Working Paper

An assessment of farm timber value chains in Mount Kenya area

The application of the "filiere" approach to small and medium scale farm timber businesses

Christine Holding Anyonge, Steven Franzel, Paul Njuguna and James Oncheiku

World Agroforestry Centre
TRANSFORMING LIVES AND LANDSCAPES

An assessment of farm timber value chains in Mount Kenya area

The application of the "filiere" approach to small and medium scale farm timber businesses

Christine Holding Anyonge, Steven Franzel, Paul Njuguna and James Oncheiku

LIMITED CIRCULATION

Correct citation: Holding Anyonge C, Franzel F, Njuguna P and Oncheiku J. 2011. An Assessment of Farm Timber Value Chains in Mount Kenya area: The Application of the "Filiere" Approach to Small and Medium Scale Farm Timber Businesses. ICRAF Working Paper No 124. Nairobi: World Agroforestry Centre. **http://dx.doi.org/10.5716/WP12033.PDF**

Titles in the Working Paper Series aim to disseminate interim results on agroforestry research and practices and stimulate feedback from the scientific community. Other publication series from the World Agroforestry Centre include Agroforestry Perspectives, Technical Manuals and Occasional Papers.

Published by the World Agroforestry Centre
United Nations Avenue
PO Box 30677, GPO 00100
Nairobi, Kenya
Tel: +254(0)20 7224000, via USA +1 650 833 6645
Fax: +254(0)20 7224001, via USA +1 650 833 6646
Email: worldagroforestry@cgiar.org
Website: www.worldagroforestry.org

About the authors

Christine HOLDING ANYONGE
Coordinating researcher and author
Contact:
via Focilide 39 (2a), Axa, Rome, 00125, Italy
Email: Christine_Holding@yahoo.co.uk

Steven FRANZEL
Principal Agricultural Economist
World Agroforestry Centre,
United Nations Avenue
PO Box 30677, GPO 00100, Nairobi, Kenya
Email: s.franzel@cgiar.org

Paul NJUGUNA
Natural Resources Manager
Mount Kenya East Pilot Project for Natural Resources Management
PO Box 996, 60100, Embu, Kenya
Email: njugunapmacharia@yahoo.com

James ONCHEIKU
Environmental Scientist
The Kenya Forestry Research Institute
PO Box 20412, 00200, Nairobi, Kenya
Email: joncheikukefri@yahoo.com

List of abbreviations and acronyms

BF	Board foot
DBH	Diameter to Breast Height
FAO	Food and Agriculture Organization of the United Nations:
GOK	Government of Kenya
Ha	hectare
IFAD	International Fund for Agricultural Development
IIED	International Institute for Environment and Development
IUFRO	International Union of Forest Research Organizations
KFWG	Kenya Forests Working Group
MAI	Mean Annual Increment
MKEPP	Mt. Kenya East Pilot Project
NGO	Non-Governmental Organization
UNEP	United Nations Environment Programme

Abstract

This paper describes and analyses a sample of value chains of timber sourced from farms in the Mount Kenya area. A combination of research methods were used including focus group discussions, a timber business census, and an in-depth business questionnaire applied to a stratified random sample of timber businesses and their value chains. The research methodology and value chain survey tool are based on the methodology of "filiere" analysis. The business questionnaire includes the institutional dimension (the identification of direct and indirect actors), the technical dimension, (conversion rates and efficiency), and the economic dimension (value added at each stage of the chain). Eight distinct processing stages (possible actions) were identified in the various value chains described by the survey from the farm to the end user. Value chains varied as to how they combined or amalgamated the eight different stages along the length of the chain. Adequate data enable a detailed analysis of 17 of those chains working with *Grevillea robusta*. The results of the various research components are presented and comparisons are made between the form and structure of the chains. The role of ownership or hiring of different stages of the chain is discussed. Recommendations to raise farmers' returns and enhance value chain efficiency are made. The technical dimension of the farm timber value chains, conversion rates and efficiency are key elements in overall returns and value added. As a result of this research the World Agroforestry Centre has initiated training activities which address skills upgrading in the handling and processing of farm-produced timber. Future possible scenarios of market-oriented farm timber production and conditions required for their viability are presented.

Keywords: smallholder timber value chains; "filiere" approach; coffee and timber agroforestry systems; eastern Mount Kenya, Kenya

Acknowledgements

The authors are grateful to the field assistant, Peter Mungai, who was instrumental in collecting the census data. We would also like to acknowledge the contribution of the business operators who took the time to respond to the longer business survey questionnaires, and hope that the findings go some way in supporting future development of the sector.

The authors would also like to recognize the contribution of the Meru and Embu district agriculture and forest offices, Forest Action Network and the local chiefs who supported the research activities and facilitated the focus groups. We also acknowledge our Centre colleagues, Sammy Carson and Jonathan Muriuki, whose in-depth knowledge of Meru and Embu districts was indispensable during the early phase of this research. Finally, thank you to Jim Roshetko (ICRAF Southeast Asia) for reviewing this paper.

Contents

List of figures

List of tables

Introduction

Wood product markets as incentives for farmers' tree growing have been documented in the global literature for some time (Arnold and Dewees 1997). Arnold (1987) argued that under particular conditions, as farm sizes decline, production objectives can change from the growing of food to the generation of income, and that the incorporation of trees into farming systems is often a response to this change in production objectives. Farmers' decisions about tree growing are influenced by the advantages to be obtained from them. Important products obtained include fruit, timber, fuel, medicine and fodder for home consumption and for sale. Farmers also appreciate the presence of trees in reducing exposure to risk, and in improving the sustainability of the system (Shepherd 1989; Warner 1997).

A shortage of local forest resources is often the catalyst of spontaneous expansion of smallholder agroforestry systems. This type of farmer-led spontaneous smallholder agroforestry development has occurred in many countries including Bangladesh (Byron 1984), Sri Lanka (Gunasena 1999), Philippines (FAO 1998; Magcale-Macandog et al 1999), Kenya (Scherr 1995; Place et al 2002) and Indonesia (Michon and Bompard 1987). With the expansion of areas under forest protection, bans on logging and restriction of access to natural forests in countries like Indonesia, Philippines and Thailand, smallholders have found alternative sources of tree products and ways of integrating trees into their farming systems through on-farm tree growing and forestry plantations (Snelder and Lasco 2008). In addition, proximity to urban centres creates high demand for timber (Wells et al 2000) fruit and other forest products, and stimulates spontaneous smallholder agroforestry. This is particularly true for areas far away from the extractive forest frontier or with farms large enough to support tree crops in addition to seasonal cash crops (Schuren and Snelder 2008). In other situations (e.g. in central and east Java) the temporary migration of young people to cities, with the older generation living on the land less able to engage in intensive agriculture practices, results in extensification of land use with tree farming as a form of a 'living saving account'. Under these conditions, smallholder farmers see tree farming as a means of diversifying their production, reducing risk, and building assets to enhance family incomes and security (Roshetko et al 2008).

In the late 1990s tree planting on farms in East Africa was documented (Tyndall 1996; Warner 1997) as providing a range of services such as protection against wind and soil erosion, to enhance soil fertility, as well as to provide fuelwood and fruit for family consumption. It was noted then that market demand was becoming a "subsidiary factor" encouraging the growing of trees, especially for fruit and poles (Tyndall, 1996). Scherr (1995), Warner (1997) and Landell-Mills (2002) noted that market influence among tree growers is likely to increase as access to markets improves, as farmers become more aware of income possibilities and as off-farm tree stocks either become more depleted or less accessible due to conservation measures. Moreover, demand for tree products is increasing as population and income increases (Wells et al 2000; Roshetko et al 2008). Warner (1997) also noted that "government policies were beginning to focus on the small farm as the producer of tree products for the nation, rather than the large commercial plantations or national forest reserves". Dove (1997) documents the shift in tree cover from forests to farms in Pakistan. In Kerala, India smallholder systems provide 83% of the state's wood production and up

to 90% of its fuelwood production (FAO 1998). Sri Lankan smallholder systems produce 73% of the nation's timber and 80% of its fuelwood (Gunasena 1999).

In the context of Kenya, Dewees and Saxena (1997) indicated that tree growing may be an attractive land use to those households which have problems of either capital or labour availability. Trees require low levels of capital to establish and maintain, and can provide income for households which might otherwise be excluded from growing cash crops because of lack of access to investment capital, or lack of labour to cultivate more intensive crops. Unlike virtually any other crop, trees can be harvested whenever the household needs for cash are the greatest. Dewees and Saxena (1997) documented an array of land, labour and capital interactions at household level that affect tree planting. They noted that many of those interactions are exogenous to rural afforestation policy and planning processes, and that consequently forest departments and other agencies with rural forestry responsibilities are often entirely unable to influence the most significant factors which result in the adoption of tree planting practices on farms. Masipiquena et al (2008) raises questions about the over-regulation and under-marketing of timber in the Philippines and M. Bertomeu (2008) asks if smallholder tree farmers can help revive the timber industry in deforested tropical countries. Snelder and Lasco (2008) reveal that large scale reforestation projects of the 20th century have often been less successful than anticipated, and that tree growing by smallholders – as an alternative to combat desertification and deforestation and promote sustainable land use – has received little attention from the scientific and development communities.

Overall, the potential of agroforestry systems for sustainable land use has long been recognized, but their potential to produce commercial timber has only been reported in a few cases (Beer et al 2002; Scherr 2004). Even fewer cases deal with the industries, often small-scale themselves, that buy timber from farmers.

