

USES, MANAGEMENT AND ECONOMIC POTENTIAL OF GARCINIA KOLA AND RICINODENDRON HEUDELOTII IN THE HUMID LOWLANDS OF CAMEROON

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AYUK, E. T., DUGUMA, B., FRANZEL, S., KENGUE, J., MOLLET, M., TIKI-MANGA, T. & ZENKENG, P. 1999. Uses, management and economic potential of *Garcinia kola* and *Ricinodendron heudelotii* in the humid lowlands of Cameroon. *Garcinia kola* and *Ricinodendron heudelotii* are among the most preferred species in the humid lowlands of Cameroon. *Garcinia kola* fruits and *Ricinodendron heudelotii* seeds are highly valued and traded. The species grow in the wild and not much work has been done in domesticating them. As part of a prioritisation exercise a field survey

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was undertaken to quantify, at the farm-level, uses, management and economic potential of the species. Results from this study show that there are several uses of different products of the species including those for medicinal purposes and for home consumption. Desired improvement objectives include reduced time to bearing, reduced tree height, higher yield, increased fruit size and spreading the fruiting period. Improvement research in those lines might increase the value of the species to land users.

Keywords: Humid lowlands of Cameroon - non-timber forest products - *Garcinia kola* - *Ricinodendron heudelotii* - improvement - farm level - economic potential - farmers' indigenous knowledge

AYUK, E. T., DUGUMA, B., FRANZEL, S., KENGUE, K., MOLLET, M., TIKI-MANGA, T. & ZENKENG, P. 1999. Penggunaan, pengurusan dan potensi ekonomi *Garcinia kola* dan *Ricinodendron heudelotii* di tanah pamah lembap di Cameroon. *Garcinia heudelotii* dan *Ricinodendron heudelotii* ialah antara spesies yang paling diutamakan di kawasan tanah pamah lembap di Cameroon. Buah-buahan *Garcinia kola* dan biji benih *Ricinodendron heudelotii* sangat tinggi nilainya dan didagangkan. Spesies ini tumbuh liar dan tidak banyak usaha dijalankan untuk mendomestikasinya. Sebagai sebahagian daripada keutamaan, satu kajian lapangan dijalankan untuk menjumlahkan, pada peringkat ladang, penggunaan, pengurusan dan potensi ekonomi spesies tersebut. Hasil kajian ini menunjukkan bahawa terdapat beberapa kegunaan produk yang berbeza bagi spesies ini termasuklah untuk tujuan perubatan dan kegunaan di rumah. Pembaikan objektif yang dikehendaki termasuklah mengurangkan masa untuk berbuah, mengurangkan ketinggian pokok, membanyakkan hasil, menambahkan saiz buah dan menyebarkan tempoh musim berbuah. Pembaikan penyelidikan dalam perkara-perkara tersebut mungkin akan dapat meningkatkan nilai spesies tersebut kepada mereka yang mengusahakan tanah di kawasan tersebut.

Introduction

The tropical moist forests which dominate the humid lowlands of Cameroon are known to be among the richest flora on earth. These forests, besides their role in maintaining and enhancing environmental quality, are also a reservoir of enormous quantity of animal and plant communities that are vital for human existence and constitute an integral part of the rural economies. Duguma *et al.* (1990) found that a great number of species are found in this ecozone. Local communities in the region depend heavily on this resource as a source of food, condiment, medicine and raw materials for various uses.

In the next few years forest products, especially non-timber forest products (NTFPs), will become of even greater economic importance for a number of reasons. First, demographic pressures on land resources have led to the need to explore non-conventional sources for the provision of badly needed food to meet the needs of the rising population. Secondly, owing to population pressure and rural to urban migration, the fallow periods in many areas have declined from over 10 years to less than 5 years (1 to 3 years in most places) rendering the system economically inefficient and environmentally/ecologically unsustainable. Thirdly, forest products provide opportunities for earning cash and consequently achieving the goal of income diversification as a strategy to

minimise risks associated with their conventional farming practices. The cash crop production sector is negatively affected by the low and fluctuating market prices. Many of the products from the tropical rain forest are being currently traded on regional and international markets and can play an essential role in earning badly needed foreign exchange.

The extent to which NTFPs can satisfy the needs of land users depends largely on how the trees can be integrated into the land use system. Multi-strata sequential and simultaneous agroforestry systems can be potential strategies for achieving this goal (Cooper *et al.* 1996). In fact, in the context of West Africa, these systems already exist (Okafor & Fernandes 1987). The existing multi-strata home garden system is, however, characterised by low species diversity and inferior genetic materials—based more on availability of planting material than on economic value and genetic superiority—that hardly contribute to the well-being of the farmers beyond the subsistence level. This system provides ample opportunities for improvement relying on: (1) a better understanding of farmers' indigenous knowledge of their ecosystem; (2) farmers' intended uses of trees (preferred products and services) and how they are integrated in their land use system; and (3) the introduction of appropriate superior plant material.

