Smallholder timber and firewood marketing in the coffee and cotton/tobacco zones of eastern Mount Kenya

Christine Holding[1], Sammy Carsan[2] and Paul Njuguna[3]

ABSTRACT

Recent analysis on tree management by farmers has moved away from the needs –based and conservation approaches that dominated much of the earlier work, and instead examines tree management in terms of farmer livelihood strategies and the dynamics of rural change. Trees in farming systems are most usefully seen in the context of farm household livelihood decision making and strategies.

In Kenya, there is a tradition of agroforestry in the country, with the planting and retention of a variety of multi-purpose trees on farms. As long ago as 1994 the Kenya Forest Masterplan advised: closer linkages between industry and farm tree growers that could provide the rural population with increased earnings from sales of wood and other industrial raw material and from the various steps in tree product harvesting, transport and processing. Kenya is not alone in this situation, and with the decline in commodity prices of farmers principle cash crops e.g. coffee, farmers are increasingly viewing tress, wood products and timber as a viable alternative cash generating farm enterprise.

This paper presents the results of two surveys designed to better understand the dynamics of timber harvesting and marketing at farm level conducted in the area of Eastern Mount Kenya. A household survey combined rural household sampling and interview techniques, farm walks, focus groups and key informant interviews to ascertain the decision making of landowners (householders/farmers). Concurrently on the same farms, a biomass survey was conducted to gain quantitative data on: stems, volumes, principle use, planting niches, diameter and age classes. 42.5% of farmers surveyed engaged in commercial marketing of tree products. Of those farmers engaged in selling trees, the numbers of trees (and concomitant volume calculations) sold from farms were found to be twice as many as those used for domestic purposes. There are however serious knowledge gaps towards farmers participating equitably in the timber and firewood markets. Often external actors with better market networks gather the greater benefits from trees on farms. Conclusions indicate that on-farm timber has the potential to contribute to the regional wood industry and small-holders livelihoods in the area surveyed.

1. INTRODUCTION

1.1 Background and objectives

Recent analysis on tree management by farmers has moved away from the needs –based and conservation approaches that dominated much of the earlier work, and instead examines tree management in terms of farmer livelihood strategies and the dynamics of rural change (Arnold, M. and Dewees, P. 1997, 1998). Trees in farming systems are most usefully seen in the context of farm household livelihood decision-making strategies.

[1] *Author for correspondence: Senior Fellow, Trees and Markets programme, World Agroforestry Centre. Email: c.holding@cgiar.org; Christine.Holding@ibaf.cnr.it*

[2] *Trees and Markets programme World Agroforestry Centre, Nairobi, Kenya*

[3] *Senior Agroforestry Officer, Ministry of Rural Development, GOK, Kenya*

Kenya's forest and agroforestry heritage

The total area of Kenya's closed canopy of indigenous forest is 1.24 million ha. (Wass, 1995). The best estimates of plantation cover date from the 1991 inventory are 165.000ha. This estimate does not include private plantations. The area of gazetted forest cover, is therefore barely 2.5% of the country. These gazetted forest areas are under continuous threat of forest excisions for uses including: agriculture (17%), settlement (35%), and re-gazetted as national park (35%) (KIFCON, 1995). The speed of excision is accelerating. In a survey of 63.3% of the gazetted forest areas in Kenya conducted in 1999, it was found that 50,000ha in the west of the Rift Valley, and 5,700 hectare in the east of the Rift Valley had either been excised or proposed for excision in the last five years. In addition, it was found that the general state of management in the plantation sector was low, with none of the forest blocks visited having a management plan (Njuguna, P. Mbegera, M. and Mbithi, D et al. 1999).

There is a strong tradition of agroforestry in the country, with the planting and retention of a variety of multipurpose trees on farms. Farm biomass inventories reveal regular density of 7.5 m^3 per ha in the central agricultural areas of the country; with this rising to 17.07 m^3 per ha, in mixed stand agroforestry systems in a matter of years with extension support in provision of seeds, silvicultural advice etc. (Njuguna P., Holding C. and Munyasya, C. 1999).

According to Kenya Forest Master Plan (1994) estimates, if the then current trends continued, by the year 2010, the majority of timber and poles would be coming from the farm estate. The Master Plan proposed a comprehensive set of measures to facilitate improved management of the forest estate. This included recommendations such as (KFMP 1994):

> *"Closer linkages between industry and farm tree growers that could provide the rural population with increased earnings from sales of wood and other industrial raw material and from the various steps in tree-product harvesting, transport and processing"*

The new commercial and entrepreneurial opportunities arising from farm sourced timber and firewood sales presents farmers, businesses and customers with new challenges and opportunities. Little is known of the current sourcing and marketing processes of timber from farms. Less is known of the actual and potential returns to farmers, the structure and efficiency of the marketing chains; and the sustainability of the farm based resource.

This paper presents the results of a farmers household survey and biomass survey, focusing on the impact of timber and firewood sourcing activities at farm level, and farmers perceptions and decision making in response to the increasing trend to source timber from farms.