The supply and demand conditions causing increases in smallholder wood production and marketing described above are evident in Kenya. Here, the enforcement of a logging ban on the forest estate in the late 1990s, resulted in the farm estate becoming the primary supplier of timber and poles. This was achieved a number of years earlier than the date predicted (2010) by the Kenya Forest Master Plan (MENR 1994).

The research described in this paper undertaken in the early 2000s captures the moment of transition from when the bulk of timber and wood products was sourced from the forest estate to the period when it was sourced from the agricultural and farm landscapes. Industry and farmers were ill-prepared for this sudden and unanticipated transition. By the time this research was undertaken many of the larger mills had closed due to lack of timber from the forests. The research documents the ad hoc market chains that emerged at the time, sourcing timber from the farm estate to the surviving businesses.

The objective of the research is to (1) assess the technical, economic and institutional aspects of those market chains, (2) describe the characteristics of those market chains that provide the best returns to the farmer, and those that provide the best added value to the business purchasing the wood, usually a furniture maker or a timber yard owner, and (3) assess problems and opportunities for improving the performance of the chains such that smallholders and other market actors can achieve greater benefits.

Recommendations, both for future research and development programme implementation are made.

Conceptual framework and research hypotheses

According to Bernstein (1996), the original inspiration of the *filiere* approach in French industrial economics was to uncover and analyse price information in the journey of a commodity from raw material to final product, through its various stages of physical transformation including processing, manufacturing, transport and storage. The approach specifically addresses social relations, institutional structures and political economy to complement premises of conventional economics.

The methodology and application of the "filiere" approach to the analysis of agricultural market chains is described in the training modules developed by Freud and Dabat (2000). The term *filiere* means a "thread" and refers to a market chain, encompassing the stages from the producer of the raw material to the customer or consumer. The data collection and analysis of the *filiere* are grouped into three components: technical, institutional and economic (Box 1).

Box 1: The three dimensions of *filiere* (market chain) analysis (Freud, Dabat, 2000)

The technical dimension

- What operations?
- With what techniques?
- What performance (productivity)?
- Which technical constraints limit enhanced efficiency?

The institutional dimension

- Who are the actors (direct and indirect)?
- What is the relationship between them?
- What are their individual and/or collective objectives?

The economic dimension

- What are the costs and benefits of operations for each stage of the chain?
- What are the costs and benefits along the whole chain (proportion of the final price amongst the actors, proportional allocation of the value added along the *filiere*)?
- What are the strong and weak transfer points in relation to prices, costs, between stages in the value chain? How are these points affected by changes in prices and costs?

The hypotheses of the research were that:

1. The market chains for sourcing timber from farms are inefficient. Economic, technical and institutional efficiency[1] can be improved, in order to increase returns to actors along the chain and to promote sustainable timber harvesting.

[1] Economic efficiency: lowest cost per unit output (Crawford (1997). Technical efficiency: volume of output per unit of timber on farm (Oncheiku 2001). Institutional efficiency: degree to which the various actors in the chain coordinate, or stages in the

2. Different business categories and chain structures pay farmers different rates per board foot (BF) of standing timber. The research seeks to identify which chain structures have the least costs and why.

3. The communication concerning knowledge, attitudes and practices between smallholder farmers and businesses is weak, such that neither is attuned to the constraints and opportunities of the other within the market chain.

4. Policies issued by government ministries and local administration with regard to farm timber production lack clarity and are a disincentive to farmers investing in planting, or retaining natural regeneration of, indigenous species.

Description of research area

The research was carried out on the eastern slopes of Mount Kenya. Ecological zones correspond to the gradient of the mountain slopes and its low lying areas: the tea and coffee zones are on the higher gradients and the cotton and tobacco zones are on the lower ones. The indigenous species in the mountainous forest are predominantly *Hagenia abyssinica, Juniperus procera, Prunus africana* and *Vitex kiniensis.* The species in the government plantation estates are *Cupressus lusitanica, Pinus patula, Pinus radiata* and *Eucalyptus.* The research was conducted in the agricultural zones where trees were grown in large numbers on farms. These were predominantly the coffee, cotton and tobacco zones. The business survey was conducted where businesses are located along the principle arterial road in the coffee zone. Farm timber, however, was sourced from all three agro-ecological zones. Farm sizes range from 0.4 ha to 0.8 ha and are privately owner occupied (pers. comm., Meru Central District office).

The volumes of trees on farms in the 1990s and early 2000s were largely a result of social forestry programmes in the 1980s (Shepherd 1989). During those years, the functional uses of trees were promoted and emphasised, such as for soil and water conservation, coffee shading, soil fertility and mulching, firewood for domestic consumption, compound shade and ornamental decoration. *Grevillea robusta* was the predominant species planted by farmers. It is planted mostly along boundaries and is compatible with other agricultural crops (e.g. maize). Densities average 76 Grevillea stems per ha (Tyndall 1996*)* In the Mount Kenya area, 155 different tree species have been recorded on farm (Betser et al 2000), and 200 different species were identified on farm (Oginosako et al 2006) with a significant retention of indigenous trees including *Cordia abyssinica, Vitex kiniensis* and *Prunus africana*. Since farm-grown trees are often used for both timber and firewood, there are household and gender decision-making interfaces between domestic use of trees for firewood (women), and trees used for sale as commercial firewood and timber (men). These decisions affect the volume and quality of farm-sourced timber available for marketing.

---

chain are coordinated. Institutional efficiency may be influenced, for example, by whether the different stages of the chain are owned and operated directly by the business, or whether different stages are hired out.

Holding et al (2006) found that the average number of timber[2] trees per hectare was 77 in the cotton zone and 155 in the coffee zone. The survey noted that almost twice as many trees are sold per household as are felled for domestic use. Proportionally more trees are sold per household in the cotton zone. The study also noted a shift in choice of planting niches towards boundary planting and woodlots. Direct income requirements would be best met by exotic species, such as grevillea, eucalyptus and *Cassia siamea*. However, indigenous species such as *Cordia africana* and *V. keniensis* are highly valued and there is evidence of strong retention on farm. In this survey an emerging concentration on a narrow range of fast growing exotic species to meet commercial timber and firewood demands was observed. It was noted that given felling rates, actual volumes, mean annual increment and current planting rates, the yield of trees on farm for firewood and timber would probably suffice for another three years only.

MKEPP (2008) surveyed a comparable cross-section of agro-ecological zones and communities and indicated that farmers still continue to plant trees. The main uses for trees were recorded as firewood (93%), fruits (79%), timber (78%), poles (64%) charcoal (43%), fodder (28%), herbs (20%), amenity (8%) and honey (5%). There were an average number of 96 trees per hectare over the five catchments surveyed. The MKEPP report also noted that communities are currently using the "standing wood stock" instead of the "interest" and hence there is no sustainability in harvesting practices. The number of timber trees per ha in a coffee agroforestry system, to avoid excessive competition with light, water and nutrients, should not exceed 100 stems per ha (Beer et al 1998). The number of timber trees per hectare recorded in both Holding et al (2006) and MKEPP (2008) are near or above the maximum number of stems allowable.

Methods

The research process used several methods as discussed below.

Focus group discussions

A series of exploratory focus group discussions were conducted in Meru in 1999 with saw-millers and farmers to ascertain their views on the problems they were facing as a result of the recently introduced logging ban, and possible solutions and opportunities. The outcome of these discussions act as a triangulation to the data, field observations and conclusions from the analysis of the 17 market chains reported elsewhere in this paper.

Business census

At the outset of this research it was not known how many timber businesses existed in the research area, nor their location, types or principal characteristics. The authors therefore conducted a census of the timber businesses in the research area in 2000.

[2] Defined as those trees grown on farm, from which timber was a potential product, depending on eventual household decision-

Two hundred and forty-six (246) businesses were located and identified, and some initial data collected from them, including:

- Location
- The principle activity (type) and size of business
- Tree species utilized and preferred
- Stock of timber and of finished products
- Customers
- Trends over the last five years or so noted by the respondent in raw material sourcing and product demand
- Size of business, as determined by level of capital investment (machinery) and number of employees.

Business sample

The business census enabled the formulation of a stratified sample for further analysis of the supply chains to the businesses. Three parameters were chosen to enable selection of this next stage of the sample:

- Type of business
- Size of business (capital investment and number of employees)
- Location of raw material sourcing prior to the logging ban: farm; indigenous forest; plantation; and mixed/multiple-sourcing.

The census identified a spread of business categories and sizes. Businesses were stratified by the main source of raw material for timber businesses prior to the logging ban, that is, whether from the farm, forest, plantation, or mixed. Between 15% and 20% of each category was selected for sampling. The resultant sample included farm sourcing (7), forest sourcing (13), plantation sourcing (7), and mixed sourcing (14). In-depth interviews were conducted with these businesses using a timber business and supply chain questionnaire.

Business and *filiere*/value chain questionnaire design and pre-test

The questionnaire used to interview the businesses was developed according to the theory and principles (Bernstein 1996) of the *filiere* approach described by Freud and Dabat (2000) and Bourgeois and Herrara (1998).

The pre-test identified a wide variety of actors and stages in the marketing chains. The categories of actors directly involved in the chains, referred to as "direct actors", were identified as:

- Male and female farmers (managing the standing tree, selling)
- Power-saw operators (felling, cutting, crosscutting and in some cases splitting)
- Mobile saw benches (splitting on site, splitting in town, splitting service)
- Transporter**s** (loading, transporting, off loading)
- Saw-millers, (splitting, producing side products (off cuts; firewood),
- Timber yards (splitting)
- Furniture workshops
- Customers.

