Challenges and opportunities for farm forestry in Kipkaren River Catchment, Kenya.

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Abstract

Although LVEMP has been supporting farm forestry in the Lake Victoria basin since 1999 through seedling production and training of farmers on tree planting and management, there is lack of baseline information on ecological and socio-economics of these activities. A survey was therefore conducted in Kipkaren catchment area in Nandi District to determine the sustainability of private nurseries, adoption of agro-forestry practices by local farmers, and the survival and early growth of planted trees. All private tree nurseries were sampled, while multiple stage sampling was used to select 60 farmers for oral interview using semi-structured questionnaires and for tree growth assessment. The study showed that the cost of seedling production in private tree nurseries was only Kshs. 2/= compared to Kshs. 6/= in centrally managed tree nurseries. Home gardens, multipurpose tree gardens, cash and food intercrops, and trees in cropland and pasturelands were the major farm forestry practices in the catchment. *Eucalyptus saligna, Cupressus lusitanica* and *Grevillea robusta* were the most preferred tree species, and were managed mainly for timber, construction poles, fencing posts and wood fuel. Land preparation using the shamba system and weeding resulted in significantly higher survival and growth performance in both species.

Key words: Seedling production, tree planting practices, tree management, early growth.

Introduction

High population densities, intensive cultivation, repeated subdivision of family lands and rapid decrease in land available for farming are some of the major causes of soil erosion, soil nutrient depletion, and wood fuel and timber shortages in the highland areas of Kenya (Ngugi and Brabley, 1986). These problems, together with declining tree cover resulting from conversion of forests to settlements, are causing increasing concern about sustainable development of Lake Victoria basin. To remedy this situation, LVEMP has been encouraging farmers to plant trees on their farms in small woodlots and boundary planting among other practices. Thus, farm forestry (i.e. the commercial growing of trees by individual farmers on their own private land [Foley and Barnard, 1984]) is an important land use option for conserving the lake since it has the potential to take over a substantial part of the functions of indigenous and plantation forests (Dewees, 1991; KFMP, 1994). It is encouraging that farmers in Kenya, in response to loss of forest cover, have been quite successful in cultivating and managing trees in and around their farms.

The Lake Victoria Environmental Management Project (LVEMP) has, therefore, been promoting tree planting in the lake basin to improve vegetation cover, provide sustainable supply of wood products to the riparian communities and reduce pressure on woody resources in critical catchment areas. In Kenya, Elgon, Cherengani, Kakamega, North and South Nandi and Tinderet forests are the main catchments for the major river systems (i.e. Rivers Nzoia, Yala and Nyando) draining into the lake from the north. From the south, the Mau complex and Transmara forest blocks are the major catchments for Rivers Sondu, Kuja and Mara. These two catchments contribute about 70% of the total water flowing into the Lake Victoria. LVEMP

interventions in these catchments have involved seedling production, strengthening the Kenya Forest Department (FD) extension services; capacity building among local farmers in tree establishment and management, and supporting the FD in rehabilitating degraded forest reserves in important catchments. Thus far, over 3 million seedlings have been planted of which 2.5 million are in farms. Over 80% of these seedlings are *Grevillea robusta* and *Eucalyptus saligna,* which are planted in farms as woodlots, along boundaries and within homesteads.

Although LVEMP has concentrated on these strategies to maintain and increase tree cover in the catchment area, no evaluation has been done to determine the effectiveness and performance of these tree-planting efforts. To assess the social and economic conditions faced by farmers, we conducted a survey in Kipkaren River catchment in Nandi District to determine the sustainability of private nurseries, adoption of agro-forestry practices by local farmers, and the survival and early growth of planted trees. The Kipkaren catchment was chosen for the study because it is one of the major catchments for River Nzoia that flows into Lake Victoria, and was also considered representative of the ecological and social conditions found in the other catchment areas. The results of the study were intended to form a basis for formulating and prioritizing capacity building for farmers and identifying appropriate extension strategies that can be replicated in other catchments in order to improve the effectiveness of LVEMP interventions.