These were two in a series of studies, conducted in the marketing and processing of farm sourced timber on the eastern slopes of Mount Kenya during 2000 – 2004

1.2 Survey objectives:

Overall objectives:

- To better understand the dynamics of timber harvesting and sales at farm level.

Specific objectives:

1. To assess the sustainability of on farm timber supply in Meru, Kenya
2. To determine the current rates of harvesting from farms in Meru
3. To assess the actual and potential returns of merchantable wood from farms in Meru

Hypothesis(es): of the (combined) two surveys:

1. Farmers in Meru District have poor valuation techniques of wood from farm.
2. Farmers incomes of wood products from trees are low, even taking into consideration actual government royalties on forest and tree products.
3. The current rate of extraction from the farm is not sustainable.
4. *Grevillea robusta* is the most commonly traded species form the farms of Meru
5. That tree products from farms are contributing an increasing proportion to household incomes.

1.3 Study area

Meru Central is one of the 13 districts in Eastern Province of Kenya. It and covers an area of about 3012 square kilometres, with over 705 square kilometres potential for livestock and agricultural farming. The topography ranges from 5200 m above sea level (Mt. Kenya) to the flat lands of Giaki/Gaitu and lower Nkuene, Igoki and Abogeta of 1400 m above sea level.

Agro-ecological zones, soils and climate

Due to the range of topography, most agro-ecological zones found in Kenya occur also in Central Meru. These include: UH1 and UH2 (pyrethrum/dairy zone), UM1 (tea/dairy zone), UM2 (coffee zone), UM3 (marginal coffee zone), LM3 (marginal cotton zone), LM3 (cotton and tobacco zone) and LM4 (sorghum/millet zone) and LM5 (ranching zone). Households for the sample were selected from UM2 (coffee zone) and LM3 (cotton/tobacco) respectively - as the two principle zones from which timber and firewood were being sourced from farms.

Soils in Meru are moderately to highly fertile with higher fertility generally occurring in the middle altitudes (Jaetzold and Schmidt, 1983). The climate and rainfall is greatly influenced by Mt. Kenya and the Nyambene Hills. Rainfall varies from 2600 mm annually in the upper highlands of Mt. Kenya to 500 mm in the lower dry parts of the district. Average annual temperatures range from 10ºC around Mt. Kenya area to 30ºC in the lower parts of the district (Ministry of Agriculture, 2000).

Forests

Forest blocks cover a total area of 86 955 ha. The main species in the gazetted indigenous forests include: *Brachylaena* sp., *Calodendrum capense, Catha edulis, Cordia africana, Croton macrostachyus, Croton megalocarpus, Ficus thonningii, Hagenia abyssinica, Juniperus procera, Lovoa swynnertonii, Markhamia lutea, Milicia excelsa, Ocotea usambarensis, Olea capensis, Olea europaea* ssp. *africana, Olea welwitschii, Premna maxima, Prunus africana* and *Vitex keniensis* (KWS, 1999). The plantation forests in Meru cover a total area of 4302 ha comprising *Cupressus lusitanica*, *Pinus patula*, *Pinus radiata* and *Eucalyptus* species. Native species, *Vitex keniensis* and *Cordia africana* have also been planted in designated plantation areas (Ministry of Natural Resources, 2000). Large-scale charcoal production and illegal extraction from government gazetted forests continue to heavily impact on the natural forests. Some of the most targeted species include: *Ocotea usambarensis, Juniperus procera, Olea europaea* ssp. *africana* and *Hagenia abyssinica* (KWS, 1999).

2. MATERIALS AND METHODS

A cross-sectional study was designed to assess smallholder timber production in Meru Central District. Actual timber production levels (biomass inventories) were assessed together with the respective household decision making processes. Both qualitative and quantitative techniques were applied in this twin study (Marsland et al, 1999)

Several survey techniques were combined to conduct the household study. Individual Farmer, face to face interviews farm walks, focus group discussions and key informant interviews (local administration, forest and agricultural department staff, firewood traders and local managers in private sectors with a direct interest in firewood supplies e.g. British American Tobacco (BAT) and Kenya Tea Development Authority (KTDA) were used to ascertain farmer decision making on timber and firewood marketing. The interview tool consisted of a structured questionnaire with open-ended questions. A checklist of points for probing on particular issues was used to introduce a greater degree of interaction on the part of the interviewee and especially to guide the focused group discussions.

Concurrently, on the same farms, a biomass survey was conducted to gain quantitative data on: no of stems and volumes; and relating these to principle use, planting niches, diameter and age classes. Recording and observation schedules were used to enumerate all the woody biomass species on the farms, that are either mainly used for timber or that have a potential of being used for timber. In most cases, a 100% enumeration was done except

in homogeneous hedges and woodlots where sampling was done. The diameter at breast height, (DBH), was measured to the nearest centimetre for all the species. The woody species were classified depending on growing niches on farm, main uses, natural or planted, approximate age, tree shape and form. A selection of these results are presented in this paper. From the stem form, useable volume calculations were estimated. The unit of analysis for the biomass survey was the farm. The biomass survey was however conducted on the same farms and at the same time as the household survey.