The pre-test enabled the development of a questionnaire with great specificity for each stage of the timber supply chain. The pre-test results also indicated the existence of varying degrees of vertical integration, with some chains conducting the whole sourcing procedure directly, others subcontracting each stage, with a full range of combinations and options in between.

Some businesses were found to be combining power-saw and mobile saw, and contracting transport; others were combining mobile saw bench and transport, but contracting for power-saw operations and loading labour. The survey tool/questionnaire therefore had to be flexible enough to take into account these variations.

The questionnaire gathered technical, institutional, financial and economic information for each stage of the farm timber chains supplying the sampled businesses. In addition, a section on business practices was included to enable comparison of the profitability and sustainability of businesses sourcing timber from farms. This enabled the calculation of the transfer price for a standard volume (board feet or BF) of wood (timber) between stages, the net margins at each stage, and added cost per standard volume along the supply chain. The questionnaire also included an open discussion section which allowed for comments on institutional constraints and opportunities as perceived by the respondent.

The structure of the questionnaire also enabled the recording of seasonal variations and volumes of raw materials, sourced and purchased during different seasons of the previous year. Business income was estimated from volumes of sales of processed timber and finished products.

Conversion rates study

A study was conducted of conversion rates using power-saws and mobile sawbenches (Oncheiku 2001) to enable the conversion of data gathered based on average diameter to breast heights (DBHs) into comparable forms of yields in BF. Farmers were selected for the study in Meru central district, from whose farms mature *Grevillea robusta* trees were identified, no more than three from any one farm. The total and merchantable lengths of the trees were measured and recorded. Each tree was cross-cut into as many logs as it could produce depending on its merchantable length. All logs were then transported manually to a central place from where they were sawn using powersaws and mobile sawbenches fitted with circular sawblades. The sawn timber yields were computed and each calculation was based on the conversion of a total number of nine logs, three logs (top, middle and bottom) from each of three trees. The process of tree felling, cross-cutting and sawing of the logs was carried out using skilled and unskilled manpower. Data was collected for both a skilled and an unskilled sawbench operator, and a skilled and unskilled powersaw operator. The data gained from this study facilitated the conversion of reported volumes to a standard measure of board feet at each stage of the chain

Results

Focus group discussions

Results of focus group discussions on constraints and solutions with a group of farmers and a group of saw-millers are given below.

The problems identified by farmers were:

- Prices of tree offered were very low
- Lack of tree valuation techniques
- Small farm size meant low tree holding capacity
- Conflicts with neighbours during felling
- Chiefs and forester permits were required to fell trees
- Poor tree management for the end purpose of timber production
- Poor practices of pruning, lopping and pollarding
- Lack of tending knowledge (water, pest and disease)
- Farmers only sell trees when they are "desperate"
- Lack of information on wood utilization options
- Family conflict with regard to tree ownership[3]
- Planting location affects value
- Places that are difficult to harvest, either steep slopes or near buildings, affects the price paid
- Transportation of harvested trees

Solutions proposed by the farmers included:

- Prices are better when farmers transport the trees than when saw-millers come to the farms.
- The forest department or extension services should provide guidelines and techniques on volume estimation so that farmers can calculate prices more effectively.
- Farmers should form associations or societies to facilitate market linkages.
- Information on commercial and forest department prices should be made available to farmers.
- Information was requested on techniques of tree management, species thinning, and pruning for timber production.
- Farmers should solve family conflict and clarify the issue of ownership of trees on their farms.
- There should be agreements with saw-millers in the event that there is damage to any property e.g. houses.

[3] This can be either *between generations*… a father can sell all the trees on a portion of the land before handing it over to his son…or *between genders in the same household*…the women may have ear marked the tree for domestic firewood or animal fodder. See also World Bank / IFAD / FAO (2008).

- Once a price is agreed upon, farmers could commit to felling and bringing logs to a collection points accessible by lorry or tractor. This would not only ensure that transportation costs are shared, but would also limit the liability experienced by saw-millers of felling trees near houses or amongst standing crops.

Saw-millers in their focus group noted that, in general, they had more information than farmers on the valuation of timber trees. The key issues they raised were:

- There are problems acquiring logs/trees from farms, because of both the actual logging and the poor road network.
- There is a need to improve technical efficiency; saw-millers estimated recovery rates to be as low as 20%.
- There is a need for a guaranteed, sustainable supply.
- In the current situation many enterprises had outdated machinery (low capital investment) and poor recovery rates.
- There is need to identify possible avenues of adding value to farm timber such as fair trade certification.
- The demand for Grevillea timber is low due to its "floury" quality and susceptibility to insect attack. Information on better utilisation of grevillea is available in research offices, but needs to be disseminated.
- Knowledge of existing supply and location of trees/logs on farm is required. For saw-millers used to harvesting allocated blocks from plantations or selective felling in forests, information on supply for farms appears scanty.
- Saw-millers expressed an interest in being trained on techniques to improve quality during processing, in enhanced valuation techniques for more accurate pricing; in getting a more precise idea of end-user requirements, and in exploring the possibility of cost sharing and linkages between farmers (associations) for addressing transport problems. Possible entry points through already existing local institutions were mentioned such as saw millers' associations; soil and water catchment committees, and men's water groups[4].

[4] Various types of women's group exist in the research area but were not mentioned during the focus group discussions, possibly due to low representation of women in these two focus groups, and the gender bias towards men in the commercialization of firewood and the trading of timber.

Business census and business and farm timber value chain questionnaire

As a result of the census, 11 different types of timber-related businesses were identified. Principle among these were: furniture workshops (168), timber yards (30), sawmills (14), furniture show rooms (11); joinery – doors, window frames etc. (10), piece work to order (7), machine shops (2), and others[5] (9). This census took place after the closure of the principle sawmills which had been reliant on the supply of raw materials from government plantation estates. This was evident in the census results, where no large sawmills or timber yards were identified in the course of the census.

The business questionnaire was designed, the data collected and analysed according to the three components of *filiere* analysis: institutional, technical and economic. The results of the business questionnaire are therefore presented in these three categories.

Of the 43 businesses interviewed, 17 provided sufficient data for a full analysis of the stages of value chain from the farm to the respondent's business. Qualitative and observational data was obtained from the remaining 25 respondents.

Complete results to the questionnaire were obtained from those businesses who had been sourcing from and continued to source their products from farms or were engaged in "mixed" sourcing. Those who had been sourcing from plantations and forests provided little or no information, perhaps because they were still purchasing wood illegally from these sources. The data presented and discussed below therefore reflect only those businesses that were sourcing from farms and functioning legally.

(i) Institutional factors

The direct actors along the supply chain were predominantly young male adults. Occasionally women owned and coordinated the contracted transport. We had intended to characterize customers according to destination, distance, age, economic status, gender, life cycle status and education. However, the only information retained by the businesses concerning customers was on destination of the product sold.

Consumers were local rural residents, and those from nearby towns or from more distant urban centres. The general trend was for consumers from further afield to buy the more expensive (indigenous timber) items, whilst local, rural residents purchased the cheaper grevillea furniture. Businesses with secure onward sales, either through furniture or construction timber contracts, had more efficient and coherent market chains from the farm than those that did not.

Raw material sourcing and sales vary depending on seasons and months of the year. Supplies fluctuate between high and low season depending on the weather. The dry season means higher supply since roads are more accessible and smallholder farmers are seeking cash between cropping seasons. In contrast, during the rainy season, supply diminishes due to lack of accessibility to farms and the presence of standing crops, making tree harvesting difficult.

It was noted that sales of products also vary depending on the time of year. For example, construction activities peak in August during school holidays and civil

[5] Coffin makers, restaurants, and firewood and charcoal sellers.

servant vacations. Furniture sales rise in anticipation of the festival and wedding seasons, notably when bonuses have been paid out to tea farmers in December, during the Christmas period, and immediately after Ramadan. Demand for school furniture is highest in January, at the start of the school year.

Saw-millers' associations did exist, but the members had tended to be the larger sawmills who had been sourcing timber from plantations and forests, and which were in the process of closing down at the time of this survey. Small and medium enterprises were not members of the associations at that time.

Figure 1 shows an indicative structure of the most commonly occurring market chain. The range of charges paid by the 17 businesses for the principle alternative stages of the chain is also indicated. In the majority of cases, all stages of the *filiere* were owned, or contracted for, by the businesses interviewed. The standing tree was purchased on-farm, and the timber and by-products were owned by the business along the length of the processing chain. The range of farm gate prices paid per BF is indicated in Box 2.

The indirect actors were the contracted transporters, agriculture and forestry extension services; the forest department and the local administration (chiefs' offices); the tea and tobacco industry; and the brokers. The forest department and chiefs' offices were responsible for issuing permits for felling and transporting trees from farms. Although the law only applied to indigenous trees, the local administration also arbitrarily apply these permits to non-native trees. In addition to the costs of travelling to the designated forest department or chief's office, the farmers were often charged an unofficial fee before being issued with a permit. Transport permits were necessary for transport beyond the district boundaries. The checkpoints did not differentiate between trees or species produced on farm and those from the forest. In addition, these permits were only required for logs and split timber; they were not required for furniture (i.e. timber already converted to furniture).

There were brokers between the businesses and the farmers. Some of the brokers were freelance; others were employees of timber businesses. Sometimes the business owner conducted this service himself. Brokers played the role of "scout" and were especially needed due to the difficulty of locating timber for sale on farms, or knowing exactly which farmers had harvestable trees of sufficient quantity to fill a lorry or tractor load and were willing to sell. Scouts would identify groups of farmers in an area, which together had sufficient quantity of timber to sell to warrant the displacement of transport. Then they would negotiate the price and "set up the deal" for the business. The brokers do not handle cash, purchase or own the timber.

