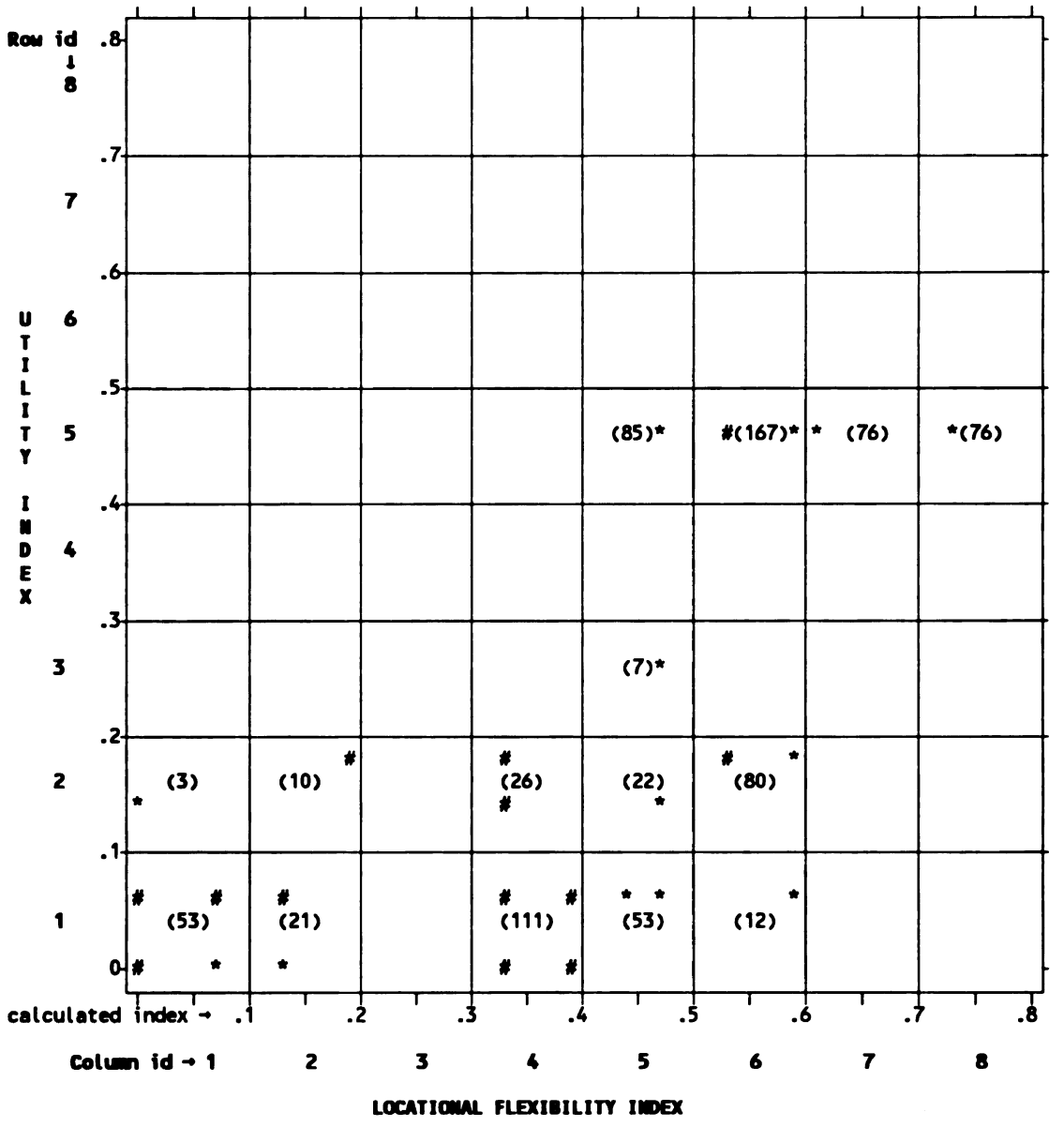
The result of these hard choices for comparison farmers is an agroforestry system with fewer species in total, but with a higher percentage of multipurpose species that are also flexible regarding their location within the farm. This is visualized in Figures 15a and 15b, in which the average locational flexibility index of a species is plotted against its average utility index. These indices were developed by the researcher to capture the enormous diversity of species, species utilizations, and locations of species within the farm in two numbers that would facilitate comparisons between the two groups of farmers. In addition, the indices were to be used to classify the inventoried species in multipurpose and/or multilocational trees, based on the idea

that true agroforestry species would need to have multiple uses for farmers and the ability to be planted at multiple locations within the farm.

The locational flexibility index is defined as the number of locations used by a species across all farms as a fraction of possible locations on a particular bloc, averaged over all blocs. The following locations where trees were located were identified: along the anti-erosion ditches, on bloc borders, in the middle of the bloc, on terrace border, along roads or paths, in a woodlot or orchard, and on the *rugo*. This index is zero (0) when a species is only planted on one particular location in a bloc, indicating the species has no flexibility on where it can or should be planted according to the informants. It may, therefore, not be useful as an agroforestry species. The flexibility index is one (1) if a species on the food crop fields, banana fields or in the woodlots was found on all six possible locations identified. Trees on the *rugo* were an exception to this, since the only way they were planted was in a hedge; the index given to trees on the *rugo* was one (1) for all species.

Whereas the locational flexibility index provides an indication of informants opinion of where a species can be grown within the farm, the utility index provides an indication of the various uses informants make of a particular species. The utility index is defined as the number of reported uses of a species across all farms as a fraction of all possible uses, averaged over all blocs. Sixteen possible uses were identified (see Table 21). If a species had only one particular use (for example for medicines), the utility index is zero; if ten or more uses were reported for a species, the index is one. Thus, a lower utility index indicates that a species is less "multipurpose," and may be less desirable or has less potential as an agroforestry species.

As can be seen in Figures 14a and 14b and from the list of species provided on the page following each figure, few species have both high flexibility and utility indexes. The majority of the species in the upper right quadrant are indigenous species that are the traditional agroforestry species (Vernonia amygdalina, Acanthus pubescens, Euphorbia tirucalli, Markhamia lutea, Ficus thonningi, Draceana afromontana, Erythrina abyssinica and Synadenium grantii), planted and maintained on the farm (particularly on the *rugo*) long before many of the exotic



LOCATIONAL FLEXIBILITY INDEX

802 cases plotted; numbers in parentheses refer to the number of observations falling within each cell.
*=single species, # multiple species.

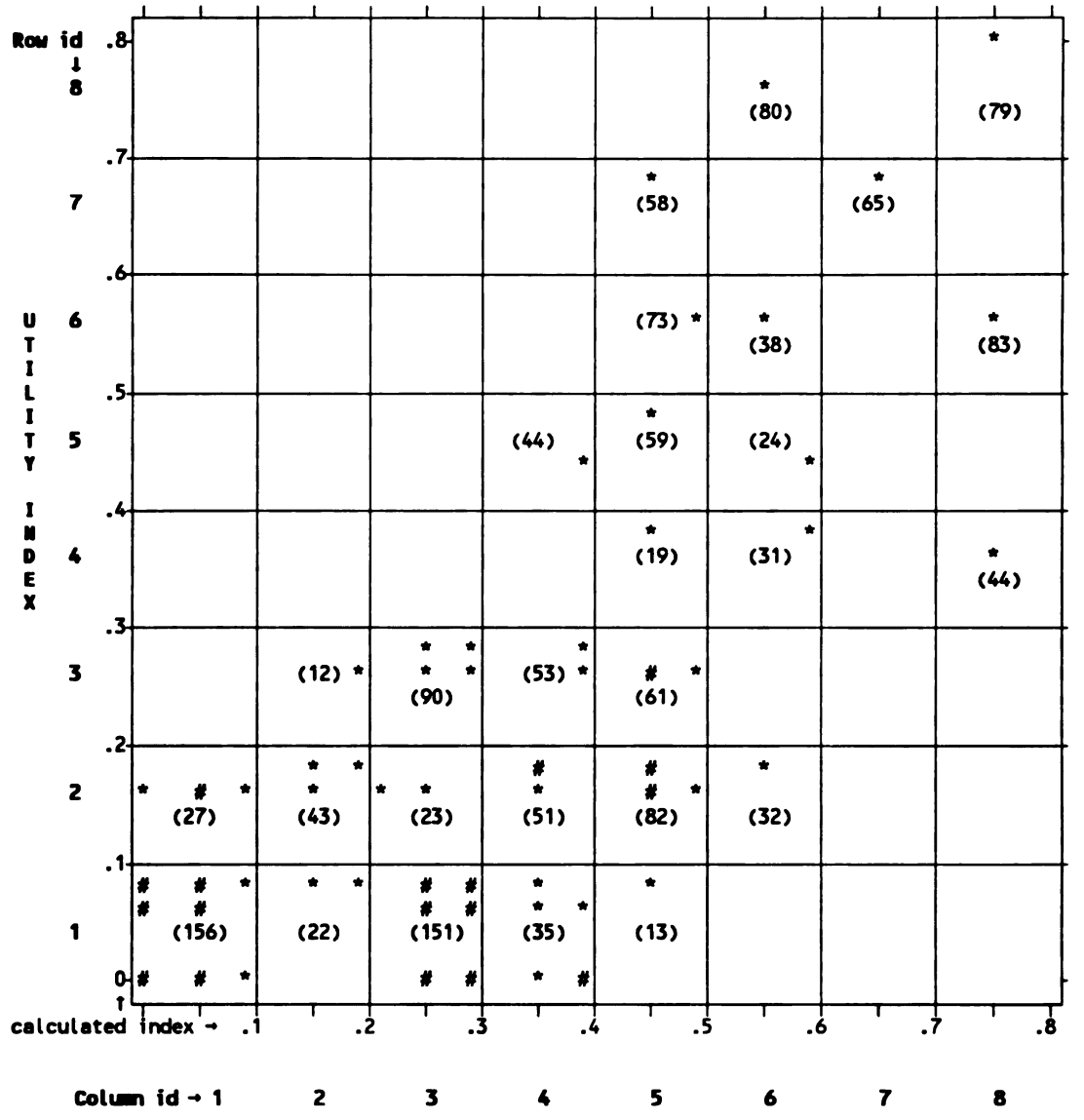
Utility index: The number of reported uses of a species across all farms as a fraction of all possible uses, averaged over all blocs (0 if only one use, 1 if 10 or more uses; for uses, see Tables 28a and b).

Locational flexibility index: The number of locations in a bloc where a species was found as a fraction of all possible locations, averaged over all blocs and farms. Locations identified were: along anti-erosion ditches, on terrace edges, on bloc borders, middle of the bloc, along roads/paths, and in woodlots/orchards.

Figure 14a: Plot of the average locational flexibility index versus the average utility index of species found on the comparison farmers' land. A list of the species within each cell is provided on the next page.

Species found in each cell of Figure 14a (numbers refer to column and row id numbers respectively):

1-1 Citrus aurantium vulgare, Calliandra callothyrsus, Cyphomandra betacea, Plumeria alba, Senecio stuhlmanii, Balthasaria schliebenii, Bersama abyssinica, Albizzia spp., Indigofera erecta, Senecio mannii, Clutia abyssinica, Vernonia sp., Crotolaria intermedia, Cassia occidentalis, Tithonia diversifolia, Tephrosia vogelii, Citrus limon, Cajanus indicus, Trema orientalis, Acacia mearnsii, Clerodendrum rotundifolium.
1-2 Leuceana leucocephela/L. diversifolia.
2-1 Manihot glaziovii, Rubus spp., Pavetta ternifolia.
2-2 Pennisetum purpereum.
4-1 Annona cherimola, Eryobotrya japonica, Coleus spp., Aloe dawei, Kalanchoe beniensis, Physalis peruviana, Ficus sp., Clerodendrum myricoïdes, Clausena anisata, Tetradenia riparia, Erytrococca bongensis, Ocimum suave, Polyscias fulva, Callitris collumellaris, Zanthoxylum gilletii, Euphorbia cotonifolia, Maytenus spp., Solanum sp., Capsicum frutescens, Cassia didymobotrya, Draceana afromontana, Nicotiana tabacum (sauvage), Carica papaya, Cedrela serrata, Clerodendrum fuscum.
4-2 Ricinus communis, Solanum aeculestrum, Morus alba, Ficus vallis-choudae.
5-1 Clerodendrum fuscum/johnstonii, Coffea arabica.
5-2 Psidium guajava.
5-3 Markhamia lutea.
5-5 Euphorbia tirucalli.
6-1 Synadenium grantii.
6-2 Erythrina abyssinica.
6-5 Eucalyptus spp, Ficus thonningii, Cupressus lusitanica.
7-5 Vernonia amygdalina.
8-4 Acanthus pubescens.
8-5 Grevillea robusta.



1548 cases plotted; numbers in parentheses refer to the number of observations falling within each cell
*=single species, # multiple species.

Utility index: The number of reported uses of a species across all farms as a fraction of all possible uses, averaged over all blocs (0 if only one use, 1 if 10 or more uses; for uses, see Tables 28a and b).

Locational flexibility index: The number of locations in a bloc where a species was found as a fraction of all possible locations, averaged over all blocs and farms. Locations identified were: along anti-erosion ditches, on terrace edges, on bloc borders, middle of the bloc, along roads/paths, and in woodlots/orchards.

Figure 14b: Plot of the average locational flexibility index versus the average utility index of species found on the tree experts' land. A list of the species in each cell is provided on the next page.

Species found in each cell in Figure 14b (numbers refer to column and row id numbers respectively):

1-1 Prunus salicifolia, Citrus aurantium vulgare, Cassia spectabilis, Artocarpus integrifolia, Carica cundinamarcensis, Aloe dawei, Psychotria mahoni, Kalanchoe spp., Chenopodium ambrosoïdes, Tribulus terrestris, Cissus quadrangularis, Cussionia holstii, Toddalia asiatica, Gloriosa simplex, Umulyawabasaza, Clausena anisata, Triumfetta cordifolia, Cassia occidentalis, Hybiscus cannabinus, Botryocline longipes, Dalbergia lactea, raisin, Umukamambogo, Ocimum americanum, Nyirakayenzi, Uruhikakiza, Citrus nobilis deliciosa, Capparis spp., Artemisia afra, Schefflera goetzenii, Embelia sp., Bersama ugandensis, Crotolaria recta, Callitris collumellaris, Clutia abyssinica, Solanum incanum, Clerodendrum myricoïdes, Verbena officinalis, Rhyndosia hirta, Plumeria alba, Cassia didymobotrya, Camellia thea, Dovyalis caffra, Pavonia urens, Basella alba, Trema orientalis, Syzygium parviflorum, Hybiscus fuscus, Mitragyne rubrostipulata, Tithonia diversifolia, Guizotia scabra, Sapium ellipticum, Virectaria major, Crotolaria intermedia, Cassia floribunda, Caesalpina decapetala, Polyscias fulva, Urukwamo, Rhus vulgaris, Entada abyssinica, Albizzia spp., Maesopsis eminii, Arundinaria alpina, Annona reticulata, Calliandra callothyrsus.

1-2 Dasylepsis racemosa, Acacia sieberiana, Maesa lanceolata, Leuceana leucocephela/L. diversifolia, Casuarina cunninghamia.

2-1 Jacaranda mimosaefolia, Cedrela serrata.

2-2 Rubus spp, Cajanus indicus, Sesbania sesban/S. macrantha.

2-3 Tephrosia vogelii.

3-1 Annona cherimola, Eryobotrya japonica, Euphorbia grantii, Idaforoma, Draceana steudnerii, Senecio ladiensis, Sanseveria spp., Rubilika, Triumfetta spp., Chenopodium ugandae, Mikaniopsis tedlei, Bersama abyssinica, Ficus asperifolia, Chenopodium spp., Phyllanthus niruri, Coryza sumatrensis, Solanum melongena, Solanum capsicoïdes, Hybiscus diversifolius, Hypoestes verticillaris, Indigofera erecta, Physalis peruviana, Urtica dioica, Cyphomandra betacae, Solanum sp., Morus alba, Nicotiana tabacum, Solanum aeculestrum, Clerodendrum buchholzii, Manihot glaziovii, Senecio stuhlmanii.

3-2 Ficus sp, Capsicum frutescens.

3-3 Ficus vallis-choudae, Pavetta ternifolia, Pinus spp., Acacia mearnsii.

4-1 Blumea alata, Kalanchoe beniensis, Coleus spp, Milletia dura, Nicotiana tabacum (sauvage), Cassia floribunda.

4-2 Carica papaya, Ricinus communis, Senecio mannii, Lantana camara.

4-3 Coffea arabica, Erytrococca bongensis.

4-5 Acanthus pubescens.

5-1 Solanum aeculestrum.

5-2 Ocimum suave, Maytenus spp, Clerodendrum fuscum, Citrus limon, Clerodendrum fuscum/johnstonii.

5-3 Clerodendrum rotundifolium, Iboza riparia, Vernonia sp.

5-4 Pennisetum purpereum.

5-5 Cupressus lusitanica.

5-6 Eucalyptus spp.

5-7 Ficus thonningii.

6-2 Synadenium grantii.

6-4 Draceana afromontana.

6-5 Markhamia lutea.

6-6 Erythrina abyssinica

6-8 Vernonia amygdalina.

7-7 Persea gratissima.

8-4 Psidium guajava.

8-6 Grevillea robusta.

8-8 Euphorbia tirucalli.

species were introduced. However, some exotics are also found in this quadrant, indicating their wide acceptance and ability to meet a variety of demands. The species found in the upper right quadrant do not vary much between experts and comparison farmers, the difference is mainly found in the less flexible and less utilitarian species found in the lower left quadrant. As mentioned previously, the total number of species of comparison farmers is much lower than of tree experts, but the proportion of cases that have high flexibility and/or utility indices (those located in or above row-column 5-5) is much higher (72%) than in the tree expert group (57%). This is an indication that the least flexible and utility providing trees are the first to be eliminated when pressure on a limited land base increases. The observed difference could have been even higher if more complete information on species use had been collected from the comparison farmers.[4]

Two interesting observations can be made from these figures. First, it shows species that may have a wider agroforestry potential if more research were undertaken. The species that may be of interest to further development are located in the 3-3 and 4-4 ranges (see Figures 14a and b). While some of the species found in these ranges are already included in research programs (for example, Tephrosia vogelii, Morus alba, Acacia mearnsii, Coffea arabica, Polyscias fulva and Cedrela serrata), many others are not. While these species may not be of great interest regarding their potential for combatting soil erosion, improving soil fertility, and providing fuelwood and fodder, it should be born in mind that farmers needs are more diverse. Any program intending to address farmer problems should, therefore, consider these wider needs of farmers and the potential for these other species to meet those needs.

The second, and more interesting observation, is that most of the newer agroforestry species being promoted in Rwanda (Leuceana spp., Calliandra calothyrsus, Tephrosia vogelii, Cajanus spp., Crotolaria sp., Casuarina sp., Cedrela serrata, Sesbania spp. among others) do not have high scores for either of the indices. Almost all of these species can be found in or below the 2-2 line. This indicates that either research and extension have not done a very good job of

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[4]As mentioned previously, due to time constraints this was not possible. Because of this, no use information was collected for 228 cases/species, decreasing the average utility index for the species in the comparison group.

promoting these species in the two areas studied, or that farmers need more time to experiment with these species to arrive at all possible locations and uses. Exotics that have been around longer, such as Grevillea robusta, Eucalyptus spp., Cupressus lusitanica (cypress), and Persea gratissima (avocado), are appreciated by the farmers for their locational flexibility and multiple utility, and consequently these species score high on the locational flexibility/utility index grid. That the newly introduced species do not score higher may also be due to the divergence between researcher and farmer objectives. For example, most farmers that planted Calliandra calothyrsus did so for its potential for timber or lumber, not for soil fertility, mulch, green manure or the stabilization of terraces. Farmers, therefore, manage Calliandra as a timber species, and perhaps after 10-15 years when they find out that the species does not provide good quality timber, may they consider using it for other purposes. This corresponds with the information provided in Tables 20a and b: of all the species present, few are planted with the express purpose of improving soil fertility, providing green manure or mulch, and soil stabilization. Most of the species are primarily used for the more tangible benefits trees provide (basically wood and stakes). However, new species may be put to novel uses or be tried on other locations as opportunities develop or as increased pressure on existing resources demand solutions for which farmers may turn to these species, even though these are presently not highly valued. In this regard, farmers often cited their initial resistance to Eucalyptus, Grevillea, Cupressus and avocado trees. Over time, these species have become so common that they now dominate the rural landscape of Rwanda. It is proof that farmers are willing to try and experiment with new ideas, but that they require sufficient time and may arrive at solutions and agroforestry systems that are completely different than was initially envisaged by the researchers and extensionists that introduced them.

3. Key findings

The main reasons to plant trees mentioned by farmers in both groups indicate a direct necessity for tree products such fuelwood, construction poles, lumber, medicines and food. Service functions and more intangible, indirect tree benefits (erosion control, climate amelioration, benefits for associated crops, etc.) were rarely mentioned as reasons for planting trees. The latter

reasons were, however, more prominent in the tree expert group than in the comparison farmer group.

Men plant trees primarily for fuelwood, construction poles, timber and to build the *rugo*, whereas women plant trees mostly to feed and heal the family (i.e. food ad medicinal trees). Women who are heads of household take an intermediary position; their reasons for planting trees are more varied than those of married women, as they take over tree planting tasks normally done by men such as planting fuelwood and timber trees.

There is an inverse correlation between farm size and the number of trees/hectare. Farms of comparison farmers have an average tree density (i.e. number of trees/hectare) that is more than twice that found on tree expert farms. However, the diversity of species on tree expert farms is 300% greater than on comparison farms. The greater species diversity on tree expert farms could be expected, as consultants interviewed in this study considered experience with a large diversity of species a prerequisite for gaining expertise and knowledge. In addition, having experience with a multitude of notions or objects is in accordance with the rwandan philosophical meaning of "knowledge."

Comparison farmers manage small pieces of land with very complex agroforestry systems with a high degree of integration of trees and crops. This requires a higher level of management skills to balance multiple needs of the family for food and tree products. The nature and content of the knowledge of the two groups of farmers studied in this research may, therefore, be different. As agroforestry research concerns the study of the integration and interaction between trees, crops and/or animals, future research should focus on the much more complex agroforestry systems of the comparison farmer group (i.e. the small farmers cultivating less than 0.25 hectares of land).

The total number of species on the farms of comparison farmers is much lower than on the tree expert farms, but the proportion of species with high flexibility and/or utility indices is much higher. This is an indication that, as farm sizes decrease, the least flexible and utility providing trees are the first to be eliminated (or better, not to be planted on the farm).

Exotic tree species such as Grevillea, Eucalyptus spp, Cupressus spp (introduced in the 1930's) and Persea gratissima (introduced in the 1950's) have become so common that they now dominate the rural landscape of the study areas. Because of their ubiquitous nature, they were often labeled as "indigenous species" by younger farmers. These species are appreciated by the farmers for their high locational flexibility and multiple utility, and, by consequence, have high scores on their respective indices. In contrast, newer agroforestry species being promoted in Rwanda (i.e. those having been introduced since the late 1970's) do not score high on either of the indices. This may be an indication that research and extension have not done a good job promoting these species, or a reflection of the cautious approach of farmers. The dominance of the older exotics is proof that farmers are willing to try and experiment with new ideas and technologies, but that they need sufficient time to experiment with them. In the end, they may arrive at solutions and agroforestry systems that are completely different than was initially envisaged by researchers and extensionists having introduced them. This does not invalidate the efforts of either research/extension or of the farmers, but is an indication of the complementarity of and the need for a synthesis between the two knowledge systems.

4. Conclusions

Rwanda is the most densely populated country in Sub-Sahara Africa with a predominantly agricultural population. Because of increasing competition for a limited land base, the amount of forest cover has steadily declined. However, people's need for trees and tree products has not decreased. While forests have all but disappeared, the total number of trees in the landscape has increased in the last few decades, albeit in a more dispersed pattern. The increased cultivation of trees on the farm has led to complex agroforestry systems based on extensive knowledge of trees, crops and animals and how to combine these to assure optimal output over time given a limited land base. This is reflected in the great diversity of species found on the farms studied, the complex arrangements of species over space and/or time, the multitude of reasons given for planting trees, and the multiplicity of uses made of these trees resulting in a situation in which no two farms have a similar agroforestry system. This is true for both tree experts and comparison farmers, although to a lesser degree in the latter group.

A difficulty in defining Rwandan agroforestry is that what constitutes a tree in the conception of research and extension is much narrower than what Rwandan farmers conceive of the equivalent term *ibiti*: all vegetation that is not grasses. Research and extension often translate agroforestry as meaning planting trees or shrubs for fodder, green manure, mulch or fuelwood in limited number of very specific and rather simple (as least as compared to what is found on the farm) arrangements. Because of the diverse needs of farmers (which move beyond economic and ecological benefits to include cultural, social and medicinal considerations), their more inclusive interpretation of the term "tree", and their individuality in designing a system best meeting those needs, agroforestry should be interpreted more broadly than presently is done by research and extension.

In Rwandan thought, the same word is used for knowledge and experience; as one obtains more experience, knowledge increases. Thus, the tree experts identified all had much experience with a variety of tree species, which translated into them being the most knowledgeable people about trees and tree cultivation. However, their being the most knowledgeable farmers about a diversity of tree species and their cultivation may not necessarily mean that they are also the persons having the most knowledge of managing these trees in an agroforestry system. This outcome was not expected when the research was initiated and the choice of tree experts made. Comparison farmers, having much smaller farms with less species diversity, have more trees of each species and have on average more than twice the number of trees per hectare than tree experts. These small but high tree density farms require farmers to have higher levels of management skills and greater knowledge of the various components and their interactions in order to produce sufficient food and other products to maintain the family. While this finding does not invalidate the results of this research, in the future it may be necessary to study both tree experts and comparison farmers regarding their knowledge since that knowledge may be divergent.

By comparing tree resources of tree experts and comparison farmers as has been done in this chapter, a prediction can be made of what the future will hold for "traditional" agroforestry in Rwanda. Enormous transformations have taken place in the agricultural systems in the last 60 years due to the efforts of both research and extension (the introduction of new crop, animal and

tree) and farmers (adapting these ideas into workable solutions, as well as generating new practices incorporating old and new technologies). The agricultural/agroforestry systems in the areas studied are very dynamic systems in constant flux. Farmers themselves are well aware of the need for continued adaptations, which explains in part their interest in trying new, multipurpose and multilocational tree species that may replace existing ones in the future. The following quote, paraphrased from several interviews, perhaps best describes the forward look of farmers and their interest in the new and unknown, dispelling the myth of the backward, innovation-resistant, ignorant peasant.

> We need new species and very much want to try them even if they do not seem to be useful at present. We know the trees we have now and what they can provide us; but new problems and opportunities arise which these species will not be able to solve. Therefore, we need new tree species to be prepared and help us for when that time arrives. And our children will be grateful for us having introduced and tried these species in our communities.

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CHAPTER VIII

FARMER EXPERIMENTATION: GENERATING KNOWLEDGE FOR THE DEVELOPMENT OF INDIGENOUS AGROFORESTRY SYSTEMS

1. Introduction

From the results in the previous chapters, it can be seen that the combined interventions by both farmers and outsiders have led to enormous changes in the landscape and created very complex and multifaceted agroforestry systems. Over time, farmers have evolved from being primarily exploiters of natural vegetation to active tree planters and managers. Simultaneous with these changes, farmers knowledge of trees changed; whereas before their knowledge was essentially limited to use aspects of trees, presently knowledge also extends to tree cultivation (planting and management) practices. However, as we saw in Chapter VI, tree use knowledge is still valued higher than tree cultivation knowledge.

The goal of this study was not to study the philosophical aspects of knowledge (although rwandan philosophy is reviewed in Appenndix I-1 to provide a frame of reference to the Rwandan system of meaning), but to determine and understand the dynamic aspects of endogenous agroforestry knowledge and technology. In particular, this study aimed at studying farmer-based processes of innovations in agroforestry. In Figure 4 (Chapter I), three processes were identified through which farmers obtain new knowledge and technology, namely the generation of new knowledge through their own experimental efforts, the adaptation of ideas (knowledge and/or technologies) acquired from exogenous knowledge systems which may or may not involve experimentation, and wholesale adoption of exogenous knowledge and technologies without further adaptation. This Chapter will focus on farmer experimental activities as a means of generating and/or adapting new agroforestry knowledge and technologies in order to answer the following research questions:

1. Why do farmers experiment? What are their objectives for experimentation?

2. How do farmers themselves define "experimentation"?
    a. Are there common elements in the methodology experimenting farmers use?
    b. What, how, why and how long was testing done before adoption or rejection?

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c. What are the adoption/rejection criteria (why or how is a particular practice better or worse than existing practices)?
d. When and under which conditions can a new practice or technology be used?
e. What other changes in production technology are needed to make a change practical and worthwhile?

These research questions were formulated in the proposal writing phase of this study, and were written from a western epistemological perspective of what experimentation is or should be.

Studies of Richards (1986) and Box (1988) had shown that farmers use experimental methods resembling western methods for food crops, but would this also be the case for trees which take a longer to reach maturity? The guided farm tours and discussions during the ranking game showed that tree cultivation appeared to be so interwoven with agricultural production and daily activities that consultants could not verbalize whether or not they used any trial period or not before deciding on full adoption of a new species. In part, this absence of recollection may also be due to the fact that farmers did not have a free choice but were obliged to adopt many agricultural technologies (for example anti-erosion ditches, the planting of Grevillea alongside these ditches, and Eucalyptus woodlots). Because of these (potential) difficulties, the case study method using repeated visits was chosen to put tree cultivation activities within the context of the farmers' lives. In addition, it was hoped that we would find out about experimental methods that consultants had used to try out new species or tree management practices that they adopted since they first started to farm.

As the case studies did not yield sufficient information about the "if", "why" and "how" questions of farmer experimentation with trees, it was decided to set up a species trial in collaboration with the ICRAF/ISAR program in Rwanda as part of the field research. The ICRAF/ISAR program provided us with seedlings and seed of 15 tree species, some of which were already widely cultivated in the research areas, and some which had not yet been tested on the farm. ICRAF also provided short descriptions in Kinyarwanda of each species. The 15 species were divided in three groups of five species each, with at least one familiar species in each group. This division was made to assure a good geographical distribution of all species among the consultants. About one month before the seedlings were distributed, consultants were asked to chose the species they would like to try on their farm on the basis of these descriptions. During the focus

group meetings, several questions were asked dealing with consultants' choice, risk associated with testing, experimental methods that they intended to use and evaluation criteria. The results of these discussions will be reported in Sections 2.2., 2.3., and 2.4. As the seedlings were distributed during the focus group meetings, which took place toward the end of the field research period, no results are yet available of how farmers actually went about testing the species, or the results they obtained from these trials.[1]

2. Results and discussion

2.1. Decision making regarding species choice and where and how to plant various species

In each of the three processes identified in Figure 4, farmers need to answer some basic questions related to species choice, the best place to plant the particular species within the farm, how it should be planted (from seed, seedlings or cutting). If the species chosen is a new species, how does the farmer go about determining whether the species is useful and beneficial to him/her? How does (s)he evaluate trials with new species? In this section, an attempt will be made to provide some answers to these questions.