Most of the tree species that are of great importance to land users in the humid lowlands of Cameroon grow in the wild since they have not been domesticated. Recently, there has been a great awareness of the need to domesticate indigenous tree species. Domestication is a dynamic process which develops from selecting the species to be domesticated, through background socio-economic studies, to the actual germplasm collections and genetic improvement (Leakey & Jaenicke 1995). Domestication ensures that valuable species are easily accessible to and manageable by land users.

The choice of species that can be improved at any given time is limited by cost considerations. What species to improve should depend on the potential products of the particular species and their value to land users. Previous research has reported information on the type of products and species from which the various products are harvested (FAO 1981, World Resource Institute 1985, Okafor & Fernandes 1987, Falconer 1992). However, despite recent efforts, empirical data on the relative economic importance of NTFPs are not available at the farm level. Detailed quantification of the monetary value of commonly used NTFPs is essential in identifying key products and species that can improve the welfare of local communities. This kind of information can be useful in identifying candidate species for improvement research.

A previous study identified the following 10 species in descending order as the ones most preferred by farmers in the region: *Irvingia gabonensis*, *Baillonella toxisperma*, *Dacryodes edulis*, *Elaeis guineensis*, *Ricinodendron heudelotii*, *Alstonia boonei*, *Guibourtia demensei*, *Entandrophragma cylindricum*, *Garconia lucida* and *Chlorophora excelsa* (Mollet *et al.* 1995, Adeola *et al.* unpublished data). The objective of this paper is to assess, at the farm level, the uses, management and economic value of *Garcinia kola* and *Ricinodendron heudelotii* in the humid lowlands of Cameroon.

Description of species

Garcinia kola Heckel (*Guttiferae*)

The species is found in moist semi-deciduous forest of secondary growth. Its area of distribution extends from Sierra Leone to the Democratic Republic of Congo (former Zaire). In Cameroon, it can be found in some regions in Mamfe and in Bertoua and Moloundou. The large tree reaches 30 to 40 m in height and 100 cm in diameter. The crown is narrowly triangular with sinuous upright branches. The bole is straight, very high, cylindrical or conical, and sometimes enlarged at the base.

Multiplication by seed has been reported with a germination rate of 80%. Young plants must be shaded.

Garcinia nuts are consumed as an aphrodisiac. The nuts figure prominently in national and inter-regional trade and fetch very high prices in the markets. The tree is a good timber and dead branches are used for firewood.

Ricinodendron heudelotii (Baill) Pierre ex Pax (*Euphorbiaceae*)

Ricinodendron heudelotii is commonly found in the secondary forest extending from Guinea to Angola and in East Africa. It is a dioecious tree and is common and locally abundant in secondary forests in Cameroon. The tree can reach 40 m in height and 120 cm in diameter.

Germination is slow with a rate of less than 40%. However, growth is rapid for young plants in open spaces. Vegetative propagation techniques have been developed for the species (Shiembo 1994, Shiembo *et al.* 1997).

The main uses of this species include those of the seeds which are a sought-after ingredient for soups and a variety of dishes; the wood is used for making household implements, drums and carvings (Shiembo 1994), and the bark is used as medicine to treat elephantiasis (Abbiw 1990) and leprosy (Bokemo 1984). The oil obtained from the seeds is also used for soap and varnish making (Abbiw 1990). The species is of high cash value to land users in Cameroon. It has been reported that for the period January to July 1995, about 172 tons of the seeds were traded in the humid forest zone of Cameroon for a value of \$US 460 000. These data were based on information collected from farmers, transporters and traders in 31 markets located in 5 provinces (CIFOR 1996).

Methods

Study site

The humid lowlands are defined as areas below 1000 m altitude with an annual precipitation of above 1500 mm, a growing period of 270–365 days and covered by tropical moist forest vegetation. In Cameroon, the humid lowlands are divided

into two zones: the coastal lines with an altitude of 0 to 300 m and the continental plateau with an altitude ranging between 600 and 800 m above sea-level (Tonye *et al.* 1986). The area delimiting the humid lowlands in Cameroon together with the study sites is shown in Figure 1.