Target farmers for interviews were randomly drawn from two administrative Divisions within Meru Central District. The two Divisions also represent two distinct agro-ecological zones (coffee and cotton/tobacco zones), which were delineated as representing the problem statement. Three locations (villages) were randomly selected as they were anticipated to provide the most representative sample from the rather large geographical Divisions. As there were no readily available lists of farmers at the location level from which to draw samples, several alternative sampling frames, were investigated for aptness. These included: list of farmers from local administrative leaders, records of land ownership from the Ministry of Lands and Settlement, ministry of agriculture soil and water conservation catchment groups and lists of farmers from local farmer institutions (e.g. coffee and tobacco cooperatives). The latter was used to draw sample as it was deemed most updated and representative. Computer generated random numbers were used to select a sample list of three to four farmers to be interviewed per village. A total of 35 farmers were randomly selected for household interviews and 31 farms considered as units for analysis for the biomass study.

The two components of the survey were analysed separately according to their respective professional norms. Quantitative data was keyed in to excel and analysis executed using analyse it for excel statistical package. This paper interprets, compares and discusses the results, implications and issues arising from the analysis of both survey components. In this way a more nuanced description of household decision making, drawing on both the farmers' perspectives and quantitative data of trees on farm was possible. Pre and post survey focus group discussions with farmers were also conducted to identify the hypothesis of the study and provide context to the results. These discussions are not, however, included in this current presentation.

3.0 RESULTS AND DISCUSSION

3.1 Farm size

The 35 farms sampled in the survey had an average of 1.80 Ha; ranging from 0.13 Ha to 11.00 Ha (Table 1). The smallest farm was found in the coffee zone while the largest farm was found in the cotton/tobacco zone.

3.2 Smallholder tree sales

This section discusses actual sales at household level and the farmer's future planting plans, according to their perspectives of the likely future developments in the timber and firewood markets.

It was found that seven species representing a fifth of all tree species inventoried are often sold at smallholder farm level to different customer and business types. Woody materials from farms are mainly sold in three forms: as firewood, in logs, or as standing trees[1]. A variety of different volume assessments are used[2], during the transactions between farmers and customers, to determine the sale price of a tree in these different forms. This lack of standardisation in measures used in the commercial harvesting and sale of trees from farms, presents difficulties in comparing anticipated tree yields (measured in m^3, or in board feet) and the volumes and rates of tree harvesting from farms.

Table 1: Farm sizes sampled (household survey)

Aez	respondents	Total Area in Ha's	Ave. farm size in Ha.
coffee	20	20.27	1.00
cotton	15	42.61	2.80

All transactions are on a cash basis. However, there are isolated cases where credits and exchanges are preferred. Parents for example sell firewood as part payment or in lieu of school fees. Also boarding schools buy firewood in stacks delivered to the premises. In these cases payment includes transport.

'Whole" or standing tree is the preferred mode of selling trees from farms. Negotiation on sales is per tree 'standing on farm', with no processing or conversion. Buyers cut and cross cut, and carry timber from farms. Branches and slabs resulting from timber recoveries are left with the farmer depending on price negotiation, if the buyer carries these products then the price of the tree is adjusted upwards. Holding, C.& Njuguna PM., [s.l.] 2006, corroborates this finding in their timber value chain analysis from the farm level. Prices paid for standing trees, were in addition to estimated volume, a function of distance, (transport costs) to be incurred.

The household survey confirmed that *Grevillea robusta* is sold for firewood as whole trees and logs. It provided a range of flexible uses and therefore yielded the highest returns per household. An average of Ksh 3757 was earned for 16 households identified during this survey.

The total income to the 25 households reporting commercial sales in the last two years was: Ksh 88,255 equivalent to an average sale of KSh 1,165 (US$ 35) per household per year. (GDP per capita in Kenya is US$ 1,441 (IMF, 2005).

Table 2 shows the number of households engaged in commercial transactions and number of stems sold in the last two years. Comparison is made with tree harvesting for domestic use in the coffee and tobacco zones. Results show that for households engaged in commercial trees sales, almost twice as many trees are sold per household as are felled for domestic use.

In the coffee zone: total trees per household felled on average during the last two years were: 58, of which 34 or 58.6% percent are sold and 24 or 41.4% are for domestic use, whereas, in the cotton zone: total trees per household felled on average during the last two years were: 76, of which 52 or 68.4% percent are sold and 31.6% were for domestic use Proportionally more trees are sold per household in the cotton zone.

Transactions experienced at farm level, indicate that 14 (56%) of all farmers interviewed had recently sold trees on their farms for the very first time, 11(44%) reported having been selling trees on farm on a continuous basis. *Grevillea robusta* was identified as the single most readily traded species grown on farm. Other important species providing additional income to many households in the cotton/tobacco and coffee zone included: *Eucalyptus* sp, *Cordia africana, Acacia abbyssinica*. Market demand included: firewood, split timber, logs and standing tree.