2.1.1. Choice of species

The choice of species is primarily motivated by the benefits and utility the species provides, either because one has seen the species on a another farm, has heard people talking about it, or because of tradition. In a few cases, consultants mentioned having had no choice about the species, because they were forced by the State to plant certain trees, for example Eucalyptus spp. during the Belgian colonial period, and Grevillea robusta as part of *umuganda* and many tree planting drives by various rural development projects. Mostly, though, farmers would plant certain trees because of their utility, even before the arrival of the 'white people' and the installation of nurseries all over the country. For example, the father would show his sons which

[1]Part of the original research plan included a return visit to the research sites nine months after seedling distribution to determine experimental designs used by farmers, to discuss performance criteria, and study farmers' opinions of the species. This was not undertaken due to civil unrest in the country.

trees to use to construct a *rugo* (Ficus thonningii, Euphorbia tirucalli, Vernonia amygdalina, Tetradenia riparia, Erythrina abyssinica). Some of these traditional species, still used today because their fast growth quickly forms a solid fence, can be used as fodder (Ficus and Vernonia) or as medicine (Vernonia, Erythrina, Euphorbia and Tetradenia), or to protect the inhabitants and their possessions from unwanted visitors (Erythrina). Copying what other farmers (whether it is a next door neighbor or a farmer visited during travels in another prefecture or country) have done is the most common way consultants chose a particular species to try on their own farms. As was explained in one meeting, "*le Rwandais est imitateur.*" Observing how the species develops and whether it is damaging to the soil and/or to associated food crops on neighboring farms before introduction will also help to determine if and where a species may potentially fit within the one's own farm, i.e., if it will conform to the other elements of the farming system (especially competition with crops), where it would be best capable of realizing its growth potential (in the woodlot, in or around the fields, on the *rugo*), or what function it could play on the farm (as boundary marker, to prevent soil erosion, to strengthen the fence of the *rugo*, food production, medicine, etc.).

Other criteria mentioned were availability, ease of planting, and whether or not the species demands a lot of manure or fertile soils. One female consultant stated that it was a matter of chance; she planted many trees of various kinds because only some would survive. While most of the consultants chose their species carefully, they concluded that it was always good to start with a trial with one or two trees to determine the results under the conditions of one's own farm.

2.1.2. Species location within the farm

There are no fixed rules of where species can or should be planted. Species location depends on one's expectations of what the species is to produce or provide, its competitive and/or allelopathic effects, and its 'social' benefits. However, there are some rules of thumb that most people follow. Timber and fuelwood trees and those that are highly competitive and/or allelopathic will be planted in woodlots distant from any crop fields (for example Eucalyptus, Cupressus, Pinus, Grevillea). Species that are good for holding the soil and preventing soil erosion are planted along the anti-erosion ditches or on the terraces (Grevillea, Vernonia). Euphorbia tirucalli and

Synadenium grantii are the species most commonly used as boundary markers. The former species is also the predominant species used as fence around the compound, with Vernonia and Ficus being secondary species. Ficus was traditionally planted on the rugo to provide fodder for the animals, but, as animal ownership has declined, many are presently found in the middle of the fields (as remnants of old *ingo*[2]) where, according to the consultants, they contribute to soil fertility through leaf litter. Fruit and medicinal trees will be grown in the fields closest to the *rugo* mostly for social reasons (fruit trees because of the risk of theft and medicinal trees in case of necessity). The exact location also depends on the size of one's farm. For example, many smaller farmers no longer plant fruit trees (particularly avocado) in the banana fields but on the *rugo*, as this will free space in the field for crops. In addition, it is not uncommon to find Eucalyptus on the *rugo* on these farms, as small farmers can no longer afford to maintain a woodlot.

The decision of where a particular species will be planted within the farm depends partially on the inherent attributes of the species. Much of the decision will depend on farmers' goals and his/her opportunities and resources to meet these goals.

2.1.3. Choice of how to plant certain species

Discussions related to the topic of how to plant a tree included talks about planting holes, use of manure, time of planting and type of propagation material necessary (seedlings, cuttings or seeds). Most consultants again emphasized that they obtained much of the information about planting methods through observation of what other farmers had done and by asking them additional instructions if necessary. The size of the plant hole depends on the species; timber trees need big holes, but for species used as vegetables or medicine small plant holes suffice. Consultants disagreed on whether or not it was necessary to add manure to the holes upon planting. Some maintained that all trees need manure, just like crops. Others stated that this was a waste of scarce manure; manure is only necessary for fruit trees in their opinion, but not for Eucalyptus, for example.

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[2]*Ingo* is the plural form of *rugo*.

Seedlings were considered best for producing high quality timber, but cuttings would grow much faster and are best for making a fence around the compound. In building the rugo, farmers said it was important to plant all the desired species at the same time, so that they will develop together and make a strong, dense fence.

Consultants also differed about the best time to plant trees. One group maintained that trees are planted at the same time as other crops, i.e. at the beginning of the short rainy season in September. Another group said that that would be too early, and that the seedlings would dry out when planted at that time. In their opinion, trees should be planted later when rains would be more plentiful (i.e. in late October-November), since that is also the time that one can obtain seedlings from the nurseries. As each species has it own planting method, both groups could be right. Seedlings are generally planted in late October-November, but cuttings and seeds of some species may be planted earlier by some farmers. However, they did agree that, in view of the many uncertainties of rainfall, plant diseases, marauding goats, landslides or weeding accidents, it may be necessary to replant a species several times before it will survive.

2.1.4. Are the decision criteria regarding species, location and planting methods the same for all farmers?

Once again, consultants' discussions provided contradictory opinions. A minority of the consultants responded that the criteria are the same for all farmers as people follow the example of their parents or imitate what neighbors have done. In some cases, extension workers, through the information they provide, also push farmers to make uniform decisions. But, as one person remarked, even if the latter is the case much still depends on the benefits one expects to obtain from a species. The latter view was supported by the majority of consultants at the meetings. As people have different motivations and objectives for tree planting activities, the criteria of species choice, planting methods and location will inevitably vary from one farmer to another as the following quotes illustrate:

> Our criteria cannot be the same. Some people calculate the benefits (s)he will obtain beforehand, and plant little or many trees as a result. Other persons are more carefree.[3]
>
> Someone can plant Vernonia amygdalina along the anti-erosion ditches. Another can plant it on his/her *rugo*, or even on the ditch but in his own way.[4]

As there are a many variables that are taken into account in deciding about species, location and planting method (utility, benefit, desired end product of the tree, farm size, soil conditions, slope, competition between trees and crops, allelopathy, preferences, motivation, interest, possibility of theft were some of the variables discussed by the consultants), and as there many species available for farmers to choose from (152 species were inventoried in the two samples of farmers, some of which provide the same or similar benefits), an almost unlimited number of variations in agroforestry systems is possible. This diversification of species and the increasing complexity of farming systems this entails are a deliberate strategy used by the farmers as a means of overcoming ecologic and economic uncertainties.

2.2. Farmers' preference for testing unknown species over known species

Among the 44 tree experts, only one choose to try out Grevillea, and less than five choose to try either Leucaena leucocephela, Calliandra calothyrsus or Sesbania sesban. The vast majority of experts favored the species that they were not familiar with, either because the species were newly introduced in the country and had not yet been tested beyond the research stations, or because farmers did not yet have the particular species on their farm. The one farmer who elected to try out Grevillea already had many trees of this species on his farm and knew its cultivation very well. He was also the only farmer who used Grevillea in an alley cropping arrangement. The remaining tree experts all rejected the tree species they already cultivated and provided a number of reasons for why they were interested in the new and unknown species. As can be seen, these reasons speak for themselves.

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[3]Nos critères ne peuvent pas être les mêmes. Il y a celui qui calcule d'abord le bénéfice qu'il va tirez et en plantera peu ou beaucoup en conséquence. Il y a un autre qui ne se souci de rien du tout.

[4]Quelqu'un peut opter pour la plantation de umubirizi sur le fossé anti-érosif. L'autre peut le planter sur le rugo, ou même sur le fossé mais à sa façon.

We did not choose the species that we know because we want to progress. We want to know those that we do not yet know so that the Rwanda of tomorrow can one day use them.[5]

We can plant them and wait to determine their utility. We walk forward for progress. We want to plant this tree for our posterity who will discover that once upon a time this tree was introduced to the region by us.[6]

We work for the Rwanda of tomorrow. We are preparing ourselves for times to come.[7]

For us, it is a sign of development. Fairly recently, Eucalyptus was introduced in the same manner. Now, we notice that there are new species that are available to us. It is very important for us to have these new species, even if we ignore these species and will not obtain any benefits. Our descendants certainly will benefit from them.[8]

Among the species that you are alluding to, there is no doubt a species that will be more important than the ones we are used to. When we have passed away, the action of the father will be recognized by his descendants. The best informed persons will talk about their economic or medicinal importance, and advice people not to cut these trees. This is the reason why we want to introduce these species in our fields.[9]

When Grevillea was introduced, we did not know its utility. The same for avocado. We only had heard talks about them. But, we did plant them anyway.

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[5]Nous n'avons pas choisi des espèces que nous connaissons parce que nous voulons progresser. Nous voulons connaître ceux que nous ignorons pour que le Rwanda de demain en fasse usage un beau jour.

[6]On peut les planter et puis attendre pour voir leur utilité. Nous marchons en avant pour le progrès. Nous voulons [planter] cet arbre pour notre progéniture qui trouvera que cet arbre a été un jour introduit par nous.

[7]Nous oeuvrons pour le Rwanda de demain. Nous préparons les temps à venir.

[8]Pour nous, ça c'est un signe de développement. Très récemment, l'eucalyptus a été introduit de la même façon. Maintenant, nous remarquons qu'il y a de nouvelles espèces qui nous arrivent. C'est très important pour nous de les avoir même si nous en ignorons l'espèce et n'en tirons pas profit, nos descendants eux en bénéficieront sûrement.

[9]Parmi ces espèces auxquelles tu fais allusion, il y a sans doute une variété plus importante que celles auxquelles nous sommes habitués. Quand on sera mort, l'acte du père sera reconnu par la descendance. Les personnes les mieux informées parleront de son importance du point de vue économique (rapporter de l'argent) ou médicinale, et conseilleront à ne pas les couper. C'est la raison pour laquelle nous cherchons à introduire ces arbres dans nos champs.

For this unknown species, we will plant it as part of the above-mentioned trial. Good or bad, we will plant it.[10]

Another example close to us is that of avocado, which many among us were adverse to eat. But many people, especially older ones, did plant them and later started noticing that the children showed an increasing interest in eating them to the point that everyone noticed its fruits were a new source of wealth in their lives. For this reason, we want to introduce these new species which will perhaps be edible or have other, similar importance.[11]

This is to increase the number of tree species we have at our disposal, to have as many varieties (species) as possible.[12]

This will also be a way of trying new species on one's own farm. In addition, even if we do not know these trees yet, we want to discover if these trees have any use.[13]

We have to think first about the possible importance of these trees, i.e. if these trees will provide any special things the species we already know do not provide. Thus, we want to plant unknown species since the others, such as Grevillea, can easily be found.[14]

Thus, we have to be curious to plant the species we do not yet know so that later we will be able to determine their importance. It is possible that the new species will provide greater benefits than those we have cultivated until now.[15]

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[10]Lors de l'introduction du grevillea, on ne connaissait pas son utilité. Tout comme l'avocatier. On en avait seulement entendu parler. Nous les avons plantés tout de même. Pour cette espèce inconnu, nous allons la planter dans le cadre des essais su-mentionnés. Bonne ou mauvaise, on la plantera.

[11]Un [autre] exemple très proche est celui des avocatiers qu'un grand nombre d'entre nous ne dédaignaient manger. Mais beaucoup de gens, surtout les vieux, les ont planté et ont commencé à noter que les jeunes s'intéressaient de plus en plus à les manger jusqu'au point où tout le monde a remarqué que ces fruits constituent une nouvelle source de richesse importante dans notre vie. C'est pourquoi on cherche à introduire ces nouvelles variétés qu'on trouvera peut-être comestible ou jouant un rôle dans ce sens.

[12]C'est pour augmenter le nombre de sortes d'arbres dont ils disposent. C'est pour avoir le plus de variétés possibles.

[13]C'est aussi une façon d'essayer des arbres jusque là inconnus sur sa propre terre. Et puis, même si nous ne les connaissons pas encore, nous désirons que ces arbres ont une utilité que nous sommes amenés à découvrir.

[14]Ici on remarque qu'il faut d'abord viser l'importance de ces arbres, c-à-d voir s'il y a quelque chose de spéciale que vont apporter ces arbres plus que ceux qu'on connaît déjà. Ainsi on veut cultiver des espèces inconnus puisque les autres, comme Grevillea, sont facilement trouvable.

[15]Donc, il faut être curieux à planter ce que nous ne savons pas pour qu'après nous sérions capable de voir leur importance. Il peut arriver que les [nouveaux] arbres ont une grande avantage plus que ceux qu'on disposait jusqu'à présent.

From the above statements, several themes emerge, some of which we already encountered in our previous discussion on the topic of knowledge in Chapter VI. On the one hand, these themes relate to personal characteristics of tree experts, such as curiosity, desire for knowledge, an internal 'drive' for discovery, recognition of one's efforts by descendants by leaving a better world for one's children. On the other hand, consultants also expressed strong feelings about the importance of experimentation with new technologies for development and progress. There was an implicit understanding that not doing so would lead to stagnation and may make an already precarious existence even worse. Constant adaptations are necessary not only to increase subsistence security through a greater diversity of species for farmers to choose from, but also because the benefits that might be obtained from these new technologies exceed those obtained from presently available species.

In a follow-up question consultants were asked if it was possible for all farmers to plant and experiment with unknown species. The vast majority of consultants answered affirmatively. In their opinion, everybody needs trees, and every (wo)man has a need to learn and to know and has some curiosity to discover the new ("*Tout homme a besoin d'évoluer et de connaître ce qu'il ignore*"[16]).

Others talked about the benefits of planting unknown species, even though they may not always be obvious at planting:

> Experience has shown that it is always beneficial to plant unknown trees, and everyone can do it. It was the same with Grevillea and cypress which are now found all over the area, and with vetiver which we were skeptical to introduce.[17]

One consultant stated that most farmers would be able to do so if they received sufficient prior information about the potential benefits, planting methods and best location for planting

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[16]Every person has a need to develop and to know what he does not yet know.

[17]L'expérience a montré qu'il est toujours bénéfique de planter des arbres inconnus, et tout le monde peut le faire. C'était la même chose avec le grevillea et le cyprès qui sont répandus partout maintenant, ainsi qu'avec le vetiveri qu'on était sceptique d'introduire.

beforehand. Some also qualified their answers by saying that the possibility of testing any new species depends on the size of one's farm:

> Provided that I have a place to plant these trees. Someone who has plenty of land can accept, but someone with a small farm cannot. It is too bad if you do not have a large enough farm for these trees; the others plant new tree species, and you remain with empty hands.[18]

Thus, in principle it is possible for everyone to try out new technologies, but in practice not everyone will do so because of a lack of interest and curiosity, or because of insufficient resources, especially land. For farmers who have little land, the risk associated with experimentation may be too great as they will need all that land to produce sufficient food for their families.

2.2.1. How do farmers deal with risk?

Consultants were well aware that there are risks involved with trying new technologies, especially if they have not been able to observe them somewhere else. But, such risks are associated with well accepted and common agricultural practices also. It is part of being a farmer, and it is impossible to escape risk:

> Almost everything has negative aspects which one has to accept no matter what. When a cow gives a good milk yield but also attacks people, you do not sell it. To return to Synadenium grantii, Euphorbia candelabrum and Euphorbia grantii we talked about earlier, these trees have been cultivated for a long time in Rwanda. Thus, if one of these trees is close to the *rugo*, all the children are informed in time about the nature and poisonous character of these trees.[19]

---

[18]Pourvu que je dispose d'un terrain où planter ces arbres. Celui qui a un terrain suffisant peut accepter, mais celui qui n'a qu'une petite exploitation ne peut pas. C'est malheureux quand tu n'as pas assez de terrain disponible pour les arbres, les autres plantent des arbres nouveaux et tu reste avec les mains vides.

[19]Pratiquement toute chose comporte des aspects négatifs qu'il faut malgré tout accepter. Quand on a une vache qui donne un bon rendement en lait mais qui s'attaque aux gens, on ne le vend pas pour autant. Si on revient a l'*umukoni* (Synadenium grantii) d'ailleurs, au même titre que *umuduha* (Euphorbia candelabrum) et *amadwedwe* (Euphorbia grantii), ces arbres sont cultivés depuis très longtemps par les Rwandais. Alors si un de ces arbres se trouve à proximité du *rugo*, tous les enfants sont informés à temps sur la nature et le caractère nocif de ces arbres.

> You (to the research assistant) you are also Rwandan; when one says to a child to be careful with this or that, he will do so. One teaches him continuously as he grows up what is harmful and what is not. Then he will conform to this.[20]

Thus, part of dealing with risk is accepting that it is there. Through education and training from a young age, farmers are made aware of the risks associated with cultivating some tree species. The insistence by some consultants on receiving information about new tree species before trying them out on their farm is in part to learn about possible negative effects the species may have so that they can deal with them. In addition to the risks associated with inherent species characteristics (i.e. toxicity, thorns or prickles, etc.), there are risks associated with how species behave in the field. New species will receive close scrutiny on any possible negative effects on the soil and competition with crops or other tree species that may develop. If such negative effects are observed, consultants had a very simple solution: remove the species from the field, either by cutting and uprooting it, or, if it was not too big, by replanting it in another field far from any food crops, preferably in the woodlot. If the species is still showing promise and possible benefits to the farmers, the information thus gained from the experiment will be passed on to neighbors, friends and future generations.

2.3. Farmers' reactions to a new, unknown species: a hypothetical scenario

As an additional test of how farmers react to new technologies, and how they would approach the incorporation of such technologies into their farming systems, they were presented with a hypothetical scenario. First, we would show them a seedling of a species we were sure they would not know, namely Chamaecytisus palmensis. This species had been tested for several years on the ISAR stations of Rwerere (Ruhengeri Prefecture) and Gakuta (Kibuye Prefecture); in the fall of 1991, some were also given to a group of farmers around the Rwerere station as part of the ICRAF/ISAR on-farm research program. However, none of the farmers in southern Rwanda had seen or heard about the species. The seedling was passed around to the people present at the meetings, who studied the plant intensively by sniffing its leaves, touching it, observing its stature and speculating about what it could be and how it could possibly be used.

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[20]Toi aussi tu es Rwandais; quand on dit à un enfant de faire attention à ceci ou cela, il le fait. On lui montre au fur et à mesure qu'il grandit ce qui est nuisible et ce qui ne l'est pas. Alors il s'y conforme.

The following dialogue illustrates the initial reactions of farmers when presented the seedling with the question whether or not they knew the species:

> No. This is the first time that we have seen it [this species].
>
> Is it *umuruku* (Tephrosia vogelii)?
>
> Me, I do not know it.
>
> This tree does not yet exist in our region.
>
> It is *umunyegenyege* (Sesbania sesban).
>
> No, no, ...
>
> It is *umuruku*.
>
> We do not really know.

After this initial introduction, the name of the species was given (farmers who had tested it around Rwerere had tentatively baptized it '*umuvumbuka*') but no additional information about its potential benefits. Consultants were then posed the question what they would do if they were given 500 seedlings of this species. This high number of seedlings was chosen deliberately to provoke audience reactions. We knew that the tree experts present at these meetings were interested in testing new species, and they would very likely have accepted without much comment any proposition involving only a small number of seedlings. Our insistence of 500 seedlings or nothing took them aback a little, and in one case led a woman to answer with the following series of rhetorical questions:

> You are imposing these 500 trees upon us. You insist too much on this! Keep our small farm sizes in mind! Are you going to plant these 500 trees of which you do not know their utility on a property of 20 meters? If I plant them in the area where I wanted to plant another crop, what will I do? Would I plant these trees if I do not know whether they are going to produce fruit or help my son?[21]

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[21]C'est comme si vous nous imposez ces 500 arbres. Vous y avez trop insisté! Tenez compte de la petitesse de nos propriétés! Est-ce que vous allez planter ces 500 arbres dont vous ignorez l'utilité sur une propriété de 20 mètres? Est-ce que si je les plantais tous dans l'endroit où je prévoyais mettre une autre culture, que ferais-je? Est-ce que je planterais ces arbres dont j'ignore s'ils vont produire tels fruits ou aider mon fils?

Getting at least some information about the species is important before a decision to accept to plant these 500 seedlings or not is made, and a number of consultants emphasized this point. The following comment was the strongest worded rejection of any species provided without any information:

> Thank you! If you proceed like that, you are only looking at complicating my life. Without explanations regarding the utility of these trees for my son, well, without explanation on how I am going to be able to follow their growth, I tell you I will not accept these trees.[22]

The vast majority of the consultants were of the opinion that it would be difficult to plant 500 seedlings of a species without knowing its utility, especially given the rather small sizes of their farms. However, they would not completely reject the offer of being involved in testing the species, but would do so with a smaller number initially. One farmer stated that he would accept all 500 seedlings, but instead of planting them all on his own farm he would distribute 2-3 seedlings to each farmer in the *cellule*. Most consultants would accept from 2-4 seedlings so they could test its performance and find out more about the utility of the species. If experience with these seedlings was positive as observed from fast growth, potential for profit, non-competitive behavior vis-à-vis crops, and they proved to provide useful products, they would increase the number of trees of the species in the future. In one meeting, consultants accepted much higher number of seedlings (100 to 200) after one farmer speculated out loud that, since umuvumbuka resembled a Crotolaria species, he could plant all 500 seedlings because, just like Crotolaria, it probably would fertilize the soil also. Following are a few of the comments made during the meetings regarding the testing that consultants intended to undertake with the *umuvumbuka* seedlings, as well as some indications of how they think about evaluating the species.

> One starts with a small number to determine the way in which they grow, and their utility.[23]

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[22]Merci. Si tu procèdes ainsi, tu ne chercherais qu'à compliquer ma vie. Sans explications au sujet de l'utilité de ces arbres pour mon fils, eh bien, sans explications sur la manière dont je vais être à mesure de suivre leur croissance, je te dis que je ne les accepterais pas.

[23]On commence par planter un petit nombre pour voir la façon dont ils grandissent, leur utilité.

> Me, I will accept four seedlings which I will plant close to the *rugo* where they can take advantage of the "urea". But, if they do not provide anything to eat to my son, I will call you to tell you that I will get rid of them.[24]
>
> Give me my two seedlings as I have a small farm. If these are profitable, I will ask you for additional ones.[25]
>
> After I have discovered their utility, I can look for more place to plant additional trees/species you give me by eliminating and replacing some trees I already have.[26]
>
> I cannot plant more than 10 seedlings in the beginning. I start with a trial. If the results are positive, I can even plant up to 1000. If the trial is not successful, I will eliminate them and will leave two trees only.[27]

How farmers are going about testing and evaluating new species will be the subject of the next section.

2.4. Farmers' approach to testing and evaluating tree species experiments

As mentioned previously, the species trial got under way at the end of our field research period in Rwanda. The following discussion is, therefore, not based on observations on what consultants actually did with the species they were given, but on interactions that took place during the focus group meetings about how they intended to go about testing of the species. Although consultants used the Kinyarwanda word for experimentation when talking about this species trial (i.e. *igerageza*[28]), *igerageza* is quite different than what researchers trained in the scientific tradition understand by the word. For trees, there does not appear to be any specific research method and

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[24]Moi, j'accepterais 4 que je planterais à proximité du rugo où ils peuvent bénéficier de l'urée. Mais au cas où ils ne donnent rien à manger pour mon fils, je t'appellerais et te signifierais que je vais m'en débarrasser.

[25]Donnez moi mes 2 arbres parce que notre propriété est petite. Si ceux-ci se révèlent une source de profit, je vous en demanderais d'autres.

[26]Après avoir compris leur utilité, je peux même leur chercher plus d'espace en arrachant certains arbres dont je dispose déjà pour que je les remplacerais par ceux que tu me donnes.

[27]Je ne peux pas dépasser 10 au départ. Je commencerais par procéder à leur essai. Avec de bons résultats, je peux arriver à 1000. Dans le cas contraire, je les arracherais et resterais avec seulement deux.

[28]*Igerageza* is derived from the verb *kugerageza*, meaning to submit to a test.

tree experiments are not done on a separate piece of land. In contrast, farmers do something resembling a scientific experimental method when testing new food crop varieties; for example, to test new bean cultivars, women use small plots of land to plant beans first in pure and later in various mixes of cultivars repeated over several seasons on different locations and soils (Sperling 1992; Sperling at al 1993; Sperling personal communication). As trees take several years to mature or to yield any usable parts, most farmers cannot afford to tie up even a small piece of land for several years just to test out one particular tree species.

Farmers testing of a new species consists of observing and evaluating the species over a certain number of years in order to determine whether the species meets their goals and expectations. "*La cultivation des espèces vise aussi à voir si tel arbre n'aura pas d'importance plus que les autres qu'on possède déjà, d'ou il faut planter l'arbre qu'on a besoin et le planter avec volonté.*"[29] These goals are not necessarily fast growth, intercropping ability etc., but for most farmers concern a certain end product: timber, fuelwood, construction poles, stakes, etc. If the species will be able to produce the desired product within the predetermined time frame, the trial is considered a success and the farmer may decide to plant additional trees of the species:

> If I discover that a certain species only provides fuelwood, I will not ask additional trees of this species. But if I discover that the species will yield timber, I will ask many seedlings from the ICRAF project.[30]

Other farmers, however, are less fixed on a particular goal, and stated that other products or benefits may be obtained from the species being tested that were not yet known at the onset of the trial:

> Among these species, those that yield timber will also be useful for other purposes. We all know very well that guava, in addition to its fruits, provide a medicine against diarrhea. Rwandans themselves do their little research.[31]

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[29]The cultivation of [new tree] species is also aimed at studying whether these will provide more benefits than the trees one already has. For this reason, one has to plant a tree one thinks will provide certain benefits, and to plant it willingly (i.e. with care).

[30]Si je constate que tel arbre fournit seulement du bois de chauffage, je n'en demande pas davantage. Si je constate qu'il fournit des planches, je veux demander beaucoup d'autres plants au projet ICRAF.

[31]Parmi ces arbres, ceux qui ne donneront pas de planches seront utiles à d'autres fins. Nous savons très biens que le goyavier, mis à part ses fruits, fournit un médicament contre le diarrhée. Les Rwandais eux-mêmes font leurs petites recherches.

> If it is a species that provides timber, we are going to saw it for boards. If it is a fruit tree, we will consider it as that. If this species can be worked to provide utensils, we will also discover this. In brief, we will discover the utility of these trees afterwards.[32]

An example not related to the above experiment is of a consultant in Maraba, who had planted one Trema orientalis in one of his fields several years before in order to test the species for timber production. He was not able to explain what had happened, but the tree turned out to be a very bushy shrub; he realized that this shrub would never be able to yield any timber and the experiment as such had failed. He was, therefore, not interested in planting additional Trema trees but kept the one he had to increase in size some more so he could at least harvest some fuelwood from it. The examples cited above also explain why the few farmers that had planted Calliandra calothyrsus on their farm had done so primarily to produce timber, not fodder, stakes or green manure. As can be seen from the first quote, fuelwood is often not a major objective for planting trees and many farmers met during the field research shared this opinion.[33] If the species would yield fuelwood as its sole product, the above consultant would not be interested in additional plantings of the species. Thus, farmers experiment primarily to discover the utility of a new species and to determine whether the species provides more or less benefits than those they already are cultivating on their farm.

> We are going to consider these species, and we will demand others of those that proved themselves useful to us. Or, we can even ask you for other tree species that we do not yet know to enrich ourselves.[34]

With the particular goal for a new species in mind and given the amount of land and other resources available, the farmers would plant the species at the best possible location within

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[32]Si c'est un arbre qui peut donner des planches, nous allons le faire scier. Si c'est un arbre fruitiers, nous allons le voir et le prendre comme tel. Si cet arbre peut être travaillé et fournir des objets d'art, nous allons également le voir. En définitive, nous verrons l'utilité de ces arbres peu après.

[33]In spite of the perception of the Rwandan government and many Western experts of a fuelwood deficit in the country, farmers are rarely interested in planting trees solely for fuelwood. As building poles and timber command a much better price, farmers consider fuelwood to be a by-product (small branches, crooked poles, etc.)

[34]Nous allons considérer ces arbres, et puis nous allons en demander encore davantage pour ceux qui nous auront intéressé à cause de leur utilité. Ou par après nous serons amenés à vous demander d'autres sortes d'arbres non encore connus pour nous enrichir.

his/her farm. For example, one female consultant stated that she would plant all the seedlings she would receive in her woodlot, in spite of the fact that they were agroforestry species. Another consultant in Kibingo, who the researcher was able to visit after he had received his seedlings, had planted the five Casuarina seedlings he had received on various locations within his food crop fields next to the *rugo* (on the edge of a terrace, on the border of his bean field and along an anti-erosion ditch). New species are, therefore, not relegated to a particular piece of land but are planted directly on the desired location. Only one farmer insisted on being told what the best place for the species to be given would be since *"Sans vos conseils, on tâtonnerait avec les endroits exacts où ces arbres doivent être plantés. Si on les plante dans les champs ou les boisements et que ce n'est pas l'endroit qu'il faut, on sera amené à les couper."*[35]

In order to carry out an experiment, consultants first liked to know how the trees were to be planted, that is whether one has to use cuttings, seeds or seedlings. This information would also help them later if they wanted to increase plantings of this species, or give planting material to friends and neighbors. Almost all consultants also stated that they would use manure or compost as their soils are poor and tree growth would be very slow without this input. One woman also mentioned that she was going to put a mulch of banana leaves around the seedlings. Additional manure or compost would be added once or twice a year. Consultants would prune any suckers which might impede growth and form, observe general health and speed of growth of the seedlings, and watch for any attacks by termites or little ants (*inshishi*). If the termite or ant attack is severe, farmers may decide to move the seedling to another location, as they have no means of combatting these insects in another way. One person stated that he would look at whether the new species can resist the wind by observing them during a violent wind storm to determine the necessity for tieing the seedlings to support stakes. Farmers will also scrutinize the interaction of the species with associated crops and trees of other species, and the effect of the species on the soil.

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[35]Without your advice, we grope around for the exact places where these trees need to be planted. If we plant them in the fields or the woodlots and this is not the right place, we will have no choice but to cut them.

How do consultants evaluate their experiments and determine whether the new species will be of interest to them? Consultants mentioned several factors to evaluate new species including size, form, amount of growth per year, diameter, health, and the effects on crops and soils.

> To observe the growth of these trees, we observe if the tree is hard or pliable. If the latter is the case, we replace it with another one or provide it with a support. We also observe of the tree grows straight, its diameter and its age. If the tree does not grow, we will uproot it. We also observe if the tree yields cuttings or seeds to distribute it to other farmers.[36]

Almost all consultants also talked about distributing plant material of the new species they would be testing to their friends and neighbors, and such extension of new technologies appears to be an important part of the evaluation and validation of the success of these technologies as the following quotes explain:

> We are going to do a common experiment. If they prove to be useful, everyone will benefit. If the experiment fails, we will still be together. But it is only a question of trial. One can easily spot a tree that does not grow as it should. Then, we move this tree to another area, or we isolate it so that it no longer harms other trees.[37]

> If this species does not harm my crops, I will introduce it in my farm and take care of it. If it gives seedlings, I will plant two myself and give a third to my neighbor. I will do the same if the species gives seeds. I will harvest them and share some with the neighbor.[38]

> In any case, this sharing depends on whether or not the species produces well or not. But if it grows well, it will get the attention of the neighbor by itself.[39]

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[36]Pour voir l'accroissement de ces arbres, on observe si l'arbre est dure ou souple. Dans ce dernier cas on le remplace avec l'autre ou bien on le donne un support pour le soutenir. Pour la croissance, on observe aussi si il monte verticalement, son épaisseur et les années qu'il a. Si l'arbre ne croit pas on le déracine. On observe aussi si l'arbre peut donner soit des boutures ou des semences pour distribuer aux autres.

[37]Nous allons faire un essai commun. S'ils se rendront utiles, ça sera pour tout le monde. dans le cas de l'échec, nous serons toujours ensemble. Mais ce n'est qu'une question d'essai. Un arbre qui ne croit pas comme il faut se fait remarquer. Alors on le déplace ailleurs où on l'isole pour qu'il cesse de nuire aux autres.