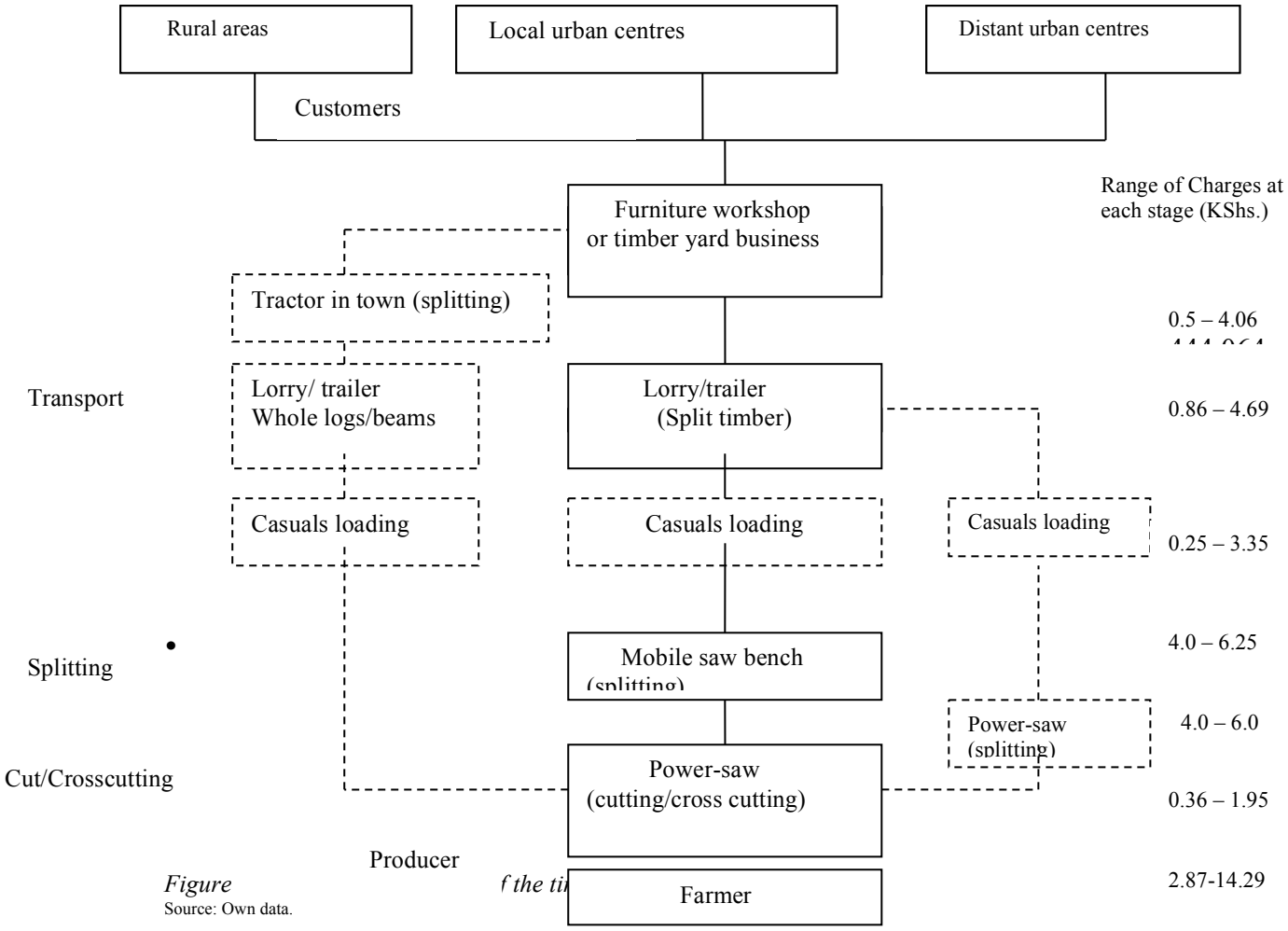


Figure *f the ti*

Source: Own data.

Notes: The chain indicated in solid lines includes the most commonly occurring structure and stages of the market chain from farm to business. Alternatives or additional stages are indicated by dotted lines. Power-saw, mobile saw bench and tractor in town were alternative ways to split timber. Any one market chain would involve only one of these three alternatives for splitting timber. Casual labour loading was sometimes an additional charge to transport, while at other times it was included in the transport charge. Business practices varied as to whether they owned (some or all) or hired during (some or all of) these stages, creating considerable additional variability in the survey results. The charges indicate the amount paid for the activity at that stage of the chain.

Another factor of potential importance influencing the efficiency of the chain was whether the business performed the operations themselves or hired others to do them. From the case studies, it is clear that this issue affected technical efficiency. The key factor in technical efficiency was the management and supervision of the various stages, and it appeared that the smoothness of transition between one segment of the chain and the next, as well as the management and supervision of the different stages, were affected by whether respective stages were performed by the owners themselves or hired out. The more tasks were hired out, the greater the costs from the conversion of the standing timber on farm until the split timber reached the business (Table 1). The average added cost to those businesses performing operations using their own employees, equipment or machinery, was 7.4 Kenya shillings (Ksh)[6] per BF; those

[6] USD 1.00 = 75 Ksh, in 2000, the year the data were collected.

who hired all operations was 8.1 Ksh per BF; and those who performed some stages and hired machinery and labour to execute others was 7.8 Ksh per BF.

Table 1: Association between whether enterprises performed operations at different stages of the "filiere" or hired service providers to conduct them

	Numbers of cases	Cost (Ksh/BF) standing tree	Additional cost from standing tree on farm to business gate (Ksh/BF)	Total cost including cost paid for standing tree and all operations along the chain (Ksh/BF)
Owners did all operations themselves	3	6.5	7.4	13.9
Owners did some operations and hired others out	6	4.5	7.8	12.3
Owners hired out all operations	5	6.7	8.1	14.8
Total	14			

Note. Information was incomplete for the other three enterprises in the sample.

Source: Own data.

(ii) Technical factors

Board feet were the standard of measurement used as a standard of comparison for the timber as it passed along the market chain. However, not all actors involved in the supply chain, particularly farmers, power-saw operators or transporters, were familiar or conversant with these measurements. The results of the conversion rates study (Oncheiku 2001) and respondent verifications were triangulated to enable accurate recording of volumes of timber at each stage of the chain. In addition, Mean Annual Increment (MAI) calculations estimates for Grevillea were obtained from research conducted in the same ecozone (Muchiri 2001).

In a quantitative assessment of sawn timber yields, we found that a skilled operator of a mobile bench can almost double yields, relative to an unskilled operator (Table 2). The unskilled power-saw operator converted the logs into timber without pre-determining the sizes on the basis of the log geometry and the log diameters. The choice of the power-saw to use was also arbitrarily done without considering the width of the cut. The overall average sawn timber recovery was 27%. The skilled power-saw operator determined the sawnwood sizes before sawing recovering the biggest sizes first, and then the smaller sizes. The skilled saw bench operator predetermined sawn wood sizes on the basis of log diameter. The highest recovery rate was 59%, while the lowest was 37% when the logs were converted using the mobile sawbench operated by experienced manpower. The average sawn timber recovery rate was 45%.

This research demonstrated that an unskilled power-saw operator was 27% less efficient than a skilled power-saw operator, and an unskilled sawbench operator generates considerable more waste, being 42% less efficient than a skilled saw bench operator. As the tree and its products are owned along the length of the "*filiere*" or value chain by the business, the business carries any losses from poor conversion. It is in the business's interest to improve technical efficiency and conversion rates by both power-saws and tractor mounted bench saws, operating on farm and in town.

Table 2: Comparison of sawn timber yields for different saws and for different levels of sawing skill

Treatments	Timber yield (Board feet/tree DBH 32 cm)[7]
Power-saw operated by unskilled manpower	66.0
Power-saw operated by skilled manpower	91.0
Mobile saw bench operated by unskilled manpower:	59.7
Mobile saw bench operated by skilled manpower	103.6

Source: own data.

The results also demonstrated that an unskilled bench operator can do more damage with a more powerful and faster machine, than an unskilled operator with a power-saw.

(iii) Economic factors

The range of total sales was Ksh 414,000 to Ksh 2,748,000 annually across the sample of businesses and depended on type, size, location, business practices and size of market catchment.