These findings sharply contrasts with those of Tyndall's (1996) which indicated that timber yards, furniture shops, and saw-millers were reported as saying that *Grevillea* timber was underrated and misunderstood by the public. Five of the six sawmills then surveyed showed that only about 2% of their business was in *Grevillea*, and all of that through species order only. Tyndall's study showed that saw-millers believed that the market share of *Grevillea* would probably grow by 20% in the next 5 to 10 years because the supplies of pine *Pinus patula*, *Cupressus lusitanica* and *Ocotea usambarensis* from forests were rapidly declining.

Table 2: Trees felled for commercial and domestic use in last two years in the cotton/tobacco and coffee zones

AEZ	No. of respondents	No of farmers selling trees	Total number of trees sold in last 2 years	Ave no of stems sold per household in last 2 years	No of farmers felling trees for domestic use	Total number of trees felled for domestic use in last 2 years	Ave number of trees for domestic use in last 2 years per household
Cotton zone	15	6 (40%[3])	314	52	11 (55%)	262	24
Coffee zone	20	9 (45%[4])	307	34	17 (85%)	409	24
Total	35	15	621	43	28	671	24

3.3 Customers and business types transacting at farm level

Seven customer and business types were identified for the traded forms of firewood, logs and standing trees. They include: furniture makers, saw millers, Kenya Tea Development Authority (KTDA) factories, local hotel operators, boarding schools and traders from the lower Arid and Semi Arid Lands (ASAL) to the South East of the survey area. Saw millers and 'neighbour' customers' constitute the largest market for farm tree resources, while KTDA tea factories occupies a third of the customer base.

All of the customer types, except boarding schools, were found to come to the farm level to buy trees. 19 (90.5%) farmers indicate that customer's source for woody material from the farms, while only 2 (10.2%) farmers sought customers for their trees. Farmers reported that "Seeking for buyers" was an unfavorable way to conduct business, as the buyers take advantage of offering very low prices as they can 'read on the farmer's face, their desperation'. They have little bargaining power when seeking market for their tree products.

In terms of distance from the customers business to the farm: the overall average distance was recorded as 28km. The furthest recorded customer was a furniture maker from Nairobi:300 km away. Transport costs are heavily factored in negotiations along the timber processing and marketing chain. Transport represents a significant proportion of the final cost of timber reaching the market (32% of the costs incurred to the business per board foot, if one includes purchase of the standing tree; or 55.36% of costs incurred to the business per board foot, in chain transactions subsequent to the purchase of standing tree[5]) (Holding, Anyonge C. & Njuguna, P.M. in preparation. 2006).

3.4 Gender and intergenerational influences on household decision making

In cases where land subdivision is imminent, but has as not yet been sub-divided to the next generation, tree planting decisions are postponed until such a time when eventual land ownership is clarified (Franzel, S. 2003). The household survey found that in the villages surveyed, conflicts on tree ownership may even occur after land subdivision has taken place. Instances were recorded where household heads cleared all the trees on the farm prior to subdividing to their sons. Usually men who subdivide land to their sons view the trees as their propertyand prior to subdivision fell them, leaving their sons to subsequently plant their own.

Thus in the understanding of local customary law, trees remain the property of those who have planted, and do not pertain to the land. The survey found that due to this differentiation between land and tree ownership, sons who have been allocated sub-divided land, yet have no secure title may be reticent to plant trees. This corresponds with Tyndall, (1996), where it was found that the head of a farm portion was about 40 years old at first planting, which indicated that a man is in his late 30s before he inherits land.

Men often determine tree sales for both timber and firewood. Women are allowed to sell trees if there are urgent household problems such as illness. Continuous pruning by women for firewood is allowed. The survey confirms previously conducted PRAs in the area (Mariene, CT. 2000) that tree management and harvesting decisions in the Meru are gender biased.

3.5 Tree planting and retention on farm

Data from the biomass survey indicates the no of stems and volumes recorded across the age class range (Figure 1). The age class tree distribution indicated a near normal trend in the region, indicating a continuous tree planting in the survey area.

The higher rate of planting during the mid 1980s to mid 1990s may be associated to bilateral projects and NGOs supporting tree nurseries and tree planting during this era. Farmers current preferences for tree planting and their objectives in so doing, are discussed in a later section of this paper.

From the farmers' responses and on farm observations, *Grevillea robusta* is the most

abundant species on farm in the combined cotton and coffee land use zone. Average no of mature harvestable *G. robusta* trees observed per farm during the household survey was: 137. Comparing the two-agro ecological zones: the cotton zone with an average of 200 harvestable *Grevillea* trees per farm has become a more important source of harvestable timber and firewood than the coffee zone with ca. 89 trees per farm (Figure 2).