[38]Si cet arbre ne nuit pas à mes cultures je l'introduirais et en prendrais soin. S'ils donnent des plants, j'en piquerais deux et donnerais le troisième au voisin. C'est tout pareil s'il donnent des semences. Je le recueillerais et le passerais au voisin.

[39]Néanmoins, ce partage dépendra du fait si cet arbre donne bien ou pas. En tout cas, si l'arbre grandit bien, il attirera le voisin de lui-même.

> If these species do not reproduce, the neighbors will have nothing as a consequence.[40]

This emphasis on extension of information and knowledge gained from consultants' *igerageza* should not be a surprise, as communication of knowledge is a major part of being recognized as being an expert on trees and tree cultivation as discussed in Chapter VI. Although agroforestry knowledge in the opinion of the consultants is largely of an individual nature, through the sharing of the technologies and the knowledge gained with them through trials, a collective stock of agroforestry knowledge is built. However, as there is no central depository for this knowledge, and as this knowledge is not recorded in any written form, the collective knowledge remains stored in the wisdom of many individuals.

3. Key findings

Utility and tangible benefits are the primary reasons why farmers plant certain tree species. Seeing and observing a species on other farms (of neighbors, friends or during travel) is important to determine if the species will be useful and if it will fit within the present farm. Imitation of what others have done (or are doing) is the most common way by which knowledge and technologies are spread.

As farmers can choose from a large number of *ibiti* to meet their diverse needs (as we saw in the previous chapter, 152 species were inventoried on the farms of the consultants), which species they actually plant on their land depends on:

- The perceived actual or potential utility and benefits of various species;
- The resources they command (land, labor, animals and manure);
- Available locations within the farm, which are related to slope, soils, crops to be produced in a certain field, and the distance from the *rugo*;
- The competitive and/or allelopathic aspects of tree species;
- Gender; and
- Personal interest, motivation, initiative and preferences.

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[40]Si ces arbres ne reproduisent pas, les voisins n'auront rien en conséquence.

Because of the large number of species from which farmers can choose, and the many variables taken into account in making a choice about species, location and planting method, an almost unlimited number of agroforestry systems is possible. The diversification of species and its resulting increase in complexity of land use systems are a deliberate strategy used by the farmers to overcome ecologic and economic uncertainties.

There is a conscious effort on the part of the farmers to build upon the body of endogenous agroforestry knowledge. In a species trial set up as part of this study, the majority of farmers chose to try species with which they were unfamiliar. Consultants justified their choice by stressing the importance of experimentation with new ideas and technologies for development and progress. Within the group of tree experts, this was expressed as a greater sense of curiosity, desire for knowledge, and internal drive for discovery, and recognition of one's efforts by descendants for leaving them a better world. There was an implicit understanding that not experimenting with new ideas would lead to stagnation and compromise an already precarious existence. Experimentation with new technologies and ideas is necessary to increase subsistence security by increasing species diversity and discovering benefits and utilities that cannot be obtained from presently available species.

Farmers do not use a specific research method for trees and tree cultivation experiments. As trees take several years to mature or to yield usable parts, most farmers (even the large ones) cannot afford to tie up land for several years to experiment with a new tree species. Thus, tests of new tree species or tree cultivation are not done on separate pieces of land, but are integrated within existing fields and crops. Although farmers refer to these tests as *igerageza* (experiments), these experimental activities are not separate from everyday agricultural activities, but closely interwoven with them. For farmers, each season is an "experiment" in which new knowledge is obtained and new ideas are generated.

While there is no uniform method in how new technologies (tree species or cultivation methods) should be tested, there are more or less standard variables which farmers will collect to evaluate the experiment:

- Will the species meet the objectives for which it was planted? (fuelwood, timber, stakes, etc.);
- Intercropping ability (i.e., allelopathic effects, competition with crops and/or other trees, shade);
- Effects on the soil (excessive water use and nutrient uptake);
- Growth;
- Disease and pest problems (in particular, termite and ant attacks); and
- Discovering other possible uses or benefits not initially intended.

Consultants were well aware of the risks involved in trying new, untested technologies. The emphasis farmers put on observing (new) species on other farms is related to studying it stature, growth pattern and possible negative effects of these species. Risks would not automatically preclude farmers from not trying new technologies, especially if the utility and benefits were perceived to be greater than the risks. But knowing what the potential risks are helps in dealing with them.

4. Summary and conclusion

For the tree experts consulted in this study, experimentation is not an activity that is separate from everyday agricultural activities as it is for researchers. The interweaving of experimental and productive practices was reflected in the discussion on species choice, location and planting methods and their approach to testing a new species (Chamaecytisus palmensis) on their farm. In this regard, Cernea's personal communication to Box (cited in Box 1988) would also be applicable here with slight modifications (noted in brackets; underlining in original):

> The farmers described [tree cultivation] as sets of practical activities rather than as patterns and rules of [tree] cultivation. Immersed in praxis, in other words, involved with the mechanics of cultivation practices, the farmers were able only to describe the sequence of their practical and empirical operations rather than to abstract, extract and formulate in a generalised manner the rules of [experimentation] embedded intrinsically in the sequence of their own practical acts.

According to the farmers, constant change and adaptations are necessary as a strategy for a better and more secure livelihood. The enormous changes in the landscape that have taken place over the last half century are indications of how farmers have adapted to meeting increasing demand for tree products at a time when natural forests and forest galleries have all but disappeared. Experimentation to adapt and/or generate new ideas and technologies regarding tree cultivation **on the farm** (acquired from both exogenous and endogenous sources) is an important part of this. The search and exchange of species and information about these species, and the experimental activities were (and are) conscious efforts on the part of the consultants to increase their knowledge of agroforestry. These results mirror those obtained by Box (1983) in his study of cassava cultivation in the Dominican Republic:

> A succession of cultivars has been established over the past fifty years, suggesting a continuous search for plants which are well adapted to prevalent cultivation conditions and market preferences. This suggest in turn a far greater amount of cultivator experimentation with cassava than has hitherto been acknowledged. Cassava cultivators can hardly be defined as traditional farmers in this respect: they innovate whenever conditions permit. .... [therefore], linking cultivator experiments to those carried out at stations may well prove to be more fertile than approaches followed until now.

Farmer-consultants in the present study do recognize the value of agricultural research, as without research they would never have been able to obtain species such as Grevillea, Eucalyptus, avocado and many others that now dominate the rural landscape in the study areas. In this regard, farmers seem to have an intuitive sense of the importance of a synthesis between the endogenous and exogenous knowledge systems. Formal (western scientific) research and development, therefore, does have an important role to play in agroforestry development, not so much to promote and design agroforestry **systems** but to increase the number of **options** available to the farmers. It should be noted that consultants emphasized the word **options**: they were not interested in ready-made solutions, but in a cafeteria system with a constant supply of technologies from which they can choose according to their needs and wants, and available resources.

The results of previous chapters showed that farmers do already practice agroforestry in very diverse and complex arrangements, even the smallest farmers cultivating less than 0.25 hectares of land. But, as the tree densities, especially on these very small farms, indicated, there is very

little room to manoeuvre to improve these systems. Any changes in the present agroforestry systems practiced by the farmers can, therefore, be only marginal ones. However, as differences in the objectives and the context within which various groups of farmers operate indicate, farmer and researcher collaboration in identifying problems and opportunities, and in developing solutions is important to develop a range of technologies that reflect these differences in objectives and context. In all cases, existing agroforestry knowledge and practices should form the starting point from which to move towards solutions; as van der Ploeg (1991) states:

> Identification of specific shortcomings, instead of the wholesale dismissal of local technologies as inadequate, can be an important mechanism to generate knowledge: it can be one of the means with which local knowledge can be developed in a fertile interaction with other knowledge. .... In this way, specific areas of local technology can be improved so that a) existing shortcomings are eliminated, and b) a solution will be found with greater local relevance than whichever 'external' technology.

Western scientific research and extension now dominate because they are more efficient in distributing information on a large scale, not necessarily because scientific agroforestry knowledge and technologies are better. Therefore, for a synthesis between the two knowledge systems to happen, two things are necessary:

- There is a need for persons with both endogenous and western knowledge of agroforestry systems to find new methods to share information with farmers in an informative, not a prescriptive, manner, and treat farmers and their knowledge with respect.
- As communication networks between tree experts amongst each other and between them and other farmers are neither very extensive nor very well organized, farmers need a framework or mechanism to distribute their knowledge on a wider scale and make it more accessible in order to advance the knowledge of indigenous agroforestry technologies.

As the results of this study show, local agroforestry knowledge and technologies are neither stagnant nor inherently 'worse' than scientific agroforestry knowledge. Endogenous agroforestry knowledge may, in many ways, be even better: through extensive efforts by farmers over the years, it has incorporated the best technologies generated by each of the knowledge tradition in

ways that are locally applicable and beneficial. The formalization of the synthesis between knowledge systems will increase the effectiveness of ongoing scientific agroforestry research and development and, more importantly, it will empower, legitimize and enhance the existing endogenous capacities for identifying problems and developing solutions, which will be an important step towards enabling rural people themselves to alleviate their poverty.

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CHAPTER IX

FINAL SUMMARY AND RECOMMENDATIONS

AGROFORESTRY IN RWANDA:

BACKWARD TO THE FUTURE OR FORWARD FROM THE PAST?

The goal of this research was to study and understand the historical and contemporary processes involved in the generation and adaptation of knowledge and technology of trees and tree cultivation by Rwandan farmers. An important point of departure in studying farmer knowledge is that we not judge the validity of that knowledge but accept it as is. First world science is only one science among many others. Each science tradition may, therefore, arrive at different conclusions about what constitutes a problem, priority or need, and what constitutes acceptable solutions. As it is social groups which give meaning to knowledge and technology, the social construction of knowledge and technology was used as a framework for this study. In particular, this study focused on 1) the dynamic aspects of Rwandan agroforestry systems, i.e. how and why these systems came into being and evolved over time, 2) the active role of farmers in the development of the agroforestry systems, and 3) the agroforestry knowledge/technology production processes (i.e. knowledge/technology acquisition, adaptation and /or generation processes).

Describing the agroforestry systems in the study areas was not the primary aim of this study. Agroforestry was used as the medium to understand the socially constructed nature of the knowledge upon which these systems are based. The visual artifacts (the agroforestry systems) are but the outcome, a reflection of farmer knowledge. Contrary to previous assumptions, this knowledge is not static but will change each growing season by implementing and maintaining these artifacts. Thus, there are extensive interactions between knowledge production processes and actual tree/crop/animal production activities on the farm. By consequence, to study knowledge production, one must also study the physical, observable artifacts constituting the agroforestry systems. The descriptions of the agroforestry systems that do occur in this dissertation (particularly in Chapter VII) served to provide a context to understand the nature and content of endogenous agroforestry knowledge and the processes involved in producing that knowledge.

1. Identification of tree experts

According to the philosophical definition of *ubumenyi* (knowledge) provided by Kagame (1958), knowledge implies knowing a plurality of objects or notions. Farmers consulted in this research equated knowledge of agroforestry with experience with the cultivation and/or use of many different tree species. By consequence, the tree experts identified with the help of a ranking procedure and community interviews were all farmers cultivating many trees of a large species diversity on their land. During the ranking game, informants explained that the larger number of trees and species diversity was possible because experts had more land, more animals and manure, better soils, greater wealth, and were more active in tree planting activities.

2. Comparing ranking game and formal survey results

These results were subsequently confirmed by data from a socioeconomic survey. The results of this survey indicated that tree experts are older, more experienced and further advanced on the family life cycle. They have greater resources (land, labor, animals, manure), and therefore can better absorb risks associated with experimentation. Tree experts are also better informed through travel, and are more observant of new species and practices during travel. In addition, they are more aggressive in seeking help and advice from extension workers, neighbors and/or veterinary assistants, and in pursuing extension and projects to gain access to new technologies (improved seeds, tree seedlings, fertilizer, lime, management practices of trees and crops, etc.). Although not all data obtained from the formal survey were mentioned as ranking criteria by game informants, the results indicate that informants were able to accurately distinguish groups of farmers within the population on certain key variables such as resources, wealth, and tree species diversity, even if only on a relative scale. The ranking game data and observations made during game implementation provided valuable contextual information about agroforestry practices. It is therefore recommended that future studies of endogenous knowledge systems combine formal and informal data collection methods as they provide both complementary and supplementary information.

3. The diversity of indigenous agroforestry systems

This research found that no two farms have a similar agroforestry system because of the individuality of farmers in designing a system best meeting their multiple needs given available resources. This individuality is reinforced by a large species diversity (193 *ibiti* were found in the study zones), the multiple reasons for planting trees, and the multiplicity of uses farmers make of trees. These factors have led to agroforestry systems with very complex arrangements of species over space and/or time.

Tree inventories of previous studies of agroforestry in Rwanda diverge greatly from the results of the present research due to the use of a different definition of what is a "tree." Whereas previous studies inventoried woody species (trees and shrubs) defined from a western conception, consultants talked about trees (*ibiti*) using the definition given by Kagame (1958): trees are all plants that are not grasses. Thus, the plants found on the farm in the indigenous agroforestry systems comprised under the term "tree" included not only trees and shrubs (as we understand them in the Western world view) but also annuals and perennials. The latter in large part contributed to the species diversity found in the study areas, and added an additional dimension and layer of complexity to the indigenous systems. However, these "non-trees" (from a Western perspective) should not be ignored as they provide significant benefits to the farmers, and often are grown in specific niches not usable for crops or trees. Future studies of agroforestry should, therefore, follow the farmers' definition of trees, and not assume that these "non-trees" are but weeds of no value.

4. Differentiation of agroforestry knowledge between tree experts and comparison farmers

Based on the methods used to identify tree experts, in combination with the generally larger farms they possessed, tree experts were shown to have a greater mean total number of trees (929) and tree species (34) than a randomly selected group of comparison farmers (i.e., non-experts) who had a mean total of 304 trees of 12 species. However, tree densities on the farms of comparison farmers were twice as high as on tree expert farms (1689 trees/hectare vs. 731 trees/hectare). Tree experts do practice agroforestry, but as they have larger farms, it is an agroforestry with

components separated in space and/or time. By contrast, comparison farmers integrate all components simultaneously on the same unit of land, averaging less than 0.25 hectares. The nature and content of the agroforestry knowledge of tree experts and comparison farmers may, therefore, be divergent. High tree density requires farmers to have higher levels of management skills and greater knowledge of the various components and their interactions. In future studies, it may be more appropriate to study the small farmers with their high tree density farms, as they are much further advanced in integrating trees and crops on a limited land base, and have more knowledge of managing these trees and crops in an agroforestry system.

Consultants indicated that knowledge about the uses and benefits of trees, especially for medicinal purposes, was valued higher than that of tree planting and cultivation. This is not surprising as trees have been used for centuries for a variety of purposes, but their purposive planting and management (outside the *rugo*) is a relatively recent phenomenon. As women are better in identifying trees and more skilled in treating everyday ailments using a wide variety of trees, they were considered more knowledgeable about agroforestry practices. Extension should, therefore, initially focus on women farmers to convince them of the benefits of trees, and later explain to the men how to go about putting improved agroforestry technologies into practice.

5. Reasons for planting trees and species choice

Specific utility and benefits were cited as the primary reasons for why farmers plant trees. As many species meet the diverse needs of farmers, species actually planted depend on:

- Resources (farm size, labor, animals, manure);
- Location within the farm (slope, soils, crops, distance from the rugo);
- Gender; and
- Personal interests, motivation, initiative and preferences.

Given these variables, coupled with continuously declining farm sizes due to the land inheritance system and thus increasing competition between trees and crops for a limited land base, decisions concerning species selection are becoming exceedingly difficult. As consultants considered all trees to be bad for the soil and to diminish crop production, the choice of species and

arrangements with the least negative influence on crops and soils becomes more and more crucial. To help make these choices, farmers made the following suggestions for research and extension:

- There should be more research on suitable species to increase the number of options available to farmers. Consultants stressed the importance of the availability of a diversity of tree species (both indigenous and exotic) as a strategy to overcome economic and ecologic uncertainties, and to meet multiple goals and needs. They want access to new species/technologies to test whether these can provide benefits not available from existing technologies, or whether they can get similar benefits quicker and more efficiently.
- New tree species to be introduced should be compatible and non-competitive with crops, non-shading, have tap roots and the ability to be used as live stakes. Ideally, and this was suggested by many of the very small farmers, research should introduce trees that produce fruit and (fuel)wood simultaneously.
- New technologies (species) should be made more accessible to farmers.

In the search for new species and intercropping arrangements of trees and crops, researchers should take into account the multiple goals and needs of farmers. Present agroforestry development efforts are too strongly geared towards rather narrow goals (fuelwood, green manure and mulch to combat declining soil fertility, or erosion control) defined by outsiders, ignoring the fact that farmers needs go beyond meeting the needs for these products and services. Researchers should not assume that other needs (for medicines, spices, fruit, twine, ...) are already being met, or will automatically be met if farmers adopt the new technologies. In this regard, it is also important to keep gender and farm size differences in tree planting objectives in mind: women and micro-holders are primarily interested in planting trees contributing to increasing the family food supply, whereas men and larger land owners prefer to plant trees for timber, construction poles and fuelwood. Women on both small and large farms also expressed great interests in planting medicinal trees. Therefore, participatory processes whereby local people and communities can identify, implement and evaluate their own priorities for tree growing will probably continue to generate more reliable project agendas than top-down approaches (Scherr 1992).

6. Land: A major constraint to agricultural development

Farmers also made a number of suggestions related to land reform. These suggestions would require political decisions at various levels of government. Their feasibility would require further study. What these suggestions do show, though, is that farmers are aware of their difficult situation in face of continuously decreasing farm sizes, and do consider and are willing to entertain radical changes if these would provide long-term solutions. The following suggestions were discussed by the farmers:

- A reform of the land tenure system to increase land holdings of each family to equal size. Farmers discussed this issue at length as a possible solution for the present generation, but had not thought about its effect on future generations with varying number of sons in each family.
- The transfer and distribution of national and communal forests to individual or groups of farmers to be cooperatively managed.
- A reorganization of the landscape from dispersed settlement to nuclear villages to be located on land unsuitable for cropping. More good land could thus be allocated for cultivation in the opinion of farmers.
- Collective farming enterprises, eliminating the need for large spaces being taken up by boundaries and boundary markers.

7. Agroforestry development through endogenous knowledge production processes

The processes by which knowledge is added, used and lost to the stock of knowledge of a social group are similar in both the endogenous knowledge system and the scientific knowledge system. In both systems, we find a certain specialization and differentiation between a small group of knowledge producers (generaters, adapters, acquirers) and a large group of knowledge users. But there are also fundamental differences between the two systems in the way knowledge and technology is produced and in the way it is validated.

Consultants described knowledge production through *igerageza* (experimentation) as an activity closely interwoven with every day agricultural activities, not separated from them as is the case

in the scientific knowledge system. These findings confirm the results of Box (1988) with cassava experimenters in the Dominican Republic, where one of his research subjects explained that experimentation can only be understood if it was grounded within everyday life experiences and activities. For farmers, experimentation is necessary for development and progress as a strategy for a better and more secure livelihood. There was an implicit understanding that not doing any experimentation would lead to stagnation, and make an already precarious existence worse. Constant adaptations are necessary, and experiments are a primary source of ideas for these adaptations. *Igerageza* is carried out not only because of curiosity, a desire for knowledge and discovery, but above all because of a desire to leave a better world for one's children.

Farmers are, therefore, eager for new information and technologies, but are reluctant to try them on their own farm if they have not seen them in practice or use. However, some farmers are more willing to try untested ideas than others, although this depends on the technology to be tested and the interests of the farmer-experimenters. Opportunities exist for research, extension and development projects to identify these farmers and develop networks of farmer-experimenters which may or may not be technology/idea specific. A fixed group of so-called "pilot farmers" who will be involved in pretesting all new technologies (as was used by PAP in Kibingo) is not recommended, as, for various reasons, few technologies spread beyond this group of farmers. As interests and resources vary between farmers, different farmers may be involved in trying different technologies (for example, Chameacytisus palmensis for stake production, Euphorbia tirucalli for erosion control, etc.).

The two knowledge traditions differ in the way in which new knowledge and technologies are validated. In the scientific knowledge system, active communication of experimental results (in journals, conferences, seminars, etc.) to fellow scientists and researchers takes place to validate the results. The primary aim of experimentation is the advancement of knowledge. By contrast, the endogenous agroforestry system is primarily use-oriented; communication of experimental results was considered by consultants an important aspect of being recognized as "being knowledgeable", but it did not appear that there was much active effort in sharing new knowledge gained. Validation of new ideas/knowledge takes place through imitation of one's efforts by other farmers (neighbors and friends), in other words by the final technology users, not by fellow

experts engaged in knowledge/technology production. Evaluating researchers and scientists involved in agroforestry technology development by a standard of acceptance of their results by farmers instead of by the number of peer-reviewed articles in scientific journals, would go a long way towards increasing collaboration between the researchers and farmers, propelling research to move from being knowledge-oriented to being development-oriented, and furthering a synthesis between the two knowledge systems (den Biggelaar 1991).

Endogenous agroforestry knowledge is neither stagnant nor inherently "worse" than scientific agroforestry knowledge. Regarding its nature and content, agroforestry knowledge of Rwandan farmers may in some respects be better as it incorporates the best technologies generated by each knowledge tradition **in ways that are locally applicable and beneficial.** Thus, one can study and compare the two knowledge traditions, but one cannot, and should not, judge them by each other's standards. There are differences between the two knowledge traditions, not only in the nature and the content of the knowledge but primarily in the distribution of that knowledge. But such differences do not preclude considering them in their own right and as equally valid.

8. Enhancing local communication networks: The key for advancing agroforestry knowledge and practices

Communication networks for knowledge sharing and distribution between tree experts amongst each other, and between them and other farmers, are neither very extensive nor very well organized. Consultants identified this virtual absence of local communication and information exchange networks as a major barrier to agricultural and agroforestry development. It is, therefore, recommended that mechanisms for local and regional information exchange are created to facilitate communication between farmers, and advance the knowledge of endogenous agroforestry technologies. Possible means to accomplish this are guided farm visits, community and/or focus group discussions such as undertaken in this research, and farmer study groups created to solving specific farm problems. Such a participatory strategy to agroforestry technology development would also assure that technologies are client-oriented, and grounded in local dynamics of socioeconomic development and of agroforestry intensification pathways (Scherr 1993). To implement such a strategy, there is a need for persons with both endogenous

and western knowledge of agroforestry systems to find new methods to share information with farmers in an informative, not a prescriptive manner, and treats farmers and their knowledge with respect.

9. Conclusion

Relative to Western knowledge, Rwandan endogenous agroforestry knowledge may indeed appear to be backward and stagnant. However, from a farmers' point of view, the simplification of agroforestry systems based on a limited number of species and arrangements as advocated by scientific research and extension under the guise of development may be a step backward. This research-extension strategy to agroforestry development appears diametrically opposed to the farmers' strategy of increasing complexity and intensity of their agroforestry systems in the face of increasing resource scarcity and degradation. These results are similar to findings of Scherr (1993) in Western Kenya. This does not mean that one should do away with research. Farmers are aware of the value of scientific research for the development of their systems and to provide a better future for their children. The widespread adoption and integration of many exotic tree and crop species in the farmer systems over the years are examples of the dynamism of the endogenous knowledge system and the importance of increased collaboration between local tree experts and researchers. However, farmers also have an inherent understanding of the importance of diversity of species and of arrangements of trees and crops in space and time. The long experience and knowledge they have gained by working the land and making a living from it provide them a solid base to move forward from the past by enriching it with new endogenous knowledge and technologies, be they science based or from other endogenous knowledge systems.

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APPENDICES

APPENDIX I-1

THE CONSTRUCTION OF THE WORLD AS REVEALED IN RWANDAN PHILOSOPHY

The literature on Rwandan philosophy is scarce. The dissertation of Kagame (1958) entitled La philosophie bantu-rwandaise de l'être is considered a standard work which many other authors have used in their research of Bantu cultures (for example Balaibutsa 1985; Jahn 1990). An understanding of the Rwandan world view (how the world is constructed, how people make sense and organize the world) is important to be able to understand endogenous knowledge in general, and endogenous knowledge of agroforestry in particular. In this section, an overview will be given of the Rwandan view of the world, particularly as it deals with how the world is constructed and what the characteristics of and relations between people, plants, animals and minerals are. It will also describe what knowledge, science, wisdom and intelligence are in this world view. This information will be helpful in understanding later chapters in the dissertation. Such an understanding is not only important in this dissertation, but also for others studying and working in Rwanda. As Balibutsa (1985) states:

> Je crois que [....] l'éducateur et le politicien doivent tenir compte de la culture rwandaise dans l'approche du développement, car le développement est impossible s'il ne s'enracine pas dans les convictions et les croyances profondes d'un peuple.

Thus, a study investigating a possible synthesis of endogenous and scientific knowledge will need to start with an understanding of Rwandan philosophy, the basis of Rwanda culture. As in most African cultures, Rwandan people did not rely on written records but on oral communication of ideas and knowledge. Spoken language, therefore, is the primary vehicle for gaining an understanding of Rwandan culture. Kagame built his Rwandan philosophy from an analysis of the language and oral records (myths, poems, etc.). Kagame was of the opinion that an understanding between different cultures could be gained only through study and comparison of the logic and world views behind the different languages. However, he was well aware of the linguistic incompatibilities between languages, and that a comparison of Rwandan and European philosophy would, therefore, not be an easy task:

> On ne peut pas transposer en langues de la zone bantu la signification scientifique de toutes les découvertes accomplies dans la zone où est en vigueur la culture européenne. Cette impossibilité ne peut être surmontée, que si la linguistique bantu s'enrichit d'abord d'une terminologie correspondant à ces découvertes. Le principe joue du rest dans les deux sens: aucune langue de la culture européenne ne peut traduire toutes les idées en cours dans les langues bantu.

The ideas expressed in this section are a translation and summary of the first nine chapters of Kagame's work. It also draws from a more recent book by Balibutsa (Les perspectives de la pensée philosophiques bantu-rwandaise après Kagame) which refutes and expands some of the concepts of Kagame, which are included in this summary where appropriate.

Kinyarwanda language as the fundamental source of philosophical information

The principal sources of information that Kagame used to develop his thesis of a Rwandan philosophy are everyday spoken language and "institutionalized documents" such as proverbs, legends, dynastic poems and stories. According to Kagame, Rwandan philosophy is intuitive: people have developed an understanding of the fundamental problems of being, and developed an adequate terminology to describe these problems, but they have not consciously studied the problem and described it in written form. The problem is left in oral form as legends, stories, myths, proverbs etc., and thus can be found in spoken language and studied linguistically. In absence of any written information, he considered spoken language to be the best reflection of how a people view the world. However, Kagame excluded direct investigations and interviews with people because of two reasons: First, he considered Rwandan people to be too "primitive" to have a notion of philosophic problems; he thought that people would not understand the meaning of the questions without lengthy explanations, which would influence their responses and would, therefore, not lead to the true philosophical meanings behind ideas and words that he was seeking. Second, Kagame recognized that there are people with extensive knowledge and wisdom regarding certain aspects of Rwandan traditional knowledge. But he declined to seek information from such persons also, since questions put to them would force the informer to reason and would not provide them with spontaneous, naive answers. Balibutsa rightly points out a contradiction in Kagame's reasoning in selecting his sources of information. If Kagame wanted to show that Rwandans have a notion of a metaphysical world, it contradicts his rejection of using people as informers because they are "too primitive":

> Il est regrettable que Kagame n'ait pas vu le caractère paradoxal et même contradictoire de considérer un peuple comme primitif et d'une culture inférieure pendant qu'on cherche à démontrer qu'il a créé une 'métaphysique.' Il est également regrettable qu'il ait écarté *à priori* la méthode du 'questionnaire' qui lui aurait pourtant fourni une base plus solide pour son argumentation alors qu'on lui reproche précisement de s'être trop appuyé sur une simple analyse linguistique.

The Rwandan world

According to Kagame, Rwandans do not have a real cosmogony since there are no myths or records dealing with the origin of the world. However, Rwandans do have a certain conception of the world. The world is composed of three layers. The middle layer is the earth upon which we live. Below the earth is the abysmal world, the habitat of the spirits of the dead (*bazimu*). For this reason, the lower layer is called *i kuzimu* (with the non-living). Above the earth is the superior level or sky (*ijuru*), the habitat of God and certain beings of extraordinary force such as thunder and lightning. The blue sky is a sort of rock in the form of a dome which serves as the solid base for the sky and as the roof for the earth. As Balibutsa wrote, the three domains of the world are conceived as having a similar structure. People talk about the inhabitants of the heavens and of the abysmal world in the same terms as those used for the world of the living: their habitat and their social and economic modes of organization are described as if they all concern real people.

Rwandans do not have a conception of the universe in the sense of it being a collective of things or beings. The astronomical knowledge of Rwandans is not as extensive as in other cultures. People do recognize some stars and planets in the heavens and have given them names: *kizuba*

(sun), *inyenyeli* (moon), *ikibonumwe* (comets and shooting stars) and *ubwirakabili* (solar eclipse), with all other stars and planets collectively spoken of as uyamuhiribona (everything that appears in the night sky). Rwandans also do not conceive of the world as a terrestrial globe, but consider world to mean nation, country, people. The borders of the world are described by expressions such as:

"There where the land/country ends."
"There where things fall in the void."
"There where the sky is held up by the sticks and palisades of the elephant grass."

No body can be infinite in Rwandan conception, all things that have a surface area must have a limit. Since the world is an expansive being, it must have a limit. Given that the surface of the earth, the habitat of the living, is the height limit, one deduces the limitations of the world in length and width. Therefore, the sticks of elephant grass which support the sky dome are the terminal wall of the earth limiting its extent. The use of elephant grass as holding up the sky in this proverb, and not trees as would be more logical at least from a western point of view, in the context of this dissertation is interesting. Apparently, elephant grass (Pennisetum purpureum) was more common during the time when Rwandans developed this concept than trees, indicating that deforestation may have occurred much longer ago than commonly assumed. As previously mentioned, Schoenbrun (1993) found that deforestation may have begun as far back as 3,000 B.C., and that by 1,000 A.D. Rwanda looked much like it does today.

Classes of nouns: the basis of a Rwandan philosophy.

According to Kagame, one can discover the basic structure of bantu languages and the procedure used to formulate abstract ideas by analyzing the structural aspects of Rwandan terminology. The linguistic structure of Kinyarwanda divides all nouns in a number of classes. Nouns consists of a "radical" which does not change; the class of the noun is determined by a "classifier" placed before the noun. Noun classes form the basis of Kinyarwanda language, and grammatical rules (verbs, adjectives, pronouns etc.) refer to these classes. Kagame built his philosophy from the surprising phenomenon that the various classes of words that indicate objects, people, human nature/quality, space/time, and mode of being can all be grouped in four categories based on the same radical: *Ntu*. *Ntu* by itself is a concept that is absolutely empty of all determined contents. *Ntu* only gets meaning when linked with another linguistic element, namely the classifier. Because *ntu* by itself is meaningless, it can serve as a support for the mental structuration of the universe at the most fundamental level, i.e. on the level of the first categorical group of "being." Starting from this phenomenon, Kagame grouped the classes of nouns in four categories of being, namely:

1. *umuntu* = people
2. *ikintu* = things
3. *ahantu* = place or time
4. *ukuntu* = mode of action, way of being of a being

Kagame considered the term *ubuntu* (liberality) as a quality of being, and therefore subsumed it under the category of *ukuntu* and not as a separate category. However, Balibutsa disagreed with this since liberality does not indicate an accidental quality of being but expresses something about the essence, the nature or state of being, i.e. a substantial quality of being. In addition, since *ubuntu* is an abstract quality that only people can possess, Balibutsa is of the opinion that *ubuntu*

should be a separate, fifth category of being indicating "human nature or quality, humanity, generosity." We can therefore summarize the categories in Rwandan philosophy as follows:

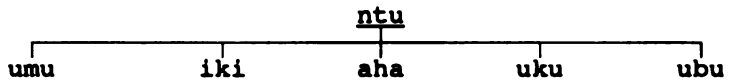
1. *umuntu* = beings with intelligence
2. *ikintu* = beings without intelligence
3. *ahantu* = localizing beings
4. *ukuntu* = modal being, accidental qualities of being
5. *ubuntu* = abstract, substantive qualities of beings with intelligence

Umuntu, beings with intelligence, refers to human beings. In fact, its plural (*abantu*) means all (wo)men or people, even though in the western conception it refers to Bantu speaking peoples.