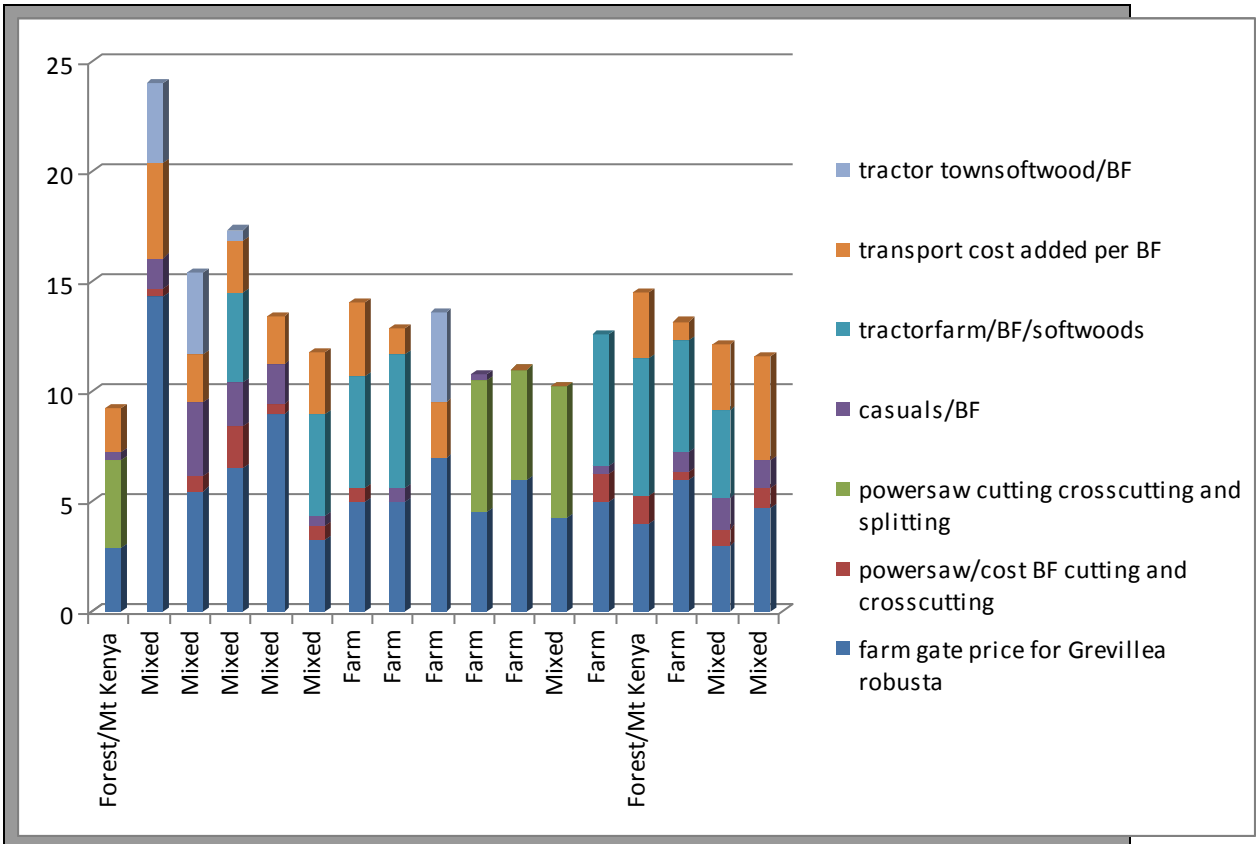
Box 2: The average farm gate price (Ksh per board foot (BF) standing tree)

Grevillea robusta. Range of prices: 4.45 Ksh/BF to 10.36 Ksh/BF. Average price: 5.64 per BF (s.d. 2.71, 17 cases)
Average price paid for *G. robusta* by furniture business: 6.42 Ksh per BF (s.d. 3.70, 8 cases)
Average price paid for *G. robusta* by timber yard businesses: 4.94 Ksh per BF (s.d. 1.22, 9 cases)
The difference in prices paid by furniture and timber yards/sawmills was not significant (p=0.27).
Cordia abyssinica: average price 7.34 BF (s.d. 5.6,12 cases)
Cupressus lusitanica: average price 9.71 BF (s.d. 1.42, 3 cases)

Several factors affected the amount of money farmers received. Furniture businesses paid slightly more per board foot on average than timber yards but the difference in prices was not significant (p= 0.27) (Box 2). Both seek high-quality timber and with a more finished end-product in mind, we expected that the furniture businesses would offer better prices. In general, the quality of management of the trees also affects the price paid. From discussions held with the business managers, a third factor influencing price was identified. If the business had a specific and secure order to meet (e.g. school furniture), then it would be willing to pay more to obtain the trees to meet that order. A fourth factor was whether the enterprise initiated the sale or whether the farmer did so. Sales initiated by the enterprise tended to pay higher prices than those initiated by farmers.

[7] The conversion rate study (Oncheiku 2001) was conducted in m^3. To convert to the more commonly used board feet the following standard rates were used: $1m^3 = 423.764$ board feet
1 board foot = 0.002359743 m^3

Figure 2 presents the proportion of added costs for each stage of the chain. The principle comparisons are between splitting with power-saw, mobile (tractor mounted saw bench) or a tractor in town. The lower prices charged for tractors in town and the mobile saw bench on farm are most likely to be linked to the level of supervision and technical expertise of regularly employed staff using the tractor mounted bench in town



Note: Y axis – Ksh per BF
X axis: former source of wood

Figure 2: Bar chart of added value at each stage of 17 chains analysed
Source: own data

Some chains, such as that described in Figure 3, proved to be ineffective on several counts. It was evident that the business described here was sourcing from farmers and from an agent who still sourced products illegally from the forest. The procurement from the forest was intermittent and insecure, and no real system of obtaining timber from farms was in place. Businesses sourcing from both forest and farm tended to have weak technical and institutional arrangements (power-saw splitting, poor transport and bulking arrangements). The research found that the farm sourcing component of these chain structures experienced great wastage, and hence were the least technically and economically efficient components of chains sourcing from farms. As mentioned earlier, little or no information was garnered from respondents

on the process or stages of the chains that involved sourcing from agents who sourced from the forest.

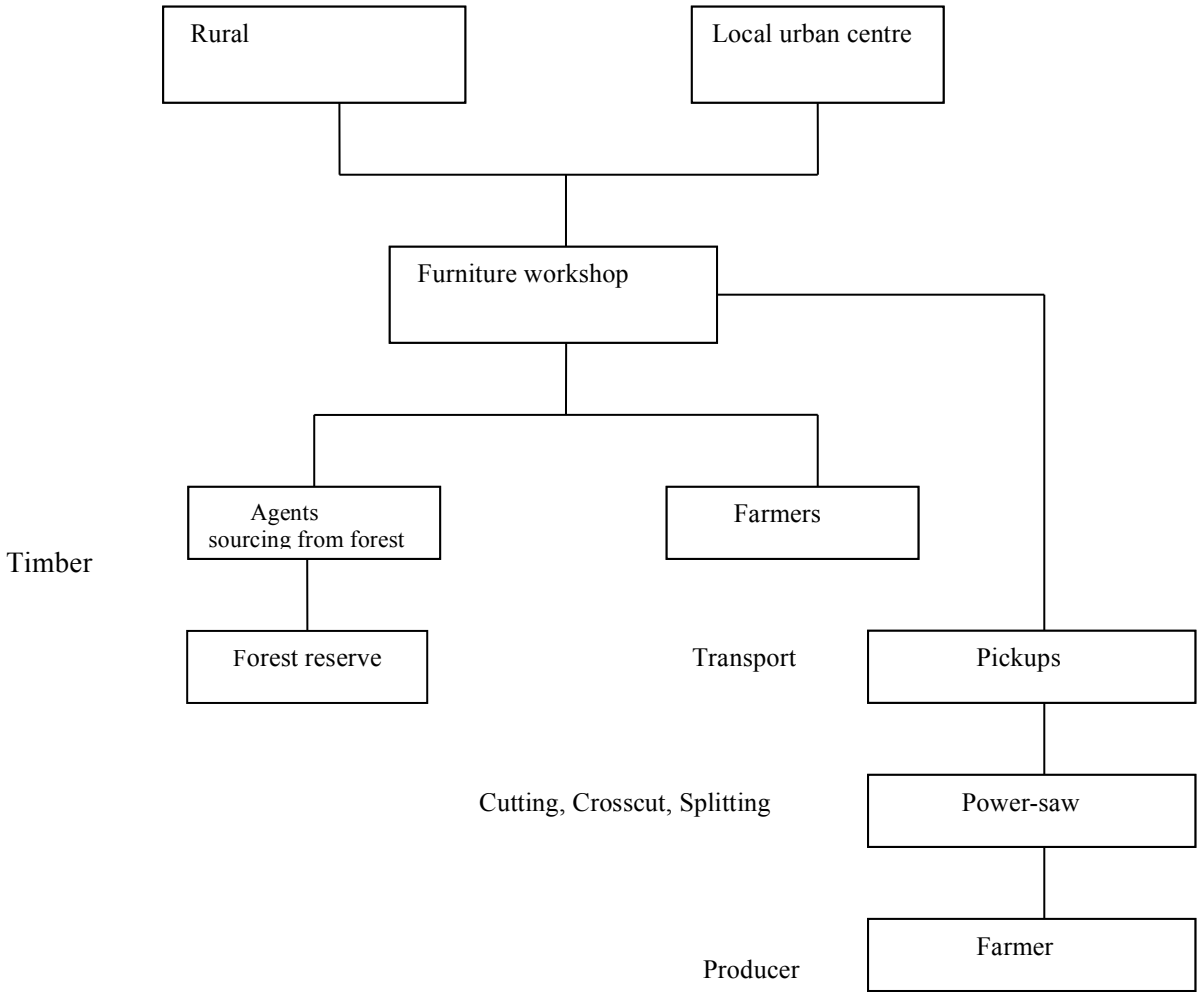


Figure 3: Structure of technically and economically inefficient market chain

Source: own data.

Discussion

A common factor of those value chains providing highest prices to farmers was that they sought timber directly from farmers. The external business paid for and brought in power-saws, mobile benches or transport to town for splitting. In all cases the initial halving or crosscutting of trees was done using power-saws on the farm. The businesses purchasing the timber had onward customers, either via timber sales, their own or another furniture shop (Figure 1). Field observations indicated that the businesses that were buying timber, either from one farm or from a group of farms in

close proximity to complete a tractor or lorry load at one time, experienced a level of transport efficiency. Key institutional, technical and economic factors in determining costs along the market chain were therefore: skilled (as against unskilled) conversion; transport efficiency (cost per BF/km determined by: transport type, whether owned or hired, load volume, full or partial load, distance), and the existence of onward customers (orders for timber or furniture). All these aspects, whilst assisting the business, also provided the farmer with better standing timber prices. Actual prices paid to farmers varied according to the quality of timber, the possibility of fulfilling a transport load in the near vicinity, and the business holding an onward customer order.