In the cotton zone in addition to *Grevillea robusta*, the most frequently occurring species are: *Militia dura, Cassia siamea, Persea americana, Mangifera indica, Combretum molle*, and *Croton* spp. (Figure 2). In the coffee zone, the most frequently occurring species in addition to *G. robusta* are *Eucalyptus* sp., *Trichilia emetica, Persea americana*, and *Vitex keniensis* (Figure 2)

The species composition for the two zones also differ, in terms of numbers and variety cotton zone farmers interviewed records 21 species, coffee zone farmers recorded 19 species. These findings coincide strongly with Oginosako (2001[6]) where it was noted that, from an ecological perspective the marginal coffee and cotton zones have the most trees, while the cotton zone has the most species.

From this survey, the average number of trees in the combined zones per household in addition to *G. robusta* were[7]: *Cassia siamae* (31), *Combretum molle* (16), *Persea americana* (14.5), and, *Eucalyptus* spp.(12).

The biomass survey data additionally, provides the following indicative[8] comparative figures in terms of total stems and volumes in the two agro-ecological zones (Table 3).

The survey findings indicated that the coffee zone was a smaller source of woody species for firewood and timber than the cotton/tobacco zone. Results earlier in this paper show almost double the volume of timber potential species available per household in the cotton/tobacco as compared to the coffee zone. It was also observed that, ungrafted fruit trees like *Persea americana* and *Mangifera indica* previously grown as a source of fruits, were now also being converted to timber and firewood for commercial purposes in the lower zone.

The greater variety and number of trees in the cotton/tobacco zone could be attributed to the larger farm size and agricultural practices in the area.. Farm size in the cotton/tobacco zone is average of 2.8 ha. compared to 1 ha.in the coffee zone (Table 2). There is also more extensive cultivation in the cotton/tobacco zone compared to the coffee zone, the cotton zone retaining a higher number of remnant woodland species. In both zones, it was found that indigenous trees tend to be left on farm longer and not readily used for commercial purposes. These trees have other values attached e.g. medicinal uses and are respected for their long term presence, as well respect for the persons who retained or/planted them the legal requirement for felling is also held to be more prohibitive than for exotics.

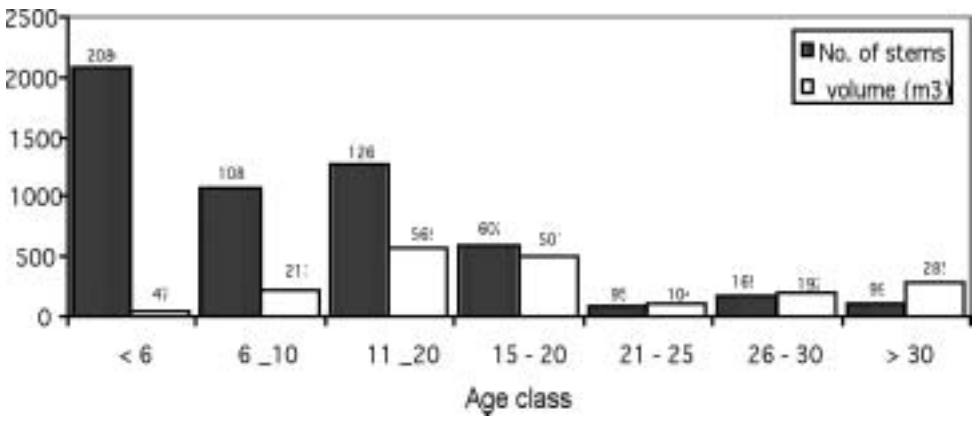

FIGURE 1. AGE CLASSES: DISTRIBUTION OF TREES AND VOLUMES (COTTON AND COFFEE ZONES).