Ikintu, that is beings without intelligence, comprises all beings in the mineral, vegetable and animal kingdoms, as well as beings of the cosmic domain such as lightning, thunder, storms and similar phenomena. Traditional Rwandan sciences place the latter among the substances.

Ukuntu contains two groups of words: (1) Abstract terms of the eighth class, adverbs of quantity, and infinitive forms of "static" verbs that express an internal mode of a being, that is, its static modification. These entities correspond to the matter or substance and the form of the being respectively, that is shape, dimension, color, weight, etc. (2) The infinitives of "active" verbs and adverbs of manner that express a mode of action.

The above categories can be arranged in a tree analogous to Porphyry's tree which shows metaphysical and logical categories of being in european philosophical systems. The Rwandan tree of metaphysical and logical categories would look as follows:



From this diagram, it becomes clear that there are no logical categories as established in european cultures. By consequences, Rwandan philosophy recognizes only one unique genus, one unique species, and, therefore, only one unique specific difference. This leads to a further conclusion that because there is only one unique genus and there are no intermediate genera, and there is no supreme being. Similarly, a species cannot be called ultimate because there are no anterior species. Thus, in the initial analysis of the essence of being, Rwanda philosophy attributes only one unique step in the hierarchy of being, that is one that goes from the unique genus to the unique species.[1] Kagame explains the phenomenon of the unique genus and species as follows:

> *Umuntu* is a being with intelligence. It corresponds with the ultimate species "reasonable" at the bottom of Porphyry's tree. *Umuntu* cannot be split in any other species; below it are only individuals and these cannot be considered a category. By definition, individualization is the negation of categories. Thus, *umuntu* goes in one step from supreme genus of being to the ultimate species. Similarly, *ikintu*, a being without

[1]At a second level of analysis which deals with existence, it is possible to distinguish logical categories similar, but not identical, to those in Porphyry's tree. We will get to these secondary metaphysical categories later.

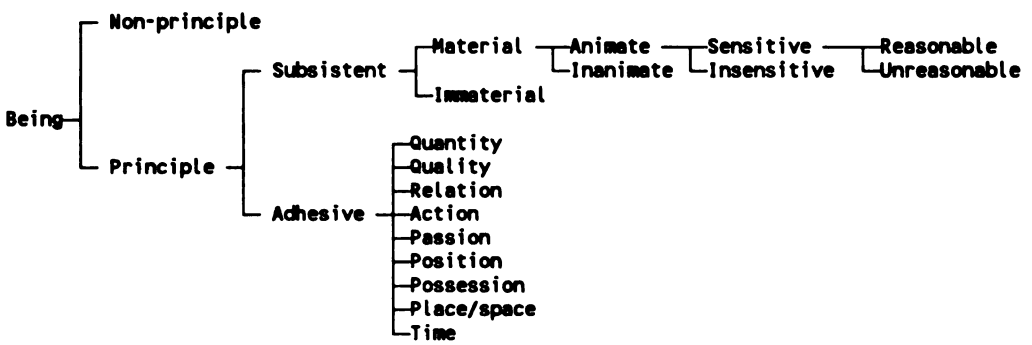
intelligence, is the ultimate species and corresponds to the ultimate species of "unreasonable" in european philosophy.

It should be noted that Rwandan philosophy talks about "being with intelligence", which is not the same as an intelligent being. Analogously, using the term "reasonable," one cannot say "reasonable being" but one has to use the term "being that has reason." If one were to use "reasonable being" as a synonym for "intelligent being," it would change the meaning of this metaphysical formula. For the same reason, one cannot call a "being without intelligence" unreasonable as is done in the philosophy based on european culture.

Comparison of Rwandan categories with Aristotelian categories

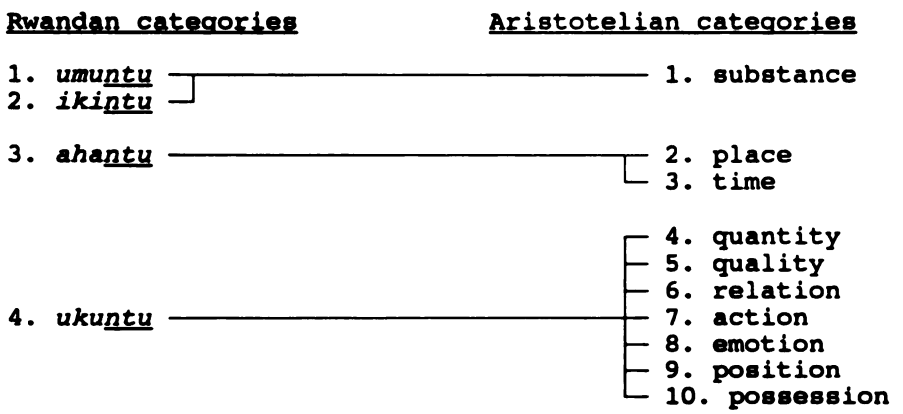
According to Balibutsa, Rwandans could never have had the idea to debate the question of "categories." However, Kagame is of the opinion that these notions could not have been absent in Rwandans' conceptions of being since they are so basic to human thought. An important part of Kagame's work is, therefore, devoted to comparing rwandan categories with those established by Aristotle. He did not intend to imply that the categories established by Aristotle and Rwandan categories are the same. Kagame used the aristotelian categories as a point of departure for comparative purposes as a sort of "control", and to legitimize the validity of the existence of a Rwandan philosophy. Kagame used the aristotelian categories because they are based on metaphysical schools of thought. Even though he discusses other ways of organizing the universe, he found their categories less applicable to Rwanda. The categories established by the more idealistic schools of thought (Kant, Renouvier) carry too much cultural baggage according to Kagame, while philosophers such as Mill are too closely related to experimental sciences with systems of categories resembling more a scientific system of organizing the world than a philosophic system.

The following figure gives a complete overview of the metaphysical categories of being according to Aristotle:



In Aristotle's view, substance (that of which other things are predicated (Kiernan, 1962)) is opposed to accident (whatever do not signify substance but are predicated of another subject, which is neither the thing itself nor something belonging to it (Kiernan, 1962); qualities or attributes that are not essential). In aristotelian philosophy, being is considered as a function of its realization in nature. In rwandan philosophy, substance is not considered in opposition to accident but above all in opposition to its operational properties: being with intelligence, being without intelligence, localizing being, modal being, substantive qualities of beings with intelligence. Therefore, Kagame preferred the term "subsistent" (meaning something that which exists in itself as an individual whole) and "adhesive" (in the sense of a being that "adheres" to

another being, indicating a sort of inseparability) instead of substance and accident because the former are closer to the rwandan conception than the latter. Based on the above scheme of aristotelian categories, Kagame draws up the following figure comparing the two:



Balibutsa did not provide any information of how *ubuntu* fits into the above comparative scheme of categories. Accidental qualities of beings with intelligence clearly refer to the category of *ukuntu*. Given the meaning of *ubuntu* (i.e. abstract, substantive qualities of beings with intelligence; the essence or nature of being of beings with intelligence) it would correspond to the aristotelian category of quality which led Kagame to reject the recognition of *ubuntu* as a separate category. However, since *ubuntu* is particularly related to people, Balibutsa firmly believes it should be a separate and fifth category. It is, therefore, not exactly clear where one would put the category of *ubuntu*, which does not have a clear cut related category in Aristotle's system as do the rwandan categories of *umuntu*, *ikintu*, *ahantu* and *ukuntu*.

Kagame's treatment of space and time as one category is most unsatisfactory for Balibutsa. *Ahantu* refers primarily to space, but it can also refer to a temporal situation, which let Kagame to conclude that Bantu people do not have an autonomous concept of time. Balibutsa finds Kagame's analysis insufficient because there is a word for time in kinyarwanda, namely igihe, which is distinct from *ahantu*. Kagame may have linked *igihe* and *ahantu* in a backward way, since the radical of *igihe*, *-he*, refers to a spatial situation: *Ugiye he?* (Where are you going?). Secondly, the derived term aho (there where) can refer to both space and time. Because Kagame build his rwandan philosophy on a linguistic analysis of kinyarwanda, searching for common and recurring elements in words and phrases to arrive at metaphysical categories, the merging of space and time in one category is understandable. According to Balibutsa, Rwandans do have a notion of time distinct from that of space. To locate objects in space, Rwandans arrange objects in a three-dimensional space, and describe their location using a real or imaginary central point. However, for every word that expresses a determination of space in relation to a central point corresponds another word which expresses a determination of length of a temporal coordinate in relation to a central instant. As Balibutsa stated, Rwandans have an intuitive sense of time as a fourth dimension, reason for which Rwandan thought intimately links space and time. Thus, determinations of spatial-temporal situation can be expressed in terms of distance or in terms of length of time or a combination of both.

Being and existence in Rwandan philosophy

In the Rwandan conception of the world, "to be" is not equal to "to exist." Verbs with a philosophical meaning, such *kuba* (to be) and *kubaho* (to exist)[2], have two different forms in Kinyarwanda, namely an actual and an habitual form. The actual form of the verb indicates the present, involving actions in progress but not yet terminated. The habitual form of the verb is used for actions already accomplished, actions in progress, and actions to be undertaken in the future. For the verb *kubaho* (to exist), the actual form is *-liho* and its habitual form is *-baho*.

-Liho implies a concrete, individualized existence of a determined subject, a living being actually realized and present in nature. It indicates the actual, present existence, an existence that was not always there and will not be always there. It is a transitory, perishable existence in the sense of "not yet dead."

-Baho, on the other hand, implies an absolute, non-temporal existence independent of time and space. It does not refer to specific individualized beings, but to larger substance such as plants and animals independent of their actual realization in nature. Therefore, *-baho* cannot be used in the first or second person since if the speaker or his/her interlocutor are in the process of talking, they actually exist now and their act of existence is not yet achieved. Thus, I existed or I will exist are impossible constructions. The differences in existence form the second level of analysis used to differentiate minerals, plants and animals.

Subgroups of *ikintu*: the mineral, plant and animal kingdoms

At the first level of analysis, at the level of essence, the world is divided into beings with intelligence and beings without intelligence based on their operative qualities. At the second level of analysis, that of existence, Kagame divides the category of *ikintu* (things) into three metaphysical categories: (1) Fixed beings, which include all inorganic beings and refers to the mineral kingdom; (2) Assimilative beings, or beings belonging to the vegetable kingdom; and (3) Sensitive beings, or beings belonging to the animal kingdom, but excluding humans. Both fixed and assimilative beings are considered beings not endowed with activities, i.e. they cannot exercise their action on other objects distinct from themselves. Kagame chose to use the term "fixed" for the mineral kingdom because minerals do not show any apparent changes resulting from their own internal reactions. They cannot increase, decrease or displace themselves without intervention of external agents.

Fixed beings

Kagame's treatment of the mineral world is rather brief. Rwandan philosophy maintains that fixed beings are limited, because an area cannot be unlimited. Thus, from a philosophical point of view, there is only a quantitative difference between a grain of sand, a stone, a mountain, the entire earth, and the total bodies making up the universe. Qualitatively, they are all the same. Second, fixed beings do not have any operative qualities, and, therefore, cannot engage any activities. Third, fixed beings do have properties, but these properties are indifferent. They can

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[2]The other verbs with dual philosophical meaning are to have and to know. These wil be discussed later in this section.

be used to produce a determined effect only if an intelligent being uses them to bring out these properties from their indifference.

Assimilative beings

Assimilative beings or beings in the vegetable kingdom have two properties: assimilation and reproduction. Since plants grow and reproduce, they have a certain activity which distinguish them from minerals. In the European conception, if plants are growing they are living and have a life. The word "life" is rendered by three words in Kinyarwanda: *ubugingo*, *ubuzima* and *amagara*. The words for "living" are rendered by *muzima* for beings with intelligence, and *kizima* for beings without intelligence. "Living" can also be translated as "existing" or "to actually be there," in which case one uses uliho for beings with intelligence, and ikiliho for beings without intelligence. The words "life" and "living" can never be attributed to plants. To have "life" or "to be living" requires the ability to act outside of oneself which presupposes cognitive qualities, something plants do not have. "Life" and "living" can, therefore, only be used for animals and people. The consequence of this is that neither trees nor grasses are living beings in the Rwandan conception. However, trees and grasses do exist as a notion of timeless, habitual existence independent of their actual realization in nature conform the notion of the vegetable kingdom.

To indicate this timeless, habitual existence, one can use the verb *-baho* to describe plants. However, it is not correct to use the form *-liho* to indicate the actual existence of trees or grasses. As defined above, *-liho* implies a concrete, individualized existence of a determined living being actually realized and present in nature. Since plants are not living, the form *-liho* cannot be used to indicate their existence. Instead of using the words "life" and "living," Rwandans use the word *ububisi* (verdancy) to describe the vital principle of plants. *Ububisi* encompasses both assimilation and reproduction. The process of wilting, which makes the characteristic properties of plants disappear, is the opposite of verdancy and is called *ubwume* (aridity). Neither verdancy or aridity can be applied to people or animals. *Ububisi* can be ascribed to people and animals, but then its meaning changes to "raw, not yet cooked."

The life cycle of plants

The beginning of a plant's life is called germination, and the same word, *kumera* (to sprout, to germinate) is used when plants are propagated from seeds or from cuttings. Trees and grasses grow (*gukura*) and increase in size, and their growth and development is proportional to the life span of each species. As stated above, plants are not living (or, synonymously, are not yet dead) beings. Thus, if plants are not living, they cannot die. Therefore, the existential end of plants is called *kwuma*: to dry, to wilt. The end of plants' life is not their decomposition or cremation. If plants are already completely dry or in a decomposing stage, they are still plants in a material sense, but they have lost the properties metaphysically characterizing them as plants and thus are no longer formally considered plants. The formal end of plants is marked by the loss of the principal internal property (*ububisi*) which happens through wilting and drying. If, however, trees or grasses are burned when they are still green, their burning formally considers them as fuel, not as dead plants.

It should be noted that in the Rwandan world view, the vegetable kingdom is divided in two groups of plants, namely *ibiti* (trees) and *ibyatsi* (grasses). Rwandans do not make a further

distinctions between annuals and perennials, or broad leaves and conifers.[3] *Ibiti* include all plants that are not grasses, while *ibyatsi* include all plants that are not trees.

Sensitive beings: the animal kingdom

The generic term for beings without intelligence that have sensitivity is animals, and this second order metaphysical category comprises mammals, fish, birds, insects etc. In contrast to minerals and plants, animals do have a life and are living. The beginning of animals' existence is indicated either by the word *kuvuka* (to be born) for mammals or *guturaga* (to hatch) for oviparous animals. The existential development of animals is called *gukura* (to grow); it should be noted that this is the same word that is being used when talking about the growth of plants. Since animals are living (meaning not yet dead), their end of existence is *gupfa* (to die). *Igicucu* is the vital principle of animals, their soul. When the animal dies, its soul separates from the body and vanishes. There is no spirit world for animals, their souls just disappear. As long as soul and body are united, the animals are living, they have a life.

The words used for life (*ubuzima*, *ubugingo* and *amagara*) were mentioned in the paragraph on assimilative things, although these terms cannot be used for plants. All three words are abstract terms, but their meaning is not exactly the same. *Amagara* is always abstract and used in this plural form, the singular *igara* is rarely if ever used in common language. Its radical, *-gara*, cannot be used to form other, concrete terms unlike the other to words for life. The radicals of both *ubuzima* and *ubugingo* and can be used to form other concrete words; for example *umuzima* (spirits), and *amagingo* (instant, a determined point of certain duration).

Before explaining the differences between the three forms of life, it is useful to introduce the third of the four verbs with philosophical importance: *kugira*, to have. As the first two of these words introduced, *kugira* has two forms of the radical, namely an actual and a habitual form. The actual form, *-fite*, is used for actual, concrete possession in the present time. The habitual form, *-gira*, is used to indicate possession of an object of a concrete, individual nature, as well as possession of timeless, abstract beings (eg. to have intelligence). Having introduced this verb, we can now return to the discussion of life.

Ubuzima (life) is the union of the soul with the body, which is dissolved at death. Normally, the verb *kuba* (to be) is used when talking about *ubuzima*, indicating that there is a union between body and soul. The meaning of *ubugingo* (life) is slightly different in that it refers to the length of the vital union between body and soul in the sense of happy to having escaped from a mortal danger and to still have a life. For this form of life, Rwandans use the habitual form of the verb *kugira* (to have), habitually because *ubugingo* has a meaning that their time for death has not yet arrived. *Ubuzima* cannot be linked to a subject with the verb "to have" since the subject is not anterior to the fact of the union of its two components (soul and body). Once the composite is there, the subject is alive and realized in nature, and the subject is anterior to his own life span. Vis-à-vis his/her own life span, the subject is no longer passive but active. Thus the necessity of attributing life (*ubugingo*, i.e. its length) to the subject with the verb to have in its habitual form of possession.

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[3]These distinctions may exist in the allocation of trees to various noun classes. As this is a linguistics problem outside the main goal of this study, no information on this was collected regarding the detailed differentiations between annuals, perennials, shrubs and trees.

The third form of life is *amagara*. *Amagara* refers to a second, unnamed principle in the union of the body and the soul of beings having intelligence. As only people can have intelligence (as will be explained in the section on the internal senses below), *amagara* can never be attributed to animals. Unlike *igicucu*, the vital principle, which vanishes when the animal or person dies, this unnamed principle remains as a determined being but without being alive: *muzima* (spirit).

The external and internal senses: differentiation between animals and humans

The external senses

Rwandans recognize five external senses, namely *kubona* (to see), *kwumva* (to hear), *gukora* (to touch), *kunukirwa* (to smell) and *kulyoherwa* (to taste). Unlike languages belonging to european culture, Kinyarwanda does not have nouns corresponding to these five senses. To indicate sight, hearing etc., Rwandans use the infinitive forms of the verbs. In Rwandan philosophy, the external senses are viewed from two aspects; firstly as contacts and physical passions, in which case each sense is recognized under its own name; secondly, when they are considered to be sources of knowledge, these external senses are grouped in two fundamental external senses, namely *kubona* (to see) and *kwumva* (to hear). Thus, Rwandans do not only talk about hearing sounds, but they also talk about hearing smell, touch and taste. *Kubona* refers to seeing colors and light, while *kwumva* refers to collisions or contact between bodies, either chemical contacts (smell and taste) or physical contacts (direct contact indicating touch, and indirect contact referring to hearing). The only difference in the external senses of animals and (wo)men is that, according to the usage of the verb *kwumva*, animals only hear sounds while (wo)men hear sounds and explanations: (wo)men understand! Thus, animals only experience external senses in the first sense, i.e. as contacts and physical passions, which do not lead to knowledge. In order to obtain knowledge, the impressions obtained from the external senses have to be assimilated and digested by the subject, who has to internalize these impressions and make them part of him/herself. No knowledge is possible without the knowing subject and the object becoming one and the same. However, only people are able to unify subject and object and, by consequence, only people can have knowledge.

The internal senses

Classical philosophy recognizes four internal senses, namely common sense, imagination, instinct and memory. Rwandan philosophy, on the other hand, only recognizes two: *kwibuka* (memory, lit. to remember) and knowledge in general which comprises the internal senses of imagination, common sense and instinct. Since knowledge in Rwandan philosophy comprises three of the four classical internal senses, what is meant by knowledge?

The verb *kumenya* (to know) is the fourth and last verb with dual philosophical meaning, and, like the verbs to be, to exist and to have, has two forms of its radical. If one talks about actual knowledge in the present, imperfect time, one uses the radical *-zi*. The habitual form of the verb, *-menya*, is used for all time forms (present, past and future) for both habitual and actual knowledge. When the subject of a sentence concerns animals, the verb to know can only be used in the third person, except in fables. According to Kagame, kumenya alludes to both knowledge and science, and he uses this distinction to differentiate between animal knowledge and intellectual knowledge.

Traditionally, *(u)kumenya*, the infinitive of the verb *kumenya* is the sole way of translating the noun "knowledge"; the term *ukumenya* implies actuality. Habitual knowledge or science (not to be confounded by science as understood in western culture) is indicated by the word *ubumenyi*. Science is to be understood as the possession of knowledge as contrasted with ignorance or misunderstanding. To have *ubumenyi* implies having a plurality of knowledge because a simple knowledge limited to one object or a limited number of notions cannot be constituted under the term *ubumenyi*.[4] If the knowledge (*ubumenyi*) that a person possesses is highly valued in society and much sought after, so that the person is considered a renowned specialist, the word *ubuhanga* (wisdom) is used in stead of *ubumenyi*. Animals can have knowledge (*ukumenya*) but they cannot have knowledge/science (*ubumenyi*). The latter can only be attributed to beings having a faculty of the same order, i.e. beings with intelligence.

The cognitive faculty with which sensitive beings with or without intelligence obtain knowledge is called *ubwenge* (intelligence). In Kinyarwanda, there are two ways to attribute intelligence to sensitive beings, one using to verb to know, the other using the verb to have. The first, to know intelligence, considers intelligence as an object and places it outside of the knowing subject. In this form, it is attributed to animals meaning to be smart, clever, perspicacious. Intelligence of animals is the object of knowledge, not the instrument of knowledge. Animal intelligence covers the activities that European philosophy attributes to the internal senses, except for memory. Common sense, instinct and imagination enter into the cognitive faculty of animals. Thus, when talking about *ubwenge* in relation to animals, it would be more correct to interpret the word as perspicacity, smartness, or, literally, non-intellectual knowledge.

The second form of attributing intelligence, to have intelligence, situates the latter within the knowing subject. In this form, it can never be used for animals but only for (wo)man. Note that we are not using the plural (wo)men here, since having knowledge can only be said of a person in singular; it cannot be attributed to humankind ((wo)men, in plural) in general.

Kagame distinguished ten properties related to intelligence, namely:

1.	*kumenya*	to know
2.	*kwibuka*	to remember
3.	*kurulikira*	to have the innate propensity
4.	*guhitamo*	to choose
5.	*gukunda*	to love/like
6.	*kwifuza*	to desire
7.	*gushaka*	to want
8.	*kuzilikana*	to think
9.	*kugereranya*	to compare
10.	*guhimba*	to invent

The first four properties, i.e. to know, remember, have the innate propensity and choose, are properties relevant to animals in Rwandan philosophy. The remaining six properties can only be attributed to (wo)men. However, due to contacts with European culture over the past 100 years, Rwandans now commonly use the properties of love/like, desire and want to describe animals in everyday language. But such use is borrowed from European culture. Traditionally,

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[4]The implications of this plurality aspect are important to determine tree experts, as will be seen in chapter 3.

these properties were contained within the concept of *kurulikira* (to have the innate propensity).

Both animals (beings without intelligence) and people (beings with intelligence) have faculties and properties that characterize sensitive beings. However, Rwandan philosophy makes a distinct difference between the sensitive and the sensitive with intelligence, to the point of putting the latter in a separate metaphysical category (*umuntu*). The differences between animals and people are fourfold. First, while the internal senses are similar between animals and (wo)men, people have an internal organ which centralizes and orients the sensations, *umutima* (the heart). Animals do have a heart, but it does not have this centralizing and orienting function. Second, the faculties and properties of (wo)men comprise particularities in relation to intelligence not found in animals, namely the ability to think/remember, compare and invent. Balibutsa added the notions of *guterekeza* (to think/reflect), *gusesengura* (to analyze), *gusobanura* (to explain), *kwiyumvira* (to meditate) and *kubona* (to see/understand) to this list. However, Kagame considered *kubona* (to see) to be an external sense, not an internal one. Third, the property of remembering is found in both animals and people, but in the latter it is not simply an internal sense as with animals. Animals do remember, but it is more remembering of learned behavior not connected to knowledge or knowing per se. The property of *kwibuka* (to remember) in people is of a higher order, and memory is a phenomena of knowledge reserved for intelligent beings only. Four, there are three additional terms related to intelligence of (wo)man that are not found in animals, namely *umunyabwenge* (intelligent person) and the abstract terms *ubushake* (will/determination) and *ubwende* (free will/intention). According to Balibutsa, it is precisely the faculties of intelligence and free will, which are specific to (wo)man, that explain the fundamental substance which remains after death: the unnamed vital principle identified by Kagame as *umuzima*, the immaterial and immortal entity of the disembodied spirit.

Due to the introduction of schools, written communication, radio and other means to transmit knowledge, the meaning of the term ubwenge has changed over the years. Whereas ubwenge meant intelligence before, its meaning nowadays is closer to cultural wisdom. Intelligence has now been linked with schools, books and formal learning, and being intelligent has become identified with having a high IQ and getting good grades in school. However, such intelligence does not necessarily mean that one has ubumenyi. In traditional Rwandan philosophy, intelligence meant knowing life, [social] relations and situations in which (s)he is placed by circumstances beyond his/her control, in other words the practical aspects of living, being a member of society and to survive in the world. To illustrate this difference, Kagame gave the following example of a hypothetical dialogue between grandmother and granddaughter:

> Really, white men have a disarming naivety! They do not have intelligence!
>
> How can you be so dumb! Could you have invented all those marvelous things which exceed our imagination like they have?
>
> Listen, my child! They have learned all that, but they do not have intelligence! They do not understand anything!

While Balibutsa dismissed this little dialogue as mere anecdotal and not worthy of further discussion, it is a reflection of tension between endogenous and exogenous knowledge systems and their differing underlying philosophies and value systems. The traditional meaning of *ubwenge* and *ubumenyi* point to the social nature and construction of knowledge. But the change in meaning of *ubwenge* from intelligence to cultural wisdom also point to an emerging (although

still a muted) struggle between endogenous knowledge and exogenous, scientific knowledge taught in schools and promoted by research and development programs. It is precisely these different opinions of what constitutes knowledge and what is important to know in order to be called knowledgeable that inspired this research. To gain an emic understanding of endogenous knowledge and its social construction, this study is using agroforestry as the medium to build such understanding.

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APPENDIX II-1

INSTRUCTIONS POUR LE JEU DE CLASSEMENT

1. Expliquez le but de l'etude

Nous voudrions étudier les connaissances des cultivateurs et cultivatrices sur l'agriculture, particulièrement leurs connaissances sur les arbres et les arbustes et comment les gens arrivent à intégrer ses plants dans leurs exploitations. Pour cultiver, on doit connaître comment de le faire; sans connaissance des sols, des cultures, du climat, des maladies etc. on y arrive pas. L'introduction des nouveaux variétés et/ou cultures, des nouveaux méthodes culturales, des changements dans les marchés et dans les prix, tout ceci demande des nouvelles connaissances. Donc, un(e) cultivateur (-trice) ne produit pas seulement de quoi à manger, mais en même temps il (elle) produit aussi des connaissance comment de le faire. Et ceci ne peut pas être appris à l'école seulement, on doit l'apprendre en pratiquant l'agriculture chaque jour. DEMANDEZ LES QUESTIONS SUIVANTES:

Est-ce que tout le monde a les mêmes connaissances de l'agriculture et de la cultivation des arbres?

Est-ce que tout le monde est un(e) bon(ne) agriculteur(-trice)?

DEMANDEZ si les gens ont des questions a ce point ou ont besoin de plus d'explications.

DEMANDEZ leur cooperation et collaboration pour ce jeu et l'entretien qui le suive.

2. Information a donner avant que l'interview propre commence

La participation dans le jeu est entièrement volontaire; à chaque moment, vous pouvez choisir de terminer votre participation, ou de ne pas répondre aux questions. Comme le chercheur principale ne parle pas couramment le kinyarwanda (même en prenant des cours ça prend du temps pour bien converser dans une langue et de la comprendre), vos réponses peuvent être enregistrer sur un magnétophone. Aussi, des photos peuvent être prises de vous pendant l'entretien. Mais, dans tous ces deux cas, votre permission sera obtenue d'avance, et vous avez le droit de demander que le magnétophone sera arrêté ou que certaines photos ne seront pas prises.

Aucune information donnée par vous portera votre nom, identité ou lieu d'habitation (chaque consultant et habitant aura une numéro codée). Toutes les données obtenues seront traitées anonymement et confidentiellement. Les renseignements et les observations obtenus et décrites dans les rapports ne porteront jamais des indications de qui ils ont été obtenus. Vos noms seront mises dans les remerciements joints au rapport sortant de cette étude seulement sur votre demande.

3. Classement des cartes

D'abord, expliquez la procédure à suivre avec l'informateur/-trice:

a. Demandez l'informateur/-trice de grouper des cartes portant les noms des cultivateurs et cultivatrices de la colline dans plusieurs tas, chaque tas représentant des individus avec les mêmes aptitudes comme cultivateur (cas de jeu 1) ou avec les mêmes connaissance sur

l'agroforesterie (cas de jeu 2). Le nombre de tas sera décidé par l'informateur, mais il faut au moins 3 tas. Assurez vous que l'informateur a compris qu'il (elle) doit classer les personnes nommés sur les cartes en tant qu'individus, pas en tant que ménages.

Jeu 1. Quelques personnes arrivent bien à cultiver leurs champs avec succès et gagnent beaucoup d'argent et de quoi à manger pour la famille, d'autres ont plus des difficultés. Peut-on appeler les personnes dans le premier catégorie "des bon(ne)s paysan(ne)s ["abahinzi(kazi) beza"]? Si non, quel terme est employé ici pour distinguer les bons et les moins bons cultivateurs? Est-ce que vous pouvez nous donné une exemple de quelqu'un dans ce colline dans chaque catégorie? Nous vous donnons/lirons des cartes avec les noms des cultivateurs (-trices) de ce colline, et vous devez les arranger en différents groupes selon leur aptitude à l'agriculture: **"abahinzi(kazi) beza"**.

Jeu 2. Nous voudrions étudier dans ce secteur comment la connaissance sur les ligneux (ou l'agroforesterie traditionnelle) est divisée entre les hommes et femmes du colline. Notre travail futur se fera surtout avec les experts locales des arbres, et nous vous demandons de nous aider à identifier ces gens. Qui sont les experts locales des arbres, c'est-à-dire, les personnes les mieux informés sur les arbres, leurs méthodes culturales, leurs utilisations [**abahinzi(kazi) bazi ibiti byinshi kandi babihinga byiza na bafite ibiti byinshi ou abahinzi(kazi) nyamwete**]? Demandez l'informateur une ou deux exemples illustrant les différences entre les gens bien informés et les gens qui ne connaissent pas bien les arbres. Nous vous donnons/lirons des cartes avec les noms des cultivateurs(-trices), et vous devez les arranger selon les connaissances des individus sur les arbres.

b. Mêlez les cartes avant chaque jeu pour qu'ils sont dans une ordre aléatoire.
c. Si l'informateur/-trice peut lire, il/elle peut lire les cartes il/elle-même; en cas contraire, lisez les noms marqués sur les cartes et puis donnez ceci à lui (elle) pour classement.
d. Si l'informateur/-trice n'est pas sûr sur l'aptitude ou les connaissance d'un individu, ou si il/elle ne connaît pas (bien) la personne pour la juger, mettez sa carte dans un tas séparé. Répondez à toute question que l'informateur/-trice vous pose pendant qu'il (elle) arrange les cartes.
f. Quand toutes les cartes ont été classées, vérifiez chaque tas (en lisant encore une fois les noms des personnes dans chaque tas) pour déterminer si les individus classés ensemble sont vraiment similaires. S'il/elle a des doutes sur un individu, il/elle pourra mettre sa carte dans un autre tas.
g. Si un des tas a plus que 40% des cartes, demandez l'informateur/-trice de la diviser en deux.