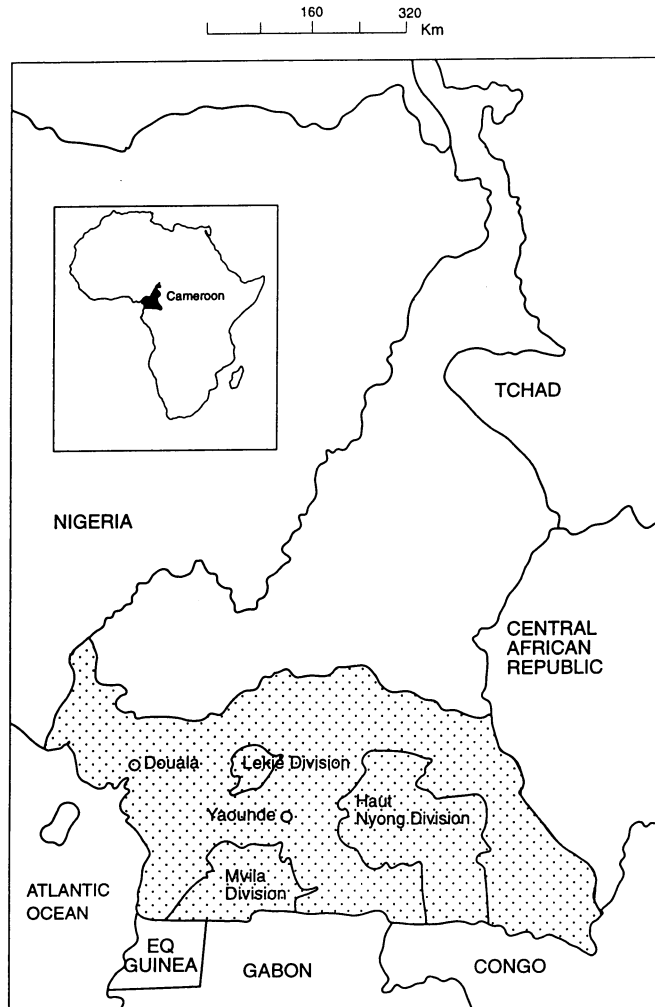


Figure 1. Study sites in the humid lowlands of Cameroon with elevation less than 1000 m above sea-level

Using secondary data on market accessibility, population density, ethnic groups and infrastructure, the priority land use system was divided into three strata corresponding to three divisions (administrative units) located in three different provinces (Table 1). The study was conducted in Mvila (South Province), Lekie (Centre Province) and Haut Nyong (East Province) administrative divisions of Cameroon.

Table 1. Variables used to stratify the study area

Division	Ethnic group	Market accessibility	Population density
Haut Nyong	Maka, Bama, Pygmies	Low	Low
Lekié	Eton	High, good infrastructure	High
Mvila	Bulu	Medium, export area but poor infrastructure	Medium

Mvila is located at latitude 2° 22'–2° 29'N and longitude 10°17'– 12°14'E. The division shares boundaries with Equatorial Guinea and the Republic of Gabon. The mean monthly temperature is 24 °C. Market accessibility is moderate in this division and there is modest infrastructure. The population density is medium (10 inhabitants km⁻²) and the dominant ethnic group is the Bulu.

The Lekié division is situated between latitude 3° 50'– 4°30'N and longitude 11° 0'– 12° 0'E. Mean monthly of the division is 25 °C. This is a highly populated area (25 inhabitants km⁻²) with good infrastructure and easily accessible to urban markets. The Etons are the major ethnic group in the division.

Haut Nyong division is located at latitude 2°0'–4°30'N and longitude 12°30'– 14° 40'E. The mean monthly temperature is 22.5 °C. The division is not easily accessible to urban markets. Population density is low (4 inhabitants km⁻²) and infrastructure is poor. The Makas constitute the major ethnic group.

In all three divisions, the rainfall pattern is bimodal, with two rainy seasons occurring during mid-March to mid-July and mid-August to mid-November. Mean annual rainfall ranges from 1650 mm in Haut Nyong to 1860 mm in Mvila. During the rest of the months, referred to as main (mid-November to mid-March) and minor (mid-July to mid-August) dry seasons, total monthly rainfall hardly exceeds 50 mm.

In Lekié, where the population pressure is high, most of the economically important trees have been removed. Farm activities are very intensive and, therefore, the dominant vegetation type is of degraded secondary forest or fallow lands with patches of grass fallow increasing from south to the north. Tree species such as *Musanga cecropioides* and *Albizia zypia* dominate the landscape. *Chromolaena odoratum* and *Panicum maximum* are the common fallow species and are associated with the practice of short fallow cycle.