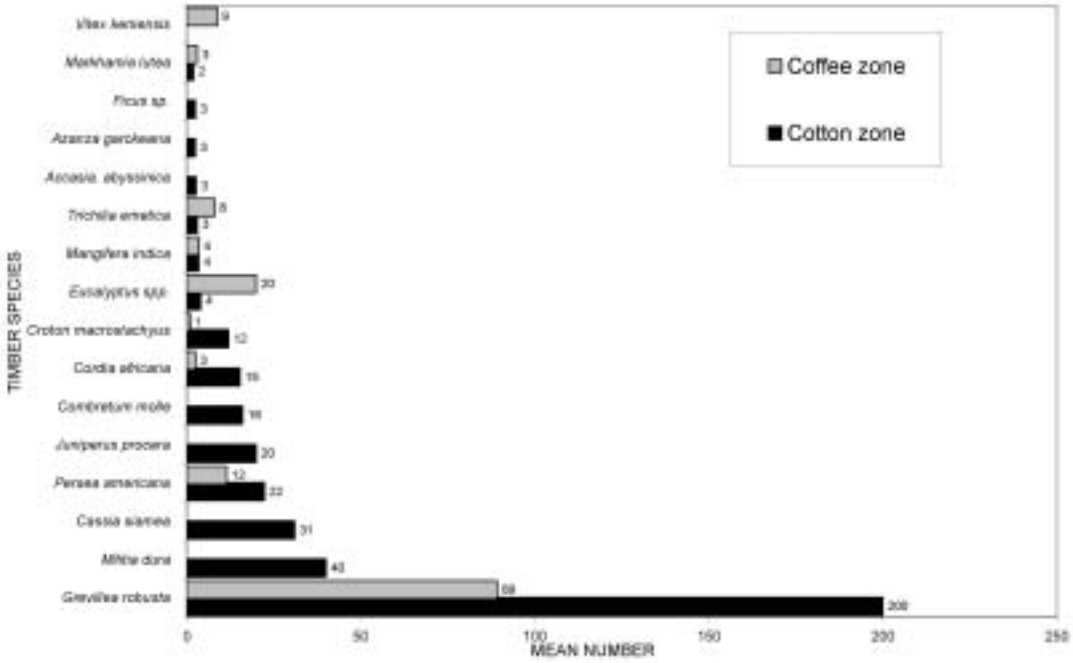

FIGURE 2. MEAN NUMBER OF TIMBER TREES PER FARM IN THE COFFFEE-COTTONZONE

3.6 Farmers tree species and 'preferred use' rankings

Farmers were asked in an open ended question to specify their species choices and preferred use categories. Arnold, M. and Dewees P. (1998) state that, farmers' plant trees in pursuit of their livelihood options, for income generation, use of available land and capital. Data show that several tree species combinations are used in agro forestry systems to achieve specific and simultaneous uses (Lengkeek, AG. and Carsan, S. 2004).

Farmers ranking on species against preferred use categories in these two zones were recorded as: cash; firewood; construction; furniture; livestock/fodder/zero grazing; timber; fruit and poles.

In addition, the survey identified several tree characteristics preferred by farmers in order of priority: fast growing; compatible with crops; regeneration; replacement; water catchments/soil conservation; coppices; dries fast (firewood); and soil fertility (leaves/mulch).

Results indicate a deliberate shift of focus by farmers from trees for environmental benefits and services as promoted by extension packages in the 1980s to tree product commercialisation. Tree cultivation for reasons like windbreaks, soil and water conservation have become a secondary objective to the current primary objective of tree planting for cash and investment.

Household survey results demonstrate, that many of the trees planted, were planted by farmers for other reasons (crop shading, soil conservation, wind breaks etc.), and cannot have been planted in anticipation of the imposition of a logging ban, and consequent increased accessibility to the local timber markets for furniture and construction industry by farmers. However, the biomass survey indicates that a clear majority of on farm tree production is made up of trees with a potential for

Table 3. [9]Comparison of stems and volumes of timber potential species per farm and per hectare in each agro-ecological zone

Agro-ecological Zone	Stems/ farm	Stems/ Ha	Vol/ Farm	Vol/ Ha
Cotton/Tobacco	214	76.96	85.6	29.12
Coffee	136	154.98	39.2	44.61
Average zones combined	174	92.79	61.63	32.86

timber production, and of supplying local and regional markets.

The biomass survey provides us with the following summation of no. of stems, volumes for recognized use groups such as: timber, firewood and fruits (Figure 3)

Coffee zone: major tree uses by the number of stems and volumes

The 16 farms in the Coffee Zone had a total of 2,176 stems out of which 1,116 (51.22%) stems were mainly used for timber production while 432 stems were classified as firewood (20.10%). The total volume was 626.63 m^3 out of which 431.83 m^3 were for timber production (68.91%) while fruit trees had 111.80 m^3 (17.84%). In the coffee zone firewood specific trees were recorded as only having 32.73 m^3, representing 5.23% of the volume of trees on farm (Figure 3).

Cotton zone: major tree uses by the number of stems and volumes

The 15 farms in the cotton zone had a total of 3,216 stems out of which 1,916 (59.58%) stems were mainly used for timber production while 1025 stems were classified as fuel wood (31.41%). The total volume was 1283.71 m^3 out of which 863.2 m^3 were for timber production (67.26%), while trees primarily planted or retained for firewood production were 265.29 m^3, representing 20.67% of the volume of trees on sampled farms (Figure 3).

In the household survey firewood is rated the second most important use, however due to the emphasis on a single main use, the biomass survey indicates that the number of stems and actual volume of trees available on farm with a specific firewood use in the coffee zone is very small - trees actually planted specifically for firewood are few. However, virtually all trees can be felled for firewood, no matter their "primary" use or produce firewood as by products, by pruning, or pollarding - hence its appearance as second rating in a multiple response option.

Local hoteliers in the cotton zone tend to use their home produced firewood, the coffee zone however is more active in providing firewood to the restaurant and food outlets in Meru Town (due to proximity reasons). Commercial firewood sales to food outlets are however of overall minimal significance as compared to the firewood required by the local agricultural industries: tobacco (e.g.50 trees required to cure 1 ha of tobacco) and tea.