4. Obtenez des informations sur les differences entre les tas

Pendant le classement des cartes, l'informateur/-trice a eu de temps pour penser au différences entre les différents tas qu'il/elle a créé. En commençant à un coté et en allant de tas en tas, demandez lui/elle ce qui différencie un tas de l'autre. Ne demande pas des informations sur des individus spécifiques, mais demandez cette information sur le groupe d'individus dans le tas entier. Qu'est-ce qu'il distingue un tas de l'autre? Pourquoi les gens dans un tas sont des meilleurs cultivateurs ou ont plus de connaissance que les gens dans le tas à coté? Qu'est-ce que les gens d'un tas possèdent que les gens dans l'autre tas n'ont pas?

JEU DE CLASSEMENT

Jeu: 1 - "Abahinzi(kazi) beza"
2 - "Abahinzi(kazi) nyamwete"

Sujets de classement: 1 - Abagore
2 - Abagabo

Tas	Numeros (codes) des individus	Charactéristiques du tas
1		
2		
3		
4		
5		
6		

Informant:

Age: _____ **Sexe:** 1 - Umugabo 2 - Umugore
Commune: _____ **Secteur:** _____
Colline: _____
Assistant: _____
Date: _____
Observations:

Numeros (codes) des individus inconnus:

NOTE: Continuez les observations au verso si necessaire.

APPENDIX II-2

INSTRUCTIONS ET QUESTIONS DE BASE POUR LES ETUDES DE CAS/BIOGRAPHIES DES EXPERTS LOCALES D'ARBRES

1. Format

Un interview de 1 à 3 heures (un matin ou un après-midi) une fois par 4 semaines. Vous devez fixer un programme de visites d'avance de sorte que vous visitez un(e) paysan(ne) de lundi à vendredi, avec le samedi comme jour de rattrapage si une personne a été absente. Un ou deux jour avant la visite régulière, passez chez lui pour lui souvenir du jour où vous venez lui visiter. Communiquez votre programme de cettes visites à moi le plus tôt que possible de sorte que je peut programmer les miennes aussi.

2. Enregistrement de l'interview dans le cahier

Vous devez tenir un cahier séparé pour chaque personne pendant le deuxième phase de l'étude. A l'extérieur du cahier, mettez le nom de l'expert locale d'arbres, commune, secteur, cellule et colline, ainsi que votre nom. Tous les rencontres avec les experts devront être enregistrer dans ce cahier.

En tête de chaque interview, mettez la date, l'heure commencée et l'heure terminée. Indiquez aussi le bloc/champ sur lequel vous avez vous entretenu (par exemple: rugo, bananeraie, ...). Exemple: **Date: 29-7-1992 Heure débutée: 8:30 Heure terminée: 10:12 Bloc rugo**

Pendant l'interview, vous pouvez vous servir des questions ci-bas en tant que guide. Néanmoins, cettes questions ne sont qu'uns indication des questions possibles; selon la situation que vous rencontrez, il faut ajouter des autres questions. Il faut toujours penser: Quand moi je veux commencer à cultiver des arbres, qu'est-ce que j'ai besoin de connaissance sur les arbres pour réussir? Qu'est-ce qu'il est important pour moi à savoir? Les informations doivent être le plus complète que possible. Souvent, les paysans ne vous parleront pas seulement des arbres et comment les planter et les entretenir, mais vraisemblablement aussi sur les circonstances familiales, politiques, économiques ou sociales qui expliquent pourquoi et comment ils ont fait (et continue à faire) les choses. Ces informations sont très important pour comprendre le raisonnement des paysans et leur approche vis-à-vis les arbres.

Pendant l'entretien avec les paysans, écrivez les points les plus important. Souvent, vous n'aurez pas le temps d'écrire des phrases complètes, seulement des mots clés. Après l'entretien, le plus vite possible de sorte que ce que les paysans vous ont dit est encore frais dans la tête, vous devez vous mettre dans un endroit calme pour rédiger ce que vous avez entendu et avec l'aide des notes prises en une sorte de composition. A la fin de cette composition, sous la tête "NOTES" ou "OBSERVATIONS", vous pouvez mettre vos propres observations et idées sur ce que vous avez entendu ou vue. Toute autre information sur l'histoire particulière que vous jugez important pour expliquer ce que les paysans ont dit vous pouvez ajouter aussi. Donc, il faut qu'il y a une stricte séparation entre les paroles des paysans (qui doivent être enregistrer le plus que possible dans leur propre mots) et vos impressions, observations et interprétations.

Pour la deuxième réunion et les réunions suivantes, résumé ce que le paysan a dit pendant la réunion précédente. Demandez s'il/elle a des additions, changements etc. a faire; aussi, vous

pouvez lui demander des questions sur les points qui n'étaient pas claire ou ceux que vous pensez n'étaient pas complète.

3. Questions de base pour guider les interviews

TEMPS INITIALE.

A. Quels arbres se trouvaient sur l'exploitation (sur cette parcelle) quand vous avez commencé à l'exploiter?
   NOTE: Pour les hommes, ceci est le temps depuis qu'il a eu l'exploitation/la parcelle en héritage de son père, ou qu'il a loué une parcelle. Pour les femmes, vous devez la demander le moment qu'elle a commencé à habiter sur l'exploitation après son mariage.

B. Pourquoi est-ce que ces arbres étaient cultivés? (Exemples: bois de feu, bois de construction, fourrage, fruits, médicaments, ombrage, clôture, ..)

C. Où dans l'exploitation/la parcelle est-ce qu'ils étaient cultivés? (Exemples: au milieu, rugo, fossé, bananeraies, ...)

D. A qui appartenaient ces arbres (qui était le propriétaire)?

E. Qui dans la famille s'occupaient, de l'entretien, de la récolte etc. de ces arbres dans le temps?

ARBRES CULTIVES POSTERIEUREMENT.

Après les questions ci-haute, demandez sur les changements que le cultivateur/-trice a fait depuis ce temps initiale: arbres éliminés, plantés, changements dans les modes d'entretien et d'utilisation, changements dans les endroits où ils sont cultivés, ...

A. Pourquoi est-ce il/elle a changé?

B. Quand est-ce qu'il/elle a changé? Ici, il sera utile d'utiliser le sommaire de l'histoire des secteurs que vous avez préparé pour faciliter le paysan à placer l'année ou le période approximative que ceci a eu lieu.

C. Qui lui a donné l'idée de changer? Est-ce que les changements ont été faites volontairement ou non? S'il/elle a planté des nouvelles espèces d'arbres, où est-ce qu'il/elle a les trouvé?
   NOTE: Demandez spécifiquement la personne, l'endroit (pays, préfecture, commune, etc.) ou l'organisation d'où l'idée est venu.

D. Est-ce qu'il/elle a accepté tout de suite à cultiver une nouvelle espèce, à changer les modes d'entretien ou d'utilisation etc., ou est-ce qu'il/elle a essayé d'abord sur un arbre/un endroit limité pour étudier si les nouvelles idées sont bonnes et rapportent quelques chose? Si oui, comment est-ce qu'il/elle a fait ceci?

E. Est-ce qu'il/elle a consulté d'autres personnes pour discuter comment mettre en exécution un nouveau pratique, les problèmes rencontrés, les résultats obtenus? Si oui, qui?

F. Est-ce que les autres paysans sur la colline ont suivi l'exemple? Si oui, est-ce qu'il/elle a activement communiqué les résultats ou les autres ont copié ce qu'ils ont vue chez lui?

APPENDIX II-3

FICHE INVENTAIRE D'ARBRES

Nom du paysan: _____ **Commune:** _____
Date: ___/___/1992 **Bloc:**_____ **Secteur:** _____
Bloc en propriété: Oui / Non **Bloc loué:** Oui / Non **Cellule:** _____

1. Espèce					
2. Nombre d'arbres					
3. Age moyen					
4. Lieu où ils se trouvent					
5. A qui appartient les arbres?					
6.Utilisation	Util. | Partie	Util. | Partie	Util. | Partie	Util. | Partie	Util. | Partie
7a.Arbre naturel?	Oui / Non	Oui / Non	Oui / Non	Oui / Non	Oui / Non
b.Pourquoi laissé?					
8a.Arbre planté?	Oui / Non	Oui / Non	Oui / Non	Oui / Non	Oui / Non
b.Si oui, par qui?					
c.Source de semence					
d.Pourquoi planté?					
9. Entretenu par qui					
b.Période d'année (mois)					
c.Comment?					
10.Récolté par qui?					
b.Période d'année (mois)					

CODES POUR LE FORMULAIRE D'INVENTAIRE D'ARBRES

QUESTION 1: Nom de l'espèce en kinyarwanda

QUESTION 3: L'age peut être trouver avec l'aide de l'histoire de la culture d'arbre (changement dans la sorte d'arbre qu'il a planté et quand)

QUESTION 4: (Lieu)
1-Sur les fossés
2-Bord du bloc
3-Milieu du bloc
4-Sur le rugo
5-Boisement
6-Pâturage
7-Bord de la terrasse
8-Sur les chemins

QUESTION 5: (Propriété d'arbres)
1-Homme chef de famille
2-Femme chef de famille (veuve etc)
3-Epouse
4-Tout membre du ménage
5-Enfants
6-Quelqu'un d'autre (non-membre de la famille)
7-Propriétaire du champ (si le champ est loué)

QUESTION 7: (Utilisation des arbres et parties utilisées)

Utilisation			Parties utilisées	
1-Bois de feu	7-Levures	13-Fumier	1-Feuilles	6-Racines
2-Bois de construction	8-Fourrage	14-Cordes	2-Fruits	7-Ecorce
3-Bois de menuiserie	9-Tuteurs		3-Branches	8-Fleurs
4-Bois pour sculpture	10-Médicaments		4-Brindilles	9-Arbre entier
5-Nourriture	11-Clôture		5-Tronc	
6-Paillage	12-Ombrage			

QUESTION 8.b. et 9.d.: *(Pourquoi laissé ou planté; écrivez les 3 raisons les plus important)*
1-Bénéficie les cultures
2-Bénéficie le climat
3-Protège le sol contre l'érosion
4-Donne de matière primaire pour des activités non-agricoles (sculpture, menuiserie, ...)
5-Source de revenu régulier
6-Epargne
7-Signification en religion traditionnelle
8-Donne de la nourriture pour l'homme
9-Donne de la nourriture pour les animaux
10-Matériel de construction pour les maisons, les ponts, etc.
11-Combustible pour la cuisine et les activités non-agricoles
12-Marquer les limites des champs
13-Construction du rugo
14-Médicine traditionelle
15-Fleurs pour les abeilles
16-Autre

QUESTION 9b., 10a. et 11a.: (Qui?)
1-Homme chef de famille
2-Femme chef de famille (veuve etc)
3-Epouse
4-Homme et femme
5-Enfants
6-Quelqu'un d'autre (non-membre de la famille)
7-Travailleur salarié
8-Propriétaire du champ (si le champ est loué)

QUESTION 9c.: (Source de semences).
1-Pépinière du secteur
2-Pépinière privé
3-Propre pépinière
4-Voisins ou amis
5-Sauvagons
6-Boutures de mes propres arbres
7-Autre (écrivez d'où)
8-Sources multiples

QUESTION 10c.: (Comment entretenu): Par exemple, taille des branches les plus bas, désherbage autour les troncs, traitements contre insectes et maladies, étêtage, taille des racines, etc.

APPENDIX II-4

QUESTIONS POUR LA REUNION DE SYNTHESE AU NIVEAU DES CELLULES APRES LA TERMINAISON DU JEU DE CLASSEMENT
Juillet-Août 1992

Version française

1. Nous avons appris qu'il y a en a des gens qui s'informent eux-mêmes pour cultiver les arbres. Où ou chez qui est-ce qu'ils vont pour s'informer sur la cultivation des arbres?

2. Pourquoi est-ce que les femmes ne peuvent pas cultiver des arbres? Si ceci dépend de la sorte d'arbre, lesquelles est-ce qu'elles peuvent cultiver (demandez pour les fruitiers aussi bien que pour les ibiti byose bya kinyarwanda).

3. Beaucoup de fois, nous avons eu la réponse que les gens qui n'ont que des petites terres ne peuvent pas cultiver des arbres. Qu'est-ce qu'ils/elles leur empêchent de cultiver des arbres? Comment ces gens arrivent à trouver assez de bois pour la cuisine, pour construire des maisons, ...?

4. On nous a dit que les exploitations deviennent de plus en plus petit, surtout à cause du système d'héritage. Quelle sera l'effet de ceci sur a) la disponibilité du bois, et b) sur les possibilités de cultiver les arbres sur l'exploitation?

5. Souvent, les gens nous ont dit que c'est surtout les jeunes qui ont peu de connaissance sur les arbres, surtout les ibiti bya kinyarwanda.

   A. Est-ce que les parents et les experts locales d'arbres ne passeront plus leur connaissance à leurs enfants? Si non, pourquoi pas?

6. Est-ce que le fumier est absolument nécessaire pour cultiver les arbres? Pourquoi?

7. Est-ce qu'il y a une différence entre le compost et le fumier par rapport à leurs effet sur les cultures?

   A. Si non, pourquoi les gens nous disent toujours qu'il faut de fumier et que seulement les moins bons paysans, sans animaux, utilisent le compost?

8. L'agroforesterie a pour but d'intégrer les arbres et les cultures. Est-ce qu'il est possible de cultiver les arbres ensemble avec les cultures? (demandez spécifiquement sur les ibiti bya kinyarwanda, n'est pas satisfait avec le gereverya, avocat, umunyegenyege, lesena etc.)

   A. Si oui, quels arbres et avec quelle cultures est-ce qu'ils peuvent être cultiver?

   B. Si non, pourquoi pas?

   C. Est-ce qu'il y avait des combinaisons d'arbres et cultures dans le passé qui ne sont plus pratiqué maintenant?

9. Les connaissances sur les arbres est différent entre les hommes et les femmes; nous avons trouver que les hommes ont plus de connaissance comment les planter, cultiver et entretenir, tandis que les femmes savent beaucoup sur les différentes utilisations (pour les médicaments, fruits, feu etc.) et connaissent bien identifier les différents arbres. Donc, c'est qui qui ont la plus grande connaissance des arbres? Qui sont plus expert?

10. Les arbres sont utiles pour les médicaments des animaux. Est-ce que les arbres qu'on utilise dans l'élévage qui ne sont pas des des médicaments? Si oui, quels arbres et comment ont les utilise?

QUESTIONS POUR LA REUNION DE SYNTHESE AU NIVEAU DES CELLULES
PRES LA TERMINAISON DU JEU DE CLASSEMENT
Juillet-Août 1992

Version kinyarwanda

INAMA Y'ABATURAGE. IBIBAYO BIGOMBA KUBAZWA.

1. Twabonye ko hari abantu biyigi sha ubwabo kugirango batere ibiti ni he cyangwa ni kwande bajya kubyihugurira?

2. Ese abagore bahinga ibiti? Niba ataribyo, se ni ukubera iki? Niba se bigombere ubwoko bw'igiti iki n'iki, ni ibihe biti ashobora guhinga? (N'ibyi mbuto ziribwa, cyangwa se ni ibindi biti bya kinyarwanda).

3. Twabonye kenshi ibi subizo bivugako abantu bafite ubutaka buto badashobora guhinga ibiti. Ni iki kibabuza kubihinga? Babona bate ibiti byo gucana cyangwa byo kubaka?

4. Batubwiye ko ubutaka burimo buba buto cyane cyane ku mpanvuzo kubyara abana no kubaha iminani
   A. Hakorwa iki kugirango dushobore kubona ibiti byo gucana?
   B. Hakorwa iki kugirango dushobore guhinga ibiti mu murima?

5. Akenshi, abantu batuburiye ko ari abantu bakiri bato badafite ubumenyi ku biti cyane cyane ibiti bya kinyarwanda. Ese ababye yi babo ntibabatoza ubwo bumenyi? Niba se ataribyo ni ukubera iki?

6. Ese ifumbire ni ngombwa ngo umuntu ahinga ibiti? Kubera iki?

7. Ese hari itandukaniizo ku ifumbire yo mukimpoteri n'iy'amatungo kubihingwa? Niba arihoya ni ukubera iki abantu batubwiye ko hagomba ifumbire cyangwa ko abahinzi utamwete (babi), batagira amatungo bakoresha ifumbire y'ingirani?

8. Ubuhinzi bw'amashyamba bufite intego yo guteza imbere ibiti n'ibihingwa. Birashoboka guhinga ibiti hamwe n'ibihingwa? (cyane cyane ibya kinyarwanda)
   A) Niba aribyo ni iki he giti wahinga n'iki he gihingwa?
   B) Niba ataribyo se ni ukubera iki?
   Kera se hari ivangwa ry'ibiti n'ibihingwa ryakorwaga ariko ritagikorwa ubu?

9. Ubumenyi bw'ibiti buratandukanye kubagore n'abagabo. Twanbonye ko abagabo bafite ubumenyi bwinshi guhinga ibiti, uko babihinga, guhinga no gufata neza ibihingwa; abagore nabo bazi cyane ako maro kabyo (ku miti, ku mbuto no ku gucana n'ibindi) kandi bazi n'ubwoko bwinshi bwabyo. Muri bose (umubago n'umugore) ninde ufite ubumenyi buruta ubw'undi kubiti?

10. Ibiti babikoresha bavura amatungo. Ese hari ibiti abakoresha mu bworozi bitari iby'imiti? Niba ari byo se n'ikine giti wakwifashisha n'uku wagikoresha?

APPENDIX II-5

QUESTIONS POUR LES REUNIONS AVEC LES EXPERTS D'ARBRES
Novembre-Décembre 1992

Version française

1. Est-ce que les arbres ont des bénéfices autre que le bois, fruits, médicaments et fourrage? Si oui: Lesquels?

2. Beaucoup de paysans nous ont dit qu'il n'y avait pas ou seulement très peu d'arbres sur leur exploitations quand ils ont commencé à les cultiver. Pourquoi c'était comme ça?
   Si la réponse donnée réfère aux Tutsi qui ont occupé toute la terre: Est-ce que les Tutsi n'ont pas eu besoin du bois pour le feu, pour la construction, des objets et autres? Où ils ont trouvé ces choses?

   Où est-ce que les paysans ont trouvé du bois, les médicaments, les fruits etc. avant avoir planté des arbres dans leur propres champs?
   Si la réponse donnée réfère aux brousse abondant dans le temps: Pourquoi cette brousse a disparu? Quelles ont été les causes de cette disparition? Comment ceci a affecté la vie des paysans?

   Pourquoi les paysans ont fait si beaucoup d'effort pour planter les arbres dans leur exploitations surtout depuis 1960? Qui leur a donné l'idée de faire ça?

3. Presque tous les paysans, même les plus petits, cultivent et maintiennent beaucoup de sortes d'arbres sur leur exploitations. Pourquoi ils font ceci? Pourquoi les paysans ne se spécialisent pas dans la cultivation d'une ou deux sortes seulement et satisfont leur besoins pour les produits des autres arbres par des échanges avec des voisins?

4. Qu'est-ce que ça veut dire que quelqu'un a beaucoup de connaissance de quelque chose? Qu'est-ce qu'on doit faire pour avoir de cette connaissance?

   Vous tous, vous avez beaucoup de connaissance des arbres. Est-ce que les connaissances que vous avez est la même pour chaqu'un de vous?
   - Si oui, expliquez de quoi consiste vos connaissance collective.
   - Si non, quelles sont les différences entre les connaissances sur les arbres de chaqu'un de vous? Pourquoi est-ce qu'il y a cette différence? *Vérifiez que chaque personne a la chance de repondre à cette question.*

5. Nous avons vu que les arbres ne sont pas plantés également dans les différentes parcelles de cultures. Souvent, il y a quelques parcelles avec beaucoup d'arbres, tandis que d'autres parcelles n'ont que peu ou pas d'arbres.

   Est-ce qu'on peut planter les arbres dans tous les parcelles qu'on cultive? Si non, pourquoi cette différence?

   Est-ce qu'il y a des différentes sortes de propriété qui ont une influence sur la cultivation d'arbres en général et le sorte d'arbres qu'on peut cultiver sur ses parcelles en particulier?

6. Selon vos informations, la plupart des arbres plantés par les paysans proviennent des semences ou boutures obtenus des voisins, amis ou parents. Comment ce système d'échange de semences est organisé et fonctionne?

7. Est-ce que tout le monde peut planter et cultiver des arbres sans apprendre comment de le faire? Si non, comment et chez qui on peut l'apprendre?

   Est-ce qu'on peut cultiver un arbre avec succès si personne connaît cet arbre et personne l'a essayé?

Seulement si la question n'est pas bien compris: En autres mots, si on connaît cultiver umubilizi, avocat, grevillea, est-ce que ça veut dire qu'on peut bien cultiver aussi un arbre tout nouveau au Rwanda et pas connu par les paysans comme alnusi ou umuvumbuka?

8. Vous avez nous dit que les paysans plantent les arbres tout de suite dans leur champs et sur leur rugos, sans les essayer d'abord sur un petit coin pour voir si cet arbre sera bon et produira bien. Donc, les paysans les plantent là où ils veulent avoir un arbre.

   Comment les paysans se décident sur:
   -Le choix d'un certain arbre;
   -La façon de planter l'arbre;
   -L'endroit où l'arbre sera planter.
   Est-ce que les critères de décision seront les mêmes pour tout le monde? Si non, les critères dépendent de quoi?

   Est-ce qu'un paysan peut planter tout de suite 500 arbres qu'il ne connaît pas dans ses champs (par exemple 500 imivumbuka (Chameacytisus))?
   -Si oui, pourquoi?
   -Si non, pourquoi pas? Comment un paysan attaque le problème d'introduction d'un nouvel arbre (en autres mots, qu'est-ce qu'il va faire avec ces 500 imivumbuka que j'ai donné et comment)?

9. Nous avons vous donné le choix pour tester un certain nombre d'arbre pour le projet ICRAF ici au Rwanda. Sans exception, tous les 44 paysans ont choisi que les arbres qu'ils ne connaissent pas ou qu'ils ne cultivent pas encore sur leur exploitations (par exemple, l'alnus [inconnu] et pas le grevillea [bien connu]).

   Pourquoi vous avez préféré à choisir les arbres inconnus?

   Est-ce que tous les paysans (grand et petit, riche et pauvre) peuvent toujours accepter à planter des arbres inconnus?
   -Si oui: Pourquoi? Comment les paysans acceptant traitent les risques?
   -Si non: Quelle est la différence entre les paysans qui peuvent accepter et ceux qui ne le peuvent pas?

   Qu'est-ce vous allez faire avec les arbres que vous avez choisis? Si vous allez faire des expérimentation (igerageza) avec ces arbres, comment vous allez le faire? Pourquoi?

   Qu'est-ce que vous allez observer (mesurer, tester,...) pour déterminer si ces arbres sont bons/utiles ou non?

   Quelles autres informations seront nécessaire pour décider d'augmenter le nombre d'un certain arbre qui est jugé bon sur votre exploitation, ou pour recommander cet arbre aux amis et voisins?

   Qu'est-ce que vous ferez quand les arbres choisis ne satisferont pas vos expectations?

10. Vous êtes invitez de dire aux chercheurs de l'ISAR et ICRAF les sortes d'arbres que vous serez intéressés à planter à l'avenir et leur caractéristiques. Quels arbres demanderez vous aux chercheurs? Quels devront être les charactéristiques de ces arbres (produits voulus, taille, façons de plantations et entretien, comportement etc.). Demandez de ranger les utilisations voulues par ordre d'importance.

QUESTIONS POUR LE REUNION AVEC LES EXPERTS-D'ARBRES
Novembre-Décembre 1992

Version kinyarwanda

1. Ese hari akandi kamaro k'ibiti mwaba muzi uretse kuba gicanwa, kikaribwa, kikavura, cyangwa se kikaba n'ubwatsi bw'amatungo? Ni ba se hari akandi kamaro muzi ni akahe?

2. Abantu benshi batubwiye ko ntabiti cyangwa se ko hari ibiti bike mu milima yabo mu gihe batangiraga kuba banyirabyoo ni ukuvuga mu gihe batangiraga kuwuhinga bwa mbere cyangwa se kuwuteramo ibiti bwa mbere. Mwe mukeka ko byaterwaga n'iki?
   Niba se biterwa n'abatutsi bari barikubiye ubutaka bwinshi:
   Abo batutsi se bo ntabwo bakeneraga ibiti byo gucana, kubaka gukuramo ibikoresho cyangwa se n'ibindi? Ibyo byose se bo babi bonaga gute? Babivanaga he?

   Abaturage se bo bavanagahe inkwi, imiti n'imbuto mbere yo kwiterera ibyabo bite mu murima yabo?
   Niba se yenda barabivanaga mu mashyamba ya kimeza: Ni kuki ayo mashyamba yaciwe? Ni iki cyayaciye? Ni iki byagabanuye ku mibereho y'abaturage?

   Ni kuki abaturage bihase gutera ibiti mu murima yabo cyane cyane kuva mu 1960? Ni nde se waba warabahaye igiterekezo cyo gukora gutyo?

3. Abaturage hafi ya kose ndetse n'abakene bahinga ubwoko bwinshi bw'ibiti mu murima wabo. Byaba biterwa n'iki?

   Ni kuki batagerageza guhinga ubwoko bumwe cyangwa se bubili yenda ngo nibagira ibindi bakenera bituruka kubindi biti badafite ngo bajye bagurana n'abo buturanye?

4. Kuvuga ngo umuntu afite ubumenyi bwinshi ku kintu iki n'iki bishaka kuvuga iki? Umuntu agomba gokora iki kugirango bavuge ko afite ubumenyi bwinshi ku kintu iki n'iki?

   Mwese mufite ubumenyi bwinshi ku biti. Buri muntu se afite ubumenyi buhwanye n'ubwundi?
   Niba aribyo, sobanura icyo ubumenyi bwanyu bushingiyeho.

   Niba ataribyo n'irihe tandukanirizo hagati y'ubumenyi bwa buri muntu n'ubw'undi ku biti? Ni kuki mufite itandukanirizo kubumenyi bwanyu ku biti?
   Musabwe gutega amatwi mukanyumvira niba ugiye gusubiza asubiza neza icyi kibazo.

5. Twabonye ko hari ibiti byi meza mu murima. Ariko cyane cyane hari imirima usangamo ibiti byinshi nk'ibyo wagera mu wundi murima ugasanga harimo bike cyangwa ntanibirimo kandi iyo murima ari iy'umuntu umwe.

   Ese umuntu ashobora gutera ibiti mu mirima yose ahingamo? Niba atari byo se ni ukubera iki?

   Ese hari ubwoko bw'imirima umuntu ashobora guteramo ibiti n'ubwo adashobora kubiteramo? Cyangwa se hari ubwoko bw'igiti ushobora gutera mu murima uyu n'uyu?

6. Dukurikije ibyo mwatubwiye, twasanze ahanini ibiti mutera mubyaka abaturanyi, inshuti n'ababyeyi. Mubigenza gute kugirango mugerageza guhana ibyo biti?

7. Ese buri muntu wese ashobora gutera ibiti nta hantu yigeze yigira uburyo babitera? Niba atari byo ni gute cyangwa ni kwande umuntu ashobora kubyigira?

Ese umuntu ashobora guhinga neza igiti nta muntu ukizi cyangwa wakigerageje kugihinga mu murima we?
Niba ikibazo cyitumvikana neza: Tuvuge niba umuntu azi guhinga umubilizi, avoka, gereveriya. Ese umuntu ashobora nanone guhinga ubwoko bw'igiti bushya bucyaduka mu Rwanda butanazwi n'abaturage urugero (nka alnusi n'umuvumbuka)?

8. Mwatubwiye ko abaturage batera ibiti mu murima yabo cyangwa ku rugo batabanje kureba aho babigeragereza mu karima bahisemo kugirango barebe niba icyo giti kizaba kiza cyangwa se kizera neza. Mbega bo bahita bagitera aho babonye kandi bashaka ko kiba.
   Abaturage se bahitamo igiti?

   Bafata bate umugambi w'uko batera igiti?

   Bahitamo bate umwanya bagomba guteramo ibiti?

   Uburyo bwose bifashisha se kugirango bahitemo ibyo byose uko ari bitatu buba ari bumwe kubantu bose? Niba ataribyo se iri hitamo rigenda rite?

   Umuturage se ashobora gutera ibiti 500 atazi mu murima we akabibona agahita abitera (urugero nk'imivumbuka 500)?

   Niba ari byose ni ukubera iki?

   Niba atari byose ni ukubera iki? We se yabigenza ate abonye nk'iyo mivumbuka 500.

9. Twagerageza kubahitishamo ubwoko bw'ibiti mukeneye ku mushinga ICRAF mu Rwanda. Nyamara abaturage 44 bose bahisemo ibiti batazi kandi batanahinga (urugero: Alnusi itazwi ntibahitamo gereveriya izwi). Ni kuki mwahisemo ibiti mutazi?

   Ese abaturage bose (abato n'abakuru, abakene n'abakungu) bose bashobora kwemera guhinga ibiti batazi?

   Niba aribyo ni ukubera iki? Abo baturage se bakwirinda bate ingaruka?

   Niba ataribyo se, ni irihe tandukanirizo riri hagati y'abakwemera guhinga ibiti batazi nabatabyemera?

   Ibiti se mwahisemo mukeka ko muzabikoresha iki? Ni mubikorera igirageza se mu zabigenza gute? Kubera iki?

   Ni iki se muzitaho kureba kugirango mumenye niba icyo giti gikura neza?

   Muzabigenza gute kugirango mwongere ibyo biti byororoke ndetse mushobore no kubihaho n'abandi?

   Muzabigenza mute ni musanga ibiti mwahisemo bidahagije?

10. Musabwe kubwira abashakashatsi ba ISAR na ICRAF ubwoko bw'ibiti muzakenera gutera ubutaha n'uburyo ibyo biti bimeze. Murumva muzaka abashakashatsi ibihe biti? Ibyo biti bigomba kuba bimeza bite? (ubwoko mushaka, uko bungana, uko buterwa n'uko bwitabwaho n'ibindi,...) Mugasaba kandi no kubatonde kanyiriza akamaro k'ibyo biti muzaba mukeneye.

APPENDIX 11-6

QUESTIONNAIRE SUR LES DONNEES SOCIO-ECONOMIQUES

Nom de l'enquêté: _____ **Commune:** _____
Sexe: Homme / Femme **Age:** _____ ans **Secteur:** _____
Date: ____/____/1992 **Cellule:** _____

A. RÉSIDENCE

1. Lieu de naissance: **Commune:** _____ **Préfecture:** _____
2. Depuis combien d'années vivez-vous sur cette exploitation? _____ années
3. Avez-vous toujours résidé sur cette exploitation? Oui / Non
   a. Si non: Autres lieux où vous avez habité (commune et préfecture) et nombre d'années:

Commune	Préfecture	
_____	_____	_____ années
_____	_____	_____ années
_____	_____	_____ années

B. ETAT FAMILIALE.

1. Est-ce que vous êtes mariés? Oui / Non
   a. Nombre de femmes: _____
2. Est-ce que vous êtes veuf/veuve? Oui / Non
3. Est-ce que vous êtes divorcé ou séparé? Oui / Non
4. 5. Nombre d'enfants total: _____ garçons _____ filles
6. Nombre d'enfants habitants sur l'exploitation: _____ garçons _____ filles
   a. Nombre de fils habitants hors du secteur: _____ garçons à _____
   b. Nombre de fils ayant pris leur héritage et cultivant cette terre: _____ garçons

C. EDUCATION ET FORMATION.

Chef de la famille (homme ou femme):

1. Ecole primaire: _____ années
2. Ecole secondaire: _____ années
3. Autre _____: _____ années
4. Autre formation (INADES, IWACU, projets, ...): Oui / Non,---> > C.5.