In Mvila and Haut Nyong, both secondary and primary rain forests are still available. The vegetation is essentially evergreen rain forest with mosaic of raffia swamps near rivers and logging areas. Dominant tree species include *Albizia* spp, *Ficus exasperata*, *Milicia excelsa*, *Terminalia superba*, *Triprochiton scleroxylon* and *Ceiba pentandra*.

The dominant soil types in all three divisions are ultisols and oxisols. However, there is a marked micro variability between the three sites. The soils of Lekié are more fertile and moderately acidic (pH 1:1 H₂O = 5 to 6) compared to the very acidic (pH 1:1 H₂O = < 5), low cation exchange capacity and high aluminium

saturation (> 40%) associated with the soils of Mvila and Haut Nyong divisions. This probably explains the relatively high population density in Lekié division compared to the low population density in East and South Provinces of Cameroon in general.

The cropping system of all three divisions includes the fallow based food crop production system, the semi-permanent cash crop production system and the multistrata home garden system. The food crops include egusi melon (*Cucumeropsis mannii*), cassava (*Manihot esculenta*), maize (*Zea mays*), groundnuts (*Arachis hypogaea*), plantain (*Musa* spp.). The main cash crops are coffee (*coffea robusta*) and cocoa (*Theobroma cacao*). In home gardens, farmers plant several crops ranging from vegetable crops such as green pepper to large fruit trees such as mango (*Mangifera indica*), safou (*Dacryodes edulis*) and *Ricinodendron heudelotii*.

Field survey

A field survey was undertaken as part of a prioritisation exercise. The survey was aimed at collecting data on production, consumption and marketing of main tree products so as to determine their economic potential and social value. The sample size is bigger, the sampling is more rigorous and the data are more comprehensive than for the preference surveys reported by Mollet *et al.* (1995).

A multi-stage procedure was used to choose the villages and farmers from the identified strata. On the basis of grids laid over a divisional area map, grid cells of 2 × 2 inch were formed. The division was then split into four quadrants each containing an equal number (4–5) of contiguous grids. From each quadrant a grid cell was selected randomly from which a village was also randomly selected. Thus, in each division, 4 villages were selected. Upon arrival in the village, 7–8 farmers were randomly chosen. Eighty interviews were held with individuals or groups of individuals. Both male and female members of the household were interviewed. Key informants were also identified from each village and were asked an additional set of questions. The selected villages in the respective divisions were Nkolfeb, Emana, Lobo and Tala (Lekié division), Djouyaya, Ntolock, and Bayong 1 (Haut Nyong division) and Mefoup, Ebolobola, Mang and Yama (Mvila division).

The value of production was estimated as the product of quantity and the price/unit of production. Quantity produced is a sum of quantity sold and quantity consumed plus other uses which include gifts. Production and value data were obtained from 8, 6, and 16 growers/collectors in the Lekié, Haut Nyong and Mvila divisions respectively for *Garcinia kola* and for *Ricinodendron heudelotii* from 26, 18 and 23 growers in the Lekié, Haut Nyong and Mvila divisions, respectively. Farm-gate prices used for this analysis were obtained by deflating the reported market prices by 20% if the distance to markets where the products were sold was greater than 20 km. From the results of this survey the potential farm-level economic value of the species was estimated for each division.

Results and discussion

Tables 2 and 3 summarise information on mode of propagation, niches, management and farmers' improvement objectives for *Garcinia kola* and *Ricinodendron heudelotii* respectively.

Mode of propagation and niches

For *Garcinia kola*, the most common mode of propagation across all three divisions is by retention/protection of young plants that are found by the farmers in their fields. Some cases of transplanting of wildings were also reported in the Lekié and Mvila divisions. In Lekié, about 38% of the farmers also planted seedlings of the species.

Retention/protection is also the main mode of propagation of *Ricinodendron heudelotii* in the study area. About 67% of the farmers propagate the species by this method in the Lekié; comparable figures are 89 and 44% in Haut Nyong and Mvila divisions respectively. In fact it is the only propagation method reported in the Haut Nyong division. Few cases of propagation through seedlings are reported in Lekié and Mvila divisions.

These results suggest that, for both species, farmers do not fully master or may be experiencing difficulties with the other propagation methods. The recent developments in the vegetative propagation of *Ricinodendron heudelotii* (Shiembo *et al.* 1996) need to be brought to the attention of land users in the region.