By contrast there was a tendency that those farmers who were paid the least for their timber, were those who sought out businesses to buy their timber. These farmers usually needed cash quickly to sort out family emergencies. The businesses were often small, the only transport being either the business's or a farmer's bicycle on which a single tree was ferried from the farm to the business. Typically, the value chain (Figure 3) only comprised the farmer and the power-saw operator; or farmer, power-saw operator and hired transport and then on to the furniture workshop. In the value chains paying less per BF to the farmer, there was no professional processing or sawmilling undertaken. Conversion was solely by power-saw, either at the farm or on the site of the furniture shop.

Small scale furniture businesses without capital investment to produce good quality furniture are also not in a position to offer good prices to farmers for raw material. The transactions between farmers selling single trees to small furniture businesses with no machinery investment, should perhaps be viewed through a different lens compared to those transactions between businesses transacting along the length of the chain, and buying from farmers who produce, sell and negotiate with a higher volume of standing timber. These are two different scenarios. One is a survival-level activity. The other is entrepreneurial and can contribute to the longer term livelihoods, employment and economic growth in rural areas.

Many trees, both indigenous and exotic, had been managed for multiple purposes, pollarded at odd heights and angles, with knots prevalent. Trees, which with better management towards timber as a product, may have been able to provide three logs, only provided one. Timber yields can be improved by training farmers and others along the market chain. However, farmers could still decide to manage their trees for multiple household needs, compromising the quality or quantity of one product in order to increase those of another product. For example, allowing large branches to grow is good for firewood supply but can compromise timber quality.

The data suggest that the chain with the least cost per BF (that is, with the least cost between price paid to the farmer and the price at which the processed timber reached the timber yard or furniture business) were those businesses which had their own transport and which were processing timber using a tractor mounted saw (saw-bench) in town, or where the timber was processed with a mobile saw-bench on farm. The choice of the equipment and operator used was usually made by the business buying the timber. In some *filiere* both the power-saw and bench are owned by the business, in others one or both stages are procured by contract. In some cases the contracted power-saw operator would in turn have rented the power-saw for the assignment.

Power-saws were generally poorly used and maintained, leading to low conversion rates.

There was informal evidence of "leakage" of certain quantities of timber by the tractor teams working on farms, which could account for the greater costs incurred for conversion per BF. Tractor teams on farms are less closely monitored and supervised than tractor teams in town. The technical competence of the team converting the timber, as well as the level of monitoring and supervision are crucial to the economic efficiency and greater timber yields of the chain.

The research did not interview any brokers directly, and did not establish how either the freelance or business employee brokers were compensated for their work. Scouting for supply and the identification of trees for sale in adjacent farms for the purposes of facilitating group transport, if not conducted, could create a technical bottleneck to the *filiere or value chain.* The broker thus appeared to play an important function, contrary to the concept of the "undesirable middleman."

On another issue, it was common for traders to exploit the loopholes in the permit system, allowing them to harvest and work with indigenous trees from the forests. Although the sale of timber from the forest was illegal, the sale of furniture made from timber harvested from the forest was technically not illegal. This created a visual anomaly in the survey area, in that though no indigenous timber was on view for sale on the road side, furniture made from indigenous timber was visibly displayed and readily available for purchase and transport beyond district boundaries.

Conclusion/recommendations

With regard to the first research hypotheses laid out at the beginning of this paper, the research demonstrated the *ad hoc* nature of the market chain, with no two *filiere* being the same. The research has through quantitative analysis and qualitative description, as well as accompanying commissioned studies, demonstrated the ways in which these *filiere* can be improved in terms of institutional, economic and technical efficiencies.

The structure of the value chains between furniture and timber businesses are virtually the same, with no distinctions between key stages or components. The key factors influencing the efficiency of the technical and economic components of the chains were the institutional elements of ownership, management and supervision of the various stages of the chain – from the procurement on farm to the processed timber available for sale from the business (timber yard or furniture maker). Efficiency was best achieved if the business managed and supervised the length of the chain. Ownership of all of the individual stages did not appear to be necessary, but did influence cumulative costs. Factors contributing to variability and efficiency in the chains of the three business types (whether timber had been formerly sourced from farm, from forest, or from both) were similar.

Concerning the second hypothesis, it was shown that furniture businesses pay farmers more Ksh per BF of standing timber (in this case *Grevillea robusta*) than timber yards or sawmills, though the difference was not statistically significant.

On the third hypothesis, the focus group interviews demonstrated that the farmers were aware that they were not taking full advantage of the opportunities provided by timber sales. The farmers cited poor management and quality of the timber (pollarding, knots etc.); poor processing and conversion practices (high level of wastage); and lack of pricing and technical knowledge to enable them to both manage trees for specific products and markets, as well as to negotiate prices with potential buyers as the reasons they were being paid relatively low rates for their trees. Thus, though in theory, trees for timber could provide additional income to farmers, they did not yield the volume nor command the price that professionals in agroforestry may have anticipated.

The focus group interviews noted that farmers expected to gain better returns through enhanced knowledge in tree management to meet market demands, and better information on prices and potential buyers for standing timber.

The results of the discussion of the saw-millers' focus group revealed several factors that were current constraints to the efficiency of the farm timber market chain: lack of knowledge of existing supply and location of trees/logs on farms; location of trees and logging procedures on farm; poor road network; lack of continuous guaranteed supply limiting investment in, and replacement of, machinery. These were further corroborated in the open-ended discussion component of the business survey questionnaire. These observations indicate the weak communication between the timber business (timber yards and furniture businesses) and the farmers and/or their representatives.

Concerning the fourth hypothesis, illegal harvesting continues to distort market chains. Some businesses continue to use agents to obtain materials from the forests or plantations who illegally source indigenous timber from forests. Farmers however are required to obtain permits to fell indigenous species, which they have planted, or are as a result of protected natural regeneration, on their farms. They are therefore *de facto* discouraged from planting high value indigenous species in favour of lesser valued exotic species, for which it is easier to obtain a felling permit. Businesses, both furniture, timber yards and sawmills, that sourced from a variety of sources had less technically and economically efficient value chains. (Figure 3) These businesses also paid farmers less for their standing timber though the differences were not significant.

To optimize returns on planted trees several specific actions are required.

Technological

- A more nuanced selection of species (including indigenous species), reflecting quality provenances and planting sites on farm is needed to enable the management of the growing tree to meet those markets (Holding, Anyonge and Roshetko 2003; Bertomeu 2005). Agencies need to promote

the planting of indigenous species, to reduce poverty, retain farm biodiversity and meet market demand for quality timber. The promotion of *G. robusta* as a timber for furniture and training on treatment of the timber is also needed.

- More training sessions and an increased number of trained power-saw and saw bench operators to improve processing and conversion rates emerged as a core element to improve the technical and economic efficiency of the market chain. The World Agroforestry Centre and its partners started such trainings (Pasiecznik 2006), however they need to be conducted on a far wider and more systematic scale. Yield recovery could be optimized with knowledge of market requirements such as sizes and quantities required. Enhanced efficiency could lead to increases in prices paid to farmers depending on the degree of competition among timber buyers and the farmers' negotiating power.
- Power-saws should be used only for felling, debranching and crosscutting. In addition, mobile saw bench owners should be encouraged to modify their equipment where the logs are fed into, and taken out of the saw to facilitate log handling (Oncheiku 2001). Closer supervision by business owners of mobile saw bench crews on farm is also crucial.

1.

Institutional

- It is recommended that farmers growing trees with a view to marketing timber and/or firewood, form associations for better access to technical information on their tree products concerning species selection, management, policy and pricing. With greater knowledge and capital, farmers' associations may gradually organize group sales of timber and own and manage more stages of the market chain and eventually manage timber processing businesses (Bertomeu 2005).
- Farmers' timber and firewood associations would beneficially include a proportion of women in decision-making capacities to ensure gender-conscious representation and monitoring in decision-making. This would help avoid cases such as those where trees on the farm are sold, and women are forced into a monetized market to procure fuelwood for cooking at home.
- Additional research could be considered on the effects of whether timber and furniture businesses own or hire the different stages of the farm timber chain (and the various alternative combinations of these options), on the conversion rates (technical) and cost (economic) efficiencies of the chain. The research could usefully look at the spread and security of employment opportunities provided by each option.

Policy

- The necessity of enforcing existing laws forbidding harvesting from forests and plantations cannot be over emphasised. Continued access to illegal timber not only depletes biodiversity, but distorts local and national timber markets to the disadvantage of those supplying the market legally. In addition, a review of those laws associated with the harvesting and transport of trees, timber and furniture is also necessary. In the meantime, perhaps the most important action to support farmer tree cultivation and management would be to remove institutional blockages such as the often local arbitrary restrictions on the sale and transport of trees grown on farms, since such

legislative hurdles prevent farmers from freely exercising their entrepreneurial talents (Gilmour 1997; Njuguna and Carsan 2001). A revision of the law would usefully consider such initiatives as franking of indigenous timber grown on farm, which in turn would encourage farmers to grow more indigenous species. The empowerment of farmers, and creation of, and/or support to local representative institutions would reduce the exploitation of farmers by unscrupulous officials, facilitate the planting of a range of species on farms to meet the demands of the local and national timber market, contribute to reducing poverty and enhancing rural livelihoods, and retain biodiversity in the landscape.