Si oui, écrivez tous les cours auxquels il/elle a participé:

Qu'est-ce que vous avez appris?	Où	Donné par qui?	Année
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

1ère Epouse:

5. Ecole primaire: _____ années
6. Ecole secondaire: _____ années
7. Autre _____: _____ années
11. Autre formation (INADES, IWACU, projets, ...): Oui / Non,---> > D.1.

2ème Epouse:

8. Ecole primaire: _____ années
9. Ecole secondaire: _____ années
10. Autre _____: _____ années

Si oui, écrivez tous les cours auxquels elle a participé:

	Qu'est-ce que vous avez appris?	Où	Donné par qui?	Année
1ère	_____	_____	_____	_____
	_____	_____	_____	_____
2ème	_____	_____	_____	_____
	_____	_____	_____	_____

D.EMPLOI HORS DE L'AGRICULTURE DES MEMBRES DE LA FAMILLE.

1.Est-ce que vous avez de l'emploi salarié à présent? **Oui / Non,---> > D.1.d.**

Si oui:

a.Comme quoi? _____

b.Où? _____

c.Depuis quand? *(l'année)* _____ ---> > D.2.

Si non:

d.Est-ce que vous avez eu de l'emploi salarié dans le passé? **Oui / Non,---> > D.2.**

Si oui: i.Comme quoi? _____ _____

ii.Où? _____ _____

iii.Combien d'années) _____ années _____ années

2.Est-ce que vous avez une fonction non-payée dans la communauté? *(Par exemple comme chef, partie politique, président d'une société ou coopérative, paysan pilote, etc).* **Oui / Non,---> > D.2.d.**

Si oui:

a.Comme quoi? _____

b.Où? _____

c.Depuis quand? *(l'année)* _____ ---> > D.3.

Si non:

d.Est-ce qu'il/elle a eu une fonction non-payée dans le passé? **Oui / Non,---> > D.3.**

Si oui: i.Comme quoi? _____ _____

ii.Où? _____ _____

iii.Combien d'années) _____ années _____ années

3.Est-ce que vous avez des enfants qui ont de l'emploi salarié? **Oui / Non,---> > E.**

Si oui:

a.Est-ce qu'ils/elles vous aident? **Oui / Non,---> > E.**

Si oui: i.Comment? _____

E.PATRIMOINE (Umutungo wanyu).

1.Superficie totale de l'exploitation: _____ **ares** **Types de sol dominant**

a.Nombre de parcelles avec cultures:	_____	_____	_____
b.Nombre de parcelles en jachère:	_____	_____	_____
c.Nombre de parcelles en pâturage permanent:	_____	_____	_____
d.Nombre de parcelles en boisements:	_____	_____	_____
e.Nombre de parcelles de café:	_____	_____	_____
f.Nombre de parcelles avec bananiers:	_____	_____	_____

2.Est-ce que vous cultivez de la terre dans les vallées? **Non / Oui, _____ ares**

a.Est-ce que cettes terres vous appartiennent? **Oui / Non**

3.Comment vous avez obtenu vos terres? **1-Par héritage** **3-Don des autorités**
2-Par achat **4-Autre,** _____

4.Est-ce que la taille de votre exploitation a changé dans les dernières 5 années?

1-Non,---> > E.5.

2-Oui, elle a augmenté à cause de **a-Héritage** **c-Don de l'autorité**
b-Achat **d-Autre** _____

3-Oui, elle a diminué à cause de **a-Héritage** **c-Expropriation par l'autorité**
b-Vente **d-Autre** _____

5.Est-ce vous donnez des parcelles en location aux autres paysans? **Oui / Non,-> > E.6.**
Si oui:
a.Combien de parcelles? _____ **parcelles**
b.Pour combien du temps? 1-Même parcelle en permanence
2-En permanence, mais chaque année une autre parcelle
3-En permanence, mais chaque saison une autre parcelle
4-Occasionnellement pour toute l'année
5-Occasionnellement surtout en saison A
6-Occasionnellement surtout en saison B
7-Occasionnellement surtout dans le grand saison sèche
c.Pourquoi vous les prêtez? _____
d.Mode et montant de loyer: _____

6.Est-ce vous louez des parcelles chez d'autres paysans? **Oui / Non,—> > F.**
Si oui:
a.Combien de parcelles? _____ **parcelles**
b.Pour combien du temps? 1-Même parcelle en permanence
2-En permanence, mais chaque année une autre parcelle
3-En permanence, mais chaque saison une autre parcelle
4-Occasionnellement pour toute l'année
5-Occasionnellement surtout en saison A
6-Occasionnellement surtout en saison B
7-Occasionnellement surtout dans le grand saison sèche
c.Pourquoi vous les louez? _____
d.Mode et montant de payement: _____

F.SITUATION DE LA MAIN D'OEUVRE SUR L'EXPLOITATION.

1.Est-ce que vous avez assez de main d'oeuvre dans votre famille pour tous les travaux culturales?
Oui,—> > F.2. / Non
Si non:
a.Est-ce que ceci a toujours été le cas? **Oui / Non**
i.Expliquez _____

2.Est-ce que vous engagez des travailleurs? *(Cerclez une réponse seulement; sous 3 mettez tous les mois applicable)*
1-Non,—> > F.3.
2-Oui, à base permanent
3-Oui, dans le(s) mois de _____

3.Est-ce que vous travaillez chez d'autres paysans? *(Cerclez une réponse seulement; sous 3 mettez tous les mois applicable)* 1-Non,—> > G.1.
2-Oui, à base permanent
3-Oui, dans le(s) mois de _____

G.ELEVAGE.

1.Est-ce que vous avez des animaux sur l'exploitation? **Oui / Non,—> > H.1.**
Si oui:
a.Combien de chacun des animaux suivants se trouvent sur votre exploitation à présent?
Inka: _____ Ihene: _____
Intama: _____ Ingurube: _____
Inkoko: _____ Inkwavu: _____
Abeilles *(nombre de ruches)*:_____

b. Entre les animaux se trouvant à présent chez vous, est-ce qu'il y des animaux qui ne vous appartiennent pas? **Oui / Non,---> > G.1.c.**

i. Si oui, combien de chacun?

Inka: _____ Ihene: _____
Intama: _____ Ingurube: _____
Inkoko: _____ Inkwavu: _____
Abeilles *(nombre de ruches)*:_____

c. Est-ce qu'il y a des animaux qui vous appartiennent mais qui ne résident pas sur votre exploitation? **Oui / Non,---> > H.1.**

i. Si oui, combien de chacun?

Inka: _____ Ihene: _____
Intama: _____ Ingurube: _____
Inkoko: _____ Inkwavu: _____
Abeilles *(nombre de ruches)*:_____

H. INFORMATIONS SUR LES CONTACTS AVEC L'EXTÉRIEUR

1. Avez-vous fait des voyages hors du secteur où vous habitez? **Oui / Non,---> > H.4.**

Si oui:

a. Où? 1-Dans d'autres secteurs de cette commune seulement
2-Autres communes dans la préfecture
3-En ville _____ _____ _____ _____
4-Autres préfectures_____ _____ _____ _____
5-Autres pays _____ _____ _____ _____

2. Est-ce que vous avez amené des semences ou des plantules d'arbres de ces voyages? **Oui / Non,---> > H.3.**

Si oui:

a. D'où est-ce que vous les avez amené? _____
_____

b. Quels arbres avez vous amené? *(Ecrivez le nom de tous ces arbres)*
_____
_____

c. Est-ce que vous les avez essayé sur votre exploitation? **Oui / Non,---> > H.3.**

Si oui:

i. Lesquels? _____

ii. Quel a été le résultat? _____

iii. Pourquoi? _____
_____
_____

3. Est-ce que vous avez vue d'autres méthodes de gestion des arbres pendant ces voyages? **Oui / Non,---> > H.4.**

Si oui:

a. Où est-ce que vous les avez vue? _____
_____

b. Quelles étaient les méthodes que vous avez vue? _____
_____
_____

c. Est-ce que vous avez les essayé sur votre exploitation? **Oui / Non,---> > H.4.**

Si oui:

i. Lesquels? _____

ii. Quel a été le résultat? _____

iii. Pourquoi? _____

4. Est-ce que vous avez eu des visiteurs qui ont vous apporté des semences ou des plantules d'arbres?
Oui / Non,---> > H.5.

Si oui:

a. Qui? *(Cerclez tous applicable)*

1-Parents	6-Conseiller
2-Frères ou soeurs	7-Agronomes/experts des projets
3-Voisins ou amis	8-Chercheurs de l'ISAR
4-Agronomes de commune	9-Autres chercheurs
5-Bourgmestre	10-Autres

b. Quels arbres ils ont vous apporté? *(Ecrivez le nom de tous les arbres apportés)*

_____

_____

c. Est-ce que vous avez les essayé sur votre exploitation? **Oui / Non,---> > H.5.**

Si oui:

i. Lesquels? _____

ii. Quel a été le résultat? _____

iii. Pourquoi? _____

_____

5. Est-ce que vous avez eu des visiteurs qui vous ont montré d'autres méthodes de gestion des arbres? **Oui / Non,---> > H.6.**

Si oui:

a. Qui? *(Cerclez tous applicable)*

1-Parents	6-Conseiller
2-Frères ou soeurs	7-Agronomes/experts des projets
3-Voisins ou amis	8-Chercheurs de l'ISAR
4-Agronomes de commune	9-Autres chercheurs
5-Bourgmestre	10-Autres

b. Quelles étaient les méthodes qu'ils ont vous montré? _____

_____

_____

c. Est-ce que vous avez les essayé vous-même sur votre exploitation?
Oui / Non,---> > H.6.

Si oui:

i. Lesquels? _____

ii. Quel a été le résultat? _____

iii. Pourquoi? _____

_____

6. Est-ce que vous discuté sur vos expériences avec des nouveaux méthodes et arbres avec d'autre personnes?

1-Non, jamais,---> > H.7.
2-Oui, de temps en temps
3-Oui, régulièrement
4-Oui, s'ils me demandent

a. Si oui, avec qui? *(Cerclez tous applicable)*

1-Parents	6-Conseiller
2-Frères ou soeurs	7-Agronomes/experts des projets
3-Voisins ou amis	8-Chercheurs de l'ISAR
4-Agronomes de commune	9-Autres chercheurs
5-Bourgmestre	10-Autres

7. Est-ce que vous avez déjà coopéré avec des projets ou des agronomes pour tester:
   a. Des nouveaux méthodes culturales: **Oui / Non**
   b. Des semences améliorées: **Oui / Non**
   c. Des nouvelles espèces d'arbres: **Oui / Non**
   d. Des nouvelles façons d'entretien des arbres: **Oui / Non**
   e. Des engrais chimiques: **Oui / Non**
   f. Du chaux: **Oui / Non**
   g. Des terrasses **Oui / Non**
   h. Autre _____ **Oui / Non**

8. Si vous avez des problèmes avec les cultures, les animaux ou les arbres, demandez- vous des conseils à d'autres personnes? **1**-Non, jamais,---> > I.
   2-Oui, de temps en temps
   3-Oui, régulièrement
   4-Oui, s'ils me demandent

   a. Si oui, avec qui? *(Cerclez tous applicable)*
   1-Parents
   2-Frères ou soeurs
   3-Voisins ou amis
   4-Agronomes de commune
   5-Bourgmestre
   6-Conseiller
   7-Agronomes/experts des projets
   8-Chercheurs de l'ISAR
   9-Autres chercheurs
   10-Autres

   b. Problèmes les plus discutés avec ces personnes:

   _____
   _____

I. OBSERVATIONS

(Ecrivez vos commentaires et observations sur l'entretien et ce que vous avez vue; continuez au verso si necessaire)

INSTRUCTIONS POUR LE QUESTIONNAIRE SUR LES DONNEES SOCIO-ECONOMIQUES

Ce questionnaire est faite pour étudier si les paysans-experts locales d'arbres se différencient (en éducation, emploi, voyages, moyens de production, élevage, etc) des autres paysans avec peu d'arbres ou de connaissance comme trouver dans le jeu de classement. Le formulaire doit être rempli pour tous les experts d'arbres identifiés (23 dans chaque commune), ainsi que pour une échantillon des paysans non-experts (36 à Maraba et 35 à Karama). Le formulaire est assez facile à remplir. Il semble être long, mais il y a beaucoup de questions qu'on peut sauter si la réponse est "non". Dans ce cas, vous pouvez sauter à la prochaine question comme indiquer dans le formulaire (par exemple, si la réponse à la question C.4. est **NON**, vous pouvez continuez avec la question C.5., indiquez par:---> > C.5.; si la réponse est **OUI**, remplissez les autres informations demandez).

Explications des questions.

B.2. En cas ou un homme a deux épouses, répondez **OUI** à cette question même si seulement une des deux épouses a décédé.
B.4. Ceci veut dire le nombre des garçons qui ont déjà pris une partie ou tous de leur héritage pour y habiter et pour cultiver la terre.

C.4. et C.11. Ceci concerne les cours de formation de courte durée organisés par les projets comme PAP, PDAG, GBK, la service de vulgarisation, des organismes comme INADES, IWACU, etc. Si quelqu'un a suivi un telle cours, écrivez le sujet du cours, le lieu où s'est tenu ce cours, le nom du projet ou organisme qui a donné le cours, et l'année qu'il/elle a participé.

D.1. Ceci concerne le travail de longue durée pour lequel il/elle reçoit une salaire. Les informations sur le travail occasionnelle comme ouvrier agricole sera demandé sous rubrique F.

D.2. Ceci implique toute sorte de travail faite pour la communauté mais pour lequel il/elle n'est pas payé. Des exemples sont données dans le formulaire.

E.1. Si le paysan ne connaît pas la superficie exacte de sa propriété, mettez "NSP" (=ne sait pas).
Pour les questions a. à f., demandez-lui/elle les deux types de sol (mettez les noms kinyarwanda) qui sont le plus courant dans chaque type de parcelle (cultures, jachère, bananes, etc.).

E.4. La taille de l'exploitation se réfère à la superficie de la parcelle, c'est-à-dire le nombre d'ares ou hectares. Si la taille a **augmenté**, les cause peuvent être héritage de la terre de son père, l'achat de la terre, un don de la commune ou autre autorité, ou autre. Si la taille a **diminué**, les causes peuvent être qu'il a donné de la terre à ses fils comme héritage, qu'il a vendu une parcelle, que les autorités lui ont enlevé (exproprié) une parcelle, ou autre. Dans les deux cas, si la réponse est **autre**, écrivez la raison.

E.5. Ceci concerne les parcelles que le paysan donne en location ou prête aux autres paysans. Sous E.5.d., mettez le montant qu'il reçoit pour ceci (si c'est le cas, autrement mettez "gratuit"), et s'il reçoit le loyer en argent, en produits, en main d'oeuvre, ...

E.6. Ceci concerne les parcelles que quelqu'un va louer chez quelqu'un d'autre. Sous E.6.d., mettez le montant qu'il doit payer pour ceci (si c'est le cas, autrement mettez "gratuit"), et s'il paye le loyer en argent, en produits, en main d'oeuvre, ...

Les questions sous F., G. et H. s'expliquent elles-mêmes.

APPENDIX III-1

CROSS-TABULATION OF GOOD FARMER WITH KNOWLEDGEABLE FARMER GROUPS

Count / Row Pct / Col Pct / Tot Pct	Good farmer groups: Best 1.00	Good 2.00	Mediocre 3.00	"Bad" 4.00	Row Total
1.00 Most knowledgeable	26 / 24.5 / 22.4 / 3.0	20 / 18.9 / 18.5 / 2.3	18 / 17.0 / 8.4 / 2.1	42 / 39.6 / 9.7 / 4.8	106 / 12.1
2.00	17 / 11.9 / 14.7 / 1.9	23 / 16.1 / 21.3 / 2.6	37 / 25.9 / 17.3 / 4.2	66 / 46.2 / 15.2 / 7.6	143 / 16.4
3.00	29 / 17.3 / 25.0 / 3.3	13 / 7.7 / 12.0 / 1.5	47 / 28.0 / 22.0 / 5.4	79 / 47.0 / 18.2 / 9.0	168 / 19.2
4.00	22 / 11.1 / 19.0 / 2.5	23 / 11.6 / 21.3 / 2.6	54 / 27.1 / 25.2 / 6.2	100 / 50.3 / 23.0 / 11.5	199 / 22.8
5.00 Least knowledgeable	22 / 8.6 / 19.0 / 2.5	29 / 11.3 / 26.9 / 3.3	58 / 22.6 / 27.1 / 6.6	148 / 57.6 / 34.0 / 17.0	257 / 29.4
Column Total	116 / 13.3	108 / 12.4	214 / 24.5	435 / 49.8	873 / 100.0

Number of valid observations = 873 Number of Missing Observations: 582

Chi-Square	Value	DF	Significance
Pearson	36.15186	12	.00031
Likelihood Ratio	34.73136	12	.00052
Mantel-Haenszel test for linear association	20.20610	1	.00001

Minimum Expected Frequency - 13.113

Statistic	Value	ASE1	T-value	Approximate Significance
Phi	.20350			.00031 *1
Cramer's V	.11749			.00031 *1
Lambda :				
symmetric	.00664	.00675	.98074	
with KNOWGRP dependent	.01136	.01153	.98074	
with GOODGRP dependent	.00000	.00000		
Goodman & Kruskal Tau :				
with KNOWGRP dependent	.00945	.00334		.00098 *2
with GOODGRP dependent	.01287	.00483		.00076 *2
Kendall's Tau-b	.11881	.02865	4.13499	
Kendall's Tau-c	.11375	.02751	4.13499	
Gamma	.16414	.03915	4.13499	
Somers' D :				
symmetric	.11837	.02855	4.13499	
with KNOWGRP dependent	.12952	.03121	4.13499	
with GOODGRP dependent	.10899	.02634	4.13499	
Pearson's R	.15222	.03430	4.54551	.00001
Spearman Correlation	.14095	.03386	4.20189	.00003

*1 Pearson chi-square probability
*2 Based on chi-square approximation

APPENDIX IV-1

AGE OF FARMERS AND NUMBER OF YEARS LIVED ON THE FARM

	comparison group				tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
AGE OF FARMER								
Mean	45	43	48	45	56	56	60	57 A
Standard Deviation	14	13	16	14	11	10	14	12
Minimum	22	26	27	22	34	39	39	34
Maximum	67	70	82	82	80	68	88	88
n	35	17	18	70	22	10	11	43
NUMBER OF YEARS THAT FARMER HAS LIVED ON THIS FARM								
Mean	22	18	25	22	32	34	35	33 A
Standard Deviation	16	13	18	16	14	9	18	14
Minimum	1	2	1	1	4	17	4	4
Maximum	56	39	60	60	55	48	65	65
n	35	17	18	70	22	11	10	43

A=difference between tree experts and control group significant at p<.01

APPENDIX IV-2

COMMUNE OF BIRTH, PRESENT RESIDENCE AND OTHER RESIDENCES

		Comparison farmers			Tree experts		
		KIBINGO n=35	MARABA n=17	SIMBI n=18	KIBINGO n=22	MARABA n=11	SIMBI n=11
COMMUNE (Pref) OF BIRTH							
Maraba (But)	n		15	16		8	10
	%		88.2%	88.9%		72.7%	90.9%
Ruhashya (But)	n			1			1
	%			5.6%			9.1%
Karama (Gik)	n	29	1		18		
	%	82.9%	5.9%		81.8%		
Nyamagabe (Gik)	n	2	1		2	1	
	%	5.7%	5.9%		9.1%	9.1%	
Mudasomwa (Gik)	n	2		1	1	1	
	%	5.7%		5.6%	4.5%	9.1%	
Rukondo (Gik)	n	1			1		
	%	2.9%			4.5%		
Kinyamakara (Gik)	n	1				1	
	%	2.9%				9.1%	
HAS FARMER ALWAYS LIVED ON THIS FARM?							
NO		1		2	5	1	
YES		34	17	16	17	10	11
IF NO, OTHER RESIDENCE 1							
Ruhango (But)	n			1			
Kinyamakara (Gik)	n			1			
Karama (Gik)	n				1		
Nyamagabe (Gik)	n				1		
Mudasomwa (Gik)	n					1	
Nyarugenge (Kig)	n				2		
UGANDA	n	1			1		
MEAN NUMBER OF YEARS		1		17	7	4	
IF NO, OTHER RESIDENCE 2							
Ngoma (But)	n				1		
Murambi (Byu)	n				1		
MEAN NUMBER OF YEARS					2		
IF NO, OTHER RESIDENCE 3							
Nyamagabe (Gik)	n				1		
MEAN NUMBER OF YEARS					4		

Abbreviations for Prefectures: But=Butare; Gik=Gikongoro; Kig=Kigali; Byu=Byumba.

APPENDIX IV-3

TOTAL NUMBER OF CHILDREN, NUMBER OF CHILDREN RESIDENT ON FARM, AND NUMBER OF BOYS LIVING OUTSIDE THE SECTEUR OR CULTIVATING INHERITED LAND

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
TOTAL NUMBER OF BOYS								
Mean	2.5	2.1	2.4	2.4	3.3	4.0	3.2	3.5 A
Standard Deviation	1.8	1.4	1.9	1.7	1.8	2.2	1.3	1.8
Maximum	7	5	7	7	7	8	6	8
n	28	10	17	55	22	10	9	41
NUMBER OF BOYS LIVING ON-FARM								
Mean	2.1	1.8	1.9	2.0	2.2	2.9	2.3	2.4
Standard Deviation	1.3	1.2	1.0	1.2	1.3	1.8	1.2	1.4
Maximum	5	4	3	5	6	6	4	6
n	25	10	11	46	17	10	9	36
NUMBER OF BOYS LIVING OUSIDE THE SECTEUR								
Mean	1.3	1.0	1.0	1.2	2.6 c,d	.	1.0	2.5 B
Standard Deviation	.5	.		.4	1.6	.	.	1.6
Maximum	2	1	1	2	5	.	1	5
n	7	1	3	11	10		1	11
NUMBER OF BOYS FARMING INHERITED LAND								
Mean	1.6	1.5	1.8	1.7	2.3	1.3	1.0	1.8
Standard Deviation	.9	.7	1.1	.9	1.3	.6		1.1
Maximum	3	2	3	3	4	2	1	4
n	8	2	5	15	7	3	3	13
TOTAL NUMBER OF GIRLS								
Mean	2.6	2.5	3.1	2.7	3.7	3.1	4.6	3.8 A
Standard Deviation	1.6	1.2	1.9	1.6	1.3	1.5	1.7	1.5
Maximum	8	5	7	8	6	6	7	7
n	32	12	14	58	22	11	10	43
NUMBER OF GIRLS LIVING ON-FARM								
Mean	2.2	2.2	2.3	2.2	2.8	2.8	2.7	2.8
Standard Deviation	1.2	1.5	1.6	1.3	1.4	1.6	1.3	1.4
Maximum	5	5	6	6	6	6	5	6
n	28	10	10	48	19	9	9	37

A=between group difference significant at p<.01
B=between group difference significant at p<.05
c=difference between Kibingo and Maraba significant at p<.01
d=difference between Kibingo and Simbi significant at p<.05

APPENDIX IV-4a

NUMBER OF YEARS OF EDUCATION AND TRAINING OF HEADS OF HOUSEHOLD (hoh)

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
MALE HOUSEHOLD HEADS								
PRIMARY EDUCATION								
Mean no. of years	4.3	3.9	3.3	4.0	4.5	4.1	3.6	4.2
Standard Deviation	1.7	1.6	1.2	1.6	1.8	1.5	1.3	1.6
n	21	9	9	39	14	9	5	28
% of all male hoh	72%	64%	69%	68%	74%	82%	50%	70%
SECONDARY EDUCATION								
Mean no. of years	2.0	.	.	2.0	3.0	.	.	3.0
Standard Deviation	.	.	.	.		.	.	
n	1			1	2			2
OTHER FORMAL EDUCATION								
Mean no. of years	2.0	3.2	3.4	3.2	3.0	3.3	3.0	3.1
Standard Deviation	.	1.1	1.7	1.3	.	1.2	1.6	1.4
n	1	5	5	11	1	3	8	12
SHORT-TERM TRAINING								
n					4			4
FEMALE HOUSEHOLD HEADS								
PRIMARY EDUCATION								
Mean	4.0	6.0	.	5.0	.	.	5.0	5.0
Standard Deviation	.	.	.	1.4	.	.	.	.
n	1	1		2			1	1
% of all female hoh	17%	33%	0%	14%	0%		100%	25%
OTHER FORMAL EDUCATION								
Mean	.	1.0	1.3	1.3	.		.	.
Standard Deviation	.	.	.6	.5	.		.	.
n		1	3	4				

APPENDIX IV-4b

NUMBER OF YEARS OF EDUCATION AND TRAINING OF WOMEN NOT BEING HEADS OF HOUSEHOLD

	comparison group				tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
FIRST WIFE								
PRIMARY EDUCATION								
Mean no. of years	5.1	4.5	5.3	5.0	4.3	2.0	4.5	3.9
Standard Deviation	1.7	3.1	.6	1.8	2.1		.7	1.9
n	17	4	3	24	7	2	2	11
% of all wives	68%	36%	27%	51%	41%	20%	22%	31%
SECONDARY EDUCATION								
Mean no. of years	.	.	.	.	5.0	.	.	5.0
Standard Deviation	.	.	.	.	.	.	.	.
n					1			1
OTHER FORMAL EDUCATION								
Mean no. of years	2.0	3.2	2.5	2.7	6.5	3.8	3.0	4.0
Standard Deviation		1.3	1.3	1.2	4.9	1.2	1.0	2.1
n	2	5	4	11	2	8	3	13
SECOND WIFE								
PRIMARY EDUCATION								
Mean no. of years	.	.	.	.	6.0	.	.	6.0
Standard Deviation	.	.	.	.	.	.	.	.
n					1			1
OTHER FORMAL EDUCATION								
Mean no. of years	.	.	.	.	2.0	.	3.3	3.0
Standard Deviation	.	.	.	.	.	.	.6	.8
n					1		3	4
SHORT TERM TRAINING								
n			3	3				

APPENDIX IV-5
SALARIED WORK AND NON-PAID COMMUNITY FUNCTIONS OF CONSULTANTS; SALARIED WORK OF CHILDREN AND HELP THEY PROVIDE TO THEIR PARENTS

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
SALARIED WORK AT PRESENT								
NO Count	34	17	18	69	20	10	10	40
Percent	97.1%	100.0%	100.0%	98.6%	90.9%	90.9%	90.9%	90.9%
YES Count	1			1	2	1	1	4
Percent	2.9%			1.4%	9.1%	9.1%	9.1%	9.1%
SALARIED WORK IN THE PAST								
NO Count	34	16	15	65	16	9	9	34
Percent	97.1%	94.1%	83.3%	92.9%	72.7%	81.8%	81.8%	77.3%
YES Count	1	1	3	5	6	2	2	10
Percent	2.9%	5.9%	16.7%	7.1%	27.3%	18.2%	18.2%	22.7%
NON-PAID COMMUNITY FUNCTION AT PRESENT?								
NO Count	33	15	17	65	17	9	10	36
Percent	94.3%	88.2%	94.4%	92.9%	77.3%	81.8%	90.9%	81.8%
YES Count	2	2	1	5	5	2	1	8
Percent	5.7%	11.8%	5.6%	7.1%	22.7%	18.2%	9.1%	18.2%
NON-PAID COMMUNITY FUNCTION IN THE PAST?								
NO Count	34	17	16	67	18	8	8	34 A
Percent	97.1%	100.0%	88.9%	95.7%	81.8%	72.7%	72.7%	77.3%
YES Count	1		2	3	4	3	3	10
Percent	2.9%		11.1%	4.3%	18.2%	27.3%	27.3%	22.7%
DOES FARMER HAVE CHILDREN WITH SALARIED WORK?								
NO Count	34	16	16	66	14	9	7	30 A
Percent	97.1%	94.1%	88.9%	94.3%	63.6%	81.8%	63.6%	68.2%
YES Count	1	1	2	4	8	2	4	14
Percent	2.9%	5.9%	11.1%	5.7%	36.4%	18.2%	36.4%	31.8%
DO SALARIED CHILDREN HELP THE FARMER?								
NO Count			1	1	3	2	2	7
Percent			50.0%	25.0%	37.5%	100.0%	50.0%	50.0%
YES Count	1	1	1	3	5		2	7
Percent	100.0%	100.0%	50.0%	75.0%	62.5%		50.0%	50.0%

A=between group chi square significant at p<.01
B=between group chi square significant at p<.05

APPENDIX IV-6
FAMILY LABOR SITUATION AND TEMPORARY FARM LABOR HIRING AND EMPLOYMENT PRACTICES

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOES FARMER HAVE ENOUGH LABOUR IN THE FAMILY?								
NO	1			1	1			1
Count Percent	2.9%			1.4%	4.5%			2.3%
YES	34	17	18	69	21	11	11	43
Count Percent	97.1%	100.0%	100.0%	98.6%	95.5%	100.0%	100.0%	97.7%
DOES FARMER HIRE LABOR?								
NO	31	15	18	64	14	7	8	29 A
Count Percent	88.6%	88.2%	100.0%	91.4%	63.6%	63.6%	72.7%	65.9%
YES, ON PERMANENT BASIS	1			1	4	1	1	6
Count Percent	2.9%			1.4%	18.2%	9.1%	9.1%	13.6%
YES,	3	2		5	4	3	2	9
Count Percent	8.6%	11.8%		7.1%	18.2%	27.3%	18.2%	20.5%
DURING THE MONTHS OF:								
January					2	1		3
March	3	2		5	2	2	2	6
April	1			1		1	1	2
September	2			2	4	2	1	7
October		2		2		3	1	4
November						2	1	3
DOES FARMER WORK FOR OTHER FARMERS?								
NO	22	11	10	43	19	11	10	40 A
Count Percent	64.7%	64.7%	55.6%	62.3%	86.4%	100.0%	90.9%	90.9%
YES, ON PERMANENT BASIS	2	1	1	4	1			1
Count Percent	5.9%	5.9%	5.6%	5.8%	4.5%			2.3%
YES,	10	5	7	22	2		1	3
Count Percent	29.4%	29.4%	38.9%	31.9%	9.1%		9.1%	6.8%
DURING THE MONTHS OF:								
January			2	2				
March	6	1	2	9			1	2
April		2	2	4	2		1	3
July	1	1		2	1			1
August		1		1	1			1
September	9	2	3	14	2		1	3
October	1	5	4	10			1	1
November		2	2	4			1	1

A=between group difference significant at p<.01 (chisquare)

APPENDIX IV-7
MANNER IN WHICH LAND WAS OBTAINED AND CHANGES IN FARM SIZE IN THE LAST 5 YEARS

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
LAND OBTAINED THROUGH:								A
INHERITANCE	34	17	16	67	17	4	6	27
Cases Percent	97.1%	100.0%	88.9%	95.7%	77.3%	36.4%	54.5%	61.4%
PURCHASE	2	1		3	3			3
Cases Percent	5.7%	5.9%		4.3%	13.6%			6.8%
GIFT OF AUTHORITIES	2	1	2	5	8	7	4	19
Cases Percent	5.7%	5.9%	11.1%	7.1%	36.4%	63.6%	36.4%	43.2%
OTHER					2		1	3
Cases Percent					9.1%		9.1%	6.8%
CHANGE IN AMOUNT OF LAND OWNED IN THE LAST 5 YRS								B
NO CHANGE	25	16	16	57	10	9	8	27
Count Percent	71.4%	94.1%	88.9%	81.4%	45.5%	81.8%	72.7%	61.4%
INCREASE	2		1	3			1	1
Count Percent	5.7%		5.6%	4.3%			9.1%	2.3%
because of ...								
INHERITANCE	1		1	2			1	1
Count Percent	50.0%		100.0%	66.7%			100.0%	100.0%
OTHER	1			1				
Count Percent	50.0%			33.3%				
DECREASE	8	1	1	10	12	2	2	16
Count Percent	22.9%	5.9%	5.6%	14.3%	54.5%	18.2%	18.2%	36.4%
because of ...								
INHERITANCE	7	1	1	9	8	2	1	11
Count Percent	87.5%	100.0%	100.0%	90.0%	66.7%	100.0%	50.0%	68.8%
SALE	1			1	2			2
Count Percent	12.5%			10.0%	16.7%			12.5%
EXPROPRIATION					1			1
Count Percent					8.3%			6.3%
OTHER					1		1	2
Count Percent					8.3%		50.0%	12.5%

A=between group chi square significant at p<.01
B=between group chi square significant at p<.05

APPENDIX IV-8a
LAND RENTED OUT TO OTHER FARMERS

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOES FARMER LOAN LAND TO OTHER FARMERS?								
NO	31	15	17	63	14	8	10	32
Count Percent	88.6%	88.2%	94.4%	90.0%	63.6%	72.7%	90.9%	72.7%
YES	4	2	1	7	8	3	1	12 B
Count Percent	11.4%	11.8%	5.6%	10.0%	36.4%	27.3%	9.1%	27.3%
NUMBER OF PLOTS RENTED OUT	2	1	1	1	2	2	2	2
LENGTH OF LEASE								
permanent/same plot		1	1	2	3	3	1	7
Count Percent		50.0%	100.0%	33.3%	42.9%	100.0%	100.0%	63.6%
permanently/change plot yearly					1			1
Count percent					14.3%			9.1%
sometimes/whole year	3	1		4	1			1
Count Percent	100.0%	50.0%		66.7%	14.3%			9.1%
sometimes/long dry seas					2			2
Count percent					28.6%			18.2%
RENT RECEIVED PER YEAR								
AVG RENT AMOUNT	325	325	300	321	275	367	1000	358
Minimum	0	50	300	0	0	0	1000	0
Maximum	700	600	300	700	1200	800	1000	1200

B=between group chi square significant at p<.05

APPENDIX IV-8b
LAND RENTED IN FROM OTHER FARMERS

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOES FARMER RENT LAND FROM OTHER FARMERS?								
NO	24	8	15	47	16	7	7	30
Count Percent	68.6%	47.1%	83.3%	67.1%	72.7%	63.6%	63.6%	68.2%
YES	11	9	3	23	6	4	4	14
Count Percent	31.4%	52.9%	16.7%	32.9%	27.3%	36.4%	36.4%	31.8%
NUMBER OF PLOTS RENTED IN	2	2	1	2	3	2	3	3
LENGTH OF LEASE								
permanent/same plot	2	5	1	8	1	3	3	7
Count Percent	18.2%	55.6%	33.3%	34.8%	16.7%	75.0%	75.0%	50.0%
permanent/change plot yearly	5	3	2	10	1	1	1	3
Count Percent	45.5%	33.3%	66.7%	43.5%	16.7%	25.0%	25.0%	21.4%
permanent/change plot seasonally	1	1		2	1			1
Count Percent	9.1%	11.1%		8.7%	16.7%			7.1%
sometimes/whole year	2			2	2			2
Count Percent	18.2%			8.7%	33.3%			14.3%
sometimes/season A*	1			1	1			1
Count Percent	9.1%			4.3%	16.7%			7.1%
RENT PAID PER YEAR								
AVG RENT AMOUNT	1160	1485	1167	1294	1317	875	1650	1286
Minimum	500	200	1000	200	500	500	600	500
Maximum	5000	6000	1500	6000	3000	1000	2500	3000

* Season A is the first growing season (September-December).