Methodology

Study Area

The Kipkaren catchment is located in Nandi District of Rift Valley Province. The catchment covers three administrative locations namely; Kipkaren, Ndalat and Ngenyilel locations. According to Jaetzold and Schmidt (1983), the rainfall in the area is bimodal with a mean annual rainfall of about 1500mm. The mean annual temperature is 18^0C with a maximum of 24^0C. The altitude is between 2000 - 2500m above sea level. The topography of the area is undulating. The soils are mainly Oxisols on the hill slopes and Luvisols on the valley bottoms. The socio-economy of Kipkaren catchment is predominantly smallholder mixed farming with maize as the major crop and finger millet and beans as minor crops, and some livestock rearing (Jaetzold and Schmidt, 1983). Some farmers have also integrated trees into their farming systems in different forms of agro-forestry practices, partly through efforts of the catchment afforestation program. The high population growth has also led to increased demand for wood products mainly for fuel wood and timber. The major land uses in the lake basin are rain fed smallholder mixed and large-scale farming, ranching in arid and semi arid lands, large-scale irrigation schemes and agro-forestry.

Sampling, data collection and analysis

All private tree nurseries in the Kipkaren catchment were sampled (38 in total). An in-depth questionnaire was used in a field survey through oral interview. Data for the LVEMP tree nursery was collected from nursery records and returns. The data collected included seed sources, tree species raised, sales, labor inputs, tools and equipment, water sources, pests and diseases, weed control, institutional support and management constraints experienced by the farmers. The survey was conducted using

a semi-structured questionnaire and direct observation. Farmers were selected using a cluster-sampling scheme. A total of 60 farmers were sampled for the interview. First, 20 LVEMP contact farmers were randomly selected, then two farmers neighboring each contact farmer were also selected for the study - one adjoining the contact farmer and the other at a minimum distance of 1 km from the contact farmer. Data collected included the types of species planted, how farmers use the trees, the relationship between farm size and adoption of agro-forestry practices, and the type of land use practices adopted. All *Eucalyptus saligna* and *Grevillea robusta* planted since 1999 in the farms were measured for root collar diameter, diameter at breast height, total height and survival. The land preparation method used for establishing each woodlot, border planting, farmland and homestead plantings and the survival of each stand were also recorded.

Results and discussion

Constraints and opportunities for private tree nurseries

Two types of private nurseries were identified: group nurseries and individual nurseries. Of the 38 nurseries surveyed, only 26% were group nurseries with a total capacity of 440,000 seedlings while the rest (74%) were individual nurseries with a total capacity of about 348,000 seedlings (Ogweno *et al.,* 2001). Figure 1 is an example of a tree nursery managed by an individual farmer.

Fig.1: Private tree nursery owned by an individual farmer in the Kipkaren river catchment. This type of nurseries produced cheaper seedlings than LVEMP centrally managed nursery.

The primary objective of these private nurseries was to generate cash income with the biggest proportion of seedlings produced being of exotic tree species (Table 1). The most common seedlings of exotic species were *Cupressus lusitanica, Eucalyptus*

saligna, Grevillea robusta and *Aberia caffra* while those of indigenous species are *Zizigium quineense, Prunus africana, Cordia abyssinica* and *Brachylaena huilensis.* Passion fruits, avocado, guavas and mangos were the most common fruit seedlings in the private nurseries.

Apparently, the type of seedlings raised depended mainly on growth characteristics and end uses. For example, *Eucalyptus saligna, Cupressus lusitanica and Grevillea robusta* are fast growing species and were targeted for fuelwood and timber (Ogweno *et al.,* 2001). Furthermore, seeds from these species are cheap and readily available through local collection. The disadvantage of local seed collection, however, is low quality linked to inbreeding and poor selection of trees for seed production. Thus, extension services by LVEMP should lay emphasis on educating farmers on appropriate seed sourcing techniques.