- Payments to smallholder farmers in the tropics for stored carbon in their soils and trees are emerging as a component of development policies and programmes. Growing timber can be a complementary activity and payments made to farmers in association with planting trees under carbon schemes, can make important contributions to their incomes (Roshetko, Lasco, and De los Angeles 2007).

Given the increased protection and focus on service provision, including carbon sequestration of natural forests, farms may have an increasing role in providing those tree and wood products previously provided by forests (The Economist 2009). A global satellite survey by Zomar et al (2009) is the first survey to quantify the extent to which trees are a vital part of agricultural production in all regions of the world. It reveals that tree cover exceeds 10% on more than 1 billion hectares (10 million square kms) – which make up 46% of the world's farmlands and are home to half a billion people. From the satellite maps this is especially evident in the Indian subcontinent, eastern and southern Africa, the Sudano-Sahelian belt running from west to east Africa, most of continental Europe, central and eastern United States, central America, eastern and northeastern Brazil. In addition, the tenure of the land, as well as the tenure of the tree and its products are crucial elements in the planning and decision-making of small-scale forestry and agroforestry in the tropics (Gilmour 1997; Franzel et al 2001; Fay and Michon 2005; World Bank/ FAO/IFAD 2008).

The fastest growing demand for wood products is in the domestic markets of developing countries (Wells et al 2000). These markets offer significant economic opportunities for small-scale agroforestry producers. Scherr (2004), Bertemeu (2008) and Masinpiquena (2008) have noted that in many countries of south and southeast Asia trees planted on farms are becoming the most important source of wood. However, as in other countries, the Philippines government has not duly acknowledged the importance of smallholder farmers as timber producers or their contribution to a sustained wood industry. Existing policies, in fact, act as a disincentive to tree planting and the marketing of farm-grown timber. Bertemeu (2008) reports that in the Philippines smallholder farmers can produce large quantities of timber and efficiently supply local and national markets.

Many products from agroforestry trees (fruit, fodder, timber, fuelwood, medicine, nuts, gums and resins) are destined for the market. These informal *filiere* are often an important source of income for millions of the rural poor in developing countries. (Holding Anyonge and Roshetko 2003, Tukan 2004, Russell and Franzel 2004, Akinnifesi 2007). More significant efforts are required by land-use planning, forest and agricultural policy makers to effectively coordinate and support the development

of such market chains and to ensure that legislation and corruption do not hinder the development of these market initiatives (Nawir et al 2007), including those for farm-produced timber. Third party (NGO or other advisory services) facilitation may be useful in the first instance to work with communities and nascent farmers' associations. Revised and effectively implemented local, regional and national policies would open pathways for fair, open and competitive markets (Scherr, 2004), to enable the rural poor in developing countries to access markets for their farm-produced timber and poles.

References

Arnold, J.E.M. 1987. Economic considerations in agroforestry. In *Agroforestry: a decade of development* (ed. H.A. Steppler and P.K. Nair) pp 173 – 80. Nairobi: World Agroforestry Centre.

Arnold, J.E.M. and Dewees, P. 1997. *Farms, trees and farmers. Responses to agricultural intensification.* London: Earthscan Publications Ltd.

Beer, J., Muschler, R., Kass, D. and Somaribba, E. 1998. *Shade management in coffee and cacao plantations.* Agroforestry Systems Vol 38 pp 139-164

Beer, J., Ibrahim, M. and Schlőnvoigt, A. 2002. Timber production in tropical agroforestry
systems of central America. In*:* Krishnapillay B., Soepadmo E., Lofty Arshad N., Wong A., Appanah S., Wan Chik S., Manokaran N., Lay Tong H. and Kena Choon K. (eds) *Forests and society: the role of research. Sub-plenary session, Vol 1, XXI IUFRO World Congress, 7-12 August 2000. Kuala Lumpur, International Union of Forest Research Organisations Secretariat, Vienna, Austria and Forest Research Institute Malaysia, Kuala Lumpur, Malaysia. pp 777-786.*

Bernstein, H. 1996. The political economy of the maize "*filiere*". *Journal of Peasant Studies Vol 23 no2/3 pp 120-146.*

Bertomeu M. 2005. Reviving the Philippine wood industry with farm-grown trees: evidence from Northern Mindanao. *Trees in agricultural landscapes: smallholder tree growing for sustainable development and environmental conservation and rehabilitation.* Chapter I Laguna, Philippines. World Agroforestry Centre, SEA Regional Office.

Bertomeu, M. 2008. Can smallholder tree farmers help revive the timber industry in deforested tropical countries? A case study from the southern Philippines. In Snelder, Denyse J. and. Lasco, RD (eds). *Advances in agroforestry. Smallholder tree growing for rural development and environmental services, Lessons from Asia.* Dordrecht, the Netherlands*:* Springer. pp 177 - 191

Betser L., Mugwe J. and Muriuki J. 2000. On-farm production and marketing of high-value tree products in the central highlands of Kenya. In: Temu A.B., Lund G., Malimbwi R.E., G. S. Kowero; K. Kleinn; Y. Malande & I. Kone Proceedings of a workshop held at Arusha, Tanzania, 1999. The African Academy of Sciences, pp.226-240.

Bourgeois, R. and Herrera, D. 1998. Filières et dialogue pour l´action. La Methode *CADIAC* CIRAD.

Byron, N. 1984. 'People's forestry: a novel perspective of forestry in Bangladesh', *Association of Development Agencies in Bangladesh News* 11, 31-37.

Carsan, S. 2001. Proceedings of the second Meru timber marketing stakeholders workshop. An activity of the Meru Timber Marketing Programme (FAN/MoARD/ICRAF) June 25-26 2001. World Agroforestry Centre, n.d.

Coe, R. 1996. Sample size determination in farmer surveys. Lecture notes, World Agroforestry Centre, Nairobi , Kenya

Crawford,I.M.1997. Agricultural and food marketing management: Marketing and agribusiness. Text 2. Rome: FAO.

Dewees, P. and Saxena, N.C. 1997. Wood product markets as incentives for farmer tree growing. In Arnold M. and Dewees P. 1997. *Farms, trees and farmers. Responses to agricultural intensification*. London: Earthscan Publications Ltd.

Dove, M.R. 1997. The shift in tree cover from forests to farms in Pakistan: a long and broad view. In: Arnold M. and Dewees P. 1997. *Farms, trees and farmers. Responses to agricultural intensification*. London: Earthscan Publications Ltd.

The Economist. 2009. Why farms may be the new forests: in the war against climate change, peasants are in the front line, Dec 2009.

Food and Agriculture Organization of the United Nations. 1998. *Asia-Pacific Forestry towards 2010: Report of the Asia-Pacific Forestry Sector Outlook Study*. FAO Forestry Policy and Planning Division, Rome and Regional Office for Asia and the Pacific, Bangkok.

FAO. 1999. Production Yearbook, Rome: FAO.

FAO. 2006. Global planted forests thematic study, results and analysis. Planted Forests and Trees Working Paper FP38E. Rome.

Fay, C. and G. Michon. 2005. Redressing forestry hegemony: when a forestry regulatory framework is best replaced by an agrarian one. *Forest, Trees and Livelihoods.* 15: 20, 193-209.

Franzel, S. Coe, R. Cooper, P., Place, F. and Scherr, S.J. 2001. *Assessing the adoption potential of agroforestry practices in sub-Saharan Africa.* Agricultural Systems, Vol 69: 37-62.

Freud, E. H., and Dabat, M-H. 2000. *Atelier de formation sur les methods d'analyse des marches agricoles.* Dossier methodologique CIRAD/ICRAF November 2000.

Gilmour, D. 1997. Rearranging trees in the landscape in the Middle Hills of Nepal. In Arnold, M. and Dewees, P. (1997) Farms*, trees and farmers. Responses to agricultural intensification*. London: Earthscan Publications Ltd.

GOK/IFAD. 2008. Woody biomass survey in five river basins. Mount Kenya East Pilot Project for Natural Resource Management (MKEPP). GOK Ministry of Water and Irrigation/IFAD Final Report.

Gunasena, H.P.M. 1999. Domestication of agroforestry trees in Sri Lanka. In Roshetko, J.M. and Evans, D.O. (eds), Domestication of agroforestry trees in Southeast Asia. *Forest, Farm, and Community Tree Research Reports.* Special issue 1999, pp 49-53.

Holding Anyonge C. and Roshetko, J. M. 2003. Farm-level timber production: orienting farmers towards the market. UNASYLVA 212 Vol. 54.

Holding Anyonge, C., Carsan, S., and Njuguna, P. 2006. Assessing farm tree supply in Meru. Smallholder timber and firewood marketing in the coffee and cotton/tobacco zones of eastern Mount Kenya. Paper published in conference proceedings: Small-scale forestry and rural development IUFRO Small-scale forestry 3.08 18-23 June 2006, weblink: http://www.coford.ie/media/coford/content/publications/projectreports/small-scaleforestryconference/Holding.pdf

Kenya Wildlife Service, UNEP, KFWG and University of Kent. 2003. Change in the state of conservation of Mt Kenya Forests: 1999-2002 An interim report.

Landell-Mills, N. 2002. Marketing forest environmental services – who benefits? Gatekeeper Series No. 104. London: International Institute for Environment and Development (IIED).

Magcale-Macandog, D.B.,Menz, K.,Rocamora, P.M., and Predo, C.D.1999. Smallholder timber production and marketing: the case of *Gmelina Arborea* in Claveria, Northern Mindanao, Philippines. *International Tree Crops Journal*. 10: 61-78.