APPENDIX IV-9a

MAJOR SOIL TYPES OF FIELDS PREDOMINANTLY USED FOR FOOD CROPS

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOMINANT SOIL TYPES								
Urusenyi								
Cases	14	10	10	34	14	4	8	26
Responses Percent	40.0%	58.8%	55.6%	48.6%	63.6%	36.4%	72.7%	59.1%
Mugugu								
Cases	18	9	9	36	10	8	4	22
Responses Percent	51.4%	52.9%	50.0%	51.4%	45.5%	72.7%	36.4%	50.0%
Inombe								
Cases	9	2	5	16	7	1	2	10
Responses Percent	25.7%	11.8%	27.8%	22.9%	31.8%	9.1%	18.2%	22.7%
Urunombe								
Cases		1		1		1	3	4
Responses Percent		5.9%		1.4%		9.1%	27.3%	9.1%
Umushenga								
Cases						2		2
Responses Percent						18.2%		4.5%

APPENDIX IV-9b

MAJOR SOIL TYPES ON BANANA (MIXED BANANA/CROP) FIELDS

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOMINANT SOIL TYPES								
Urusenyi								
Cases	11	7	9	27	12	3	7	22
Responses Percent	37.9%	46.7%	56.3%	45.0%	60.0%	27.3%	63.6%	52.4%
Mugugu								
Cases	14	7	5	26	7	7	2	16
Responses Percent	48.3%	46.7%	31.3%	43.3%	35.0%	63.6%	18.2%	38.1%
Inombe								
Cases	7	2	5	14	3	1	2	6
Responses Percent	24.1%	13.3%	31.3%	23.3%	15.0%	9.1%	18.2%	14.3%
Urunombe								
Cases						1	3	4
Responses Percent						9.1%	27.3%	9.5%
Umushenga								
Cases						1		1
Responses Percent						9.1%		2.4%

APPENDIX IV-9c

MAJOR SOIL TYPES OF FIELDS IN COFFEE

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOMINANT SOIL TYPES								
Urusenyi								
Cases	13	7	4	24	13	4	7	24
Responses Percent	40.6%	58.3%	26.7%	40.7%	61.9%	44.4%	70.0%	60.0%
Mugugu								
Cases	16	5	8	29	10	5	3	18
Responses Percent	50.0%	41.7%	53.3%	49.2%	47.6%	55.6%	30.0%	45.0%
Inombe								
Cases	5		4	9	3	1	1	5
Responses Percent	15.6%		26.7%	15.3%	14.3%	11.1%	10.0%	12.5%
Urunombe								
Cases		1		1		1		1
Responses Percent		8.3%		1.7%		11.1%		2.5%
Umushenga								
Cases						1		1
Responses Percent						11.1%		2.5%
Igishonyi								
Cases	1			1				
Responses Percent	3.1%			1.7%				

APPENDIX IV-9d

MAJOR SOIL TYPES OF FIELDS IN PERMANENT PASTURE

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOMINANT SOIL TYPES								
Urusenyi								
Cases	5			5	3	1	1	5
Responses Percent	38.5%			35.7%	18.8%	25.0%	33.3%	21.7%
Mugugu								
Cases	7	1		8	11	2	2	15
Responses Percent	53.8%	100.0%		57.1%	68.8%	50.0%	66.7%	65.2%
Inombe								
Cases	2			2	3			3
Responses Percent	15.4%			14.3%	18.8%			13.0%
Umushenga								
Cases						1		1
Responses Percent						25.0%		4.3%

APPENDIX IV-9e

MAJOR SOIL TYPES OF FIELDS IN FALLOW

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOMINANT SOIL TYPES								
Urusenyi								
Cases	5		2	7	6			6
Responses Percent	35.7%		40.0%	36.8%	31.6%			25.0%
Mugugu								
Cases	8		2	10	10	3	1	14
Responses Percent	57.1%		40.0%	52.6%	52.6%	100.0%	50.0%	58.3%
Inombe								
Cases	2		1	3	3			3
Responses Percent	14.3%		20.0%	15.8%	15.8%			12.5%
Urunombe								
Cases							1	1
Responses Percent							50.0%	4.2%

APPENDIX IV-9f

MAJOR SOIL TYPES OF FIELDS PLANTED AS WOODLOTS

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DOMINANT SOIL TYPES								
Urusenyi								
Cases	9	3	3	15	9	3	5	17
Responses Percent	39.1%	37.5%	33.3%	37.5%	40.9%	30.0%	55.6%	41.5%
Mugugu								
Cases	10	5	7	22	16	5	2	23
Responses Percent	43.5%	62.5%	77.8%	55.0%	72.7%	50.0%	22.2%	56.1%
Inombe								
Cases	4		1	5	3	1	2	6
Responses Percent	17.4%		11.1%	12.5%	13.6%	10.0%	22.2%	14.6%
Umushenga								
Cases						2		2
Responses Percent						20.0%		4.9%
Igishonyi								
Cases	1			1				
Responses Percent	4.3%			2.5%				

APPENDIX IV-10a

MEAN AND MAXIMUM NUMBER OF VARIOUS ANIMALS OWNED BUT NOT RESIDING ON THE FARM

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
% HAVING ANIMALS	6.9%	7.7%	11.1%	7.8%	31.6%	20.0%	36.4%	30.0%
NUMBER OF COWS								
Mean	1.0	.	.	1.0	2.0	.	1.0	1.7
Standard Deviation	.	.	.	.	1.4	.	.	1.2
Maximum	1	.	.	1	3	.	1	3
n	1			1	2		1	3
NUMBER OF GOATS								
Mean	.	.	2.0	2.0	1.0	1.5	2.3	1.9
Standard Deviation	.	.	.	.	.	.7	1.5	1.2
Maximum	.	.	2	2	1	2	4	4
n			1	1	1	2	4	7
NUMBER OF SHEEP								
Mean	1.0	.	.	1.0	3.0	.	.	3.0
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	1	.	.	1	3	.	.	3
n	1			1	1			1
NUMBER OF PIGS								
Mean	.	.	.	.	2.5	.	.	2.5
Standard Deviation	.	.	.	.	1.7	.	.	1.7
Maximum	.	.	.	.	4	.	.	4
n					4			4
NUMBER OF CHICKENS								
Mean	.	1.0	.	1.0	2.0	.	.	2.0
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	1	.	1	2	.	.	2
n		1		1	1			1

APPENDIX IV-10b

MEAN AND MAXIMUM NUMBER OF ANIMALS RESIDING ON THE FARM WHICH ARE NOT OWNED

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
% HAVING ANIMALS	57.1%	15.4%	55.6%	46.0%	42.1%	50.0%	54.5%	47.5%
NUMBER OF COWS								
Mean	1.3	.	1.0	1.3	2.0	1.0	1.0	1.4
Standard Deviation	.6	.	.	.5		.		.5
Maximum	2	.	1	2	2	1	1	2
n	3		1	4	2	1	2	5
NUMBER OF GOATS								
Mean	1.1	1.0	.	1.1	1.8	.	1.5	1.7 A
Standard Deviation	.3	.	.	.3	.8	.	.6	.7
Maximum	2	1	.	2	3	.	2	3
n	11	1		12	6		4	10
NUMBER OF SHEEP								
Mean	1.4	1.0	.	1.3	2.0	.	5.0	3.0
Standard Deviation	.5	.	.	.5		.	.	1.7
Maximum	2	1	.	2	2	.	5	5
n	5	1		6	2		1	3
NUMBER OF PIGS								
Mean	1.0	1.0	1.0	1.0	1.5	1.0	1.0	1.2
Standard Deviation		.			.7		.	.4
Maximum	1	1	1	1	2	1	1	2
n	7	1	3	11	2	3	1	6
NUMBER OF CHICKENS								
Mean	1.5	8.0	2.5	3.2	2.8	.	1.3	2.1
Standard Deviation	.7	.	2.1	2.9	1.0	.	.6	1.1
Maximum	2	8	4	8	4	.	2	4
n	2	1	2	5	4		3	7
NUMBER OF RABBITS								
Mean	1.0	.	.	1.0	.	.	.	.
Standard Deviation		.	.		.	.	.	.
Maximum	1	.	.	1	.	.	.	.
n	2			2				
NUMBER OF BEE HIVES								
Mean	.	.	.	.	.	2.0	.	2.0
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	2	.	2
n						1		1

A=between group difference significant at p<.01

APPENDIX VI-1

SOURCES OF NEW AGROFORESTRY TECHNOLOGIES: TRAVEL OUTSIDE THE *SECTEUR* OF RESIDENCE

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
HAS FARMER TRAVELED OUTSIDE SECTEUR OF RESIDENCE?								
NO	12	12	8	32 b	4		1	5 A
Count Percent	34.3%	70.6%	44.4%	45.7%	18.2%		9.1%	11.4%
YES	23	5	10	38	18	11	10	39
Count Percent	65.7%	29.4%	55.6%	54.3%	81.8%	100.0%	90.9%	88.6%
IF YES, DESTINATION								
OTHER SECTEURS OF COMMUNE	6			6				
Cases Percent	26.1%			15.8%				
OTHER COMMUNES IN PREF.	16	2	5	23	7	2	1	10
Cases Percent	69.6%	40.0%	50.0%	60.5%	38.9%	18.2%	10.0%	25.6%
TO THE CITY	5	2		7	7	5	1	13
Cases Percent	21.7%	40.0%		18.4%	38.9%	45.5%	10.0%	33.3%
OTHER PREFECTURES	3	1	5	9	8	7	7	22
Cases Percent	13.0%	20.0%	50.0%	23.7%	44.4%	63.6%	70.0%	56.4%
OTHER COUNTRIES	1	1	5	7	2	4	7	13
Cases Percent	4.3%	20.0%	50.0%	18.4%	11.1%	36.4%	70.0%	33.3%
DID FARMER BRING BACK TREE SEEDS FROM TRAVELS?								
NO	21	3	8	32	6	8	6	20 A
Count Percent	91.3%	60.0%	80.0%	84.2%	33.3%	72.7%	60.0%	51.3%
YES	2	2	2	6	12	3	4	19
Count Percent	8.7%	40.0%	20.0%	15.8%	66.7%	27.3%	40.0%	48.7%
DID FARMER TRY THE TREE SEEDS (S)HE BROUGHT?								
YES	2	2	2	6	12	3	4	19
Count Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
DID FARMER OBSERVE OTHER TREE MGT METHODS?								
NO	22	5	10	37	18	11	10	39
Count Percent	95.7%	100.0%	100.0%	97.4%	100.0%	100.0%	100.0%	100.0%
YES	1			1				
Count Percent	4.3%			2.6%				
DID FARMER TRY THESE TREE MGT METHODS?								
NO	1			1				
Count Percent	100.0%			100.0%				

A=between group chi square significant at p<.01 b=within group chi square significant at p<.05

APPENDIX VI-2a
SOURCES OF NEW AGROFORESTRY TECHNOLOGIES: FARM VISITORS BRINGING NEW TREE SPECIES

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DID FARMER HAVE VISITORS WHO BROUGHT TREE SEEDS?								b
NO	32	17	15	64	15	11	11	37
Count Percent	91.4%	100.0%	83.3%	91.4%	68.2%	100.0%	100.0%	84.1%
YES	3		3	6	7			7
Count Percent	8.6%		16.7%	8.6%	31.8%			15.9%
IF YES, WHO?								
PARENTS			1	1				
Cases Percent			33.3%	16.7%				
AGRONOMES DE COMMUNE	2		1	3	1			1
Cases Percent	66.7%		33.3%	50.0%	14.3%			14.3%
BURGOMASTER			1	1				
Cases Percent			33.3%	16.7%				
PROJECT AGRONOMISTS					4			4
Cases Percent					57.1%			57.1%
ISAR RESEARCHERS	1			1	3			3
Cases Percent	33.3%			16.7%	42.9%			42.9%
OTHER RESEARCHERS			1	1				
Cases Percent			33.3%	16.7%				
OTHER	1			1				
Cases Percent	33.3%			16.7%				
DID FARMER TRY THESE NEW TREE SPECIES?								
YES	3		2	5	7			7
Count Percent	100.0%		100.0%	100.0%	100.0%			100.0%

b=within group chi square signifiacnt at p<.05

APPENDIX VI-2b
SOURCES OF NEW AGROFORESTRY TECHNOLOGIES: FARM VISITORS EXPLAINING NEW TREE MANAGEMENT METHODS

	Comparison farmers				Tree experts			
	KIBINGO	MARABA	SIMBI	TOTAL	KIBINGO	MARABA	SIMBI	TOTAL
DID VISITORS SHOW FARMER NEW TREE MGT METHODS?								
NO	33	16	18	67	20	10	11	41
Count Percent	94.3%	94.1%	100.0%	95.7%	90.9%	90.9%	100.0%	93.2%
YES	2	1		3	2	1		3
Count Percent	5.7%	5.9%		4.3%	9.1%	9.1%		6.8%
IF YES, WHO?								
AGRONOMES DE COMMUNE	1			1	2	1		3
Cases Percent	50.0%			33.3%	100.0%	100.0%		100.0%
COUNCILLOR		1		1				
Cases Percent		100.0%		33.3%				
ISAR RESEARCHERS	1			1				
Cases Percent	50.0%			33.3%				
DID FARMER TRY THESE NEW METHODS?								
NO	1			1		1		1
Count Percent	50.0%			33.3%		100.0%		33.3%
YES	1	1		2	2			2
Count Percent	50.0%	100.0%		66.7%	100.0%			66.7%

APPENDIX VII-1

LIST OF ALL TREE SPECIES (IBITI) CULTIVATED ON FARMS IN THE *COMMUNES* OF KARAMA AND MARABA

EXOTIC TREE SPECIES	
1.	Euphorbia cotonifolia
2.	Artocarpus fraxinifolius
3.	Prunus salicifolia
4.Amacunga	Citrus aurantium vulgare
5.Amapera	Psidium guajava
6.Avoka	Persea gratissima
7.Calliandra	Calliandra callothyrsus
8.Callitrisi	Callitris
9.Cassiya	Cassia spectabilis
10.Casuarina/umubunda	Casuarina cunninghamia
11.Gereverya	Grevillea robusta
12.Icyayi	Camellia thea
13.Igifenesi (jacquier)	Artocarpus integrifolia
14.Ikawa	Coffea arabica
15.Ikinyomoro/itunda	Cyphomandra betacea
16.Indimu	Citrus limon
17.Inturusu/intusi	Eucalyptus spp.
18.Ipapaya	Carica papaya
19.Ipapaya y'umusozi	Carica cundinamarcensis
20.Isederela	Cedrela serrata
21.Jacaranda	Jacaranda mimosaefolia
22.Lesena	Leucena leucocephela/L. diversofolia
23.Mandarine	Citrus
24.Pinusi/umubunda	Pinus spp.
25.Seremoliya	Annona cherimola
26.Umudwedwe	Plumeria alba
27.Umukunde/Itenderwa	Cajanus indicus
28.Umunoferiya (néfrier)	Eryobotrya japonica
29.Umutima w'imfizi	Annona reticulata
30.Umuzonibari (cyprès)	Cupressus lusitanica
31.Umwembe	Mangifera indica
INDIGENOUS TREE SPECIES	
32.	Dovyalis caffra
33.Akaziraruguma	Begonia meyeri-johanni
34.Amadwedwe	Euphorbia grantii
35.Bambuwa	Coryza sumatrensis
36.Barakatsi	Acacia mearnsii
37.Bugangabukare	Hygrophila auriculata
38.Iboberi	Morus alba
39.Icyicamahirwe	Tithonia sp
40.Icyuyuyu	Pavonia urens
41.Icyumwa	Trichodesma zeylanicum
42.Idaforoma	
43.Idoma	Vernonia aenulans
44.Igicucu	Manihot glaziovii

45.Igicumucumu	Botriocline ugandensis
46.Igicunshu	Coleus kilimandschari
47.Igihungeri	Protea madiensis
48.Igihondohondo	Draceana steudneri
49.Igikakarubamba	Aloe dawei
50.Igikakarubamba kizungu (taburini)	Aloe sp
51.Igikamba/itabi	Nicotiana tabacum
52.Igisura	Urtica dioica
53.Igitabitabi	Nicotiana tabacum (wild tobacco)
54.Igitenetene	Kalanchoe spp
55.Igitoborwa	Solanum capsicoïdes
56.Igitotsi	Blumea alata (syn lagera)
57.Igiturabuguma	Hybiscus diversifolius
58.Igitovu	Acanthus pubescens
59.Ikararambwe	Rubia cordifolia
60.Ikegera	Senecio ladiensis
61.Ikibonobono	Ricinus communis
62.Ikibonobono	Psychotria sp
63.Ikigwarara	Berkheya spekeana
64.Ikiha=Umuduha	Euphorbia candelabrum
65.Ikimungu	Opuntia vulgaris/O. ficus indica
66.Ikinyankurwe	Clerondendrum fuscum/johnstonii
67.Ikinyondonyondo	Kalanchoë spp
68.Ikizimyamuliro	Guizotia scabra
69.Ikiziranyenzi	Clerondendrum rotundifolium
70.Ikura	arbre non-id.
71.Imbabazi	Microglossa pyrifolia
72.Indarama	Plante non-id.
73.Inkeli/umukeli	Rubus rigidus
74.Intobo	Solanum aculeastrum
75.Intoryi	Solanum melongena
76.Inyabarasanya	Bidens pilosa
77.Inzirane	Cassia floribunda
78.Iralire	Senecio stuhlmannii (syn. cydonifolia)
79.Ireke/Iginetenete	Kalanchoe beniensis
80.Isonga	Ocimum americanum
81.Kamenamaseke	Polygala luteo-viridis
82.Kavunjahomo/Akavunjahoma	Chenopodium ambrosioïdes
83.Mahuru	Leptactina platyphilla
84.Magaru	Hypoestes verticillaris
85.Nyirakayenzi	
86.Quinquina	Cinchona sp
87.Rubamba	Sanseveria spp
88.Rubilika	?
89.Ubuhandanzovu	Tribulus terrestris
90.Ubutwiko	Helichrysum fruticosum
91.Umubazi	Monechma subsessile (epiphyte)
92.Umubilizi	Vernonia amygdalina
93.Umubogora	Cissus quadrangularis
94.Umucaca	Cynodon aethiopicus/C. ulemfuensis
95.Umucucu	Solanum incanum
96.Umucundura	Triumfetta spp
97.Umucyuro	Cassia didymobotrya

98.Umufatangwe	Ceasalpina decapetala
99.Umufumba	Ekebergia capensis
100.Umufumbageshi	Balthasaria schliebenii var. intermedia
101.Umuganashya	Cussonia holstii
102.Umugasa	Toddalia asiatica
103.Umugano	Arundinaria alpina
104.Umugombe	Chenopodium ugandae
105.Umugote	Syzygium parviflorum
106.Umugwamporo/umuboboli	Trema orientalis
107.Umuhanga	Maesa lanceolata
108.Umuharakuku	Rhyndosia hirta
109.Umuhashya	Dalbergia lactea
110.Umuhati	Draceana afromontana
111.Umuhati kizungu (w/ red leaves)	Draceana afromontana?
112.Umuhatu	Pavonia patens
113.Umuhe	Clerondendrum fuscum
114.Umuhengeli/irandani	Lantana camara
115.Umuhikakiza	Plante non-id.
116.Umuhokoro	Mikaniopsis tedlei
117.Umuhombo	Ficalhoa laurifolia
118.Umuhuhu/gapeli	Physalis peruviana
119.Umuhuhwe	Croton dichogamus
120.Umuhumuro	Maesopsis emenii
121.Umukamambogo	
122.Umukaragata	Embelia schimperi
123.Umukiryi	Virectaria major
124.Umuko	Erythrina abyssinica
125.Umukobe	Ficus sp
126.Umukoni	Synadenium grantii
127.Umukoni kizungu (w/ red leaves)	Synadenium compactum?
128.Umukonora	Gloriosa simplex
129.Umukorokombe	Grewia similis
130.Umugosora	Verbena officinalis
131.Umukubayoka	Cassia floribunda
132.Umukumbuguru	Clerondendrum buchholzii
133.Umukurazo	Vernonia hochstetteri
134.Umukuzanyana	Clerondendrum myricoïdes
135.Umulyawabasaza	arbuste non-id.
136.Umumenamabuye	Pavetta ternifolia
137.Umumeya	Albertisia exelliana
138.Umunanira	Rhamnus prinoides
139.Umunkamba	Clematis sinensis/C. hirsuta
140.Umuno	Clausena anisata
141.Umunyegenyege	Sesbania sesban/S. macrantha
142.Umunyinya	Acacia sieberiana
143.Umuravumba	Tetradenia riparia
144.Umurehe	Ficus vallis-choudae
145.Umurerabana	Vernonia adoensis
146.Umuretezo	Anisopappus africanus
147.Umurogora/umukaka	Bersama abyssinica
148.Umuryogera	Crotolaria recta
149.Umuruku	Tephrosia vogelii
150.Umusagara	Rhus vulgaris

151. Umusange	Entada abyssinica
152. Umusarenda	Triumfetta cordifolia
153. Umusasa	Sapium ellipticum
154. Umusave	Markhamia lutea
155. Umusebe	Cassia floribunda
156. Umusebeya	Albizzia spp
157. Umusekera	Macaranga neomilbreadiana
158. Umusena/umuseno	Ficus asperifolia
159. Umusene	Dasylepis racemosa
160. Umushubi	Maytenus spp./Dovyalis spp.
161. Umushunshu	Solanum incanum
162. Umusororo	Indigofera erecta
163. Umutagara	Senecio mannii
164. Umutagarasoryo	Solanum anguivii/S. indicum
165. Umutakaforo	?
166. Umutarishonga	Clutia abyssinica
167. Umutinsyi	Erytrococca bongensis
168. Umutobotobo	Solanum aeculestrum
169. Umutozo	Hybiscus fuscus
170. Umuturirwa	Waltheria indica
171. Umuturuturu	Schefflera goetzenii
172. Umuvumo	Vernonia spp
173. Umuvumu/gasuru	Ficus thonningii
174. Umuyenzi	Euphorbia tirucalli
175. Umuyogera/kayogera	Crotolaria incana ssp purpurescens
176. Umuyogoro	Milletia dura
177. Umuyoka	Cassia occidentalis
178. Umuzabibu	raisin
179. Umuzibaziba	Mitragyne rubrostipulata
180. Umwamira	Terminalia mollis?
181. Umwange	Senecio angulatus
182. Umwanzuranya	Vernonia smithiana
183. Umwenya	Ocimum suave
184. Umwisheke	Chenopodium ambrosoïdes
185. Umwumba	Prunus africana
186. Umwungo	Polyscias fulva
187. Uruberwa	Hybiscus cannabinus
188. Urubingo	Pennisetum purpureum
189. Uruhehe	Botryocline longipes
190. Uruheza	Phyllanthus niruri
191. Urukwamo	Pennisetum sp
192. Urusayura	Thunbergia alata

APPENDIX VII-2

NUMBER OF OCCURENCES AND AVERAGE NUMBER OF TREES PER SPECIES BY SECTEUR

NOTE: The following table extends over 18 pages.

	Comparison farmers				Tree experts			
	KIBINGO n=36	MARABA n=17	SIMBI n=18	TOTAL n=71	KIBINGO n=22	MARABA n=11	SIMBI n=11	TOTAL n=44
Euphorbia tirucalli								
n species/cases	28	29	27	84	29	29	21	79
Mean	15	55	52	41	20	46	36	34
Standard Deviation	20	66	81	63	26	57	68	52
Maximum	98	250	300	300	113	200	260	260
Grevillea robusta								
n species/cases	46	18	12	76	44	24	15	83
Mean	16	15	10	15	36	29	13	30
Standard Deviation	15	24	12	17	44	31	12	37
Maximum	63	96	36	96	215	117	49	215
Vernonia amygdalina								
n species/cases	41	16	19	76	41	18	21	80
Mean	7	4	8	7	12	10	7	10
Standard Deviation	5	4	8	6	14	9	7	12
Maximum	18	15	23	23	64	33	31	64
Eucalyptus spp.								
n species/cases	47	11	9	67	41	19	13	73
Mean	118	60	151	113	342	122	73	237
Standard Deviation	237	85	322	231	423	204	78	354
Maximum	999	250	999	999	999	874	240	999
Persea gratissima								
n species/cases	32	13	14	59	32	20	13	65
Mean	3	2	2	3	6	5	4	5
Standard Deviation	2	2	2	2	6	4	3	5
Maximum	8	6	9	9	21	16	10	21
Ficus thonningii								
n species/cases	26	14	16	56	26	15	17	58
Mean	4	6	6	5	3	6	8	5
Standard Deviation	3	5	6	4	3	6	9	6
Maximum	13	14	20	20	12	23	30	30
Cupressus lusitanica								
n species/cases	27	9	6	42	44	10	5	59
Mean	10	15	8	11	39	18	8	33
Standard Deviation	14	12	8	13	64	33	9	58
Maximum	58	33	20	58	315	103	23	315

Coffea arabica								
n species/cases	23	13	13	49	6	13	13	32
Mean	105	106	106	106	160	127	62	107
Standard Deviation	84	126	84	95	125	196	80	147
Maximum	370	460	274	460	371	750	230	750
Psidium guajava								
n species/cases	7	6	9	22	19	16	9	44
Mean	2	2	2	2	5	3	2	4
Standard Deviation	1	1	1	1	5	3	2	4
Maximum	3	3	5	5	22	9	7	22
Acanthus pubescens								
n species/cases	11	3	3	17	28	9	6	43
Mean	21	17	2	17	75	23	7	55
Standard Deviation	23	4	2	19	74	16	8	66
Maximum	61	20	4	61	250	50	20	250
Pavetta ternifolia								
n species/cases	6	1	3	10	28	9	7	44
Mean	40	15	26	33	60	21	15	45
Standard Deviation	36	.	23	31	51	15	13	46
Maximum	111	15	50	111	180	46	31	180
Erythrina abyssinica								
n species/cases	3	4	5	12	21	14	3	38
Mean	6	2	1	3	5	4	1	4
Standard Deviation	6	2	0	3	4	6	1	5
Maximum	12	5	2	12	15	23	2	23
Synadenium grantii								
n species/cases	6	3	3	12	24	4	4	32
Mean	2	1	9	3	6	2	2	5
Standard Deviation	1		7	5	6	1	1	5
Maximum	3	1	17	17	26	2	3	26
Capsicum frutescens								
n species/cases	4	8	10	22	8	5	6	19
Mean	2	4	7	5	3	3	5	3
Standard Deviation		4	13	9	2	2	5	3
Maximum	2	13	43	43	7	5	15	15
Draceana afromontana								
n species/cases	5	3	1	9	19	7	5	31
Mean	24	22	10	22	13	7	22	13
Standard Deviation	35	13	.	26	18	4	20	16
Maximum	83	31	10	83	58	15	51	58
Iboza riparia								
n species/cases	4	6	5	15	9	7	8	24
Mean	2	4	7	4	4	16	3	7
Standard Deviation	2	3	5	4	7	19	5	12
Maximum	4	8	13	13	22	50	16	50

Markhamia lutea								
n species/cases	4	3		7	13	5	6	24
Mean	2	4	.	3	4	4	2	4
Standard Deviation	1	3	.	2	6	2	1	5
Maximum	3	7	.	7	24	7	4	24
Pinus spp.								
n species/cases	6	2	1	9	15	2	4	21
Mean	3	2	1	2	10	5	16	10
Standard Deviation	2		.	1	14	4	28	17
Maximum	5	2	1	5	54	8	58	58
Rubus spp.								
n species/cases	5	2		7	15	4	2	21
Mean	6	13	.	8	17	13	5	15
Standard Deviation	4	11	.	6	19	14	6	17
Maximum	11	20	.	20	62	30	9	62
Pennisetum purpureum								
n species/cases	5	1	4	10	7	7	5	19
Mean	12	67	37	27	14	25	44	26
Standard Deviation	9	.	47	33	14	27	22	24
Maximum	25	67	100	100	34	78	71	78
Carica papaya								
n species/cases		3	5	8	5	4	11	20
Mean	.	12	2	6	1	3	7	5
Standard Deviation	.	17	1	10	0	5	9	7
Maximum	.	31	4	31	2	10	32	32
Cyphomandra betacea								
n species/cases	1	1	1	3	15	2	7	24
Mean	1	1	4	2	2	1	5	3
Standard Deviation	.	.	.	2	1		6	4
Maximum	1	1	4	4	6	1	18	18
Clerondendrum fuscum/johnstonii								
n species/cases	4			4	22			22
Mean	9	.	.	9	13	.	.	13
Standard Deviation	8	.	.	8	16	.	.	16
Maximum	17	.	.	17	75	.	.	75
Erytrococca bongensis								
n species/cases	1	3		4	10	10	1	21
Mean	1	2	.	2	13	8	2	10
Standard Deviation	.	2	.	1	17	12	.	14
Maximum	1	4	.	4	52	41	2	52
Cedrela serrata								
n species/cases	4	2	1	7	10	3	4	17
Mean	3	3	1	3	4	2	2	3
Standard Deviation	2	3	.	2	4	1	1	3
Maximum	5	5	1	5	12	3	4	12