The niches for *Garcinia kola* in Lekié and Mvila divisions are home gardens, tree crop fields, fallow land, food crop fields and virgin forests, each of these having on average one tree per grower. In Haut Nyong, tree crop fields and virgin forest are the main niches. Collection from the forest is highest in Haut Nyong—83% of the farmers growing the species—followed by the Lekié (25%) and Mvila divisions (13%). The high proportion collecting from the forest in Haut Nyong indicates the availability of virgin forests in the division.

Ricinodendron heudelotii is found in a variety of niches in the study area. In the Lekié and Mvila divisions, it is found mostly in tree and food crop fields, home gardens, fallow land and virgin forests. In Haut Nyong division, the species is found in most of the niches. The proportion of farmers collecting from the forest ranges from 35% in Haut Nyong to only 4% in Lekié. About 13% of the farmers in Mvila collect the species from the forests. The low figure in Lekié is probably related to the disappearance of secondary forest in the region. Generally, *Ricinodendron heudelotii* seems to be more widely distributed than *Garcinia kola* with higher averages in each niche.

Table 2. Uses, niches and management of *Garcinia kola* in the humid lowlands of Cameroon*

	Lekié division (N ^b =8)	Haut Nyong division (N ^b =6)	Mvila division (N ^b =16)
Local name	G'niel (Eton)	Ngwell (Mpong Mpong)	Onyae (Bulu)
% Farms with tree (Average # of trees/grower)	29(4)	30(4)	50(7)
Mode of propagation	Retain/Protect-3 Plant seeds-3 Transplant wildings - 2	Retain/Protect-4	Retain/Protect-6 Transplant wildings - 1
Main source of seeds, if planted	Market place-1; Neighbours-1; Nurseries-1.	Not available	Not applicable
Criteria for selection of fruit of tree	Large fruit tree-1; Yearly production-1.	Large fruit tree-2; Good tasting fruit-2; Good production-2; Yearly	Good production-2; Large fruit tree-2; Good tasting fruit-1; Yearly production-1.
Niches ^c	Home garden-2(1); Tree crop fields-2(1); Fallow land-1(1); Food crop fields-1(1); Virgin forest-1(1).	Virgin forest-4(4); Tree crop fields-2(1)	Tree crop fields-9(3); Fallow land-4(4); Virgin forest-3(1); Food crop fields-1(1); Home garden-1(1).
Uses (non-food)	Firewood-3; Medicinal use- 2(diarrhoea): bark; Timber-1; Poles-1.	Firewood-4; Medicinal use-3(diarrhoea): bark; Poles-3; Stakes-3.	Medicinal use-3(diarrhoea): bark; Firewood-3; Timber-1; Poles-1
Management tasks undertaken	Harvesting(climb)-3; Harvesting (gather)-3; Processing-2; Pruning-1.	Processing-4; Harvesting (gather)-3; Pruning-1; Disease/Insect control-1;	Harvesting (gather)-4; Harvesting (climb)-3; Processing-2; Disease and insect control-2; Pruning-1.
Improvement objective ^a	Reduce time to bearing-3; Reduce tree height-2; High yield-1; Fruit size-1.	Fruit size-4; Regularity-2; Spread fruiting-2; Reduce tree height-2; Pest and disease resistance-1.	Fruit size-5; High yield-4; Spread fruiting-3; Reduce tree height-2; Regularity-1.

Notes: a: All numbers denote number of respondents making particular choice; b: Number of growers/collectors;
c: The number in parentheses is the average number of trees (to the nearest non-zero integer) in the given niche.

Table 3. Uses, niches and management of *Ricinodendron heudelotii* in the humid lowlands of Cameroon^a