Also, there is need for more incentives to enable farmers acquire critical nursery tools and equipment. Indirect incentives would also be in the form extension services to train farmers on appropriate nursery management practices, proper selection of nursery sites, and strategies for marketing seedlings.

Table 1. The number of exotic, indigenous and fruit tree seedlings produced in private nurseries in Kipkaren Catchment area as indicated by total sales.

Exotic tree species	**Sales 2000**	**Sales 2001**	**Seedlings at nursery**
Cupressus lusitanica	35150	55210	43560
Eucalyptus saligna	33850	48970	45880
Grevillea robusta	27130	51019	26515
Aberia caffra	10200	16737	15490
Casuarina equisetifolia	0	5500	11800
Hakea saligna	9200	4800	2850
Senegalese thorn (falcata)	2360	7800	1650
Others combined	35950	36810	16785
Total	**153840**	**226846**	**164530**
Indigenous Species			
Zizigium quineense	3300	4250	10630
Prunus africana	2250	6400	6706
Cordia abyssinica	100	3020	3610
Brachylaena huilensis	800	750	4095
Markhamia lutea	100	3000	1200
Podocarpus gracillior	400	600	3016
Olea africana	700	1600	270
Palms	1200	1070	10
Sesbania sesban	600	1350	50
Others combined	39167	39753	3636
Total	**48617**	**61793**	**33223**

Table 1 (contd.)

Fruit trees			
Passion fruits	710	650	20
Avocado	200	860	110
Guavas	490	500	0
Mango (*Mangifera indica*)	180	630	60
Lemon	115	200	20
Eryabota japonica	10	10	100
Coffee (Ruiru 11)	0	0	115
Pawpaws	0	0	36
Total	**1705**	**2850**	**461**

Most nurseries surveyed (56%) raised seedlings in polythene tubes using forest soil or soil obtained from farmlands and nursery sites (Ogweno *et al*., 2001). Also, most nurseries (69%) used farmyard manure mixed with the potting soil as a cheap source of seedling nutrition. Interestingly, as much as 46% of the farmers also applied chemical fertilizers (DAP and CAN) to improve the growth vigor of the seedlings. There was prevalent use of clay soil, which is normally discouraged because of its poor aeration and drainage (Prasad, 1985). It is well understood that the fertility of the soil used for raising seedlings determines the quality of planting stock. Fertilization of the soils is important to replace lost nutrients (Driessche, 1984). This is also an area of opportunity to educate farmers on how to enhance production of high quality seedlings.

As reported by Ogweno *et al.,* (2001), the main constraints to nursery management were lack of funds for the purchase of potting materials, tools and equipment (mainly watering cans, wheelbarrows and spades), pests and diseases, and livestock damage. The other problem was associated with seed procurement of certain species, mainly *Grevillea robusta, Hakea saligna, Olea africana* and *Terminalia mentalis*. Thus, promotion of seed vending would help in sourcing for these seeds that were in low supply. This would, however require quality control measures to only high quality seeds are marketed. Nurseries owned by individuals rely mainly on family labor while group members do most activities in those owned by groups (youth and women groups). Most private nurseries (56%) engaged casual workers as opposed to LVEMP nursery that employs permanent labor for transporting soil to the nursery site, filling polythene bags with soil and pricking out. Consequently, the average cost of seedling production was only Kshs 2/= compared to Kshs 6/= for LVEMP centrally managed tree nursery (Ogweno *et al.,* 2001).