Cajanus indicus								
n species/cases	5	3	3	11	9	1	3	13
Mean	5	2	3	3	42	2	5	31
Standard Deviation	3	1	1	2	88	.	4	74
Maximum	9	3	4	9	269	2	10	269
Vernonia spp.								
n species/cases		2		2	16	3	2	21
Mean	.	1	.	1	6	2	2	5
Standard Deviation	.		.		10	1	1	9
Maximum	.	1	.	1	42	3	2	42
Clerondendrum rotundifolium								
n species/cases	1	3	2	6	8	5	3	16
Mean	1	2	16	6	4	4	1	4
Standard Deviation	.	1	21	12	4	5	1	4
Maximum	1	3	30	30	12	12	2	12
Acacia mearnsii								
n species/cases	5		1	6	8	3	4	15
Mean	12	.	39	16	36	5	12	23
Standard Deviation	11	.	.	15	51	4	5	39
Maximum	24	.	39	39	129	10	18	129
Morus alba								
n species/cases	7		1	8	9	2	1	12
Mean	6	.	12	7	14	2	4	11
Standard Deviation	8	.	.	8	17	1	.	16
Maximum	24	.	12	24	45	2	4	45
Clerondendrum fuscum								
n species/cases	1	2	1	4	8	4	4	16
Mean	1	2	2	2	3	14	16	9
Standard Deviation	.	1	.	1	4	13	14	11
Maximum	1	2	2	2	12	32	29	32
Solanum aeculestrum								
n species/cases	1	5	1	7	8	4	1	13
Mean	1	2	2	2	16	2	1	10
Standard Deviation	.	1	.	1	17	1	.	15
Maximum	1	3	2	3	52	4	1	52
Maytenus/Dovyalis/Canth.								
n species/cases		1	2	3	8	5	3	16
Mean	.	2	4	3	3	3	1	3
Standard Deviation	.	.	1	1	3	2	1	2
Maximum	.	2	4	4	7	6	2	7
Citrus limon								
n species/cases			3	3	9	3	3	15
Mean	.	.	2	2	3	2	2	3
Standard Deviation	.	.	1	1	2	1	1	2
Maximum	.	.	2	2	6	3	3	6

Ricinus communis								
n species/cases		4	1	5	6	5	2	13
Mean	.	2	2	2	4	5	10	5
Standard Deviation	.	1	.	1	4	2	2	3
Maximum	.	4	2	4	10	8	11	11
Citrus aurantium vulgare								
n species/cases	3	1	2	6	4	2	3	9
Mean	1	1	1	1	2	4	3	3
Standard Deviation		.			1		1	1
Maximum	1	1	1	1	4	4	4	4
Leucena spp.								
n species/cases	3			3	8	2	2	12
Mean	36	.	.	36	31	4	2	21
Standard Deviation	4	.	.	4	42	4	1	36
Maximum	39	.	.	39	127	6	2	127
Ficus vallis-choudae								
n species/cases	6			6	6	2	1	9
Mean	2	.	.	2	2	1	1	2
Standard Deviation	2	.	.	2	1		.	1
Maximum	5	.	.	5	4	1	1	4
Tephrosia vogelii								
n species/cases	3			3	9	2	1	12
Mean	16	.	.	16	101	4	2	77
Standard Deviation	11	.	.	11	82	1	.	83
Maximum	23	.	.	23	215	4	2	215
Ocimum suave								
n species/cases	1	1	1	3	8	2	2	12
Mean	1	1	7	3	22	6	7	17
Standard Deviation	.	.	.	3	21	5	2	19
Maximum	1	1	7	7	47	9	8	47
Solanum anguivii								
n species/cases		4	4	8	1	3	2	6
Mean	.	1	2	2	1	2	2	2
Standard Deviation	.		2	1	.	1	1	1
Maximum	.	1	5	5	1	3	3	3
Annona cherimola								
n species/cases		2	2	4	2	4	3	9
Mean	.	1	1	1	1	2	1	1
Standard Deviation	.					1		0
Maximum	.	1	1	1	1	2	1	2
Cassia didymobotrya								
n species/cases	1	1		2	5	3	2	10
Mean	2	1	.	2	3	1	1	2
Standard Deviation	.	.	.	1	3			2
Maximum	2	1	.	2	7	1	1	7

Coleus kilimandschari								
n species/cases		2	1	3	6	1	1	8
Mean	.	2	1	1	4	8	3	4
Standard Deviation	.	1	.	1	7	.	.	6
Maximum	.	2	1	2	17	8	3	17
Polyscias fulva								
n species/cases	3			3	7		1	8
Mean	2	.	.	2	3	.	1	2
Standard Deviation	1	.	.	1	2	.	.	2
Maximum	3	.	.	3	7	.	1	7
Senecio stuhlmannii								
n species/cases	1			1	5	2	2	9
Mean	1	.	.	1	1	13	6	5
Standard Deviation	.	.	.	.	1	15	4	7
Maximum	1	.	.	1	3	23	8	23
Kalanchoe beniensis								
n species/cases	1			1	4	1	4	9
Mean	4	.	.	4	5	12	28	16
Standard Deviation	.	.	.	.	3	.	48	32
Maximum	4	.	.	4	9	12	100	100
Mikaniopsis tedlei								
n species/cases					9		1	10
Mean	.	.	.	.	4	.	1	4
Standard Deviation	.	.	.	.	9	.	.	8
Maximum	.	.	.	.	28	.	1	28
Senecio mannii								
n species/cases			1	1	7		2	9
Mean	.	.	2	2	28	.	6	23
Standard Deviation	.	.	.	.	48	.	4	43
Maximum	.	.	2	2	133	.	9	133
Plumeria alba								
n species/cases		1		1		6	2	8
Mean	.	2	.	2	.	2	2	2
Standard Deviation	.	.	.	.	.	1		1
Maximum	.	2	.	2	.	2	2	2
Manihot glaziovii								
n species/cases		1	2	3	3	2	1	6
Mean	.	2	2	2	2	38	1	14
Standard Deviation	.	.	1	1	2	45	.	28
Maximum	.	2	2	2	4	70	1	70
N. tabacum (t.sauvage)								
n species/cases	1	2		3	2	2	1	5
Mean	5	7	.	6	23	6	1	12
Standard Deviation	.	8	.	6	30	6	.	19
Maximum	5	13	.	13	44	10	1	44

Lantana camara								
n species/cases					8		1	9
Mean	.	.	.	.	3	.	1	3
Standard Deviation	.	.	.	.	3	.	.	3
Maximum	.	.	.	.	9	.	1	9
Hypoestes verticillaris								
n species/cases					3	2	3	8
Mean	.	.	.	.	11	5	2	6
Standard Deviation	.	.	.	.	9	4	2	7
Maximum	.	.	.	.	20	7	4	20
Clerondendrum myricoïdes								
n species/cases	1	2		3	2	2	1	5
Mean	1	1	.	1	2	2	1	2
Standard Deviation	.	.	.		1	1	.	1
Maximum	1	1	.	1	3	3	1	3
Sesbania sesban/macrantha								
n species/cases					4	2	1	7
Mean	.	.	.	.	29	2	1	17
Standard Deviation	.	.	.	.	24	1	.	22
Maximum	.	.	.	.	51	2	1	51
Mangifera indica								
n species/cases						4	3	7
Mean	.	.	.	.	.	1	2	2
Standard Deviation	.	.	.	.	.	1	1	1
Maximum	.	.	.	.	.	2	3	3
Nicotianum tabacum								
n species/cases					4	1	2	7
Mean	.	.	.	.	5	4	13	7
Standard Deviation	.	.	.	.	5	.	11	7
Maximum	.	.	.	.	13	4	20	20
Chenopodium ugandae								
n species/cases					5	1	1	7
Mean	.	.	.	.	5	1	1	4
Standard Deviation	.	.	.	.	6	.	.	5
Maximum	.	.	.	.	15	1	1	15
Cassia floribunda								
n species/cases					2	4	1	7
Mean	.	.	.	.	2	32	1	19
Standard Deviation	.	.	.	.	1	42	.	33
Maximum	.	.	.	.	3	89	1	89
Trema orientalis								
n species/cases	1			1	4	1		5
Mean	3	.	.	3	2	1	.	1
Standard Deviation	.	.	.	.	1	.	.	1
Maximum	3	.	.	3	2	1	.	2

Indigofera erecta								
n species/cases	1			1	4		1	5
Mean	7	.	.	7	3	.	2	3
Standard Deviation	.	.	.	.	2	.	.	2
Maximum	7	.	.	7	6	.	2	6
Callitris columellaris?								
n species/cases		1		1		3	2	5
Mean	.	35	.	35	.	3	8	5
Standard Deviation	.	.	.	.	.	2	7	5
Maximum	.	35	.	35	.	4	13	13
Calliandra callothyrsus								
n species/cases	1			1	4			4
Mean	2	.	.	2	3	.	.	3
Standard Deviation	.	.	.	.	1	.	.	1
Maximum	2	.	.	2	4	.	.	4
Jacaranda mimosaefolia								
n species/cases					1	2	2	5
Mean	.	.	.	.	8	2	5	4
Standard Deviation	.	.	.	.	.	1	6	4
Maximum	.	.	.	.	8	2	9	9
Ficus sp.								
n species/cases		1		1	1	2	1	4
Mean	.	1	.	1	4	3	3	3
Standard Deviation	.	.	.	.	.	1	.	1
Maximum	.	1	.	1	4	4	3	4
Entada abyssinica								
n species/cases					2	1	2	5
Mean	.	.	.	.	22	1	3	10
Standard Deviation	.	.	.	.	25	.	3	16
Maximum	.	.	.	.	39	1	5	39
Albizzia spp.								
n species/cases	1			1	4			4
Mean	6	.	.	6	7	.	.	7
Standard Deviation	.	.	.	.	5	.	.	5
Maximum	6	.	.	6	12	.	.	12
Clutia abyssinica								
n species/cases		1		1	2		2	4
Mean	.	2	.	2	3	.	2	2
Standard Deviation	.	.	.	.	2	.	1	1
Maximum	.	2	.	2	4	.	2	4
Crotolaria incana								
n species/cases	1			1	4			4
Mean	1	.	.	1	34	.	.	34
Standard Deviation	.	.	.	.	39	.	.	39
Maximum	1	.	.	1	75	.	.	75

Milletia dura								
n species/cases					5			5
Mean	.	.	.	.	9	.	.	9
Standard Deviation	.	.	.	.	9	.	.	9
Maximum	.	.	.	.	23	.	.	23
Cassia occidentalis								
n species/cases		1		1		3	1	4
Mean	.	1	.	1	.	3	2	3
Standard Deviation	.	.	.	.	.	2	.	2
Maximum	.	1	.	1	.	5	2	5
Maesa lanceolata								
n species/cases					5			5
Mean	.	.	.	.	7	.	.	7
Standard Deviation	.	.	.	.	7	.	.	7
Maximum	.	.	.	.	17	.	.	17
Eryobotrya japonica								
n species/cases		1		1	1		2	3
Mean	.	1	.	1	1	.	1	1
Standard Deviation	.	.	.	.	.	.		
Maximum	.	1	.	1	1	.	1	1
Draceana steudeneri								
n species/cases						1	3	4
Mean	.	.	.	.	.	4	1	2
Standard Deviation	.	.	.	.	.	.		2
Maximum	.	.	.	.	.	4	1	4
Triumfetta spp.								
n species/cases					3		1	4
Mean	.	.	.	.	8	.	10	9
Standard Deviation	.	.	.	.	13	.	.	10
Maximum	.	.	.	.	23	.	10	23
Physalis peruviana								
n species/cases			2	2	1		1	2
Mean	.	.	26	26	2	.	100	51
Standard Deviation	.	.	35	35	.	.	.	69
Maximum	.	.	50	50	2	.	100	100
Clerondendrum buchholzii								
n species/cases					1	2		3
Mean	.	.	.	.	1	5	.	3
Standard Deviation	.	.	.	.	.	5	.	4
Maximum	.	.	.	.	1	8	.	8
Acacia sieberiana								
n species/cases					4			4
Mean	.	.	.	.	4	.	.	4
Standard Deviation	.	.	.	.	3	.	.	3
Maximum	.	.	.	.	7	.	.	7

Bersama abyssinica								
n species/cases			1	1	1	2		3
Mean	.	.	1	1	2	2	.	2
Standard Deviation	.	.	.	.	.	1	.	1
Maximum	.	.	1	1	2	2	.	2
Solanum melongena								
n species/cases					4			4
Mean	.	.	.	.	4	.	.	4
Standard Deviation	.	.	.	.	3	.	.	3
Maximum	.	.	.	.	7	.	.	7
Casuarina cunninghamia								
n species/cases						4		4
Mean	.	.	.	.	.	3	.	3
Standard Deviation	.	.	.	.	.	1	.	1
Maximum	.	.	.	.	.	4	.	4
Aloe dawei								
n species/cases			1	1			2	2
Mean	.	.	1	1	.	.	3	3
Standard Deviation	.	.	.	.	.	.	3	3
Maximum	.	.	1	1	.	.	5	5
Senecio ladiensis								
n species/cases					3			3
Mean	.	.	.	.	5	.	.	5
Standard Deviation	.	.	.	.	6	.	.	6
Maximum	.	.	.	.	12	.	.	12
Sanseveria spp.								
n species/cases					1		2	3
Mean	.	.	.	.	15	.	1	6
Standard Deviation	.	.	.	.	.	.		8
Maximum	.	.	.	.	15	.	1	15
Cissus quadrangularis								
n species/cases					2		1	3
Mean	.	.	.	.	2	.	19	7
Standard Deviation	.	.	.	.	1	.	.	10
Maximum	.	.	.	.	2	.	19	19
Rhus vulgaris								
n species/cases					2		1	3
Mean	.	.	.	.	2	.	5	3
Standard Deviation	.	.	.	.	1	.	.	2
Maximum	.	.	.	.	3	.	5	5
Chenopodium ambrosioïdes								
n species/cases					1		2	3
Mean	.	.	.	.	1	.	2	1
Standard Deviation	.	.	.	.	.	.	1	1
Maximum	.	.	.	.	1	.	2	2

Urukwamo (Plante ni)								
n species/cases					1	2		3
Mean	.	.	.	.	1	33	.	22
Standard Deviation	.	.	.	.	.	35	.	31
Maximum	.	.	.	.	1	58	.	58
Solanum capsicoides								
n species/cases					2	1		3
Mean	.	.	.	.	1	1	.	1
Standard Deviation	.	.	.	.	.	.	.	
Maximum	.	.	.	.	1	1	.	1
Euphorbia grantii								
n species/cases					2			2
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	
Maximum	.	.	.	.	1	.	.	1
Solanum aculeastrum								
n species/cases					2			2
Mean	.	.	.	.	3	.	.	3
Standard Deviation	.	.	.	.	2	.	.	2
Maximum	.	.	.	.	4	.	.	4
Ceasalpina decapetala								
n species/cases						1		1
Mean	.	.	.	.	.	5	.	5
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	5	.	5
Rhyndosia hirta								
n species/cases					1		1	2
Mean	.	.	.	.	2	.	3	3
Standard Deviation	.	.	.	.	.	.	.	1
Maximum	.	.	.	.	2	.	3	3
Maesopsis emenii								
n species/cases					2			2
Mean	.	.	.	.	2	.	.	2
Standard Deviation	.	.	.	.	1	.	.	1
Maximum	.	.	.	.	3	.	.	3
Verbena officinalis								
n species/cases							2	2
Mean	.	.	.	.	.	.	17	17
Standard Deviation	.	.	.	.	.	.	23	23
Maximum	.	.	.	.	.	.	33	33
Syzygium parviflorum								
n species/cases					2			2
Mean	.	.	.	.	33	.	.	33
Standard Deviation	.	.	.	.	28	.	.	28
Maximum	.	.	.	.	53	.	.	53

Clausena anisata								
n species/cases	1			1	1			1
Mean	1	.	.	1	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	1	.	.	1	1	.	.	1
Triumfetta cordifolia								
n species/cases					2			2
Mean	.	.	.	.	31	.	.	31
Standard Deviation	.	.	.	.	14	.	.	14
Maximum	.	.	.	.	41	.	.	41
Dasylepis racemosa								
n species/cases					1	1		2
Mean	.	.	.	.	2	1	.	2
Standard Deviation	.	.	.	.	.	.	.	1
Maximum	.	.	.	.	2	1	.	2
Solanum incanum								
n species/cases					1		1	2
Mean	.	.	.	.	1	.	4	3
Standard Deviation	.	.	.	.	.	.	.	2
Maximum	.	.	.	.	1	.	4	4
Hybiscus fuscus								
n species/cases					1		1	2
Mean	.	.	.	.	3	.	1	2
Standard Deviation	.	.	.	.	.	.	.	1
Maximum	.	.	.	.	3	.	1	3
Hybiscus cannabinus								
n species/cases					1		1	2
Mean	.	.	.	.	77	.	10	44
Standard Deviation	.	.	.	.	.	.	.	47
Maximum	.	.	.	.	77	.	10	77
Dalbergia lactea								
n species/cases					2			2
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Hybiscus diversifolius								
n species/cases					2			2
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Tithonia diversifolia								
n species/cases		1		1		1		1
Mean	.	10	.	10	.	29	.	29
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	10	.	10	.	29	.	29

Cinchona sp.								
n species/cases					1	1		2
Mean	.	.	.	.	123	1	.	62
Standard Deviation	.	.	.	.	.	.	.	86
Maximum	.	.	.	.	123	1	.	123
Citrus nobilis deliciosa								
n species/cases					1		1	2
Mean	.	.	.	.	1	.	1	1
Standard Deviation	.	.	.	.	.	.	.	
Maximum	.	.	.	.	1	.	1	1
Sapium ellipticum								
n species/cases					2			2
Mean	.	.	.	.	33	.	.	33
Standard Deviation	.	.	.	.	35	.	.	35
Maximum	.	.	.	.	58	.	.	58
Virectaria major								
n species/cases					2			2
Mean	.	.	.	.	6	.	.	6
Standard Deviation	.	.	.	.	2	.	.	2
Maximum	.	.	.	.	7	.	.	7
Euphorbia cotonifolia								
n species/cases			1	1				
Mean	.	.	2	2	.	.	.	.
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	2	2	.	.	.	.
Prunus salicifolia								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Cassia spectabilis								
n species/cases							1	1
Mean	.	.	.	.	.	.	1	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	1	1
Camellia thea								
n species/cases					1			1
Mean	.	.	.	.	3	.	.	3
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	3	.	.	3
Artocarpus integrifolia								
n species/cases							1	1
Mean	.	.	.	.	.	.	3	3
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	3	3

Carica cundinamarcensis								
n species/cases					1			1
Mean	.	.	.	.	4	.	.	4
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	4	.	.	4
Annona reticulata								
n species/cases							1	1
Mean	.	.	.	.	.	.	2	2
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	2	2
Dovyalis caffra								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Pavonia urens								
n species/cases					1			1
Mean	.	.	.	.	2	.	.	2
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	2	.	.	2
Idaforoma								
n species/cases							1	1
Mean	.	.	.	.	.	.	4	4
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	4	4
Blumea alata								
n species/cases							1	1
Mean	.	.	.	.	.	.	6	6
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	6	6
Psychotria mahoni								
n species/cases					1			1
Mean	.	.	.	.	9	.	.	9
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	9	.	.	9
Kalanchoë spp.								
n species/cases							1	1
Mean	.	.	.	.	.	.	3	3
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	3	3
Basella alba								
n species/cases					1			1
Mean	.	.	.	.	12	.	.	12
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	12	.	.	12

Chenopodium ambrosioïdes								
n species/cases							1	1
Mean	.	.	.	.	.	.	1	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	1	1
Rubilika								
n species/cases							1	1
Mean	.	.	.	.	.	.	1	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	1	1
Tribulus terrestris								
n species/cases							1	1
Mean	.	.	.	.	.	.	2	2
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	2	2
Balthasaria schliebenii								
n species/cases		1		1				
Mean	.	12	.	12	.	.	.	.
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	12	.	12	.	.	.	.
Cussonia holstii								
n species/cases							1	1
Mean	.	.	.	.	.	.	5	5
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	5	5
Toddalia asiatica								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Arundinaria alpina								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Gloriosa simplex								
n species/cases							1	1
Mean	.	.	.	.	.	.	1	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	1	1
Umulyawabasaza (arbuste ni)								
n species/cases							1	1
Mean	.	.	.	.	.	.	1	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	1	1

Cassia floribunda								
n species/cases					1			1
Mean	.	.	.	.	47	.	.	47
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	47	.	.	47
Ficus asperifolia								
n species/cases							1	1
Mean	.	.	.	.	.	.	1	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	1	1
Mitragyne rubrostipulata								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Botryocline longipes								
n species/cases					1			1
Mean	.	.	.	.	94	.	.	94
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	94	.	.	94
Phyllanthus niruri								
n species/cases							1	1
Mean	.	.	.	.	.	.	5	5
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	5	5
Coryza sumatrensis								
n species/cases							1	1
Mean	.	.	.	.	.	.	1	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	1	1
raisin								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Umukamambogo (Plante ni)								
n species/cases					1			1
Mean	.	.	.	.	3	.	.	3
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	3	.	.	3
Ocimum americanum								
n species/cases						1		1
Mean	.	.	.	.	.	1	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	1	.	1

Guizotia scabra								
n species/cases						1		1
Mean	.	.	.	.	.	10	.	10
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	10	.	10
Nyirakayenzi								
n species/cases						1		1
Mean	.	.	.	.	.	1	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	1	.	1
Uruhikakiza (Plante ni)								
n species/cases						1		1
Mean	.	.	.	.	.	1	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	1	.	1
Urtica dioica								
n species/cases							1	1
Mean	.	.	.	.	.	.	1	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	.	.	1	1
Capparis sp.								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Artemisia afra								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Schefflera goetzenii								
n species/cases					1			1
Mean	.	.	.	.	4	.	.	4
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	4	.	.	4
Hybiscus div spp								
n species/cases					1			1
Mean	.	.	.	.	19	.	.	19
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	19	.	.	19
Embelia sp.								
n species/cases					1			1
Mean	.	.	.	.	41	.	.	41
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	41	.	.	41

Bersama ugandensis								
n species/cases					1			1
Mean	.	.	.	.	71	.	.	71
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	71	.	.	71
Crotolaria recta								
n species/cases					1			1
Mean	.	.	.	.	1	.	.	1
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	.	.	1	.	.	1
Waltheria indica								
n species/cases			1	1				
Mean	.	.	1	1	.	.	.	.
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	1	1	.	.	.	.
Sonchus div spp								
n species/cases			1	1				
Mean	.	.	1	1	.	.	.	.
Standard Deviation	.	.	.	.	.	.	.	.
Maximum	.	.	1	1	.	.	.	.
TOTAL PER SECTEUR								
n species/cases	396	218	202	816	844	373	325	1542
Mean/species	28	22	26	26	35	22	14	27
Standard Deviation	93	52	84	82	122	69	35	98

APPENDIX VII-3a
TREE MAINTENANCE ACCORDING TO SPECIES OWNERSHIP, COMPARISON FARMERS
(n=number of species-cases)

TREE TENURE STATUS	Who maintains the species?							TOTAL
	MALE HEAD OF HOUSEHOLD	FEMALE HEAD OF HOUSEHOLD	WIFE	HUSBAND AND WIFE	CHILDREN	OTHER	WHOLE FAMILY	n=821
MALE HEAD OF HOUSEHOLD	433		8	13	37	13	21	525
Column Percent	98.9%		66.7%	92.9%	39.8%	37.1%	72.4%	82.5%
% of planted spp owned	77.0%		1.4%	2.3%	6.6%	2.3%	3.7%	93.4%
FEMALE HEAD OF HOUSEHOLD		15	2		43	22	8	90
Column Percent		100.0%	16.7%		46.2%	62.9%	27.6%	14.2%
% of planted spp owned		13.5%	1.8%		38.7%	19.8%	7.2%	81.1%
WIFE	1		2	1	12			16
Column Percent	.2%		16.7%	7.1%	12.9%			2.5%
% of planted spp owned	5.6%		11.1%	5.6%	66.7%			88.9%
CHILDREN					1			1
Column Percent					1.1%			.2%
% of planted spp owned					100.0%			100.0%
OWNER OF THE FIELD	1							1
Column Percent	.2%							.2%
% of planted spp owned	50.0%							50.0%
OTHER	3							3
Column Percent	.7%							.5%
% of planted spp owned	60.0%							60.0%
TOTAL	438	15	12	14	93	35	29	636
Column Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Row Percent	68.9%	2.4%	1.9%	2.2%	14.6%	5.5%	4.6%	100.0%
% of all planted trees	62.7%	2.1%	1.7%	2.0%	13.3%	5.0%	4.1%	91.0%
NOT MAINTAINED								185
% of all tree species								20.9%

NOTE: "% of planted species owned" is a percent of total column of Table 18a.

APPENDIX VII-3b
TREE MAINTENANCE ACCORDING TO SPECIES OWNERSHIP, TREE EXPERTS (n=number of species-cases)

TREE TENURE STATUS	Who maintains the species?							TOTAL
	MALE HEAD OF HOUSEHOLD	FEMALE HEAD OF HOUSEHOLD	WIFE	HUSBAND AND WIFE	CHILDREN	OTHER	WHOLE FAMILY	n=1551
MALE HEAD OF HOUSEHOLD	538	2	4	20	69	43	48	724
Column Percent	96.8%	22.2%	33.3%	83.3%	61.6%	68.3%	77.4%	86.4%
% of planted spp owned	55.2%	0.2%	0.4%	2.1%	7.1%	4.4%	4.9%	74.3%
FEMALE HEAD OF HOUSEHOLD		6			42	14	11	73
Column Percent		66.7%			37.5%	22.2%	17.7%	8.7%
% of planted spp owned		5.9%			41.2%	13.7%	10.8%	71.6%
WIFE	3	1	7	2	1	5	1	20
Column Percent	.5%	11.1%	58.3%	8.3%	.9%	7.9%	1.6%	2.4%
% of planted spp owned	6.8%	2.3%	15.9%	4.5%	2.3%	13.4%	2.3%	45.5%
ALL HOUSEHOLD MEMBERS TOGETHER	13			1				14
Column Percent	2.3%			4.2%				1.7%
% of planted spp owned	33.3%			2.6%				35.9%
CHILDREN	1			1			2	4
Column Percent	.2%			4.2%			3.2%	.5%
% of planted spp owned	10.0%			10.0%			20.0%	40.0%
OTHER, NON-HOUSEHOLD MEMBER			1			1		2
Column Percent			8.3%			1.6%		.2%
OWNER OF THE FIELD	1							1
Column Percent	.2%							.1%
% of planted spp owned	100.0%							100.0%
TOTAL	556	9	12	24	112	63	62	838
Column Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Row Percent	66.3%	1.1%	1.4%	2.9%	13.4%	7.5%	7.4%	100.0%
% of all planted trees	47.5%	0.8%	1.0%	2.1%	9.6%	5.4%	5.3%	71.6%
NOT MAINTAINED								713
% of all tree species								53.7%

NOTE: "% of planted species owned" is a percent of total column of Table 18b.

APPENDIX VII-4a
HARVESTING OF TREES ACCORDING TO SPECIES OWNERSHIP, COMPARISON FARMERS
(n=number of species-cases)

TREE TENURE STATUS	Who maintains the species?							TOTAL
	MALE HEAD OF HOUSEHOLD	FEMALE HEAD OF HOUSEHOLD	WIFE	HUSBAND AND WIFE	CHILDREN	OTHER	WHOLE FAMILY	n=821
MALE HEAD OF HOUSEHOLD	433		8	13	37	13	21	525
Column Percent	98.9%		66.7%	92.9%	39.8%	37.1%	72.4%	82.5%
% of planted spp owned	77.0%		1.4%	2.3%	6.6%	2.3%	3.7%	93.4%
FEMALE HEAD OF HOUSEHOLD		15	2		43	22	8	90
Column Percent		100.0%	16.7%		46.2%	62.9%	27.6%	14.2%
% of planted spp owned		13.5%	1.8%		38.7%	19.8%	7.2%	81.1%
WIFE	1		2	1	12			16
Column Percent	.2%		16.7%	7.1%	12.9%			2.5%
% of planted spp owned	5.6%		11.1%	5.6%	66.7%			88.9%
CHILDREN					1			1
Column Percent					1.1%			.2%
% of planted spp owned					100.0%			100.0%
OWNER OF THE FIELD	1							1
Column Percent	.2%							.2%
% of planted spp owned	50.0%							50.0%
OTHER	3							3
Column Percent	.7%							.5%
% of planted spp owned	60.0%							60.0%
TOTAL	438	15	12	14	93	35	29	636
Column Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Row Percent	68.9%	2.4%	1.9%	2.2%	14.6%	5.5%	4.6%	100.0%
% of all planted trees	62.7%	2.1%	1.7%	2.0%	13.3%	5.0%	4.1%	91.0%
NOT MAINTAINED								185
% of all tree species								20.9%

NOTE: "% of planted species owned" is a percent of total column of Table 18a.

APPENDIX VII-4b
HARVESTING OF TREES ACCORDING TO SPECIES OWNERSHIP, TREE EXPERTS
(n=number of species-cases)

TREE TENURE STATUS	Who maintains the species?							TOTAL
	MALE HEAD OF HOUSEHOLD	FEMALE HEAD OF HOUSEHOLD	WIFE	HUSBAND AND WIFE	CHILDREN	OTHER	WHOLE FAMILY	n=1551
MALE HEAD OF HOUSEHOLD	538	2	4	20	69	43	48	724
Column Percent	96.8%	22.2%	33.3%	83.3%	61.6%	68.3%	77.4%	86.4%
% of planted spp owned	55.2%	0.2%	0.4%	2.1%	7.1%	4.4%	4.9%	74.3%
FEMALE HEAD OF HOUSEHOLD		6			42	14	11	73
Column Percent		66.7%			37.5%	22.2%	17.7%	8.7%
% of planted spp owned		5.9%			41.2%	13.7%	10.8%	71.6%
WIFE	3	1	7	2	1	5	1	20
Column Percent	.5%	11.1%	58.3%	8.3%	.9%	7.9%	1.6%	2.4%
% of planted spp owned	6.8%	2.3%	15.9%	4.5%	2.3%	13.4%	2.3%	45.5%
ALL HOUSEHOLD MEMBERS TOGETHER	13			1				14
Column Percent	2.3%			4.2%				1.7%
% of planted spp owned	33.3%			2.6%				35.9%
CHILDREN	1			1			2	4
Column Percent	.2%			4.2%			3.2%	.5%
% of planted spp owned	10.0%			10.0%			20.0%	40.0%
OTHER, NON-HOUSEHOLD MEMBER			1			1		2
Column Percent			8.3%			1.6%		.2%
OWNER OF THE FIELD	1							1
Column Percent	.2%							.1%
% of planted spp owned	100.0%							100.0%
TOTAL	556	9	12	24	112	63	62	838
Column Percent	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Row Percent	66.3%	1.1%	1.4%	2.9%	13.4%	7.5%	7.4%	100.0%
% of all planted trees	47.5%	0.8%	1.0%	2.1%	9.6%	5.4%	5.3%	71.6%
NOT MAINTAINED								713
% of all tree species								53.7%

NOTE: "% of planted species owned" is a percent of total column of Table 18b.

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