There are firewood species that are currently being exploited that have been on the farmers' field as woodland remnants. They include: *Combretum molle, Acacia abbyssinica, Cussonia* sp. *Azanza garckeana*. It's interesting to note that no plans were mentioned to replant additional numbers of these species, particularly in the cotton/tobacco zone where they are mainly exploited. There is an emerging concentration on a narrow range of fast growing exotic species to meet commercial timber and firewood demands.

4. CONCLUSIONS

On farm timber has the potential to contribute to the regional wood industry and small-holders livelihoods in the area surveyed. Trees sold on farm are not only a source of income for farm families, but also cushion farmers when the markets for their principle commodity based farm enterprises fail (e.g. coffee, tobacco, cotton). There are however serious knowledge gaps towards farmers participating equitably in the timber and firewood markets. Often, outsiders with better market networks gather the greater benefits from smallholder timber value chain.

Farmers are willing and able to plant a wide variety of tree species, particularly when their direct benefit to the household is evident. There is a heavy reliance on *Grevillea robusta* to respond to market demands for firewood and timber. Diversification of fast-growing species would enhance farmers' product options and the sustainability of the landscape. Farmers' tree planting activities are also limited by lack of coordination of germplasm supply, leading to a limited diversity and quantity available at farm level.

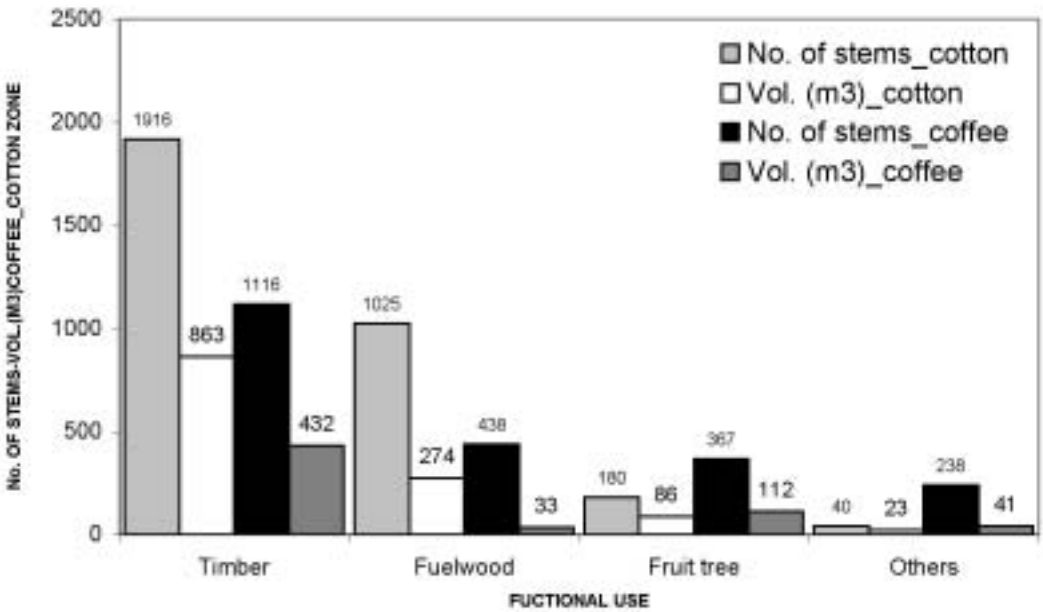

FIGURE 3: NUMBER OF STEMS AND VOLUMES IN THE COTTON/TOBACCO AND COFFEE ZONES

It was noted that farmers are shifting from planting trees for functional uses (e.g. soil and water conservation) to commercial uses. In this survey, it was found that 42.5% of farmers were engaged in commercial marketing of tree products. Of those farmers engaged in selling trees, the number of trees sold from farms were found to be twice as many as those used for domestic purposes. The commercial aspect of trees grown on farms needs to be far more recognised by managers, policy makers and planners in the sector.

Firewood was noted to be a sizable portion of the overall wood product market. Quantification of the same was difficult due to lack of standard measures used in firewood transactions. The major players in the firewood markets are the agricultural industries e.g. tea and tobacco. Without substantial and continuous support to the farmers, via regular germplasm supply or various modalities of tree growing contracts, there is cause for concern at the rate of industrial firewood harvesting in the region. The current wood extraction rates in Meru central were shown not to be sustainable. The local hotels, food outlets and schools are significant firewood consumers in the farm neighbourhoods. However, they are not major players in the overall firewood market and their demands can be met without any risk on sustainability of farm supply.

It was noted that farmers market their firewood and timber as individuals according to specific household needs. Farmers, prefer this flexibility, and are currently disinclined to organise trees sales as a group. However groups have been successfully used as conduits for technical (tree management, mensuration and valuation) and marketing information, and as an entry point for raw materials sourcing from farms.

It was found that some farmers are aware of the potential negative impacts of over -harvesting on their local environment and are lobbying for better regulation of timber and industrial firewood harvesting in the region. There is a need to identify enhanced tree cropping systems, that are compatible with the principle agricultural enterprises of the two zones surveyed.