	Lekié division (N ^b =8)	Haut Nyong division (N ^b =6)	Mvila division (N ^b =16)
Local name	Essang (Eton)	Adje Sap, Zool (Mpong Mpong)	Ezang (Bulu)
% Farms with tree (Average # of trees/grower)	93(4)	85(17)	72(6)
Mode of propagation	Retraub/Protect-21 Plant seeds-5 Transplant wildings-4	Retain/Protect-16	Retain/Protect-10 Plant seeds - 1
Main source of seeds, if planted	Neighbours-3; Own farm, any tree-3; Own farm, selected tree-2; Market place-2; Tree experts-2.	Own farm, selected tree-1; Market place-1; Neighbours-1.	Not applicable
Criteria for selection of fruit of tree	Good production-5; Good tasting fruit-3; Yearly production-3; Large fruit tree-2.	Good tasting fruit-5; Good production-4; Yearly production-4; Large fruit tree-3; Early maturity-2.	Good production-2; Year production-2; Large fruit tree-2; Early maturity-2; Good tasting fruit-1.
Niches ^c	Tree crop fields-20(3); Food crop fields-6(1); Home garden-5(1); Fallow land-4(1); Virgin forest-3(1).	Tree crop fields-9(6); Virgin forest-9(5); Food crop fields-8(5); Home garden-6(2); Fallow land-3(1).	Tree crop fields-10(3); Fallow land-7(2); Food crop fields-7(2); Virgin forest-2(1);
Uses (non-food)	Medicinal use-10 (yellow fever, dysentery, diarrhoea, hernia, small pox); bark; Firewood-11; Stakes-2; Timber-1; Poles-1; Fodder-1.	Firewood-9; Medicinal use-8 (hernia); bark; Poles-1; Stakes-1.	Firewood-9; Timber-6; Medicinal use-3 (diarrhoea); bark; Poles-1; Fodder-1.
Management tasks undertaken	Harvesting (gather)-22; Processing-19; Harvesting (climb)-2; Disease/Insect control-1.	Processing-15; Harvesting (gather)-14; Harvesting (climb)-1.	Harveting (climb)-8; Harvesting (gather)-8; Processing-6; Disease/Insect control-1.
Improvement objective ^a	High yield - 12; Fruit size - 11; Reduce time to bearing - 7; Reduce tree height - 6; Spread fruiting - 5.	Reduce time to bearing-5; High yield-4; Regularity-4; Reduce tree height-3; Spread fruiting-2.	High yield-8; Fruit size-7; Reduce tree height-5; Good tasting fruit-4; Reduce time to bearing-3.

Notes: a: All numbers denote number of respondents making particular choice; b: Number of growers/collectors; c: The number in parentheses is the average number of trees (to the nearest non-zero integer) in the given niche.

Effect on tree and food crops

The proportion of farmers who perceive any effect of *Garcinia kola* on tree or food crops (Table 4) is low except in the Haut Nyong division where 50% feel that the species has a mixed effect—that is, favourable in some areas and unfavourable in others—on tree crops. These results suggest that the species may be compatible with food crops and therefore suitable for agroforestry systems. In the case of Haut Nyong, this means that appropriate management practices need to be developed to mitigate the negative effect of the species on tree crops.

Table 4. Effect of *Garcinia kola* tree on different crops in the humid lowlands of Cameroon (% of respondents)

		Division		
		Lekié	Haut Nyong	Mvila
Tree crop	Increase	13	0	6
	Reduce	13	17	0
	Mixed	0	50	13
Food crop	Increase	0	0	0
	Reduce	13	0	0
	Mixed	0	17	6

Note: % do not add up to 100 because respondents did not provide answers to all questions.

An examination of the effect of *Ricinodendron heudelotii* on tree and food crops (Table 5) shows that, in Lekié, many more farmers than in the other divisions believe that the tree has a positive effect on tree crops. The reason given for the negative effect is shade which is also given as one of the reasons for the positive effect together with the leaves.

Table 5. Effect of *Ricinodendron heudelotii* tree on different crops in the humid lowlands of Cameroon (% of respondents)

		division		
		Lekié	Haut Nyong	Mvila
Tree crop	Increase	39	17	9
	Reduce	19	17	13
	Mixed	8	22	17
Food crop	Increase	4	6	17
	Reduce	19	22	9
	Mixed	12	11	13

Note: % do not add up to 100 because respondents did not provide answers to all questions.

For Haut Nyong, farmers' perceptions show that the same number of farmers associate the species with both negative and positive effects on tree crops. Concerning food crops the evidence seems to suggest that *Ricinodendron* has a negative effect on these crops due mostly to the shade.

In Mvila farmers' perceptions are somewhat similar to those in Haut Nyong with respect to the effect of *Ricinodendron* on tree crops. This is, however, not the case for the effect on food crops as many more farmers associate a positive effect with the species than those who attribute it a negative effect.

The perception of a mixed effect is balanced across all three divisions with respect to food crops. For the effect on tree crops, however, it is lowest in the Lekié division. Again, the implication of these results is that appropriate management practices need to be developed to enhance the compatibility of these species with tree and food crops.

Uses, management and improvement objectives

The bark of *Garcinia kola* is reported to be used for the treatment of diarrhoea. The wood is used as timber, poles and stakes for yams and its dead branches for firewood in all three divisions. *Garcinia* nuts play a very important social function as they are often offered as gifts to visitors.

Ricinodendron heudelotii is used for treating various ailments including yellow fever, dysentery, diarrhoea, hernia and small pox. The main part used is the bark. Other uses are for firewood (dead branches), timber, poles, stakes and fodder. These uses cut across the three divisions with the exception of timber and fodder which are not mentioned in Haut Nyong.