Efforts by LVEMP to promote private nurseries have been mainly through provision of seeds, nursery tools and equipment and marketing of seedlings. The institution support has reached 42 % of the nurseries that were surveyed (Ogweno *et al*., 2001). 31% of the nurseries had also received similar assistance from the Forest Department. Only 8% of the private nurseries had a problem in marketing their produce. This implies that there is great market potential for seedlings in the area. One of the key components of fostering sustainable management of the nurseries and a distribution system that is responsive to demands is to educate the farmers on appropriate nursery practices and new tree species that are responsive to local needs. It is widely

acknowledged that, public and community nurseries have a demonstration effect that could stimulate private investment, which have an important role in sustainable development of local communities. Another critical factor in nursery management is the production of quality seedlings, which is determined by careful site selection, drainage is easily controlled and which enhances other nursery activities such as watering, movement of equipment and protection against livestock damage.

Tree farming practices

Most farms in the Kipkaren catchment were smallholdings with the average farm sizes ranging between 4 - 15 acres. These farm sizes are characteristic of the whole catchment (Jaetzold and Schmidt, 1983), thus appropriate for adoption of agro-forestry practices. Eight main tree farming practices were undertaken in the Kipkaren catchment, namely; home gardens, woodlots, boundary planting, multipurpose tree gardens, cash and food crop combinations, scattered trees in croplands, and trees in pastureland as described by Imo *et al*., (2001). All households surveyed had ***home gardens*** (i.e. an intimate, multi-storey combination of various trees and crops around homesteads [Nair, 1993; Young, 1997]) although with varied levels of component diversity and richness. The home gardens in the catchment area had a characteristic multi-layered structure with bananas and fruit trees (mainly mango, avocado or lemon trees) forming the upper strata (Imo *et al.,* 2001). The middle strata were dominated by annual food crops such as maize and sorghum, together with fruits like *Annona senegalensis* and *Psidium guajava*, while the lowest strata had vegetables and root crops such as potatoes and cassava. Most of these home gardens were not protected from animals, thus management of the gardens appeared difficult during the dry season when animals graze freely.

All farmers had planted trees in ***woodlots*** (i.e. a section of the farm is set a side exclusively for tree growing [Tejwani, 1987]) mainly of exotic species such as *G. robusta, C. lusitanica* and *E. salignaas*. These woodlots were managed mainly for poles, timber and fuel Wood. ***Boundary planting*** (i.e. tree growing a long farm boundaries or demarcation within farms (Tejwani, 1987) as shown in Figure 2 was also practiced by all the farmers surveyed (Imo *et al*., 2001).

Fig. 2: Boundary planting of *Grevillea robusta* in Kipkaren catchment. About 100% of the farmers surveyed practiced this type of tree farming.

Trees in pastureland (trees growing on rangeland, in an open, mixed spatial, natural and randomly distributed, providing shelter for grazing animals, and influencing the soil and grass beneath them [Young, 1997) was practiced by 100% of the farmers surveyed (Imo *et al*., 2001). The most dominant tree species in these pasturelands were *Cordia* abyssinica*, Prunus africana* and *Erythrina tomentosa*, and had been deliberately left by the farmers to provide shade for the livestock. However, there was no deliberate attempt by the farmers to include common fodder tree species such as *Luceana diversifolia, Calliandra callothysus* and *Sesbania sesban* in their pasturelands, a strategy that would help improve the status of fodder production in the catchment.

Trees in cropland (i.e. trees are planted or are naturally left during land clearing, randomly distributed in cropped land, in an open, mixed spatial system (Young, 1997) was practiced by 60 - 80% of the farmers interviewed (Imo *et al.,* 2001). The most common practice involved leaving scattered indigenous tree species such as *Erythrina tomentosa, Cordia abyssinica* and *Croton macrostychus* on croplands with maize underneath. Apparently, a significant number of farmers disliked trees in croplands due to their shading effects on the crops. Thus, proper species selection for croplands, their arrangement and management would help make the practice more appealing hence encourage tree domestication. ***Multipurpose tree gardens*** (multispecies, multilayer dense plant associations with no organized planting arrangement [Nair, 1993; Young, 1997]) were practiced by 40 - 57% of the farmers in the Kipkaren catchment area (Imo et al. 2001). These gardens were located in agriculturally less productive sites or on sites susceptible to high erosion. Thus, these tree gardens served both economic and ecological functions. The main tree species planted under this system of agro-forestry were mainly exotics such as *Eucalyptus saligna,*

Cupressus lusitanica, Pinus patula and *Grevillea robusta*, and were planted at wide spacing to allow for grazing.