Masipiguena, A.B., Masipeguena, M.D. and Groot, W.T. 2008. Over-regulated and under-marketed – smallholders and the wood economy in Isabela, the Phillipines. In Snelder Denyse J. and Rodel D. Lasco (eds). *Advances in agroforestry. smallholder tree growing for rural development and environmental services: lessons from Asia.* Dordrecht, the Netherlands Springer.

Michon, G. and J.M. Bompard. 1987. *Agroforesteries indonésiennes: contributions paysannes à la conservation des forêts naturelles et de leurs ressources.* Rev. Ecol. (Terre Vie) 42: 3-37.

MENR (Ministry of Environment and Natural Resources) 1994. *Kenya Forest Master Plan (KFMP)* Government of Kenya, Nairobi.

Muchiri, M., Miina, J. and Pukkala, T. 2001. *Yield of Grevillea robusta in the maize fields of Kenya.* Faculty of Forestry, Joensuu, Finland ISBN 952 – 458-063-2.

Nawir, A.A., Kassa, H., Sandewall, M., Dore, D., Campbell, B., Ohlsson, B., and Bekele, M. 2007. Stimulating smallholder tree planting – lessons from Africa and Asia in *UNASYLVA* 228 Vol 58 p53 -58.

Njuguna, P. and Carsan, S. 2001. Proceedings of the Forest Department, Chiefs and Farmers Representatives Seminar on Rules and Regulations Governing on Farm Timber Marketing and other Tree Products in Meru Central District. (An activity of the Meru Timber Marketing Programme-FAN/ICRAF/MARD). n.p., 29th March 2001.

Oginosako, Z., Simitu, P., Orwa, C. and Mathenge, S. 2006. Are they competing or compensating on farm? Status of indigenous and exotic tree species in a wide range of agro-ecological zones of Eastern and Central Kenya, surrounding Mt. Kenya. ICRAF Working Paper no. 16. Nairobi: World Agroforestry Centre.

Oncheiku, J. 2001. Assessment of sawn timber yields (recovery rates) of *G.robusta* from farmlands in Meru Central District, Kenya. A report commissioned for the Meru timber marketing pilot programme. KEFRI, unpublished.

Opanga, P.S. 2000. Emerging Markets for *Grevillea robusta*: farm fimber in Igioki and Ntakira locations of Meru Central District. n.p., September 2000.

Pasiecznik, N.M. and Carsan S. 2006. *Turning Trees to Timber. Report of a chain saw demonstration/training course.* HDRA UK and ICRAF Nairobi.

Place, F., Zomer, R., Kruska, R., de Wolff, T., Kristjanson, P., Staal, S. and Njuguna, E.C. 2002. 'Development pathways in medium-high potential Kenya: A meso level analysis of agricultural patterns and determinants'. Paper presented at the Conference on Policies for Sustainable Land Management in the East African Highlands, held 24-26 April 2002 in Addis Ababa, Ethiopi*a.*

Roshetko, J.M., Lasco, R.D. and Delos Angeles, M.D.. 2007. Smallholder agroforestry systems for carbon storage. *Mitigation and Adaptation Strategies for Global Change 12:219-242.*

Roshetko, J.M., Snelder, D.J., Lasco, R.D., and van Noordwijk, M. 2008. Future challenge: a paradigm shift in the forestry sector. In: Snelder, D.J. and Lasco, R. (eds). Smallholder tree growing for rural development and environmental services. pp 453-485

Russell, D. and Franzel, S. 2004. Trees of prosperity: agroforestry, markets and the African smallholder. In: Nair, P.K.R, Rao, M.R., and Buck, L.E. New vistas in agroforestry. *A compendium for the 1st World Congress of Agroforestry 2004.* Dordrecht, Netherlands: Kluwer Academic Publishers.

Scherr, S.J. 1995. Economic factors in farmer adoption of agroforestry: patterns observed in western Kenya, *World Development* 23(5): 787-804.

Scherr, S.J. 2004. Building opportunities for small farm agroforestry to supply domestic wood markets in developing countries. In: *Agroforestry Systems* 61: pp 357-370 Kluwer Academic Publishers.

Schuren, S.H.G. and Snelder D.J. 2008 Tree growing on farms in northeast Luzon (Philippines): smallholders' motivations and other determinants for adapting

agroforestry systems. In Snelder, D.J. and Lasco, R. (eds). Smallholder tree growing for rural development and environmental services. Dordrecht, the Netherlands: Springer Science, pp 75-98.

Shepherd, G. 1989 Putting trees into the farming system: land adjudication and agroforestry on the lower slopes of Mount Kenya. Network Paper 8a. ODI, Summer 1989.

Snelder, D.J. and Lasco, R. 2008 (eds). Smallholder tree growing for rural development and environmental services. Dordrecht, the Netherlands: Springer Science.

Tukan, J.C.M., Yuliyanti, Roshetko J.M., and Dudung. Darusman. 2004. Pemasaran Kayu dari Lahan Petani di Provinsi Lampung. (Marketing timber from farmers' land in Lampung Province). Agrivita 26: 131-140.

Tyndall, B. 1996. The socio-economics of *Grevillea robusta* within the coffee land use system of Kenya. Agroforestry Research Networks for Africa AFRENA, Report 109.

UNASYLVA. 2007. Small-Scale Forestry, 228 Vol 58.

Warner, K. 1997. Patterns of tree growing by farmers in eastern Africa. In: Arnold, M. and Dewees, P. 1997. Farms*, trees and farmers. Responses to agricultural intensification*. London: Earthscan Publications Ltd.

Wells, J. 2000. Competing demands for renewable natural resources in the context of rapid urbanization. Construction wood markets in four African towns Final report. South Bank University, Faculty of the Built Environment, London UK. Research project financed by DG XII of the Commission of European Communities. RTD programme: Cooperation with Third Countries and International Organisations Contract number: ERBIC18CT960101.

World Bank/IFAD/FAO. 2008. Agroforestry landscapes: gendered space, knowledge and practice. In: *Gender and Sustainable Agricultural Livelihoods Sourcebook* Module 15, Thematic Note 2. Washington, DC: World Bank.

Zomer, R., Trabucco, A., Coe, R., and Place, F. 2009. Trees on farms: analysis of global extent and geographical patterns of Agroforestry. Nairobi: World Agroforestry Centre.

Working Paper Series 2010/2011

97. Economic viability of Jatropha curcas L. plantations in Northern Tanzania- assessing farmers' prospects via cost-benefit analysis.
98. Hot spot of emission and confusion: land tenure insecurity, contested policies and competing claims in the central Kalimantan Ex-Mega Rice Project area
99. Agroforestry competences and human resources needs in the Philippines
100. CES/COS/CIS paradigms for compensation and rewards to enhance environmental Services
101. Case study approach to region-wide curriculum and teaching materials development in agroforestry education in Southeast Asia
102. Stewardship agreement to reduce emissions from deforestation and degradation (REDD): Lubuk Beringin's Hutan Desa as the first village forest in Indonesia
107. Tree domestication by ICRAF and partners in the Peruvian Amazon: lessons learned and future prospects in the domain of the Amazon Initiative eco-regional program
108. Memorias del Taller Nacional: "Iniciativas para Reducir la Deforestación en la region Andino - Amazónica", 09 de Abril del 2010. Proyecto REALU Peru
109. Percepciones sobre la Equidad y Eficiencia en la cadena de valor de REDD en Perú –Reporte de Talleres en Ucayali, San Martín y Loreto, 2009. Proyecto REALU-Perú.
110. Reducción de emisiones de todos los Usos del Suelo. Reporte del Proyecto REALU Perú Fase 1
111. Programa Alternativas a la Tumba-y-Quema (ASB) en el Perú. Informe Resumen y Síntesis de la Fase II. 2da. versión revisada
112. Estudio de las cadenas de abastecimiento de germoplasma forestal en la amazonía Boliviana
113. Biodiesel in the Amazon
114. Estudio de mercado de semillas forestales en la amazonía Colombiana
115. Estudio de las cadenas de abastecimiento de germoplasma forestal en Ecuador
116. How can systems thinking, social capital and social network analysis help programs achieve impact at scale?
117. Energy policies, forests and local communities in the Ucayali Region, Peruvian Amazon
118. NTFPs as a Source of Livelihood Diversification for Local Communities in the Batang Toru Orangutan Conservation Program
119. Studi Biodiversitas: Apakah agroforestry mampu mengkonservasi keanekaragaman hayati di DAS Konto?
120. Estimasi Karbon Tersimpan di Lahan-lahan Pertanian di DAS Konto, Jawa Timur
121. Implementasi Kaji Cepat Hidrologi (RHA) di Hulu DAS Brantas, Jawa Timur
122. Kaji Cepat Hidrologi di Daerah Aliran Sungai Krueng Peusangan, NAD,Sumatra
123. A Study of Rapid Hydrological Appraisal in the Krueng Peusangan Watershed, NAD, Sumatra

The World Agroforestry Centre is an autonomous, non-profit research organization whose vision is a rural transformation in the developing world where smallholder households strategically increase their use of trees in agricultural landscapes to improve their food security, nutrition, income, health, shelter, energy resources and environmental sustainability. The Centre generates science-base knowledge about the diverse role that trees play in agricultural landscapes, and uses its research to advance policies and practices that benefit the poor and the environment.

United Nations Avenue, Gigiri - PO Box 30677 - 00100 Nairobi, Kenya
Tel: +254 20 7224000 or via USA +1 650 833 6645
Fax: +254 20 7224001 or via USA +1 650 833 6646
www.worldagroforestry.org