The above findings highlight farmers' indigenous knowledge of the medicinal value of both species for the treatment of a variety of ailments. This aspect cannot be underestimated especially given the present economic environment whereby pharmaceutical products are becoming out of reach of resource poor farmers.

A variety of management tasks are performed on *Garcinia*. In Lekié, these are pruning, harvesting by climbing, harvesting by gathering and processing. Farmers feel that each of these tasks involves much work. In Haut Nyong, the tasks reported are pruning, disease and insect control, harvesting by gathering and processing. As in Lekié, each of these tasks is rated as involving a lot of work. Pruning, disease and insect control, harvesting by climbing, harvesting by gathering and processing are the main tasks performed on the species; all of which by farmers' rating involve much work.

Key management activities undertaken on *Ricinodendron heudelotii* include disease and insect control, harvesting by climbing, harvesting by gathering and processing. Disease and insect control is mainly for weevils which attack the leaves and for borers and insects that attack the fruits of the species. The key management activities are common in all three divisions except for disease/insect control which is not practised in the Haut Nyong division. In general, farmers rate all these activities as involving a lot of work. Processing is mostly done by women who sometimes form groups of 3–4 to carry out this activity.

The current evidence indicates that pruning is not undertaken on *Ricinodendron heudelotii*. For both species, however, it seems that management practices undertaken are labour intensive. This calls for the need to examine strategies and improvement objectives which may reduce the labour requirement of appropriate management options.

Farmers in Lekié wish to see, for *Garcinia kola*, a reduction of time to bearing, higher yield, increase in fruit size and a reduction of tree height. Increase in fruit size, regular production, spreading of fruiting across the year, reduction of tree height and resistance to pest and disease are the major improvement objectives in Haut Nyong division. In Mvila farmers desire bigger fruits, higher yield, spread of fruiting across the season, reduction in tree height and regular production.

Concerning *Ricinodendron heudelotii*, the improvement objectives identified by farmers in Lekié are higher yield, reduction of time to bearing, increased fruit size, reduced tree height and spread fruiting throughout the year. In Haut Nyong, the same objectives are expressed with the exception of spreading fruiting which is replaced by regular production. Higher yield, reduction of time to bearing, increasing fruit size, reduced tree height and good tasting fruit are the improvement objectives in Mvila division.

Suggested improvement objectives are consistent with management practices identified above. For instance, in both species, farmers would like the species to be shorter. This may be related to the fact that they perceive harvesting by climbing as a difficult task. In general, the improvement objectives indicate the social and economic importance of both species to land users in the humid lowlands of Cameroon.

Economic value and potential

Mean production estimates and seasonal breakdown of the value of production of *Garcinia kola* and *Ricinodendron heudelotii* are shown in Tables 6 and 7 respectively. Seasonal variation of prices was observed for the species. Early in the season prices are usually high owing to the limited quantity available in the market. The lowest prices are observed at the middle of the season. A seasonal breakdown of the analysis is presented in this paper.

The production season for *Garcinia kola* runs from May to August in Lekié, February to August in Haut Nyong and February to July in Mvila. For *Ricinodendron heudelotii* most production is between February and December in Lekié, January and October in Haut Nyong and March and December in Mvila.

Of the three divisions, the highest level of production of *Garcinia kola* is in the Haut Nyong division with a mean production of 60 kg/grower or collector, followed by Mvila (34 kg) and Lekié (13 kg). A larger proportion of the production is for household consumption with the exception in Haut Nyong where 75% of the production is sold. On the basis of peak season prices the annual contribution of *Garcinia kola* ranges from 6500 FCFA (\$US 13.00) in Lekié to 30 000 FCFA (\$US 60.00) in Haut Nyong. The figure in Haut Nyong is based

on data from one grower, though. The value of production of this species is 11 390 FCFA (\$US 23.00)/year in Mvila.

Ricinodendron heudelotii production is highest in the Lekié (48 kg) followed by Haut Nyong (33 kg) and lastly Mvila divisions (17 kg). The proportion of the seeds of this species consumed is greater than that sold except in Haut Nyong where 64% of the production is sold. The potential annual revenue, based on mid-season prices, generated by the species is 11 390 FCFA (\$US 23.00) in Lekié, 8580 FCFA (\$US 17.00) in Haut Nyong and 2720 FCFA (\$US 6.00) in Mvila.

The proportions of both species used for household consumption show the roles they play for food security in the region. In the case of *Garcinia*, as mentioned earlier, it is commonly offered as gifts to visitors to demonstrate the host's hospitality. *Ricinodendron's* role is mainly in the preparation of various dishes. In addition both species constitute a source of additional income to land users.