Perennial crop-tree combination (tree crops or plantation crops are grown with other annual crops, with the tree crops as the main economic output [Young, 1997] was practiced by only 20 - 40% of the farmers interviewed (Imo *et al*., 2001). The main tree cash crop planted was coffee with beans, maize or potatoes as the major under crops. The declining coffee market, however, has had an adverse effect on the management of this agro-forestry practice as most coffee trees had been left unmanaged, thereby limiting attention of the farmers on the under crop. Also, most farmers (80%) who practiced this agro-forestry system had planted *Grevillea robusta* or *Cordia abyssinica* to provide shade for the coffee trees (Figure 3).

Fig. 3: *Grevillea robusta* in coffee establishment in Kipkaren catchment. About 80% of the farmers surveyed practiced this type of tree farming.

With a revived coffee market, this practice has a potential to enhance integration of coffee, multipurpose tree species and food crops into the farming landscape in the Kipkaren catchment.

Farmers' preference for tree species

Farmers in Kipkaren catchment had varied preferences for different tree species as discussed by Imo *et al*., (2001). Among the exotic tree species, the most preferred exotic tree species were *Eucalyptus saligna* (60 - 75% of the farmers), *Cupressus lusitanica* (67 - 75% of the farmers) and *Grevillea robusta* (30 - 40% of the farmers). These trees were used mainly for timber and construction poles. These tree species were grown mainly in woodlots, a situation that is comparable to one in Embu and Meru where *G. robusta* is also planted mainly on the borders and woodlots (Spiers and Stewart, 1992). Unlike *E. saligna*, *G. robusta* was represented in all the types of planting including farmland. These findings agree with Dewees and Saxena (1995) who reported that in western Kenya, woodlots account for a substantial proportion of the total area planted with trees, mainly *Eucalyptus* spp. The most preferred indigenous trees were *Prunus africana* (70 - 91% of the farmers), *Zizigium quineense* (60 - 80%), *Erythrina tomentosa* (50 - 70%) and *Croton macrostychus* (60 - 75%), and had been retained in farmlands for timber, construction poles and firewood. In terms of tree integration into the farming systems, *Eucalyptus saligna, Acacia mearnsii, Acacia senegal* and *Cupressus lusitanica* were not preferred in croplands since they are known to reduce crop yield due to their competitive effects on crops.

Tree survival

The survival of trees planted was compared under different types of planting, land preparation for the two species explained by Matano *et al*., (2001). *Grevillea robusta* had significantly higher survival compared to *E. saligna (*83% and 70%, respectively), suggesting that higher adaptability of *G. robusta* in the area. In terms of land preparation, stands established under the shamba system had significantly higher survival compared to the stands established through simple pitting (Matano *et al*., 2001). Thus, 'shamba' system should be recommended for establishment of these trees. This method has been very successful in the establishment of Cypress, pine and Acacia plantations in Kenya' s gazetted forests (KFMP, 1994).

In terms of the type of planting, *E. saligna* planted in homesteads had higher survival compared to trees of the same species in woodlots and borders (Matano *et al.,* 2001). However, the difference between survivals in borders was not significantly different from homestead plantings. The low survival of *E. saligna* in woodlots could be attributed to the establishment of the species through simple pitting. Eucalypts are very intolerant to weeds and will perform well without weed competition in the first year (FAO, 1981), thus should be established using the shamba system. For *G. robusta*, woodlots in homesteads had better survival compared to border planting. The difference in mean survival of homesteads and woodlots were similar, but were significantly different from the mean survival of border plantings Matano *et al.,* (2001).