Jointly considering, and comparing the results of the household and farm biomass surveys provide researchers and development workers working in the area around Mount Kenya programmes with insights into the prevailing dynamics of smallholder timber production and marketing. Much was also learnt on the methodology of combining these complementary components. The survey size was not large, and larger surveys would be useful to further corroborate these findings.

ACKNOWLEDGEMENTS

This research and subsequent analysis was conducted as part of a PhD research programme conducted under the auspices of the Dept of Forest Products and Marketing, Swedish University of Agricultural Sciences, (SLU), supported by ICRAF (DFID), Forest Action Network - Kenya, and FAO. Many persons too numerous to mention, assisted in facilitation of the field work and focus group interviews. Any errors in survey design or representation of results are however, entirely the responsibility of the authors.

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ANNEX 1

For computing the tree volume, the tree species were classified into four different types on the basis of stem form and branching habit. The useable volume of a tree was calculated using the following equation:

$$\ln (v) = a + b \ln (d)$$

In which v is a useable volume, (Dm^3), d is diameter at breast height (cm), and a and b are constants. Constants a and b for different tree types were as follows:

Tree type	Parameter a	Parameter b	Reference
1	- 2.2945	2.5703	Laasasenaho 1982
2	-1.7322	2.3992	Pukkala 1989
3	-1.6493	2.3567	Pukkala 1989
4	-1.6840	2.2406	Pukkala 1989

ANNEX 2

Woody biomass survey: this information is already contained in the main body

Number of trees and densities; and average volume in the region.

Number of stems

The total number of trees with a potential for timber production enumerated in the 31 farms in the two zones was 5,395 in an area of 58.14 hectares. This gave an average of 174 timber/potential timber trees per farm in the region which translates to 92.79 stems per hectare.

The 15 farms enumerated in the coffee/tobacco zone had a total of 3216 stems in an area of 44.08 hectares. This resulted in an average of 214 trees per farm and a density of 76.96 stems per hectare. In the coffee zone, the 16 farms had 2179 stems in an area of 14.06 Ha. The number of trees per farm was therefore 136 stems per farm and a density of 154.98 stems per hectare (in the body).

Notes

1 Poles were not found to be traded in these zones, poles were mainly cut for domestic use.

2 For example, firewood sales units depend largely on the customer or business types. Neighbours buying for various uses such as weddings and other festivities buy tree pruning as bundles often bought on estimate of 'how much bundle can be carried on the back' – a back load. A back load is estimated as 25 kgs (KIFCON 1993). However, the cartload predominates as the major measure of firewood in the two zones surveyed. Key informant information indicated that a cartload is roughly equivalent to a stack. Firewood stacks, are however, not a standard measure, and can vary between customers and location. Kenya Tea Development Authority factories buy trees whole; cut, cross cut and stack, – payment is based on number of stacks yielded. Stacks prepared and purchased by KTDA measure: 4ft x 4ft x 4ft. KTDA pays for stacks at Ksh 120, costing its own labour and transport in the production of the stack at about 300Ksh, so total cost to the factory is estimated at Ksh 450 per stack. KTDA factories collect the firewood from farms, payment is deferred until it is received at the factory. Farmers travel to the factory (an average of 50 kms) to receive payment. Stacks prepared and sold by farmers independently in Gaitu area measure: 4ft x 3ft x 3ft. A farmer prepared stack sells at Ksh 200 per stack.

3 40% of the sampled households in the cotton zone

4 45% of the sampled households in the coffee zone

Table 2: Number of trees and densities in the region(in the body)

Zone	Number of farms	Total area (Ha)	Total Number of Stems	Stems/farm	Stems/ha
Zone	Number of farms	Total area (Ha)	Total Volume (m^3)	Volume/Farm (m^3)	Volume/Ha (m^3)
Cotton/Tobacco	15	44.08	1,283.706	85.58	29.122
Coffee	16	14.06	627.249	39.203	44.612
Totals	31	58.14	1,910.955	61.636	32.863

5 calculations: Ksh 227.27 (total value added including purchase of standing tree)/17 (no of business chains) = Ksh 13.37 (ave. total costs to business) 4.28 as prop of 13.37 = 32%

Ksh 131.48 (total value added after purchase of tree to end of chain)/17 (no of business chains) = Ksh 7.73 (ave total added value) 4.28 as prop of 7.73 = 55.36%

6 Oginosaku (2001): In his 83 plot botanical and ecological survey he found that the highest number of trees and shrubs occur in the marginal coffee and cotton zones – however though, they have the largest number of trees, they have a fewer number of species. He found that indigenous represented a higher percentage of all trees in the lower zones, whilst exotic species are a higher percentage in the upper zones.

7 Not included in the average data are the single species results from one household of Militia dura,(40 trees) and Juniperus procera (20 trees).

8 Sample size from coffee zone (16) and cotton zone (15)

9 refer Annex 2: Number of Trees and Densities in the two zones; and Average Volumes in the two zones, - the data from which this table is compiled)