Table 6. Mean annual production estimates (kg/grower) and yearly value of production (FCFA^a/grower) of *Garcinia kola* nuts in the humid lowlands of Cameroon

Variable	Division		
	Lekié	Haut Nyong	Mvila
Production	13	60	34
Sales ^b	5 (40%)	45 (75%)	9 (27%)
Consumption ^b	8 (60%)	15 (25%)	24 (72%)
Other ^b (e.g. gifts)	0 (0%)	0 (0%)	1 (2%)
Value of production^c			
Using beginning of season prices	26 000 (14 000)	30 000	34 000 (7500)
Using middle of season prices	6500 (3800)	30 000	11 390 (2515)
Using end of season prices	2600 (1400)	30 000	42 500 (9500)

Notes:

- \$US \cong 500 FCFA.
- Figures in parentheses are percentages of total production.
- Number in parenthesis are standard errors. All figures are rounded up to nearest 5 FCFA and value of production is estimated by multiplying total production by deflated farm-gate prices.
- Deflated farm-gate prices used are 2000 FCFA kg⁻¹, 500 FCFA kg⁻¹ and 200 FCFA kg⁻¹ for beginning, middle and end of season respectively in Lekié; 500 FCFA kg⁻¹, 500 FCFA kg⁻¹ and 500 FCFA kg⁻¹ for beginning, middle and end of season respectively in Haut Nyong and 1000 FCFA kg⁻¹, 335 FCFA kg⁻¹ and 1250 FCFA kg⁻¹ for beginning, middle and end of season respectively in Mvila.

Table 7. Mean annual production estimates (kg/grower) and yearly value of production (FCFA^a/grower) of *Ricinodendron heudelotii* nuts in the humid lowlands of Cameroon

Variable	Division		
	Lekié	Haut Nyong	Mvila
Production	48	33	17
Sales ^a	20 (43%)	21 (64%)	5 (27%)
Consumption ^b	22 (45%)	12 (36%)	12 (72%)
Other ^b (e.g. gifts)	6 (12%)	0 (0%)	1 (1%)
Value of production^{c,d}			
Using beginning of season prices	20 160 (4650)	10 560 (5605)	5440 (1500)
Using middle of season prices	11 280 (2590)	8580 (5100)	2720 (760)
Using end of season prices	17 520 (4025)	14 520 (8700)	2655 (740)

Notes:

- \$US \cong 500 FCFA.
- Figures in parentheses are percentages of total production.
- Numbers in parenthesis are standard errors. All figures are rounded up to nearest 5 FCFA and value of production is estimated by multiplying total production by deflated farm-gate prices.
- Deflated farm-gate prices used are 420 FCFA kg⁻¹, 235 FCFA kg⁻¹ and 365 FCFA kg⁻¹ for beginning, middle and end of season respectively in Lekié; 320 FCFA kg⁻¹, 260 FCFA kg⁻¹ and 440 FCFA kg⁻¹ for beginning, middle and end of season respectively in Haut Nyong and 320 FCFA kg⁻¹, 160 FCFA kg⁻¹ and 155 FCFA kg⁻¹ for beginning, middle and end of season respectively in Mvila.

Summary and further research needs

Garcinia kola and *Ricinodendron heudelotii* play a major role in household economies in the study area. The nuts of *Garcinia kola* fulfil important social functions for producers in the area as they are very frequently presented to visitors. Besides, the bark is used for medicine in the treatment of diarrhoea. It is also used as timber, firewood (dead branches), stakes and poles. *Ricinodendron* seeds are used in the preparation of sauces which are highly appreciated by the people, thereby fulfilling important function for food security. Both species also secure additional revenue for the farmers in the humid lowlands of Cameroon.

Farmers in the study area have identified important traits which they desire improved. These improvement objectives cut across all three divisions and both species. They include reduction of time to bearing, higher yield, increased fruit size, reduction of tree height, regularity in production, resistance to pests and diseases and spreading of fruiting across the entire year.

Both species seem to be compatible with cropping patterns in the region and hence suitable for agroforestry systems prevalent in the study area. Although *Garcinia kola* and *Ricinodendron heudelotii* do not contribute nearly as much as *Iringia gabonensis* and *Dacryodes edulis* (Ayuk *et al.* unpublished data) to household income in the humid lowlands of Cameroon, they are valuable species. Further research needs to be undertaken in improving our understanding of the market opportunities and constraints of these species. It is also important to identify methods to quantify the non-food uses of these species.

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