Tree management and early growth

The survey revealed that, early growth performance of *E. saligna* was better compared to *G. robusta* under all types of tree planting and management practices as discussed by Matano *et al*., (2001). Also, growth performance of trees increased in the following order: woodlots > homesteads > boundary plantings. Figure 4 shows a two-year woodlot of *E. saligna* with average height of 8m. In terms of tree management, the most important practices were fertilization, fencing, tree pruning, and most importantly land preparation and weeding (Matano *et al*., 2001). Fertilization was done using farmyard manure. Also, fencing to protect the trees from livestock was restricted to homestead plantings only. Although all households practiced pruning, there is need for improved pruning schedules in order to reduce shading and to improve the quality of the tree products.

Land preparation and weeding was mainly by the shamba system (where trees are intercropped with maize, beans or millet) or as single pitting (where holes are dug and tree seedlings planted), although a few farmers practiced ploughed and planted tree seedlings without intercropping. A comparison of these methods of land preparation indicated that the shamba system and ploughing resulted in higher growth of both *E. saligna and G. robusta* (Matano *et al.,* 2001). These findings agree with reports by FAO (1981) who indicated that ploughing to a depth of 10cm promotes growth of forest plantations since trees are very sensitive to weed competition. In addition, weeding had a positive effect on tree growth for both species, indicating that both species are intolerant to weed competition. Evans (1987) indicated that protection from weed competition and browse is a principle requirement for early growth. Thus, farmers should be encouraged to weed their tree crops regularly especially during early establishment

Conclusions

Results from this survey of the Kipkaren catchment suggest a number of conclusions that may also be applicable to other catchment areas within the lake Victoria Basin. First, home gardens, woodlots, boundary planting, trees in pasturelands, trees in croplands, multipurpose tree gardens and perennial-crop combinations are the most adopted agro-forestry practices in the catchment area. The majority of farmers preferred exotic tree species (*Eucalyptus saligna, Cupressus lusitanica* and *Grevillea robusta*) probably because of their high commercial value since they were managed mainly for timber, poles and fuel wood. Integration of these trees in croplands was, however, poor because of their negative effects of crops.

Secondly, it is cheaper to produce seedlings in private tree nurseries than the centrally managed LVEMP tree nursery. Thus, there is increased private investment in seedling production mainly of exotic species of *Cupressus lusitanica, Eucalyptus saligna*, *Grevillea robusta* and *Aberia caffra* and indigenous species of *Zizigium quineense, Prunus africana Cordia abyssinica, and Brachylaena huilensis.* Passion fruits, avocado, guavas and mangoes are also prevalent in the nurseries. The major constraint faced by these farmers is lack of funds for the purchase of polyphone bags; seeds and tools were identified as the main constraints in seedling production. Thirdly, proper tree management practices such as land preparation, fertilization,

pruning and weeding improved the performance of both *E. saligna* and *G. robusta* trees.

Recommendations

Farmers should be assisted in farm planning to enhance optimal allocation of land to competing land uses. Studies that optimize tree-crop-soil interactions should also be undertaken as a mechanism for enhancing integration of trees into croplands including fruit trees and fast growing fodder tree species to improve livestock production. Extension services should deliberately emphasize the commercial aspects of the agro-forestry to enhance adoption of improved agro-forestry practices within the catchment. A model for diagnosing land use problems and for recommending appropriate interventions, and monitoring and evaluating impacts of tree planting programmes in the project areas should also be developed. Institutional support through incentives such as subsidies, technical support and creation of market opportunities would boost private investment in seedling production. Although efforts by LVEMP have motivated and raised awareness on the importance of seedling production, there is need for intensification of extension services to educate the farmers on better nursery management practices for sustained production. Also, community nurseries should be expanded for demonstration purposes, as well as to find cheaper alternatives to polythene bags for porting. Finally, farmers should be encouraged to use the shamba system in establishing *E. saligna*, and regular weeding and protection of young seedling. There is need to investigate the effect of different weed management practices on early growth and survival of the tree seedlings.

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